R.V. "Charles Darwin" 92/95 Cruise Report

April 6th to May 2nd 1995

Natural Environment Research Council
Dunstaffnage Marine Laboratory
P.O.Box 3 Oban
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Marine Physics Group Cruise Report, May 5th 1995

Anton Edwards & Martyn Harvey

LEG 1 (6-13th April)

Fairlie to Dunstaffnage

Aims

1. To identify suitable sites on the LOIS northern mooring line for benthic process studies at depths of approx. 400, 700, 1000 and 1500 metres.
2. To carry out first set of process measurements in the LOIS study at these sites

Scientific Personnel

Martyn Harvey	DML (Principal Scientist)	Jim Watson	DML
Lynda Mitchell	SAMS	Andrew Patience	SAMS
Ann-Marie Habin	University of Liverpool.	Jane Foster	University of Edinburgh
John Hughes	BODC	Valerie Cummings	BODC
		Julie Armishaw	University of Southampton

Narrative

On April 6th, "Charles Darwin" sailed from Fairlie in calm conditions for station 1500N. A small delay occurred when some flotsam wreckage was recovered in the North Channel in the evening. Progress was slow in the night with heavy seas but station N1500 was reached about midday on the 7th and the coring programme was started. It continued in good calm conditions until the 10th April after which wind increased but conditions remained workable until 12th April when the ship reached Dunstaffnage Bay to await transfer of staff for leg 2.

Results

The ship's track is shown in figure 1. The description of cores is made according to those responsible. The following tables summarise all cores taken during this leg of the cruise .

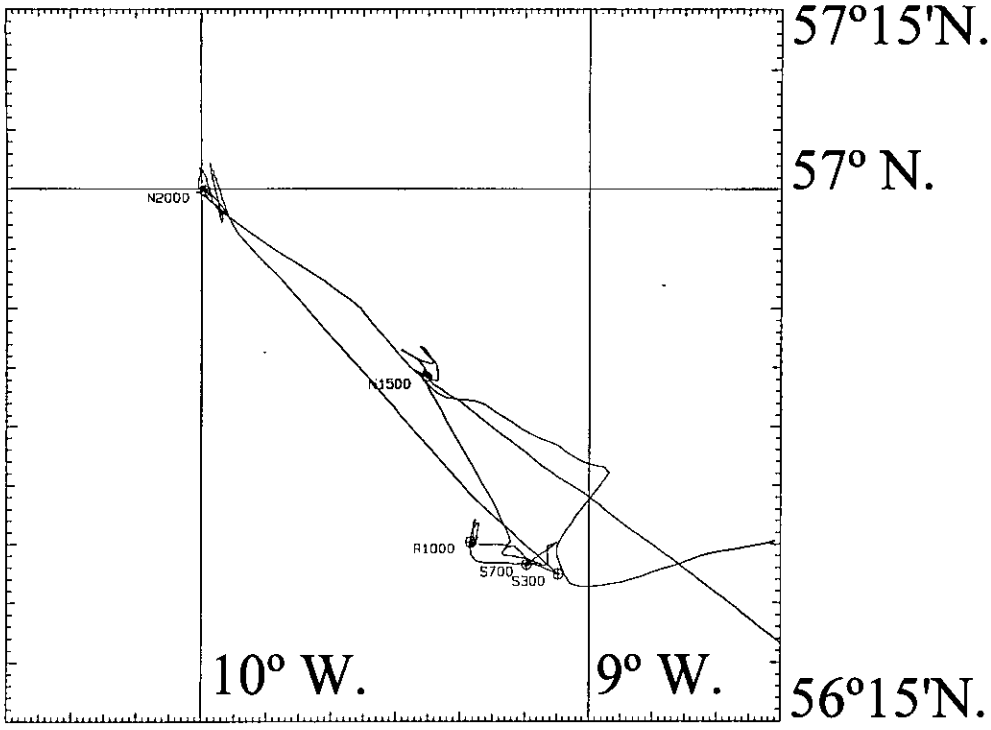


Figure 1: Tracks in Leg 1.

Table 1 : CD92a/95 NISKIN bottle casts

Cruise ID	Cast ID	Est. time of bottle firing	Station	Lat. °N.	Lon. ° W	Water depth, metres	Comments
CD92A	NWB1	07/04/95 12:12	N1500	56.74	9.42	1535	Failed to close
CD92A	NWB2	07/04/95 13:18	N1500	56.74	9.43	~1540	
CD92A	NWB3	07/04/95 14:30	N1500	56.74	9.44	~1540	
CD92A	NWB4	08/04/95 14:52	R1000	56.5	9.31	~1015	
CD92A	NWB5	08/04/95 15:42	R1000	56.51	9.29	~1000	
CD92A	NWB6	10/04/95 05:25	S700	56.47	9.16	~690	
CD92A	NWB7	10/04/95 06:03	S700	56.47	9.16	~685	
CD92A	NWB8	11/04/95 05:59	N2000	57	10	~2068	
CD92A	NWB9	11/04/95 07:27	N2000	57	9.99	~2055	

Table 2: CD92a/95 Box Cores

Cruise	Event	Date/time	Station	D	Lat. °N	Lon. °W	Depth	Comments
Key: S = Short Core; M = medium core; L = Long core. Jane, Martyn, Lynda, Julie : processed as below.								
CD92A	BC1	08/04/95 09:42	N1500	1	56.74	9.42	~1540	3 subcores (Julie), surface (Jane)
CD92A	BC2	08/04/95 11:38	N1500	2	56.74	9.42	~1540	300 micron sift for John Gage
CD92A	BC3	09/04/95 08:56	R1000	1	56.5	9.3	1010	3 subcores (Julie), surface (Jane)
CD92A	BC4	09/04/95 13:16	S700		56.47	9.16	685	No mud
CD92A	BC5	09/04/95 16:37	S700		56.47	9.16	680	A little mud; 3 subcores (Julie)

Table 2: CD92a/95 Box Cores

Cruise	Event	Date/time	Station	D	Lat. °N	Lon. °W	Depth	Comments
CD92A	BC6	09/04/95 17:57	S700		56.47	9.16	690	300 micron sift for John Gage
CD92A	BC7	11/04/95 14:45	N2000		57	10	~2055	Empty!
CD92A	BC8	11/04/95 15:53	N2000		57	10.01	~2060	Empty!
CD92A	MC1	07/04/95 15:55	N1500	1	56.74	9.42	~1540	Jane 1S Martyn 4S Lynda 3S AM 1S2L
CD92A	MC2	07/04/95 17:13	N1500	2	56.74	9.42	~1540	Jane 1S Martyn 3S Lynda 4S AM 1S2L
CD92A	MC3	07/04/95 18:30	N1500	3	56.74	9.42	1545	Jane 1S Martyn 3S Lynda 4S AM 1S2L
CD92A	MC4	09/04/95 05:27	R1000		56.5	9.3	1010	Empty!
CD92A	MC5	09/04/95 06:04	R1000	1	56.5	9.3	~1010	Jane 1S Martyn 4S Lynda 3S AM 1S2L
CD92A	MC6	09/04/95 06:56	R1000	2	56.5	9.3	~1010	Jane 1S Martyn 3S Lynda 3S AM 1S2L
CD92A	MC7	09/04/95 07:51	R1000	3	56.5	9.31	~1010	Jane 1S Martyn 3S Lynda 3S AM 1S2L
CD92A	MC8	10/04/95 07:06	S700		56.47	9.16	~685	Empty!
CD92A	MC9	10/04/95 07:40	S700	1	56.47	9.17	~680	Jane 1S Lynda 3S AM 1L 2S
CD92A	MC10	10/04/95 08:30	S700	2	56.47	9.16	680	Jane 1S Martyn 4S Lynda 2S AM 3S
CD92A	MC11	10/04/95 09:15	S700	3	56.47	9.16	675	Jane 1S Martyn 3S Lynda 3S AM 3S
CD92A	MC12	10/04/95 09:56	S700	4	56.47	9.16	675	Martyn 3S Lynda 2S (5S wasted)
CD92A	MC13	10/04/95 11:26	S300		56.46	9.08	395	4 tubes to test bottom - & it's NBG!
CD92A	MC14	11/04/95 08:49	N2000	1	57	10	~2055	Jane 1S Martyn 4S Lynda 2S AM 3S
CD92A	MC15	11/04/95 10:16	N2000	2	57	10	~2055	Jane 1S Martyn 3S Lynda 3S AM 3S
CD92A	MC16	11/04/95 11:45	N2000	3	57	10	~2055	Jane 1S Martyn 3S Lynda 3S AM 3S
CD92A	MC17	11/04/95 13:11	N2000	4	57	10	~2055	Lynda 2S Julie 2S

Key: S = Short Core; M = medium core; L = Long core. Jane, Martyn, Lynda, Julie : processed as below.

Table 3: CD92a/95 Sholkovitz Gravity Cores

Cruise	Event	Date/time	Stn	Lat N	Lon W	Depth	Comments
CD92A	SC1	08/04/95 07:55	N1500	56.74	9.42	1,530	
CD92A	SC2	08/04/95 16:49	R1000	56.5	9.3	9,985	
CD92A	SC3	10/04/95 16:47	N2000	57	9.99	2,060	

Lynda Mitchell (SAMS)

Cores:

1500 m1 1 m cores (3 for C isotope analysis, 3 for lead 210, 3 for meiofauna, 2 for forams).

1 short Sholkovitz (~ 30cm) for lead 210.

1 box - sieved for size class analysis of fauna.

1000m10 m/cores (as 1500m station but 1 core only for forams).

1 Sholkovitz, almost 1m long.

700m10 m/cores as 1000m.

1 box core, very sandy, box only about half full.

Sediment too coarse for Sholkovitz coring.

2000m1 short Sholkovitz (~ 30cm).

Jane Foster (University of Edinburgh)

Cores:

From each station (700m, 1000m, 1500m, 2000m) 3 multicores were taken, one from each of the first 3 drops. Slicing was in 0.5cm intervals for 10cm and 1cm for the remainder of the core (all cores are less than 30cm in length). All cores were destined for ^{210}Pb analysis.

Bed-hop camera.

The camera was deployed thrice:

8 - April 0614 - 0802 Station N1500 - Film 7, 25 shots.

8 - April 1828 - 1948 Station N1000 - Film 8, 25 shots.

9 - April 1932 - 2024 Station N700 - Film 9, 25 shots.

The camera was not operated at 2000m because of a broken lead.

Anne-Marie Habin (University of Liverpool)

Cores:

1500 m	**core 1** redox potential by E_H measurement of 2 cm slices, slices frozen in bags.
	core 2 pore waters extracted by centrifugation of 4 cm slices, slices kept in cold and dark.
	core 3 organic and trace metal analysis: sliced 1 cm intervals, frozen in jars.
1000 m	3 cores as above.
700 m	3 cores as above.
2000 m	3 cores as above, E_H electrode gave unusually high potentials.

Julie Armishaw (University of Southampton

Box Cores:

1500m	1 box core, 3 push cores from the box core.
	1 push core halved on board and general description taken.
	2 push cores stored in cold room for further sedigraph and X-ray analysis
1000m	as 1500m station
700m	as 1500m station
2000m	2 box core attempts made; 2 failures.

Multi cores

2000m	2 cores stored cold for future sediment grain size analysis and X-ray analysis.

Martyn Harvey (DML)

At each station:

2 drops of 2x25l niskin bottles to within 15m of the sea bed to obtain water for incubations of sediment cores for oxygen uptake rate measurement. The constant temperature room was used for these incubations so that *in situ* temperatures could be maintained. A 1 litre NIO bottle fitted with a reversing thermometer was attached to the wire so that this temperature could be measured.

3 drops of the multicorer

2 cores from each were taken for oxygen uptake rate measurement. Water samples taken during the incubations were titrated to determine their oxygen content whilst on board. Water samples were also filtered and frozen for subsequent measurement of their nutrient (nitrate, ammonium and phosphate) contents so that sediment nutrient fluxes could be determined.

1 core from each was sectioned into 5cm depth horizons and subcores taken from these to determine the sediment sulphate reduction rate and porosity.

1 further core was taken, sectioned similarly, and the sediment in each horizon was centrifuged and the resultant pore water filtered and frozen for subsequent determination of its sulphate content.

John Hughes (BODC)

In order to keep a complete record of all instrument deployments, a rough log was kept in the main lab in GMT. Notes were also made of the activities of the scientific personnel, and together with data on the ship's position and water depth this information was collated into spreadsheets and distributed to the participants at the end of the cruise. Much time was spent assisting in the various scientific activities, of which my particular favourite had to be shovelling mud into a sieve on a sunny Saturday afternoon. At the end of the cruise, data logged by the RVS ABC logging system was archived on a QIC (quarter-inch cartridge) and carried off for processing at a later date.

LEG 2 (Dunstaffnage to Dunstaffnage)

Scientific Personnel

Anton Edwards	DML (Principal scientist)	Martyn Harvey	DML
Ivan Ezzi	DML	Neil MacDougall	DML
Dr Ken Jones	DML	Louisa Watts	University of Newcastle
Sam Barker	University of Newcastle	Judith Murphy	UEA
Matthew Osborne	University of Dundee	Kit Moss	BODC

Aims

1. To service the DML/SES (Shelf Edge Study) current mooring Y in the Tiree Passage
2. To work the Anton Dohrn - Rockall seamount CTD/nutrient/chlorophyll section
3. To service the DML/WOCE current meter mooring at station M
4. To recover the RVS acoustic release mooring at station M
5. To work CTD and water sampling stations in the SES area lines N and S
6. To measure rates of nitrogen fixation in the euphotic zone of the shelf and ocean west of Scotland
7. To collect large volume water samples over the shelf for Caesium isotope analysis
8. To collect zooplankton samples in the shelf/Rockall Trough area
9. To work CTD sections west of Hatton Bank

Narrative

April 13th Scientific staff joined "Charles Darwin" in Ardmucknish Bay from 0910 BST onwards via "Calanus". The first officer held a safety briefing for scientific staff at 1600. While gear was made fast and tested, the day was passed at anchor until 2000. The vessel steamed through the Sound of Mull towards the Tiree Passage. The day was calm and bright.

April 14th The day dawned misty. After daybreak, the Tiree Passage mooring was lifted, serviced and relaid. By 1500Z, the ship had started a line of CTD and water sampling stations from the Sound of Mull to Barra. Conditions became more cloudy and by late evening a slight swell was running south of Barra.

April 15th Swell increased after midnight under a north-westerly wind. The vessel worked CTD and water stations towards the shelf break at 57°N. 9°W, arriving in the late afternoon. A plan to service the SES mooring S200 on the morrow was postponed because of forecast northerly winds and the ship continued to work westwards towards Anton Dohrn seamount.

April 16th With moderating winds and an improved forecast, the line westwards was left around 0800 after station O in favour of going to recover the mooring S200. The mooring was successfully retrieved by 1600 and a line of CTD stations was worked west to S1500. The wind continued northerly about force 5 during the remainder of the day. A box course was then followed to N1500, with only surface measurement from the non-toxic supply during the night.

April 17th We started work on an eastward line N of stations from N1500 but broke off at 1200BST to go to S200 to relay the SES mooring. The mooring was laid successfully in a depth of 200 metres despite the rather sudden onset of a strong northerly wind during pay-out. The vessel then returned to line N at its eastern end N140 so as to work CTD stations west during the evening. These were abandoned at about 2300 BST when waves were starting to break over the working area. The northerly wind continued overnight.

April 18th The vessel remained hove-to until midday when the wind abated slightly and we returned to work at station N900. The N-line was complete at N900 by 1310 Z. We then steamed in strengthening northerly winds to start line S at S1500. This station was not worked until after daybreak because of swell and frequent northerly squalls during the night.

April 19th Work recommenced at S1500 at 0900 BST. The ship worked eastwards in fresh northerly winds with fluorimetric CTD casts to 500 metres and water bottles below that. After difficulty in handling water bottles safely, work was again abandoned in a northerly gale about 2200 BST.

April 20th Brighter weather was accompanied by a continuing squally northerly wind of about 30 to 35 knots which prevented any resumption of work. The vessel remained hove-to in the SES N/S area. At about 1600 BST we were notified that the SES meteorological buoy laid at S140 was out of its watch circle, so headed towards the recorded position. The buoy was in correct position, as in a later notification.

April 21st By 0200BST the wind had moderated to 20 knots, the swell was a little easier and CTD/water sampling resumed at station S300. The S line was completed during the day in fresh northerly winds and course was set for station N to rejoin the Anton Dohrn - Rockall section.

April 22nd The wind remained fresh and northerly. We decided that conditions were too rough to attempt recovery of the DML and RVS moorings at station M because of the difficulty of seeing surface floats in a rough sea. CTD and water bottling work therefore continued westwards to station J when we decided to head for Dunstaffnage to put a seaman ashore to attend to his dying mother.

April 23rd The journey to Dunstaffnage was made in the continuing strong northerly wind and moderate swell that only relaxed in the early morning in the Minch. Winds moderated throughout the day. The seaman was transferred via "Seol Mara" around 1700 BST at Dunstaffnage and "Charles Darwin" then headed west once more in calm conditions to station M to start mooring work.

April 24th Station M was reached about 0930 BST. The RVS mooring was successfully recovered. The DML mooring was interrogated and released but failed to rise. A crossed track was worked over the position, confirming that the release was indeed at minimum range there. Repeated attempts failed to change the depth of the release, so the mooring was abandoned and course set to complete the Anton Dohrn CTD section. Stations I and H were worked before it was discovered that Dr Jones was in serious difficulties with muscular spasm in his back. He was hospitalised. Work was therefore abandoned and Dr Jones was taken to Oban, leaving the ship via the Oban lifeboat at 0815 BST on the morning of April 26th.

April 26th The ship once again headed west, passing the shelf edge in the late evening and collecting water for N15 incubation en route to Rockall.

April 27th Station A near Rockall was worked soon after noon. The ship then headed east in light easterly winds to work the Anton Dohrn section to station J on the seamount.

April 28th We continued to work the Anton Dohrn CTD section, diverting in the afternoon after station I to a line J1-J4 running north-south across the seamount. This line was worked in a freshening easterly wind that reached 20 knots or more.

April 29th After station I, work was abandoned soon after midnight in strong north-easterly winds. Station K was left behind as the vessel slowly steamed east into the wind. In the early afternoon, conditions were marginal but work resumed at station L in the early evening.

April 30th Winds continued fresh south-easterly during the night and in the morning as the ship worked towards the shelf edge at station R. The SES line N was started in the evening.

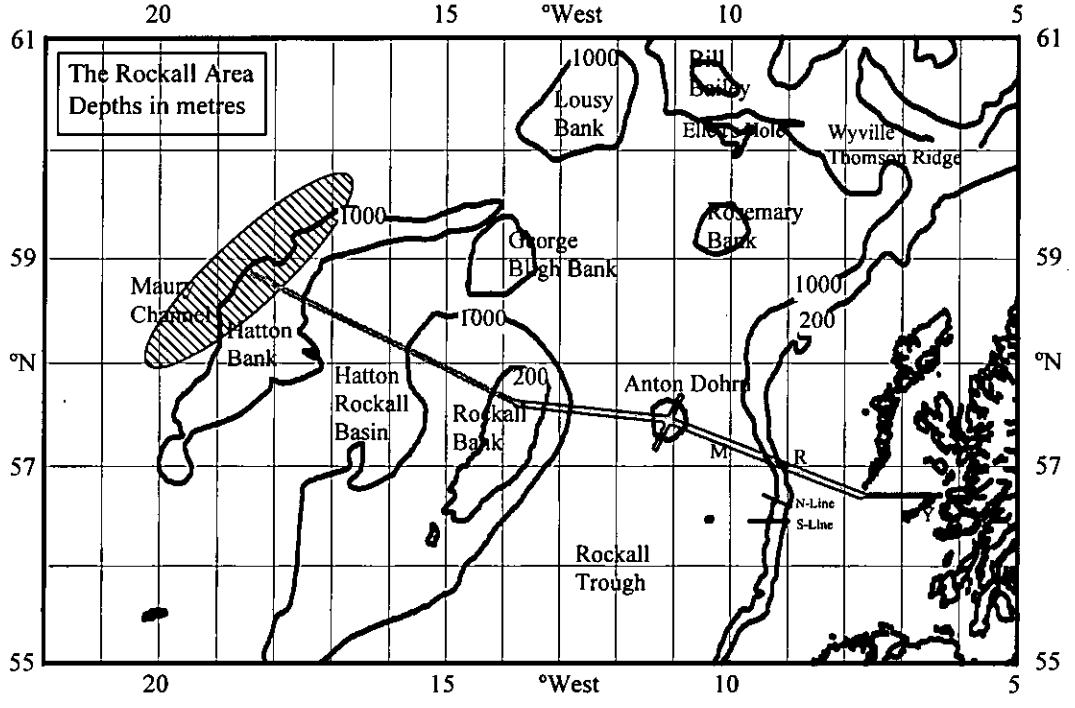
May 1st SES line N was complete by dawn and the ship returned to the Anton Dohrn - Sound of Mull line to complete a line of stations on the shelf. Work stopped at 1800BST at station 6G.

May 2nd Scientific staff and equipment were disembarked at Dunstaffnage from 0830 onwards via DML's ship "Calanus".

Results

Figure 2 shows the areas of work. All objectives east of Rockall were attempted and, with the exception of the mooring recovery at M, were successful. The accumulation of time lost to bad weather and personnel transfer to Oban meant that all work planned for west of Rockall had to be abandoned.

Figure 2: Working areas, Leg 2



CTD and nutrient sections

All CTD and water bottle stations are listed in the following table. Representative sections are appended to this report. Water samples listed in the table were analysed for nutrient concentrations with a Lachat autoanalyser.

Stn	Dist. to next	Lat °N	Long °W	Date, April 95 / Time Z.	Data Disc/ Dip No.	CTD depth approx	SS	Water bottles *Italics* =*CTD Calibration bottle*	Notes
1G	5.0'	56 40.0	6 08	14/1343	01/001	150		0,20,*25*,40,60,80,110,125,135	
2G	3.2'	56 41.0	6 17	1510	002	44		5,15,*20*,30	Caesium sample
3G	3.2'	56 42.5	6 22	1603	-	-			Steam through only
4G	5.0'	56 44.0	6 27	1630	003	100		5,15,*20*,30,60,80,100	
5G	5.0'	56 44.0	6 36	1727	-	-			Steam through only
6G	8.2'	56 44.0	6 45	1815	004	48		5,15,*20*,3040	Caesium sample

	Stn	Dist. to next	Lat °N	Long °W	Date, April 95 / Time Z.	Data Disc/ Dip No.	CTD depth approx	SS	Water bottles *Italics =CTD Calibration bottle*	Notes
146	7G	5.5'	56 44.0	7 00	1945	005	140		5,15,*20*,30,60,80,100,120	Zooplankton (1)
	8G	5.5'	56 44.0	7 10	2145	-	-			Steam through only
158	9G	5.5'	56 44.0	7 20	2225	006	158		5,15,*20*,30,60,80,100,120	Caesium sample
221	10G	5.5'	56 44.0	7 30	15/0008	007	225		5,15,*25*,30,60,100,140,160, 180,200,210	
54	11G	5.8'	56 44.0	7 40	0156	008	61		5,15,*25*,30,50	Caesium sample
	12G	5.8'	56 45.5	7 50	0307	-	-			Steam through only
126	13G	5.8'	56 47.0	8 00	0404	009	124		5,15,30,*20*,60,80,100,115	Caesium sample
	14G	5.8'	56 48.5	8 10	0519	-	-			Steam through only
142	T	6.2'	56 50.2	8 20	0608	010	135		5,15,*20*,30,60,80,100,120,1 25	
132	15G	10	56 53.0	8 30	0743	011	130		5,15,*20*,30,60,80,100,120	Caesium sample
132	S	8	56 57.0	8 47	1025	012	126		5,15,*20*30,60,80,100,120	
136	R	4	57 00.0	09 00	1238	013	132		5,15,*25*,30,60,80,100,120, 128	
156	R1	4	57 01.5	09 06	1414	02/014	154		5,15,*25*,30,60,80,100,120 140,145	
228	Q	4	57 03.0	09 13	1533	015	311		5,15,*22*,30,60,100,150, 200,250,280,290	
822	Q1	4	57 04.5	09 19	1713	016	764		5,15,30,100,200,300, 400,500,600,*755*	
1419	P	5	57 06.0	09 25	1913	017	1393		5,15,30,100,200,400,600, 800,1200,*1301*,1400	Zooplankton (1)
1787	P1	5	57 07.5	09 33	2339	03/018	1778		nt,15,30,100,200,300,500,8 00,1100,1400,1600,1750,*17 73*,1774	
1935	O	12	57 09.0	09 42	16/0611	019	1937		5,15,30,100,200,300, 500,1000,1500,1900,*1915*	
195	S200		56 27.14	09 02.90	1230	020	179		nt, bottom,*170*	
	S200	2.5	56 27.14	09 02.90	-	-				Retrieve Mooring
146	S140	3	56 27.14	08 58.27	1540	021	146		*140*	CTD (no fluorimeter) only
290	S300	1	56 27.14	09 04.00	1636	022	301		*295*	
546	S500	1.5	56 27.14	09 07.00	1735	023	539		*500*	Chlorophyll from non-toxic supply
660	S700	3.5	56 27.14	09 09.50	1829	04/024	708		*675*	
900	S850	3	56 27.14	09 15.00	1950	025	900		*880*; Zooplankton (1)	
988	S1000	10	56 27.14	09 20.00	2157	026	1046		*300*	
1410	S1500	17	56 27.14	09 39.00	17/0025	027	1512		*1500*	
	SW1		56 33.00	09 34.00	0232	-	-		Continuous steaming	
	SE1		56 30.00	09 57.50	0423	-	-			
	NE1		56 33.00	08 56.80	0439	-	-			
	NW1		56 38.00	09 30.00	0653	-	-			

	Stn	Dist. to next	Lat °N	Long °W	Date, April 95 / Time Z.	Data Disc/ Dip No.	CTD depth approx	SS	Water bottles *Italics* =*CTD Calibration bottle*	Notes
1482	N1500	-	56 43.13	09 24.50	0738	05/028	1496		*1,439*	CTD (no fluorimeter) only
1160	N1100	7	56 40.80	09 15.00	0949	029	1126		*400*	
133	N140	2.5	56 36.30	08 56.10	1734	04/030	136		*130*	Chlorophyll from non-toxic supply
195	N200	1	56 37.20	09 00.38	1823	031	197		*185*	
311	N300	2	56 37.45	09 01.35	1904	05/032	304		*331*	
477	N600	2	56 38.10	09 04.00	1953	033	506		*485*	
708	N700	3	56 38.80	09 06.75	2056	06/034	712		*696*	
861	N900	3.5	56 39.80	09 10.00	18/1222	035	906		*890*	
						CTD to 500 metres only for fluorimetric measurements & water bottles to bottom.				
1515	S1500	10	56 27.14	09 39.00	19/0816	036	1520		5,15,30,60,*75*,100,200, 400,800,1200,1500	
988	S1000	3	56 27.14	09 20.00	1242	037	1050		5,15,30,60,100,200,400, *500*,600,800,1020	
900	S850	3	56 27.14	09 15.00	1417	038	~900		5,15,*30*,45,85,185,385, 585,785,865	
660	S700	2	56 27.14	09 09.50	1615	039	707		5,15,30,60,100,200,300, *500*,400,500,600	lost bottle
546	S500	2	56 27.14	09 07.00	1836	040	550		5,15,30,*30*,100,200,400, 600,800,1020	
290	S300	-	56 27.14	09 04.00	2020	-	300		5,15,30,100,200,300, 400,500,540	
290	S300	1	56 27.14	09 04.00	21/0126	041	360		5,15,30,100,*100*,200, 300,350	
195	S200	3	56 27.14	09 02.90	0316	042	227		5,15,30,*30*,60,100,140, 160,215	
146	S140	10	56 27.14	08 58.27	0441	07/043	144		5,15,30,60,80,100, 120,*132*,135	
133	N140	2	56 36.30	08 56.10	0649	044	133		5,15,30,*30*,60,80,100, 120,130	
195	N200	2	56 37.20	09 00.38	0800	045	230		5,15,30,60,90,130,170,*230*	
311	N300	3	56 37.45	09 01.35	0944	046	335		5,15,30,60,100, 150,200,*200*,250,300	
477	N600	2	56 38.10	09 04.00	1035	047	485		5,15,30,100,200,300, 400,*477*,485	
708	N700	3	56 38.80	09 06.75	1239	048	728		5,15,30,*30*,100,200,400, 600,715	
861	N900	3	56 39.80	09 10.00	1426	049	915		5,15,30,100,200,*330*,350, 500,650,800,925	
1160	N1100	6	56 40.80	09 15.00	1624	050	1133		5,15,30,*30*,100,200,400, 600,800,1000,1100	
1482	N1500	-	56 43.13	09 24.50	1846	051	1488		5,15,30,100,200,400,*500*, 800,1200,1400,1480	Zooplankton (1)

	Stn	Dist. to next	Lat °N	Long °W	Date, April 95 / Time Z.	Data Disc/ Dip No.	CTD depth approx	SS	Water bottles *Italics =CTD Calibration bottle*	Notes
2110	N	12'	57 14.0	10 03	22/0109	052	2112		*2100*	
2220	M	10'	57 18.0	10 23	0500	08/053	2219		5,15,30,100,200,500, 1000,1500,2000,2200,*2240*	CCAP surface water collection
2253	L	7½'	57 22.0	10 40	1118	054	2101		-	
788	K	7½'	57 24.0	10 52	1409	09/055	788		5,15,30,100,200,300,400, 500,600,700,770,*770*	
591	J	7½'	57 27.0	11 05	1633	10/056	590		*580*	
755	I	7½'	57 28.0	11 19	24/1524	057	751		5,15,30,100,200,300,400, 500,600,730,*740*	
2025	H	10'	57 29.0	11 32	1751	058	2021		*2010*	
	LOU1	-	57 17	11 29	27/0328	059	200		^{15}N samples	
112	A	10'	57 35.0	13 38	1155	11/060	113		5,15,30,60,80,105,*102*	
182	B	10'	57 34.0	13 20	1354	061	178		*25*	
336	C	5'	57 33.0	13 00	1531	062	300		5,15,30,60,100,150,200, 250,290,*290*	
1000	D	7½'	57 32.5	12 52	1704	12/063	1704		*1000*	
1658	E	12½	57 32.0	12 38	1913	12/064	1660		5,15,30,100,200,400,800, 1200,1600,1630,*100,*	Zooplankton (3)
1817	F	12½	57 30.5	12 15	28/0022	13/065	1809		*1790*	
1812	G	10'	57 29.5	11 51	0358	066	1800		5,15,30,100,200,400,800, 1200,1600,*1700*,1740	
2023	H	7½'	57 29.0	11 32	0834	014/067	2027		*1800*	
755	I	15	57 28.0	11 19	1136	068	753		*740*	
	J1	7½'	57 07.5	11 13	1459	069	2228		*2000*	
	J2	7½'	57 18.0	11 09	1807	15/070	780		*780*	
591	J	7½'	57 27.0	11 05	1952	071	565		*300*	
	J3	30	57 37	11 02	2147	072	2147		*900*	
2220	M	12'	57 18.0	10 23	1747	073	2221		*2202?*	
2210	N	10'	57 14.0	10 03	2225	074	2110		*2111?*	Zooplankton (3)
1935	O	5	57 09.0	09 42	30/0326	16/075	1935		*1900*	
1787	P1	5	57 07.5	09 33	0550	16/076	1782		*1700*	
1419	P	4	57 06.0	09 25	0827	077	1390		*480*	
822	Q1	4	57 04.5	09 19	1035	17/078	786		*760*	
288	Q	4	57 03.0	09 13	1200	079	311		*300*	
156	R1	4	57 01.5	09 06	1317	080	154		*143*	
136	R	20	57 00.0	09 00	1403	081	133		*120*	
1482	N1500	7	56 43.13	09 24.50	1814	082	1498		*1500*	
1160	N1100	3.5	56 40.80	09 15.00	2037	083	1131		*1100*	
861	N900	3	56 39.80	09 10.00	2216	18/ 084	919		*910*	
708	N700	3	56 38.80	09 06.75	2343	085	671		*655*	

	Stn	Dist. to next	Lat °N	Long °W	Date, April 95 / Time Z.	Data Disc/ Dip No.	CTD depth approx	SS	Water bottles *Italics* =CTD Calibration bottle	Notes
477	N600	2	56 38.10	09 04.00	1/0048	086	478		*480*	
311	N300	2	56 37.45	09 01.35	144	087	339		*320*	
195	N200	1	56 37.20	09 00.38	0226	088	196		*180*	
133	N140	23	56 36.30	08 56.10	0310	089	132		*125*	
132	S	10	56 57.0	8 47	0537	090	128		*120*	
132	15G	6.2'	56 53.0	8 30	0706	091	130		*120*	
142	T	5.8'	56 50.2	8 20	0814	092	136		*136*	
	14G	5.8'	56 48.5	8 10	0900	-	-		steam through	
126	13G	5.8'	56 47.0	8 00	0950	093	123		*110*	
	12G	5.8'	56 45.5	7 50	1040	-	-		steam through	
54	11G	5.5'	56 44.0	7 40	1133	094	60		*50*	
221	10G	5.5'	56 44.0	7 30	1250	095	213		*200*	
156	9G	5.5'	56 44.0	7 20	1355	096	158		*140*	
	8G	5.5'	56 44.0	7 10	1452	-	-		steam through	
146	7G	8.2'	56 44.0	7 00	1537	097	137		*125*	
42	6G	5.0'	56 44.0	6 45	1700	098	48		*40*	
	5G	5.0'	56 44.0	6 36			-		steam through	
	3G	3.2'	56 42.5	6 22			-		steam through	

Underway fluorimetric measurements

The DML continuously recording GPS/fluorimeter ran throughout most of the cruise. A representative map of the temperature and chlorophyll variability in the SES area is shown in figure 3.

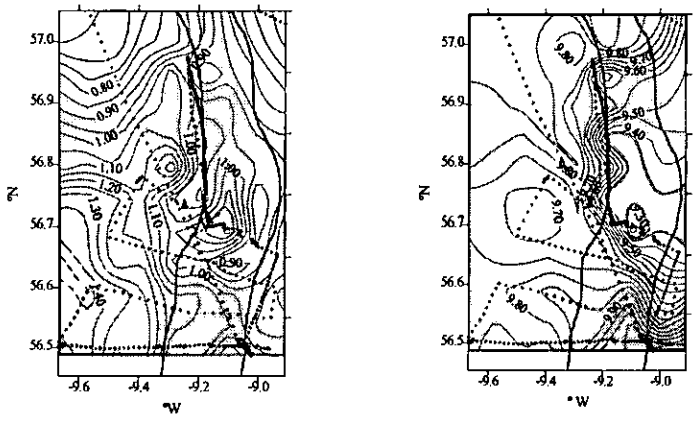


Figure 3: Fluorimetric and Temperature variability over the SES N and S lines 16/17 April

Phytoplankton new production and remote sensing (Louisa Watts)

The overall aim of my postdoctoral research is to develop regional models and algorithms for the use of remotely sensed data in the estimation of phytoplankton new production. The specific objective of

the CD92 cruise is to obtain information on phytoplankton nitrogen assimilation rates in the North Atlantic during periods of relatively high biological activity during the spring month of April. This will be achieved through the execution of ^{15}N ship-board experiments.

The information obtained will be used to obtain typical values of the f ratio ((uptake of nitrate)/(uptake of nitrate and regenerated nitrogen)) for this area. This will contribute to a large global database, presently being compiled, which aims to assign vertical structure (chlorophyll and irradiance levels) and photosynthetic growth rate parameters to regions within the world's oceans (biogeochemical provinces). Such parameters will vary from season to season. Having assigned these parameters to different geographical areas, colour satellite images can then be taken and parameters assigned to each pixel. Through the use of existent algorithms and models, the pixel growth parameters can be combined with the locally derived vertical biomass profile to yield primary productivity rates on large horizontal scales. Combining these rates with the empirically derived f ratios for each region, the extent of new production can then also be estimated on a global scale. For the North Atlantic region data exist from approximately 8000 chlorophyll profiles and 2000 photosynthesis experiments such that photosynthetic properties can be assigned to different areas within this ocean given a particular season. f ratio data for this area are sparse however.

Measurements of the optical properties of the water column using a 4Pi light sensor, are also being carried out on the cruise, so that any vertical variations in the measured spectral irradiance profile through the water column can be established. This information is useful in the application of spectral models to primary productivity computations, and yields useful information on the attenuation coefficient of the water column given different concentrations of chlorophyll present.

Methods and Techniques:

Nitrogen assimilation experiments were carried out on 6 occasions at a series of stations spanning an area from the Shelf Edge area, west of Barra Head in the Outer Hebrides, to the Rockall Trough. Dates and locations of the stations can be found in the following table.

Sampling for ^{15}N assimilation experiments.

Date, April 1995	Station	Position	Depths, m.	CTD Dip/ Other analyses
16	O	57°08.7'N 09°41.4'W	0,4,7,13,17,30	019 / Chl, nutrients
20	Passage	56°32.3'N 09°04.4'W	surface	Chl, nutrients
22	M	57°14.0'N 10° 23.0'W	0,4,7,13,17,30	052 / Chl, nutrients
27	LOU1	57° 16.9'N 11° 29.2'W	0,5,10,17,23,40	LOU1 / Chl, nutrients
28	G	57° 29.4'N 11°50.4'W	0,5,10,17,23,40	066 / Chl, nutrients
30	O	57° 09.2'N 9°41.4'W	0,5,10,17,23,40	075 / Chl, nutrients

The experiments consisted of on-deck incubations. The sampling strategy involved collection of seawater from 6 different depths at a station before dawn (between 0400 hrs and 0500 hrs), using six seven-litre NIO bottles attached at predetermined depth intervals on a hydrographic wire. The 6 different depths were chosen to cover the euphotic zone, the depth of which was determined the previous day from a measured irradiance profile. The depth of the euphotic zone was calculated as (-4.6/attenuation coefficient). Depth intervals between the bottles were calculated so as water was collected at depths at which there was 1 %, 6.9 %, 13.8 %, 32.6%, 55 % and 97% of the surface irradiance light.

At each depth water was transferred from the NIO bottle to a 10 litre polycarbonate carboy. 600 mls of this water were then dispensed into 6, clear polycarbonate, Nalgene bottles (3 duplicate pairs). These bottles had been pre-spiked with 1 μ mol l-1 15N-NO3, 0.1 μ mol l-1 ^{15}N-NO3, 0.1 μ mol l-1 ^{15}N-NH4 additions respectively. After the first station, only the 1 μ mol l-1 ^{15}NNO3 addition was made (not the 0.1 μ mol l-1 ^{15}N-NO3 addition as well), along with the NH4 addition, because results from on-going nutrient measurements had shown ambient NO3 levels to be between 9 and 10 μ mol l-1. Spike additions are calculated to represent 10% of the ambient concentration; enough to saturate the uptake mechanisms of the phytoplankton but not enough to enhance the growth rate.

The bottles were then incubated for 24 hours (0600 hrs to 0600 hrs the next day) using an on-deck method of incubation. This involved placing the 6 sets of bottles from the 6 different depths into 6 polypropylene crates each covered with a sealed polyethylene blue filter, the shading of which was designed to simulate the in situ light level found at that particular depth. Surface seawater was continually flowed through the crates throughout the incubation to keep the samples at approximate in situ water temperatures. When the incubations were finished the samples were immediately filtered. Filtering was carried out under vacuum (5 inches Hg) using 25 mm GF/F filter papers and a filtered seawater rinse. The filters were then placed in a domestic freezer for preservation of the algal cells and storage.

The filters are to be transported to Newcastle University in a frozen condition where the atom % ^{15}N levels on the filters will be determined using isotope ratio mass-spectrometry.

At the time of sampling at each station approximately 150 mls of water was also collected from each depth for the measurement of the ambient NO3 and NH4 levels, using a Lachat Quikchem autoanalyser. 200 mls of water was also filtered from each depth onto 25 mm GF/F filter papers, under vacuum (5 in Hg), and the filter papers were transferred to a domestic freezer for the future analysis of chlorophyll a concentrations per depth. A Seabird CTD was also deployed through the water column at each station which yielded information on the mixed layer depths and, when the fluorimeter was attached, the biomass profile.

It should be noted that the mixed-layer depth at stations was generally at least 120 m deep and that the accompanying trace showed chlorophyll also mixed to these depths. Hence, on occasion, when the weather was too rough for deployment of NIO bottles the incubations were carried out using surface seawater only, from the non-toxic seawater supply. It was then assumed that the water column properties (and the f'ratio) were well-mixed to depths below the euphotic zone (generally 30 to 50m).

Preliminary Results

An inverse relationship has been noted between the calculated euphotic zone depths and the chlorophyll voltage readings taken from the fluorimeter on deck (i.e. the non-toxic seawater supply). This is illustrated in Figure 4. The light profiles were measured at approximately the same time for any particular day, at ~1300 hours, and the results suggest that the more chlorophyll present in the surface layers, the more the incident radiation will be absorbed in the surface, thus leading to shallower euphotic zone depths

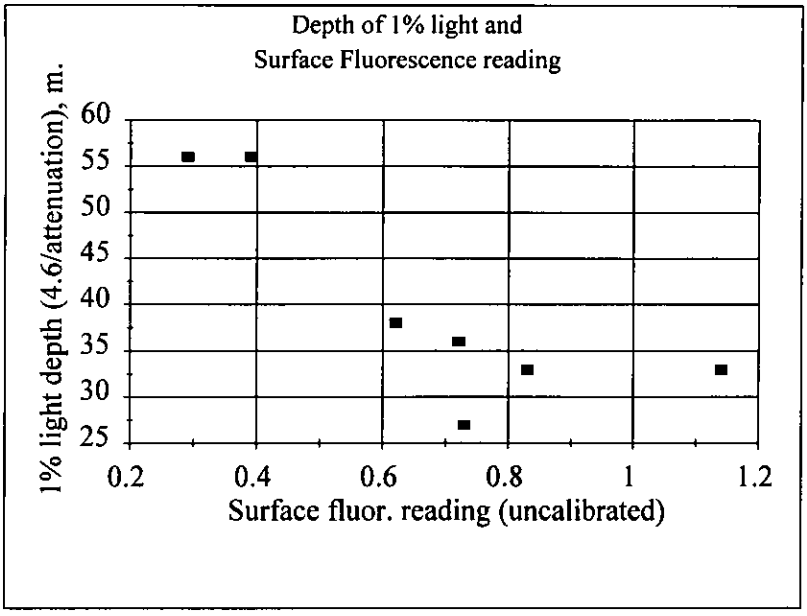


Figure 4: Relation of chlorophyll fluorescence values to the attenuation coefficient

Zooplankton Sampling (Sam Barker, University of Newcastle)

The natural abundance of the stable isotopes of carbon and nitrogen (C^{12} and C^{13} and N^{14} and N^{15}) can be used to determine trophic positions of marine organisms because of an isotopic enrichment occurring with each increase in trophic level (typically 0.1% for carbon and 0.3% for nitrogen). This information can be used to assign trophic positions for the species concerned.

Stations were sampled on an opportunistic basis at sites which were available immediately after nightfall (circa 2100 to 2200 BST) to enable thorough sampling of the greater than 500 micron range of plankton to be caught (the majority of the zooplankters). These were then identified and divided into the differing species. In conjunction with this, water samples were taken and filtered to obtain different size fractionation of the smaller plankton (sub 125 micron and sub 64 micron size ranges). All the samples taken were, after identification, frozen for subsequent analysis with dual isotope ratio mass spectrometry in order to elucidate their isotopic composition from their characteristic isotopic signatures.

Moorings

The layout of the moorings is shown in the following figures.

Acknowledgements

The competent and cheerful services of the master, Robin Plumley, and all his crew are cordially acknowledged. The DML participants, in difficult times, are particularly grateful to all their university colleagues who so assiduously, cheerfully and willingly helped to man or woman this cruise.

Performance of Equipment

All ship's equipment performed satisfactorily apart from the Lebus winch installed on the after deck for mooring operations. The winch is too slow and of too small a barrel diameter for the deployment of moorings. The slowness wastes a deal of ship time. The smallness is damaging for wires and gear wound round it. I (AE) recommend that the views of mooring experts are sought in future before committing the ship to working with such an inadequate device.

SES 200 Southern mooring April 1995

Deployment and recovery times

SES S200 Mooring recovery 16th April 1995

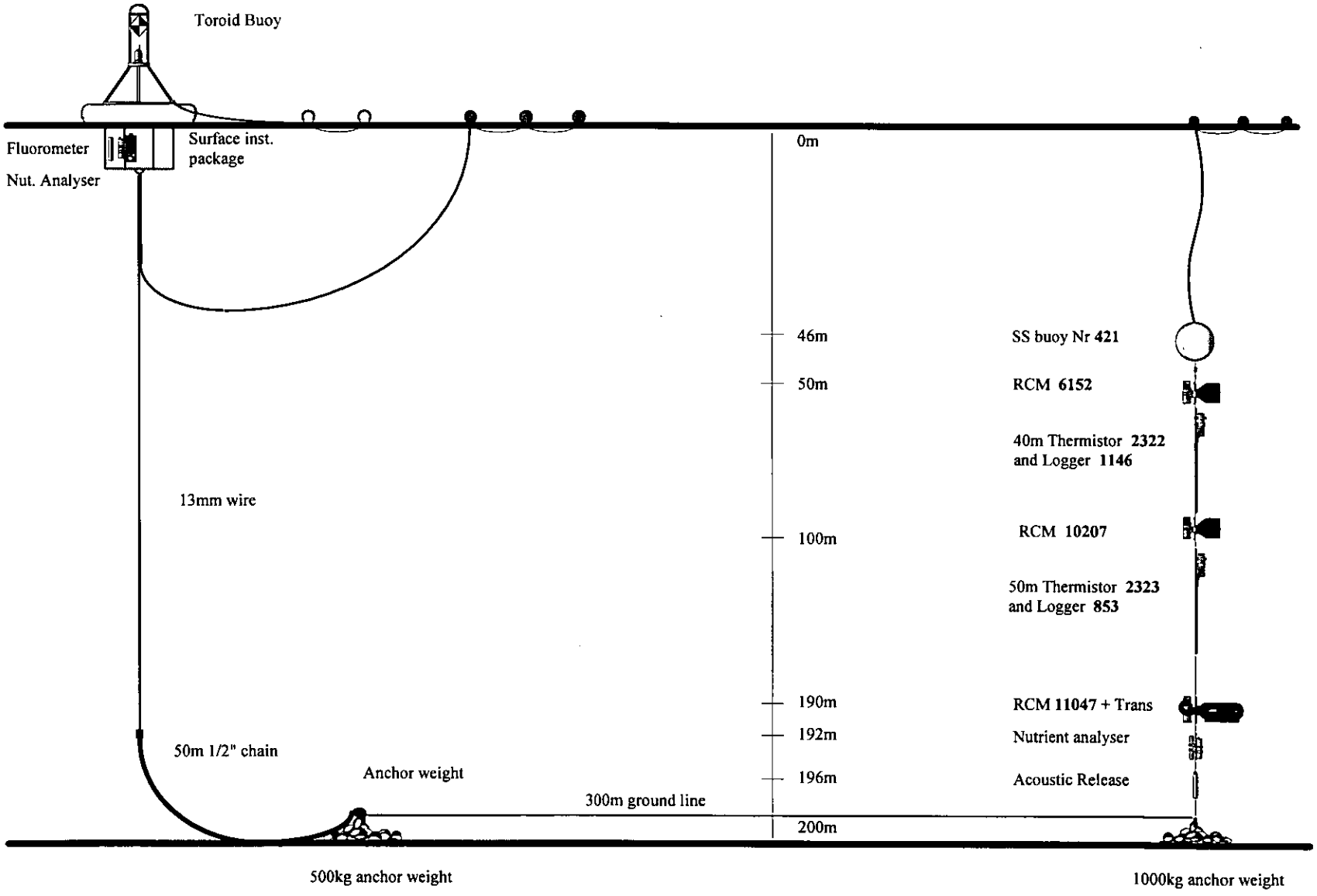
Time Z	Narrativc	Position °N.	Position °W.	Depth, m.
1300	Toroid grappled	56 27.11	09 02.50	196
1307	Toroid inboard	56 27.10	09 02.51	195
1321	1st anchor inboard	56 27.13	09 02.47	195
1333	2nd anchor inboard	56 27.15	09 02.54	205
1336-1339	Release / nitrate analyser / CM 11047 + transmissometer inboard	56 27.17	09 02.54	206
1347	TC logger 853 / CM 6152 inboard	56 27.18	09 02.59	210
1349	Subsurface buoy grappled	-	-	
1352	Subsurface / TC logger 1146 / CM 6152 inboard	56 27.19	09 02.57	210

SES S200 mooring deployment 17th April 1995

Time Z	Narrativc	Position °N.	Position °W.	Depth, m.
1434	Toroid overboard	56 27.26	09 01.45	156
1439	Sub surface buoy / CM 6152 / TC logger 1146 overboard	56 27.26	09 01.45	160
1441	CM 10207 / TC logger 853 overboard	56 27.26	09 01.45	159
1443	Release / nitrate analyser / CM 11047 + transmissometer overboard	56 27.26	09 01.45	160
1445	1st anchor overboard	56 27.26	09 01.45	160
1514	1st anchor on bottom	56 27.07	09 02.52	200
1523	2nd anchor on bottom	56 27.11	09 01.58	207
1527	Toroid released	56 27.11	09 01.58	210

SES S200 (Southern mooring)

Mooring deployed 17th April 1995



SES 200 Mooring April 1995

Instrument start and stop times

Instruments from SES S200 mooring recovered 16th April 1995

Meter 10207	Time of last cycle	16:10:05 Z	16 04 95	DSU=19050
Meter 6152	Time of last cycle	16:10:07 Z	16 04 95	DSU=19170
Meter 11047	Time of last cycle	18:10:05 Z	16 04 95	DSU=14040
Logger 1146	Time of last cycle	19:00:14 Z	16 04 95	DSU=30048

All instruments on a 10 minute cycle.

Note: Logger 853 is an old tape instrument. This was left running as there was no spare tape or reader on board.

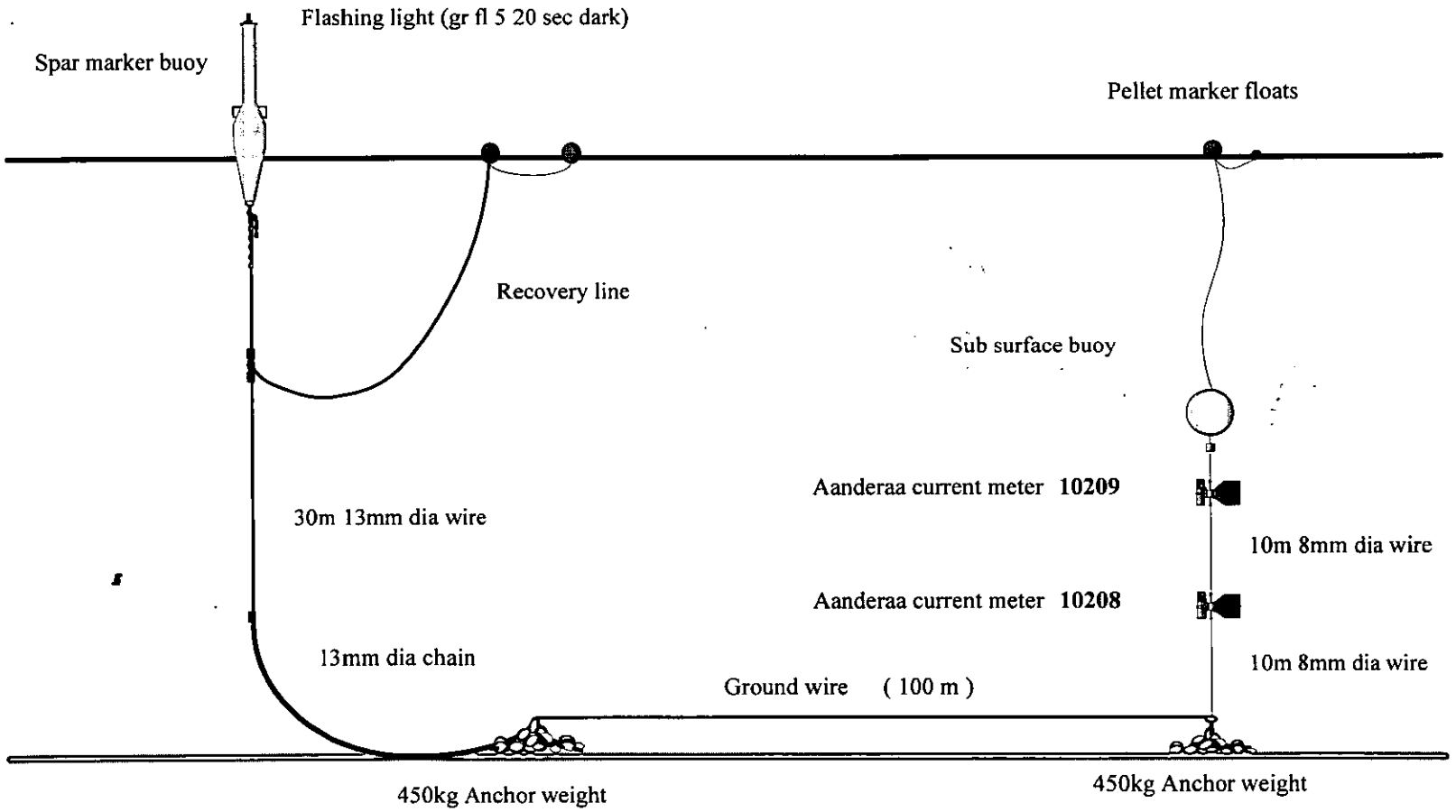
Instruments deployed on SES S200 mooring on 17th April 1995

Meter 10207	Time of first cycle	06:10:00 Z	17 04 95
Meter 6152	Time of first cycle	06:10:00 Z	17 04 95
Meter 11047	Time of first cycle	05:40:00 Z	17 04 95
Logger 1146	Time of first cycle	05:40:00 Z	17 04 95

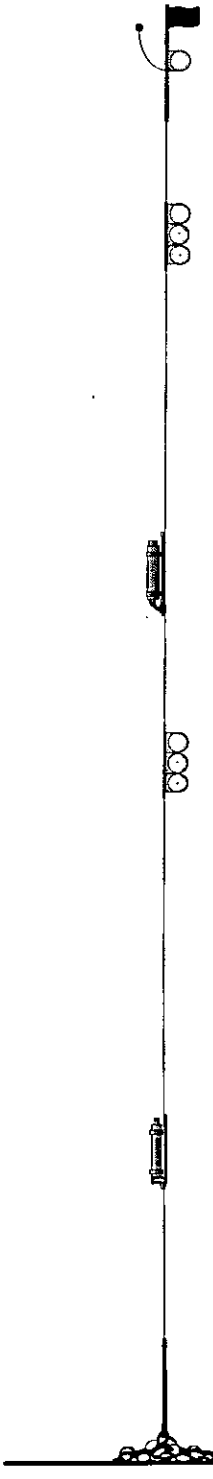
All instruments on a 10 minute cycle.

Tiree Passage Mooring Y

Deployed 14th April 1995



RVS Acoustic Trials Mooring



Flag buoy arrangement

10m 16mm Polypropylene rope

3 off Benthos 17" spheres

20m 8mm PVC coated wire

IOS CR200 Acoustic release

5m 8mm wire

3 off Benthos 17" spheres

20m 8mm PVC coated wire

Oceano RT361 Acoustic release

12m 8mm wire

5m 1/2" Longlink chain

350kg Anchor weight