WOCE CRUISE 18DD9303/1
Chief Scientist: Ron Perkin
Vessel: John P. Tully
Dates: March 5 TO 18, 1993

I. CRUISE REPORT: Repeat hydrography on Lines P and R

A. Cruise Narrative

1. Highlights

This cruise was equipped with much of the equipment which will be used on a 1994 WOCE survey. For the first time, the large A-frame and Lantech winch were tested to 3000 m, the length of the cable presently on the drum. A series of recommendation for improvements in winch controls and rosette recovery methods have been prepared. A system of "bungee" cords was used for heave compensation but the new A-frame will be equipped with an active compensation system in the near future.

Almost all of the CTD data and water samples were collected with a Guildline 8737 "WOCE CTD" in combination with a 24 bottle G.O. rosette equipped with digital reversing thermometers. The CTD was used to trigger the bottle closures and although, sometimes a trip signal had to be sent more than once, there were no untripped bottles. Some software changes are expected to improve the two way communication between the underwater package and deck unit.

Nutrient, freon and oxygen samples were analysed on board and CTD data processing was largely completed before docking.

2. Cruise Summary Information

a. Cruise track

The cruise took place along Line P (PR6) begining at the mouth of Juan de Fuca Strait on the Canadian West Coast, and extending westward 1400 km to Station Papa (50o N, 145o W). The return leg, along Line R (900 km), could not be done because of lack of time.

b. Table of Stations by type

Sample type□No. stations□Max. depth (m)□□□CTD casts□□31□3000□□Rosette casts□9□3000□□Hydro casts□1□4200□□Loop samples□31□surface□□Vertical Net Tows□3□□□□c. Floats and Drifters deployed□- a single half day deployment of an in situ primary productivity incubator at Station Papa (P26) was successful.
- a 40 hour deployment of a sediment trap array was successful

3. Principal Investigators:

C.S. Wong□Climate Chemistry, IOS□Freons, TCO2□□F.A. Whitney□Climate Chemistry, IOS□Nutrients□□H.J. Freeland□Ocean Physics, IOS□Ocean Circulation□□R.G. Perkin□Ocean Physics, IOS□CTD□□□□4. Preliminary Results□□a. Narrative□The ship left the dock at IOS on the morning of March 6 and proceeded with a series of shakedown tests of the new winch in the sheltered waters of Saanich Inlet. After dropping off the mechanical technicians the cruise proceeded to the Straits of Juan da Fuca and began sampling along line P. A failure in the bow thruster, needed for station keeping in the 30 knot winds, delayed work for about one day. The engineering crew restored the bow thruster and the remainder of the cruise went smoothly in moderate to fair weather. Two days were spent at Station P in intensive sampling for both IOS and UBC oceanographic studies. The ship returned directly to Esquimalt harbour to be turned over to the next cruise on March 18.

Our plans to intensify sampling and modify procedures for a WOCE one time survey in 1994 are progressing. Valuable experience was gained by using the large winch and A-frame combination designed for deep ocean work. Some control problems were encountered but only partially remedied at sea. Also, the ship's crew have made recommendations for improvements in launch and recovery procedures which should result in safer operations in heavy seas.

On-board analysis and processing of chemical and physical data will streamline the production of data reports and archive files.

5. Major Problems
The new bow thruster on the Tully was not fully reliable and needed repairs occasionally. The time allotted to the cruise was not sufficient to complete Line R.

6. Other incidents
None.

7. Participants & Affiliations:
The following table includes all scientific personnel involved in this expedition.

Parameter□Group
IOS*,UBC#□Personnel
□□□□□□CTD, Rosette, salinities□Ocean Physics□John Love□Marie Robert□□Cruise Psychology□University of Szczecin□Anna Flak□□ O2, reversing thermometers □Ocean Physics□Bernard Minkley□□Freons□Climate Chem.□Wendy Richardson□□Water sampling□sediment traps□Climate Chem.□Ron Bellegay□□Nutrients□Climate Chem.□Frank Whitney□□CO2 Sampling□Climate Chem.□Ron Bellegay□□Data Processing□Ocean Physics□Ron Perkin□□Net tows□UBC□Hugh Maclean□□primary productivity□UBC□Diana Varela□□N recycling□UBC□Diana Varela□□Trace Metals□UBC□Helen Nicolidakis□□pCO2□Climate Chem.□Tim Soutar□□□* Institute of Ocean Sciences, 9860 West Saanich Road, Sidney, B.C., Canada, V8L 4B2□# University of British Columbia, Vancouver, B.C.□□□B. Description of Measurement Techniques and Calibrations□□1. Water sampling□ The Tully has a sea water line (USW, uncontaminated sea water) that services its main laboratory. Near the water intake, conductivity and temperature sensors are sampled every 2 minutes and data is logged on the ship's SAIL system. At each CTD station, samples were taken for salinity (to calibrate the conductivity cell) nutrients, chlorophyll a and total CO2.

Niskin samplers (10 L) were used for all rosette casts. Water samples were collected in the order: Freons , O2, TCO2, nutrients and salinity. Freon samples were drawn into 100 mL glass syringes and then stored under sea water until samples were analyzed. Oxygen samples were immediately pickled with standard reagents (Carpenter, 1965) and the temperature of the sample recorded using a Guildline Model 2175A digital thermometer. TCO2 samples were pickled with 200uL saturated HgCl2 solution, and stored cool until coulimetrically analyzed onboard. Salinity samples were drawn into borosilicate bottles for analysis onboard ship using a Guildline Portasal salinometer.

2. Hydro cast temperature and depth
The sole hydrocast was taken at Stn. P in conjunction with trace metal samples. Mercury reversing thermometers failed to function but salinities were taken to 4200 m.

3. Oxygen
The micro-Winkler procedure of Carpenter (1965) with a starch end-point titration was used. The sulfuric acid concentration was increased to 420 mL/L (from 320 mL/L) to improve the dissolution of the precipitate. This lowered the pH of titrated samples to 1.78 - 1.95, av = 1.84 (n=4) from a recommended pH of 2, which may increase air oxidation of iodide (Carpenter, 1965). Standards were prepared as outlined in WOCE Report 73/91. A probe colorimeter was tested for sensitivity to the starch endpoint. The use of 10 L Niskins for most of our sampling improved our oxygen results noticeably. Duplicate samples agreed much better than in our last cruise (October 1991).

□Cruise 9105□Cruise 9201□□Sp = (sum d^2/2k)^0.5□1.09 uM/kg□0.57 uM/kg□□k = no. of pairs□21□22□□Range□10 to 280 uM/kg□10 to 300 uM/kg□□ Sp is the pooled standard deviation of pairs.□Quality checks:□a. Samples 16, 29, 30 and 32, bad

titration end point noted on deck log: data flagged 3□b. Sample 37 over titrated end point, data flagged 5.
c. Samples123 and 130 - bubbles in O2 flask noted in log, flagged data with a 3.

4. Nutrients

Samples were collected in 16 x 125 mm polystyrene test tubes (duplicate samples taken from each depth). With the exception of USW samples and the first hydro cast at P26, all samples were analyzed within 3 h of collection. USW (L1 to L31) and samples 84 to 105 were refrigerated for up to 1 day before analysisor were frozen and analyzed within 2 weeks (P32 to J05). Standard solutions are routinely made at concentrations 100 to 250 times higher than the lowest standards used and are diluted daily for standardizations. Nitrate and silicate are checked against commercial CSK Standards (WACO Pure Chemical Industries) to verify that no gross contaminations or errors have been made in their preparation. Their molarity is based on the accurate weights taken during preparation. Reagents that have been consistently used for 5 years or longer include KNO3 (Primary Standard, Fisher), NaSiF6 (Certified, Fisher) and KH2PO4 (Reagent ACS, MCB). Standards have proven to be stable for upto 6 months when preserved with 1 mL/L chloroform and stored in the dark.
An aging Technicon Autoanalyzer sampled a single test tube for NO3 & NO2, PO4 and Si according to Technicon procedures.
NO3 + NO2 were reduced with Cd/Cu, then complexed with sulfanilamide and N-Naphthylethylene-diamine to form an azo dye (Technicon Method No. 158-71W/B). PO4 produces a molybdenum blue complex in presence of acidic molybdate and ascorbic acid (Technicon Method No. 155-71W). Dissolved Si also forms a molybdenum blue complex and oxalic acid removes PO4 interference (Technicon Method 186-72W). Occasional problems with this equipment caused some minor loss of data quality.
Lab temperatures were occasionally checked during each analytical run, and varied between 17 and 25 oC over the length of the cruise.

Ten pairs of Niskins were tripped within 4 dbar of each other at various stations: Sp = 0.02 uM/kg PO4, 0.15 uM/kg NO3,
0.004 uM/kg NO2, and 0.34 uM/kg Si
Quality checks:
a. The PO4 and NO3 for sample 93 seem low. They were run right after a STD 0 was run ands are flagged with a 3.
b. Sample L9 was stored two days before analysis, flagged 3.

5. Salinity

A Guildline Model 8410 Portosal (SN 58,879) salinometer was used onboard ship to analyze all samples. IAPSO Standard Seawater, Batch 118, was used for daily calibrations. Duplicate samples from 2000 to 3800 m, run in sequence, had a standard deviation Sp = 0.001 (k=9), confirming that sampling and analyses are precise, and that Niskin bottles did not leak (since a salinity gradient is evident in leaking bottles).

6. CTD

Guildline Model 8737 CTD (SN 59901) was used for almost all the casts. It was outfitted with a Paros pressure sensor, two additional temperature sensors and circuitry for triggering the rosette bottle closures and detecting the confirmation. Profiles routinely reached 3000 m.
Calibration was done pre-cruise and during the cruise using the spare temperature sensors, digital reversing thermometers and bottle salinities. Pressure was checked during the cruise using a reversing pressure sensor attached to one of the bottles.
Bottle comparisons were within .002 in salinity excpt above 1000m. Later investigation showed that the trend above 1000 m was due to the fitting of bottle data using a cell constant. Due to a large offset imposed by the temperature compensation correction, a cell constant and offset should have been fit to the salinity differences. This was corrected in later versions of the data.

Cell cleaning at the end of the cruise did not affect performance.

□□7. Freons□ Since many tests need to be completed before we can supply data of assured quality, we will not submit Freon data from this cruise. However, I will outline our procedures in way of providing a progress report.□ Glass syringes (100 mL) were rinsed then filled from the spigot of 10 L Niskin samplers, before other sampling was begun, and always within 1 h of sample bottles coming to the surface. Filled syringes were stored under sea water to reduce possible atmospheric contamination.

An analyzer designed after the system described in Bullister and Weiss (1988) was tested only briefly before going onboard ship. Consequently, most analyses at sea were intended to check the replicability of our sampling and contamination from ship's air and water samplers. Since many new 10 L Niskin bottles were being used without cleaning, it was feared that contamination would spoil all data. However, deep water blanks proved that Freons from 400 to 600 m were detectable.

Report from Helen Nicolidakis; TRACE METALS, UBC
Summary of work done during March '93 Line P cruise, 9303

Water was collected for analysis of several trace metals [including 1st row transition, Zr, Hf, Cd, Pb, etc.]. Total number of casts were 16 for a total of 14 depths, [25, 50, 100, 250, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4200] and two replicates [100 & 1000]. DOC samples were collected from each cast for Keith Johnson.
In-situ sampler, built at U.B.C., was pressure tested to 1000 m. Due to condensation problems, electronics, valves and flow meter were not tested 'in-situ'. It is hoped that further testing of this sampler can be carried out during the next Station P cruise.

References

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

Macdonald, R.W. and McLaughlin, F.A. 1982. The effect of storage by freezing on dissolved inorganic phosphate, nitrate and reactive silicate for samples from coastal and estuarine waters. Water Res. 1: 95-104.