Chemical Results from the April 2001 NPEO Project

Water sampling procedure

Modifications of the aircraft (Twin Otter) sampling approach were undertaken that afforded significant improvements in sampling conditions with respect to the operation in 2000. Upon landing the aircraft at a particular site, a gas-powered generator was set running in the aft storage compartment with its exhaust venting out the slightly ajar compartment door (Photo 1). A Hermann Nelson heater was plugged into this generator and set on the ice adjacent to the pilot's side of the aircraft. Its ducting was routed into the aircraft through the pilot's window (Photo 2). The motor head of the ice drill was held in the heat stream of the Hermann Nelson while snow was shoveled from the ice in the vicinity of the main cargo doors of the aircraft. The warmed drill motor was then used to drill a 10-inch diameter hole through the ice. Next a nylon shelter was suspended from the cargo doors and a gantry for a small hydrographic winch set into place (Photo 1). The combination of the waste heat of the generator from the rear compartment and the heat from the Hermann Nelson from the forward section kept the aircraft and area within the nylon shelter warm enough to prevent freezing of the samples, CTD, XCTD equipment (and personnel!).

Photo 1: View of the aft Twin Otter aircraft set-up for hydrographic sampling, April, 2001.

Photo 2: View of the forward Twin Otter aircraft set-up for hydrographic sampling, April, 2001. Co-Pilot Kevin Heslop placing ducting from Hermann Nelson heating unit through cockpit window.

Seawater samples were obtained using the battery-powered portable winch to cast 4 1.5-L Niskins at a time. The custom constructed Niskins (General Oceanics model 1010 with 8" extension and modified plunger) were mounted on a small diameter Kevlar line, with the deepest one mounted 1 meter above an internally recording Seacat SBE19 CTD. These were lowered to target depth as indicated on the winch meter wheel. Before the wire was paid back in, a slotted PVC disc connected to a vacuum pump was slipped over the wire and set on the ice to cover the hole. This system, provided by Dr. Humphrey Melling of the Institute of Ocean Sciences, Sidney, BC, prevents build up of ice on the line and allows the line to re-spool smoothly (see lower right Photo 3). Of course this must be removed from the wire just before each Niskin and the CTD are retrieved.

Photo 3: Jamie Morison of APL-UW retrieving a Niskin bottle in the sampling shelter at the forward cargo doors of the Twin Otter aircraft, April, 2001.

Upon retrieval, each Niskin was transferred to a rack in the heated aircraft and samples were drawn immediately. Salinity samples were collected into 125-ml amber glass bottles the caps of which were fitted with conical polyethylene inserts. Oxygen isotope samples were collected into similar containers of smaller volume (20-ml). Barium samples were collected into 20-ml polyethylene scintillation vials. Nutrient samples were collected into 60-ml polyethylene bottles and stored frozen until analysis. At the North Pole camp station, samples were also drawn into calibrated flasks for O_2 (dissolved oxygen gas). These samples were taken first and in replicate for the purposes of testing conditions for calibrating an O_2-sensor to be deployed in 2002. The usual pickling reagents ($MnCl_2$ and NaOH/NaI) were added to these samples immediately upon collection following standard procedures (Dickson, 1994).

Table 1: North Pole Environmental Observatory CTD station data

CTD Cast No.	Station ID	Latitude	Longitude	Date	Time UTC
Cast 2	2001 Station 1; camp	89° 34.2' N	73° 03.5' E	4/9/2001	17:38
Cast 3*	2000 Station 4	87° 28.4' N	90° 50.2' W	4/9/2001	21:18
Cast 4*	2000 Station 6	84° 55.4' N	67° 23.4' W	4/10/2001	13:52
Cast 5*	2000 Station 1	89° 38.3' N	166° 44.5' W	4/11/2001	18:49
Cast 6	2001 Station 3	87° 14.7' N	179° 48.5' E	4/12/2001	08:53
Cast 7	2001 Station 2	88° 59.2' N	179° 41.4' W	4/12/2001	22:42
Cast 8	2001 Station 5	85° 01.3' N	166° 28.9' W	4/13/2001	16:56
Cast 9	2001 Station 4	86° 08.2' N	171° 02.0' W	4/13/2001	20:03
Cast 10	2001 Station 1;camp	89° 28.3' N	54° 43.2' E	4/14/2001	13:02

**reoccupation of 2000 stations-CTD casts only, no water samples taken*

Analytical procedures

Bottle salinities were analyzed using a Guildline Autosal standardized with IAPSO standard seawater. Precision for these determinations was 0.002 practical salinity units. Analyses of the frozen phosphate, silicic acid, nitrate, nitrite and ammonia samples were performed ashore using a hybrid Alpkem RFA 300 and Technicon AA-II (AutoAnalyzer II) — based system and the JGOFS/WOCE suggested nutrient protocols (Gordon et al., 1994). The silicic acid, nitrate plus nitrite and nitrite channels were RFA-based, the phosphate and ammonium channels, AA-II. The samples were thawed and immediately analyzed for all nutrients. After standing overnight in the dark, the samples were reanalyzed for silicic acid to avoid polymerization effects (Gordon et al., 1994). The short-term precision of the nutrient analyses is typically: Silicic acid, 0.2%; phosphate, 0.4%; nitrate 0.3%; nitrite, 0.02μM; and ammonium, 0.03μM. However, the inter-cruise reproducibility achieved during the WOCE Hydrographic Program, Pacific One-Time Survey was for silicic acid, phosphate and nitrate, respectively, ca. 1%, 2% and 1% (unpublished data, Ross et al., 2000).

Barium was determined by isotope-dilution using an VG Thermo Excel inductively coupled quadrupole mass spectrometer as previously described with minor modifications (Falkner et al., 1994). Precision is estimated to be 3% for this suite of Ba measurements. Oxygen isotopes were analyzed by the CO_2 equilibration method on the COAS Finnegan Mat 251. Results are reported in del units relative to VSMOW and 1-sigma precision is estimated to be +/- 0.05. Dissolved O_2 was analyzed by modified Winkler titration to a starch endpoint (Dickson, 1994) at Alert within 24 hours of sample collection. Replicates were returned to Oregon State University and analyzed 14 days later. Care was taken to assure that the ground glass joint remained moist throughout sample transport and storage. In the laboratory, dissolved oxygen was measured by whole-flask titrations and amperometric end-point detection using a PC-controlled titrator (Culberson and Huang, 1987). The actual apparatus followed the adaptation to PC's by Knapp et al. (1989).

Results

Data are given in Table 1. The CTD depths and temperatures were assigned to the individual bottles by matching the bottle salinity to the CTD salinity at the depth closest to the target value. The depth values given in the table have been rounded to the nearest tenth meter in the surface sample and nearest meter at depth. Temperatures are for the specific matching sample. One chemistry and salinity of a sample obtained from 500 m at station 2 (not shown), showed the Niskin did not trip until near the surface. CTD information for the upper portion of the cast at station 2 appears to be unreliable and so is not given. Otherwise depth matching was straightforward since salinities agreed within expected analytical error. There was no evidence of sample freezing and so unlike in 2000, no corrections to the analytical data are required.

Table 1 (panel A)

Date	Station	target depth m	CTD m	bot sal psu	CTD temp degC	P μM	NO3 μM	NO2 μM
14-Apr-01	1	5	9.9	32.284	-1.77	0.384	2.69	0.014
14-Apr-01	1	100	101	34.135	-1.55	0.665	7.62	0.011
14-Apr-01	1	275	272	34.863	1.43	0.873	12.26	0.006
14-Apr-01	1	500	510	34.881	0.70	0.887	12.45	0.006
12-Apr-01	2	5	13.5	31.642	-1.74	0.426	2.27	0.006
12-Apr-01	2	100	99	33.885	-1.71	0.663	7.11	0.006
12-Apr-01	2	275	276	34.835	0.91	0.880	12.52	0.006
12-Apr-01	3	5	-	31.711	-	0.523	2.21	0.008
12-Apr-01	3	100	104	34.010	-1.57	0.676	7.90	0.008
12-Apr-01	3	275	276	34.846	1.06	0.873	12.44	0.011
13-Apr-01	4	5	11	31.409	-1.73	0.491	2.21	0.008
13-Apr-01	4	75	75	33.382	-1.75	0.646	6.20	0.008
13-Apr-01	4	100	99	33.934	-1.62	0.648	7.49	0.005
13-Apr-01	4	275	276	34.851	1.11	0.865	12.50	0.005
13-Apr-01	4	500	505	34.869	0.52	0.889	12.85	0.005
13-Apr-01	5	5	3	31.144	-1.73	0.809	1.29	0.018
13-Apr-01	5	75	75	33.427	-1.76	0.719	6.74	0.010
13-Apr-01	5	275	276	34.835	0.86	0.867	12.60	0.013
13-Apr-01	5	500	512	34.869	0.47	0.897	12.95	0.006

Table 1 (panel B)

Station	target depth m	% Pacific water*	Si μM	del18O	Ba nM	O_2 ml/L starch	O_2 ml/L amperometric
1	5	10.0	4.96	-2.83	56.3	8.901	8.767
1	100	8.6	4.97	-0.53	45.1	7.980	7.902
1	275	nd	6.01	0.23	43.3	7.354	7.448
1	500	nd	6.79	0.19	42.3	7.415	7.378
2	5	21.9	5.78	-3.48	58.0	nd	nd
2	100	13.0	6.56	-0.88	48.2	nd	nd
2	275	nd	7.08	0.25	43.4	nd	nd
3	5	38.1	6.33	-3.75	69.5	nd	nd
3	100	7.7	5.57	-0.54	49.5	nd	nd
3	275	nd	6.35	0.24	45.4	nd	nd
4	5	33.1	6.38	-3.65	61.3	nd	nd
4	75	18.7	7.16	-1.13	53.0	nd	nd
4	100	7.1	5.65	-0.72	47.8	nd	nd
4	275	nd	6.44	0.22	43.9	nd	nd
4	500	nd	6.95	0.18	43.7	nd	nd
5	5	84.0	8.77	-3.45	66.6	nd	nd
5	75	24.7	9.04	-1.44	50.1	nd	nd
5	275	nd	6.75	0.21	41.6	nd	nd
5	500	nd	7.30	0.21	42.9	nd	nd

*see discussion for derivation of this parameter; nd = not done

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