

CRUISE REPORT: Repeat hydrography on Lines PR5 & PR6  
WOCE Cruise No. 18DD9309/1

Chief Scientist: Frank Whitney  
Ship: John P. Tully  
Ports of Call: none  
Cruise Dates: May 14 to June 1, 1993  
Expedition Designation: 18DD9309/1

#### Cruise Narrative

IOS WOCE and UBC JGOFS both completed successful programs on this cruise to Station Papa (PS1). WOCE sampling included 55 CTD and 10 Rosette casts to provide chemical data and CTD calibration salinities. Onboard analyses included salinity, oxygen, nitrate, nitrite, phosphate, silicate, hourly air and sea surface pCO<sub>2</sub>, and chlorophyll a. The JGOFS program measured biological productivity at 5 stations along Line PR6, conducting many deck incubations to measure C and N uptake rates. A warm water anomaly of 1.5°C above the long term average extended well off coast. In this water, zooplankton were dominated by salps, with Vellela also being moderately abundant.

#### Cruise Summary Information

Lines PR5 and PR6 were completed, although sampling depth was limited by the length and strength of CTD cable, and by damage to our hydro wire. We tested our Lantec winch with Rosette casts as deep as 3700 dbar, improving its speed controls in the process. A combination of cable age, weather and winch used limited our sampling depth to a maximum of between 3000 and 3700 dbar.

##### Table of Stations by type

Sample type: No. stations: Max. depth: CTD casts 54 3700 db Rosette casts 9 3600 db Loop samples 58 5 m Moorings 4 4260 m Floats and Drifters deployed A drifting sediment trap line was deployed for 3 days at Station P26. Particulate materials were collected on filters for measurements of total, carbon and nitrogen fluxes.

At MP32, an Argos drifter drogued at 100 m, was hand deployed.

#### Moorings deployed and recovered

A current meter mooring was serviced and redeployed near P20. A single sediment trap was anchored 500 m above the bottom in 1300 m of water near P04. At station P26, two moorings with traps at 250 and 1000 m, and at 3800 m were deployed.

#### Principal Investigators

Howard Freeland Climate change IOS C.S. Wong Climate chemistry IOS Ron Perkin Physical measurements IOS Frank Whitney Chemical measurements IOS Preliminary Results Modifications made to the Lantec winch give us confidence that this winch will handle our deep ocean sampling needs on our next cruise (February 1994). Cable loads caused some concern, reaching 4000 lb in heavier swells. Our simple heave damping system, a rubber bungie that allows the CTD block to travel up to 10 feet, was proven effective in reducing peak loads. Goals Achieved CTD surveys of PR5 and PR6 to 3000 m (max. 3700 m) completed. Rosette sampling to 3000 m (max. 3600 m) successful at 9 stations. JGOFS sampling for plankton, uptake measurements and N cycling completed. Moorings recovered (2) and deployed (4). Further testing of Lantec winch was successful to 3600 m. Spooling and winch controls work well after alterations.

#### Problems and Goals not Achieved

A broken strand in our hydro wire eliminated any deep sampling; few samples below 3000 m were collected.

## Cruise Participants & Affiliations

F.A. Whitney □ Nutrients □ IOS

N. Hall-Patch □ CTD/Rosette □ IOS □ B.G. Minkley □ T/S/O □ IOS □ R. D. Bellegay □ Trap moorings/sampling □ IOS □ R. Bigham □ Mooring/sampling □ IOS □ T.J. Soutar □ Electronics, pCO<sub>2</sub> □ IOS □ P. Boyd □ Primary Productivity □ DOUBC □ D. Varela □ N cycling □ DOUBC □ H. McLean □ Zooplankton/sampling □ DOUBC □ S. Doherty □ nano-plankton □ DOUBC □ M. Wen □ zooplankton □ DOUBC □ S. Ruskey □ lab assistant □ DOUBC □ J. Wu □ natural 15N and 13C □ DOUBC □ M. Robert □ CTD/sampling □ McGill University □ Institute of Ocean Sciences, Sidney, B.C., Canada. □ Department of Oceanography, University of B.C., Vancouver, B.C.

## Measurement Techniques and Calibrations

### Water sampling

A General Oceanics Rosette holding 23 10 L Niskin samplers, and a Guildline Model 8737 CTD was used for routine sampling in the upper 3000 m of the water column. Cable was not reliable enough to routinely venture deeper.

Trace metal samplers used 30 L Go-Flo samplers on Kevlar line.

Productivity, POC/N, chlorophyll and some nutrient samples were collected with 10 L Go-Flo samplers on Kevlar line.

A sea water loop consisting of an intake at 4 m, a thermosalinograph well, a pump, insulated PVC tubing and a manifold at a laboratory sink, supplied water continuously to a pCO<sub>2</sub> equilibrator and for miscellaneous sampling. This sampling is denoted USW (uncontaminated sea water) in the .SUM file.

### Oxygen

An automated titration system (Brinkman Dosimat) using the micro-Winkler method (Carpenter, 1965) detected the iodine end-point colorimetrically. Duplicate samples came from pairs of Niskin bottles that were tripped within 2 min and 2 db of each other.

Depth Range (m) □ Conc. Range (uM/kg) □ Sp of pairs □ □ 300 to 3000 □ 15 to 115 □ 0.95 (k=11) □ □ □ Where the standard deviation of pairs  $Sp = \{(\sum d^2)/2k\}^{1/2}$ , d is difference between pairs, and k is the number of pairs. The rather high Sp likely reflects the inexperience of some samplers. Samples taken from 4 Niskins tripped at 3001 0.4 m had oxygen concentrations of 100.5 0.15 umol/kg. □ Standards were prepared as outlined in WOCE Report 73/91.

### Quality checks:

Sample 35 - oxygen sample saturated with an air bubble - flagged with 3.

Sample 102 - oxygen sample has large air bubble - flagged with 3.

P26-2 profile, samples 126 to 148 - problems with probe stability, changed colorimeter - data flagged 3.

Plotted all oxygen data from the cruise and there were no outliers.

### Nutrients

Samples were collected in polystyrene tubes (16 x 125 mm) and refrigerated for a maximum of 8 h (Rosette) or 30 h (USW) before being analyzed. Four nutrients analysed by Technicon procedures were NO<sub>3</sub>&NO<sub>2</sub>, NO<sub>2</sub>, PO<sub>4</sub> and Si. Check standards were analyzed in mid-profile and concentrations calculated as a check on system performance.

Std. deviation  
n of check std.

Nitrate  
0.38  
26

Nitrite  
0.008  
14

Phosphate  
0.03  
15

Silicate  
0.61  
26

Concentrated standards were prepared on 6 Jan 93 from oven dried (80oC) reagents.

Reagent □ Concentration (g/L) □ Std 1 □ (umol/L) □ Std 2 □ (umol/L) □ Std 3 □ (umol/L) □ Std 4 □ (umol/L)

KNO3 □ 0.25252 □ 12.0 □ 24.0 □ 36.0 □ 48.0

Na2SiF6 □ 1.40945 □ 44.97 □ 89.94 □ 134.91 □ 179.88

NaNO2 □ 0.00845 □ 0.49 □ 0.98 □ 1.47 □ 1.96

KH2PO4 □ 0.03409 □ 1.002 □ 2.004 □ 3.006 □ 4.008

Working standards were made every 1 to 2 days by diluting 1 to 6 mL of various stock solutions to 250 mL with 3.2% NaCl (w/v in double run Milli-Q water).

Pooled standard deviation of pairs,  $Sp = 0.01$  uM/kg PO4,  $0.12$  uM/kg NO3, and  $0.32$  uM/kg SiO4 for 14 pairs of Niskins, each pair tripped within 9 db of eachother.

Laboratory Temperatures:

Varied between 19 and 25 oC, and were recorded approximately hourly during analyses.

Comments on nutrient analyses:

NO3 - at station P04, standard curves were strongly non-linear. To improve linearity of NO3 standards, the sample flow was decreased from 0.32 to 0.16 mL min<sup>-1</sup> after the first station.

NO2 - not analyzed at J05 because reagents ran short.

PO4 - a connector leaked during stations P26-2 and R16. This caused a reduced sample flow and produced results that were erratic. P26 samples were run again after cool storage in polystyrene tubes for 2d. Data from this profile are lower than long term averages, and are flagged with 3.

Sample 31 is high due to bad peak formation - flagged with a 3.

Sample 36 is high - flagged with 3.

Sample 155 sucked air - flagged as sample lost - data quality 5.

Plotted all PO4 data from cruise and there seems to be more station to station scatter than is typical. Perhaps there were problems with the splitter leaking during the entire cruise.

Salinity

Samples were collected in glass bottles and analyzed onboard ship using a Guildline Model 8410 Portasal. The Portasal was standardized daily with IAPSO standard sea water Batch P118, 11/91. Precision is estimated from samples drawn from pairs of Niskin samplers tripped at the same depth (within 2 db).

Depth Range (dbar) □ Conc. Range (psu) □  $Sp = \sqrt{\frac{\sum d^2}{2k}}$  □ 300 to 3000 □ 33.9 to 34.7 □ 0.00086 (k=11) □ □ Where the standard deviation of pairs  $Sp = \{(\sum d^2)/2k\}^{1/2}$ , d is

difference between pairs, and k is the number of pairs. From 4 Niskins tripped at 3001 db, salinities were 34.6519 0.0006. □Data Checks:  
Sample 198 is low indicating bottle not tripped at correct depth. BTLNBR labelled as 4 (did not trip correctly) and flagged all samples with 3 (questionable values), although the analyses were good.  
Values for samples 189 and 192 are high indicating bottle did not trip at the correct depth. BTLNBR labelled as 4 and all samples flagged with 3.

#### CTD

The CTD probes (Models 8737 and 8705) used during this cruise are made by Guildline Instruments of Smiths Falls, Ontario, Canada. Their resolution and accuracy will be provided when data is submitted.

#### References

Carpenter, J.H. 1965. The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method. *Limnol. Oceanogr.*, 10: 141-143.