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NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE FOR MARINE ENVIRONMENTAL RESEARCH

CRUISE REPORT
RVS: FR 14/83
IMER: MICRON III

VESSEL — RRS FREDERICK RUSSELL

PERIOD — 20 August - 1 September 1983

PERSONNEL

R F C MANTOURA Principal Scientist
P H BURKILL
N J P OWENS
M B JORDAN
E M S WOODWARD
J A STEPHENS
C A LLEWELLYN
C A SIMPSON

Saturday 20 August — Sailed from Millbay Plymouth 0900 for E5, streaming UOR (1600-2123). E5 at 2228, bottle hydrocast. Steam to GL7 deploying UOR 2228. Cruise Tracks shown in Fig.1.

Sunday 21 August — Proceeded to GL7. UOR i/b at 1130. On st GL7 (48° 15.1'N, 09°30.1'W) at 1200. Commence vertical profiling (VP) time series to include : 7. 1ℓ NIO hydrocasts at 1,5,10,15,20,25, 30,40,60,80m XBT, in situ fluorescence profile, O_2, pigments, Coultes Counts, POC, PON, nutrients, at the following times/ positions. GL7 - VP1 (1807-1819; 48° 15.2'N; 09° 32.8'W)

Monday 22 August — GL7 - VP2 (0000-0058; 48° 06.3'N; 09° 48.1'W)
GL7 - VP3 (0630-0726; 48° 04.7'N; 09° 46.4'W)
GL7 - VP4 (1200-1230; 48° 04.9'N; 09° 48.9'W)
GL7 - VP5 (1330-1423; 48° 04.9'N; 09° 47.8'W)
depths: 100,200,300,400,500,800,1000,1250,1500m
GL7 - VP6 (1815-1836; 48° 05.3'N; 09° 47.5'W)
GL7 - VP7 (0027-0050; 48° 06.8'N: 09° 45.0'W)
Collected 30ℓ GOFLO samples from 1,10,15,25,30m (0600) and deployed (1040) 'in situ No.1' for ^{14}C size fractionated production and 15N - nitrogen assimilation/regeneration. Recovered 2030. Thymidine incorporation exp in VP4.

Tuesday 23 August — Collected 30ℓ GOFLO from 1,10,15,25,30m (VP8) for 'in situ No.2' Standard $^{14}C/^{15}N$ uptake experiment (1012-2030)

+ ΔO_2 prim prod, Coulter Counter damaged by power surge. Pump vertical profiling (1454-1900).

Wednesday 24 August — Steam to CS2 (0600), streaming UOR. UOR fowling at 0815. 48° 47.4'N 08° 56.4'W at 1200; Recover UOR 8120. Set course for Penzance at 1836.

Thursday 25 August — Arrive Penzance at 0900. Replacement microcomputer printer and Coulter accessory delivered o/b and commissioned. Depart Penzance at 1330 for CS-2, towing UOR 1622-2038. Arrive CS2 at 2030; Hove to.

Friday 26 August — Commence Vertical Profiling time series (as in GL7) for light, O_2,NO_3,NO_2,NH_4, pigments, POC, PON, Lugols thymidine Coulter Counts accompanied by fluoresence hydrocast at following times and position.
CS2 - VP1 (0643-0657 ; 50° 28.8'N 07° 01.2'W)
CS2 - VP2 (1235-1249 ; 50° 28.8'N 06° 58.4'W)
CS2 - VP3 (1830-1850 ; 50° 28.2'N 06° 58.5'W)
Collected 30ℓ GOFLO samples (0543-0620) for 'in situ No.3' for ^{14}C, ^{15}N assimilation/remineralisation —
'in situ No.3' rig deployed at 0952, recovered at 2041.
Shot Dhan Parachute Drogue Buoy 0830. Deployed sedimentation traps at 29m and 54m depths, at 1118. N-remineralisation rates measurements.

Saturday 27 August — CS2 - VP4 (0040-0100; 50° 27.0'N; 06° 55.5'W)
CS2 - VP5 (0600-0630; 50° 26.5'N; 06° 58.7'W)
CS2 - VP6 (1233-1242; 50° 26.4'N; 06° 54.8'W)
CS2 - VP7 (1837-1847; 50° 25.3'N; 06° 56.5'W)
Collected 30ℓ GOFLO samples (0530-0559) for 'in situ No.4' bottle rig deployed at 0923,recovered 2035. ^{14}C, ^{15}N, ΔO_2 primary production remineralisation. Time course diurnal variation in rates of ^{14}C and ^{15}N uptake and remineralisation. Recovered Dhan Parachute buoy at 2035. Size-fractionated respiration experiments.

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Sunday 28 August	30ℓ bottle hydrocast (0547-0627) for 'in situ No.5' for measurement of N-preference index and $^{14}C/\Delta O_2$ primary production. Deployed 'in situ No.5' rig 0918, recovered at 1845. Microzooplankton grazing rates. Sediment Coring at St CS 2.
Monday 29 August	30ℓ hydrocast (0530) 'in situ No.6' NH_4+/MA autotrophic uptake experiment. Deployed rig #6 1130 recovered 1620. Stimulation of ΔO_2 $prod^n/respir^n$ time course by NH_4^+ Coulter counts of pump vs bottle samples. Acantharian hydrocast.
Tuesday 30 August	30ℓ GOFLO hydrocast (0530) for 'in situ No.7' to measure NH_4 uptake kinetics and ^{14}C primary production. Deploy №7 rig 0924, recover at 2030. Hydrocast for N_2 fixation. High Resolution Vertical Profile (1100-1125) at 1,5,10,15 20,22,23,24,25,26,27,28,29,30,32,35,40,60,80m for T, NO_3, NO_2, NH_4, O_2, PO_4, Si, Chlorophyll pigments bacterial counts POC, PON, Size particles NH_4^+ regeneration and O_2 respiration.
Wednesday 31 August	30ℓ GOFLO hydrocast (0530) for 'in situ No.8' for $^{14}C/\Delta O2$ Size fractionated NH_4 stimulation experiments deployed at 0710 recovered 1205. ^{14}C uptake in waters of various depths incubated in high illumination. Recovered sedimentation traps 0900. Set course to Carmathan Bay at 051°T. UOR deployed 1722. Recover 2400.
Thursday 1 September	Adverse weather forecast alter course 0400 to Lands' End and return to Plymouth.

Objectives

1) To continue investigations of nitrogen cycling processes in the euphotic pelagic microbial food web in stratified oligotrophic shelf waters.

a) To measure vertical gradients of trace dissolved nitrogen (NH_4, NO_3, NO_2), particulate nitrogen and microbial nitrogen (phytoplankton, bacteria and microzooplankton).

b) To measure nitrogen assimilation by phytoplankton and their primary production.

c) To measure nitrogen regeneration by bacteria and microzooplankton, and bacterial production.

d) To measure microzooplankton grazing on bacteria and phytoplankton.

e) To measure microplankton community photosynthetic and respiratory activity.

f) To measure sedimentation rates from the euphotic zone.

2) To continue a seasonal study of phytoplankton at Station A1 (co-operative IMER/MBA project).

Procedures and Methods

The objectives were met by a variety of measurements of states and rates of nitrogen fluxing performed largely by experiments in situ or on board ship. To acheive continuity between measurements of water column constituents a drogue was deployed at the station to provide a sampling marker. The vertical gradients of trace dissolved nitrogen were determined by shipboard auto-analysis and chemiluminescence techniques while particulate and microbial nitrogen were fixed or frozen for later analysis at Plymouth. The vertical fluxing of particulate nitrogen across the thermocline was measured using DAFS, Aberdeen sedimentation traps situated above and below the

thermocline for a 4.9-day period. Nitrogen assimilation and primary production were determined using in-situ incubations of natural samples spiked with ^{15}N and ^{14}C; samples were size fractionated (>5μm; 5-0.8μm; 0.8-0.2μm) after incubation to provide characterization of autotrophy. Nitrogen remineralization by bacteria and microzooplankton were estimated by ^{15}N isotope dilution techniques simultaneously with nitrogen assimilation. Bacterial production was determined by ^{3}H-thymidine incorporation while microzooplankton grazing was estimated by dilution response incubations of natural communities. Microplankton photosynthesis and respiration rates were determined using microprocessor controlled photometric Winkler titrations of dissolved oxygen. N_2 fixation was measured by acetylene reduction procedure. Photosynthetic pigments were separated, identified and quantified by HPLC. To provide comparison with the thermally stratified stable water column at CS2, a less stable shelf break station (GL7) was also investigated.

Equipment Performance: Most of IMER equipment worked well at sea. Auto analyzer NO_2 chemiluminesence and O_2 autotitration systems performed to specification. UOR data acquisition successful. Light profiling successful at sea. A power surge aboard the vessel disrupted the Coulter Population Accessory and a faulted computer printer outputting UOR data. Both were replaced off Penzance. Minor problems with HPLC pump were rectified by

switching around gradient pumps and reprogramming gradient. GOFLOW bottles provided by RVS were poor condition, requiring constant maintenance (valves, triggers, vent). Bottle rigs recovery >95%; smooth recovery of Dhan parachute drogue and sedimentation traps. Coring required several attempts to recover indisturbed sediment core from sandy bottom. We are grateful to Dr J Davies (DAFS) for the loan of sedimentation traps for this cruise.

Preliminary Results

Vertical profiles of NO_3^-, NH_4^+, $O_{2\,exc}$ (O_2 excess/deficiency) chlorophyll *a* and temperature obtained at CS-2 in Celtic Sea on 30 August 1983 are shown in Fig.2. As little as 7 nM NO_2^- N l^{-1} and 37 nM NO_3^- N l^{-1} were detected in the mixed nutrient-depleted O_2-supersaturated surface waters. These, together with high levels of chlorophyll *a* (1.5 - 1.7 $\mu g\ l^{-1}$), indicate autotrophic uptake of N. The thermocline region is made up of two sharp, temperature discontinuities of 1.7°C m^{-1} located at 20-22m (T_1) and 25-26m (T_2). The sharp NH_4^+ concentration peak (4.7 μM-N l^{-1}) at T_1 coincides exactly with the O_2 deficiency and a primary NO_2^- maximum indicating net heterotrophic regeneration of N with only partial nitrification of NH_4^+ to NO_2^- and NO_3^-. The identity of the heterotrophic organisms (bacterial, micro- or macro-zooplanktonic) which are responsible for the NH_4^+ maximum must await further analyses of samples. At the second pyncnocline, T_2, there is a sharp build up of NO_3^- and NO_2^- which together with excess NH_4^+ diffusing from T_1, appear to support net production (excess O_2) at the base of the thermocline. We are currently combining these profiles with the rates of nitrogen uptake, recycling and sedimentation to estimate fluxes of N. at CS-2 and GL7.

Diurnal variations in surface concentrations of NO_3^-, NO_2 and O_2 have also been recorded and these reflect the diel changes in the balance between anabolism and catabolism.

5 µm ammonia-N l^{-l} added to sea water enhanced net photosynthesis by 23%; in contrast respiration rates remained unaltered by supplementary nitrogen. Size fractionation of the microplankton population revealed that organsims less then 5 µm in size contributed the majority of respiration activity while a significant heterotrophic flux was also found in organisms ≤0.6 µm in size.

Cruise Success

The project was highly successful and greatly helped by the favourable weather conditions. We are grateful to the Master, Officers and crew for their professional and motivated support in our research.

Prepared by: R F C Mantoura PSO
Approved by: B L Bayne
Date : 11 June 1984

Circulation List:

Internal

B L Bayne
P N Claridge
P H Burkill
R F C Mantoura
N J P Owens
M B Jordan
E M S Woodward
J A Stephens
C A Llewellyn
A Simpson
File
Notice board

External

NERC Swindon	Foxton
RVS Barry	Skinner x 2
IOS MIAS	Mrs Edwards
MBA	Denton
DAFS	McIntyre
MAFF	Harden-Jones
IOS	Auger

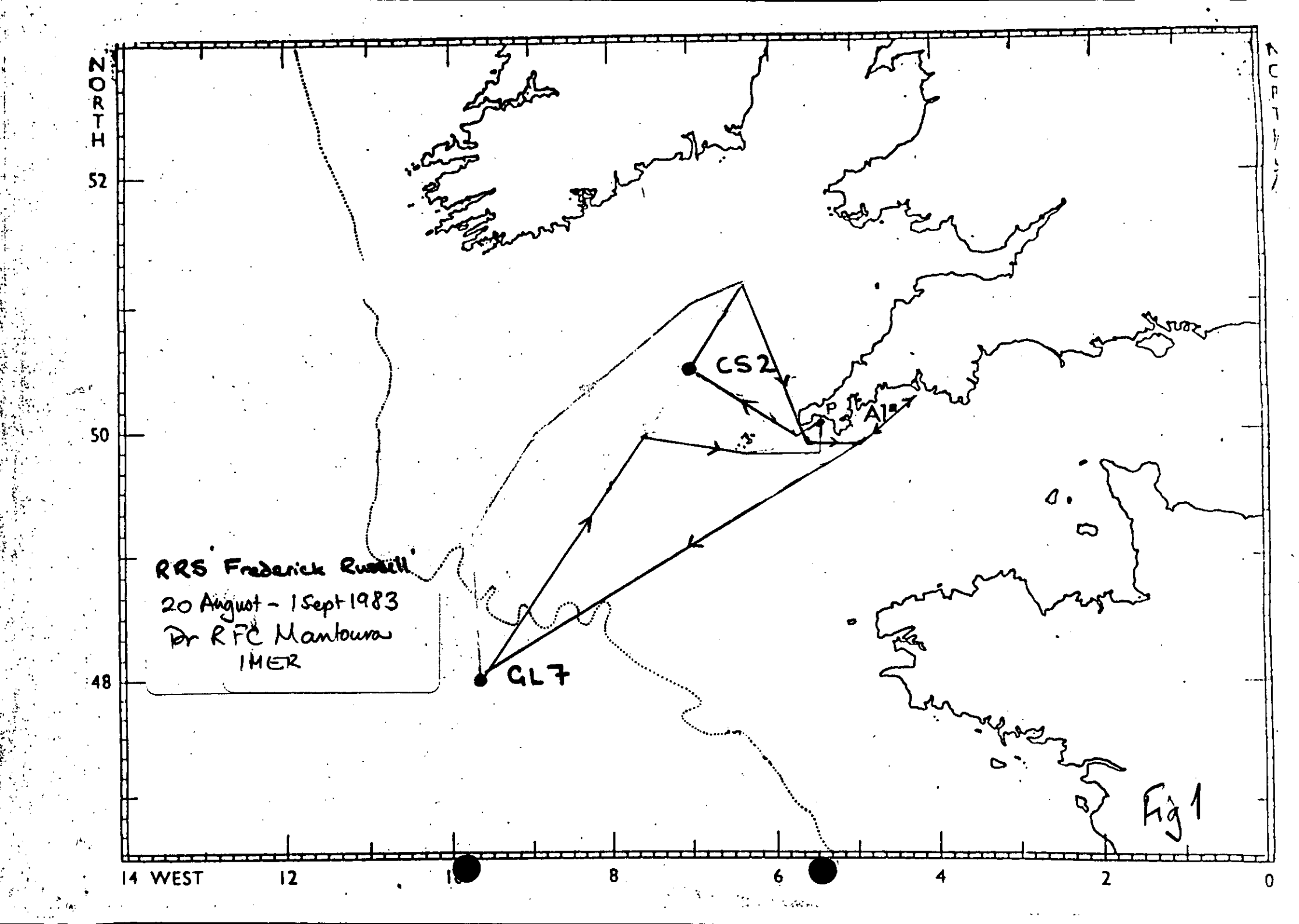
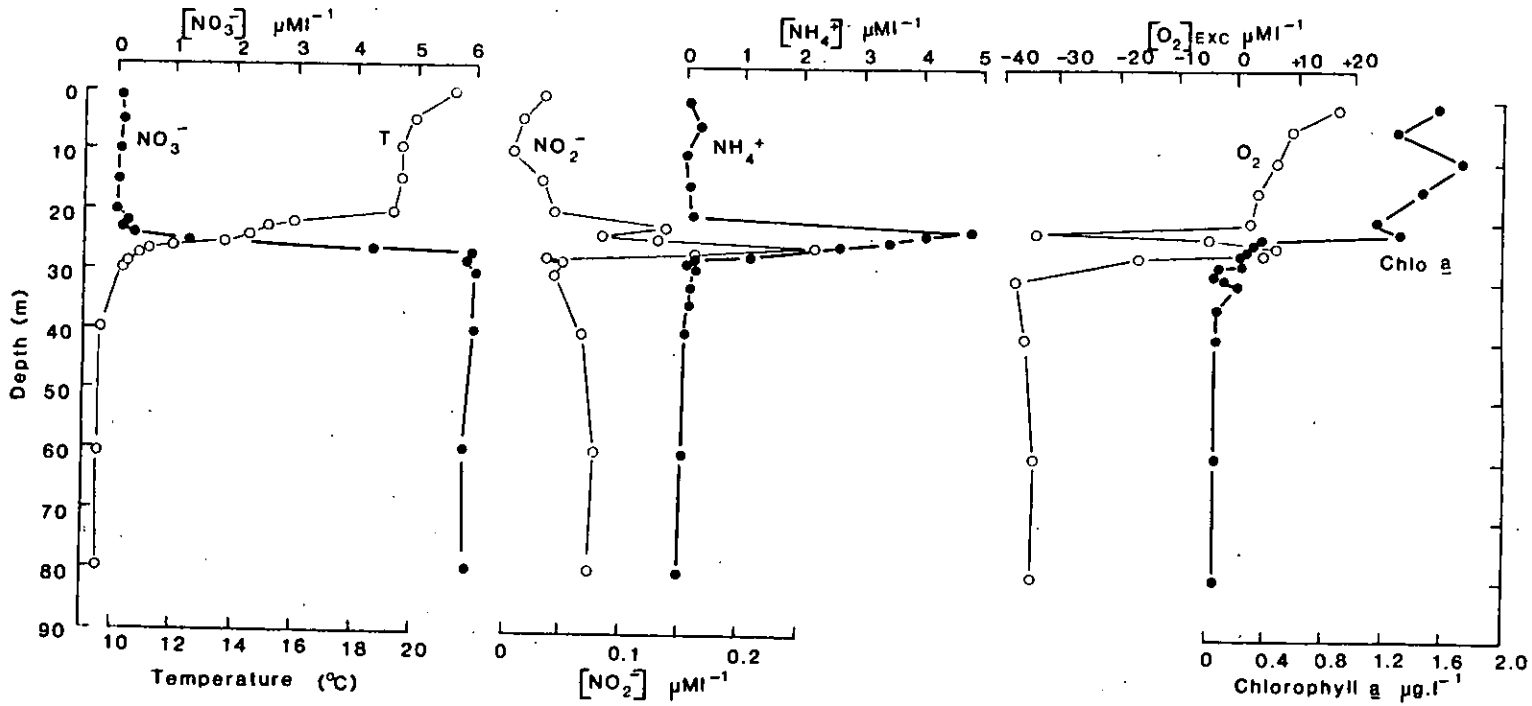

NORTH
52
50
48
14 WEST
12
8
6
4
2
0
CS2
A1
GL7
RRS Frederick Russell
20 August - 1 Sept 1983
Dr R F C Mantoura
IMER

Fig 1



Vertical structure of nitrate (NO_3^-), nitrite (NO_2^-) ammonia (NH_4^+), oxygen excess deficiency (O_2 exc), chlorophyll a and temperature in the Celtic Sea (50°30'N, 07°00'W) 30 August, 1983. Nitrogen is severely depleted (down to 7nM $NO_2^-l^{-1}$ and 37nM $NO_3^-l^{-1}$) by phytoplankton production in surface waters, and regenerated by bacterial ammonification (NH_4^+) and nitrification (NO_2^-) at the thermocline as well as upwards diffusion of NO_3 from deep water.

Fig 2