Indexed JAR/

MRS. P EDWARDS. PG

I.O.S.

RRS DISCOVERY

CRUISE 160A

28 JULY – 9 AUGUST 1986

GEOCHEMICAL STUDIES IN THE ENGLISH CHANNEL

CRUISE REPORT NO. 195

1987

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES DEACON LABORATORY

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

Wormley, Godalming,
Surrey, GU8 5UB, U.K.

Telephone: 0428 79 4141
Telex: 858833 OCEANS G
Telefax: 0428 79 3066

Director: Dr. A.S. Laughton FRS

Natural Environment Research Council

INSTITUTE OF OCEANOGRAPHIC SCIENCES

DEACON LABORATORY

CRUISE REPORT No.195

RRS DISCOVERY

Cruise 160A

28 July - 9 August 1986

Geochemical studies in the English Channel

Principal Scientist

D.J. Hydes

1987

DOCUMENT DATA SHEET

AUTHOR HYDES, D.J. *et al*	PUBLICATION DATE 1987
TITLE RRS *Discovery* Cruise 160A, 28 July - 9 August 1986. Geochemical studies in the English Channel.	
REFERENCE Institute of Oceanographic Sciences, Deacon Laboratory, Cruise Report, No. 195, 46pp.	

ABSTRACT

Water column sampling was carried out from RRS *Discovery* at 48 stations in the English Channel from 0°30'W to 5°30'W between 28 July and 8 August 1986. Three deeper water stations were also occupied at the shelf edge in water depths between 4500m and 450m. Nutrient, salinity and aluminium samples were taken from standard N.I.O. bottles, a "clean" system of GO-FLO bottles suspended on a Kevlar line was used for trace metal sampling in the Channel. At the shelf edge all water samples were taken from GO-FLOs mounted on a rosette. A CTD was used to look at the structure of the thermocline and halocline to determine sampling depths. All the station positions and hydrographic data collected during the cruise are listed here.

This was the final of a programme of three cruises aimed at determining both the concentrations of biogeochemically active metals which are potential pollutants in coastal waters and how concentrations of such metals vary seasonally. Typical summer conditions were encountered on this cruise. Nutrient levels were depleted and a well established thermocline was present west of Lyme Bay.

ISSUING ORGANISATION Institute of Oceanographic Sciences Deacon Laboratory Wormley, Godalming Surrey GU8 5UB. UK. Director: Dr A S Laughton FRS	TELEPHONE 0428 79 4141 TELEX 858833 OCEANS G TELEFAX 0428 79 3066

KEYWORDS *COASTAL OCEANOGRAPHY* *TRACE METALS* *NUTRIENTS* *ENGLISH CHANNEL* *SEASONAL VARIATIONS* *DISCOVERY/RRS - CRUISE(1986)(160A)*	CONTRACT PROJECT CO 71 PRICE £11.00

Copies of this report are available from:
The Library, Institute of Oceanographic Sciences, Deacon Laboratory.

CONTENTS

SHIP'S PERSONNEL

M. Harding	Master
E. Dowling	Chief Officer
P. Oldfield	Second Officer
S. Beal	Third Officer
I. Bennett	Chief Officer
P. Jago	First Engineer
R. Perriam	Second Engineer
P. March	Third Engineer
B. Smith	Electrical Engineer
F. Williams	Chief Petty Officer

SCIENTIFIC PERSONNEL

D. Hydes	IOS, Wormley	Principal Scientist
R. Dyer	IOS, Wormley	
N. Hooker	IOS, Wormley	
G. Lake	IOS, Wormley	
A. Jones	IOS/UEA	
T. Jickels	East Anglia University	
C. Symon	Lancaster University	
P. Daly	Liverpool University	
G. Jacinto	Liverpool University	
M. Nimmo	Liverpool University	
D. Harper	MAFF, Burnham-on-Crouch	
A. Jones	RVS, Barry	
S. Heron	Southampton University	
A. Tappin	Southampton University	
J. Bunting	IOS, Wormley	Buoy Mooring
K. Goy	IOS, Wormley	Buoy Mooring
G. Griffiths	IOS, Wormley	Buoy Mooring
J. Perrett	IOS, Wormley	Buoy Mooring

ACKNOWLEDGEMENTS

The willing help, co-operation and advice of the Master, Officers and Crew of RRS Discovery are gratefully acknowledged, as is the help of A. Fisher and R. Clement in fitting out the ship for the cruise. Everyone played their part to make Discovery 160A a successful cruise.

ITINERARY

Depart Falmouth UK	28 July 1986
Work on shelf and shelf edge	
Drop off mooring party Falmouth	1 August 1986
Work in English Channel	
Arrive Falmouth, UK	8 August 1986

OBJECTIVES

This was the last of a series of three cruises in the English Channel, aimed at determining both the concentrations of biogeochemically active metals, on the individual cruises, and how they vary with the annual cycle in biological production, by comparing results from the different cuises (November 1985, May 1986, August 1986). On each cruise, a grid of 48 stations was to be worked across the English Channel from 0°30' to 5°30'W (this proved possible only on the first and last cruises). In addition on this, the final cruise, it was possible to occupy three stations at the shelf edge. These stations enabled pristine ocean water to be collected by the same systems as used in the Channel and should, by comparison, provide valuable information on the accuracy and precision of our measurements. In addition, a current and wave-monitoring buoy was laid.

NARRATIVE

Scientific fitting-out of the laboratory and sampling equipment commenced on July 27th, RRS Discovery alongside in Falmouth. In the forward Hydro-lab. were mounted the NIO and GOFLO bottle racks. The GOFLO bottle filtering rack was mounted on the forward wall, and N_2 bottles supplying the pressure for filtering were lashed on the outside of the forward bulkhead. In the Bio-lab. were the clean bench for loading filters and the chlorophyll filtration system. In the Electronics area, the CTD receiving system was set up and the electronic preparations of the buoys were done. In the constant temperature computer room the Autolab salinometer was installed with a BBC microcomputer for data reduction. The continuous-flow analyser for the nutrients and the fluorimeter were in the Chemistry container. The MAFF electro-chemical analytical system was set up in the aft rough lab. During the afternnon of the 27th a fault was discovered with the CTD for which we had no spare parts. These were promptly delivered from Wormley by the afternoon of the 28th. Preparations for sailing continued through the 28th. Discovery sailed from Falmouth at 1600 on the 28th for the DB2 mooring site into a choppy sea and fresh winds - this slowed down work.

The mooring site was reached at 1136 on 29th July. Conditions for mooring were ideal - calm and sunny. Between deployments of the individual buoys, a water bottling shakedown station was run; this went smoothly. Launching of the buoys was successfully completed at 1930 and we sailed for the first of the three shelf-edge stations. The salinometer pump could not be made to work satisfactorily and a telex was sent requesting a spare. At Station 11345, two casts of GOFLO bottles were successfully run. At Station 11346 a clear signal of the presence of Mediterranean water at around 1000 m depth was seen on the CTD record. Problems developed with the CTD and rosette sampler during the first lowering. Finding the fault delayed completion of the station until 0400 on July 31st. At this stage it was decided to drop the mooring party off in Falmouth before starting the Channel grid at Station A1. En route to Falmouth, Station 11347 was completed successfully, the MAFF overside pumping system was deployed for the first time, considerable difficulty was experienced trying to keep it away from the side of the ship. On August 1st the mooring party were dropped off to a boat off Falmouth at 0845 in bright calm weather. A spare pump for the salinometer was received. The channel grid was started at Station A1 at 1115 in deteriorating weather. Stations A1 to A4 were completed successfully; on Station A5 it proved impossible to deploy safely the CTD from the midships winch platform. Scientific work was abandoned at 0100 on August 2nd. The weather improved rapidly and Station A5 was completed at 1039 on August 2nd. There were no further serious delays to the grid sampling programme and it was completed at 1230 on August 6th. At Station D3 surface water samples were collected away from the ship using the "Zodiac". Commencing at 2005 on August 6th at 50°08'N, 2°23'W a line of ten stations at 20'W intervals was begun; this resulted in a reoccupation of Stations C3, B3 and A3 which were re-sampled in more detail than as part of the grid; at the other stations CTD information only was collected. From J10 Discovery proceeded to

Plymouth Sound where the output from the River Tamar was sampled over a tidal cycle. Sampling was completed at 1515 on August 8th and a course was set for Falmouth. We were alongside at 1800 and disassembly of the scientific gear commenced. The scientific party left the ship at 1300 on August 9th.

Although this was a summer cruise, the weather conditions we encountered were far from ideal. We were, however, fortunate, to be working from RRS Discovery and less than nine hours' working time were lost due to bad weather. If we had been working on a smaller ship we might easily have lost two or three days' working time.

MOORING DEPLOYMENT

Three moorings were deployed in a cluster about 0.8 nm north of ODAS 10 (DB2), a large 6 m environmental data buoy, in the South Western Approaches close to the shelf edge. Deployment was carried out from the after deck using the buoy-first technique.

The first mooring consisted of a 1.6 m diameter discus buoy with an electromagnetic current sensor at 1.0 m below the surface, using the ARGOS system for data telemetry and location. Below the buoy at about 4 metres a VACM was attached, then a weighted line to a 34" buoyancy sphere moored to the sea bed.

The second mooring had a similar buoy but it carried an experimental electromagnetic current sensor designed to measure shear in the uppermost 0.4 m.

The third mooring consisted of a 30-foot spar buoy with three UAECM type current meters and an acoustic Doppler current profiler beneath it, together with an Aanderaa pressure/temperature logger. The spar was tethered to a 34" sub-surface buoyancy sphere by a surface line buoyed up by polo floats.

The deployments were made without incident in almost ideal weather conditions. Although the spar is unwieldy, the use of four stray lines kept it well under control during the lifting operation. The skill and competence of the ship's officers and crew also contributed to the successful deployment.

G. Griffiths, K. Goy
J. Bunting, J. Perrett

HYDROGRAPHIC SAMPLING

At the deeper water stations, 11345-11347, all the water samples were collected using GOFLO bottles mounted on a rosette sampler above a CTD unit. Salinity, nutrient trace metal and aluminium samples were taken from the bottles. This was followed by a string of six NIO bottles deployed from the 4-mm steel hydrowire. Standard NIO bottles with thermometers, racks and reversing thermometers were hung alternately on the wire with "trace metal clean" NIO bottles from which the thermometer racks were removed. The bottles were subsampled for salinity (250 ml) nutrients (30 ml) and aluminium (300 ml). The filled salinity bottles were allowed to equilibriate with room temperature and were then measured on an Autosal salinometer. Corrosion, caused over a number of years by seawater getting into the vacuum pump on the salinometer, stopped it working at the beginning of the cruise but it proved possible to repair. Nutrient samples were stored in a refrigerator prior to analysis.

R. Dyer, S. Heron, N. Hooper, G. Jacinto
T. Jickells, A. Jones, A. Jones, G. Lake
M. Nimmo, C.Symon, A. Tappin

NUTRIENT AND ALUMINIUM ANALYSES

The nutrients were determined using a Chemlab continuous-flow automated analyser system coupled to a data reduction system based on a Commodore Pet microcomputer. Nitrate, phosphate and silicate were determined on each sample collected, using standard methods described in IOS Report No. 177. The system had been in use on the two preceding Discovery cruises 159 and 160 and continued to work well. A total of 472 samples was analysed.

Subsamples for the determination of aluminium were taken from each of the NIO bottle samples taken, and a smaller number of samples was taken from GOFLO bottles at the deep stations and in the Channel for comparison with the NIO results. Two types of NIO bottles were used on this cruise: three standard bottles fitted with neoprene rubber end-caps and three bottles fitted with "trace metal clean" silicone rubber end-caps and titanium closing springs. No detectable differences in aluminium concentrations were observed between samples collected with the three different types of bottle.

D. Hydes

TRACE METALS

This is the third of three planned cruises which have been designed to provide information on the biogeochemical cycling of a series of trace metals in a coastal zone of the British Isles. Measurements of dissolved trace metals by other participating groups (LUDO, SUC, MAFF; see below) will complement and extend the range of elements determined. The water column is expected to have undergone a degree of stratification due to radiant input over the summer months, resulting in a shallow upper mixed layer separated from a deeper lower mixed layer by a well-defined thermocline. It is intended that the sampling strategy will give data on the possible influences of this water column structure (and associated phytoplankton growth) on trace metal concentrations and distributions. Additionally, the sampling strategy will allow for any benthic inputs of dissolved trace metals to be recognised.

At the three deep water stations a GOFLO water bottle rosette frame with a CTD instrument attached beneath was deployed on a 10-mm single core conducting table from the midships A-frame. Twelve 2.5 litre Teflon-lined GOFLO bottles were fixed to the rosette frame. Use of the CTD enabled the water column structure to be continuously monitored as the instrument descended, via a BBC Micro and monitor. Samples were taken at selected depths by sending an electrical signal to the rosette via the single core hydrowire. The GOFLO bottles were sub-sampled on board for nutrients (PO_4, NO_3, SiO_4) and chlorophyll.

Trace metal samples were obtained using a 'clean' system. This consisted of 2.5 litre Teflon-coated GOFLO bottles deployed from a separate winch on the foredeck which had been wrapped with plastic sheeting and wound with 6 mm Kevlar line (polycarbonate core, Dacron sheath). The Kevlar line was led over the ship's side via an all-plastic sheave fitted to the foredeck A-frame, and was weighted with a polyester-coated lead hydroweight. The use of this system was considered necessary to prevent adventitious contamination of the seawater samples. Up to four GOFLO bottles were deployed per station, with no more than two bottles on the line at any one time. The GOFLO bottles were sub-sampled on board for nutrients (PO_4, NO_3, SiO_4) and chlorophyll.

Samples of particulates for chlorophyll analysis were collected by vacuum filtration on Whatman GF/F filters and stored frozen until land-based laboratory fluorometric analysis. To obtain samples for dissolved trace metal analysis, each GOFLO was pressurised to 5 psi (using filtered nitrogen) and the seawater was filtered through an in-line acid-cleaned 0.4 μm Nuclepore membrane into an acid-cleaned polyethene bottle. These samples were acidified (1 ml sub-boiling concentrated HNO_3 per litre of seawater) to a pH of approximately 2 and stored at room temperature. At all times during filtering and storage the polyethene bottles were kept in resealable polyethene bags. Membranes used for filtration were retained and stored frozen. All membrane handling and acidification were carried in a laminar-flow hood.

At a single station, the ability of several NIO bottles (which had been modified by fitting silicone rubber end-caps and titanium springs) to sample for trace metals in a 'clean' manner were tested by comparison to GOFLO bottle samples taken at similar depths in a stable part of the water column, i.e. above and below the thermocline. Both bottle types were deployed on Kevlar line via the foredeck winch and A-frame.

On shore, a series of trace metals (Cd, Mn, Co, Cu, Ni, Pb, Zn and possibly Fe) will be determined in the seawater samples using chelation followed by solvent extraction as a preconcentration and separation step prior to measurements of the metal concentrates by graphite furnace atomic absorption spectrophotometry. Correlations between metal concentrations and other parameters (salinity, nutrients, chlorphyll) will be identified in order to gain insights into the biogeochemical cycling of these metals in the coastal environment.

Analysis of the particulates for trace metals using a sequential leaching technique will also be carried out, if time permits, in order to assist in the interpretation of metal cycling.

S. Heron, G. Jacinto, T. Jickells
M. Nimmo, C. Symon, A. Tappin

IODINE

The thermodynamically stable form of dissolved iodine in seawater is iodate, though iodide is also present in surface ocean and coastal waters. The iodide is believed to be formed by the reduction of iodate by biological processes with the subsequent oxidation of iodide being a slow process. Previous studies in oligotrophic central ocean gyres have demonstrated seasonal cycles in iodine speciation that are related to both biological and hydrographic factors. The aim of the sampling conducted during Discovery 160A was to allow the iodine speciation in the more productive waters of the English Channel to be compared to that in central ocean areas.

Water samples were collected at 5 m depth from 26 stations during the cruise and filtered through Whatman GF/F filters. The filters were retained for chlorphyll analysis and the filtrate stored refrigerated in glass bottles. Samples were subsequently returned to the shore laboratory for analysis for iodate and total iodine.

T.D. Jickells

CTD-ROSETTE OPERATION

On arriving at the ship, the CTD/Rosette combination was found unoperational. On investigation the Rosette's pressure balance diaphragm was found to have leaked, letting in sea water. The diaphragm was repaired, the housing refilled with oil and the equipment re-assembled and tested.

Shelf edge stations

With the CTD/Rosette combination now operational, the first station was occupied at 0200 on 30 July.

Station 11345	2000 m - fired all bottles
Station 11345#1	1000 m - fired all bottles
Station 11346	4500 m - no bottles fired

The fault diagnosed was a continuity break in the sea cable end. This was repaired and the dip repeated sucessfully.

Station 11346#2	4500 m - fired all bottles
Station 11346#3	1250 m - fired all bottles
Station 11347	450 m - fired all bottles

All first leg CTD data was recorded on digidata and water structure profiles stored on disc.

Channel Grid

The Rosette bottle sampler was not required on this leg and so it was detached from the CTD which was used on its own.

During the second leg 58 stations were worked, the CTD being used to a maximum depth of 100 m to obtain a water structure profile at each station; all profiles were saved on disc. The set-up of equipment worked successfully throughout the cruise.

N.J. Hooker, A. Jones

WINCHES AND OTHER MECHANICAL SCIENTIFIC EQUIPMENT

Equipment, including the electric and midships winch in addition to the FWD hydraulic system, was used comprehensively during this course of this cruise.

No major problems were incurred and the reconditioned FWD hydraulic pump-fitted previously in Tenerife worked well.

G. Lake, R. Dyer

NICKEL SPECIATION USING CATHODIC STRIPPING VOLTAMMETRY

The purpose of the cruise was to collect a series of filtered seawater samples (ca 100 ml). Modified 2.5 litre modified GOFLO bottles were used. Samples were taken from a deepwater station, 11345, and each of the Channel grid stations.

The seawater was stored frozen and on return to Liverpool they will be analysed using cathodic stripping voltammetry for labile, organic and total nickel. From such information, levels and distribution of the various metal fractions will be obtained. This data, along with the available back-up data, should, we hope, identify the biogeochemical parameters controlling the marine chemistry of nickel.

This data will be compared with previous nickel speciation data obtained from samples collected from the English Channel during cruises on the RRS Frederick Russell (12/85) and on the RV G.A. Reay (8/86).

If time permits, other metal speciation analysis will be carried out on the samples. In addition to the 100 ml seawater samples, i.e. surface and 40 m, samples were collected at stations D3, E3 and F3. Complexing capacity titrations for Cu, Ni and Zn will be carried out on these samples yielding organic-metal complex stability constants and the seawater metal complexing capacities. Again, comparisons with data from Frederick Russell 12/85 and

G.A. Reay 8/86 will be made.

M. Nimmo

SHIPBOARD ELECTROCHEMICAL MEASUREMENTS

The main aim of the cruise was to collect water samples for trace metal analysis on a grid in the English Channel and a depth profile off the coastal shelf west of Ushant. Surface water samples were collected using the MAFF buoy sampler and as many samples as possible were analysed on board.

Samples were collected at all the stations but there were some problems avoiding contamination as the buoy tended to drift into the side of the ship, a difficulty not previously encountered. This was occasionally reflected by the results obtained on board the ship where intermittent high values were recorded. Samples have been retained for analysis as soon as time should make itself available.

Those cadmium results obtained show a spread of 9-40 ng Cd l^{-1} with the lower values in the middle of the Channel and to the west. Lead data is far less well defined but the same pattern is discernable with values from 23-150 ng Pb l^{-1}. Copper concentrations require confirmation after UV irradiation as they are well below expected levels at 14-180 ng Cu l^{-1}.

The results should be available by next summer.

P. Daly, D. Harper, A. Jones

BRIEF DESCRIPTION OF HYDROGRAPHIC, NUTRIENT AND ALUMINIUM DATA

Table 1 lists the station positions, time of arrival at the station and the water depth. Results for salinity, temperature, silicon, phosphate, nitrate, aluminium, chlorophyll and phaeophyton are listed in Table 2. In Table 3, averaged results for each station are listed. Averaged results for the three cruises Frederick Russell 12/85, G.A. Reay 1/86 and Discovery 160A are listed in Table 4.

In August 1986 a well developed thermocline existed in the Channel to the west of Lyme Bay. This thermocline was characterised by warm water overlying colder water of higher salinity. The strength of the thermocline increased from east to west. On Tracks D, E and F the water was well mixed, except at Station F7 where there was a salinity increase down the water column. This gradient probably results from influence of River Seine water.

Nutrient levels were as expected for the line of year. Phosphate and nitrate levels were low in surface water in the stratified waters at the western end of the Channel and in the mixed waters. These elements are removed by primary productivity in these waters. Silicon concentrations showed a concentration gradient across the thermocline. This is considered to be a relict feature of the low silicon concentrations which resulted from removal of silicon from solution into shell material during the spring diatom bloom. Comparison of the average silicon concentrations (Table 4) shows that overall silicon concentrations were lower in May.

Aluminium concentrations changes are similar to the nitrate and phosphate concentrations being lowest in August. The more detailed sampling at the J stations clearly resolves an aluminium gradient like that of the nutrients across the thermocline. This would be expected if the aluminium were being removed from solution by biological processes. An interesting point, for which there is no explanation at present, is that on the cross-Channel tracks the largest changes in aluminium across the thermocline were seen on the C rather than the A track.

Discovery Cruise 160A

TABLE 1 - Station Positions

STATION Number	POSITION		DATE d/m	TIME BST	DEPTH m
	Lat. N	Long. W			
mooring → 11344	48°45'	08°56'	29/7	1236	
11345	48°00'	10°00'	30/7	0220	3200?
11346	47°30'	11°00'	30/7	1320	4540
11347	48°22'	9°32'	31/7	1240	530
11348					
Track A					
1	50°02'	5°30'	1/8	1140	46
2	49°48'	5°29'	1/8	1509	82
3	49°35'	5°30'	1/8	1910	94
4	49°25'	5°31'	1/8	2223	99
5	49°11'	5°30'	2/8	1001	100
6	49°00'	5°30'	2/8	1320	108
Track B					
1	50°11'	4°30'	3/8	1253	60
2	49°59'	4°31'	3/8	1048	71
3	49°47'	4°29'	3/8	0700	78
4	49°35'	4°31'	3/8	0420	86
5	49°25'	4°32'	3/8	0202	92
6	49°13'	4°30'	2/8	2300	90
7	49°01'	4°28'	2/8	2002	93
8	48°49'	4°30'	2/8	1750	94
Track C					
1	50°16'	3°30'	3/8	2030	52
2	50°06'	3°31'	3/8	2230	62
3	49°56'	3°30'	4/8	0016	64
4	49°50'	3°29'	4/8	0214	69
5	49°36'	3°31'	4/8	0400	73
6	49°27'	3°30'	4/8	0600	74
7	49°16'	3°30'	4/8	0816	75
8	49°05'	3°30'	4/8	1012	72
9	48°57'	3°27'	4/8	1150	64

Discovery Cruise 160A

TABLE 1 - Station Positions continued

STATION Number	POSITIONS Lat. N	Long. W	DATE d/m	TIME BST	DEPTH m
11348					
Track D					
1	50°29'	2°28'	5/8	1223	51
2	50°18'	2°30'	5/8	1016	53
3	50°07'	2°25'	5/8	0745	58
4	49°58'	2°23'	5/8	0605	62
5	49°46'	2°31'	5/8	0253	73
6	49°36'	2°28'	5/8	0040	50
7	49°22'	2°30'	4/8	2204	54
8	49°13'	2°31'	4/8	2030	54
9	48°58'	2°29'	4/8	1800	45
10	48°51'	2°35'	4/8	1610	37
Track E					
1	50°34'	1°32'	5/8	1710	30
2	50°22'	1°33'	5/8	1900	37
3	50°12'	1°32'	5/8	2040	67
4	49°59'	1°29'	5/8	2230	74
Track F					
1	50°36'	0°28'	6/8	1312	43
2	50°24'	0°29'	6/8	1136	47
3	50°13'	0°31'	6/8	0957	50
4	50°02'	0°30'	6/8	0815	50
5	49°50'	0°31'	6/8	0635	36
6	49°40'	0°30'	6/8	0445	26
7	49°33'	0°29'	6/8	0325	31
Track J					
1	50°08'	2°23'	6/8	2118	61
2	50°05'	2°49'	7/8	0025	60
3	50°01'	3°07'	7/8	0240	61
4	49°56'	3°31'	7/8	0515	67
5	49°53'	3°51'	7/8	0908	72
6	49°50'	4°09'	7/8	1112	72
7	49°47'	4°30'	7/8	1220	76
8	49°44'	4°50'	7/8	1512	81
9	49°39'	5°10'	7/8	1620	87
10	49°36'	5°30'	7/8	1840	95
T1	50°21'	4°09'	8/9	0315	
T14	50°21'	4°09'	8/8	1515	

Discovery Cruise 160A

TABLE 2A - Station 11345

Sample Depth m (wire out)	Salinity PSU	Temp. (CTD) °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
5	35.612	17.19	0.3	0.14	0.4	3.9	0.0	0.0
20	35.601	17.18	0.8	0.20	2.0	(55.7)	0.1	0.1
30	35.612	17.08	0.3	0.12	0.4	3.8	0.1	0.1
50	35.566	14.23	0.4	0.22	1.7	3.7	0.2	0.2
75	35.566	12.00	1.3	0.50	6.9	4.0	0.2	0.1
100	35.563	11.59	1.2	0.49	7.0	5.9	0.2	0.2
150	35.564	11.35	2.4	0.60	9.0	6.1	0.0	0.1
200	35.564	11.22	2.9	0.62	9.5	9.5	0.0	0.1
400	35.531	10.96	3.7	0.68	10.5	10.1	0.0	0.1
600	35.531	10.67	3.8	0.68	10.6	9.5	0.0	0.0
700	35.529	10.18	7.2	0.99	15.7	13.9		
800	35.607	10.10	8.2	1.12	16.8	18.2	0.0	0.0
900	35.494	9.90	1.1	0.20	2.7	off		
1000	35.069	9.55	8.2	1.04	16.5	17.1	0.0	0.0
1100	35.709	9.44	9.8	1.11	17.4	19.2		
1300	35.541	8.07	5.7	0.82	12.9	11.9		
1400	35.450	-	11.6	1.17	18.2	17.4		
1500	35.356	6.72	11.9	1.18	18.1	15.9		
1600	35.147	5.34	12.2	1.19	18.3	16.2		
1700	35.088	4.83	13.0	1.23	18.4	15.0		
1800	35.086	4.55	13.0	1.20	18.2	14.5		
1900	35.045	4.29	16.0	1.27	18.3	14.4		
2000	35.040	3.89	16.0	1.22	18.3	16.1		

Discovery Cruise 160A

TABLE 2A - Station 11346

Sample Depth m (wire out)	Salinity PSU	Temp. (CTD) °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
5	35.593	16.86	0.3	0.13	0.3	19.2	0.2	0.1
10	35.589	16.86	0.8	0.24	2.5	2.8		
20	35.584	16.87	0.3	0.20	0.4	6.0	0.4	0.1
30	35.583	16.53	0.3	0.13	0.4	4.3	0.3	0.3
100	35.586	11.66	0.3	0.17	1.2	5.3		
200	35.511	11.25	1.8	0.62	9.2	7.1	0.0	0.0
500	35.490	10.48	4.3	0.80	12.1	11.5		
800	35.490	9.80	4.4	0.80	12.1	11.5	0.0	0.0
1000	35.596	9.50	-	-	-	15.5		
1000	35.698	9.47	9.1	1.13	17.2	21.6	0.0	0.0
1100	35.611	8.46	10.3	1.16	17.5	20.7		
1250	35.616	6.91	10.3	1.16	17.7	21.7	0.0	0.0
1523	35.562	4.70	1.3	0.26	3.0	(52.6)	0.1	0.2
1723	35.015	4.00	10.7	1.22	17.9	12.9		
2073	34.956	3.68	10.7	1.22	17.7	10.6		
2423	34.970	3.27	13.5	1.23	17.9	12.5		
3123	34.998	2.73	27.0	1.38	19.3	18.8		
3473	34.985	2.60	29.6	1.40	19.6	19.6		
3823	34.985	2.52	36.1	1.50	20.8	21.7		
4173	34.919	2.49	39.4	1.53	21.0	24.0		
4550	34.904	2.49	41.4	1.57	21.6	24.8		
4603	34.900	2.50	41.4	1.56	21.4	26.3		

Discovery Cruise 160A

TABLE 2B - Hydrographic data from Channel grid

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
A1N	00	35.147		0.8	0.22	0.4	8.9		
	05	35.151	15.30	0.8	0.08	0.2	14.1		
	10	35.147		0.8	0.08	0.3	8.7		
	15	35.146	15.11	0.9	0.08	0.2	8.7		
	25	35.174		2.4	0.08	0.2	12.0		
	40	35.208	11.33	2.5	0.15	0.3	10.9		
A1G	05			0.8	0.08	0.2	8.1	4.2	0.8
	40			2.5	0.10	0.2	11.1	1.9	0.5
A2N	00	35.174		0.4	0.07	0.2	8.1		
	05	35.176	16.35	0.4	0.17	0.2	7.8		
	15	35.185		0.7	0.08	0.2	9.3		
	20	35.238	11.78	2.3	0.10	0.2	10.5		
	40	35.265		2.8	0.29	2.4	12.7		
	60	35.290	11.42	2.9	0.37	2.8	10.9		
A2G	05			0.4	0.07	0.2	9.3	1.1	0.4
	40			2.8	0.33	2.2	10.0	0.1	0.1
A3N	00	35.250		0.5	0.08	0.4	6.7		
	10	35.253	15.71	0.5	0.02	0.4	19.6		
	15	35.254		0.6	0.09	0.5	6.6		
	25	35.302	10.80	2.4	0.32	4.0	11.1		
	50	35.302		2.5	0.35	4.0	12.3		
	80	35.301	10.80	2.5	0.31	4.1	13.3		

Discovery Cruise 160A

TABLE 2A - Station 11347

Sample Depth m (wire out)	Salinity PSU	Temp. (CTD) °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
5	35.545	15.65	0.7	0.28	3.2	15.5	No data	No data
10	35.540	15.63	0.3	0.21	1.7	3.4		
20	35.540	15.20	0.3	0.23	1.4	8.7		
50	35.536	13.36	1.0	0.44	5.3	9.1		
100	35.540	11.59	2.1	0.62	9.4	4.6		
100	35.547	11.59	2.7	0.68	9.7	7.0		
200	35.547	11.06	2.1	0.64	9.4	4.4		
300	35.537	10.84	3.1	0.69	10.4	6.4		
350	35.529	10.81	3.8	0.76	11.2	8.7		
400	35.529	10.80	3.8	0.75	11.2	10.8		
440	35.528	10.80	3.8	0.76	11.3	11.3		
450	35.532	10.80	3.9	0.77	11.3	10.1		

Discovery Cruise 160A

TABLE 2B - continued (2)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
A3G	05			0.5	0.11	0.5	7.7	0.8	0.4
	40			2.4	0.33	4.2	11.5	0.3	0.2
A4N	00	35.223		0.2	0.09	0.5	11.9		
	05	35.227	16.01	0.2	0.07	0.3	10.6		
	16	35.251		0.5	0.16	0.7	9.0		
	25	35.382	11.64	1.6	0.28	2.9	10.3		
	40	35.375		1.8	0.33	3.5	9.8		
	60	35.375	11.24	1.8	0.33	3.9	13.0		
A4G	05			0.3	0.18	0.7	18.1	0.7	0.3
	40			0.6	0.29	1.2	14.4	0.5	0.2
A5N	00	35.234		0.2	0.06	0.3	9.6		
	05	35.234	15.88	0.2	0.08	0.2	14.7		
	24	35.392		1.2	0.24	1.8	10.1		
	40	35.426	11.94	1.3	0.25	2.2	7.9		
	60	35.428		1.3	0.29	3.4	8.6		
	80	35.418	11.57	1.8	0.29	3.3	13.9		
A5G	05			0.2	0.07	0.1	9.8	1.3	0.3
	40			1.4	0.31	2.5	10.4	0.1	0.1

Discovery Cruise 160A

TABLE 2B - continued (3)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
A6N	00	35.318		0.3	0.07	0.1	7.0		
	10	35.321	15.78	0.3	0.08	0.1	8.5		
	20	35.396		0.7	0.12	0.2	5.6		
	25	35.414	12.81	1.0	0.19	1.5	6.4		
	50	35.447		1.5	0.33	3.8	8.0		
	70	35.443	11.50	1.8	0.30	4.1	10.3		
A6G	05			0.3	0.06	0.1	7.8	4.9	1.1
	40			1.4	0.21	1.7	12.2	1.3	0.3
B1N	00	35.029		0.3	0.04	0.1	7.4		
	05	35.033	13.61	0.3	0.03	0.0	8.6		
	20	35.053		1.0	0.06	0.1	6.2		
	24	35.056	12.42	1.1	0.03	0.0	6.9		
	40	35.120		2.9	0.13	0.7	8.2		
	50	35.133	11.35	3.5	0.15	0.7	10.3		
B1G	05			0.5	0.02	0.0		7.2	1.6
	20			1.3	0.05	0.2		3.6	0.6
	40			3.1	0.15	0.8		0.4	0.2
B2N	00	35.089		1.7	0.04	0.0	8.0		
	05	35.088	13.39	1.6	0.06	0.1	8.4		
	15	35.112		1.8	0.12	0.0	7.3		
	20	35.162	11.92	2.0	0.08	0.0	8.0		
	40	35.218		2.8	0.12	1.2	9.2		
	60	35.228	11.00	2.9	0.10	0.9	9.7		

Discovery Cruise 160A

TABLE 2B - continued (4)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
B2G	05			2.3	0.06	0.1	-	4.7	0.7
	20			2.3	0.11	0.1	-	2.6	0.3
	40			2.8	0.11	1.0	-	0.1	0.1
	60			2.1	0.05	0.1	-	(7.3)	(1.0)
B3N	00	35.172		1.6	0.04	0.0	8.4		
	05	35.172	13.37	1.6	0.02	0.0	10.8		
	15	35.184		1.7	0.01	0.0	8.6		
	25	35.202	12.08	2.1	0.00	0.1	9.4		
	50	35.241		2.6	0.19	1.8	9.6		
	70	35.234	11.22	2.7	0.18	1.6	9.6		
B3G	05			1.5	0.02	0.0		15.2	2.1
	20			2.0	0.00	0.0		1.0	0.2
	40			2.6	0.15	1.3		0.1	0.1
	70			2.6	0.16	1.4		0.1	0.1
B4N	00	35.171		0.5	0.01	0.0	9.2		
	05	35.179	15.40	0.5	0.00	0.0	15.9		
	20	35.218		1.2	0.07	0.4	7.3		
	40	35.277	11.81	2.1	0.18	1.5	7.5		
	60	35.268		2.3	0.18	1.4	8.4		
	80	35.256	11.41	2.5	0.16	1.4	7.9		
B4G	05			0.5	0.01	0.0	-	3.6	1.0
	20			1.4	0.13	0.7	-	0.1	0.1
	40			2.0	0.18	1.6	-	0.3	0.3

Discovery Cruise 160A

TABLE 2B - continued (5)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
B5N	00	35.160		0.4	0.04	0.0	7.9		
	15	35.155	15.80	0.4	0.01	0.1	10.9		
	20	35.154		0.5	0.00	0.0	8.1		
	25	35.268	13.38	0.9	0.10	0.6	9.3		
	40	35.312		1.6	0.20	1.6	6.8		
	80	35.293	12.01	2.1	0.20	1.7	8.4		
B5G	05			0.4	0.00	0.1	-	5.5	1.5
	20			0.6	0.12	0.1	-	2.4	0.6
	40			1.5	0.20	1.6	-	0.1	0.1
B6N	00	35.213		0.1	0.04	0.0	6.0		
	05	35.213	16.01	0.1	0.04	0.0	8.5		
	25	35.202		0.2	0.07	0.0	7.0		
	29	35.303	13.00	0.8	0.16	1.3	6.5		
	40	35.280		1.3	0.21	1.8	7.7		
	80	35.290	12.51	1.4	0.20	1.8	8.3		
B6G	05			0.1	0.04	0.0	-	3.1	1.1
	25			0.8	0.17	1.4	-	0.2	0.4
	40			1.0	0.19	1.7	-	0.2	0.2
	85			1.4	0.21	1.6	-	0.2	0.1

Discovery Cruise 160A

TABLE 2B - continued (6)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
B7N	00	35.288		0.1	0.03	0.1	6.9		
	05	35.291	15.30	0.1	0.08	0.1	(20.2)		
	25	35.302		0.1	0.06	0.1	4.1		
	40	35.303	13.38	0.4	0.12	1.2	4.8		
	60	35.304		0.8	0.18	1.6	6.2		
	85	35.304	12.99	1.1	0.19	1.8	7.2		
B7G	05	-		0.1	0.04	0.0	-	0.6	0.2
	20	-		0.1	0.04	0.1	-	1.1	0.3
	40	-		0.5	0.12	0.1	-	1.2	0.3
	85	-		1.1	0.19	1.8	-	-	-
B8N	00	35.266		1.1	0.16	1.9	8.4		
	05	35.270	13.97	1.1	0.16	1.8	11.0		
	20	35.266		1.2	0.15	1.8	9.9		
	40	35.282	13.64	1.2	0.16	1.8	9.7		
	60	35.290		1.2	0.19	2.0	8.0		
	85	35.290	13.38	1.2	0.19	2.0	9.6		
B8G	05	-		1.2	0.17	1.8	-	0.4	0.3
	20	-		1.2	0.14	1.6	-	0.6	0.4
	40	-		1.2	0.16	1.8	-	0.5	0.4

Discovery Cruise 160A

TABLE 2B - continued (7)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
C1N	00	35.042		0.3	0.06	0.2	6.3		
	05	35.047	13.55	0.3	0.07	0.2	(12.0)		
	12	35.055		0.6	0.06	0.3	6.8		
	20	35.059	13.13	1.1	0.09	0.5	6.8		
	30	35.063		1.5	0.13	0.7	9.3		
	40	35.058	12.81	1.6	0.13	0.8	9.3		
C1G	05			0.05	0.30	0.1	-	2.9	1.0
	40			0.14	1.6	0.8	-	1.4	0.6
C2N	00	34.996		0.2	0.05	0.0	4.8		
	05	35.002	13.77	0.2	0.04	0.1	(8.1)		
	20	35.026		0.4	0.07	0.2	5.8		
	25	35.034	12.90	1.1	0.09	0.9	6.1		
	40	35.049		2.3	0.24	1.7	10.0		
	55	35.047	12.11	2.4	0.21	1.7	16.0		
C2G	05			0.1	0.03	0.1		5.1	2.3
	40			2.1	0.23	1.8		0.8	0.4
C3N	00	35.049		0.5	0.06	0.0	5.8		
	15	35.050	14.94	0.5	0.04	0.1	(8.7)		
	25	35.064		0.5	0.04	0.1	5.5		
	30	35.059	12.77	1.5	0.08	0.3	7.0		
	40	35.057		2.1	0.12	1.9	9.8		
	55	35.062	11.93	2.1	0.14	1.8	12.4		

Discovery Cruise 160A

TABLE 2B - continued (8)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
C3G	05			0.6	0.04	0.0	-	14.9	2.2
	40			2.3	0.23	1.8	-	0.5	0.4
C4N	00	35.064		0.2	0.05	0.1	6.3		
	10	35.063	15.68	0.2	0.05	0.0	7.3		
	20	35.071		0.2	0.05	0.2	7.9		
	27	35.037	12.35	2.3	0.24	2.5	14.2		
	35	35.037		2.3	0.24	2.5	14.0		
	60	35.049	12.23	2.2	0.24	2.5	13.8		
C4G	05			0.3	0.04	0.0	-	3.1	0.7
	40			2.3	0.25	2.6	-	0.4	0.3
C5N	00	35.052		0.1	0.04	0.0	5.1		
	05	35.051	15.95	0.2	0.07	0.0	5.5		
	15	35.052		0.2	0.05	0.0	6.0		
	30	35.040	13.21	2.2	0.20	1.7	15.0		
	45	35.062		2.3	0.21	2.1	15.0		
	65	35.064	12.68	2.3	0.22	2.1	15.2		
C5G	05			0.1	0.04	0.0	-	1.0	0.3
	40			2.3	0.20	1.8	-	0.3	0.2

Discovery Cruise 160A

TABLE 2B - continued (9)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
C6N	00	35.051		0.1	0.06	0.0	5.6		
	05	35.054	15.36	0.1	0.08	0.0	6.4		
	20	35.072		0.1	0.04	0.0	6.0		
	35	35.066	13.73	1.7	0.16	1.3	12.3		
	50	35.058		2.6	0.22	2.1	17.0		
	65	35.054	13.17	2.7	0.23	2.1	17.2		
C6G	05			0.1	0.04	0.0	-	1.2	1.0
	40			2.2	0.26	1.8	-	1.4	0.5
C7N	00	34.854		1.3	0.06	0.1	11.3		
	05	34.926	15.24	1.3	0.06	0.1	13.1		
	20	35.024		1.4	0.07	0.3	10.5		
	30	35.066	14.49	1.6	0.13	0.5	11.4		
	40	35.074		2.3	0.19	1.5	14.6		
	65	35.069	14.04	2.4	0.19	1.4	14.9		
C7G	05			1.2	0.05	0.0	-	1.9	0.5
	40			2.3	0.18	1.5	-	0.4	0.2
C8N	00	34.945		2.0	0.10	0.6	14.7		
	05	34.946	15.40	2.0	0.11	0.6	(18.1)		
	09	35.009		2.0	0.17	1.0	14.7		
	20	35.045	14.80	2.0	0.16	1.0	13.5		
	40	35.061		2.0	0.16	1.0	15.2		
	65	35.065	14.58	2.0	0.17	1.0	14.1		

Discovery Cruise 160A

TABLE 2B - continued (10)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
C8G	05			2.0	0.13	0.9	-	0.5	0.4
	40			2.0	0.16	1.2	-	0.4	0.3
C9N	00	35.054		1.8	0.15	1.1	13.3		
	05	35.058	15.04	1.8	0.15	1.0	14.1		
	20	35.078		1.7	0.14	1.0	11.8		
	30	35.085	14.80	1.6	0.14	0.9	10.9		
	40	35.107		1.4	0.13	0.9	11.0		
	55	35.118	14.54	1.3	0.14	0.9	10.2		
C9G	05			1.8	0.14	1.0	-	0.6	0.4
	40			1.4	0.13	0.9	-	0.7	0.5
DN1	00	35.091		1.9	0.06	0.1	15.2		
	05	35.092	15.22	1.9	0.06	0.1	15.4		
	15	35.089		1.9	0.06	0.1	15.7		
	25	35.091	15.16	1.8	0.06	0.1	16.4		
	35	35.091		1.5	0.06	0.1	15.7		
	45	35.087	15.12	1.5	0.06	0.1	17.2		
DG1	05			1.9	0.07	0.1		-	-
	20			1.9	0.07	0.1		-	-

Discovery Cruise 160A

TABLE 2B - continued (11)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
DN2	00	35.228		0.5	0.00	0.1	9.6		
	05	35.229	14.11	0.5	0.01	0.1	(13.4)		
	15	35.223		0.5	0.00	0.1	9.7		
	25	35.226	14.10	0.5	0.04	0.1	9.0		
	35	35.224		0.5	0.00	0.1	10.2		
	40	35.224	14.12	0.5	0.00	0.1	9.7		
DG2	05			0.5	0.00	0.1	-	1.8	0.9
	40			0.5	0.00	0.1	-	2.1	0.9
DN3	00	35.139		0.2	0.05	0.2	9.8		
	05	35.147	14.18	0.2	0.06	0.1	(12.4)		
	10	35.143		0.2	0.05	0.1	9.8		
	25	35.145	14.18	0.2	0.04	0.0	9.6		
	40	35.143		0.2	0.05	0.0	9.0		
	50	35.143	14.18	0.2	0.08	0.0	9.8		
DG3	05			0.2	0.05	0.0	-		
	40			0.2	0.04	0.0	-		
DN4	00	34.974		1.6	0.13	1.6	9.3		
	05	34.980	14.04	1.6	0.12	1.5	10.1		
	15	34.973		1.6	0.13	1.4	9.7		
	30	34.972	14.06	1.6	0.11	1.4	9.3		
	45	34.972		1.6	0.11	1.4	9.0		
	55	34.974	14.08	1.6	0.11	1.4	9.8		

Discovery Cruise 160A

TABLE 2B -continued (12)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
DG4	05			1.6	0.12	1.4	-	2.9	1.2
	40			1.6	0.11	1.4	-	2.8	0.7
DN4	00	34.915	14.28	0.8	0.07	0.7	8.3		
	05	34.915		0.8	0.07	0.6	8.4		
	20	34.914	14.05	1.0	0.08	0.9	9.8		
	35	34.914		0.9	0.08	0.9	9.8		
	50	34.917	13.88	1.0	0.12	1.1	9.7		
	65	34.917		1.0	0.08	1.1	10.3		
DG5	05			0.7	0.06	0.7	-	0.8	0.5
	40			1.0	0.08	1.1	-	0.8	0.5
D6N	00	34.905		1.7	0.11	0.9	13.8		
	05	34.909	14.79	1.7	0.11	0.9	13.3		
	15	34.917		1.6	0.10	0.9	13.9		
	25	34.913	14.78	1.6	0.10	0.9	13.8		
	35	34.917		1.5	0.10	0.9	14.8		
	45	34.917	14.77	1.5	0.10	0.9	13.6		
D6G	05			2.1	0.16	1.4	-	1.0	0.6
	40			1.6	0.10	1.0	-	1.2	0.8

Discovery Cruise 160A

TABLE 2B - continued (13)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
D7N	00	34.921		1.5	0.10	0.7	12.8		
	05	34.932	14.60	1.5	0.10	0.8	14.2		
	20	34.927		1.5	0.09	0.8	13.2		
	30	34.926	14.61	1.5	0.10	0.8	13.0		
	40	34.927		1.5	0.10	0.8	13.3		
	50	34.927	14.62	1.5	0.10	0.9	13.1		
D7G	05			1.5	0.10	1.0	-	1.0	0.6
	40			1.6	0.11	0.9	-	1.1	0.5
D8N	00	34.846		2.0	0.10	0.9	13.5		
	05	34.853	15.43	2.0	0.10	0.8	(26.0)		
	20	34.847		2.0	0.10	0.8	14.2		
	23	34.847	15.43	2.0	0.10	0.8	13.5		
	40	-		1.9	0.10	0.6	12.8		
	45	34.855	15.29	1.9	0.11	0.6	12.8		
D8G	05			2.3	0.10	0.8	-	0.7	0.2
	40			1.9	0.10	0.8	-	1.0	0.4
D9N	00	34.834		2.4	0.10	0.5	13.1		
	05	34.841	15.72	2.4	0.13	0.6	13.1		
	10	34.833		2.4	0.10	0.5	14.3		
	20	34.836	15.73	2.4	0.11	0.5	13.3		
	30	34.836		2.4	0.11	0.4	13.6		
	40	34.837	15.74	2.4	0.10	0.4	13.4		

Discovery Cruise 160A

TABLE 2B - continued (14)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
D9G	05			2.4	0.10	0.5		0.5	0.4
	20			2.4	0.10	0.5		0.5	0.3
	35			2.4	0.10	0.5		0.4	0.3
D10N	00	34.829		2.6	0.12	0.9	15.4		
	05	34.832	15.85	2.6	0.14	0.9	16.1		
	10	34.828		2.6	0.12	1.0	14.7		
	15	34.827	15.87	2.6	0.12	0.8	14.8		
	25	34.828		2.6	0.12	0.8	15.0		
	32	34.831	15.85	2.6	0.19	0.8	15.1		
D10G	05			2.6	0.10	0.7	-	0.4	0.4
	20			2.6	0.11	0.9	-	0.3	0.4
	30			2.6	0.11	0.8	-	0.4	0.4
E1N	00	34.634		1.0	0.07	0.1	23.5		
	05	34.634	16.58	1.0	0.07	0.1	23.3		
	10	34.630		1.0	0.05	0.1	23.6		
	15	34.638	16.51	1.0	0.08	0.1	23.5		
	20	34.645		1.0	0.06	0.1	22.6		
	25	34.655	16.47	1.0	0.05	0.1	23.0		
E1G	05			1.0	0.08	0.1		0.6	0.4

Discovery Cruise 160A

TABLE 2B - continued (15)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
E2N	00	34.939		0.9	0.04	0.1	13.6		
	05	34.944	15.55	0.9	0.06	0.1	15.0		
	10	34.940		0.9	0.04	0.1	13.8		
	15	34.940	15.56	0.9	0.04	0.1	14.1		
	20	34.940		0.9	0.05	0.1	14.0		
	30	34.940	-	0.9	0.05	0.1	14.3		
E2G	05			0.9	0.04	0.1		0.8	0.4
E3N	00	35.042		0.2	0.03	0.2	9.3		
	05	35.051	14.57	0.2	0.04	0.3	10.3		
	20	-		0.2	0.04	0.2	8.8		
	30	35.049	14.54	0.2	0.06	0.2	9.8		
	40	35.049		0.2	0.05	0.2	9.6		
	60	35.048	14.56	0.2	0.04	0.2	9.4		
E3G	05			0.2	0.04	0.2		3.0	0.8
E4N	00	34.898		2.2	0.13	2.0	13.2		
	05	34.897	14.52	2.2	0.14	2.1	19.6		
	20	34.890		2.2	0.15	2.0	14.9		
	30	34.894	14.53	2.2	0.13	2.0	12.6		
	40	34.898		2.2	0.14	2.0	13.2		
	65	34.895	14.53	2.2	0.13	1.9	13.1		
E4G	05			2.2	0.14	1.8		0.6	0.4

Discovery Cruise 160A

TABLE 2B - continued (16)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
F1N	00	34.944		0.8	0.08	0.3	14.6		
	05	34.950	15.63	0.8	0.09	0.2	15.8		
	15	34.954		0.8	0.08	0.2	15.8		
	20	34.956	15.51	0.8	0.08	0.2	17.0		
	25	34.956		0.8	0.08	0.3	14.6		
	35	34.958	15.50	0.7	0.08	0.2	16.3		
F1G				0.9	0.08	0.3		0.9	0.4
F2N	00	34.997		0.9	0.15	0.4	12.1		
	05	34.998	15.10	0.9	0.15	0.2	12.3		
	10	34.998		0.9	0.15	0.2	12.2		
	20	34.998	15.09	0.9	0.15	0.2	11.7		
	30	34.998		0.9	0.15	0.2	11.4		
	40	34.998	15.08	0.9	0.15	0.2	12.0		
F2G	05			0.9	0.07	0.4			
	40			0.9	0.08	0.5			
F3N	00	34.977		2.7	0.09	1.1	13.6		
	05	34.978	14.68	2.7	0.08	1.1	16.4		
	10	34.976		2.7	0.09	1.1	15.1		
	20	34.977	14.68	2.7	0.07	1.1	13.5		
	30	34.976		2.7	0.07	1.1	14.5		
	40	34.975	14.68	2.7	0.07	1.1	13.6		
F3G	05			2.6	0.08	1.0		0.6	0.3
	40			2.6	0.09	1.1		0.6	0.3

Discovery Cruise 160A

TABLE 2B - continued (17)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon μM	Phosphate μM	Nitrate μM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
F4N	00	34.814		3.0	0.13	1.7	14.1		
	05	34.814	14.90	3.0	0.14	1.8	17.3		
	10	34.815		3.0	0.13	1.8	14.1		
	20	34.819	14.90	3.0	0.13	1.8	13.6		
	30	34.830		3.0	0.13	1.8	16.0		
	40	34.843	14.85	3.0	0.13	1.8	14.2		
F4G	05			2.8	0.15	1.9		0.8	0.3
	40			2.8	0.14	1.9		0.7	0.3
F5N	00	34.641		2.6	0.18	1.2	12.7		
	05	34.641	15.40	2.6	0.17	1.3	14.2		
	10	34.641		2.6	0.17	1.2	13.2		
	15	34.641	15.38	2.6	0.17	1.2	13.8		
	20	34.647		2.6	0.16	1.2	12.9		
	30	34.642	15.39	2.6	0.16	1.2	13.7		
F5G	05			2.4	0.17	1.3		1.5	0.4
	20			2.4	0.18	1.3		1.3	0.4
F6N	00	34.439		2.2	0.25	0.4	12.6		
	05	34.440	15.82	2.2	0.28	0.4	12.6		
	10	34.438		2.1	0.26	0.4	12.3		
	15	34.443	15.82	2.1	0.25	0.4	12.3		
	20	34.601		2.1	0.24	0.4	11.8		
	22	34.446	15.82	2.1	0.24	0.4	12.4		

Discovery Cruise 160A

TABLE 2B - continued (18)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
F6G	05			2.1	0.26	0.4		0.9	0.3
	20			2.0	0.22	0.4		1.5	0.4
F7N	00	34.162		2.9	0.42	0.6	13.2		
	05	34.211	16.24	3.1	0.41	0.8	14.6		
	10	34.230		3.1	0.39	0.7	13.3		
	15	34.296	16.08	3.1	0.36	0.6	14.5		
	20	34.324		3.2	0.35	0.6	14.7		
	25	34.365	15.97	3.2	0.32	0.7	15.7		
F7G	05			2.9	0.43	0.5		0.7	0.4
	20			3.2	0.34	0.9		0.6	0.4
J4N	00	35.034		1.6	0.03	0.0	11.0		
	05	35.038	14.08	1.6	0.02	0.0	9.5	14.1	1.2
	10	35.032		1.6	0.01	0.0	8.3		
	15	35.025	14.08	1.6	0.01	0.0	8.2	15.1	1.8
	20	35.023		1.7	0.01	0.0	8.3		
	25	35.034	13.95	1.6	0.01	0.0	8.3	16.5	1.8
	30	35.046		2.1	0.09	1.1	9.4		
	35	35.046	12.62	2.6	0.16	1.8	11.5		
	40	35.042		2.6	0.18	2.0	12.5		
	45	35.044	12.29	2.7	0.20	2.0	11.9		
	50	35.048		2.7	0.17	1.9	11.9		
	55	35.047	12.28	2.7	0.16	2.0	13.4		

Discovery Cruise 160A

TABLE 2B - continued (19)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
J7N	00	35.118		2.2	0.00	0.0	7.8		
	05	35.116	13.05	2.2	0.00	0.0	7.8		
	15	35.120		2.2	0.00	0.0	7.7		
	20	35.152	12.42	2.4	0.04	0.5	8.3		
	25	35.177		2.6	0.03	0.2	8.6		
	30	35.216	11.29	2.9	0.10	1.3	9.6		
	45	35.219		3.0	0.12	1.4	10.0		
	50	35.219	11.26	2.9	0.14	1.1	10.4		
	55	35.218		3.0	0.12	1.2	9.9		
	60	35.218	11.28	3.0	0.12	1.2	9.7		
	70	35.219	11.28	3.0	0.12	1.2	9.9		
J7G	05			2.3	0.01	0.0		3.4	0.5
	20	35.218		3.0	0.11	1.3		0.2	0.1
	40			3.0	0.12	1.4		0.2	0.1
	60			3.0	0.13	1.4		0.2	0.1

Discovery Cruise 160A

TABLE 2B - continued (20)

	Sample Depth m	Salinity PSU	Temp. °C	Silicon µM	Phosphate µM	Nitrate µM	Aluminium nM	Chlorophyll ug/l	Phaeophytin ug/l
J10N	00	35.258		1.1	0.01	0.0	6.5		
	05	35.258	13.50	1.1	0.01	0.0	8.3		
	10	35.256		1.1	0.00	0.0	6.5		
	15	35.260	13.45	1.1	0.01	0.0	6.5		
	20	35.264		1.2	0.00	0.0	6.9		
	25	35.268	13.06	1.3	0.02	0.0	7.1		
	30	35.343		2.1	0.18	3.4	9.9		
	40	35.367	10.70	2.4	0.29	4.8	11.6		
	50	35.368		2.4	0.29	4.6	11.8		
	60	35.370	10.65	2.4	0.29	4.9	11.7		
	75	35.369		2.4	0.29	5.0	11.4		
	90	35.365	10.69	2.4	0.28	5.1	11.9		
J10G	05			1.1	0.01	0.0		4.0	0.9
	40			1.1	0.01	0.0		4.4	1.1

Discovery Cruise 160A

TABLE 2C - Hydrographic data from Tamar tidal station

	Sample Depth m	Time BST	Salinity PSU	Silicon µM	Phosphate µM	Nitrate µM	Chlorophyll ug/l	Phaeophytin ug/l
T1	7	0215	34.224	2.0	0.01	0.2	1.5	0.5
T2	7	0315	34.456	1.5	0.24	1.6	2.6	1.1
T3	7	0415	34.690	1.6	0.16	1.1	2.2	0.9
T4	7	0515	34.758	1.5	0.14	0.9	2.1	0.8
T5	7	0615	34.817	1.4	0.11	0.6	2.1	0.7
T6	7	0715	34.783	1.6	0.14	0.8	1.7	0.6
T7	7	0815	34.706	1.5	0.14	0.9	2.0	0.6
T8	7	0915	34.538	1.6	0.22	1.4	2.3	1.0
T9	7	1015	34.290	1.5	0.27	1.8	2.9	0.7
T10	7	1115	34.349	1.6	0.25	1.8	2.4	0.9
T11	7	1215	34.147	1.7	0.27	2.0	2.5	1.0
T12	7	1315	34.277	1.7	0.28	1.9	2.5	1.0
T13	7	1415	34.616	1.8	0.24	1.2	2.6	0.9
T14	7	1515	34.809	1.8	0.19	1.1	2.2	0.7

Discovery Cruise 160A

TABLE 3 - Averaged Results for Each Station

STATION Number	SALINITY	TEMPERATURE °C	ALUMINIUM nM	SILICON µM	PHOSPHATE µM	NITRATE µM
Track A						
1	35.15	15.2	9	0.8	0.08	0.3
	35.21	11.3	11	2.5	0.15	0.3
2	35.17	16.4	8	0.4	0.07	0.2
	35.27	11.4	11	2.8	0.37	2.6
3	35.25	15.7	7	0.5	0.08	0.4
	35.30	10.8	13	2.5	0.32	4.0
4	35.22	16.0	11	0.2	0.80	0.4
	35.37	11.2	11	1.8	0.33	3.7
5	35.23	15.9	10	0.2	0.70	0.3
	35.43	11.6	14	1.5	0.29	3.4
6	35.32	15.8	7	0.3	0.80	0.1
	35.44	11.5	10	1.7	0.32	4.0
Track B						
1	35.03	13.6	7	0.3	0.04	0.1
	35.13	11.4	10	3.5	0.15	0.7
2	35.09	13.4	8	1.7	0.05	0.0
	35.23	11.0	9	2.9	0.11	1.1
3	35.17	13.4	9	1.6	0.04	0.0
	35.23	11.2	10	2.7	0.19	1.7
4	35.17	15.4	8	0.5	0.01	0.0
	35.26	11.4	8	2.4	0.18	1.4
5	35.16	15.8	8	0.4	0.01	0.0
	35.29	12.0	8	2.1	0.20	1.7
6	35.21	16.0	7	0.1	0.04	0.0
	35.29	12.5	8	1.4	0.21	1.8
7	35.29	15.3	6	0.1	0.06	0.1
	35.30	13.0	7	1.1	0.19	1.7
8	35.27	14.0	9	1.1	0.16	1.9
	35.29	13.4	9	1.2	0.19	2.0

Discovery Cruise 160A

TABLE 3 - Averaged results for each station - continued (2)

STATION Number	SALINITY	TEMPERATURE °C	ALUMINIUM nM	SILICON µM	PHOSPHATE µM	NITRATE µM
Track C						
1	35.04	13.6	6	0.3	0.06	0.2
	35.06	12.8	9	1.6	0.13	0.8
2	35.00	13.8	5	0.2	0.50	0.1
	35.05	12.1	13	2.4	0.23	1.7
3	35.05	14.9	6	0.5	0.04	0.1
	35.06	11.9	11	2.1	0.13	1.9
4	35.06	15.7	7	0.2	0.05	0.1
	35.04	12.2	14	2.3	0.24	2.5
5	35.05	16.0	6	0.2	0.05	0.0
	35.06	12.7	15	2.3	0.21	2.1
6	35.05	15.4	6	0.1	0.06	0.0
	35.06	13.2	17	2.7	0.23	2.1
7	34.85	15.2	11	1.3	0.06	0.1
	35.07	14.0	15	2.4	0.19	1.5
8	34.95	15.4	15	2.0	0.10	0.6
	35.06	14.6	15	2.0	0.16	1.0
9	35.05	15.0	13	1.8	0.15	1.0
	35.11	14.5	10	1.4	0.14	0.9
Track D						
1	35.09	15.2	16	1.9	0.06	0.1
2	35.22	14.1	10	0.5	0.00	0.1
3	35.14	14.2	10	0.2	0.05	0.1
4	35.97	14.1	9	1.6	0.12	1.4
5	34.91	14.3	8	0.8	0.07	0.7
	34.92	13.9	10	1.0	0.10	1.1
6	34.91	14.8	14	1.6	0.10	0.9
7	34.93	14.6	13	1.5	0.10	0.8
8	34.85	15.4	13	2.0	0.10	0.8
9	34.83	15.7	13	2.4	0.11	0.5
10	34.83	15.9	15	2.6	0.12	0.9
Track E						
1	34.63	16.5	24	1.0	0.07	0.1
2	34.94	15.6	14	0.9	0.05	0.1
3	35.05	14.6	10	0.2	0.04	0.2
4	34.90	14.5	13	2.2	0.14	2.0

Discovery Cruise 160A

TABLE 3 - Averaged results for each station - continued (3)

STATION Number	SALINITY	TEMPERATURE °C	ALUMINIUM nM	SILICON µM	PHOSPHATE µM	NITRATE µM
Track F						
1	34.94	15.5	15	0.8	0.08	0.2
2	35.00	15.1	12	0.9	0.15	0.2
3	34.98	14.7	14	2.7	0.07	1.1
4	34.81	14.9	15	3.0	0.13	1.8
5	34.64	15.4	14	2.6	0.17	1.2
6	34.44	15.8	12	2.1	0.25	0.4
7	34.16	16.2	13	2.9	0.42	0.6
	34.37	16.0	16	3.2	0.32	0.7
Track J						
4	35.03	14.1	8	1.6	0.01	0.0
	35.05	12.3	12	2.7	0.17	2.0
7	34.12	13.1	8	2.2	0.00	0.0
	35.22	11.3	10	3.0	0.12	1.2
10	35.26	13.5	7	1.1	0.01	0.0
	35.37	10.7	12	2.4	0.29	5.0

Discovery Cruise 160A

TABLE 4 - Summary of results from the cruises in November 1985, May 1986 and August 1986. Ranges, averages and ratios to phosphate, standard deviation on average in brackets, S - surface, D - deep.

	Range	Average	Ratio/PO_4
<u>Salinity</u> (psu)			
November	34.53-35.36	35.08 (0.17)	
May	34.60-35.37	35.12 (0.26)	
August	34.16-35.44	35.00 (0.22)	
<u>Temperature</u> (°C)			
November	9.6-13.4	12.4 (0.7)	
May	7.9-9.6	8.7 (0.5)	
August	11.0-16.6	15.1 (0.8)	
<u>Silicon</u> (µM)			
November	2.1-5.6	3.3 (0.8)	8.5
May	0.1-2.5	0.6 (0.7)	3.2
August	0.0-3.5	S 1.1 (0.9) D 1.8 (0.8)	S 13.8 D 11.3
<u>Phosphate</u> (µM)			
November	0.26-0.78	0.39 (0.09)	
May	0.11-0.35	0.19 (0.07)	
August	0.00-0.42	S 0.08 (0.06) D 0.16 (0.08)	
<u>Nitrate</u> (µM)			
November	2.9-9.2	5.3 (1.4)	13.6
May	< 0.5-5.1	2.2 (1.8)	11.6
August	0.0-4.1	S 0.5 (0.5) D 1.3 (1.1)	S 6.3 D 8.2
<u>Aluminium</u> (nM)			
November	13-67	28 (10)	72
May	13-29	20 (5)	105
August	5-23	S 10.5 (4) D 12.5 (3)	131, 78