RRS Charles Darwin

Cruise CD176

Birkenhead to Falmouth
via Rockall, Iceland and Oban

6 October to 28 October 2005

T Sherwin, J Allen, J Bicknell, G Corbel, C Embling, J Evans, I Ezzi, G Fones, P Lamont, S Mendes, D Mountifield, M Nielsdottir, P Provost, P Singhruck, M Stinchcombe

A joint SAMS / NOCS cruise led by
the Scottish Association for Marine Science

Internal Report No 248

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Rockall

(photo: Paul Provost)

Scientific crew at Rockall (missing:- John Allen, Jeff Bicknell)

Ship's officers on Trafalgar Day

Scientific crew:

Toby Sherwin	SAMS	PSO /physical oceanography
Ivan Ezzi	SAMS	Nutrients
Paul Provost	SAMS	Technical support / moorings
Peter Lamont	SAMS	Coring
John Allen	NOCS	Physical oceanography
Gary Fones	NOCS	Iron
Mark Stinchcombe	NOCS	Nutrients / oxygen
Gwenna Corbel*	ERI Thurso	Physical oceanography
Maria Nielsdottir*	NOCS	Iron
Patama Singhruck*	UEA	Physical oceanography
Sonia Mendes*	Aberdeen University	Cetacean monitoring
Clare Embling*	SMRU	Cetacean monitoring
Dougal Mountifield	UKORS	CTD support (TLO)
Jeff Bicknell	UKORS	IT support
Jez Evans	UKORS	Technical support

* PhD student

Ship's crew:

Peter	Sarjeant	Master
Peter	Reynolds	C/O
Malcolm	Graves	2/O
Kieron	Hailes	3/O
Kishorkumar	Jethwa	C/E
James	Bills	2/E
David	Ardern	3/E
Anyagou	Ogbuh	3/E
Robert	Masters	Eto
Michael	Minnock	Cpos
Michael	Drayton	Cpod
Mark	Squibb	Pod
Stewart	Barrett	S1a
David	Buffery	S1a
John	Dale	S1a
Perry	Dollery	S1a
Peter	Searle	Mm1a
Keith	Curtis	Scm
John	Haughton	Chef
Neil	Rodda	Asst. Chef
Graham	Mingay	Stwd

Summary

This report describes the events and activities that occurred during CD176, a joint SAMS / NOCS cruise on the NERC *RRS Charles Darwin* that took place in the late autumn of 2005. The principle objective of the cruise was to undertake the sampling of the Extended Ellett Line a section of CTD and bio-chemical monitoring stations that run from Ardnamurchan Point in Scotland to Rockall and on to Iceland, ending close to the volcanic island of Surtsey. Secondary objectives included making trace metal observations with a view to i) an investigation of circulation in the Rockall Trough and ii) researching the limiting role of iron in biological production in the Iceland Basin, investigating cetacean distributions and undertaking coring activities. In addition the cruise provided training and data for 5 PhD students on board and one, Clare Johnson, who was unable to join the ship. The Ellett line is a vitally important section that provides data to monitor the state of the North Atlantic. As this report shows, the cruise itself is about more than just collecting monitoring data - it also provides a ready platform for additional process studies and novel research.

In all 66 oceanic CTD stations were occupied and the ship travelled a total of about 4000 km between Birkenhead and Oban. Although a significant amount of downtime was encountered - mainly due to bad weather - the cruise was nevertheless very successful. It completed the section from Scotland to Rockall, an ADCP mooring was laid in the gully leading away from the Wyville Thomson Ridge (the 'Ellett' gully) which was mapped in detail; iron incubation measurements were made with water from the Iceland Basin; a large number of sperm whales and dolphins were heard in the Rockall Trough; the presence of acorn worms in the muds at the bottom of the Faroe-Shetland Channel was confirmed. In addition nearly all the CTD and underway sensors performed satisfactorily, and in particular the oxygen sensor on the stainless steel CTD performed very well. After much work on a neglected system on board the *Charles Darwin* the vessel mounted ADCP gave good data. And on the final leg home we carried out a very detailed survey of the water quality just above the Migulay cold water coral reef.

Given the potential for bad weather as this time of year a large amount work was achieved, and credit for this can go in no small way to the master of the ship, Peter Sarjeant, who made invaluable strategic decisions about the routing of the cruise. No group achieved all its objectives, but neither did any one come away empty handed. The major disappointment of the cruise was failing to complete the Extended part of the Ellett line in the Iceland Basin, and it was a pity that weather and time prevented the *Charles Darwin* from visiting the deep water coring site in the Rockall Trough.

Acknowledgements

This success of this cruise not only depended on the skills of the master, but also on the professionalism and good humour of the whole of the ship's crew. Most scientists only spend a very small part of their time at sea so it is particularly important to have an understanding crew. The skills of the bridge officers in holding the ship on position, of the engineers in maintaining the running of the ship's systems, of the catering staff in providing excellent food under sometimes difficult conditions, and of the ABs in operating winches and handling sensitive scientific equipment is much appreciated.

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CTD Cast summaries

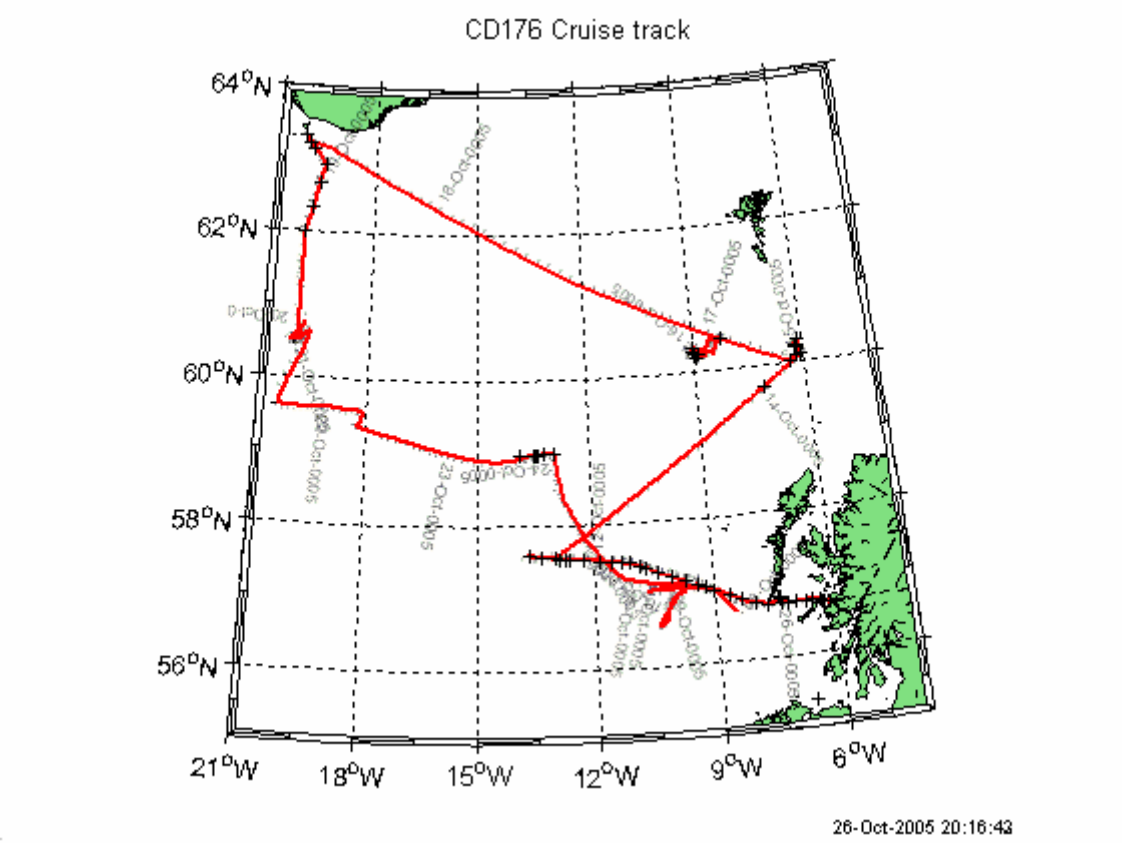
Appendix 2

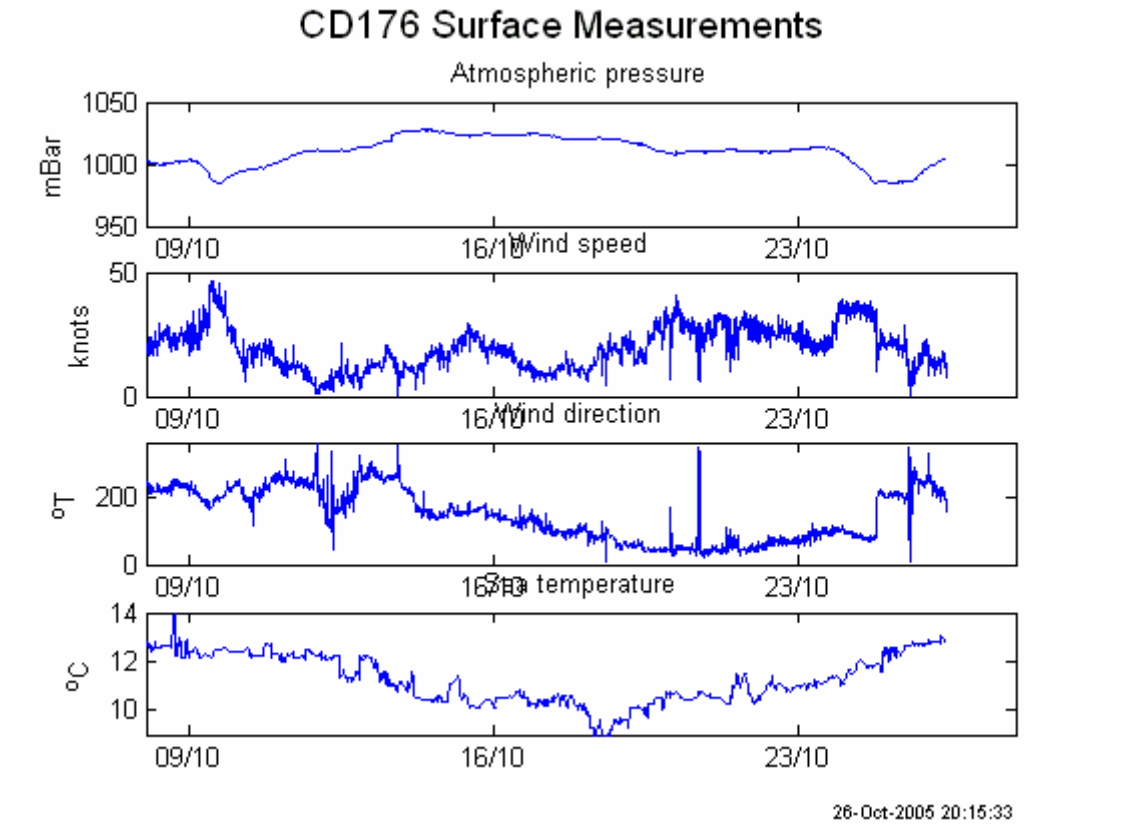
Diary of events

Chronology

Date		Location	Activity
06-Oct-05	Thursday	Birkenhead / Irish Sea	Under way
07-Oct-05		Northern Ireland	Test
08-Oct-05		Rockall Tough	Ellett line
09-Oct-05		Rockal Trough	Hove to
10-Oct-05		Rockall Trough	Hove to / Ellett line
11-Oct-05		Rockall Trough	Ellett line
12-Oct-05		Rockall	Ellett line
13-Oct-05	Thursday	Rockall Trough	Under way
14-Oct-05		Faroe Shetland Channel	Coring
15-Oct-05		Faroe Shetland Channel	Hove to
16-Oct-05		Wyville Thomson Ridge	Ellett gully mooring / survey
17-Oct-05		Iceland Basin	Under way
18-Oct-05		Iceland Basin	Extended Ellett line
19-Oct-05		Iceland Basin	Extended Ellett line / Iron
20-Oct-05	Thursday	Iceland Basin	Hove to
21-Oct-05		Iceland Basin	Under way
22-Oct-05		Hatton Bank	Under way
23-Oct-05		George Bligh Bank	Aluminium sampling
24-Oct-05		Rockall Trough	Under way
25-Oct-05		Scottish shelf	Ellett line / Mingulay reef
26-Oct-05		Scottish shelf	Ellett line
27-Oct-05	Thursday	Sound of Mull	Clearing up
28-Oct-05		Oban	Disembarkation of most staff
29-Oct-05		West coast	Packing en route
30-Oct-05		Falmouth	End of cruise

Cruise Track





1 Narrative

Toby Sherwin, SAMS

1.1 Thursday 6th October

Irish Sea. Wind: SE, F3; Sea state : slight

Left Birkenhead dockside at 1000 z and entered the Mersey heading for North Channel. Sea calm, but a poor weather prediction suggested that a rapid transit to the northern side of Ireland was advisable. Scientific and ship's crew separately advised of the plans for the cruise. ADCP (bottom tracking) and ship's underway systems switched on. Permission has not yet been granted by the Icelanders to enter their waters. Spoke to Steinar Gudlaugsson in Iceland yesterday and discovered that they are being very strict about all this. Have sent him an e-mail explaining exactly what we will be doing - basically simple CTDs.

1.2 Friday 7th October

North of Ireland. Weather: F7-9 early on, later 6. Sea state: rough near Loch Foyle, swell further offshore

On station TRIALS off Loch Foyle by 0930 z for a shakedown deployment of the CTD and other equipment in relatively calm conditions. The CTD / LADCP system was deployed to 70 m, and all bottles fired (one, no 2 failed). The CTD was recovered and watch assistants were taught how to take nutrient water samples. Clean fish deployed. At first it was too far out and compromised the safety of the ship (danger of entanglement with the propeller). It was therefore brought in until about 2-3 m below the surface at which depth it was considered safe, provided no sharp turns to starboard are undertaken. The whale watchers hydrophone was deployed, recovered and re-deployed safely. Bridge have been acquainted with the need to keep above 4 knots when the hydrophone is out and to warn the watch when the ship is 20 minutes from station. At about 1600 h left station and headed out to Sta. R near the shelf from where it is planned to work the line westward. It is intended to catch up with the inshore stations towards the end of the cruise. Received a request for further clarification of our intentions to survey in Icelandic waters from Steinar Gudlaugsson.

1.3 Saturday 8th October

Rockall Trough. Wind F5/6 increasing during the day; sea state 7

Started Ellett line at 0315z, beginning at Sta R near the shelf edge and working westward. Although conditions were rough progress was made through the first few stations with the watchkeepers gradually learning how to use the system. At Sta. P however the ship's movement in the heavy sea caused excessive loads to be placed on the hydrographic wire and in order to reduce the load it was necessary to drop the wire out speed to below 25 m per minute. Station P, which is only 1000 m deep eventually took about 5.5 h to complete. The latter part of the station was further delayed when it was discovered that the wire was crossing over whilst spooling as the CTD was raised. The misalignment of the spooling system was such that it was necessary to spool out wire to about 2300 m, and to do this the ship had to move out into deep water. The problem was eventually solved by 2045z and Darwin returned to Sta. O under worsening weather conditions. A detailed response to Steinar Gudlaugsson was prepared detailing as well as we good exactly what instruments we would be using, and emphasising once again that we had not plans to undertake a geophysical survey of any kind.

1.4 Sunday 9th October

Eastern Rockall Trough. Wind: S F7, increasing to F 9-10 late evening; sea state: very rough

(photo: John Dale)

At 0150 z the hydrophone and at 0250 z the clean fish were recovered in board in deteriorating weather conditions, and all deck operations ceased. Spent the whole day hove to whilst the winds increased to 50 knots as a depression passed towards the north-east. No work was undertaken, although the underway system continued to run and some software housework was performed.

1.5 Monday 10th October

Eastern Rockall Trough. Wind: SE F6 later 4; sea state rough, but moderating during the day.

Early morning received a further email from Steinar Gudlaugsson indicating that he was now satisfied with our intentions and that he would be recommending that we be allowed to survey in Icelandic waters. At 1115 z a test was performed on the CTD winch using a 600 kg to 600 m to check that the spooling problem had been resolved. Upon a satisfactory of this test the Ellett line was restarted at Station O at 1255 z. Although the sea was somewhat confused with two large cross swells the ship's motion was reasonably comfortable. A further problem with the CTD winch was reported during the afternoon - that of a judder with a period of approximately 5 seconds. In addition the temperature / salinity traces on the CTD looked poor with periodic 'plumes' in the trace. A close examination of this phenomenon was undertaken by the PSO who revealed that the problem was not caused by the winch but rather it was due to surging of the CTD in the relatively large swell - the pressure sensor showed that the CTD was oscillating vertically through about 4 m and creating a turbulent zone that degraded the temperature observations. The judder has been reduced by further adjustments on the CTD winch and by running it faster at depth, once enough wire has been paid out to give it sufficient weight. Station N was also completed that evening.

1.6 Tuesday 11th October

Central Rockall Trough, Anton Dohrn. Wind: SE F4; sea state: moderate

Stations M to J were completed by 1100 z and Charles Darwin then moved on to 57° 25.19' N, 11° 8.23' W to a current meter mooring that had been deployed by FRS and which we had been asked to recover since they had been unable to reach it due to bad weather earlier on. The acoustic release was detected and released. Unfortunately it failed to rise, and a series of tests indicated that it was lying on its side at the bottom. After 2 hours of trying, a report was sent to FRS and the release and its associated current meters were left for them to recover at some later date. In the afternoon a review was undertaken of the procedures for bottle sampling as it was apparent that on some stations where aluminium was taken that the whole procedure was taking longer than the time to travel between stations. There was particular concern that within the next 24 h we would be encountering 4 stations at the edge of the Rockall Bank that required a lot of aluminium measurements and that will take a long time to sample. A list of reserve watch keepers was made up who can be called on to speed up the work.

1.7 Wednesday 12th October

Anton Dohrn to Rockall. Wind E F2; sea state: slight.

Rapid progress was made along the western part of the original Ellett line to Rockall, and stations F to A were completed. An extra station, D1 (1468 m), was added on the Rockall shelf edge in an attempt to detect Wyville Thomson Ridge overflow water. The altimeter gave an intermittent problem, which is believed to due to the age of a connector which loses its credibility in cold deep water. The rate of sampling has been speeded up, particularly in aluminium stations by having 3 samplers and a scribe, at least during aluminium stations, and taking filtered aluminium (the slowest part of the process) immediately after oxygen. The problem of speed of sampling is only really apparent when stations are very close together. A problem with the nutrient auto-analyser was detected, and it may be necessary to proceed with filtered samples. Help is being sought from Dunstaffnage. The swath bathymetry was run over the Rockall shelf edge, although the whale watchers reported that it interfered with their listening programme. The PSO is having difficulty persuading the watch keepers to keep a proper log, and a minor change to the arrangements was made with Gwenna Corbel taking over leadership of the 4-8 watch (much to the relief of the incumbent).

Between 1630 and 1730 BST we came close to Rockall. Since the conditions were very calm, Captain Sarjeant very kindly brought the ship close into the Rock on its southern side so that we could get a good view. This was a highpoint of the cruise - the rock itself is extremely small, no bigger than a house, and the opportunity was much appreciated by the scientific staff.

Earlier the captain was informed of a forecast of extremely bad weather conditions forecast for the Iceland Basin, and in view of this it was decided to break off from the Ellett line at Rockall and make for the Wyville Thomson ridge where the winds were forecast to be less severe. The ability to use plots of this forecast was useful in appraising all scientific of the need for this strategy. At 2100 z we set a course towards the NE.

1.8 Thursday 13th October

Rockall to south of Wyville Thomson Ridge. Wind F3-4; sea state 2.

On passage from Rockall, moving at well over 10 knots. Discovered that a random bug exists for all LADCP data up to CTD020 (i.e. all the Ellett Line). Will have to see if shows

up in the plotted data. Switched from RDI version 16.27 back to 16.18. The whale watchers reported a large number of sperm whales from their hydrophones particularly in the deep water near Rockall Bank. Reached the southern coring site (WTSa) at 1930z, and deployed Megacorer. Although good coring conditions had been encountered at this site in the previous years, this time the Megacorer failed to provide any samples, and after 5 attempts (including moving to another site nearby) this location was abandoned midnight in preference to the northern site whilst god conditions prevailed.

1.9 Friday 14th October

North of Wyville Thomson Ridge. Wind F4 rising to F7 before midnight; sea state: moderate swell

Part of the main lab on *Charles Darwin* with the CTD control system on the right, and showing the entrance to the computing laboratory. Jez and Paul between cores.

Arrived at coring Sta. WTNb1 at 0440z. This time 18 excellent core tubes were recovered from three deployments and Megacoring was completed by 0815z. At about 0800z a large group of pilot whales were sighted passing very close to the side of the ship. A CTD section was undertaken across the Faroe-Shetland Channel to collect a background aluminium profile (with supporting CTD section) and to allow the coring team to have some rest before returning to WTNb1 with the box corer. Box coring proceeded under gradually deteriorating conditions with everyone very mindful of the difficulty of managing the large NIOZ corer in confined conditions on the starboard side of the ship. After three perfect box cores were recovered box coring ceased at 0100z.

1.10 Saturday 15th October

North of the Wyville Thomson Ridge. Wind S F7-8 decreasing; sea state: heavy swell

Finished the Faroe-Shetland Channel section (Stas FSC3 and FSC4) and then sailed to the western end of the Wyville Thomson Ridge to Sta. FSC5. Arriving there it was discovered that the clash of the directions of the heavy SW swell and strong winds made it impossible to hold station and Darwin hove to until early evening when conditions had moderated sufficiently to allow us to start CTD work

1.11 Sunday 16th October

Western end of Wyville Thomson Ridge. Wind SE F4-5; sea state: moderate swell reducing during the day

Undertook a combined CTD section and swath survey across the western end of the deep gully that runs down the southern side of the WTR. The total time for this section (from D0 to D7) was excessive, being about 13.5 hours for 7 stations with a total length of 9 miles and a typical depth of 750 m. The reason for this is the very slow running of the CTD winch which at times was typically being run at 20 m/min. At this rate it will take 4 days to run the extended part of the Ellett line rather than three. We have an alternative on board (the TOBI winch), but although RSU told me we could use it if we needed it, UKORS do not want us to because any damage to the fibre optic cable could jeopardise work planned for the HERMES project in the near future. It's a money / turf wars thing, which I shall slug out until I'm forced to give in. I have asked Andy Louch at RSU to get us permission to use the TOBI deep tow winch. The ADCP was successfully deployed at 1457z in the gully. I'm not sure if it's gone in the best position - the recorded depth was 1125 m, but just 2 cables to the south it was 1170 m. The currents near the sea bed were of order 1.5 m s^{-1} westward so the instrument may well have landed a kilometre or two to the west of this position. After this Darwin undertook a zigzag course swathing the gully up towards the ridge, and at 2230z after Sta FSC5 had been completed just north of the WTR we set a course of WNW towards Iceland. Still no word from SAMS about the autoanalyser.

1.12 Monday 17th October

Faroe Shetland Channel to Iceland Basin. Wind F5; sea state: slight swell

Underway to the northern end of the Extended Ellett Line (Rockall to Surtsey extension). Hydrophone was retracted at 1430z as we entered Icelandic waters. Set up a phase of regular e-mail correspondence awaiting a response from RSU about the TOBI winch. This when it came in was pretty much as expected, a lot of prevarication preceding a statement that we could only use the TOBI winch if the other one breaks down. However, Jez Evans, the UKORS TLO, is under instruction not to use the cable. We need clearer advice than this - what happens if the system breaks down outside working hours? Have set Mark Inall and Ken Jones onto the case for SAMS.

1.13 Tuesday 18th October

SE Iceland. Wind E F4 -F6 later; sea state: slight to moderate

Arrived at the northern end of the Extended Ellett line at 1245z. In consultation with John Allen, we agreed to rearrange this end, which as it stands keeps straight on the 20° W longitude and pays no regard to the orientation of the bathymetry. Four stations, IB19 to IB22, were scratched and replaced with five others, IB19s to IB23s. The extra station was included to give better coverage of the shelf slope region, in order to provide the capability of monitoring the deep Arctic outflow. Not for the first time the Thematic Chart (C6566) appeared to be more accurate than the navigation chart (on which the station positions were based). Station IB22s, which should have been in 500 m was found to be in about 650 m, and should be moved further north another time. A problem with the link to the slave LADCP meant that only the downward looking instrument was used on Stas IB22s and IB23s. Ken is still trying to get RSU/UKORS to agree to allow us to decide when and if we should use the TOBI deep tow winch. So far they are prevaricating. We have finally given up any hope of using the auto-analyser again on this cruise and will resort to filtering and freezing nutrient samples.

1.14 Wednesday 19th October

Iceland Basin. Wind NE F5-F7; sea state: moderate to rough

This morning woke to find that for the first time on this cruise we were actually on or about the station I had expected to be. Winch is veering and hauling at about 60 m/min in moderate sea conditions. At 1130z swapped from the stainless frame to a titanium frame for Stas IB16 to IB12 to allow iron measurements to be made. LADCP measurements will not be undertaken until we swap back to the stainless frame. Note: it was subsequently discovered that the oxygen sensor was not functioning properly, and these data will have to be discarded. At 1430z I received an e-mail from Colin Day offering us a couple of extra days at the end of the cruise, but I have turned it down - it would have been a logistical nightmare that would have burnt up all our remaining energy. At about 2000z a single Argo float was deployed by Jeff at Sta. IB15 (see photo). This evening the winds are building towards a predicted F7, and gusting F8. With wind and seas both running from the NE it was agreed to steam south to Sta. IB15 and either recommence the line there, or heave to.

1.15 Thursday 20 October 2005

Iceland Basin. Wind: NE F7-8; sea state rough

RRS Charles Darwin remained hove to all day near Sta. IB15. At times it seemed possible that conditions might abate enough to continue the Extended Ellett Line, but this never happened.

1.16 Friday 21 October 2005

Iceland Basin. Wind: NE F7-8; sea state rough

At 0800z with conditions and forecasts remaining unchanged it was decided at a meeting between the Captain, PS, TLO and John Allen to abandon the stations in the central Iceland Basin and move south to Sta. IB9 (NW of Hatton Bank). The situation will be reviewed once we get there. It now appears to be impossible to get to a deep coring site at 55° N, which was on the SAMS Deep Sea Benthic Group's wish list for the cruise. Progress through the water was very slow - at 1330 z we crossed south of Icelandic waters and into 'unprotected' waters. However, conditions were too rough to deploy the whale watchers' hydrophone so we continued making surface measurements only. Celebrated the 200th anniversary of the Battle of Trafalgar in the bar with a glass of rum courtesy of the 2nd Mate, who made a little speech to a group of us about Lord Nelson. Today's forecasts for Saturday and Sunday look worse than they did yesterday.

1.17 Saturday 22 October 2005

Iceland Basin - Rockall Plateau. Wind NE F6-7; sea state moderate to rough

Very little change in the weather. At another 0800 z meeting it was agreed to continue east in the hope of finding better conditions to the east of Hatton Bank. The swell continues to be

too rough to deploy the hydrophone, but the swath was used to map the seabed beneath our track on the Hatton Bank for JNCC as we headed for Rockall. At 1400 z a further analysis of the weather suggested that the only chance for doing any work in the west of the Rockall Trough was at George Bligh Bank, and course was altered in that direction. Speed over the ground in the present NE swell is limited to about 5 knots.

Non-stop in the main lab. Mark, Patama, Maria, Clare, Paul, John (asleep again), Sonia.

1.18 Sunday 23 October 2005

George Bligh Bank. Wind E 5-6; sea state moderate

We're working again today! At about midday we arrived over George Bligh Bank to find that the sea had gone down sufficiently that we could move the stainless frame into position under the hydrographic winch and put it over the side. Since then we've worked eastward down the slope and part way out towards Rosemary Bank, conducting Aluminium sampling particularly close to the sea bed. Hydrophone was also put over the stern, and for a while we also swathed the eastern side of George Bligh Bank. The depression expected from the SW has slowed down and we were in position to take advantage of the opportunity. As the evening approached the captain suggested that we could also consider working Rockall Bank to the south of the present line. Have decided to try it tonight, having discussed options with John Allen.

1.19 Monday 24 October 2005

Rockall Trough trying to make the Malin Shelf. Wind SE 7-8; sea state rough

At midnight weather conditions had deteriorated to an extent that the captain ordered the cessation of scientific activities. All day we crawled at 4 to 5 knots SE towards Sta. R at the shelf edge of the Scottish shelf Ellett line stations.

1.20 Tuesday October 25th

Scottish Shelf. Wind SE F4, later W F3. Sea state moderate to slight

At 0715 z we arrived and started the inshore section of the Ellett line. Station R had been conducted at the beginning of the cruise and was now repeated to create a formal ending to the inshore section. The inshore line of Ellett line CTD station was then commenced, but in order to rationalise the amount of work done every other station was dropped up to Barra Head, and a new station 16G was introduced to replace Stas S and 15G. At 1630 z we broke off the Ellett line sampling to go to Migulay Reef to undertake a near bottom CTD survey for Lyndsey Dodds, a SAMS PhD student. Very precise position fixing was required for this survey since the reef covers a small area, about 1.5 by 0.5 nm and she'd quoted us positions to the nearest 15 cm! (As Ivan said "which bit of the CTD does she want over the sampling site?!").

1.21 Wednesday 26 October

Sound of Mull. Wind: F4; sea state slight

Continued working the inshore end of the Ellett line to Sta. 1G opposite Ardmore Point at the northern end of the Sound of Mull. At 0830 z the final CTD station was completed, the non-toxic supply was switched off and the surfmet sampling system switched off. The gathering of scientific data ceased, but salinity calibrations, data processing and reporting continued.

1.22 Postscript

At the end of the cruise we discovered that Sonia and Clare had been making a video of the cruise 'CD176 - the Movie'. The video was shown to everyone on the last night of the cruise, and was very well received by staff - it provides an excellent backdrop to the cruise itself. Anyone interested in seeing it should contact one of the scientific staff.

2 Passive acoustic survey for cetaceans in the Northeast Atlantic

Clare Embling, SMRU and Sónia Mendes, Aberdeen University

This passive acoustic survey for cetaceans forms part of two PhD projects studying the foraging ecology of sperm whales (Sónia Mendes), and modelling the distribution & relative abundance of sperm whales and dolphins using measurable environmental variables (Clare Embling) in Northeast Atlantic waters. The latter project is part of a larger study funded by the Defence Science and Technology Laboratory (DSTL) to produce predicted distribution maps for marine mammals based on measurable environmental variables. These maps will be used by the military during exercises off the west coast of Scotland to minimize the effects of such operations on marine mammals in the area.

Passive acoustic surveys for cetaceans were carried out in the Northeast Atlantic from the RRS Charles Darwin between the 6th and the 28th of October 2005. Surveys were conducted using a towed hydrophone array (0.2-250kHz). The hydrophone array was towed between standard hydrographic stations along the Ellet Line, parts of the Wyville-Thompson Ridge and George Bligh standard hydrographic lines, where travel time between stations exceeded 30 minutes. Towed array surveys were also carried out during transits between hydrographic lines, mega-coring and box-coring locations, moorings deployment and recovery sites. Around 99 hours of acoustic monitoring effort were carried out which corresponds to around 1500 km. Two-minute listening stations were carried out each 15 minutes. In total, 395 listening stations were made. Sperm whales were detected in 28.4% of all stations (Fig. 2.1) and dolphin species (which includes pilot whales) were detected in 44.6% of all stations (Fig. 2.2). There were also 8 sightings, three of pilot whales groups, one of three sperm whales, one unidentified whale blow (fin or sei whale), two sightings of unidentified dolphin species, and we were joined by a group of common dolphins following the vessel for 4 hours on the last night of surveying. Recordings were automatically made for 30 seconds every 2 minutes together with long continuous recordings carried out when in the presence of whales or dolphins either vocalizing close to the vessel or emitting unusual sounds. Further data collection was hampered both by very poor sea conditions, and not receiving permission to monitor for whales within Icelandic waters along the Extended Ellet Line.

The detection rates of sperm whales (28% of the time) and dolphins (45% of the time) are exceptionally high in comparison to other surveys carried out in the area. Every year since 2000, we have also been involved in twice yearly oceanographic surveys of the Faroe-Shetland Channel waters which usually have very low detection rates of sperm whales at the same time of year – last year this was only 3%. This survey has also been unique in the type of vocalizations detected from sperm whales – including codas (short click trains that are associated with social communication between animals), buzzes (associated with feeding behaviour), and long rapid click trains that have not been heard from sperm whales in this area before (to our knowledge). There were also an unusually high density of low frequency (2-6 kHz) whistles (assumed to be pilot whales) and fewer high frequency (>10 kHz) whistles (dolphins) than usual.

Low frequency recordings (0.0001-0.2 kHz) were made using sonobuoys deployed at hydrographic stations in water depths greater than 300m. 27 sonobuoys were deployed. Post processing of these recordings will be carried out by René Swift in order to detect vocalizations of baleen whales.

It is planned that the towed hydrophone array data will be analysed by Sónia Mendes (Aberdeen University), and Clare Embling (Sea Mammal Research Unit) independently as

part of their PhD research projects, as detailed earlier. Both studies will be integrating the acoustic cetacean data with the oceanographic data collected during the cruise, in order both to understand foraging habitats of sperm whales & to produce predictive models of both sperm whale and dolphin distributions.

Clare, Sonia and their winch

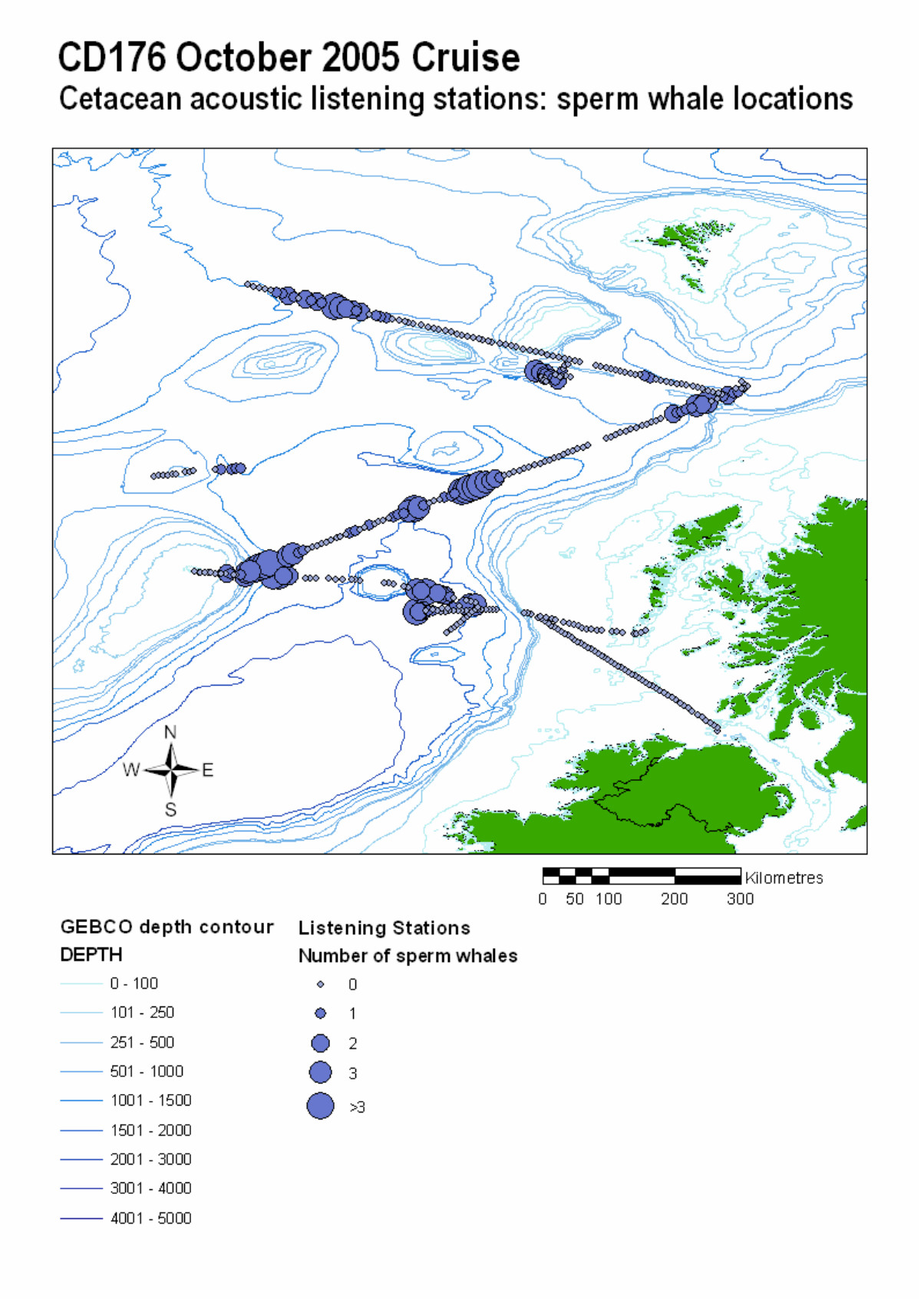


Fig. 2.1 Sperm whale summary

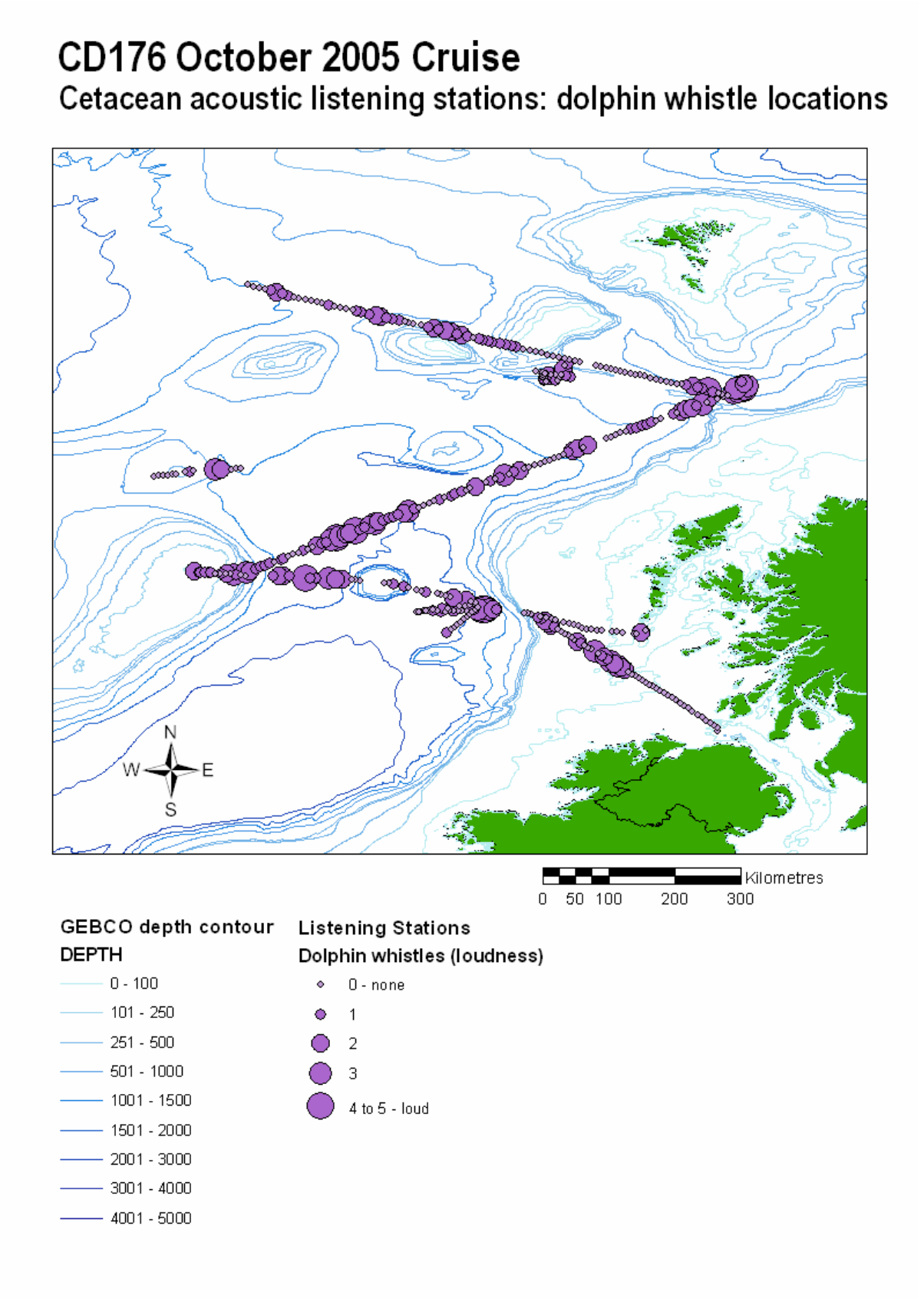


Fig. 2.2. Dolphin summary

3 Coring report

Paul G. Provost, SAMS

3.1 Coring apparatus

Bowers and Connelly Mega corer

Core size 110x800mm (LxØ).

The mega corer was used to collect undisturbed surface sediment samples for biological, chemical and physical analyses.

NIOZ Box Corer

Core size 500x500x550mm (L,W,D)

The box corer was used to collected undisturbed samples for biological analysis.

The hydraulically damped action of the mega corer on sediment penetration is thought retain the very fine floc material and biota that can be lost from the sample caused by the turbulence at the sediment-seawater interface by other corers (for example, the box corer).

3.2 Method

The mega corer was deployed from the vessel using the starboard midships gantry. The veer (drop) speed was approximately 60 m/min to approximately 50m above seabed. The winch was stopped for approximately 30 seconds for wire to settle and then dropped at 15-25 m/min into seabed. Once the corer had landed onto the seabed, 10-15m of additional wire was paid out (depending on sea conditions) and the corer was allowed to rest on the seabed for 2 minutes to allow the hydraulic firing action of the corer to complete. The wire was then hauled to recover the corer. Therefore in total the corer sat for approximately 3 minutes on the seabed. The haul (recovery) speed was up to 65m/min.

The box corer was deployed from the vessel using the starboard midships gantry. The veer (drop) speed was approximately 60 m/min to approximately 50m above seabed. The winch was stopped for approximately 30 seconds for wire to settle and then dropped at 15-25 m/min into seabed. Once the corer had landed onto the seabed, 5m of additional wire was paid out and then the wire was immediately hauled to complete the mechanical action of the corer. The haul (recovery) speed was up to 65m/min.

3.3 Results

7 mega corer deployments were made during the cruise. The corer was set up to collect from 4 of the core tube positions to increase sediment depth penetration at the Wyville Thompson ridge Southern site. Every drop produced at least one satisfactory undisturbed core. At the Wyville Thompson ridge Northern site, the sediment was less cohesive and allowed greater corer penetration which allowed 6 core tube positions to be used. At this site a full compliment of successful undisturbed cores were collected.

3 box corer deployments were made during the cruise. All deployments were made at the Wyville Thompson ridge Northern site and each drop produced successful undisturbed cores.

4 Benthic sampling

Peter Lamont, SAMS

There were three objectives for benthic sampling, two of which were achieved. These were a) to obtain replicate megacores from both sides of the Wyville Thomson ridge and b) to obtain boxcores from the north side for acorn worms. The third objective of repeating five 1975 boxcores from the SAMS Permanent Station (2900 m) was not possible mainly because of weather and also logistics.

Wyville Thomson South (59° 42.90'N 07° 09.00W) was cored first with very limited success due to firm sediment. Penetration of the core tubes was poor (typically < 15 cm) even when only four cores were fitted to the corer. Five cores were obtained from the last three of four deployments. At Wyville Thomson North, core penetration was normal and fifteen good cores were obtained some exceeding 30 cm sediment depth.

4.1 Methods

Megacores were either horizontally sliced at 1,2,2,5,5,5 cm (0-1, 1-3, 3-5, 5-10, 10-15 and 15-20 cm horizons) or sliced at 10 and 10 cm (0-10 and 10-20cm) . Sediment was placed in 4% formaldehyde solution in seawater to fix invertebrate fauna, for a minimum of two days before washing on a 250 micron sieve and transferring to 80% alcohol for preservation. Relative core positions on the megacore frame were recorded as Roman numerals for clarity, running anticlockwise.

Boxcore surfaces (NIOZ pattern) were photographed and obvious fauna picked off for separate fixing and preservation. Once the box side was removed, the 0-2 cm layer was cut away for washing, fixing and preservation (250 micron fraction). The 0-2 cm layer in box 1197 was washed fresh, but, in boxes 1198 and 1199, was fixed first, while from box 1199 the 2-5 cm layer was also fixed and preserved.

All boxcores were picked apart with trowel and spatula to find acorn worms and any other fauna, particularly burrowing annelids. Depths of burrows were noted and sometimes photographed while tubes were collected and also any specimens encountered. All cores taken are summarized in Table 4.1.

4.2 Results

Only five short cores were obtained from the WTS site. Little fauna was observed in these megacores apart from some small annelid tubes on the surface of MGC1193 core I.

Three megacorer deployments at WTN yielded 3, 6 and 6 cores respectively from soft mud. Pycnogonids, ophiuroids and cumaceans were frequently seen on the core surfaces and fine burrows were observed below the 20 cm limit. Accordingly, core MGC1196 VI, was in addition sliced to 30 cm sediment depth.

WTN boxcores were typically full of sediment to within 7-8 cm of the box top providing plenty of depth for observations of burrows.

Five acorn worms were recovered for preservation in alcohol for genetics analysis for comparison with *Stereobalanus Canadensis* reported from the Norwegian Sea. Other specimens will probably be present in the washed, unsorted sediment retained in formaldehyde. A fine specimen of burrowing echinoid, Fig. 4.1 was obtained from NBC1199 as was also a nemertean worm c180 mm long by c3.5 mm wide Fig. 4.2. The latter was placed in alcohol to permit genetics analysis. NBC1199 also contained a relatively large pycnogonid of about 40 mm leg span. This, and another smaller specimen, were

maintained alive in a fridge until 25th October. Maldanid polychaete tubes were observed forming a 'U' shape in one case, Fig. 4.3, extending to c16 cm depth and a total observed length of about 41 cm. The example illustrated had been cut by the box side on the right of the photograph. The outer surface of this and other maldanid tubes observed had a rust red colouring at around 5-15 cm sediment depth. Several relatively large spionid polychaetes (c8omm long by 5mm wide) were obtained from NBC1199 just below the 5 cm horizon. In places in all boxcores, fine burrows were observed extending to below 30 cm. Some annelid fragments were extracted from these fine burrows and placed in alcohol.

In NBC1197 the test remains of five echinoids in close proximity to each other were observed at c30 cm sediment depth together with the remains of a gastropod. A single similar urchin test, illustrated in Fig. 4.4, was also observed in NBC1199 at 8 cm depth in the sediment. Most of the test plates from this specimen were recovered to a vial (No.823) and preserved in alcohol.

As usual with macrofauna, full results will only be obtained once the samples are sorted and identified in the laboratory. Other photographs taken are contained in the cruise photos CDrom with file names corresponding to the relevant sample information.

Fig. 4.1 Burrowing echinoid, NBC1199

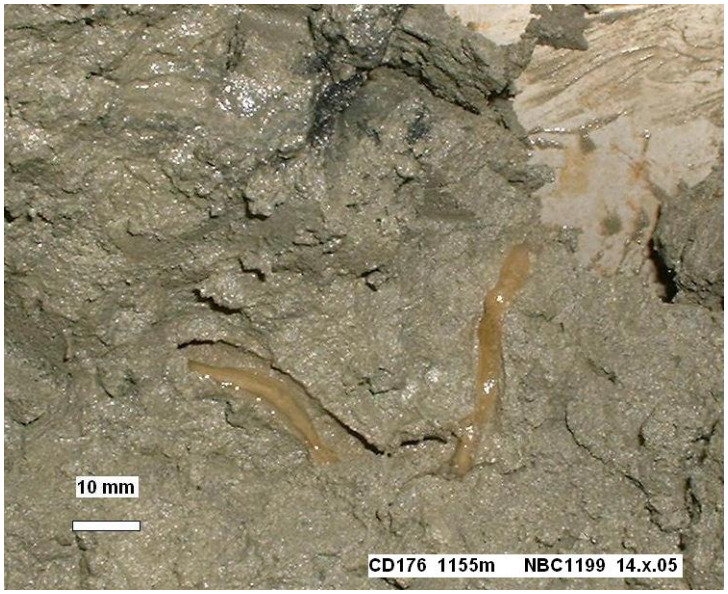


Fig. 4.2 Nemertean worm in situ, NBC1199

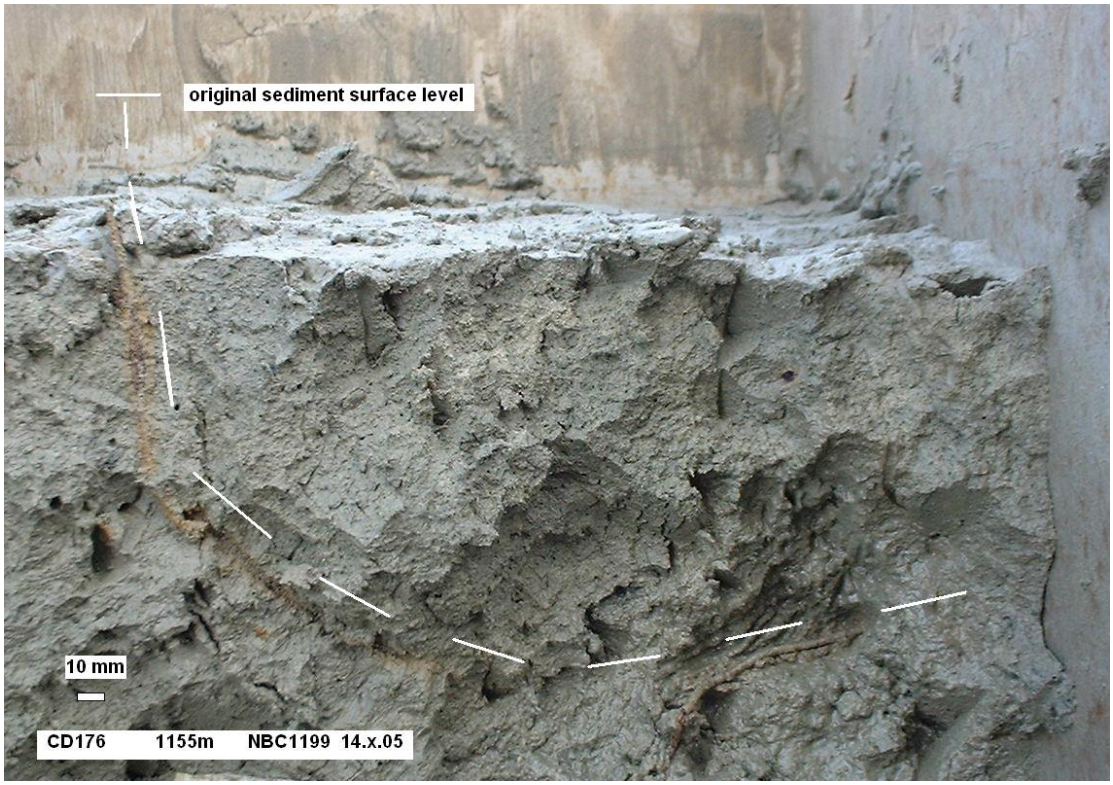


Fig. 4.3 Maldanid (Polychaeta, Maldanidae) tube indicated by the dashed white line. The sediment surface has been removed at 5 cm depth and also the left hand section of the tube. The rust red stain traces its route and another part of the tube can be seen to the right before meeting the boxcore side where it has been cut as the core box penetrated the sediment. NBC1199

Fig. 4.4 Echinoid test at 8 cm sediment depth, NBC1199 Fig. 4.5 An Acorn worm

Table 4.1

Event No.	Water depth	Gear	SAMS No.	Date (yy.mm.dd)	Notes
#22	1094	MGC	1191	05.10.13	I @ 1,2,2,5,4 - to 14 cm. One core only, poor penetration (14cm).
#23	1093	MGC	1192	05.10.13	II @ 1,2,2,5,?; V @ 1,2,2,5,?
#24	1093	MGC	1193	05.10.13	I @ 1,2,2,5; V @ 10, 10 (bubbled)
#25	1153	MGC	1194	05.10.14	I, II, V @ 1,2,2,5,5,5
#26	1154	MGC	1195	05.10.14	I,V,II,VIII @ 1,2,2,5,5,5; IV, V(?) @ 10,10
#27	1154	MGC	1196	05.10.14	I,II,IV,VIII @ 1,2,2,5,5,5; V @ 10,10; VI @ 10, 10, 10.
#31	1158	NBC	1197	05.10.14	0 - 2 cm sieved fresh, 250 micron
#32	1159	NBC	1198	05.10.14	0 - 2 cm formalin, sieved, 250 micron
#33	1155	NBC	1199	05.10.14	0 - 5 cm formalin then sieved, 250 micron; excellent core, fauna rich, photographs

5 Swath bathymetry

Toby Sherwin, SAMS, and Jeff Bicknell, UKORS

Four brief swath bathymetry surveys were conducted during the cruise, on Rockall, over the Ellett gully, across the Hatton Bank and on the eastern flank of the George Bligh Bank. Except for the Ellett gully, where an informal area survey was conducted, the surveys simply comprised opportunistic strips that were collected beneath the ship's track as she travelled from one station to the next. No attempt was made to calibrate or validate the data which have been treated 'as found'. Data from both Ellett gully and George Bligh Bank surveys have been converted into Ascii and are provided on the accompanying DVD.

The Rockall Bank survey took place on the Rockall Shelf itself and did not reveal any particularly interesting features. Several steep scarps can be seen in the lower flanks of the George Bligh Bank. The Hatton Bank data were collected at the request of JNCC, but at first sight did not suggest any unusual features.

The Ascii files from the survey of the Ellett gully have been used in conjunction with bathymetric data collect from an earlier *Scotia* cruise, and from an even earlier survey by Dave Ellett of SAMS to produce a new bathymetric chart of the gully. All data were pooled into squares of 0.005° latitude and 0.01° longitude (i.e. about 500 m square) before being gridded with a Krigging technique and plotted with Surfer. Whilst the southern side of the gully appears to be fairly uniform, the degree of indentation of the northern side where several 'tributaries' feed down from the Faroe Bank is surprising (see Fig. 5.1). It can be seen that the ADCP was placed about 1 km upstream of a deep hole that is over 1400 m deep at 60.245° N, 8.91° W.

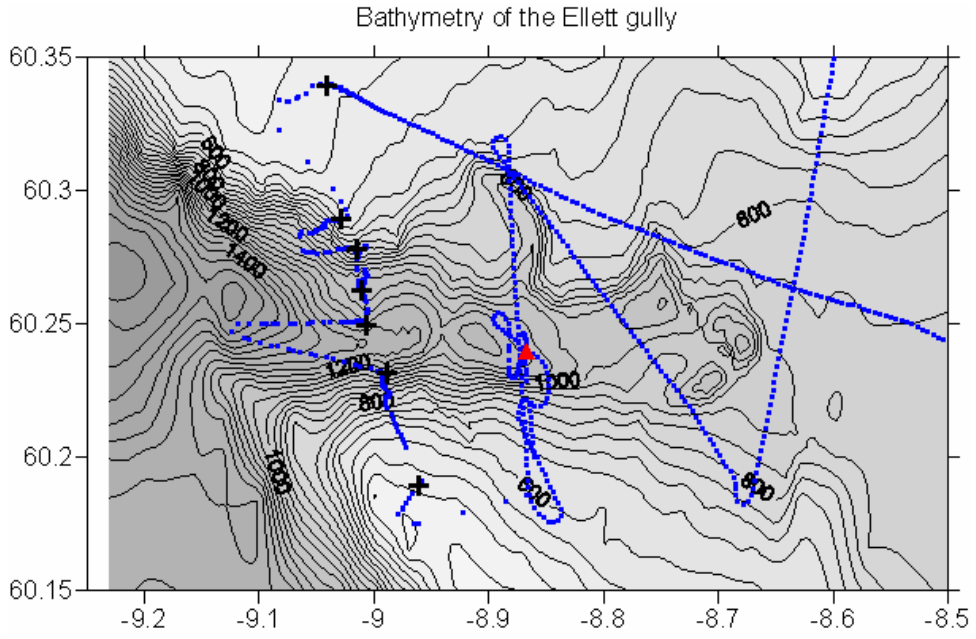


Fig. 5.1. Ship's track in blue. Swath was not used along the approach to D0 from ESE, but was used elsewhere. The red diamond shows the position of the ADCP mooring.

6 UKORS Instrumentation

Dougal Mountifield, UKORS

6.1 CTD Operations

A total of 66 CTD casts were undertaken on the cruise, 64 of which used the stainless steel frame and 2 used the titanium frame.

6.1.1 Stainless Steel CTD Frame

The stainless steel frame configuration was as follows:

• Sea-Bird 9/11 *plus* CTD System

• 24 by 10L Ocean Test Equipment External Spring Water Samplers

• Sea-Bird 43 Oxygen Sensor

• Chelsea MKIII Aquatracka Fluorometer

• Chelsea MKII Alphatracka 10cm path Transmissometer (low Vair at start of cruise)

• Wetlabs BBRTD Back Scatter Sensor (removed due to connector flooding problems)

• OED LADCP Pressure Case Battery Pack

• RD Instruments Workhorse 300 KHz Lowered ADCP (downward-looking master configuration)

• RD Instruments Workhorse 300 KHz Lowered ADCP (upward-looking slave configuration)

• PML/RVS PAR Sensors (DWIRR and UWIRR) (removed for casts deeper than 500m)

• Benthos Altimeter

The pressure sensor is located 30cm from the bottom of the water samplers, and 119 cm from the top of the water samplers. This frame was used for the majority of casts where clean Fe work was not being undertaken. Notably even though it has several aluminium pressure cases it was used for Al sampling.

6.1.2 Stainless Steel CTD Frame Instrument Configuration

The Sea-Bird CTD configuration for the stainless steel frame was as follows:

• SBE 9 plus Underwater unit s/n 09P-37898-0782

• Frequency 0—SBE 3P Temperature Sensor s/n 03P-4151 (primary)

• Frequency 1—SBE 4C Conductivity Sensor s/n 04C-3054 (primary)

• Frequency 2—Digiquartz Temperature Compensated Pressure Sensor s/n 94756

• Frequency 3—SBE 3P Temperature Sensor s/n 03P-4105 (secondary)

• Frequency 4—SBE 4C Conductivity Sensor s/n 04C-2580 (secondary)

• SBE 5T Submersible Pump s/n 05T-2793

• SBE 5T Submersible Pump s/n 05T-3609

• SBE 32 Carousel 24 Position Pylon s/n 32-19817-0243

• SBE 11 plus Deck Unit s/n 11P-24680-0587

The auxiliary A/D output channels were configured as below:

• V1 --- SBE 43 Oxygen s/n 43B-0709

• V2 --- Benthos Altimeter s/n 874

• V3 --- Chelsea MKIII Aquatracka Fluorometer s/n 88-2050-095 (088095)

• V4 --- PML/RVS PAR DWIRR s/n 10

• V5 --- PML/RVS PAR UWIRR s/n 11

• V6 --- WetLabs Back Scatter Sensor BBRTD s/n 115R

• V7 --- Chelsea MKII Alphatracka 10cm path Transmissometer s/n 161050

The additional self-logging instruments were configured as follows:

• RDI Workhorse 300 KHz Lowered ADCP (downward-looking master configuration) s/n 1855

• RDI Workhorse 300 KHz Lowered ADCP (upward-looking slave configuration) s/n 5415

The LADCPs were powered by the NOC battery pack s/n WH004 installed on the CTD frame.

6.1.3 Stainless Steel CTD Frame Deployment Notes

The main Seabird instrument configuration file for this frame was '0782_SS.con'. This was used by the master PC with an NMEA navigation feed.

On test cast CTD001 rosette position 2 did not fire. The carousel was cleaned and no further problems were encountered.

The Wetlabs BBRTD read 0V throughout cast CTD001 – 004. After this the BBRTD was removed from the frame as there was no requirement for its use from the science party. Hence no useful BBRTD data from the SS frame for this cruise. Suspect problem caused by connector flooding. Due to requirements to work deeper than 500m UWIRR and DWIRR PAR sensors were removed prior to CTD004. CTD001-003 were in the dark hence no useful PAR data for this cruise. PAR data for Fe work by Gary Fones taken from Surfmet system.

On Jday 280 the 10cm transmissometer was cleaned and air and blank readings were taken at Vair =4.111V and Vblank=0.015V. The air reading was around 0.34V lower than last cal and bench test. Subsequent cleaning on Jday 286 gave Vair=4.433V and Vblank=0.018V which are nearly the same as last cal and bench test. Suspect lenses were fouled by oil film prior to Jday 286. Note that transmission readings were often >100%.

On Jday 284 the fluorometer suffered from excessive spiking. Inspection revealed dissolved power pin caused by connector flooding. Aluminium Break-Out Box (BOB) removed for inspection and replacement of damaged bulkhead connector. Titanium BOB run on SS frame to maintain CTD ops during repair of Al BOB. Al BOB refitted to SS frame on Jday 290 (CTD034 onwards). Damaged fluorometer cable replaced.

Slave (up-looking) LADCP had zero length file for cast CTD013. Suspect script file was sent at 115200 baud instead of 9600. Master (down-looking) LADCP unit crashed during data download of CTD020. Rebooting the unit allowed recovery of the cast data with no problems. At the start of the cruise the LADCP firmware was updated to v16.27. A bug report that was received from RDI Instruments mid cruise prompted the downgrading of both units to v16.18 from cast CTD021 onwards. Slave LADCP suffered loss of communications for casts CTD034 and 35. The problem was traced to a damaged 'star' cable which was

replaced with a spare for CTD036 onwards. Hence no LADCP slave data for casts 34 & 35. The slave LADCP produced an erroneously short file (9kb for CTD060) the cause of which is unknown. The LADCPs were not run for the 5 Mingulay coral stations (CTD053-057), or for some of the shallow shelf stations (CTD061-065) as the water depth was sufficiently shallow to rely solely on the VMADCP.

Frequent problems were encountered with the BOB connector for the altimeter (V2) flooding, resulting in loss of altimetry. When this happened casts were stopped further from the bottom than the requirement of 10m to ensure the safety of the package. A 10kHz pinger was fitted to the SS frame for a few casts as a backup for the altimeter. The PSO was unhappy with its proximity to the master LADCP and requested its removal. Nearer the end of the cruise the altimeter problems improved. Perhaps the cold bottom waters (-0.5 deg C) that were being worked in contributed to poor connector sealing. Soft bottom substrates were frequently encountered, resulting in reduced altimetry range of 20-30m.

There was a repeat cast at station FSC2 due to bottle bottoms not sealing properly (CTD022).

Seabird CTD software on both master and slave deckunit PCs was upgraded to v5.35 on Jday 289 following problems with crashing.

SS frame swapped out for Ti for casts CTD041 and 042. SS casts continued from CTD043 onwards.

All SS CTD sensors remained onboard for use during CD177.

6.1.4 Titanium CTD Frame

The titanium frame configuration was as follows:

• Sea-Bird 9/11 *plus* CTD system

• 24 by 10L Ocean Test Equipment External Spring Trace-metal Water Samplers

• Sea-Bird 43 Oxygen Sensor (poor data caused by suspected torn membrane)

• Chelsea MKIII Aquatracka Fluorometer

• Chelsea MKII Alphatracka 10cm path Transmissometer

• Wetlabs BBRTD Light Scatter Sensor

• Benthos Altimeter (swapped from SS frame for Ti casts)

The pressure sensor is located 30cm from the bottom of the water samplers, and 119 cm from the top of the water samplers. This frame was used for Fe trace metal work.

This was a recently manufactured frame and had its first deployment during this cruise with no problems.

6.1.5 Titanium CTD Frame Instrument Configuration

The Titanium Sea-Bird CTD configuration was as follows:

• SBE 9 *plus* Underwater Unit s/n 09P-34173-0758

• Frequency 0—SBE 3P Temperature Sensor s/n 03P-2729 (primary)

• Frequency 1—SBE 4C Conductivity Sensor s/n 04C-2165 (primary)

• Frequency 2—Digiquartz Temperature Compensated Pressure Sensor s/n 90074

• Frequency 3—SBE 3P Temperature Sensor s/n 03P-2728 (secondary)

• Frequency 4—SBE 4C Conductivity Sensor s/n 04C-2164 (secondary)

• SBE 5T Submersible Pump s/n 05T-3002

• SBE 5T Submersible Pump s/n 05T-3085

• SBE 32 Carousel 24 Position Pylon s/n 32-24680-0346

• SBE 11 *plus* Deck Unit s/n 11P-24680-0587

The auxiliary A/D output channels were configured as below:

• V0 --- SBE 43 Oxygen s/n 43B-0612

• V2 --- Benthos Altimeter s/n 874

• V3 --- Chelsea MKIII Aquatracka Fluorometer s/n 088242

• V6 --- WetLabs BBRTD Light Scatter Sensor s/n 183

• V7 --- Chelsea MKII Alphatracka 25cm path Transmissometer s/n 161048

6.1.6 Titanium CTD Frame Deployment Notes

The main Seabird instrument configuration file for this frame was '0758_ti.con'. This frame was used for casts CTD041 and CTD042.

Expectedly due to the very small number of deployments (two) of this frame, few problems were encountered. The main problem was a lack of altimetry caused by flooding of the Break-Out Box (BOB) connector. Due to only one altimeter being available, this was swapped between the SS and Ti frames as necessary.

Due to altimeter problems on CTD041 in addition to fluorometer spiking, the altimeter was moved from V2 to V4 and the fluorometer moved from V3 to V5 for cast CTD042. A new Seabird instrument configuration (con) file was created '0758_ti_Alt_Fluo.con' for this cast. There was some spiking of the transmissometer during CTD042.

Trial of rubber encapsulated lanyard ferrules on the TM-free bottles successful with coating remaining intact.

The SBE43 dissolved oxygen sensor fitted to this frame was found to be damaged with a suspected punctured membrane. Hence oxygen data from casts CTD041 and 42 is of no use. The damaged sensor was returned to SBE post-cruise for repair and recalibration. Both temperature and conductivity sensor pairs used on this frame were returned to SBE for 6 month calibration after the cruise.

6.2 Surface Sampling and Meterology (SurfMet) System

SurfMet, the UKORS surface water & meteorological suite of instrumentation was run for the duration of the cruise.

6.2.1 Surfmet System Instrument Configuration

The SurfMet system comprises:

• Transmissometer – Seatech – s/n T-1019D

• Fluorometer – Wetlabs W3S s/n 134

• Conductivity sensor – FSI OCM s/n 1333

• Temperature sensor in bow pickup – FSI OTM s/n 1370

• Temperature sensor in TSG housing – FSI OTM s/n 1361

• Air Temperature and Relative Humidity sensor – Vaisala HMP44L s/n S 5040001

• Atmospheric Pressure – Vaisala PTB100A s/n S3440012

• Port and Starboard PAR sensors – DRP5 s/n's 5143 and 5144

• Port and Starboard TIR sensors – Kipp & Zonen TIR s/n's 962276 and 962301

• Wind direction – Vaisala WAV vane s/n 22306

• Wind speed – Vaisala VAA anemometer s/n 21213

The SurfMet system is controlled via a LabView program running on a desktop PC and logged at 30 second intervals to the ship's central datalogging (ABC) System.

6.2.2 Surfmet System Operation Notes

The flow through the surfmet underway system was stopped on day 279 for several hours to repair a significant leak in the transmissometer flow through tube assembly that was allowing air to enter causing bubbles in the tube. The tube was repaired and the flow restarted at approx 2300 GMT.

The non-toxic was also stopped for an hour by the ships engineers to service a valve early in the cruise.

The science party drew regular discrete samples from the TSG outflow for salinity and fluorometry calibrations.

6.3 Salinometry

An Autosal 8400B salinometer (s/n 68426) was used on this cruise to process approximately 150 samples either from the CTD casts or the underway non-toxic supply. The salinometer was located in the Constant Temperature Laboratory and operated at 21°C bath temperature and 20°C to 20.5°C ambient lab temperature. The samples were run manually by the science party. All samples were processed according to WOCE standards and protocols.

Discrete samples for calibrating the SurfMet TSG were taken from the outflow of the TSG in the Wetlab.

6.4 Miscellaneous

The 150 kHz UKORS vessel mounted ADCP and EM12 Swath Bathymetry system was run during the cruise and their data included by the UKORS Computing Engineer in the main cruise archive.

CTD Frame

7 CTD surveys

Toby Sherwin, SAMS, Patama Singhruck, UEA and Paul Provost, SAMS

7.1 Summary

A total of 66 CTD profiles using a Seabird SBE19 system were conducted during CD176. The performance of the system, which was very good, is described elsewhere in this report; here we confine ourselves to a few comments about the results. The data were processed using standard Seabird software, and have subsequently been plotted using Matlab software. The section contour plots shown here and on the DVD are admittedly a little crude, but nevertheless they show the main features of the region. All CTD data, with associated calibration coefficients where appropriate will be transferred to BODC for archiving.

The principle sections that were completed were i) Ellett line (Rockall Trough), ii) Ellett line (Scottish shelf), iii) Section D across the Ellett gully, iv) the eastern flank of the George Bligh Bank. In addition the northern extent of the Extended Ellett line, where it crosses the Faroe Bank Channel and Iceland Faroe Ridge overflows, was completed, although it was not possible to work south of 60° N because of bad weather. The inability to complete the southern end of the Extended Ellett line to Rockall is the major omission of this cruise. Finally brief surveys of the Faroe Shetland Channel and the cold water coral reef at Mingulay were conducted.

7.2 Individual sections

7.2.1 Rockall Trough

By and large the Rockall Trough section revealed a typical picture (Figs 7.1, 7.2). Some of the salient features are: water on the eastern side of the Trough was warmer and saltier than that on the western side; beneath the seasonal surface layer a relatively saline core centred on about 350 m was found close to the Scottish Shelf; there was a salinity minimum at about 1800 m indicative of Labrador Sea Water; density surfaces sloped upwards on the Rockall Bank suggesting the southward movement of water on that side; a pronounced oxygen minimum was observed at 1000 m that was slightly deeper and more intense on the eastern side. A TS plot for Sta M in the deepest part of the Trough suggests that the water mass distribution seems to closer to the May 1998 than the Oct 1996 situation described by Holliday (2003, ICES Marine Science Symposia). Thus ENAW still predominates in the eastern part of the North Atlantic.

7.2.2 Section D, Ellett gully

The LADCP data show clear evidence of a strong westward flowing bottom current. There is also evidence of a geostrophic tilt in the CTD profiles, with the interface between warm and cold water being about 40 m deeper in the centre of the channel (D4) than on the northern side (D3) - see also Fig. 7.3.

7.2.3 Northern end of Extended Ellett line

This section, from 62° N appears to have captured the Faroe Bank Channel overflow as it passes around the Icelandic Shelf edge at a depth of about 1000 m. Further south, at 60 ° N, the survey appears to have passed through a cold core mesoscale eddy.

7.2.4 George Bligh Bank

This section was chosen in the hope that it might be possible to detect the Wyville Thomson Ridge overflow. The 7° isotherm is slightly higher in the west, which suggests a southward flow around the base of the bank, but there is no strong evidence of the overflow. This section will await further intensive investigation back home.

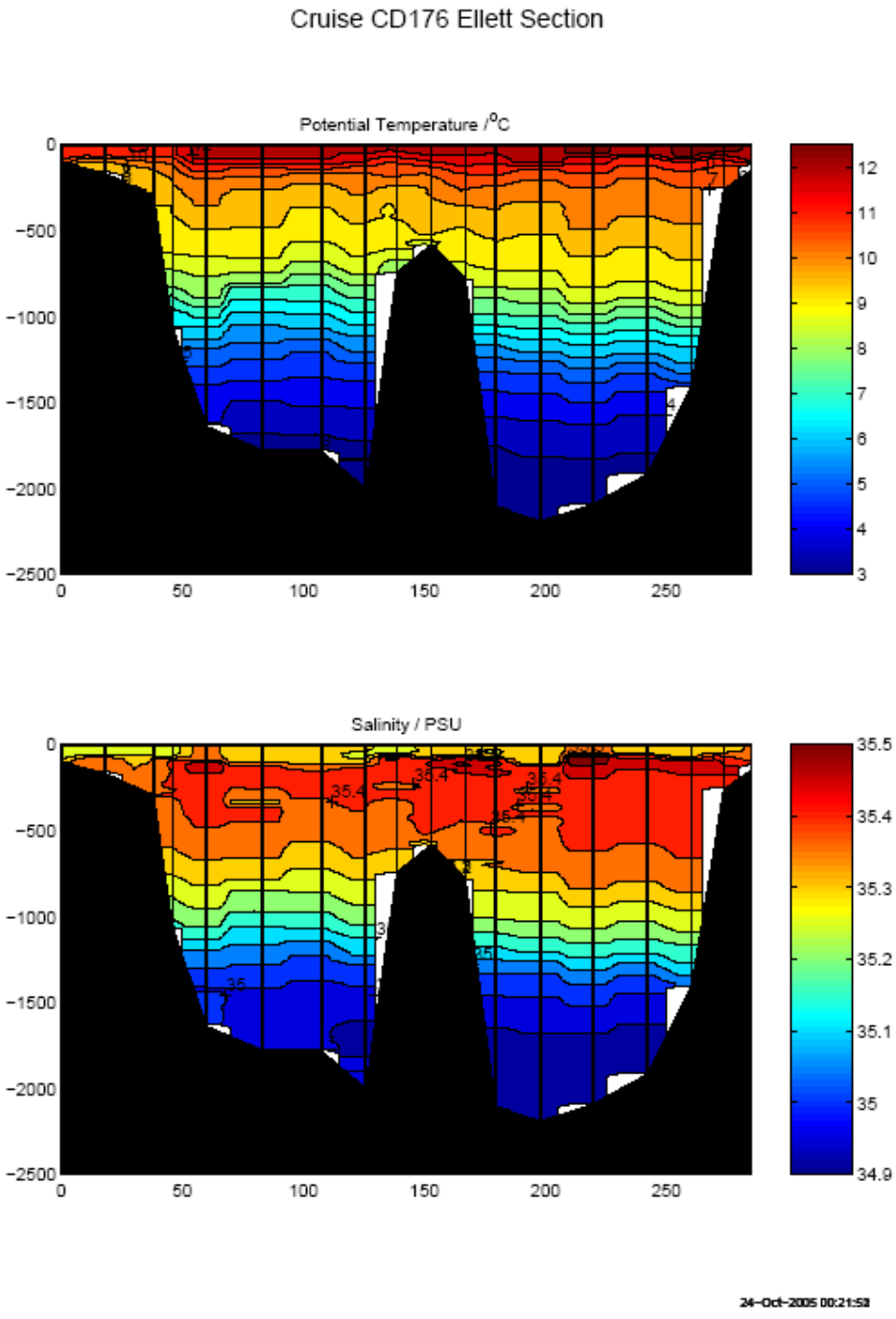


Fig. 7.1. Temperature and salinity sections across the Rockall Trough. Rockall Bank is on LHS and the Anton Dohrn Seamount in the centre.

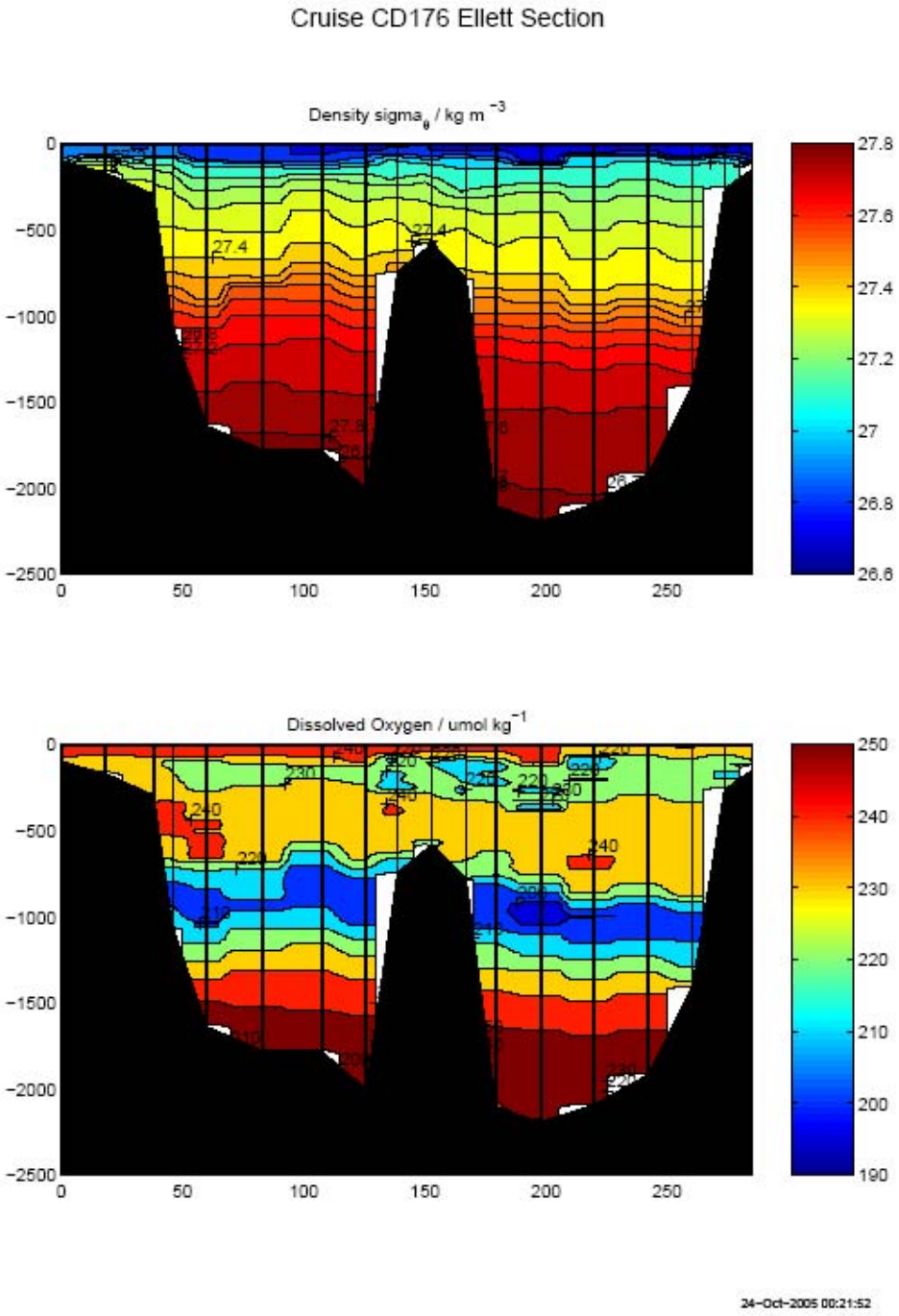


Fig. 7.2. Density and dissolved oxygen sections across the Rockall Trough

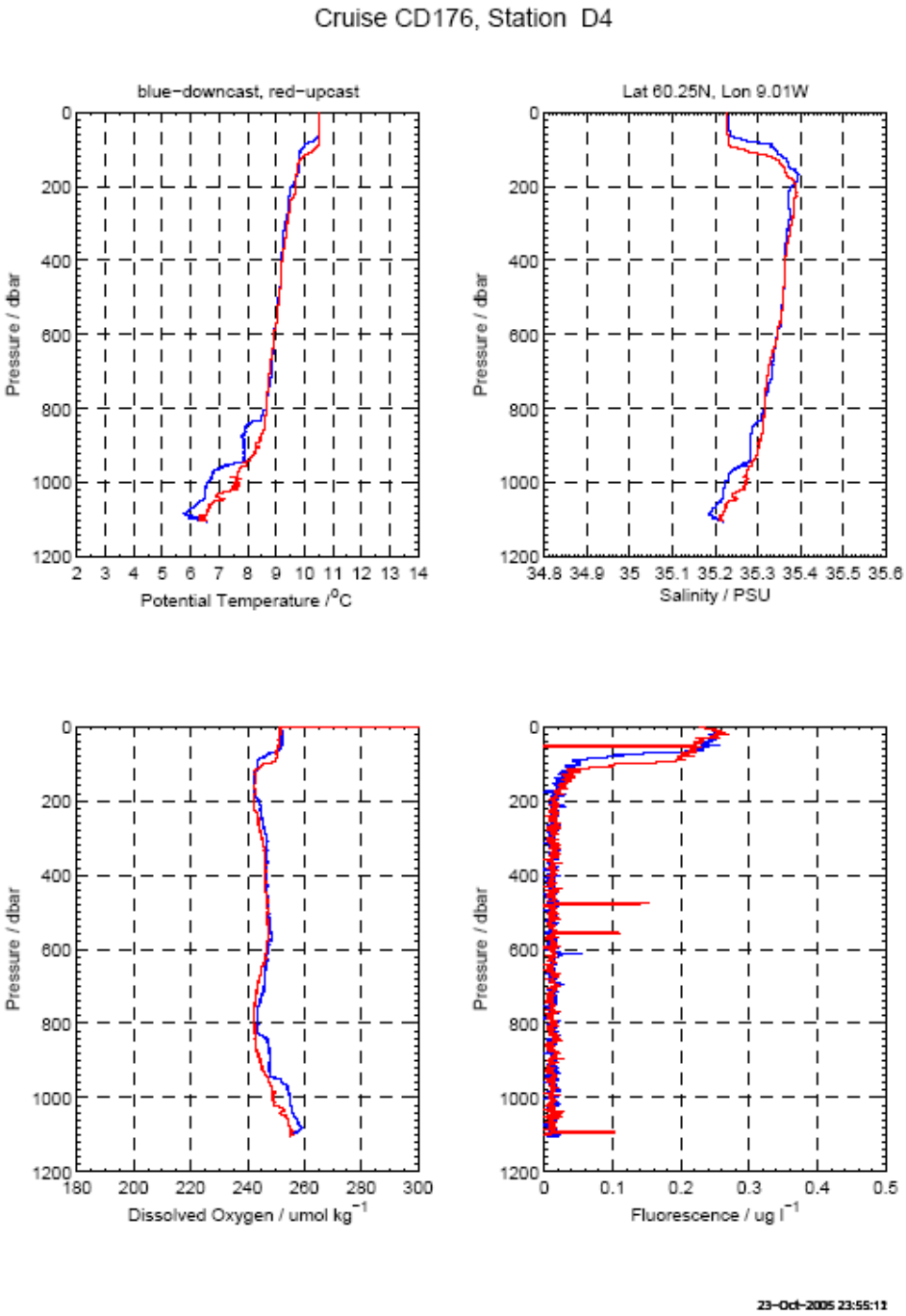


Fig. 7.3. Profiles of the main CTD parameters in the Ellett gully. The LADCP profile from this station is shown elsewhere.

7.3 CTD salinity calibration

The final calibration of the CTD sensor on the stainless frame is given below (Fig. 14.1). The calibration samples were measured in the constant temperature laboratory on *Charles Darwin.*

If S_A is the actual salinity and S_M the measured salinity then

$$S_A = 0.9803 S_M + 0.7044$$

with a correlation coefficient of $R^2 = 0.9955$

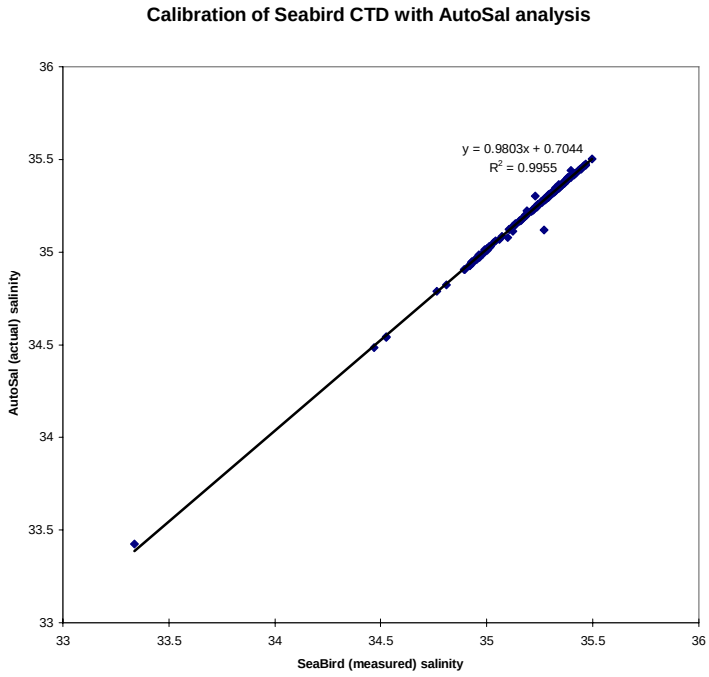


Fig. 14.1. CTD salinity calibration curve.

Note that at the time of the production of this report the calibration curve for the CTD on the titanium frame (CTD041 and CTD042 only) is not available.

8 Dissolved inorganic nutrients: chlorophyll: particulate organic carbon (POC).

Ivan Ezzi, SAMS

8.1 Introduction

As part of the general suite of parameters measured at the Ellett line time series monitoring stations chlorophyll biomass is measured along with the primary nutrients and organic carbon content. Water was collected at CTD stations as detailed in "CTD sheets" for analysis both on board and at SAMS. Samples were taken at depths corresponding to discernible water masses or areas exhibiting raised or lowered values as determined from the CTD fluorescence, temperature, salinity and oxygen traces.

8.2 Nutrients

Water samples were analysed on board for dissolved inorganic nutrients ammonia, phosphate, silicate and nitrate. Samples were removed from CTD Niskin bottles and either run directly on the autoanlyser or stored in refrigerator for analysis later. After the first four days of CTD stations the autosampler on the autoanalyser developed a fault and the instrument was no longer usable. Thereafter all samples were filtered and frozen for analysis at SAMS.

Below are some typical results from a deep water station. All results will be lodged with BODC.

Depth	Ammonium	Phosphate	Silicate	NO3,NO2
m	uM	uM	uM	uM
5	0.53	0.35	0.31	5.42
30	0.49	0.36	0.35	5.49
90	0.37	0.49	1.34	8.05
150	0.55	0.58	2.15	9.55
300	0.58	0.71	3.83	11.99
500	0.27	0.78	4.78	12.72
850	0.23	1.06	9.28	16.90
1200	0.32	1.08	10.31	16.96
1600	0.07	1.07	11.18	16.73
1800	0.31	1.06	12.63	16.51
1900	0.30	1.07	14.84	16.72
2005	0.40	1.07	17.65	16.94

8.3 Chorophyll

Water samples were filtered and frozen for later HPLC analysis at SAMS. Chlorophyll pigments A and B would be determined. Samples were also taken from the non-toxic sea water supply at the thermosalinograph to be used for calibration of underway fluorimeter.

8.4 Particulate organic carbon

Water samples were filtered and frozen for later carbon analysis at SAMS.

9 Dissolved Oxygen analysis

Mark Stinchcombe, NOCS

9.1 Introduction

Dissolved oxygen measurements were required to calibrate the oxygen sensor on the CTD frame. To do this, the 10litre Niskin bottles on the CTD framed were fired to take water samples from various depths of each CTD profile. The water was then analysed for dissolved oxygen using a Winkler titration technique and these values were compared to the values given by the CTD oxygen sensor. Between 3 and 18 bottles were fired on each cast depending on the depth of the water at that station and the detail on the oxygen trace from the sensor on the CTD frame.

9.2 Method

Sampling procedure – Oxygen samples were drawn off first from the CTD Niskin bottles. All fired bottles were samples, except when two bottles were fired at one depth, in which case only one sample per depth was sampled for. To sample, a piece of rubber tubing, approximately 10cm long, was attached to the Niskin bottle nozzle. The tube was put to the bottom of the oxygen bottle and then the screw cap was released to allow the water to flow. The water was allowed to overflow the bottle until it had been flushed by approximately 3 times the volume of water required to fill it. Then the nozzle was closed again and the tubing carefully removed to prevent any drips or bubbles forming. The temperature of the water was then measured and noted.

Analysis – Straight from sampling, the sample is fixed. Using automatic dispensers that have brought out to the CTD, 1ml of manganese chloride (600g/l solution) was added (the tip of the dispenser being inserted to just below the water level to prevent bubbles being introduced into the sample), followed by 1ml of alkaline iodide (320g/l sodium hydroxide solution mixed with 600g/l sodium iodide solution). The lid is placed on the bottle (making sure no bubbles are in the sample) and the bottle is thoroughly shaken. A precipitate of manganese (II) and (III) hydroxides forms. Let this settle and give the sample another shake approximately 30 minutes after the sample was taken. Let the precipitate settle out again. Take the lid off and add 1ml sulphuric acid (280ml/l sulphuric acid solution) and a magnetic stirring bar, put the sample on the stirrer in the Dissolved oxygen Analyser (DOA). Stir until the precipitate has gone and a clear yellow iodine solution is formed. Insert the pipette from the automated burette and set the DOA running. The automated burette will slowly add a sodium thiosulphate solution (25g/l solution). The DOA will then titrate the sample until the iodine solution has been reduced to a colourless iodide and tetrathionate solution. Note down the amount of titre required to titrate the sample, add this to the oxygen bottle spread sheet, along with the temperature of the sample when it was sampled, and the spreadsheet will produce the amount of dissolved oxygen in the sample in umoles per litre.

CTD's sampled – The CTD's sampled for dissolved oxygen were 001 test, 002 R, 003 Q, 004 P, 005 O, 006 N, 007 M, 008 L, 009 K, 010 J, 011 I, 012 H, 013 G, 014 F, 015 E, 016 D1, 017 D, 018 A, 019 B, 022 FSC2, 030 D4, 033 FSC5, 034 IB22S, 035 IB23S, 036 IB21S, 037 IB20S, 038 IB19S, 039 IB18S, 040 IB17, 041 IB16, 042 IB15, 043 GB2, 044 GB3, 045 GB4, 046 GB5, 047 GB6, 048 R, 049 16G and 050 T.

9.3 Comparison of O2 sensor against discreet sampling

Two main plots have been drawn to show the relationship between the O2 sensor on the CTD frame and the discreet samples. Figure 9.1 shows the O2 concentration as determined by the sensor plotted against the concentration of O2 as determined by Winkler titration. Figure 9.2 is the difference between the O2 concentration as determined by the Winkler titration and the O2 concentration as determined by the sensor, plotted over time, to gain an understanding of how the sensor was performing over time and the amount of drift that occurred during the cruise.

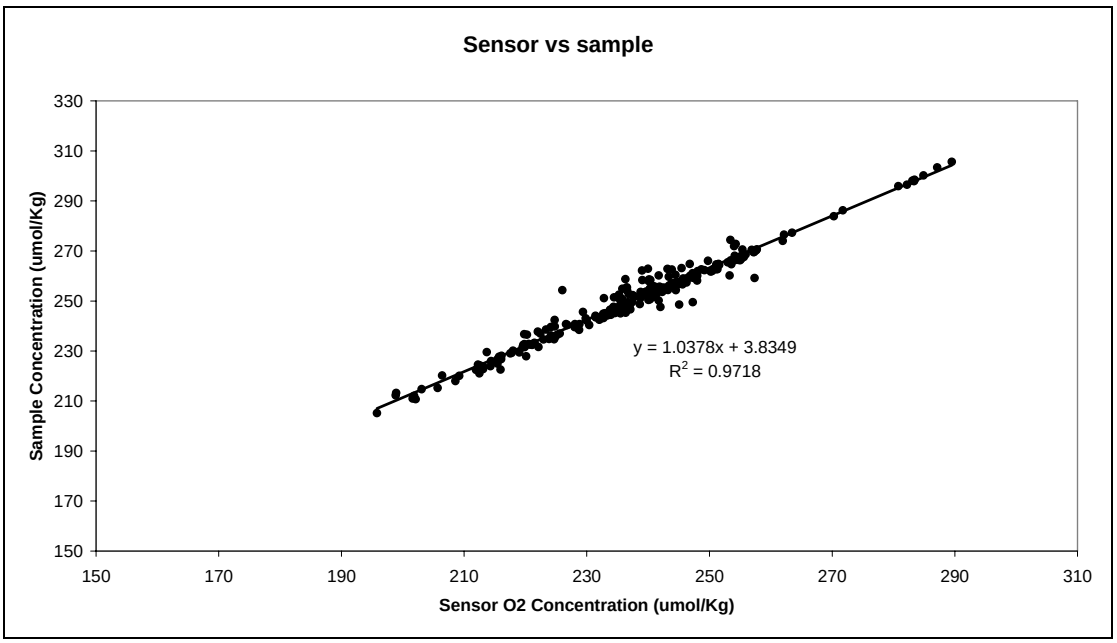


Fig. 9.1.

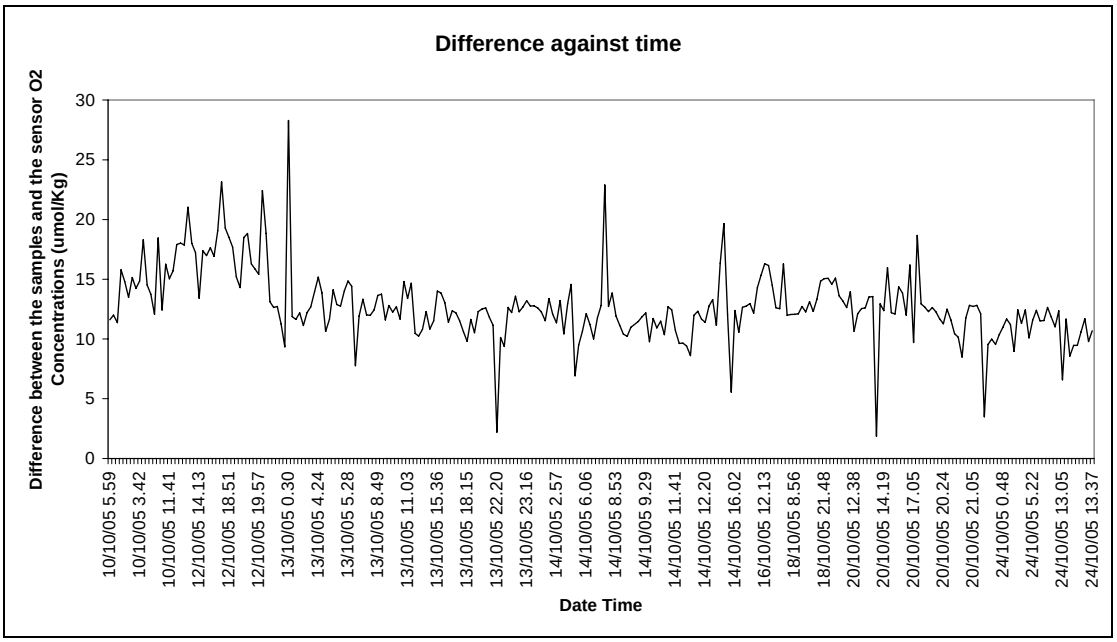


Fig. 9.2.

The equation of the line from Fig. 9.1 provides us with a useful calibration term to convert from the oxygen value as recorded by the sensor to a real value of oxygen concentration in umol/Kg.

Figure 9.3 shows the actual values recorded for both the sensor and the discreet samples. Figure 9.4 shows the difference between the sensor and discreet O2 concentrations plotted against the temperature that they were sampled at, to see if there is some correlation between the temperature of the water and the performance of the sensor on the CTD frame. This plot indicates that there was no change in the performance of the sensor with a change in temperature.

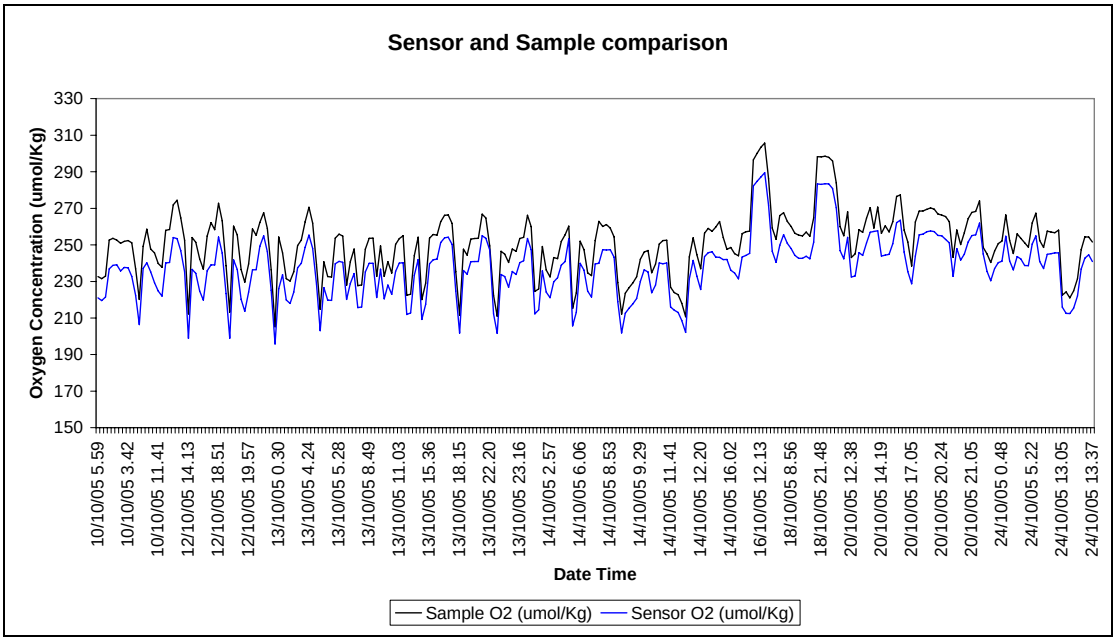


Fig. 9.3.

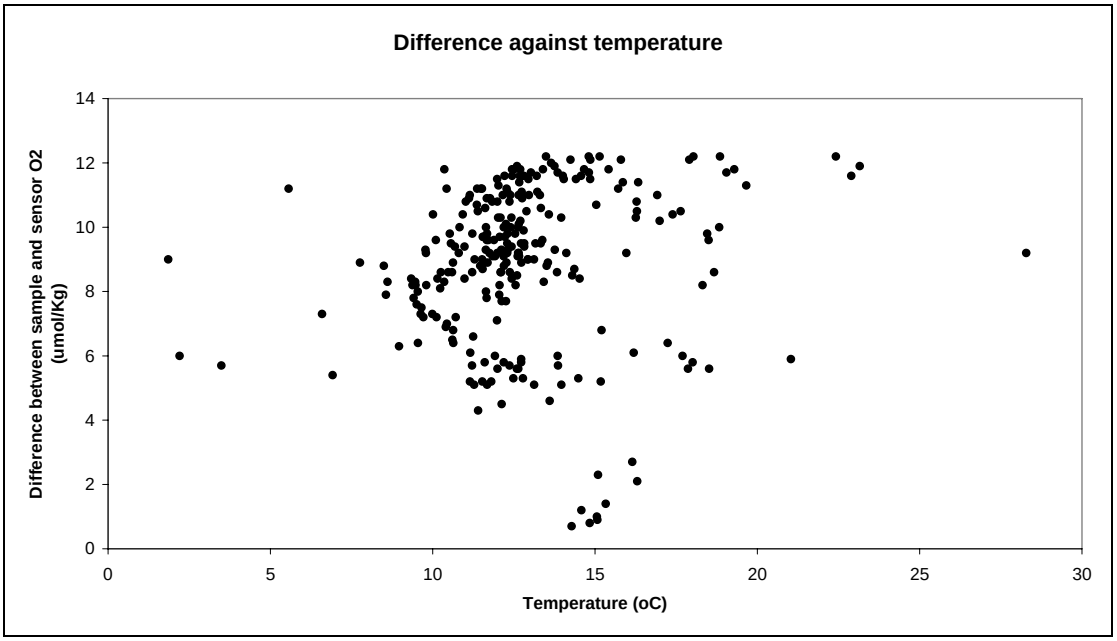


Fig. 9.4.

10 Mooring report

Paul G. Provost, SAMS

One mooring was successfully deployed at the western end of a steep sided gully in the Wyville Thompson ridge. The mooring was constructed around an upward looking acoustic Doppler current profiler (Fig. 10.1). The mooring was constructed on the aft deck of the ship, and streamed from the stern gantry, floatation first, and when in position the anchor was cut free for the mooring to freefall to the seabed. All mooring equipment was provided by UKORS mooring division, NOC, Southampton.

Mooring deployment details	Instrument set-up for ADCP
Position: 60º14.365' N, 008º52.198' W Depth: 1125m Date: 16 October 2005 Time: 14:57 GMT	High power, long range mode Time of First Ping: 13 October 2005 08:00 GMT Ensemble interval: 30 mins Number of depth cells: 64 Pings per Ensemble: 33 Depth Cell Size: 8 m Blank After Transmit: 7.04 cm Frequency: 76.8 kHz Expected battery life: 180 days

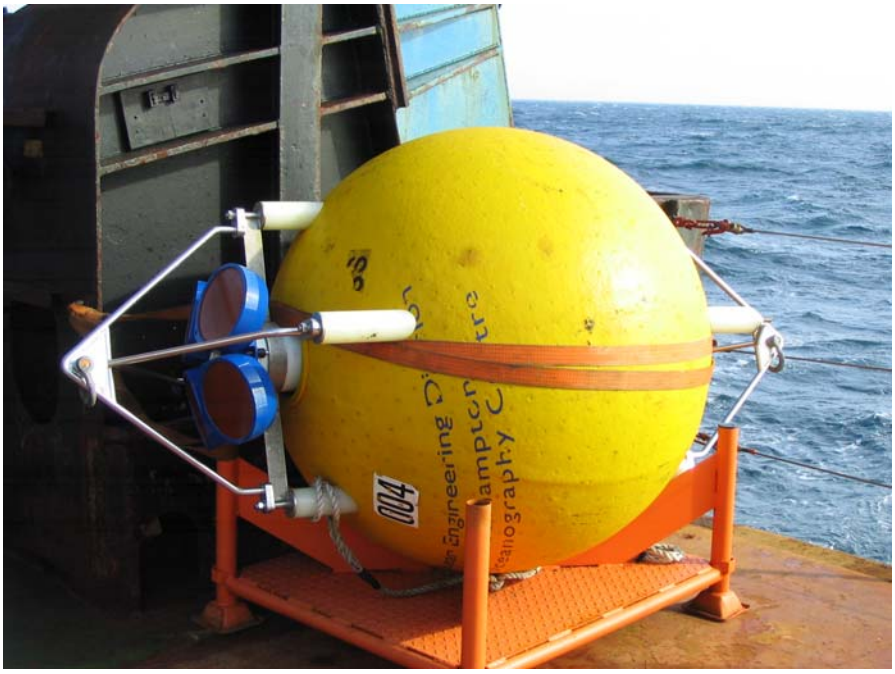


Fig. 10.1 The ADCP located in its buoy.

Item	Details	Height above seabed
Argos beacon	Seimac MML, Serial no. 11712	38.5m
17” glass flotation sphere	Benthos	38.5m
Rope (30mm 3-strand polyprop)	7.5m, soft eye splice	
5/8” oval link		
Cosby shackle		
5/8” oval link		
shackle		
RDI ADCP	RD Instruments Workhorse, Serial No. 1644	31m
49” syntactic sphere	Floatation Technologies	30m
Shackle		
Titanium swivel (SWL 3T)		
shackle		
5/8” oval link		
Cosby shackle		
5/8” long link chain	Galvanised, 10m	
Cosby shackle		
Acoustic release	Oceano RT661 B2S, Serial No. 234	20m
20mm oval link		
Cosby shackle		
Line (10mm polyester multi-braid)	20m	
Cosby shackle		
Anchor clump	800kg	0m

11 LADCP data processing

Toby Sherwin, SAMS

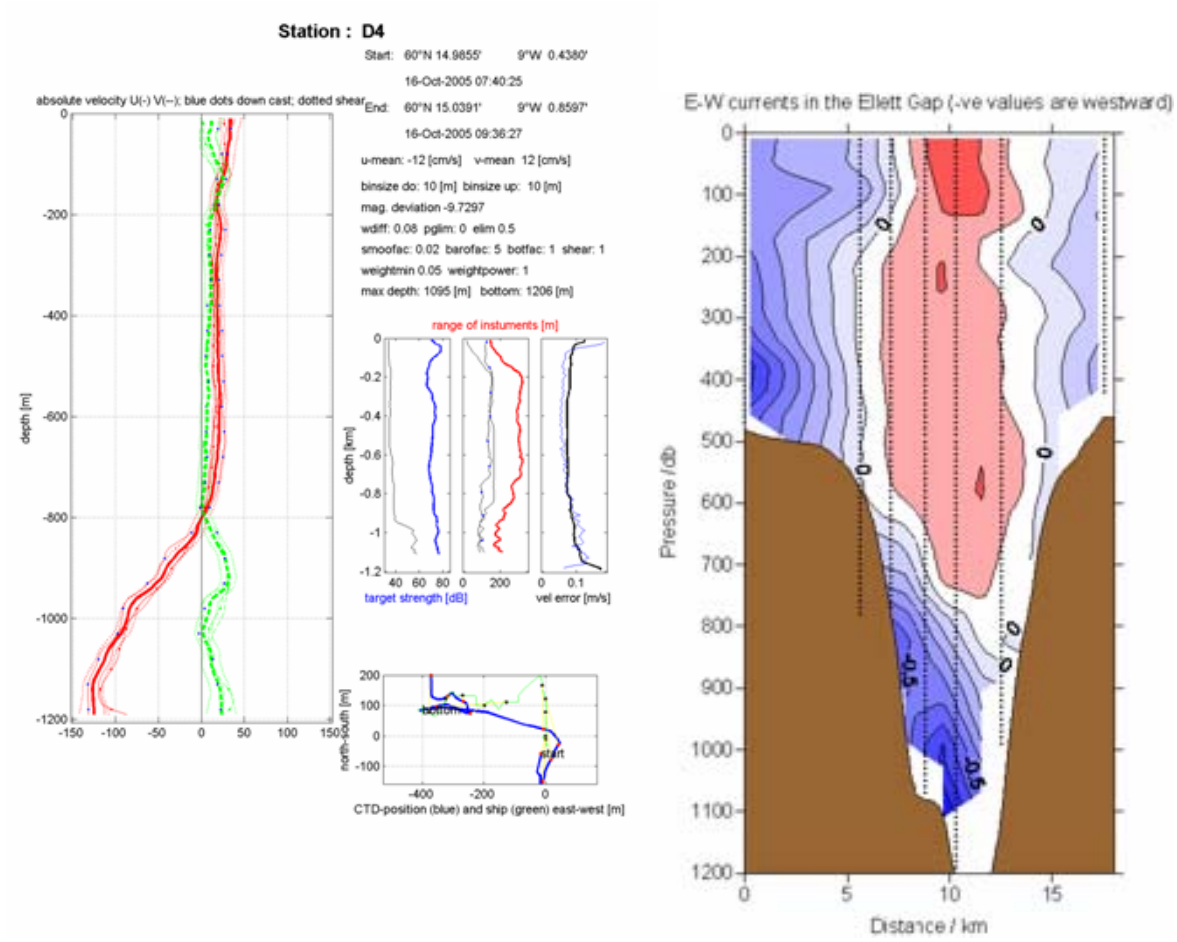
Two Lowered Acoustic Doppler Current Profilers (LADCP) were used whenever the stainless steel frame was deployed. Their performance is described by Dougal Mountifield in another section of this report. Here we focus on the viability of the data.

The LADCP data have been processed in Matlab using the 'Visbeck' data processing suite as a 'black box', i.e. without fully understanding how it works and without tuning any parameters. Ship's navigation and the CTD pressure sensor have both been used to improve the accuracy of the derived profiles. It was found, when processing currents at Sta. D4 that a significant improvement in the estimate of the depth mean current was gained by using the navigation data, and that a second improvement in the shape and overall depth of the profile appeared when the CTD pressure sensor was employed. These two improvements suggest that navigation and pressure corrections were being correctly used.

A detailed appraisal of the performance of the instruments has been conducted on data collected in the Ellett gully, where an unambiguous westward current often occurs in the deep water. Figure 11.1a shows the velocity profile at Sta D4 (CTD cast 30), at the deepest point in the gully. A strong westward current of up to 130 cm s^{-1} is seen in the water below 800 m. The error bars on both the E-W and N-S currents are acceptably small.

The section plot across the gully (Fig. 11.1b) shows a plausible lateral distribution of velocity. A favourable comparison with surface velocities observed with the vessel mounted ADCP was also found (see next section).

A brief investigation of the velocity section across the Rockall Trough was less convincing, and further work would be required to establish confidence in the currents observed there



a) b)

Figure 11.1. a) Profile of currents at Sta D4 (from the summary figure produced with the Visbeck software). b) Section D, showing the distribution of E-W currents across the Ellett gully in m s^{-1}. Sta D4 is located at 10 km. The corresponding temperature and salinity profiles at Sta. D4 are shown in Fig. 7.3.

12 Vessel Mounted ADCP (VM-ADCP), Navigation / Heading / Gyro

John Allen, NOCS, Gwenna Corbel, UHI Thurso, and Jeff Bicknell, UKORS

12.1 Introduction

As with previous cruises, an RDI narrowband 150kHz Vessel-Mounted Acoustic Doppler Current Profiler (VM-ADCP) was in operation on RRS *Charles Darwin*. The VM-ADCP is mounted in the hull at an approximate depth of 5 m. This section describes the operation and data processing paths for the VM-ADCP. The GPS navigation and 3D-GPS ashtech heading data processing is described first since they are key to the accuracy of the ADCP current data.

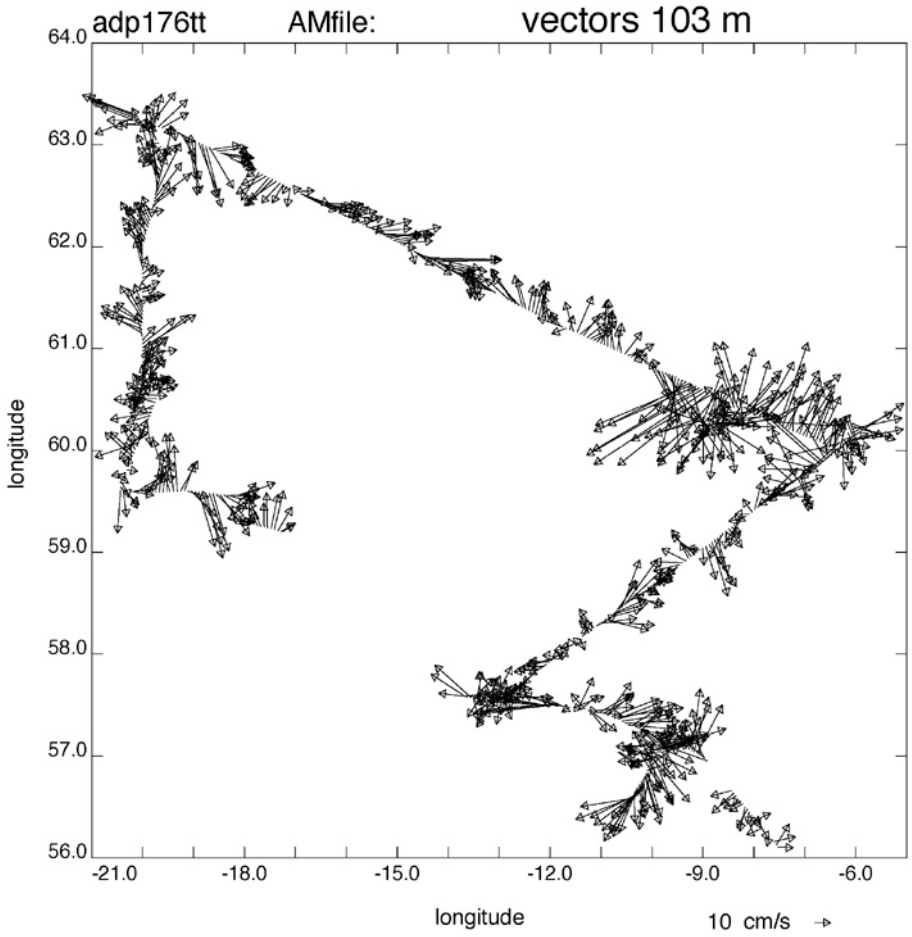


Fig. 12.1 An expedient trick to create a vector plot for a complex cruise like CD176, is to append all VM-ADCP files together, re-grid to 4 km distance run intervals along track using PSTAR programme *padpav* and then select a single depth using *pcopyg*. To a considerable extent this quickly avoids the messy separation of "on-station" data particularly where stations may involve many different deployments/recoveries, some of them non-stationary !. An example is shown above, here vectors are plotted for a depth of 103 m.

12.2 Navigation

The ship's best determined position was calculated by the RVS process *bestnav* (10 second averaging period). The main data source for CD176 was the GPS Trimble 4000 system. This

system used the differential corrections from an Ashtech G12 system and had been determined to be the most accurate system on a number of preceding cruises. The navigational precision achieved by this system can enable a calculation of ship's velocities to better than 1 cms^{-1} over even a 2 minute interval, and therefore below the instrumental limits of the RDI ADCP systems.

Data were transferred daily from the RVS Level C *bestnav* stream to the PSTAR absolute navigation file, abnv1761. The ship's gyro (*gyronmea*) data stream was also transferred daily.

Scripts:

navexec0: transferred data from the RVS *bestnav* stream to PSTAR, calculated the ships velocity, appended onto the absolute (master) navigation file and calculated the distance run from the start of the master file. Output: abnv1761.

gyroexec0: transferred data from the RVS *gyronmea* stream to PSTAR, a nominal edit was made for directions between 0-360° before the file was appended to a master file. Output: gyro1761

12.3 Heading

The ships attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. Using a combined cross of 4 antenna, combined on a single pole and using a 1 metre square footprint, mounted on the main mast, the Ashtech system measured the phase difference between incoming satellite signals and from which determined the ship's heading, pitch and roll. Configuration settings from previous calibrations (prior to CD139 February 2002) were used throughout the cruise, these were:

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

	X(R)	Y(F)	Z(U)
1-2 Vector	-0.504	0.495	0.000
1-3 Vector	0.000	0.996	0.000
1-4 Vector	0.496	0.498	-0.011

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

ashexec0: transferred data from the RVS *gps_ash* stream to PSTAR.

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

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

heading	0 < hdg < 360 (degrees)
pitch	-5 < pitch < 5 (degrees)
roll	-7 < roll < 7 (degrees)
attitude flag	-0.5 < attf < 0.5
measurement RMS error	0.00001 < mrms < 0.01
baseline RMS error	0.00001 < brms < 0.1

ashtech-gyro heading -5 < a-ghdg < 5 (degrees)

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

-1.0 < pitch <1.0

0 < mrms < 0.004

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ships velocity was calculated from position and time, and converted to speed and direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. Diagnostic plots were produced to check this. During ship manoeuvres, bad weather or around data gaps, there were spikes which were edited out interactively (PSTAR program *plxyed*).

Ashtech 3D GPS coverage was good. Gaps over 1 minute in the data stream are listed below.

time gap : 05 279 21:15:41 to 05 279 21:18:20 (2.6 mins)

time gap : 05 283 16:43:51 to 05 283 16:46:40 (2.8 mins)

time gap : 05 283 16:46:40 to 05 283 17:12:15 (25.6 mins)

time gap : 05 284 07:00:48 to 05 284 07:05:50 (5.0 mins)

time gap : 05 284 08:57:02 to 05 284 09:06:56 (9.9 mins)

12.4 150 kHz VM-ADCP

The 150kHz RDI ADCP was logged using RDI Data Acquisition Software (DAS) version 2.48 with profiler firmware 17.10. The instrument was configured to sample over 120 second intervals with 96 bins of 4 m thickness, pulse length 4 m and a blank beyond transmit of 4m. The high vertical resolution was chosen to support the remote detection of zooplankton patchiness in acoustic backscatter amplitude. When sensible in the cruise the ADCP was switched to bottom track mode over shallow topography to enable calibration.

Spot gyro heading data were fed into the transducer deck unit where they were incorporated into the individual ping profiles to correct the velocities to earth co-ordinates before being reduced to a 2 minute ensemble. However, this gyro feed had been left disconnected when the ADCP deck unit was refitted prior to the previous cruise. This was not noticed until 22:00 on jday 281 (2 days into the cruise). Data before this were rotationally corrected to a 1 minute averaged gyro data file before routine processing.

Following advice from RDI, the VM-ADCP on RRS *Charles Darwin* had been refitted to a heading offset of ~45°. This offset was accounted for in the DAS software configuration on CD176. On some earlier cruises (both on *Charles Darwin* and *Discovery*) the ADCP PC clock had been synchronised with the ship's master clock, so removing the tedious need for logging the drift of the PC clock and correcting for it in the processing (old **adpexec1**). Sadly this has not been available for some time, was not available on CD176, and thus **adpexec1** was resurrected.

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

12.4.1 Data processing:

adpexec0: transferred data from the RVS level C *adcp* data stream to PSTAR. The data were split into two; "gridded" depth dependent data were placed into "adp" files while "non-gridded" depth independent data were placed into "bot" files. Velocities were scaled to cm/s and amplitude by 0.42 to db. Nominal edits were made on all the velocity data to remove both bad data and to change the DAS defined absent data value to the PSTAR value. The depth of each bin was determined from the user supplied information. Output files: adp176##, bot176##

adpexec1: Clock correction applied to both, gridded and non-gridded files. The PC clock was found to have a steady but large drift, ~ 50 seconds per day, so time checks were made every 24 hours and these offset values were used in **adpexec1** to create a clock correction file for calibrating adcp time. The time offset is determined by recording the ship's UTC clock time when the 120 second ping timer reached 00:00:00 (or 00:00:01, as this would also be a terminator), and recording the PC time stamp on the refreshed screen. These times should correspond and the difference between them provides the clock offset. Output files: adp176##.corr, bot176##.corr

adpexec2: this merged the adcp data (both files) with the ashtech a-ghdg created by **ashexec2**. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: adp176##.true, bot176##.true.

adpexec3: applied the misalignment angle, ø, and scaling factor, A, calibration factors to both adcp files. The adcp data were edited to delete all velocities where the percent good variable was 25% or less. Again, variables were renamed and re-ordered to preserve the original raw data. Output Files: adp176##.cal, bot176##.cal.

adpexec4: merged the adcp data (both files) with the *bestnav* navigation file (abnv1761) created by *navexec0*. Ship's velocity was calculated from spot positions taken from the abnv1761 file and applied to the adcp velocities: the *bestnav* averaging is now only 10 seconds, and therefore there is no requirement to take spot values from the raw 1 second GPS4000 dataset which still has the rare spike. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from abnv1761. Output Files: adp176##.abs, bot176##.abs.

12.4.2 Calibration:

VM-ADCPs are neither perfectly vertical or perfectly rotated inline with the ship when they are fitted. Furthermore small movements can take place over time. This creates both an amplitude and directional error (misalignment angle) in the derived current velocities that needs to be removed through calibration. The easiest way to calibrate for this is in bottom tracking mode; where it can be shown that the clockwise misalignment angle ϕ can be obtained from

$$\tan\phi = \left(V_g U_s - U_g V_s\right) \Big/ \left(V_g V_s + U_g U_s\right) \quad ,$$

and the amplitude factor A can be obtained from

$$A = \left(V_g V_s + U_g U_s\right) \Big/ \left(V_g{}^2 + U_g{}^2\right)\cos\phi \quad ,$$

where (U_g,V_g) are the east and north bottom velocity components determined from the VM-ADCP and (U_s,V_s) are the east and north components of the ship's velocity derived from the navigation data. Much of this calibration is probably carried out semi-automatically by the latest software, but it is worth checking the results, particularly on a training exercise. Whilst collecting the data for a calibration the ship should make a straight line course at a gentle speed (say ~ 8 knots) for an hour or so if possible.

A calibration of the VM-ADCP was achieved using bottom tracking data available from our departure through the Irish Sea and our departure from the southern Iceland shelf. Using long, straight, steady speed sections of standard two minute ensemble profiles we obtained a calibration of $\phi = 3.5°$ $(\pm s.d. = 0.5)$ and $A = 1.0105$ $(\pm s.d. = 0.0057)$.

12.4.3 Data quality:

The processing stages produced sensible sized velocity vectors for expected water motion in this part of the Iceland basin (Fig. 12.2). Further analysis will be required to compare the data to geostrophic calculations from CTD data. However it was possible to compare eastward velocities in the deep channel extending westwards from the Wyville Thompson ridge (section D) with those derived from the LADCP instruments fitted to the CTD frame and presented elsewhere in this report, both magnitudes and directions agreed very closely.

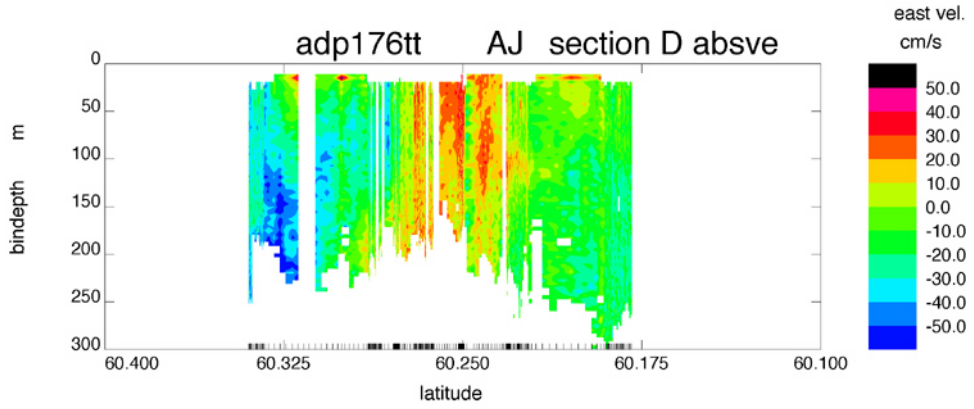


Figure 12.2 Raw two minute ensemble VM-ADCP data contoured for section D (gully on the south side of the Wyville Thompson ridge - along ~ 9° W), eastward current component shown.

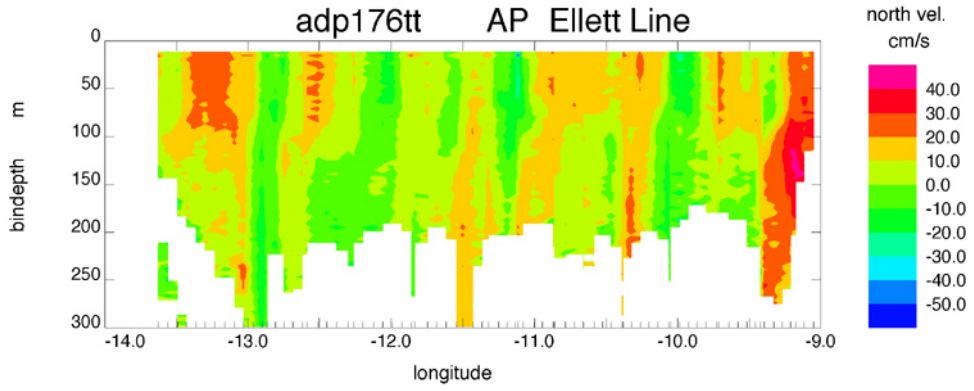


Figure 12.3. 4 km along track averaged VM-ADCP data contoured for the Ellett line (Between stations R and A), northward current component shown.

13 Thermosalinograph and SurfMet Data

Jeff Bicknell, UKORS and Gwenna Corbel, UHI Thurso

13.1 Instruments

Underway surface meteorology and thermosalinograph measurements were made by the RVS Surfmet system throughout Darwin cruise 176. The instruments used, together with their serial numbers and manufacturer are listed in Table 13.1.

Table 13.1

Instrument	Manufacturer	Serial number
OTM (temperature) Housing	FSI	1370
OTM (temperature) Remote	FSI	1361
Fluorometer	WetLabs	134
Transmissometer	SeaTech	T1019D
Barometric Pressure	Vaisala	S3440012
Temperature / Humidity	Vaisala	S5040001
PPAR (DRP-5)	Didcot/ELE	5143
SPAR (DRP-5)	Didcot/ELE	5144
PTIR (Pyranometer)	Kipp & Zonen	962276
STIR (Pyranometer)	Kipp & Zonen	962301
OCM (Conductivity)	FSI	1333
Anemometer	Vaisala	21213
Wind Vane	Vaisala	22306

13.2 Processing

No processing of the underway data was undertaken. However, the data have been saved in ascii txt format.

1. The raw data (1 s intervals) have been saved under the name: ***surfmet.txt.jz (where the first three numbers correspond to the JDay)
2. A 1 min-average file has been created daily from 6:00am to 6:00 am the next day and saved under the name: whale_data**.txt (20 files)
3. A 10 min-average file has been created daily from midnight to midnight the next day and saved under the name: met**.txt (21 files)

13.3 Salinity Calibration of Underway Data

A full calibration of underway data will be done post cruise. However, a first comparison between the samples taken and the values recorded by Surfmet gives a good agreement between the values (Fig. 13.1).

The corrected surfmet value can be calculated using the following equation :

$$S_{corrected} = 0.9512S + 1.1661$$

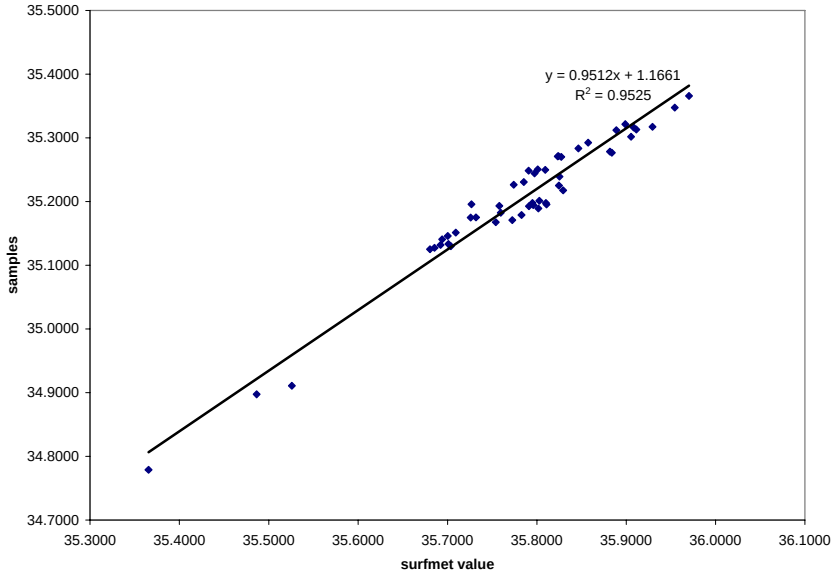


Fig. 13.1. Underway salinity calibration data

14 Aluminium sampling

Toby Sherwin, SAMS

Samples were taken from the Rosette sampler at 14 CTD stations, located on the Ellett Line (8), in the Faroe-Shetland Channel (3) and at the edge of the George Bligh Bank (3). Typically 8 to 10 Nisken bottles were sampled per CTD station, following the strategy discussed before the cruise, and for each bottle one filtered and one unfiltered sample was taken. Towards the end of the cruise, when it became apparent that there were not very many aluminium sample bottles left, the number of Nisken bottles sampled per cast was reduced to 6. The sampling strategy aimed to provide a fairly even distribution of aluminium samples over the water column along the deep water of the Ellett line. At the edge of the Rockall shelf and the George Bligh bank samples were concentrated near the bottom. In the Faroe-Shetland Channel and the Wyville Thomson Ridge gully the emphasis was on sampling the bottom waters that were crossing the ridge, in an attempt to identify the source waters to the north of the Rockall Trough.

The sampling procedure followed the protocol prepared by Clare Johnson before the cruise, with one exception which is outlined below. It was realised early on that aluminium sampling was taking a long time and holding up the cruise by an unacceptable amount since the next station was reached before the full sampling suite had been completed. After a reappraisal the strategy was streamlined by sampling unfiltered aluminium at each Nisken bottle immediately after oxygen sampling, with two people doing the work. One would hold the tube and syringe whilst the other had the bottle and new filter. After the sampling tube has been flushed with water from a new Nisken, the syringe was filled. From this first filling the sample bottle was rinsed twice with two 30 ml quantities flushed through the filter. The bottle was then filled from the second drawing of sea water into the syringe (this involved removing and then reattaching the filter to the syringe). The unfiltered samples were undertaken immediately after the filtered ones. To further speed up the sampling procedure a ‘scribe’ was employed to write down the numbers of the sample bottles which were randomly selected from the bags provided. These numbers can be found on the nutrient sampling sheets.

At nearly all stations, the filter was placed in a bag with the filtered sample, whilst the unfiltered sample was placed in a bag on its own. Both filtered and unfiltered bottles were then placed together in a large aluminium bag marked with the cruise id, station name and CTD number and stored in a chest freezer.

Both samplers wore protective gloves when sampling, and the crew were instructed not to smoke in the vicinity of the CTD rosette system both before a cast and when the samples were being collected.

These data will be analysed by Clare Johnson, a PhD student at SAMS.

15 Iron Biogeochemistry in the North-East Atlantic

Gary R. Fones and Maria Nielsdottir, NOCS

15.1 Main objectives of study

The overall aim of this study was to test the working hypothesis that parts of the high latitude north Atlantic are potentially Fe limited. The main objectives were:

1. To map changes in total dissolved (< 0.2 μm) Fe taken during the Extended Ellett Line in relation to other key parameters including macronutrients and chlorophyll, in order to better understand the role of Fe in this region.
2. To determine the vertical distribution of Fe at key stations in the Icelandic Basin in order to elucidate the inventory of iron and nutrient ratios down through the water column.
3. To undertake bioassay incubations at a control (Rockall Trough) and potentially Fe limited (Icelandic Basin) site.

15.2 Sampling Rationale

15.2.1 Underway TM Fish

Samples were taken along the Extended Ellett Line from the 6th to the 27th of October 2005 on cruise CD176 aboard RRS Charles Darwin. During CD176, despite the weather conditions 153 surface samples (♦) were collected along the extended Ellett Line and other areas in the north east Atlantic (Fig. 15.1) using a trace metal clean fish (Fig. 15.2). Water was pumped using a high volume peristaltic pump from the fish deployed on the port side at a depth of 1-2 m directly into the clean container where it was either withdrawn (Fig. 15.3) un-filtered or filtered directly though a 0.2 μm in-line filter cartridge (Sartorious).

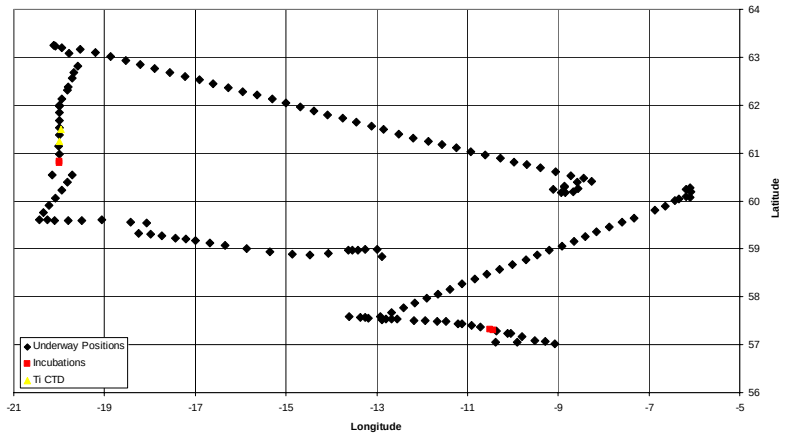


Fig. 15.1: Sampling positions for underway samples, incubations and Ti CTD's

Underway samples were taken filtered for dissolved iron (< 0.2 mm) and un-filtered for nutrients (nitrate and nitrite [hereafter nitrate], phosphate and silicate) and chlorophyll A.

Fig. 15.2: Deployed underway sampling fish container

Fig. 15.3: Underway manifold in the clean

15.2.2 Titanium CTD rosette system

During CD176, only two Ti CTD (▲) (Fig. 15.1) stations were possible (Table 15.1) due to bad weather conditions in the Icelandic Basin. CTD profiles were obtained using a Sea-Bird sensor package and a Chelsea Scientific Instruments fluorometer. Samples were exclusively collected for dissolved iron (0.2 μm) using specially designated modified OTE bottles (Fig. 4).

Table 15.1: Titanium CTD stations occupied during CD176

Station #	Julian Day	Sea bed depth (m)	Position	Sampling depths (m)
IB16	292	2224	61° 30.009 N 19° 59.901 W	10, 50, 100, 300, 850, 1200, 1760, 2205
IB15	292	283	61° 15.171 N 20° 00.28 W	10, 50, 100, 350, 750, 1200, 1900, 2330

Water from the OTE bottles were sub-sampled directly into acid washed 250 mL LDPE bottles and subsequently filtered through 25 mm PTFE syringe filters using a peristaltic pump into 125 mL acid washed LDPE bottles in a laminar flow cabinet (Fig. 15.5). Samples were then acidified with ultra-pure HCl (125 μl per 125 mL – 6M), and double bagged. Samples were also taken from other bottles fired at the same depth for nutrients (nitrate and nitrite [hereafter nitrate], phosphate and silicate), Chlorophyll A and POC.

Fig. 15.4: Modified OTE bottles for trace metal work

Fig. 15.5: In-line filtration

15.2.3 Bioassay Incubations

Two Fe addition incubations were undertaken during CD176 (Fig. 15.1), one in the Rockall Trough and one in the Icelandic Basin (■). 12 x two litre acid-washed polycarbonate bottles were filled un-filtered in the clean container and an iron addition of 2 nM was made to six of these. 6 bottles were used for a time series (3 control and 3 +Fe) and 6 bottles were used for the end point (3 control and 3 +Fe). The bottles were subsequently double bagged and placed in the incubator. The incubator was kept at ambient sea water temperature by pumping through non-toxic sea water. Light levels were adjusted to 50% surface light by covering the incubator with a light resistant blue film. The incubator was secured to three pallets on the ships deck. During the incubation period samples were periodically taken. At time zero (start of incubation) samples were taken for dissolved iron, nutrients, Chlorophyll A, HPLC determinations, particulate organic carbon (POC), particulate organic nitrogen (PON), phytoplankton (Lugols) and FRRf determinations (phytoplankton physiology). Subsequent samples were taken after Day 1, 3 and 5 from the time series bottles (x 6) for nutrients, Chlorophyll A, and FRRf determinations.

Fig. 15.6: On-deck Incubation box

At day five the six end point bottles (x 6) were subsampled for the full suite of determinants - dissolved iron, nutrients, Chlorophyll A, HPLC determinations, particulate organic carbon (POC), particulate organic nitrogen (PON), phytoplankton (Lugols) and FRRf determinations (phytoplankton physiology).

15.3 Samples and Analysis

15.3.1 Dissolved Iron

Collected samples for dissolved iron will be undertaken at NOCS using a flow injection chemiluminescence (FI-CL) system. The system is based on pre-concentration of Fe (III) and (II) from seawater onto an 8-hydroxyquinoline column, which is then subsequently eluted and mixed with a buffered luminol stream in the presence of hydrogen peroxide. The chemistry is carried out in a continuous flow system. The reaction leads to the production of light in the blue part of the spectrum, which is measured by a highly sensitive photo-multiplier tube [PMT], and the light emitted is directly related to the Fe in the original sample. Control of the flow system and data collection is done through a LabView programme, and NI DAQ and control cards.

15.3.2 Inorganic Nutrients

Samples for nutrients (nitrate, phosphate and silicate) were taken from the underway system, Ti CTD and bioassays. Samples were collected in 30 mL Sterilin containers, rinsed with twice their own volume of sample and kept refrigerated at 4°C until analysis. At the start of the cruise nutrient determinations were undertaken on board ship, however, a malfunction with the auto sampler meant that samples could not be analysed and were subsequently frozen. Analysis for nitrate, phosphate and silicate will be undertaken at NOCS using a Skalar Sanplus continuous flow autoanalyser following the methods outlined by Sanders and Jickells (2000).

15.3.3 Chlorophyll A

Samples for Chlorophyll A were taken from the underway system to compare with dissolved Fe values and nutrient values and also to calibrate the underway fluorometer. Bottles were rinsed with sample and then stored until filtration, which generally commenced within 15 minutes. Aliquots of 200 mL (100 mL up to #85) were filtered onto 25 mm GF/F filters at low (<10Kpa) vacuum pressure (Fig 15.7), placed in a small (2 mL) centrifuge tube, wrapped in foil and stored at -80°C. Chlorophyll A determinations will be undertaken at NOCS where they will be extracted from frozen filter papers by sonication in 90% acetone and measured using a Turner Designs fluorometer, following the protocol outlined in Welshmeyer (1994).

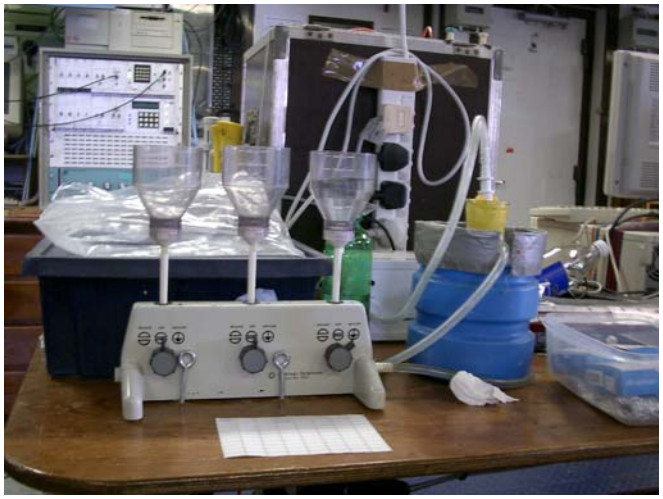


Fig. 15.7: Filtration System

15.3.4 HPLC

Samples for HPLC were taken at the start and end points of the bioassays. Samples were filtered in the same manner as Chlorophyll A only a larger volume was filtered, 500 mL. Filter papers were then wrapped in foil and stored dry in plastic bags at -80°C. HPLC determinations will be undertaken at NOCS by high-pressure liquid chromatography (HPLC). Pigments will be extracted from frozen filter papers by sonication in 90% acetone and then passed through a nylon membrane filter (0.2µm) before measurement with a ThermoFinigan HPLC following the method outlined by Barlow et al, (1997). Pigments present will be identified using an on-line diode array spectrophotometer and through co-elution with commercial pigment standards.

15.3.5 POC and PON

Samples for POC and PON were taken at the start and end points of the bioassays. Samples were filtered using pre-ashed filters in the same manner as Chlorophyll A only a larger

volume was filtered, 1000ml. Filter papers were then wrapped in foil and stored dry in plastic bags at -80°C.

15.3.6 Fast Repetition Rate Fluorometer (FRRF)

Fast Repetition Rate Fluorometer (FRRF) measurements were used to monitor the physiological health of the photosynthetic machinery in the phytoplankton population being studied. Samples were analysed on ship from the bioassays which were subsampled into dark LDPE bottles. Samples then underwent a 30 minute dark incubation at sea surface temperature to allow relaxation of all photochemical and non-photochemical quenching (Simpson and Hydes, 2003), sub-sampling was generally restricted to periods of darkness or early dawn to limit recovery time.

After the incubation period measurements of dark-adapted physiology were acquired from samples with Chelsea Instruments FAST track fast repetition rate fluorometer (Fig. 15.8) which was operated in conditions of near to complete darkness. At NOCS the values of dark-adapted maximum photochemical quantum efficiency (Fv/Fm) and the functional absorption cross-section (σPSII) will be calculated by fitting the measured saturation curves to the biophysical model of Kolber et al. (1998) using MATLABTM code outlined in Laney (2003).

Fig. 15.8: Fast Repetition Rate fluorometer (FRRf)

15.4 Results and Discussion

No results were available by the end of the cruise. Most of the samples will be worked up within a few months of returning to NOCS. Despite the weather conditions a large amount of work was able to be undertaken. However whether October is a particularly good month of the year for these experiments remains open. A time frame of May through August would prove far more beneficial to test this hypothesis.

15.5 Report on facilities and equipment used in Fe work

15.5.1 Clean container laboratory

Overall the container lab worked well, and provided a high quality environment for the demanding trace metal work being undertaken during CD176. One problem noted was the hinges of the rear door appear to have become very rusty, this is very close to the MQ system and needs to be addressed.

15.5.2 Underway clean Fish sampling system

This system from University of Plymouth worked extremely well; no real problems were encountered during the cruise. The fish towed at a depth of ~ 1-2 m depending on weather conditions. Despite the extreme weather the Fish kept functioning throughout. The high volume peristaltic pump produced ~ 2 litres per minute.

15.5.3 Ti CTD Rosette System

System worked well even though due to bad weather only two deployments were made. Bottles needed to be cleaned before use in the clean container. This should have been stipulated during UKORS cruise planning.

15.5.4 Fast Repetition Rate Fluorometer (FRRF)

The UKORS FRRf system worked well during the cruise and had the correct leads for using in discrete sampling mode.

16 CD176 Event Log

Date	Time GMT	Latitude	Longitude	Event No.	Depth	I/W (GMT)	Bottom (GMT)	O/W (GMT)	Station	Activity	Comments
7/10/05	0939	55 22.23 N	06 43.24 W	#1	75	0956	1003	1023	TRIALS	CTD001	SHAKEDOWN
8/10/05	0315	57 00.01 N	08 59.87 W	#2	130	0323	0332	0346	R	CTD002	
8/10/05	0535	57 03.00 N	09 12.92 W	#3	294	0541	0558	0626	Q	CTD003	
8/10/05	0805	57 06.06 N	09 24.91 W	#4	1396	0805	0936	1204	P	CTD004	Slow (sea state and winch problems)
10/10/05	1255	57 09.30 N	09 42.38 W	#5	1932	1255	1344	1454	O	CTD005	
10/10/05	1721	57 13.82 N	10 03.31 W	#6	2104	1721	1843	2005	N	CTD006	
10/10/05	2230	57 18.16 N	10 22.87 W	#7	2211	2230	2341	0106	M	CTD007	
11/10/05	0300	57 22.04 N	10 40.03 W	#8	2100	0305	0412	0536	L	CTD008	
11/10/05	0744	57 24.00 N	10 51.85 W	#9	787	0744	0816	0854	K	CTD009	
11/10/05	1009	57 27.00 N	11 04.90 W	#10	588	1009	1009	1107	J	CTD010	
11/10/05	1431	57 28.04 N	11 19.00 W	#11	748	1445	1507	1547	I	CTD011	
11/10/05	1650	57 29.00 N	11 32.00 W	#12	2019	1650	1739	1851	H	CTD012	
11/10/05	2111	57 29.50 N	11 51.00 W	#13	1806	2111	2206	2320	G	CTD013	
12/10/05	0114	57 30.52 N	12 15.00 W	#14	1805	0114	0200	0317	F	CTD014	
12/10/05	0446	57 32.00 N	12 37.00 W	#15	1657	0446	0525	0635	E	CTD015	
12/10/05	0805	57 32.24 N	12 44.80 W	#16	1468	0805	0847	0958	D1	CTD016	
12/10/05	1111	57 32.55 N	12 52.00 W	#17	1065	1111	1140	1230	D	CTD017	
12/10/05	1553	57 35.07 N	13 38.04 W	#18	108	1553	1601	1619	A	CTD018	
12/10/05	1828	57 34.02 N	13 19.90 W	#19	173	1828	1838	1855	B	CTD019	
12/10/05	2020	57 33.00 N	12 59.80 W	#20	294	2020	2036	2055	C	CTD020	
13/10/05	1937	59 42.99 N	07 08.81 W	#21	1094	2053	1937	1959	WTSA	MEGA001	+ac. Release trial
13/10/05	2055	59 42.96 N	07 08.86 W	#22	1094	2053	2122	2150		MEGA002	4 TUBES
13/10/05	2210	59 43.13 N	07 09.26 W	#23	1093	2211	2235	2305	WTS?	MEGA003	NEW SITE 4 TUBES
13/10/05	2321	59 43.02 N	07 09.11 W	#24	1093	2315	2339	0015	WTS?	MEGA004	
14/10/05	0459	60 05.75 N	06 03.76 W	#25	1153	0457	0525	0556	WTN6	MEGA005	4 TUBES 3 GOOD
14/10/05	0609	60 05.78 N	06 03.84 W	#26	1154	0607	0631	0657	WTN6	MEGA006	6 TUBES 6 GOOD

14/10/05	0721	60 05.81 N	06 03.90 W	#27	1154	0717	0744	0815	WTN6	MEGA007	6 TUBES
14/10/05	0929	60 12.95 N	06 11.90 W	#28	1209	0929	1005	1100	FSC2	CTD021	LEAKING BOTTLES
14/10/05	1116	60 12.78 N	06 12.13 W	#29	1205	1116	1154	1246	FSC2	CTD022	
14/10/05	0627	60 17.80 N	06 06.70 W	#30	627	1351	1412	1431	FSC1	CTD023	
14/10/05	1733	60 05.95 N	06 03.56 W	#31	1158	1728	1753	1821	WTNB1	BOXC001	GOOD
14/10/05	1907	60 06.03 N	06 04.36 W	#32	1159	1905	1931	2000	WTNB1	BOXC002	GOOD
14/10/05	2038	60 05.89 N	06 04.13 W	#33	1155	2034	2058	2130	WTNB1	BOXC003	GOOD
14/10/05	2344	60 05.15 N	06.18.89 W	#34	1097	2858	0078	0100	FSC3	CTD024	NO BOTTLES FIRED
15/10/05	0201	60 00.89 N	06 21.08 W	#35	0935	0201	0229	0307	FSC4	CTD025	NO BOTTLES FIRED
15/10/05	2342	60 20 38 N	09 82.81 W	#36	485	2342	0002	0027	D0	CTD026	
16/10/05	0142	60 17.32 N	09 02.17 W	#37	605	0142	0214	0245	D1A	CTD027	
16/10/05	0335	60 16.69 N	09 00.91 W	#38	750	0335	0416	0447	D2	CTD028	
16/10/05	0527	60 15.77 N	09 00.68 W	#39	1095	0527	0610	0655	D3	CTD029	
16/10/05	0750	60 15.00 N	09 00.45 W	#40	1151	0750	0844	0938	D4	CTD030	
16/10/05	1048	60 14.00 N	08 59.30 W	#41	1051	1048	1121	1158	D5	CTD031	
16/10/05	1243	60 11.30 N	08 57.85 W	#42	454	1243	1258	1323	D7	CTD032	
16/10/05	1457	60 14.36 N	08 52.20 W	#43	1125	1457			MOORING	MOORING	ADCP IN GULLY
16/10/05	2111	60 25.57 N	08 14.61 W	#44	759	2111	2144	2225	FSC5	CTD033	
18/10/05	1220	63 12.99 N	20 03.92 W	#45	660	1220	1237	1303	IB22S	CTD034	NO SLAVE ADCP
18/10/05	1410	63 18.99 N	20 12.99 W	#46	125	1410	1418	1430	IB23S	CTD035	NO SLAVE ADCP
18/10/05	1625	63 08.17 N	19 55.02 W	#47	1028	1625	1653	1732	IB21S	CTD036	
18/10/05	1944	62 54.97 N	19 32.60 W	#48	1415	1944	2019	2109	IB20S	CTD037	
18/10/05	2321	62 40.14 N	19 40.55 W	#49	1686	2321	2359	0054	IB19S	CTD038	
19/10/05	0342	60 20.04 N	19 49.84 W	#50	1799	0342	0431	0531	IB18S	CTD039	
19/10/05	0806	61 59.99 N	20 00.19 W	#51	1812	0806	0846	0950	IB17S	CTD040	
19/10/05	1353	61 30.00 N	19 59.90 W	#52	2224	1353	1438	1538	IB16	CTD041	Ti FRAME NO LADCP
19/10/05	1800	61 15.17 N	20 01.30 W	#53	2383	1800	1849	1958	IB15	CTD042	Ti FRAME NO LADCP
23/10/05	1056	58 58.58 N	13 34.92 W	#54	609	1056	1114	1137	GB2	CTD043	
23/10/05	1242	58 58.58 N	13 27.23 W	#55	1014	1242	1305	1348	GB3	CTD044	
23/10/05	1445	58 58.81 N	12 23.04 W	#56	1302	1445	1515	1556	GB4	CTD045	
23/10/05	1702	58 59.01 N	13 11.97 W	#57	1559	1702	1738	1824	GB5	CTD046	
23/10/05	1943	58 59.99 N	12 57.12 W	#58	1498	1943	2020	2057	GB6	CTD047	
25/10/05	0725	57 00.05 N	08 59.86 W	#59	130	0725	0736	0746	R	CTD048	
25/10/05	0921	56 54.97 N	08 38.32 W	#60	128	0921	0932	0943	16G	CTD049	

25/10/05	1120	56 50.17 N 08 20.02 W	#61	130	1120	1128	1139	T	CTD050	
25/10/05	1344	56 46.92 N 08 00.02 W	#62	120	1344	1351	1400	13G	CTD051	
25/10/05	1604	56 44.07 N 07 40.30 W	#63	61	1604	1608	1621	11G	CTD052	
25/10/05	1827	56 49.24 N 07 23.17 W	#64	117	1828	1838	1844	M4	CTD053	
25/10/05	1914	56 49.53 N 07 23.84 W	#65	149	1914	1931	1937	M9	CTD054	
25/10/05	1959	56 49.32 N 07 24.12 W	#66	120	1959	2015	2025	M6	CTD055	
25/10/05	2050	56 49.25 N 07 24.68 W	#67	111	2050	2100	2105	M5	CTD056	
25/10/05	2138	56 48.29 N 07 23.92 W	#68	195	2138	2153	2159	M10	CTD057	
25/10/05	2250	56 44.05 N 07 19.90 W	#69	154	2250	2258	2309	9G	CTD058	
26/10/05	0022	56 44.10 N 07 10.09 W	#70	174	0022	0031	0039	8G	CTD059	
26/10/05	0203	56 43.99 N 06 59.95 W	#71	135	0202	0210	0219	7G	CTD060	
26/10/05	0343	56 43.96 N 06 44.75 W	#72	45	0343	0348	0356	6G	CTD061	
26/10/05	0446	56 44.04 N 06 35.86 W	#73	75	0446	0453	0503	5G	CTD062	
26/10/05	0609	56 44.05 N 06 22.00 W	#74	86	0609	0616	0626	4G	CTD063	
26/10/05	0708	56 42.05 N 06 22.00 W	#75	74	0708	0716	0724	3G	CTD064	
26/10/05	0803	56 41.07 N 06 16.89 W	#76	40	0803	0811	0817	2G	CTD065	
26/10/05	0927	56 40.03 N 06 08.06 W	#77	177	0927	0938	0949	1G	CTD066	

16.1 Data Statement

All data from CD176 are stored either on the DVDs supplied by UKORS to the Principle Scientist and others at the end of the cruise, or with BODC, or with the data originators. CTD data are stored directory \ctd_data\processed_Data. Note that up to CTD040 26 quantities are presented in the asc files, but that this number reduces to 24 thereafter. The missing channels are the PAR sensors, which were only used in the first 3 stations.

The DVDs contain many more figures and photographs.

Tuesday October 9th, wind 50 knots: “no work was undertaken”

(photo John Dale)

Appendix 1

CTD Cast summaries

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
trials	#1	001	73.5	55	22.01	6	42.41

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
7/10/05	0956	1003	1023	NR	18	4 to 5	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	60	1006					
2	60	1006					
3	60	1006					
4	60	1006					
5	60	1006					
6	50	1009					
7	50	1009					
8	50	1009					
9	50	1009					
10	50	1009					
11	35	1012					
12	35	1012					
13	35	1012					
14	35	1012					
15	35	1012					
16	15	1015					
17	15	1015					
18	15	1015					
19	15	1015					
20	15	1015					
21	5	1019					
22	5	1019					
23	5	1019					
24	5	1019					

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
R	#2	002	130	57	13.0	8	59.75

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
8/10/05	0323	1333	0346	11	20	4-5	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	124	0334	X	X	X	X	
2	124	0334					
3	50	0337	X	X	X	X	
4	50	0337					
5	15	0340	X	X	X	X	
6	15	0340					
7	5	0342	X	X	X	X	
8	5	0342					
9							
10							
11							
12							
13							
14							
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16							
17							
18							
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
Q	#3	003	268	57	03.28	9	12.48

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
8/10/05	0541	0556	0626	15	22	rough	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	260	0559	X	X	X	X	
2	260	0559					
3	200	0604	X	X	X	X	
4	200	0604					
5	100	0610	X	X	X	X	
6	100	0610					
7	60	0614	X	X	X	X	
8	60	0614					
9	30	0617	X	X	X	X	
10	30	0617					
11	10	0620	X	X	X	X	
12	10	0620					
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
P	#4	004	1403	57	6.25	9	25.13

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
8/10/05	0805	0936	1203	10	25	6-7	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1402	0936	X	X	X	X	X
2	1370	0940					
3	1300	0946	X	X	X		X
4	1225	0951				X	
5	1000	1007	X	X	X	X	
6	800	1021	X	X	X	X	X
7	600	1031	X	X	X	X	
8	400	1123	X	X	X	X	X
9	300	1133	X	X	X	X	
10	200	1141	X	X	X	X	
11	122	1147	X	X	X	X	X
12	75	1154	X	X	X	X	
13	35	1158	X	X	X		
14	20	1200					
15	10	1202	X	X	X	X	X
16							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
O	#5	005	1933	57	09.0103	09	42.921

Date	Time in (GMT)	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
10/10/05	1255	1454	NR	18	Mod swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1920	1344	X	X	X	X	
2	1800	1349	X	X	X	X	
3	1600	1355	X	X	X	X	
4	1400	1402	X	X	X	X	
5	1000	1413	X	X	X	X	
6	500	1426	X	X	X	X	
7	350	1433	X	X	X	X	
8	200	1439	X	X	X	X	
9	100	1444	X	X	X	X	
10	70	1447	X	X	X	X	
11	40	1450	X	X	X	X	
12	10	1453	X	X	X	X	
13							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
N	#6	006	2106	57	13.51	10	03.31

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
10/10/05	1721	1843	2005	11	16	Mod sea heavy swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2090	1844	X	X	X	X	
2	1900	1851	X	X	X	X	
3	1600	1901	X	X	X	X	
4	1300	1912	X	X	X	X	
5	1000	1923	X	X	X	X	
6	700	1933	X	X	X	X	
7	500	1940	X	X	X	X	
8	200	1950	X	X	X	X	
9	100	1954	X	X	X	X	
10	65	1957	X	X	X	X	
11	40	1959	X	X	X	X	
12	10	2001	X	X	X	X	
13							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M	#7	007	2211	57	18.177	10	22.923

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
10/10/05	2230	2340	0106	NR	15	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2200	2341	X	X	X	X	
2	1900	2351	X	X	X	X	
3	1600	0000	X	X	X	X	
4	1300	0012	X	X	X	X	
5	1000	0022	X	X	X	X	
6	800	0030	X	X	X	X	
7	600	0038	X	X	X	X	
8	400	0046	X	X	X	X	
9	286	0050	X	X	X	X	
10	150	0055	X	X	X	X	
11	100	0059	X	X	X	X	
12	20	0104	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
L	#8	008	2106	57	22.00	10	39.97

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
11/10/05	0300	0412	0536	8	12	Mod swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2110	0413	X	X	X	X	X
2	1900	0424	X	X	X	X	X
3	1600	0435	X	X	X	X	X
4	1300	0445	X	X	X	X	X
5	1000	0454	X	X	X	X	X
6	700	0503	X	X	X	X	X
7	500	0509	X	X	X	X	X
8	200	0518	X	X	X	X	X
9	100	0523	X	X	X	X	X
10	65	0526	X	X	X	X	
11	40	0528	X	X	X	X	X
12	10	0530	X	X	X	X	
13							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
K	#9	009	788	57	24.00	10	51.83

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
11/10/05	0744	0816	0854	4.5	12	Mod swell	

ottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	786	0816	X	X	X	X	X
2	700	0820	X	X	X	X	X
3	500	0828	X	X	X	X	X
4	300	0836	X	X	X	X	X
5	120	0843	X	X	X	X	X
6	65	0846	X	X	X	X	X
7	20	0849	X	X	X	X	X
8	5	0851	X	X	X	X	X
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
J	#10	010	587	57	27.00	11	05.00

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
11/10/05	1009	1035	1107	4.9	10	Mod swell	

ottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	583	1035	X	X	X	X	
2	400	1043	X	X	X	X	
3	270	1048	X	X	X	X	
4	230	1052	X	X	X	X	
5	120	1057	X	X	X	X	
6	70	1100	X	X	X	X	
7	30	1103	X	X	X	X	
8	5	1105	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
I	#11	011	750	57	28.07	11	19.38

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
11/10/05	1445	1507	1547	9	8	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	739	1508	X	X	X	X	
2	700	1511	X	X	X	X	
3	600	1515	X	X	X	X	
4	400	1522	X	X	X	X	
5	250	1527	X	X	X	X	
6	100	1532	X	X	X	X	
7	60	1536	X	X	X	X	
8	25	1539	X	X	X	X	
9	8	1542	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
H	#12	012	2018	57	28.98	11	32.37

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
11/10/05	1650	1739	1851	9	9	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2005	1739	X	X	X	X	X
2	1900	1744	X	X	X	X	X
3	1800	1749	X	X	X	X	X
4	1600	1755	X	X	X	X	X
5	1200	1806	X	X	X	X	X
6	850	1815	X	X	X	X	X
7	500	1824	X	X	X	X	X
8	300	1832	X	X	X	X	X
9	150	1837	X	X	X	X	
10	90	1840	X	X	X	X	X
11	30	1843	X	X	X	X	X
12	8	1845	X	X	X	X	
13							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
G	#13	013	1797	57	29.48	11	51.43

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	2111	2206	2320	5.2	3	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1785	2206	X	X	X	X	
2	1700	2212	X	X	X	X	
3	1500	2220	X	X	X	X	
4	1000	2236	X	X	X	X	
5	800	2243	X	X	X	X	
6	500	2254	X	X	X	X	
7	300	2302	X	X	X	X	
8	150	2308	X	X	X	X	
9	100	2311	X	X	X	X	
10	80	2313	X	X	X	X	
11	50	2316	X	X	X	X	
12	10	2319	X	X	X	X	
13							
14							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
F	#14	014	1806	57	30.87	12	15.98

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	0114	1200	0317	NR	8	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1776	0201	X	X	X	X	
2	1700	0207	X	X	X	X	
3	1500	0215	X	X	X	X	
4	1000	0230	X	X	X	X	
5	800	0237	X	X	X	X	
6	500	0246	X	X	X	X	
7	200	0254	X	X	X	X	
8	150	0257	X	X	X	X	
9	100	0301	X	X	X	X	
10	80	0305	X	X	X	X	
11	50	0308	X	X	X	X	
12	10	0310	X	X	X	X	
13							
14							
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21							
22							
23							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
E	#15	015	1649	57	32.08	12	37.52

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	0446	0525	0635	5	4	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1647	0526	X	X	X	X	X
2	1642	0528					X
3	1612	0533					X
4	1597	0536					X
5	1497	0541					X
6	1000	0554	X	X	X	X	
7	800	0600	X	X	X	X	X
8	600	0606	X	X	X	X	X
9	400	0612	X	X	X	X	
10	200	0618	X	X	X	X	
11	120	0622	X	X	X	X	X
12	40	0625	X	X	X	X	
13	15	0628	X	X	X	X	X
14							
15							
16							
17							
18							
19							
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21							
22							
23							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D1	#16	016	1468	57	32.27	12	45.01

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	0805	0847	0958	NR	7	fair	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1455	0847	X	X	X	X	X
2	1430	0850					
3	1405	0853	X	X	X	X	X
4	1305	0857	X	X	X	X	X
5	1100	0905	X	X	X	X	
6	900	0912	X	X	X	X	X
7	800	0916	X	X	X	X	X
8	750	0919					
9	700	0922					
10	650	0926					
11	600	0929	X	X	X	X	X
12	550	0932	X	X	X	X	X
13	400	0936					
14	150	0943	X	X	X	X	X
15	80	0946	X	X	X	X	
16	30	0949	X	X	X	X	
17	15	0951				X	
18	5	0953	X	X	X	X	
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D	#17	017	1070	57	32.53	12	52.03

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	1111	1140	1230	NR	9	good	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1057	1141	X	X	X	X	X
2	1032	1143	X	X	X	X	
3	1006	1146	X	X	X	X	X
4	906	1151	X	X	X	X	
5	850	1154	X	X	X	X	X
6	600	1202	X	X	X	X	
7	500	1206	X	X	X	X	X
8	300	1214	X	X	X	X	
9	100	1220	X	X	X	X	X
10	70	1222	X	X	X	X	X
11	25	1225	X	X	X	X	X
12	5	1228	X	X	X	X	X
13							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
A	#18	018	107	57	35.10	13	38.04

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	1553	1601	1619	10	8	good	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	100	1602	X	X	X	X	
2	50	1609	X	X	X	X	
3	30	1611	X	X	X	X	
4	10	1613	X	X	X	X	
5	5	1614	X	X	X	X	
6							
7							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
B	#19	019	173	57	34.03	13	90.70

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	1828	1838	1855	10	7	slight	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	165	1838	X	X	X	X	
2	100	1843	X	X	X	X	
3	50	1846	X	X	X	X	
4	20	1848	X	X	X	X	
5	5	1850	X	X	X	X	
6							
7							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
C	#20	020	293	57	32.9	12	59.9

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
12/10/05	2020	2036	2055	3.0	8	slight	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	294	2036	X	X	X		X
2	280	2037	X	X	X		X
3	200	2041	X	X	X		X
4	100	2045	X	X	X		X
5	70	2048	X	X	X		
6	30	2051	X	X	X		X
7	15	2052	X	X	X		
8	5	2053	X	X	X		
9							
10							
11							
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23							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC2	#28	021	1206	60	12.95	6	12.11

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
14/10/05	0929	1005	1100	3.9	13	Good-slight	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1196	1005					
2	1150	1008					
3	800	1020					
4	620	1026					
5	600	1028					
6	500	1033					
7	400	1038					
8	200	1045					
9	50	1051					
10							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC2	#29	022	1206	60	12.74	6	11.93

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
14/10/05	1116	1154	1246	25		15	slight

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1195	1155		X		X	X
2	1195	1155				X	
3	700	1208		X		X	X
4	700	1208					
5	620	1213		X		X	X
6	620	1213				X	
7	580	1215		X		X	X
8	580	1215					
9	500	1221		X			X
10	500	1221					
11	400	1228		X			X
12	400	1228					
13	140	1235		X			X
14	140	1235				X	
15	50	1239		X			
16	50	1239				X	
17							
18							
19							
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22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC1	#30	023	627	60	17.8	6	6.7

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
14/10/05	1351	1412	1431	12	11	slight	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1							
2							
3							
4							
5							
6							
7							
8							
9							
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11							
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23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC3	#34	024	1085	60	4.726	6	19.549

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
14/10/05	2358	0028	0100	NR	16	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1							
2							
3							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC4	#35	025	930	60	0.909	6	21.689

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
15/10/05	0201	0229	0307	NR	21	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1							
2							
3							
4							
5							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D0	#36	026	473	60	20.06	9	3.546

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
15/10/05	2342	0002	0027	NR	23	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	461	NR					
2	301	NR					
3	10	0021					
4							
5							
6							
7							
8							
9							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D1A	#37	027	780	60	17.184	9	2.677

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	0142	0214	0245	NR	19	Mod.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	750	0215					
2	100	0234					
3	20	0237					
4							
5							
6							
7							
8							
9							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D2	#38	028	791	60	16.99	9	00.69

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	0335	0416	0447	50	20	Heavy swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	750	0416					
2	500	0427					
3	35	0442					
4							
5							
6							
7							
8							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D3	#39	029	039	60	16.08	9	00.36

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	0527	0610	0655	10	19	Heavy swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1095	0612					
2	700	0628					
3	250	0643					
4							
5							
6							
7							
8							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D4	#40	030	1122	60	15.07	9	00.53

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	0750	0844	0938	NR	18	Heavy swell	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1135	0844		X			X
2	1000	0851		X			X
3	950	0856		X			X
4	900	0859		X			X
5	850	0903		X			X
6	800	0906		X			X
7	700	0910		X			X
8	200	0928		X			X
9	20	0935		X			X
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D1	#41	031	895	60	13.622	8	59.522

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	1048	1121	1158	NR	18	HEAVY SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	883	1121					
2	150	1142					
3	20	1147					
4							
5							
6							
7							
8							
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#CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
D7	#42	032	416	60	11.11	008	58.13

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	1243	1258	1323	NR	15	HEAVY SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	417	1258					
2	100	1309					
3	20	1314					
4							
5							
6							
7							
8							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
FSC5	#44	033	767	60	25.7	008	14.3

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
16/10/05	2111	2144	2225	4.5	10	GOOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	760	2144	X	X	X	X	X
2	760	2144					
3	700	2148	X	X	X	X	X
4	700	2148					
5	650	2151	X	X	X	X	X
6	650	2151					
7	580	2155	X	X	X	X	X
8	580	2155					
9	550	2158	X	X	X	X	X
10	550	2158					
11	520	2200	X	X	X	X	X
12	520	2200					
13	300	2208	X	X	X	X	X
14	300	2208					
15	150	2213	X	X	X	X	X
16	20	2219			X	X	
17	20	2219					
18							
19							
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23							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB22S	#45	034	658	63	12.98	002	03.88

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
18/10/05	1220	1237	1303	7	17	MOD.	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	650	1238	X	X	X	X	
2	550	1242	X	X	X	X	
3	300	1248	X	X	X	X	
4	200	1252	X	X	X	X	
5	100	1255	X	X	X	X	
6	50	1258	X	X	X	X	
7	20	1300	X	X	X	X	
8	5	1302	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB23S	#46	035	125	63	18.99	020	12.21

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
18/10/05	1410	1418	1430	NR	13	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	120	1419	X	X	X	X	
2	110	1421	X	X	X	X	
3	90	1423	X	X	X	X	
4	50	1426	X	X	X	X	
5	20	1428	X	X	X	X	
6	5	1430	X	X	X	X	
7							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB21S	#47	036	1028	63	08.38	19	54.67

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
18/10/05	1625	1653	1732	8	19	SLIGHT	

Bottle no	Depth	Time	X	X	X	X	Al
1	1020	1653	X	X	X	X	
2	800	1659	X	X	X	X	
3	600	1705	X	X	X	X	
4	400	1710	X	X	X	X	
5	200	1715	X	X	X	X	
6	100	1719	X	X	X	X	
7	50	1721	X	X	X	X	
8	30	1724	X	X	X	X	
9	15	1725	X	X	X	X	
10	5	1727	X	X	X	X	
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12							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB20S	#48	037	1414	62	55.0	19	32.49

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
18/10/05	1944	2019	2109	3.5	19	SL SWELL	

Bottle no	Depth	Time	Chl	nutrients	POC	DO	Al
1	1403	2020		X	X	X	
2	1300	2024	X	X	X	X	
3	1200	2029		X	X	X	
4	1000	2035		X	X	X	
5	800	2040	X	X	X	X	
6	400	2049		X	X	X	
7	200	2055	X	X	X	X	
8	100	2059		X	X	X	
9	50	2102	X	X	X	X	
10	15	2105	X	X	X	X	
11	5	2107	X	X	X	X	
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB19S	#49	038	1680	62	40.49	19	40.689

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
19/10/05	2321	2359	0054	10	21	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1667	2359		X	X	X	
2	1600	0003		X	X	X	
3	1400	0008	X	X	X	X	
4	1050	0017		X	X	X	
5	900	0022		X	X	X	
6	750	0027	X	X	X	X	
7	680	0030		X	X	X	
8	550	0035		X	X	X	
9	500	0038	X	X	X	X	
10	100	0048	X	X	X	X	
11	50	0050	X	X	X	X	
12	10	0053	X	X	X	X	
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
1B18S	#50	039	1796	62	20.23	19	48.91

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
19/10/05	0342	0431	0531	40	21	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1790	0432		X	X	X	
2	1500	0441	X	X	X	X	
3	1100	0451		X	X	X	
4	1000	0455		X	X	X	
5	800	0500	X	X	X	X	
6	500	0508		X	X	X	
7	300	0513		X	X	X	
8	150	0517		X	X	X	
9	100	0519	X	X	X	X	
10	50	0522	X	X	X	X	
11	35	0525	X	X	X	X	
12	10	0527	X	X	X	X	
13							
14							
15							
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19							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB17	#51	040	1815	62	00.18	20	00.41

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
19/10/05	0806	0846	0950	4.5	19	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1800	0847		X		X	
2	1700	0851				X	
3	1500	0857				X	
4	1200	0905	X	X	X	X	
5	900	0913				X	
6	800	0917		X		X	
7	600	0923				X	
8	400	0930	X	X	X	X	
9	200	0935	X	X	X	X	
10	100	0939					
11	50	0941	X	X	X	X	
12	20	0944	X	X	X	X	
13	5	0946	X	X	X	X	
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB16S	# 52	041	2221	61	30.142	19	59.82

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
19/10/05	1353	1438	1538	15			

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2205	1439					
9	2205	1439	X	X	X	X	
2	1760	1452					
10	1760	1452		X			
3	1200	1504					
11	1200	1504	X	X	X	X	
4	850	1513					
12	850	1513		X			
5	300	1525					
13	300	1525	X	X	X	X	
7	100	1531					
14	100	1531	X	X	X	X	
6	50	1534					
15	50	1534	X	X	X	X	
8	10	1537					
16	10	1537	X	X	X	X	

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
IB15	#53	042	2380	61	15.67	20	00.83

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
19/10/05	1800	1849	1858	50	27	HEAVY SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	2330	1850					
9	2330	1850	X	X	X	X	
2	1900	1902					
10	1900	1903	X	X	X	X	
3	1200	1919					
11	1200	1919	X	X	X	X	
4	750	1930					
12	750	1929	X	X	X	X	
5	350	1939					
13	350	1939	X	X	X	X	
6	100	1947					
14	100	1946	X	X	X	X	
7	50	1950					
15	50	1951	X	X	X	X	
8	10	1953					
16	10	1953	X	X	X	X	

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
GB2	#54	043	618.5	58	58.28	13	34.83

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
23/10/05	1056	1114	1137	11	20	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	600	1115	X	X	X	X	
2	600	1115					
3	400	1121	X	X	X	X	
4	400	1121					
5	175	1127	X	X	X	X	
6	175	1127					
7	80	1130	X	X	X	X	
8	80	1130					
9	30	1133	X	X	X	X	
10	30	1133					
11	15	1135	X	X	X	X	
12	15	1135					
13	5	1137	X	X	X	X	
14	5	1137					
15							
16							
17							
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21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
GB3	#55	044	1013	58	58.59	13	27.12

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
23/10/05	1242	1305	1348	NR	22	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1002	1305		X			X
2	1002	1305					
3	975	1308		X			X
4	975	1308					
5	950	1311		X			X
6	950	1311					
7	925	1313		X			X
8	925	1313					
9	900	1316		X			X
10	900	1316					
11	850	1319		X			X
12	850	1319					
13	800	1322		X			X
14	800	1322					
15	700	1326					
16	700	1326		X			X
17	600	1330					
18	600	1330		X			X
19	500	1334		X			X
20	500	1334					
21	400	1337		X			
22	400	1337					
23	300	1341		X			
24	300	1341					

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
GB4	#56	045	1297	58	58.71	13	23.07

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
23/10/05	1445	1515	1556	10	22	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1288	1515		X			X
2	1288	1515					
3	1240	1518		X			X
4	1240	1518					
5	1150	1522		X			X
6	1150	1522					
7	1000	1526		X			X
8	1000	1526					
9	900	1530		X			X
10	900	1530					
11	630	1536		X			X
12	630	1536					
13	140	1546		X			X
14	140	1546					
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							

CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
GB5	#57	046	1559	58	59.01	13	11.87

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
23/10/05	1702	1738	1824	5	22	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1550	1739		X			X
2	1550	1739		X			X
3	1480	1742		X			X
4	1480	1742					
5	1300	1748		X			X
6	1300	1748					
7	1025	1755		X			X
8	1025	1755					
9	500	1806		X			X
10	500	1806					
11	50	1815		X			
12	50	1815					
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
GB6	#58	047	1498	59	00.08	12	57.16

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
23/10/05	1943	2020	2057	4.5	25	ROUGH	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	1498	2020				X	
2	1498	2020					
3	130	2044				X	
4	130	2044					
5	40	2048				X	
6	40	2048					
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
R	#59	048	130	56	59.98	008	59.98

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/98	0725	0736	0746	2.8	19	“NOT BAD”	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	132	0736				X	
2	60	0739				X	
3	5	0742				X	
4							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
16G	#60	049	129	56	54.93	008	38.30

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	0921	0932	0943	3.2	17	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	128	0932	X	X	X	X	
2	100	0934	X	X	X	X	
3	60	0937	X	X	X	X	
4	30	0939	X	X	X	X	
5	5	0941	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
T	#61	050	130	56	50.124	08	19.988

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	1120	1128	1139	9	15	MOD	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	123	1128	X	X	X	X	
2	110	1130	X	X	X	X	
3	60	1133	X	X	X	X	
4	30	1135	X	X	X	X	
5	5	1137	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
13G	#62	051	121	56	49.917	08	00.04

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	1344	1351	1400	8	0.3	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	114	1351	X	X	X	X	
2	100	1354	X	X	X	X	
3	20	1357	X	X	X	X	
4	5	1350	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
11G	#63	052	62	56	44.07	007	40.38

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	1604	1608	1621	8.7	16	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	55	1609	X	X	X	X	
2	32	1612	X	X	X	X	
3	15	1614	X	X	X	X	
4	5	1615	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M4	#64	053	117	56	49.22	007	23.19

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	1827	1838	1844	5	16	MOD SWELL	

ottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	117	1838					
2	117	1838					
3							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M9	#65	054	146	56	49.51	007	23.89

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/98	1914	1931	1937	3.8	15	MOD SWELL	

ottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	150	1931					
2	150	1931					
3							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M6	#66	055	113	56	49.31	07	24.16

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	1959	2015	2025	66	15	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	108	2015					
2	108	2015					
3							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M5	#67	056	111	56	49.25	07	24.68

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	2050	2100	2105	4.5	21	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	90	2100					
2	90	2100					
3							
4							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
M10	#68	057	193	56	48.29	07	23.97

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/05	2138	2153	2159	2.8	19.3	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	192	2153					
2	192	2153					
3	192	2153					
4							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
9G	#69	058	156	56	44.05	07	19.94

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
25/10/98	2250	2259	2309	4	21	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	155	2259	X	X	X		
2	100	2302	X	X	X		
3	30	2305	X	X	X		
4	5	2308					
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
8G	#70	059	175	56	44.175	007	10.029

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0022	0031	0031	10	15	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	168	0031				X	
2	120	0034				X	
3	10	0038				X	
4							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
7G	#71	060	135	56	44.017	06	59.96

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0202	0210	0219	8	15	MOD SWELL	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	130	0211	X	X	X	X	
2	110	0213	X	X	X	X	
3	90	0215	X	X	X	X	
4	5	0219	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
6G	#72	061	38	56	43.93	006	44.73

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0343	0348	0356	9	16	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	38	0349	X	X	X	X	
2	15	0351	X	X	X	X	
3	5	0353	X	X	X	X	
4							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
5G	#73	062	75	56	43.99	006	35.91

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0446	0453	0503	8	11	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	70	0454	X	X	X	X	
2	40	0456	X	X	X	X	
3	15	0458	X	X	X	X	
4	5	0459	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
4G	#74	063	84	56	44.04	006	26.87

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0609	0616	0626	10	12	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	75	0617	X	X	X	X	
2	40	0620	X	X	X	X	
3	15	0623	X	X	X	X	
4	5	0624	X	X	X	X	
5							
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
3G	#75	064	76	56	42.5	06	21.99

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0708	0716	0724	3.4	15	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	75	0716	X	X	X	X	
2	40	0718	X	X	X	X	
3	15	0720	X	X	X	X	
4	5	0722	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
2G	#76	065	38	56	41.04	06	16.92

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0803	0811	0817	NR	16	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	37	0811	X	X	X	X	
2	12	0813	X	X	X	X	
3	5	0815	X	X	X	X	
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CTD cast summary

RRS Charles Darwin cruise CD176

October 6 to 28, 2005

Station name	Event no	CTD no	Water depth (m)	Latitude (deg)	Latitude (min)	Longitude (deg)	Longitude (min)
1G	#77	066	180	56	40.01	06	08.06

Date	Time in (GMT)	Time at bottom	Time out (GMT)	Altimeter height (m)	Wind speed	Sea state	
26/10/05	0927	0938	0949	4.5	7	SLIGHT	

Bottle no	Depth	Time	Chl	Nutrients	POC	DO	Al
1	185	0938	X	X	X	X	
2	95	0942	X	X	X	X	
3	5	0947	X	X	X	X	
4							
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Appendix 2

Diary of Events

edited by

Peter Sarjeant

Master, *Charles Darwin*

CRUISE 176 DIARY OF EVENTS October 2005

Times in text are BST 'til 30th Oct.

2005-10-05 Vittoria Wharf, Birkenhead

0900 Scientific & Technical staff for CD 176 join vessel. Mobilisation work continues. Vessel taking FW & fresh provisions this day.

1500 Sign on of Scientific & Technical party + Safety Briefing & Familiarisation Tour.

2005-10-06

1036 Complete tests of ME, Bow Thrust & Steering Gear – all satisfactory.

1050 PoB

1104 ERSB

1113 Singled up F&A. ME @ dead slow ahead.

1117 All gone & clear

1131 Transitting Cut

1138 All fast in Alfred Basin

1222 Transitting lock on level

1250 Canada buoy abeam stbd

1355 Formby buoy abeam port

1401 Pilot away

1406 RFAOP; Bar Lt V/l 283 degs x 3.0 nm

1430 Anchors all secure

1615 All personnel mustered at Emergency then Boat Stations for drill purposes

1815 Cruise briefing by PS followed by logistics discussion

1958 Pt Lynas 199 degs x 21.5 nm; A/c 352 (T)

2200 54 18.8N 05 02.9W

2005-10-07

0015 Crammag Hd 086 degs x 5.6 nm; A/c 325 (T)

0400 Mull of Kintyre 005 degs x 4.4 nm

0500 Altararry Hd 219 degs x 7.8 nm; A/c 282 (T)

0830 55 31.9N 07 08.5W A/c 125 degs twds rvsd Trials position

1025 55 22.2N 06 43.7W Hove-to on Trials station

1032 PES deployed

1054-1123 CTD deployment

1132 Trace metals fish outboard, port qtr

1200 55 21.2N 06 39.9W Wind SxW 30 knots

1300-1340 Trial manoeuvres & cable length adjustment of TM fish

1358 55 20.1N 06 34.6W Cetacean hydrophone streamed

1409-1500			Trial manoeuvres
1521	55 27.9N	06 30.3W	Trials completed; set co towards Station 'R', Ellett Line
2000	56 06.4N	07 31.5W	

2005-10-08

0100	Barra Hd 075 degs x 27.2 nm		
0400	56 59.3N	08 59.0W	Hydrophone recovered
			Wind SW 17 knots
0424	57 00.0N	08 59.9W	Hove-to & CTD deployed (Station R)
0445			CTD recovered
0520			Sampling completed
0532			Hydrophone streamed on passage to Station Q
0614	57 02.6N	09 10.7W	Hydrophone recovered
0640	57 03.1N	09 12.9W	Hove-to & CTD deployed
0725			CTD recovered
0755			Sampling completed; v/l on passage to Station P
			Wind SW 20 knots
0904	57 06.0N	09 24.9W	Hove-to & CTD deployed
1037			@ 1403m & comm hauling
1140			Hauling @ slow rate due riding turn on CTD winch
1200			Wind SW 26 knots
1307	57 06.2N	09 26.0W	CTD recovered
1443			Sampling complete; v/l passaging to deeper water to re-scroll CTD wire
1450			Hydrophone streamed
1600			Wind SW 21 knots
2000			Wind SW 24 knots
2022	57 02.5N	10 39.3W	Hydrophone recovered
2034	57 02.4N	10 39.8W	Hove-to & veering clump-weighted CTD wire
2130			Comm hauling from 2250m wire out
2220			Wire re-wound & weight recovered
2230	57 02.3N	10 39.3W	Deck secure & v/l on passage to Station O
2242			Hydrophone streamed
2359			Wind SWxW 27 knots

2005-10-09

0150	57 08.8N	09 43.3W	Hydrophone recovered
0206	57 09.2N	09 41.8W	Hove-to on Station; assessing Wx conditions & forecast
0224			V/l remains hove-to, commencing weather downtime
0256			Trace metal fish recovered
0304			Deck secure & all weather doors fastened

0400	57 07.2N	09 43.0W	Wind SWxS 25 knots
0800	57 01.6N	09 43.7W	
1200	56 58.4N	09 54.0W	S'ly 36 knots; 995 mbars
1600	56 54.2N	10 03.2W	SSW 41 knots; 988 mbars
2000	56 47.8N	10 08.6W	SSW 42 knots; 988 mbars
2359	56 40.9N	10 11.0W	SW 26 knots; 994 mbars

2005-10-10

0400	56 35.4N	10 19.3W	WSW 18 knots; 996 mbars
0720	56 33.1N	10 26.7W	V/l turned through heavy residual swell & returning to Station O
0800			Wind SWxW 14 knots; Mod/heavy SW'ly swell
0842			Hydrophone streamed
1150	57 07.8N	09 43.0W	Hydrophone recovered
1200			Wind SxW 21 knots
1237			Hove-to on station & test weight deployed for CTD winch test
1306			Weight recovered
1350	57 09.3N	09 42.3W	Trace Metals fish deployed
1355			CTD deployed @ Station O
1444			Veered to 1920m & commence hauling/sampling
1558	57 09.0N	09 43.0W	CTD recovered
			Wind SSW 19 knots
1642			Sampling complete; streaming hydrophone on passage to Stn N
1800			Hydrophone recovered
1821	57 13.8N	10 02.9W	Hove-to & CTD deployed
1944			Veered to 2090m & commence hauling/sampling
2000			Wind SWxW 18 knots
2106			CTD recovered; commence passage to Stn M
2124			Hydrophone streamed
2251			Hydrophone recovered
2322	57 18.0N	10 22.9W	Hove-to & CTD deployed
2359			Wind SWxW 14 knots

2005-10-11

0042	57 18.2N	10 22.9W	Veered to 2200m & commence hauling/sampling
0209			CTD recovered
0229			Hydrophone streamed on passage to Stn L
0327			Hydrophone recovered
0400	57 22.0N	10 40.1W	Hove-to & CTD deployed
			Wind WSW 9 knots
0513			Veered to 2110m & commence hauling/sampling

0634			CTD recovered
0650			Hydrophone streamed on passage to Stn K
0735			Hydrophone recovered
0746	57 24.1N	10 51.8W	Hove-to @ Stn K
			Wind WSW 12 knots
0835			CTD deployed
0917			Veered to 786m & commence hauling/sampling
0955			CTD recovered
1009			Hydrophone streamed on passage to Stn J
1058			Hydrophone recovered
1109	57 27.0N	11 04.9W	Hove-to & CTD deployed
1136			Veered to 583m & commence hauling/sampling
1209			CTD recovered
			Wind WSW 10 knots
1216			Relocating for Mooring recovery
1244	57 25.4N	11 07.6W	Hove-to 0.4nm downwind of site; interrogating
1249			Release triggered
1320			Closing in on site; acoustic release believed horizontal on seabed
1335	57 25.2N	11 08.3W	Sitting on site; range to acoustic release 630m (depth 610m)
1355			Horizontal range to site 0.25nm; release commands repeated
1420	57 25.2N	11 08.3W	Acoustic release again verified on seabed beneath ship
			Same depth/range readings as before. Recovery attempts aborted
1440	57 25.3N	11 08.8W	V/l heading for Station I
1545	57 28.0N	11 19.2W	Hove-to & CTD deployed
			Wind WxS 10 knots
1645			CTD recovered
1657			Hydrophone streamed on passage to Stn H
1737			Hydrophone recovered
1749	57 29.0N	11 32.0W	Hove-to & CTD deployed
1840			Veered to 2005m; commence hauling/sampling
1948			CTD recovered
1959			Hydrophone streamed on passage to Stn G
			Wind SW'ly 5 knots
2100			Hydrophone recovered
2108	57 29.5N	11 50.9W	Hove-to @ Stn G awaiting scientists/technicians
2210			CTD deployed
2307	57 29.5N	11 51.5W	Veered to 1785m; commence hauling/sampling
2359			Wind NxW 5 knots

2005-10-12

0025			CTD recovered
0037			Hydrophone streamed on passage to Stn F
0149			Hydrophone recovered
0214	57 30.6N	12 15.0W	CTD deployed
0300			Veered to 1800m; commence hauling/sampling
0415			CTD recovered
			Wind Lt & Variable
0429			Hydrophone streamed on passage to Stn E
0530			Hydrophone recovered
0546	57 31.9N	12 37.3W	Hove-to & CTD deployed
0627			Veered to 1647m; commence hauling/sampling
0734			CTD recovered; v/l relocating to Stn D1
0812	57 32.2N	12 44.9W	Hove-to @ Stn D1 awaiting scientists
			Wind SE'ly 5 knots
0905			CTD deployed
0948			Veered to 1453m; commence hauling/sampling
1056			CTD recovered; v/l relocating to Stn D
1105			Swath running
1210	57 32.5N	12 52.0W	Hove-to & CTD deployed
			Wind SxW 5 knots
1241			Veered to 1056m; commence hauling/sampling
1333			CTD recovered
1342			Hydrophone streamed on passage to Stn A
1602	57 34.4N	13 30.1W	Rockall It brng 284 degs x 5.9nm
			Wind SWxW 7 knots
1633			Hydrophone recovered
1652	57 35.1N	13 38.0W	Hove-to & CTD deployed
1702			Veered to 102m; commence hauling/sampling
1718			CTD recovered
1721			CVTMO passing Rockall Islet
1800	57 35.7N	13 41.2W	Set co 098 degs for Stn B
1813			Hydrophone streamed
1916			Hydrophone recovered
1928	57 34.0N	13 19.9W	Hove-to & CTD deployed
1952			CTD recovered
			Wind SW'ly 6 knots
2006			Hydrophone streamed on passage to Stn C
2109			Hydrophone recovered
2120	57 32.9N	12 59.9W	Hove-to & CTD deployed
2136			Veered to 294m; commence hauling/sampling

2156			CTD recovered
2205			Deck secure; v/l on 22hr passage to Wyville Thomson Ridge area - decision based on 3-day Wx prognoses
2215			Hydrophone streamed
2359			Wind WxS 7 knots

2005-10-13

0400	58 06.9N	11 30.4W	Wind WSW 9 knots
1200	58 55.4N	09 19.9W	Wind W'ly 9 knots
1615			Emergency & Boat drills conducted
			Wind WxS 13 knots
2006			Hydrophone recovered
			Wind WxS 12 knots
2030	59 43.0N	07 08.8W	Hove-to on Stn WTSa & Megacore deployed
2102			Megacore triggered @ 1114m; commence hauling
2140			Megacore recovered
2154			Replicate coring
2300			Repositioning
2312	59 43.1N	07 09.3W	Megacore deployed
2340			Megacore triggered @ 1116m; commence hauling
2359			Wind SWxW 12 knots

2005-10-14

0008			Megacore recovered
0018			Replicate coring
0122			Recovered & secured
0139	59 43.3N	07 07.6W	Hydrophone streamed on passage towards Stn WTNb
0400			Wind SW 9 knots
0530			Hydrophone recovered
0554	60 05.7N	06 03.8W	Hove-to & Megacore deployed
0626			Megacore triggered @ 1164m; commence hauling
0656			Recovered
0707			Replicate coring
0817			Replicate coring
			Wind S'ly 12 knots
0916	60 05.8N	06 03.9W	Megacore recovered; set co for FSC2
0929			Hydrophone streamed
1014			Hydrophone recovered
1028	60 12.9N	06 11.8W	Hove-to & CTD deployed
1106			Veered to 1196m; commence hauling/sampling

1158		CTD recovered; repeat requested by PS due leaking bottles
		Wind SxE 16 knots
1216	60 12.8N 06 12.1W	CTD deployed
1256		Veered to 1195m; commence hauling/sampling
1346		CTD recovered; v/l relocating
1452	60 18.0N 06 06.9W	Hove-to & CTD deployed @ FSC1
1512		Veered to 620m; commence hauling/sampling
1529		CTD recovered
1544		Relocating to WTNb core station @ Master's request
		Wind SExS 20 knots
1601-1718		Hove-to for CTD/Box corer shift & set up
1828	60 05.8N 06 03.6W	Hove-to & NIOZ corer deployed
1853		On bottom @ 1178m & commence hauling
1922		Corer recovered; securing & repositioning
1959	60 06.1N 06 04.5W	Corer deployed
		Wind SExS 20 knots; building SW'ly swell
2030		On bottom @ 1169m & commence hauling
2059		Corer recovered; securing & repositioning
2134	60 05.9N 06 04.1W	Corer deployed
2200		On bottom @ 1160m & commence hauling
2226		V/l head to swell for & corer recovered
2334		Equipment changeover completed; v/l on passage to FSC3
2344		Hydrophone deployed
2359		Wind SExS 16 knots; moderate SW'ly swell

2005-10-15

0029		Hydrophone recovered
0057	60 05.0N 06 19.1W	Hove-to & CTD deployed
0130		Veered to 1085m; commence hauling/sampling
0200		CTD recovered; v/l relocating to FSC4
0302	60 00.9N 06 21.1W	Hove-to & CTD deployed
0330		Veered to 915m; commence hauling/sampling
0405		CTD recovered
		Wind SSE 18 knots; mod/heavy SW'ly swell
0445		Deck secure
0458		Hydrophone streamed on passage towards Stn FSC5
0800		Wind SSE 15 knots; heavy SSW'ly swell
1125		Hydrophone recovered
1200	60 25.6N 08 14.1W	Hove-to @ FSC5 assessing weather
		Wind SSE 18 knots; heavy SSW'ly swell

1212		Hove-to; Wx downtime
		Wind SSE 18 knots; Heavy SSW'ly swell
1300		Wind S'ly 27 knots
1500		Wind S'ly 22 knots
1800	60 18.1N 08 24.9W	SxE 20 knots; heavy SSW'ly swell
2130	60 13.8N 08 25.9W	Moderating conditions; set co. for Stn 'D0'
2152		Hydrophone streamed
2358		Hydrophone recovered
		Wind SExS 16 knots

2005-10-16

0009	60 20.2N 09 01.7W	Hove-to on station
0042		CTD deployed
0105		Veered to 460m; commence hauling/sampling
0127		CTD recovered; securing & relocating to 'D1A'
0227	60 17.4N 09 01.6W	Hove-to on station
0242		CTD deployed
0315		Veered to 750m; commence hauling/sampling
0344		CTD recovered
0400		Deck secure; proceeding to 'D2'
		Wind SxE 18 knots
0435	60 16.7N 09 00.9W	Hove-to & CTD deployed
0517		Veered to 750m; commence hauling/sampling
0545		CTD recovered; slow steaming towards 'D3' whilst sampling
0627	60 15.7N 09 00.7W	Hove-to & CTD deployed
0712		Veered to 1095m; commence hauling/sampling
0755		CTD recovered; slow steaming towards 'D4' whilst sampling
		Wind SExS 17 knots
0850	60 15.0N 09 00.4W	Hove-to & CTD deployed
0944		Veered to 1135m; commence hauling/sampling
1039		CTD recovered
1046		Secure; swathing diversion en route to next station
1148	60 13.9N 08 59.3W	Hove-to @ Stn 'D5' & CTD deployed
		Wind SE 16 knots
1222		Veered to 880m; commence hauling/sampling
1256		CTD recovered; relocating to Stn 'D7'
1332		Hove-to @ 'D7'
1343	60 11.3N 08 57.9W	CTD deployed
1359		Veered to 417m; commence hauling/sampling
1423		CTD recovered

1437			Swathing along selected tracks, general direction of ADCP site
1533	60 14.8N	08 52.0W	Hove-to preparing mooring for release
1557	60 14.365N	08 52.198W	ADCP bottom mooring released inti 1125m water
			Wind SExS 12 knots; mod/long SSW'ly & mod/average S'ly swell
1610	60 13.8N	08 52.6W	Commence swath survey
1622			Hydrophone deployed
1722	60 11.3N	08 51.9W	A/c 358 degs
1816	60 18.9N	08 53.6W	Complete turn to 140 degs
1928	60 11.2N	08 40.2W	Complete turn to 012 degs
2050	60 24.9N	08 33.7W	Complete turn to 086 degs
2159			Hydrophone recovered
2202	60 25.5N	08 14.7W	Hove-to @ FSC5 @ completion of Swath survey
2212			CTD deployed
2244			Veered to 760m; commence hauling/sampling
2324			CTD recovered
2330	60 25.9N	08 14.2W	Deck secure; set co for 63 00N 20 00W – on passage to Iceland
2341			Hydrophone streamed
			Wind SE'ly 11 knots

2005-10-17

0400	60 44.2N	09 37.1W	Wind SE'ly 9 knots
0800	61 00.9N	10 50.0W	Wind SE'ly 8 knots
1200	61 18.0N	12 07.3W	Wind ExS 7 knots
1600	61 37.4N	13 22.0W	Wind ExS 11 knots
2000	61 56.6N	14 36.5W	Wind E'ly 10 knots
2359	62 15.9N	15 52.1W	Wind ENE 9 knots

2005-10-18

0400	62 35.1N	17 09.0W	Wind ESE 8 knots
0800	62 55.0N	18 27.5W	Wind ExS 12 knots
1200	63 11.4N	19 49.1W	Wind ENE 19 knots; V/l closing on Stn IB22S
1246	63 13.0N	20 04.1W	Hove-to on station; delay due to ADCP fault on CTD
1320	63 13.0N	20 03.9W	CTD deployed
1339			Veered to 650m; commence hauling/sampling
1406			CTD recovered; securing & v/l on passage to IB23S
1509	63 19.0N	20 12.2W	Hove-to & CTD deployed; Surtsey Is brng 267 degs x 10.44nm
1520			Veered to 120m; commence hauling/sampling
1534			CTD recovered; securing & in transit towards IB21S
1600			Wind ESE 14 knots
1717	63 08.1N	19 55.1W	Hove-to on station

1725		CTD deployed
1754		Veered to 1020m; commence hauling/sampling
1830		CTD recovered; securing & in transit towards IB20S
2000		Wind E'ly 18 knots
2036	62 55.0N 19 32.6W	Hove-to on station
2042		CTD deployed
2121		Veered to 1403m; commence hauling/sampling
2212		CTD recovered; securing & in transit towards IB19S
2359		Wind NExE 18 knots

2005-10-19

0012	62 40.0N 19 40.2W	Hove-to on station
0021		CTD deployed
0100		Veered to 1667m; commence hauling/sampling
0158		CTD recovered; securing & in transit towards IB18S
0400		Wind ExN 23 knots
0435	62 20.0N 19 50.0W	Hove-to on station
0443		CTD deployed
0553		Veered to 1790m; commence hauling/sampling
0630		CTD recovered; securing & in transit towards IB17
0800		Wind ENE 22 knots
0855	62 00.0N 20 00.0W	Hove-to on station
0905		CTD deployed
0948		Veered to 1800m; commence hauling/sampling
1051		CTD recovered; securing & v/l in transit towards IB16
1148-1155		Temporary heave-to to exchange CTD rigs
1200		Wind ENE 21 knots
1437	61 30.0N 20 00.0W	Hove-to on station awaiting OED
1453		CTD deployed
1540		Veered to 2205m; commence hauling/sampling
1600		Wind NE 26 knots
1641		CTD recovered
1656		Deck secure; v/l in transit towards IB15
1837	61 15.0N 20 00.1W	Hove-to on station
1859		CTD deployed
1948	61 15.7N 20 00.8W	Argos float released
1951		CTD veered to 2330m; commence hauling/sampling
2000		Wind NE 32 knots
2100		CTD recovered

2128			Sampling complete & deck secure; v/l in transit to IB13 @ Master's req
2359	60 54.7N	20 00.0W	Wind NE 28 knots

2005-10-20

0253	60 30.0N	20 02.9W	V/l hove-to; Master assessing conditions
0306			V/l on weather downtime, hove-to head-to-sea @ min revs
0400			Wind NE 31 knots
0800	60 32.4N	19 58.0W	Wind NE 35 knots; rough sea, heavy swell
1200	60 37.3N	19 56.4W	Wind NExE 30 knots
1600	60 44.2N	19 50.0W	Wind NE 31 knots; rough sea, v. heavy swell
1700	60 45.9N	19 48.2W	V/l swung to port & running down-wind
1915	60 29.8N	20 12.8W	V/l swung & hove-to head to weather
2000			Wind NE 25 knots; rough sea, very heavy swell
2359			Wind NE 30 knots

2005-10-21

0400	60 33.5N	19 50.8W	Wind NE 32 knots; rough sea, very heavy swell
0800			Wind NE 32 knots
0900			PS chairs meeting to review science in light of weather info.
0930	60 38.4N	19 38.1W	V/l swung to port to run before weather; relocating to Stn IB9
1200	60 14.8N	19 55.5W	Wind NE 32 knots; v. heavy quartering sea & swell
1600	59 36.9N	20 26.8W	A/c to 090 (G) towards IB9; Wind NE 28 knots
2000	59 35.5N	19 49.6W	Wind NE 30 knots; rough sea, v. heavy swell
2359	59 36.2N	19 13.6W	Wind NE 30 knots; V/l making good 4.5 knots towards IB9

2005-10-22

0400	59 34.3N	18 34.6W	Wind NExE 24 knots; mod/rough sea, heavy swell
0700	59 33.5N	18 04.8W	A/c to 200 (G) running downwind towards IB9
0800	59 25.5N	18 09.6W	Wind NExE 28 knots
0840	59 19.9N	18 14.4W	V/l heaving-to @ IB9; PS meeting to assess Wx prospects
0914	59 19.9N	18 12.7W	Decision to run Swath line E'ward across Hatton Bank
			Set co to make good 105 degs
1200	59 16.1N	17 44.5W	Wind ENE 28 knots; rough sea, heavy swell
1600	59 11.0N	17 04.5W	Wind ExN 25 knots
1630			Adjust co to 098 degs towards George Bligh Bank
1730			Adjust co to 103 degs to ease motion
2000	59 05.2N	16 26.1W	Wind ExN 30 knots; rough sea, heavy swell
2359	58 59.7N	15 46.8W	Wind ENE 25 knots

2005-10-23

0400	58 54.8N	15 05.1W	Wind ExN 26 knots; rough sea, heavy swell
0720			Adjust co to 083 degs towards George Bligh Bank
0800	58 53.0N	14 20.2W	Wind E'ly 30 knots
0830			Hydrophone streamed
0930	58 54.4N	13 59.2W	Adjust co to 073 degs towards Stn GB2
1112			Hydrophone recovered
1122	58 58.2N	13 35.6W	V/l hove-to on station; shifting gear & set up
1157			CTD deployed
			Wind E'ly 22 knots; moderate sea & swell
1216			Veered to 600m; commence hauling/sampling
1241			CTD recovered; securing & set co for GB3
1342	58 58.6N	13 27.2W	Hove-to & CTD deployed
1406			Veered to 1002m; commence hauling/sampling
1452			CTD recovered; securing & set co for GB4
1531			Hove-to on station
1544	58 58.9N	13 23.0W	CTD deployed
1600			Wind ESE 24 knots
1616			Veered to 1288m; commence hauling/sampling
1653			CTD recovered; securing & set co for GB5
1707			Hydrophone deployed
1744			Hydrophone recovered
1753			Hove-to on station
1803	58 59.0N	13 11.9W	CTD deployed
1836			Veered to 1550m; commence hauling/sampling
1921			CTD recovered; securing and set co for GB6
1930			Hydrophone deployed
2000			Wind ExS 30 knots; rough sea, low/mod swell
2028			Hydrophone recovered
2040	59 00.0N	12 57.1W	Hove-to & CTD deployed
2121			Veered to 1498m; commence hauling/sampling
2155			CTD recovered in building sea conditions; securing on deck
2210			Samples recovered & deck secure; set co for NRB7
2359	58 50.5N	12 52.8W	Transit to NRB stations suspended due weather conditions
			V/l strng 160 (G) @ 90 rpm
			Wind ExS 35 knots; rough sea, mod/heavy swell

2005-10-24

0400	58 34.8N	12 47.9W	Strng 160 (G), making good 3.2 knots
			Wind E'ly 35 knots
0800	58 19.3N	12 41.7W	Wind ExS 32 knots

1200	58 03.7N	12 26.0W	Wind E'ly 33 knots; rough sea, heavy swell
1600	57 49.0N	12 12.5W	Stng 128 (G); making good 3.8 knots
			Wind E'ly 35 knots
1900			Adjust co to 140 (G) & incr to 105 rpm
2000	57 35.2N	11 52.5W	Wind E'ly 30 knots
2200			Wind S'ly 16 knots; Adjust co to 135 (G) & incr to 120 rpm
2359	57 13.5N	11 13.6W	Wind SSW 16 knots

2005-10-25

0006	57 12.9N	11 12.3W	Set co 100 (G) for Stn R (Shelf edge) on Ellett Line
0400	57 07.0N	10 11.1W	Wind SWxS 22 knots; moderate confused sea & swell
0824	57 00.0N	08 59.9W	V/l hove-to on station for resumption of science
0826			CTD deployed (Stn R)
0833			Trace metals fish recovered
0837			CTD veered to 132m; commence hauling/sampling
0847			CTD recovered; securing & set co for Stn 16G
0900			Hydrophone streamed
1010			Hydrophone recovered
1020	56 55.0N	08 38.3W	Hove-to & CTD deployed
1033			Veered to 128m; commence hauling/sampling
1044			CTD recovered; securing & set co for Stn T
1057			Hydrophone streamed
1159			Hydrophone recovered
1220	56 50.1N	08 20.0W	Hove-to & CTD deployed
1229			Veered to 123m; commence hauling/sampling
1242			CTD recovered; securing & set co for Stn 13G
1256			Hydrophone streamed
1419			Hydrophone recovered
1443	56 46.9N	08 00.0W	Hove-to & CTD deployed
1453			Veered to 114m; commence hauling/sampling
1504			CTD recovered; securing & set co for Stn 11G
1523			Hydrophone streamed
1621			Hydrophone recovered
			Wind SW 12 knots
1644	56 44.1N	07 39.9W	Hove-to on station
1704			CTD deployed
1710			Veered to 55m; commence hauling/sampling
1718			CTD recovered; securing & set co for Mingulay Stns
1735			Hydrophone streamed
1835			Hydrophone recovered

1843	56 49.0N	07 23.3W	Commence seabed survey in vicinity of coral beds
1921			Commence CTD deployments x 5 over coral beds
			Sites as follows: M4 56 49.25N 07 23.19W
			M9 56 49.50N 07 23.91W
			M6 56 49.31N 07 24.18W
			M5 56 49.23N 07 24.70W
			M10 56 48.26N 07 23.95W
2000			Wind WSW 16 knots; mod sea & swell; v/l head to sea
2300			Series completed; set co for Stn 9G
2351	56 44.0N	07 19.9W	Hove-to & CTD deployed
			Wind WSW 20 knots

2005-10-26

0001			CTD veered to 155m; commence hauling/sampling
0012			CTD recovered; securing & set co for Stn 8G
0122	56 44.1N	07 10.1W	Hove-to & CTD deployed
0133			Veered to 168m; commence hauling/sampling
0143			CTD recovered; securing & set co for Stn 7G
0303	56 44.0N	07 00.0W	Hove-to & CTD deployed
0312			Veered to 130m; commence hauling/sampling
0323			CTD recovered; securing & set co for Stn 6G
0400			Wind WSW 12 knots
0443	56 44.0N	06 44.8W	Hove-to & CTD deployed
0449			Veered to 38m; commence hauling/sampling
0455			CTD recovered; securing & set co for Stn 5G
0544	56 44.0N	06 35.9W	Hove-to & CTD deployed
0554			Veered to 70m; commence hauling/sampling
0603			CTD recovered
0624	56 43.9N	06 35.7W	PES recovered; Anchors cleared away; v/l set co for Stn 4G
0708	56 44.0N	06 26.9W	Hove-to & CTD deployed
0717			Veered to 75m; commence hauling/sampling
0725			CTD recovered; securing & set co for Stn 3G
0800			Wind SWxS 10 knots
0808	56 42.5N	06 22.0W	Hove-to & CTD deployed
0816			Veered to 75m; commence hauling/sampling
0826			CTD recovered; securing & set co for Stn 2G
0904	56 41.1N	06 16.9W	Hove-to & CTD deployed
0910			Veered to 37m; commence hauling/sampling
0917			CTD recovered; securing & set co for Stn 1G
1016	56 40.0N	06 08.0W	Hove-to on Station

1027		CTD deployed
1039		Veered to 185m; commence hauling/sampling
1054		CTD recovered; End of Scientific sampling
		Personnel processing, report writing & clewing-up
1111	56 39.9N 06 05.5W	V/l entering Sound of Mull; Ardmore Pt 251 degs x 1.3nm
1200		Wind S'ly 9 knots
		Co & Spds various along Sound, selecting optimum anchorage
1600		Approaching Salen anchorage
1609		Let go stbd anchor
1616		Brought up at 5 sh in water
1724		RFWE; BT available; ER watches
2000		Wind SSE 28 knots
2359		Wind SxE 12 knots

2005-10-27

0400	Wind SxE 18 knots
0800	Wind SSE 25 knots
1030	Both L'boats lowered to embarkation deck for planned maintenance & recovered.
1200	Wind SSE 25 with gusts to 40 knots
1600	Wind SExS 30 knots; Port anchor veered to 1.5 sh in water as 'dredge'; BT off – to 1 genny
2000	Wind SExS 32 knots
2359	Wind SSE 32 knots

2005-10-28

0400	Wind SSE 38 knots
0606	ME, BT & Steering gear tested & satis
0624	ERSB
0635	Comm. Heaving port anchor
0639	Port anchor home
0641	Comm. Heaving stbd anchor
0655	Anchor sighted & clear
0705	Rounding Eileanan Glas & SE bound, Sound of Mull
0800	Wind SSE 30 knots
0858	Entering Duart Bay
0914	Hove-to
0920	'Calanus' secure alongside
0936	Transfer of gear & personnel complete
0938	'Calanus' clear; v/l manoeuvring out of Duart Bay

1000		Resume passage; Lady's Rock brng 044 degs x 0.4nm
1200	56 11.3N 05 53.7W	Wind S'ly 24 knots
1330-1500		Transitting Sound of Islay
2000	55 01.0N 05 41.1W	
2359	54 27.4N 05 16.3W	Wind SxW 19 knots

2005-10-29

0600	53 36.3N 05 18.3W	Wind SSW 19 knots
1200	52 49.1N 05 27.8W	Wind SSE 31 knots; V/l 196 degs @ 5.5 knots
1800	52 24.0N 05 39.1W	Wind S'ly 38 knots
2359	52 03.3N 05 49.2W	Wind SxW 31 knots

2005-10-30

Clocks retarded 1 hr @ 0200BST to UTC

0200 UTC		Transitting Smalls TSS @ 5 knots
0600	51 28.8N 06 03.1W	Wind S'ly 33 knots
1200	50 53.8N 06 01.7W	Wind S'ly 28 knots
1800	50 28.1N 06 02.3W	Wind SWxS 30 knots
2306	49 50.0N 06 01.2W	V/l clear of Scillies TSS, A/c 090 degs; speed 6 knots

2005-10-31

0400	Rounding Lizard Pt @ approx 7nm range.
0700	4nm S of Helston buoy; preparations for arr. Falmouth

1609	First lines
1617	All fast 4&2 F&A
1618	RFWE

P. Sarjeant

Master