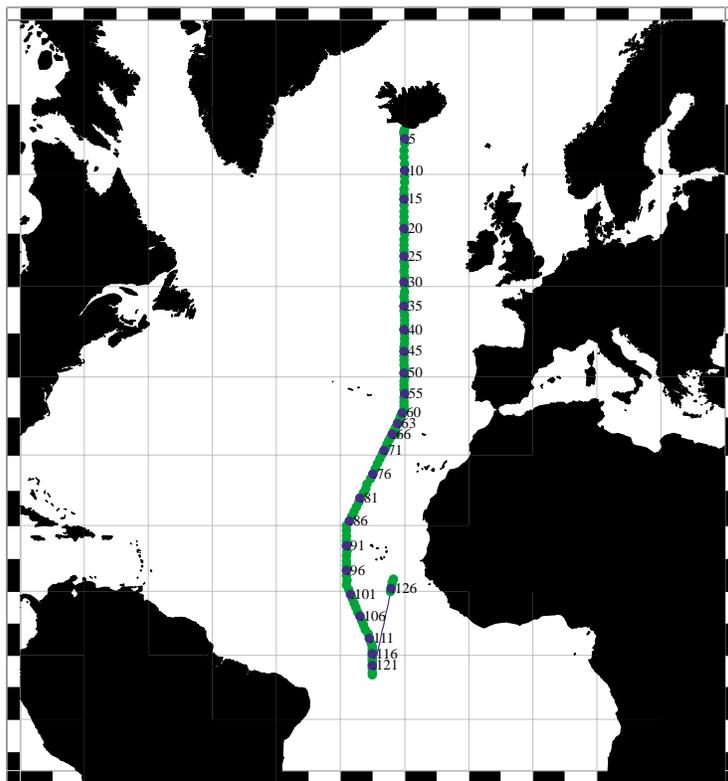


**A. Cruise Narrative: A16N**  
(updated April, 2004)



**A.1. Highlights**

**WHP Cruise Summary Information**

WOCE section designation	<b>A16N</b>		
Expedition designation (EXPCODE)	<b>32OC202_1-2</b>		
Chief Scientist/affiliation	<b>Michael McCartney/WHOI</b>		
Dates	1988.07.23 – 1988.09.01		
Ship	<i>RV OCEANUS</i>		
Ports of call	Reykjavik, Iceland to Funchal, Madeira		
Number of stations	133		
Geographic boundaries of the stations	29°01.1' W	63°19.8' N	19°58.4' W
		00°00.3' N	
Floats and drifters deployed	none		
Moorings deployed or recovered	none		
Contributing Authors	J. Bullister		

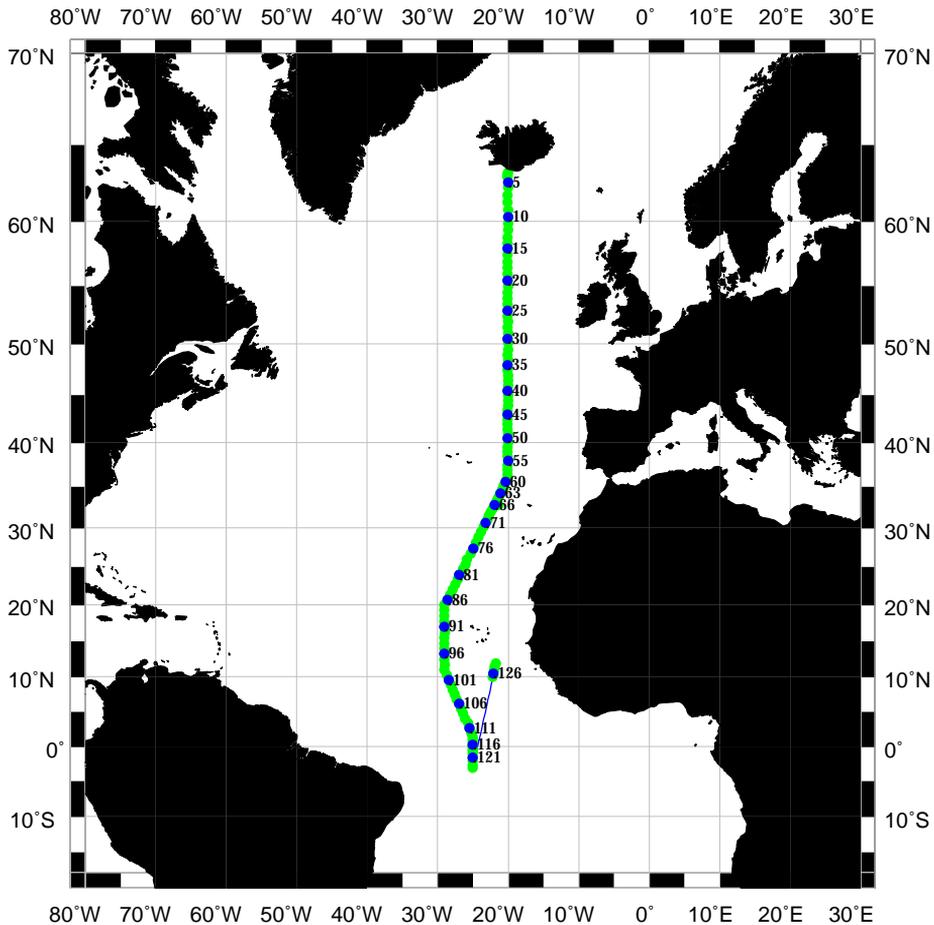
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## WHP Cruise and Data Information

Instructions: Click on headings below to locate primary reference or use navigation tools above. (Shaded headings were not available when this report was assembled)

<b>Cruise Summary Information</b>		<b>Hydrographic Measurements</b>
Description of scientific program		<b>CTD Data</b>
Geographic boundaries of the survey		CTD - general
Cruise track (PI) (WHPO)		CTD - pressure
Description of stations		CTD - temperature
Description of parameters sampled		CTD - conductivity/salinity
Bottle depth distributions (figure)		CTD - dissolved oxygen
Floats and drifters deployed		<b>Bottle Data</b>
Moorings deployed or recovered		Salinity
Principal Investigators for all measurements		Oxygen
Cruise Participants		Nutrients
Problems and goals not achieved		CFCs
Other incidents of note		Helium
		Tritium
		Radiocarbon
		CO2 system parameters
		Other parameters
<b>Underway Data Information</b>		
Navigation		<b>DQE Reports</b>
Bathymetry		
Acoustic Doppler Current Profiler (ADCP)		CTD Data Consistency Check
Thermosalinograph and related measurements		S/O2/nutrients
XBT and/or XCTD		CFCs
Meteorological observations		14C
Atmospheric chemistry data		
<b>Acknowledgments</b>	<b>References</b> ODF Doc CFC Doc	<b>Data Processing Notes</b>

# Station locations • A16N • McCartney • 1988



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NOTE: For full text and figures, please refer to SIO Reference 91-16 (May 1991)

Data Report Prepared by:  
**Oceanographic Data Facility**  
Scripps Institution of Oceanography  
University of California, San Diego

Sponsored by National Science Foundation Grant OCE 86-14486

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Appendix A: CTD Processing Notes

Appendix B: Remarks for Deleted or Missing Samples

Cruise Track

Station and Cast Descriptions

Personnel List

CTD and bottle data (see SIO/ODF publication\*)

Vertical Sections

\* SIO Reference 91-16    ODF Publication No. 229

## 1. OVERVIEW

The first leg of OCEANUS 202 commenced on July 23, 1988 with departure from Reykjavik, Iceland at 10:12 A.M. GMT. The first station was located just offshore of southern Iceland at 63°19.7'N, 19°59.9'W to a depth of 195 meters. The first leg ended at Station 65 on August 6, 1988 at 33°18'N, 21°37'W. After a brief port stop in Funchal, Madeira, work resumed with a reoccupation of Station 65 (at 32°51'N, 21°20'W) on August 11, 1988, and continued through Station 129 on August 27, 1988.

Station spacing was generally 30 nautical miles from Stations 1 to 71 with the exception of reduced spacing over steep topography. Spacing from Stations 72 to 112 was about 46 nautical miles. Spacing was reduced across the equator. Stations 61, 62, 63, and 65 were repeated in order to complete the patchy vertical sampling resulting from a pylon problem, discussed below.

Each station consisted of a CTD/rosette cast to within 10 meters of the ocean bottom, with the exception of the repeated casts at Stations 61, 62, 63 and 65 which were 1000 to 1500 meters. The rosette carried 24 4-liter bottles.

Ship navigation was either Loran-C (to about 50°N), GPS or transit-omega, the latter used only when GPS fixes were insufficient. Navigation was recorded on a SAIL loop and was networked to ODF's computer system where it was used for station positions and bathymetry. Bathymetry was recorded every five minutes from the OCEANUS' PGR.

An acoustic doppler current profiler (ADCP) was operated throughout the first leg by Frederick Bingham of SIO. Water in the transducer well resulted in termination of ADCP acquisition on August 21. Scripps Shipboard Technical Support/Oceanographic Data Facility (ODF)ls/Neil Brown Mark 3 CTD #2, rosette frame and General Oceanics pylon were used throughout. A set of new 2.5 liter Niskin bottles were provided by John Bullister of WHOI; they were designed to minimize 0-ring contact with the sample water so that CFC samples would be as uncontaminated as those drawn from 10-liter bottles.

Bob Williams and Forrest Mansir of ODF provided the at-sea support of the ODF equipment. CTD data were acquired on an ODF deck unit and Integrated Solutions computer, audio backups were recorded on video tape. Frank Delahoyde of ODF provided the software support and shipboard CTD data processing. Salinity samples were analyzed on a Guildline autosalinometer by Forrest Mansir and Leonard Lopez of ODF. Oxygen samples were analyzed on the ODF's titration rig by Ron Patrick of ODF and Bob Williams. Nutrient samples were analyzed for NO<sub>3</sub> NO<sub>2</sub> PO<sub>4</sub> and SiO<sub>3</sub> on an Alpkem Rapid Flow Analyzer, by Joe Jennings from Oregon State University. The OSU and ODF computer systems were networked for data transfer and thus permitted complete preliminary data reports at various points during the cruise.

CFC samples were collected by John Bullister, Scott Doney, and Chris Johnston and were processed at sea. Tritium/helium samples were collected by Scott Doney for later processing by Bill Jenkins' group at WHOI. Because of the water demands when

tritium/helium and CFC samples were both being drawn, oxygen samples were drawn from the copper helium tube rinse water.

Preliminary CTD data processing was carried out at sea during and after the casts. Subsets of CTD data comparable to the water samples were provided to the bottle data files immediately after each station in order to facilitate examination and quality control of the bottle data as the laboratory analyses were completed. It was discovered relatively quickly at sea that one of the ODF pylons was occasionally double-tripping and then skipping trips. This and other tripping problems were persistent on this expedition, perhaps partly because of the high profiling speeds and attendant stress on the terminations and slip rings. The effects on the final data are documented later in this report. ([Appendices A](#) and [B](#)).

## **2. Niskin Bottle Data Collection, Analyses and Processing**

After each rosette cast was brought on board, analysts drew water samples from each sampler for various parameters and recorded the water sample bottle assignment along with the Niskin sampler it was drawn from. STS/ODF data checking procedures included verification that the sample was assigned to the correct level. This was accomplished by checking the raw data sheets, which included the raw data value and the water sample bottle, versus the sample log sheets. The raw data computer files were also checked for entry errors. Investigation of data included comparison of bottle salinity and oxygen with CTD data, and review of data plots of the station profile alone and compared to nearby stations.

If a data value did not either agree satisfactorily with the CTD or with other nearby data (for example in a plot comparison), analyst and sampling notes, plots, and nearby data were reviewed. If any problem was indicated the data value was flagged or deleted. (However, ODF preserves in its archives all bottle data values.)

Problems with the rosette pylon and electrical harness caused tripping problems. In most cases, ODF reports CTD data from scheduled bottle trip levels even when there might not have been a water sampler closure. This has been done to preserve a well-sampled discrete profile and hence better accommodate investigators who prefer using bottle data files exclusively. Other extra CTD levels were extracted from CTD data for purposes of reporting data at the deepest point. Because there is only a small separation between the deepest bottle and the deepest CTD level, we advise caution in use of this bottommost level if the data are interpolated. The repeated stations 61, 62, 63 and 65 should not be merged as unacceptable offsets in most parameters results.

### **2.1. Pressure and Temperature**

All pressures and temperatures for the Niskin bottle data tabulations for Oceanus Cruise 202 were extracted from the processed CTD data, usually those from the corrected 10-second average bottle trip files collected during the up cast. (See below.)

### **2.2. Salinity**

Salinity samples were drawn into ODF citrate salinity bottles which were rinsed three times before filling. Salinity was determined after sample equilibration to laboratory temperature, usually within about 8-36 hours of collection. Salinity has been calculated according to the equations of the Practical Salinity Scale of 1978 (UNESCO, 1981) from the conductivity ratio determined from bottle samples analyzed (minimum of two recorded analyses per sample bottle after flushing) with a Guildline Autosol Model 8400A salinometer standardized against Wormley P-108 standard seawater, with at least one fresh vial opened per cast, or from the corrected CTD conductivity, temperature, and pressure.

Accuracy estimates of bottle salinities run at sea are usually better than 0.002 psu relative to the specified batch of standard. Although laboratory precision of the Autosol can be as

small as 0.0002 psu when running replicate samples under ideal conditions, at sea the expected precision is about 0.001 psu under normal conditions, with a stable lab temperature. Still, because a small droplet of fresh water, or the residue from a small evaporated droplet of seawater, can affect a bottle salinity in the third decimal place, and because the Autosal salinometer is sensitive to environmental fluctuations (such as experienced in the van borrowed for this expedition), salinities from bottle samples have a lower true precision under field conditions than in the laboratory. There was a problem with temperature control in the van where the salinity analysis occurred. Some of the missing bottle salinity values are attributed to these problems. ODF typically deleted the Niskin bottle salinity from this report, and substituted the corrected CTD salinity, whenever there was any question regarding its validity (See [Appendix B](#)).

### **2.3. Oxygen**

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board and after CFC and Helium were drawn. Nominal 100 ml volume iodine flasks were rinsed carefully with minimal agitation, then filled via a drawing tube, and allowed to overflow for at least 2 flask volumes. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice; immediately, and after 20 minutes, to assure thorough dispersion of the  $\text{Mn}(\text{OH})_2$  precipitate. The samples were analyzed within 4-36 hours.

Dissolved oxygen samples were titrated in the volume-calibrated iodine flasks with a 1 ml microburet, using the whole-bottle Winkler titration following the technique of Carpenter (1965). Standardizations were performed with 0.01N potassium iodate solutions prepared from pre-weighed potassium iodate crystals. Standards were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up and compared to assure that the results were reproducible, and to preclude basing the entire cruise on one standard, with the possibility of a weighing error. A correction (-0.014 ml/l) was made for the amount of oxygen added with the reagents. Combined reagent/seawater blanks were determined to account for oxidizing or reducing materials in the reagents, and for a nominal level of natural iodate (Brewer and Wong 1974) or other oxidizers/reducers in the seawater.

The quality of the  $\text{KIO}_3$  is the ultimate limitation on the accuracy of this methodology. The assay of the finest quality  $\text{KIO}_3$  available to ODF is 100%,  $\pm 0.05\%$ . The true limit in the quality of the bottle oxygen data probably lies in the practical limitations of the present sampling and analytical methodology, from the time the rosette bottle is closed through the calculation of oxygen concentration from titration data. Overall precision within a group of samples has been determined from replicates on numerous occasions, and for the system as employed on this expedition, one may expect  $\pm 0.1$  to 0.2%. The overall accuracy of the data is estimated to be  $\pm 0.5\%$ .

## **2.4. Nutrients**

The following section was contributed by Lou Gordon of Oregon State University. Nutrient analyses were performed by Joe C. Jennings, Jr. and Lee Goodell of Oregon State University using an Alpkem Corp. Rapid Flow Analyzer, Model RFA-300 (RFA). The methods for silicic acid, nitrate plus nitrite and nitrite were those given in the Alpkem manual (Alpkem, 1987). The method for phosphate was an adaptation of OSU's hydrazine reduction method for the AutoAnalyzer-II (Atlas et al., 1971). The adaptation consisted of scaling reagent concentrations and pump tube sizes to duplicate final concentrations of reagents in the sample stream used with OSU's AutoAnalyzer-II phosphate method. All of these methods had been tested as implemented on the RFA-300 by comparison with an AutoAnalyzer-II simultaneously running OSU's existing AutoAnalyzer-II methods. The results were equal or better in all cases, with respect to accuracy, precision, linearity and interferences.

Sampling for nutrients followed that for the tracer gases, He, Tritium, CFCs, and dissolved oxygen. Samples were drawn into 30 cc high density polyethylene, narrow mouth, screw-capped bottles. Then they were immediately introduced into the RFA sampler by pouring into 4 cc polystyrene cups which fit the RFA sampler tray. Both the 30 cc bottles and 4 cc cups were rinsed three times with rinses of approximately one third their volume prior to filling. Analyses routinely were begun within twenty minutes after the 30 cc bottles were filled and completed within an additional hour and a half. When the RFA malfunctioned, delays of up to several hours were experienced. If the delay was anticipated to be more than one half hour, the samples were refrigerated. Samples were refrigerated and stored up to 8 hours on stations 7-8. Station 13 was refrigerated for ca. 6 hours. All samples from stations 1-6 were irretrievably lost because of difficulties in starting up the RFA system at the beginning of the expedition.

During this cruise short-term precision was monitored by analyzing replicate samples taken from the same Niskin bottle and by taking replicate samples from Niskin bottles tripped at the same depth. Results from closely similar depths on the same station were also compared. The results are shown in Table I. It is emphasized that these data represent short-term precision, on order of minutes to an hour.

To check accuracy results were compared with historical data taken from the region. Selected, modern, high quality data sets were used for the comparison. The present data set compares within OSU's accuracy estimated from identified sources of error and estimates of their magnitude, i.e., silicic acid, 2%; phosphate, 1%; nitrate plus nitrite, 1%; and nitrite, 0.02 micromoles per liter. The fractional values are relative to the highest concentrations found in the regional water columns.

**Table I:** Short-term precision results for nutrient measurements from cruise OCEANUS 202. Entries are one standard deviation of a single analysis computed by pooling variances. Units are micromoles per liter throughout.

- Case I describes replicates taken from different Niskin bottles tripped at the same depth;
- Case II, replicates from the same Niskin bottles; and
- Case III, samples from closely adjacent depths.
- "DF" gives the number of degrees of freedom for each compiled set.

<b>Case</b>	<b>Phosphate</b>	<b>Nitrate+Nitrite</b>	<b>Silicic Acid</b>	<b>Nitrite</b>	<b>DF</b>
I	0.012	0.10	0.16	0.01	63
II	.014	.10	.12	.005	93
III	.019	.16	.14	.01	30

### **3. CTD Data Collection, Analyses and Processing**

CTD sensors and electronics have known response limitations in a dynamic marine environment. To the extent that the instrument responses are stable and repeatable, ODF and other groups can use an evolved set of sensor models, calibration procedures, and algorithms to correct the output of the instrument. ODF NBIS MkIII CTD data represents a successful application of these procedures, with the possible exception of the oxygen sensor data. It is possible under ideal circumstances to produce deep CTD data with an absolute accuracy of about 2 dbar, 0.002°C, and 0.002 psu. (Absolute accuracies are sometimes worse, especially in high gradient and/or high ship roll situations.)

During ODF CTDO operations, pressure, temperature, conductivity, dissolved oxygen, elapsed time, altimeter, transmissometer and voltage signals were acquired from the underwater unit at a maximum frequency (i.e., for P, T, and C) of 25 Hz. The data were transmitted as an FSK signal which was demodulated by an ODF-designed deck unit. The deck unit output a 9600 baud RS-232C data stream. An Integrated Solutions UNIX workstation computer served as the real time data acquisition processor.

Data acquisition consisted of storing all raw binary data and also generating and storing a corrected and filtered 0.5-second average time series. (Audio data were recorded on video tape as an ultimate back-up.) An absolute value and first-order gradient single-frame filter was applied to each channel. For each 0.5 seconds of data, a 4,2 sigma standard deviation filter was passed over each channel. The remaining data for the 0.5 second block were then averaged. Conductivity was corrected for thermal and pressure effects. Pressure and conductivity were lagged to match the PRT temperature response. Pressure was corrected for thermal and pressure hysteresis effects. Data calculated in real time from this time series were reported and plotted during the cast. Also, an average of the time series data (usually 10 seconds) was calculated for each water sample collected during the data acquisition (these CTD values corresponding to rosette bottle closures were also be recomputed later when necessary). If required, a spike/drop-out filter was employed to remove remaining large pressure, temperature and conductivity spikes from the 0.5-second time series data. (These were the type due to cable and slip ring noise, for example.) A ship-roll filter (disallowing pressure reversals) was used during the transformation of the data to a 2.0 dbar pressure series.

### **3.1 CTD Laboratory Calibrations**

The CTD pressure transducer was calibrated pre- and post-cruise in a temperature-controlled bath to the ODF Ruska deadweight-tester pressure standards. In the pressure calibration the mechanical hysteresis loading and unloading curves were measured pre-/post-cruise at 0.2/0.5°C to a maximum of 8830 psi, and at 28.5/28.1°C to a maximum of 2030 psi. The transducer thermal response time is derived from the pressure response to a thermal step change from the high to the low bath temperatures. For high latitude work, the "high temperature" calibration is often performed at 5°C.

The CTD PRT temperature transducer was calibrated pre- and post-cruise in a temperature controlled bath with a NBS ATB 1250 resistance bridge and a Rosemount standard platinum resistance thermometer which is checked frequently against the triple points of water and diphenyl ether. Seven or more calibration temperatures between 0 and 31°C were measured pre- and post-cruise.

### **3.2 CTD Pressure Corrections**

The dynamic response of the pressure sensor is typically quite different than the published specifications. Pressure error contributes inaccuracies to properties (especially salinity) calculated from pressure and other measurements. The pressure transducers used by ODF exhibit both a thermal response and a pressure hysteresis. These response characteristics are repeatable and can be corrected by a model based upon calibration experiments. Since this type of sensor is prone to a pressure hysteresis that is dependent upon the maximum loading pressure, the model utilizes a single loading pressure calibration and multiple unloading pressure calibrations (to various maximum pressures). The calibration is repeated at various calibration temperatures (see above). A lagged temperature (calculated from the CTD PRT sensor temperature) is used to model the internal transducer temperature, based upon thermal step change response calibration data. In this way ODF can produce final CTD pressures from the up and down casts accurate to 2 dbars. While this degree of accuracy is not critical per se to most oceanographers, it minimizes the effects of pressure errors on salinity calculations.

Thermometric pressures were not measured on this expedition. The pre- and post-cruise laboratory pressure calibrations were compared. Other than a small offset, which was automatically adjusted for each cast as the CTD entered the water, there was no remarkable difference between the two calibration results for CTD #2. The pre- and post-cruise calibrations agreed within 2.5 decibars, and there was no significant slope difference. No change was made to the shipboard CTD pressure data, to which the pre-cruise pressure calibrations had already been applied. Oceanus 202 pressures from stations with low ship roll are probably accurate to about  $\pm 3$ dbar, with some degradation probable at stations with high ship roll.

### 3.3. CTD Temperature Corrections

CTD #2 had two PRTs. PRT #1 was the main temperature sensor and was used exclusively in all data processing. PRT #2 was a secondary temperature sensor installed to provide a check for the primary PRT.

A comparison of the pre- and post-cruise laboratory PRT temperature transducer calibrations showed an average +0.0035°C shift for PRT #1. and an average +0.0030°C shift for PRT #2. There was a also very small slope difference between the two PRT #1 calibrations. There were no thermometric temperatures measured to check for drifts or shifts in the CTD temperature sensor during the cruise, and no remarkable instances of drift were observed. Because there was far less scatter in the pre-cruise results, the pre-cruise calibration coefficients were used, plus an additional +0.002°C offset to balance out the pre-/post-cruise difference.

While the PRT laboratory calibration is thought to be accurate to within  $\pm 0.001^\circ\text{C}$  Oceanus Cruise 202 temperatures in low gradient regions, i.e. where the CTD electronics have stabilized to the ambient water temperature and the response time errors are small, are probably accurate in absolute terms to about  $\pm 0.002^\circ\text{C}$ .

### 3.4. CTD Conductivity Corrections

Check-sample conductivities were calculated from the bottle salinities using corrected CTD pressures and temperatures. The differences between sample and CTD conductivities from pressures less than 1500 decibars were fit to CTD conductivity using a linear least-squares fit. Values greater than 2 standard deviations from the fit were rejected. The resulting conductivity correction slopes for each cast were fit to station number, giving a continuous smoothed conductivity slope correction as a function of station number. Conductivity differences were calculated for each cast after applying the preliminary conductivity slope corrections. Residual conductivity offsets were then calculated for each cast and fit to station number. The resulting smoothed offsets were then applied to the data.

The conductivity sensor and/or electronics for CTD #2 displayed a sensitivity to pressure change beginning about 1500 decibars. This effect was better isolated by first applying the preliminary conductivity correction described above. After careful examination, it was determined that the problem began about 1350 decibars, where the effect on conductivity was negligible. The distortion continuously increased to the cast bottom, where the effect was approximately 0.03 mmhos/cm for a 6000-decibar cast. An additional first-order conductivity slope as a function of pressure was determined using deep conductivity differences:

$$\text{newC} = \text{oldC} - 6.34\text{e-}6 * \text{pressure} + (\text{Offset at 1350 decibars})$$

After applying this slope to the CTD data from 1350 decibars to the bottom of each cast, the conductivity slope as a function of conductivity and conductivity offset corrections were recalculated.

All depth ranges were used to determine the final conductivity slopes as a function of conductivity. The final smoothed slopes were determined in two groups, with the first 69 stations grouped together and the rest of the stations, with a constant slope, in the second group. Smoothed offsets were applied to each cast, then manually adjusted to account for discontinuous shifts in the conductivity transducer response, and/or to insure a consistent deep  $\Theta$ -S relationship from station to station.

The final bottle-CTD conductivity differences give the following results:

	<b>mean conductivity difference (btl-CTD)</b>	<b>standard deviation</b>	<b># values in mean</b>
all pressures	-.00026 mmhos/cm	.00545	2956
allp (4,2rej)	-.00025 mmhos/cm	.00222	2775
press <= 1500	-.00009 mmhos/cm	.00685	1800
press >= 1500	-.00052 mmhos/cm	.00170	1156

("4,2rej" means a 4,2 standard-deviation rejection filter was used on the differences before generating the results).

### 3.5 CTD Dissolved Oxygen Data

Dissolved oxygen data were acquired using a Sensormedics (Formerly Beckman) dissolved oxygen sensor. The same oxygen sensor was used during the entire cruise. Sufficient (>12/cast) high-quality oxygen check samples were collected to make CTD oxygen calibration feasible.

CTD down-cast raw oxygen currents were extracted from the corrected pressure-series data at isopycnals corresponding to the up-cast check-samples. The differences between CTD and check-sample dissolved oxygens were used to generate coefficients for a sensor model on a station-by-station basis. In the ODF software model of the response of the Beckman dissolved O<sub>2</sub> sensor, filters are employed to correct for temperature and pressure response. The temperature at the surface of the sensor membrane is calculated and used to compute the diffusion time constant for the membrane. A diffusion time delay is also calculated. Pressure, temperature and salinity are found at the diffusion time and modeled to match the O<sub>2</sub> response. Oxygen partial pressure is then calculated taking into account the dissolved O<sub>2</sub> partial-pressure in atmospheres, the sensor current, the offset current of the sensor, the pressure at response-time, the pressure correction coefficient, the temperature correction coefficient, the temperature at response-time, the salinity at response-time, the salinity correction coefficient, the natural log of the slope of O<sub>2</sub> conversion, and the offset of O<sub>2</sub> conversion. Modeling coefficients are determined by applying a non-linear fitting procedure to residual differences derived from Winkler titration check sample data.

The statistics below represent the final bottle-CTD oxygen differences:

	mean oxygen diff.(btl-CTD)	standard deviation	#values in mean
all pressures	+ .0009 ml/l	.0921	3037
allp (4,2rej)	+ .0030 ml/l	.0371	2827
press <=1500	- .0001 ml/l	.1137	1874
press >=1500	+ .0025 ml/l	.0366	1163

("4,2rej" means a 4,2 standard-deviation rejection filter was used on the differences before generating the results).

Several casts in this cruise did not have any bottle data for an extensive portion of the cast. Bottle oxygen values from nearby stations were matched up to those down-casts in order to ensure a reasonable data fit. The following casts were affected: station 61-63 cast 1 (used corresponding cast 2 oxygens for missing bottles above 1200 decibars), station 64 cast 1 (used station 63 cast 1 bottle values between 3800 decibars and bottom), and station 127 cast 1 (used station 126 cast 1 bottles, where reasonable, above 3800 decibars). These added bottle differences were included when generating the final statistics in the paragraph above.

The oxygen sensor often requires several seconds in the water before it is wet enough to respond properly; this is manifested as low oxygen values at the start of some casts. Flow-dependence problems occur when the lowering rate varies, or when the CTD is stopped, as at the cast bottom or bottle trips, where depletion of oxygen at the sensor causes lower oxygen readings. CTD down-cast oxygen data are typically better because of the more continuous lowering rate; any non-bottom CTD stops observed in the down-trace data are documented in the CTD Processing Notes ([Appendix A](#)).

Several casts without bottom oxygen bottle values did not have an appropriate nearby-cast bottle to substitute. The bottom data of the CTD traces for such casts tend to wander a little in the low direction. This may happen on other casts because of slowing down the package for the bottom approach.

### 3.6. Additional Processing

A software filter was used on half of the casts to remove various conductivity, temperature, or oxygen spiking problems. These spiking problems were due to signal reception problems caused by slip rings, pylon noise (numerous new end terminations and signal problems on this expedition) and ship-roll generated spiking not solved by the roll filter. Overall, less than 0.4% of the time-series data in those casts were affected. Pressure did not require filtering. The down-cast (up-cast for Stations 10, 115, and 125) portion of each time-series was then pressure-sequenced into 2-decibar pressure intervals. A ship-roll filter was applied to disallow pressure reversals on every cast except station 11 cast 2: a 17 percent reduction in the number of missing data levels for this cast resulted from not using the filter.

Density inversions which still remain in high-gradient regions cannot be accounted for by a mis-match of pressure, temperature and conductivity sensor response. Detailed examination of the raw data shows significant mixing occurring in these areas as a consequence of ship roll. The ship-roll filter resulted in a reduction in the amount and/or size of density inversions.

Several shipboard time-series data sets had problems with large areas of missing or noisy data. Many of these casts were partially or fully recovered by re-digitizing the raw signal from analog tape. Those casts which could not be fully recovered by filtering or re-digitizing are documented in the CTD Processing Notes ([Appendix A](#)). All other remaining problems are documented in the inventory as well.

### **3.7. General Comments/Problems**

There is one pressure-sequenced CTD- data set, to near the ocean floor, for each of 129 stations, numbered 1 through 129. There were also 4 stations - 61, 62, 63, and 65 - which had two casts (deep and shallow) in order to recover shallower bottle data information missed on the deep casts because of rosette malfunctions, there were two shakedown stations, and there was one aborted cast, for a total of 136 CTD casts. The first three of the two cast stations were collected during re-occupations of the stations (about 22 hours later). These four shallower casts were originally given a cast number of 11 but are now called cast 2. The aborted cast was carried out at Station 11, and another CTD cast was done immediately afterward at the same location (and called cast 2). The data from the shakedown stations are not included in any distributions of the data.

The data reported are all from down-casts with the exception of stations 10, 115 and 125 (all cast 1), which are up-casts. The up-cast was used for Station 10 cast 1 because the down-cast had significantly more noise/gaps than the up-cast. Station 115 cast 1 down-cast had one large 280-decibar data gap, and the up-cast was fine. Station 125 cast 1 down-cast had several large data gaps (40-300+ decibars) which were not recoverable from analog tape, the up-cast was recovered with no gaps and without the signal-noise problems experienced shipboard.

Other casts with notable problems are as follows: Station 10 cast 1 up-cast, although better than the down-cast, has 1% missing data; its largest interpolated gap is 5 consecutive levels. Station 35 cast 1 down-cast was recorded from 14 decibars in-the-water; the up-cast showed this area to be within a good mixed layer. The down-cast, with the surface levels extrapolated, was used because of the benefit of using down-casts for oxygen processing. Station 11 cast 2 had many gaps: 5% of its data, including one 50-decibar gap, were missing and interpolated. Its down-cast was used because the up-cast was just as bad. Station 112 cast 1 also had gapping problems: 4% of its data were missing and interpolated, much of it concentrated in one 110-decibar gap. In general, missing data levels have been extrapolated/interpolated. All pertinent comments/problems from shipboard and post-processing notes are documented in the CTD Processing Notes ([Appendix A](#)).

Most gaps in Oceanus 202 CTD data were caused by signal interruption between the CTD and shipboard equipment, i.e. from slip ring and/or end termination problems. When possible, missing data were recovered from the raw data (videotape) backup, i.e. when the problems were caused by deck unit maladjustment. Low recording volume on the video backup prevented data recovery for the Station 125 down cast.

The 0-decibar level of some casts was extrapolated using a quadratic fit through the next three deeper levels. Recorded surface values have been rejected only when it is fairly obvious that the drift is due to the sensors adjusting to the in-water transition; if there is any doubt or a possibility that the data is real, it is left alone. Extrapolated surface levels, as well as other single interpolated levels which fill in for missing data, are documented in the CTD Processing Notes. The interpolated levels for the three stations with multiple problems, mentioned above, are documented in the CTD Processing Notes ([Appendix A](#)).

During post-cruise conductivity data calibrations it was noticed that there was an apparent +0.002 conductivity offset in the deep data for some stations. This apparent offset appeared in both the down-casts and up-casts for the affected stations. A similar phenomenon has been noticed before in this and other CTDs where the raw conductivity value crosses from 32.768 to 32.767, that is, when the most significant bit in the 16 bit number is turned off. On some stations, a -0.002 shift back appears yet deeper, where the raw conductivity value crosses back over to 32.767 from the other direction. This problem indicates need for instrument service. It is most noticeable in Atlantic Ocean data because this particular conductivity "crossover" value typically occurs in deep water, where salinity is fairly stable over many hundreds of meters.

There were various winch, wire and rosette problems throughout the cruise. This resulted in numerous stops, pauses or yoyos during casts. Only the most significant of these have been noted. As mentioned above, these severe changes in the lowering rate can affect oxygen data in particular.

## 4. Data Tables and Plots

### 4.1. Station and Cast Description

Latitudes and longitudes were read from the ship's navigation system. The "Start Up" time is the time (GMT) at the beginning of the CTD up cast. The bottom depth was read from the PGR, and corrected according to Carter Tables (Carter, 1980). The value (in meters) in the column "DAB" (Distance above bottom) was obtained from the PGR, unless the "Comments" column reports altimeter, as was the ocean depth. If one adds the reported distance above bottom to the maximum sampling depth (reported in the CTD data) to calculate the ocean depth, there is often a difference, due to the difference in method of measurement of maximum sampling depth versus ocean depth. Also note that the maximum sampling depth is calculated from the corrected CTD data since the deepest bottle may not have been closed at the deepest CTD sampling point. If less than 24 bottles were sampled, the number of samples taken are reported in the comments. The complementary programs are reported in the "Samples" column.

### 4.2. Tabular Data, CTD and Niskin Bottle

Station numbers are consecutive from the beginning to end of the cruise, without interruption, except for two unreported test stations. Cast numbers are consecutive at each station, including aborted casts. However, at stations 61, 62, and 63, the second cast took place during reoccupations about 18 hours to 4 days later. **Meteorological data** were collected by the ship's officers and were copied from the Oceanus Bridge Log.

The headings in both the CTD data and NISKIN bottle data have been abbreviated to PRESS, TEMP, and O<sub>2</sub> for pressure (decibars), temperature (degrees Celsius), and oxygen (milliliters per liter). In the CTD data listings, specific volume anomaly (centiliters/ton) was abbreviated SVA and calculated according to Millero *et al.* (1980) and Fofonoff *et al.* (1983), Dynamic Height (dynamic meters) to DYN HT, (Sverdrup *et al.*, 1942), Sound Velocity (meter per second) to SVEL, (Chen and Millero, 1977), Vaisala Frequency (cycles per hour) to VAIS FREQ which uses a subroutine by Bob Millard modified by Lynne Talley to incorporate Gaussian weighting after formulation of Breck Owens and N. P. Fofonoff. In the bottle data listings, the headings have been abbreviated to O<sub>2</sub> SAT, (Weiss, 1970), SiO<sub>3</sub>, PO<sub>4</sub>, NO<sub>3</sub>, and NO<sub>2</sub> for oxygen saturation (percent saturation), silicate, phosphate, nitrate, and nitrite (micromoles/liter), respectively. Density anomalies in sigma-notation follow the usual practice; e.g. sigma-theta (or sigma-0) is the potential density in kg/m<sup>3</sup> referenced to pressure=0, from which 1000 has been subtracted. Potential temperature,  $\theta$ , (degrees celsius) has been calculated according to Fofonoff (1977) and Bryden (1973) and depth (meters) by Saunders (1981) and Mantyla (1982-1983).

Throughout the battle data report alphabetic characters may be found in the tabular data. These characters have the following meaning.

- D A salinity value, normally (default) from a bottle sample, has been taken from CTD records.
- U A data value is suspect, although no obvious reason has been found.

Comments and investigation of these values are reported in [Appendix B](#)

### **4.3. Station Plots** (see SIO Reference 91-16 -- ODF Publication No. 229)

The hydrographic station plots provide a visualization of the data that is not possible from listings. For each station, the upper plots are CTD data, the lower two plots are bottle data.

### **4.4. Vertical Sections**

The vertical sections were contributed by Mizuki Tsuchiya and Lynne Talley and are being published by Tsuchiya, Talley and McCartney (1991). The potential temperature, salinity and potential density sections are based on CTD data. Note for the potential density section that  $\sigma_0$  is contoured on the 0-1500 meter panel, while  $\sigma_2$  is contoured from 0-3000 meters and  $\sigma_4$  is contoured from 3000-6000 meters on the full-depth panel. The oxygen, silica, nitrate and phosphate sections are based on discrete data; the CTD profiles were used to resolve some difficulties in contouring oxygen.

## **5. Acknowledgements**

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## **7. Chlorofluorocarbon Analysis Methods** (John Bullister)

Specially designed 2 liter water sample bottles were used on the cruise to reduce CFC contamination. These bottles have a modified end-cap design to minimize the contact of the water sample with the end-cap O-rings after closing. The O-rings used in these water sample bottles were vacuum-baked prior to the first station. Stainless steel springs covered with an epoxy powder coat were used inside the bottles (instead of elastic tubing) used close the bottles.

Water samples for CFC analysis were usually the first samples collected from the 2 liter bottles. Care was taken to co-ordinate the sampling of CFCs with other samples to minimize the time between the initial opening of each bottle and the completion of sample drawing. In most cases, dissolved oxygen, helium/tritium and nutrient samples were collected within several minutes of the initial opening of each bottle. To minimize contact with air, the CFC samples were drawn directly through the stopcocks of the 2 liter bottles into 100 ml precision glass syringes equipped with 2-way metal stopcocks. The syringes were immersed in a holding tank of clean surface seawater until analyses.

For air sampling, a ~100 meter length of 3/8" OD Dekaron tubing was run from the analytical system to the bow of the ship. Air was sucked through this line using an Air Cadet pump. The air was compressed in the pump, with the downstream pressure held at about 1.5 atm using a back-pressure regulator. A tee allowed a flow (~100 cc/min) of the compressed air to be directed to the gas sample valves, while the bulk flow of the air (>7 liter/minute) was vented through the back pressure regulator.

Concentrations of CFC-11 and CFC-12 in air samples, seawater and gas standards on the cruise were measured by shipboard electron capture gas chromatography (EC-GC), using the techniques described by Bullister and Weiss (1988). For seawater analyses, a ~30-ml aliquot of seawater from the glass syringe was transferred into the glass sparging chamber. The dissolved CFCs in the seawater sample were extracted by passing a supply of CFC-free purge gas through the sparging chamber for a period of 4 minutes at ~70 cc/min. Water vapor was removed from the purge gas while passing through a short tube of magnesium perchlorate desiccant. The sample gases were concentrated on a cold-trap consisting of a 2-inch section of 1/8-inch stainless steel tubing packed with Porasil C (80-100 mesh) backed by a 2 inch section packed with Porapak T (80-100 mesh) immersed in a bath of isopropanol held at -20°C. After 4 minutes of purging the seawater sample, the sparging chamber was closed and the trap isolated. The dewer full of cold isopropanol was removed and the trap was submerged into a dewer of boiling water. The sample gases held in the trap were then injected onto a precolumn (12 inches of 1/8-inch O.D. stainless steel tubing packed with 80-100 mesh Porasil C, held at 90°C), for the initial separation of the CFCs and other rapidly eluting gases from more slowly eluting compounds. The CFCs then passed into the main analytical column (10 feet, 1/8-inch stainless steel tubing packed with Porasil C 80-100 mesh, held at 90°C), and then into the EC detector.

The CFC analytical system was calibrated frequently using standard gas of known CFC composition. Gas sample loops of known volume were thoroughly flushed with standard

gas and injected into the system. The temperature and pressure were recorded so that the amount of gas injected could be calculated. The procedures used to transfer the standard gas to the trap, precolumn, main chromatographic column and EC detector were similar to those used for analyzing water samples. Two sizes of gas sample loops were present in the analytical system. Multiple injections of these loop volumes could be done to allow the system to be calibrated over a relatively wide range of CFC concentrations. Air samples and system blanks (injections of loops of CFC-free gas) were injected and analyzed in a similar manner. The typical analysis time for seawater, air, standard and blank samples was about 8 minutes.

Concentrations of CFC-11 and CFC-12 in air, seawater samples and gas standards are reported relative to the SIO93 calibration scale (Cunnold, et. al., 1994). CFC concentrations in air and standard gas are reported in units of mole fraction CFC in dry gas, and are typically in the parts-per-trillion (ppt) range. Dissolved CFC concentrations are given in units of picomoles of CFC per kg seawater (pmol/kg). CFC concentrations in air and seawater samples were determined by fitting their chromatographic peak areas to multi-point calibration curves, generated by injecting multiple sample loops of gas from a CFC working standard (cylinder 9944) into the analytical instrument. The concentrations of CFC-11 and CFC-12 in this working standard were calibrated before and after the cruise versus a primary standard (36743) (Bullister, 1984). No measurable drift in the concentrations of CFC-11 and CFC-12 in the working standard could be detected during this interval. Full range calibration curves were run at intervals of ~ 3 days during the cruise. Single injections of a fixed volume of standard gas at one atmosphere were run much more frequently (at intervals of 1 to 2 hours) to monitor short term changes in detector sensitivity.

The small volume (~2 liter) water sampling bottles were designed and constructed prior to this cruise because of the small rosette package used. The inner surfaces of the bottles may not have had adequate time to desorb any excess levels of CFCs present in the PVC pipe used to construct the bottles, and this may have contributed to the relatively high and variable CFC-11 blanks observed in some samples. CFC blanks were estimated from samples collected in regions where low or CFC-free water was expected. Measured CFC-12 concentrations were consistently low and near the detection limit for depths between 2000-4000 meters from 30N -14N, and these samples were used to estimate the mean CFC blanks for the expedition. A CFC-12 blank correction of 0.001 pmol/kg was applied to the entire cruise. The CFC-11 blanks were higher and more variable with an average of ~0.06 pmol/kg (see [listing of replicate samples](#) given at the end of this report). In some cases, applying these blank corrections to low concentration samples yields negative reported concentrations.

On this expedition, we estimate precisions (1 standard deviation) to be the greater of about 0.018 pmol/kg or 1.8% for dissolved CFC-11 and 0.004 pmol/kg or 1.5% for CFC-12.

A number of water samples had clearly anomalous CFC-11 and/or CFC-12 concentrations relative to adjacent samples. These anomalous samples appeared to occur more or less randomly during the cruise, and were not clearly associated with other features in the water column (eg. elevated oxygen concentrations, salinity or temperature features, etc.).

This suggests that the high values were due to individual, isolated low-level CFC contamination events. These samples are included in this report and are given a quality flag of either 3 (questionable measurement) or 4 (bad measurement). A total of ~116 analyses of CFC-11 were assigned a flag of 3 and ~46 analyses of CFC-12 were assigned a flag of 3. A total of ~112 analyses of CFC-11 were assigned a flag of 4 and ~89 CFC-12 samples assigned a flag of 4.

In addition to the file of mean CFC concentrations reported for each water sample in the data tables (keyed to the unique station: sample ID), tables of the following are included in this report:

**Table 1a:** A16N Replicate dissolved CFC-11 analyses

**Table 1b:** A16N Replicate dissolved CFC-12 analyses

**Table 2:** A16N CFC air measurements

**Table 3:** A16N CFC air measurements (interpolated to station locations)

A value of -9.0 is used for missing values in the listings.

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Table 1a: A16N Replicate dissolved CFC-11 analyses

STN	SAMP	F-11									
13	24	1.699	43	24	0.055	61	23	0.030	65	23	0.097
13	24	1.705	43	24	0.096	62	15	0.189	65	24	0.046
14	14	1.709	47	22	0.191	62	15	0.209	65	24	0.077
14	14	1.692	47	22	0.168	62	17	0.091	65	24	0.027
20	6	3.321	47	23	0.173	62	17	0.108	69	20	0.026
20	6	3.292	47	23	0.171	62	18	0.090	69	20	0.001
20	22	1.463	47	23	0.166	62	18	0.019	69	21	0.007
20	22	1.477	49	4	2.654	62	18	0.032	69	21	-0.002
35	22	0.102	49	4	2.771	62	18	0.063	69	22	0.011
35	22	0.097	50	6	2.694	62	19	0.027	69	22	-0.032
35	23	0.058	50	6	2.625	62	19	0.010	69	23	0.010
35	23	0.039	50	24	0.047	62	19	0.013	69	23	-0.022
36	22	0.075	50	24	0.040	62	20	0.043	69	24	-0.006
36	22	0.082	50	24	0.033	62	20	0.028	69	24	-0.030
36	24	0.023	51	22	0.028	62	20	0.029	72	1	2.036
36	24	0.019	51	22	0.040	62	21	0.007	72	1	1.984
37	23	0.117	55	21	0.033	62	21	0.015	72	2	2.080
37	23	0.067	55	21	0.029	62	21	0.000	72	2	1.995
37	24	0.060	55	23	0.045	62	23	0.032	72	3	2.170
37	24	0.060	55	23	0.061	62	23	0.015	72	3	2.228
41	20	0.162	55	24	0.059	65	1	0.099	72	4	2.124
41	20	0.161	55	24	0.038	65	1	0.070	72	4	2.264
42	20	0.276	59	2	2.445	65	1	0.058	72	5	2.252
42	20	0.197	59	2	2.409	65	20	0.039	72	5	2.263
42	21	0.264	61	20	0.023	65	20	0.007	124	19	0.011
42	21	0.278	61	20	0.062	65	21	0.017	124	19	0.018
42	22	0.094	61	20	0.001	65	21	0.071	124	24	-0.013
42	22	0.138	61	21	0.000	65	21	0.003	124	24	0.010
43	22	0.119	61	21	0.011	65	22	0.017	125	21	0.023
43	22	0.098	61	21	0.002	65	22	0.013	125	21	0.017
43	22	0.084	61	22	0.035	65	22	0.038	127	14	-0.018
43	23	0.058	61	22	0.020	65	23	0.040	127	14	-0.018
43	23	0.055	61	23	0.040	65	23	0.043			

Table 1b: A16N Replicate dissolved CFC-12 analyses

STN	SAMP	F-12	STN	SAMP	F-12	STN	SAMP	F-12	STN	SAMP	F-12
13	24	0.724	43	23	0.011	61	21	0.007	65	23	-0.001
13	24	0.719	47	22	0.103	61	21	0.007	65	23	0.007
14	14	0.747	47	22	0.088	61	22	0.011	65	23	0.006
14	14	0.816	47	23	0.080	61	22	0.003	65	24	0.010
20	6	1.540	47	23	0.079	61	22	0.003	65	24	0.010
20	6	1.551	47	23	0.093	61	23	-0.001	65	24	0.017
20	22	0.681	49	4	1.277	61	23	0.003	69	20	-0.001
20	22	0.801	49	4	1.320	61	23	0.007	69	20	0.002
35	22	0.023	50	6	1.241	62	15	0.072	69	21	0.002
35	22	0.026	50	6	1.246	62	15	0.101	69	21	0.002
35	23	0.031	50	24	0.023	62	17	0.026	69	22	0.002
35	23	0.036	50	24	0.043	62	17	0.023	69	22	0.002
36	22	0.011	50	24	0.020	62	18	0.037	69	23	-0.001
36	22	0.021	51	22	0.003	62	18	0.028	69	23	-0.001
36	23	0.024	51	22	0.007	62	18	0.023	69	24	0.002
36	23	0.011	51	23	-0.001	62	18	0.033	69	24	-0.001
36	24	0.043	51	23	0.003	62	19	0.003	72	1	0.974
36	24	0.007	53	23	0.003	62	19	0.007	72	1	0.959
36	24	0.014	53	23	0.003	62	19	0.003	72	2	0.947
36	24	0.025	55	20	0.022	62	20	0.007	72	2	0.963
37	22	0.027	55	20	0.017	62	20	0.010	72	3	1.039
37	22	0.018	55	21	0.027	62	20	0.007	72	3	1.065
37	23	0.022	55	21	0.027	62	21	0.003	72	4	1.009
37	23	0.011	55	21	0.026	62	21	0.006	72	4	1.087
37	24	0.025	55	22	0.035	62	21	0.007	72	5	1.072
37	24	0.020	55	22	0.027	62	22	0.006	72	5	1.072
37	24	0.019	55	22	0.040	62	22	0.014	124	19	0.008
38	23	0.052	55	23	0.024	62	23	0.007	124	19	0.012
38	23	0.046	55	23	0.035	62	23	0.003	124	20	0.005
41	20	0.059	55	23	0.023	62	24	0.011	124	20	0.002
41	20	0.071	55	24	0.007	62	24	0.003	124	21	0.005
41	22	0.033	55	24	0.014	65	1	0.017	124	21	0.002
41	22	0.049	55	24	0.021	65	1	0.006	124	22	-0.001
42	20	0.122	59	2	1.145	65	1	-0.001	124	22	0.005
42	20	0.142	59	2	1.129	65	20	0.003	124	24	0.002
42	21	0.090	59	21	0.014	65	20	0.007	124	24	0.005
42	21	0.110	59	21	0.020	65	20	0.016	125	21	0.011
42	22	0.057	59	24	0.011	65	21	0.006	125	21	0.008
42	22	0.047	59	24	0.003	65	21	-0.001	127	14	0.017
43	22	0.032	61	20	-0.001	65	21	0.006	127	14	0.017
43	22	0.035	61	20	0.003	65	22	0.003			
43	22	0.028	61	20	0.007	65	22	0.003			
43	23	0.025	61	21	-0.001	65	22	0.007			

Table 2: A16N CFC air measurements

**Leg 1**

Date	Time (hhmm)	Latitude	Longitude	F11 (PPT)	F12 (PPT)
27 Jul 88	2240	53 58.9 N	020 00.0 W	257.6	459.6
27 Jul 88	2250	53 58.9 N	020 00.0 W	254.9	457.9
27 Jul 88	2302	53 58.9 N	020 00.0 W	254.7	457.5
28 Jul 88	2138	51 29.0 N	020 00.0 W	252.8	456.0
28 Jul 88	2147	51 29.0 N	020 00.0 W	252.5	458.4
28 Jul 88	2157	51 29.0 N	020 00.0 W	252.8	457.9
31 Jul 88	1539	44 59.8 N	019 19.0 W	255.8	457.4
31 Jul 88	1549	44 59.8 N	019 19.0 W	253.9	459.3
31 Jul 88	1557	44 59.8 N	019 19.0 W	252.8	458.3
1 Aug 88	1730	42 30.2 N	020 00.4 W	252.3	457.6
1 Aug 88	1740	42 30.2 N	020 00.4 W	251.4	457.1
1 Aug 88	1750	42 30.2 N	020 00.4 W	252.2	456.1
3 Aug 88	0542	38 59.0 N	020 00.0 W	251.9	458.1
3 Aug 88	0553	38 59.0 N	020 00.0 W	251.8	459.4
3 Aug 88	1606	38 00.7 N	019 59.3 W	250.3	460.0
3 Aug 88	1616	38 00.7 N	019 59.3 W	250.8	459.8
3 Aug 88	1627	38 00.7 N	019 59.3 W	250.9	459.9
4 Aug 88	1102	36 00.2 N	020 00.7 W	253.3	458.9
4 Aug 88	1115	36 00.2 N	020 00.7 W	252.8	461.3
4 Aug 88	1125	36 00.2 N	020 00.7 W	251.9	459.2
5 Aug 88	0524	34 40.5 N	020 48.7 W	251.1	453.9
5 Aug 88	0535	34 40.5 N	020 48.7 W	250.5	456.6

**Leg 2**

Date	Time (hhmm)	Latitude	Longitude	F11 (PPT)	F12 (PPT)
12 Aug 88	0551	31 03.0 N	022 55.0 W	247.4	460.5
12 Aug 88	0602	31 03.0 N	022 55.0 W	247.1	459.3
12 Aug 88	0614	31 03.0 N	022 55.0 W	244.8	462.5
13 Aug 88	2104	26 44.9 N	025 16.5 W	250.8	459.9
14 Aug 88	2030	24 00.2 N	026 54.7 W	251.9	461.7
15 Aug 88	1253	22 43.6 N	027 28.6 W	248.4	453.4
19 Aug 88	1058	10 18.0 N	028 41.3 W	234.9	442.1
19 Aug 88	1111	10 18.0 N	028 41.3 W	235.4	440.0
19 Aug 88	1126	10 18.0 N	028 41.3 W	238.9	445.4
20 Aug 88	2225	06 48.0 N	027 12.0 W	233.9	437.3
20 Aug 88	2235	06 48.0 N	027 12.0 W	234.0	433.9
21 Aug 88	2134	04 06.0 N	026 06.0 W	231.6	436.0
21 Aug 88	2145	04 06.0 N	026 06.0 W	232.8	437.5
21 Aug 88	2155	04 06.0 N	026 06.0 W	232.9	434.1
22 Aug 88	0428	02 41.4 N	025 29.6 W	232.3	435.2
22 Aug 88	0438	02 41.4 N	025 29.6 W	231.4	441.5
22 Aug 88	0448	02 41.4 N	025 29.6 W	238.4	441.0
22 Aug 88	0459	02 41.4 N	025 29.6 W	233.1	437.2
24 Aug 88	1212	01 30.0 S	025 00.0 W	235.3	437.2
24 Aug 88	1222	01 30.0 S	025 00.0 W	234.8	431.8
24 Aug 88	1232	01 30.0 S	025 00.0 W	231.3	429.5

**Table 3:** A16N CFC air measurements (interpolated to station locations)

STN	LATITUDE	LONGITUDE	DATE	F11 (ppt)	F12 (ppt)
1	63 19.8 N	019 59.9 W	23 Jul 88	254.2	457.9
2	63 12.6 N	020 00.3 W	23 Jul 88	254.2	457.9
3	63 08.0 N	020 00.4 W	24 Jul 88	254.2	457.9
4	62 59.3 N	020 00.7 W	24 Jul 88	254.2	457.9
5	62 40.3 N	019 59.9 W	24 Jul 88	254.2	457.9
6	62 19.8 N	020 00.1 W	24 Jul 88	254.2	457.9
7	61 49.6 N	020 01.3 W	24 Jul 88	254.2	457.9
8	61 19.6 N	020 00.8 W	24 Jul 88	254.2	457.9
9	60 49.5 N	019 58.9 W	24 Jul 88	254.2	457.9
10	60 19.6 N	019 59.9 W	25 Jul 88	254.2	457.9
11	59 50.6 N	019 59.2 W	25 Jul 88	254.2	457.9
12	59 23.6 N	019 59.2 W	25 Jul 88	254.2	457.9
13	58 49.4 N	020 00.8 W	26 Jul 88	254.2	457.9
14	58 22.5 N	020 01.2 W	26 Jul 88	254.2	457.9
15	57 59.6 N	020 00.8 W	26 Jul 88	254.2	457.9
16	57 29.5 N	020 00.6 W	26 Jul 88	254.2	457.9
17	56 59.2 N	020 01.2 W	26 Jul 88	254.2	457.9
18	56 29.2 N	020 01.2 W	27 Jul 88	254.2	457.9
19	55 59.3 N	020 01.8 W	27 Jul 88	254.2	457.9
20	55 29.3 N	020 00.6 W	27 Jul 88	254.2	457.9
21	54 59.1 N	019 59.8 W	27 Jul 88	254.2	457.9
22	54 29.2 N	020 00.8 W	27 Jul 88	254.2	457.9
23	53 59.0 N	020 00.8 W	27 Jul 88	254.2	457.9
24	53 30.0 N	020 00.6 W	28 Jul 88	254.2	457.9
25	52 59.1 N	020 01.1 W	28 Jul 88	254.2	457.9
26	52 29.1 N	020 00.3 W	28 Jul 88	254.2	457.9
27	51 59.1 N	019 59.6 W	28 Jul 88	254.2	457.9
28	51 29.2 N	020 00.9 W	28 Jul 88	254.2	457.9
29	50 58.9 N	019 59.9 W	29 Jul 88	254.2	457.9
30	50 28.4 N	020 01.3 W	29 Jul 88	254.2	457.9
31	50 04.6 N	019 59.4 W	29 Jul 88	254.2	457.9
32	49 28.1 N	020 00.2 W	29 Jul 88	254.2	458.0
33	48 58.7 N	020 00.7 W	29 Jul 88	253.4	457.9
34	48 30.3 N	019 59.6 W	30 Jul 88	253.4	457.9
35	47 59.8 N	020 00.6 W	30 Jul 88	253.4	457.9
36	47 29.2 N	020 01.4 W	30 Jul 88	253.4	457.9
37	46 59.3 N	019 59.4 W	30 Jul 88	252.9	457.6
38	46 29.4 N	019 58.4 W	30 Jul 88	253.1	457.6
39	45 58.8 N	020 00.2 W	31 Jul 88	253.1	457.6
40	45 29.1 N	020 00.7 W	31 Jul 88	253.1	457.6
41	44 59.4 N	019 59.7 W	31 Jul 88	253.1	457.6
42	44 29.6 N	019 59.6 W	31 Jul 88	253.1	457.6
43	43 59.8 N	019 59.1 W	1 Aug 88	253.1	457.6
44	43 29.7 N	020 02.5 W	1 Aug 88	253.1	457.6
45	43 00.1 N	020 01.4 W	1 Aug 88	253.1	457.6

**Table 3:** A16N CFC air measurements (interpolated to station locations)

STN	LATITUDE	LONGITUDE	DATE	F11 (ppt)	F12 (ppt)
46	42 30.7 N	020 00.7 W	1 Aug 88	253.1	457.6
47	42 00.8 N	020 00.5 W	1 Aug 88	252.8	457.9
48	41 29.9 N	020 01.3 W	2 Aug 88	252.2	458.5
49	41 00.8 N	019 59.6 W	2 Aug 88	251.4	458.5
50	40 30.9 N	020 01.8 W	2 Aug 88	251.4	458.5
51	40 01.1 N	019 59.7 W	2 Aug 88	251.4	458.5
52	39 31.1 N	020 00.6 W	2 Aug 88	251.4	458.5
53	38 59.5 N	020 00.8 W	3 Aug 88	251.7	459.6
54	38 31.6 N	020 02.3 W	3 Aug 88	251.7	459.6
55	38 01.1 N	019 59.1 W	3 Aug 88	251.7	459.6
56	37 30.0 N	020 00.3 W	3 Aug 88	251.7	459.6
57	37 00.2 N	020 00.4 W	4 Aug 88	251.7	459.6
58	36 29.7 N	020 00.4 W	4 Aug 88	251.4	458.7
59	36 00.3 N	020 01.4 W	4 Aug 88	251.5	458.7
60	35 34.9 N	020 16.8 W	4 Aug 88	251.4	458.7
61	35 05.8 N	020 32.1 W	5 Aug 88	251.4	458.7
62	34 39.3 N	020 48.7 W	5 Aug 88	251.4	458.7
63	34 12.9 N	021 04.4 W	6 Aug 88	251.4	458.7
64	33 45.8 N	021 18.9 W	6 Aug 88	251.4	458.7
65	33 19.3 N	021 36.4 W	6 Aug 88	251.4	458.7
66	32 49.9 N	021 52.6 W	11 Aug 88	248.4	459.6
67	32 23.4 N	022 08.5 W	11 Aug 88	248.4	459.6
68	31 56.9 N	022 23.8 W	11 Aug 88	248.4	459.6
69	31 30.0 N	022 41.7 W	12 Aug 88	248.4	459.6
70	31 03.0 N	022 54.9 W	12 Aug 88	248.4	459.6
71	30 36.1 N	023 10.4 W	12 Aug 88	248.4	459.6
72	30 09.1 N	023 24.7 W	12 Aug 88	248.4	459.6
73	29 29.1 N	023 48.0 W	12 Aug 88	248.4	459.6
74	28 50.7 N	024 13.0 W	13 Aug 88	248.4	459.6
75	28 07.2 N	024 30.7 W	13 Aug 88	248.4	459.6
76	27 25.1 N	024 55.5 W	13 Aug 88	248.4	459.6
77	26 44.9 N	025 16.5 W	13 Aug 88	248.4	459.6
78	26 02.1 N	025 49.5 W	14 Aug 88	248.4	459.6
79	25 23.4 N	026 00.2 W	14 Aug 88	248.4	459.6
80	24 43.9 N	026 21.1 W	14 Aug 88	248.4	459.6
81	24 00.2 N	026 54.7 W	14 Aug 88	248.4	459.6
82	23 23.8 N	027 05.5 W	15 Aug 88	248.4	459.6
83	22 43.6 N	027 28.6 W	15 Aug 88	248.4	459.6
84	22 04.3 N	027 51.1 W	15 Aug 88	248.4	459.6
85	21 22.7 N	028 14.8 W	15 Aug 88	248.4	459.6
86	20 41.0 N	028 36.7 W	16 Aug 88	243.4	450.4
87	20 00.4 N	029 00.9 W	16 Aug 88	243.4	450.4
88	19 15.4 N	029 00.2 W	16 Aug 88	243.4	450.4
89	18 30.7 N	029 00.6 W	16 Aug 88	243.4	450.4
90	17 44.9 N	029 00.5 W	17 Aug 88	243.4	450.4

**Table 3:** A16N CFC air measurements (interpolated to station locations)

STN	LATITUDE	LONGITUDE	DATE	F11 (ppt)	F12 (ppt)
91	17 01.0 N	028 59.9 W	17 Aug 88	241.0	446.7
92	16 15.3 N	028 56.7 W	17 Aug 88	239.6	444.8
93	15 30.7 N	029 00.3 W	17 Aug 88	239.6	444.8
94	14 45.4 N	029 01.1 W	17 Aug 88	237.6	442.0
95	14 00.1 N	029 00.0 W	18 Aug 88	237.6	442.0
96	13 15.7 N	029 00.7 W	18 Aug 88	235.9	440.0
97	12 29.6 N	028 59.3 W	18 Aug 88	234.3	438.3
98	11 45.6 N	028 59.1 W	18 Aug 88	234.3	438.3
99	10 59.2 N	028 59.4 W	19 Aug 88	234.3	438.3
100	10 17.5 N	028 40.9 W	19 Aug 88	234.3	438.3
101	09 35.3 N	028 24.2 W	19 Aug 88	234.3	438.3
102	08 55.7 N	028 05.8 W	19 Aug 88	234.3	438.3
103	08 13.5 N	027 49.3 W	20 Aug 88	234.3	438.3
104	07 32.2 N	027 31.4 W	20 Aug 88	234.3	438.3
105	06 50.1 N	027 15.2 W	20 Aug 88	234.3	438.3
106	06 09.3 N	026 55.9 W	20 Aug 88	233.4	437.1
107	05 27.6 N	026 40.0 W	21 Aug 88	233.4	437.1
108	04 46.1 N	026 23.8 W	21 Aug 88	233.4	437.1
109	04 03.9 N	026 04.5 W	21 Aug 88	233.2	437.5
110	03 24.5 N	025 39.8 W	21 Aug 88	233.2	437.5
111	02 41.5 N	025 29.8 W	22 Aug 88	233.2	437.5
112	02 00.2 N	025 12.9 W	22 Aug 88	233.2	437.5
113	01 25.9 N	025 00.9 W	22 Aug 88	233.4	436.1
114	01 00.2 N	025 00.2 W	22 Aug 88	233.8	436.2
115	00 39.4 N	024 58.7 W	22 Aug 88	233.8	436.2
116	00 20.0 N	025 00.1 W	23 Aug 88	233.8	436.2
117	00 00.3 N	024 59.8 W	23 Aug 88	233.8	436.2
118	00 19.9 S	025 00.8 W	23 Aug 88	233.8	436.2
119	00 40.1 S	025 00.0 W	23 Aug 88	233.8	436.2
120	01 00.1 S	025 00.3 W	23 Aug 88	233.8	436.2
121	01 30.2 S	024 59.8 W	23 Aug 88	233.8	436.2
122	02 00.3 S	024 59.2 W	24 Aug 88	233.8	436.2
123	02 37.8 S	024 59.8 W	24 Aug 88	233.8	436.2
124	03 01.7 S	024 58.8 W	24 Aug 88	233.8	436.2
125	10 02.0 N	022 08.0 W	27 Aug 88	233.4	437.1
126	10 29.0 N	022 04.0 W	27 Aug 88	233.4	437.1
127	10 58.0 N	021 57.0 W	27 Aug 88	233.4	437.1
128	11 27.3 N	021 51.5 W	27 Aug 88	233.4	437.1
129	11 57.0 N	021 44.0 W	27 Aug 88	233.4	437.1

## APPENDIX A OCEANUS 202 (McTT) CTD Processing Notes

NOTE: All casts are down-cast 2-decibar pressure-series data, unless otherwise noted

Station	Cast	Remarks
1	1	0-dbar level extrapolated
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	0-dbar level extrapolated
8	1	0-dbar level extrapolated
9	1	0-dbar level extrapolated
10	1	up cast; signal problems: <ul style="list-style-type: none"> <li>• lost signal/gaps, down and up</li> <li>• 13 levels (1916 of data) missing</li> </ul> 6 single levels interpolated: <ul style="list-style-type: none"> <li>• 1298, 1306, 1318, 1344, 1542, 2430 dbars</li> </ul> 2 multiple levels interpolated: <ul style="list-style-type: none"> <li>• 1550 thru. 1552 dbars (2 consecutive levels)</li> <li>• 1568 thru. 1576 dbars (5 consecutive levels)</li> </ul>
11	2	new end termination prior to aborted cast 1: <ul style="list-style-type: none"> <li>• data begins after in water (6 dbars);</li> <li>• signal dropouts down from 1330 dbars,</li> <li>• major signal dropouts below 2000 dbars down and up;</li> <li>• no bottles above 500 dbars</li> </ul> 71 levels (5% of data) missing 3 single levels interpolated: <ul style="list-style-type: none"> <li>• 2106,2438, 2700 dbars</li> </ul> 10 multiple levels extrapolated/interpolated- <ul style="list-style-type: none"> <li>• 0 thru 2 dbars (2 consecutive levels)</li> <li>• 686 thru 690 dbars (3 consecutive levels)</li> <li>• 1342 thru. 1344 dbars (2 consecutive levels)</li> <li>• 1348 thru. 1362 dbars (8 consecutive levels)</li> <li>• 1366 thru. 1374 dbars (5 consecutive levels)</li> <li>• 1828 thru. 1940 dbars (7 consecutive levels)</li> <li>• 1982 thru. 2028 dbars (24 consecutive levels)</li> <li>• 2034 thru. 2044 dbars (6 consecutive levels)</li> <li>• 2082 thru. 2094 dbars (7 consecutive levels)</li> <li>• 2114 thru. 2116 dbars (2 consecutive levels)</li> <li>• 2694 thru. 2696 dbars (2 consecutive levels)</li> </ul>
12	1	0-dbar level extrapolated; repaired pylon prior to cast; new end termination
13	1	0-dbar level extrapolated
14	1	
15	1	
16	1	
17	1	
18	1	rosette and pylon replaced prior to cast
19	1	
20	1	
21	1	rosette hit bottom after bottom trip

**APPENDIX A OCEANUS 202 (McTT) CTD Processing Notes**

NOTE: All casts are down-cast 2-decibar pressure-series data, unless otherwise noted

Station	Cast	Remarks
22	1	
23	1	
24	1	0-dbar level extrapolated
25	1	0-dbar level extrapolated
26	1	0-dbar level extrapolated; 470-dbar level interpolated
27	1	
28	1	0-dbar level extrapolated
29	1	
30	1	pylon problems, top 8 bottles did not trip
31	1	pylon changed prior to cast
32	1	0-dbar level extrapolated
33	1	0-dbar level extrapolated, data begins after cast in water (3 dbars)
34	1	0-dbar level extrapolated; pinger signal weak
35	1	0-12 dbars: (7 consec. levels) extrapolated, data begins after in water (14 dbars); 1278-dbar level interpolated; 20-minute stop at 3640 dbars
36	1	0-dbar level extrapolated
37	1	
38	1	0-dbar level extrapolated
39	1	0-dbar level extrapolated
40	1	no pinger, used altimeter for bottom reading
41	1	0-2 dbars (2 consec. levels) extrapolated, data begins after in water (4 dbars); CTD signal losses up
42	1	0-dbar level extrapolated; CTD signal losses upcast
43	1	
44	1	0-dbar level extrapolated
45	1	
46	1	0-dbar level extrapolated
47	1	
48	1	
49	1	0-dbar level extrapolated; CTD signal losses upcast
50	1	
51	1	multiple CTD signal losses upcast
52	1	0-dbar level extrapolated; CTD signal losses upcast
53	1	
54	1	0-dbar level extrapolated; 1098-1102 dbars (3 consec. levels) interpolated power surge problems; yoyo at 1190 to 1114 dbars down, winch problems, winch test at 2045 dbars down 3-min. stop
55	1	yoyos at 24 dbars to near-surface down
56	1	

**APPENDIX A OCEANUS 202 (McTT) CTD Processing Notes**

NOTE: All casts are down-cast 2-decibar pressure-series data, unless otherwise noted

Station	Cast	Remarks
57	1	0-dbar level extrapolated; sea turtle observing upcast
58	1	
59	1	0-dbar level extrapolated, data begins after cast in water (3 dbars); 1034-dbar level interpolated
60	1	5344-dbar and 5348-dbar levels interpolated; winch slipping on upcast
61	1	no bottles above 1180 dbars; unusual low CTD oxygen area 1450-2750 dbars
61	2	
62	1	CTD signal losses upcast; no bottles above 1310 dbars
62	2	
63	1	0-dbar level extrapolated; no bottles above 1060 dbars
63	2	
64	1	
65	1	
65	2	0-dbar level extrapolated; first cast in 5 days, following port-stop conductivity sensor probably not soaked before cast
66	1	0-dbar level extrapolated; small CTD oxygen inversion where pauses at 5200 dbars down
67	1	
68	1	
69	1	0-dbar level extrapolated; new end termination; CTD oxygen inversion 1820-1940 dbars down, origin unknown; short in cable to slip-rings discovered after cast; transmiss. shifted at this cast
70	1	
71	1	CTD signal losses upcast
72	1	
73	1	
74	1	
75	1	0-dbar level extrapolated; CTD signal losses upcast
76	1	CTD signal losses upcast
77	1	
78	1	
79	1	0-dbar level extrapolated
80	1	CTD signal losses upcast
81	1	
82	1	CTD signal losses upcast
83	1	CTD signal losses upcast
84	1	CTD signal losses upcast
85	1	CTD signal losses upcast

**APPENDIX A OCEANUS 202 (McTT) CTD Processing Notes**

NOTE: All casts are down-cast 2-decibar pressure-series data, unless otherwise noted

Station	Cast	Remarks
86	1	CTD oxygen offset 2150 dbars: down, origin unknown
87	1	0-dbar level extrapolated
88	1	0-dbar level extrapolated; 3-minute stop at 2045 dbars down; change trip-box mid-upcast no voltage
89	1	winch problems: stop 7/9 minutes at 1625/1750 dbars down
90	1	winch problem: stop 10 minutes at 2245 dbars down
91	1	
92	1	winch stopped 6 minutes at 900 dbars down; winch testing during upcast
93	1	
94	1	0-dbar level extrapolated
95	1	0-dbar level extrapolated
96	1	
97	1	0-dbar level extrapolated; 1734-dbar level interpolated
98	1	winch slipping on upcast
99	1	
100	1	stop 8 minutes at 4665 dbars down to throw circuit breaker (winch?)
101	1	
102	1	
103	1	
104	1	
105	1	
106	1	
107	1	0-dbar level extrapolated
108	1	
109	1	0-dbar level extrapolated
110	1	
111	1	0-dbar level extrapolated
112	1	lost signal at 2500 dbars down, deck unit problems 78 levels (4% of data) missing 8 single levels interpolated: 2766, 3154, 3388, 3416, 3438, 3490, 3852, 3860 dbars 7 multiple levels interpolated: <ul style="list-style-type: none"><li>• 2318 thru. 2424 dbars (54 consecutive levels)</li><li>• 2760 thru. 2762 dbars (2 consecutive levels)</li><li>• 3410 thru. 3412 dbars (2 consecutive levels)</li><li>• 3498 thru. 3506 dbars (5 consecutive levels)</li><li>• 3510 thru. 3514 dbars (3 consecutive levels)</li><li>• 3520 thru. 3522 dbars (2 consecutive levels)</li><li>• 3880 thru. 3882 dbars (2 consecutive levels)</li></ul>
113	1	0-dbar level extrapolated; winch slipping on upcast
114	1	CTD signal losses upcast
115	1	up cast; 0-dbar level extrapolated; 2252-2254 dbars (2 consec. levels) interpolated; deck unit/CTD signal problems at 2164 dbars down
116	1	0-dbar level extrapolated; winch slipping on upcast

**APPENDIX A OCEANUS 202 (McTT) CTD Processing Notes**

NOTE: All casts are down-cast 2-decibar pressure-series data, unless otherwise noted

Station	Cast	Remarks
117	1	0-dbar level extrapolated; EQUATOR
118	1	0-dbar level extrapolated; CTD signal losses upcast
119	1	
120	1	0-dbar level extrapolated
121	1	change to transmiss. #100D before cast
122	1	0-dbar level extrapolated
123	1	1280-dbar and 2444-dbar levels interpolated
124	1	0-dbar level extrapolated; 4776-dbar level interpolated
125	1	up cast; new end termination; recording/signal problems until 2525 dbars down; transmiss. signal shifted "back" this (diff. transmiss. than sta. 69) poor fit in bottom 500 dbars of CTD oxygen (upcast)
126	1	
127	1	no bottles above 3830 dbars (planned/deep multi-trips)
128	1	0-dbar level extrapolated
129	1	

## **APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

Investigation of data may include comparison of bottle salinity and oxygen with CTD data, review of data plots of station profile and adjoining stations. CTD data is reported instead of bottle salinity when the comments refer to deleted salinity samples or no samples. There was a problem with the shies wire which caused many of the tripping problems. There was also a problem with temperature control in the van where the salinity analysis occurred. This caused many of the problems with salinity. Extra levels may occur for each station. These levels were extracted from CTD data for purposes of reporting deepest sampling level.

### **Station 001**

- 106-17 Sample log: No salinity or oxygen per sampling schedule. Duplicates @ 120db include water samples; therefore CTD trip information for these 12 bottles deleted. No nutrients or freon sampled.
- 119  $\Delta$ -S .006 @ 120db, sample high as compared with duplicate samples. Oxygen agrees with CTD and duplicates. Suspect salinity problem with drawing or analysis. Delete salinity sample (35.139).
- 120 Sample log: No salinity or oxygen per sampling schedule. Duplicates @ 120db that include water samples; therefore CTD trip information deleted. No nutrients or freon sampled.

### **Station 003**

- 102 Sample log: Not closed, no water. Level not included in data tables, not necessary duplicate @8db.
- 119  $\Delta$ -S @820db is .059. Salinity was 35.110, salt bottle #3813. Oxygen fits station profile. Bottle could have leaked, salinity and oxygen value could fit higher in the water column, but for now, will assume that there was only a problem with salinity. Delete salinity value.

### **Station 004**

- 117  $\Delta$ -S @810db is .060. Salinity was 35.065, salt bottle #3636. Appears to be a sampling error, value close to shallower level. Oxygen agrees with station profile- Delete salinity value leave oxygen
- 124 Sample log: Bottle drained before salinity was sampled. CTD salinity @ 1246db reported.

### **Station 005**

- 122  $\Delta$ -S @ 1293db is .0060. Salinity is 34.993; salt bottle #3526. The first inclination was to leave salinity data; there are salinity changes reflected in CTD data. Salinity @ 1293db shows slight deviation from the distribution at adjoining stations. – M. Tsuchiya. After further review and from the comments by M. Tsuchiya; delete salinity value.

## **APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

### **Station 007**

101-08 Sample log: Tripping problems, no water samples. CTD data reported to augment temperature and salinity profile. CTD data level not necessary, duplicate @ 357db.

### **Station 008**

107 Sample log: Was not tripped. CTD data level not necessary, duplicate @ 3db.  
108 Sample log: Was not tripped. Use surface CTD data @3db.

### **Station 010**

101 No confirm for CTD trip at surface. Did not get CTD data; bottle not sampled.  
108 Sample log: No sample per sampling schedule. Duplicate trip @506db, level not necessary.  
112 Salinity (34.962) @ 1063db deleted because of CTD difference.  
113  $\Delta$ -S @ 1214db is .0057. Salt bottle #3327. Oxygen looks good. Delete salinity (34.926).  
114 Salinity (34.931) @ 1366db deleted because of CTD difference.  
117 Salinity (34.928) @ 1820db deleted because of CTD difference.

### **Station 011**

201-12 No water samples taken. CTD data reported from surface to 407db to augment temperature and salinity profile.  
202 Delete duplicate CTD data @ 106db.  
213  $\Delta$ -S @506db is .0108. Salt bottle #e76. Duplicate trip at this level which agrees with CTD data. Other parameters agree well with duplicates. Delete bottle salinity (35.093).

### **Station 013**

108 Sample log: Bottom O-ring pinched, leaky pushed back in to sample. Short salt Salinity and oxygen @508db fits station profile. Oxygen a little low compared with adjacent stations. Principal Investigator (L.T.) deleted nutrients. Footnote salinity and oxygen uncertain.

### **Station 015**

119 Oxygen: Ship roll got sample. No oxygen sample @ 1111db.

### **Station 017**

119 Sample log: Bottle dry, no samples. CTD data reported @506db to augment temperature and salinity profile.

**APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

**Station 018**

117 Sample log: Bottom lanyard from #18 caught. No water samples. CTD data reported @699db to augment temperature and salinity profile.

**Station 019**

103 No samples drawn, triplicate @9db therefore CTD data not necessary.

**Station 022**

105-09 No water samples taken, duplicate trips @5db; therefore CTD data not necessary.

**Station 024**

101 Sample log: Not closed. Duplicate trip @9db therefore CTD data not necessary.

**Station 025**

122  $\Delta$ -S @2317db is -.0175. All other parameters fit station profile, suspect a sampling error. Delete bottle salinity (34.936).

**Station 026**

123  $\Delta$ -S @2536db is -.0047. Salt bottle #3498. All other water parameters agree with duplicate level. Delete bottle salinity (34.950), suspect analysis problem. Analysts indicated ship roll.

**Station 030**

101-08 Sample log: No water, ramp shaft stuck on #9. CTD data report @ 10db to augment temperature and salinity profile.

**STATION 031**

121 delta-S is -.0046 @3538db. Suspect some analysis or drawing problem. Delete bottle salinity.

**STATION 039**

111 Salinity @840db is missing, no reason on salinity sheet.

**APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

**STATION 040**

- 101 Sample log: Leaked when rosette was brought out of water. Salinity was not drawn @5db; oxygen is reasonable.
- 107 delta-S @510db is -.0199. Salt bottle #3049. Suspect drawing error. Delete bottle salinity (35.408).
- 124 delta-S @4610db is .0037. Salt bottle #3078. Suspect analysis error. Delete bottle salinity (34.913).

**STATION 041**

- 107 delta-S @300db is -.0193. Salt #48kk. Deviates from adjacent station comparison. Delete bottle salinity (35.624).

**STATION 043**

- 121 Salinity (34.957) deleted because of CTD difference. This could have been a sampling error @ 3288db with # 19 @2760db.
- 122 Sample log: No water left for nutrients. No nutrient samples @3609db.

**STATION 044**

- 114 Salinity: Salt Bottle #16z leaky (removed). delta-S @ 1269db is .0058. Delete bottle salinity (35.161).
- 121 delta-S @3204db is .0040. Salinity: Leaker - salt bottle #3526. Delete bottle salinity (34.941).

**STATION 048**

- 120 delta-S @1810db is .0044. 34.993; salt bottle #3398. Delete bottle salinity.
- 121 delta-S @2015db is .0044. Salinity was 34.983; salt bottle #3908. Delete bottle salinity.
- 124 delta-S @2540db is .0044. Salinity was 34.958; salt bottle #3608. Delete bottle salinity.

**Station 049**

- 124 Oxygen (5.54) @4771db deleted because sample pickled late.

**Station 052**

- 116  $\Delta$ -S @2049db is -.0045. Salinity was 35.055, salt bottle #76k Console ops: CTD moved before trip. Suspect this means that water samples were contaminated. Delete salinity and oxygen samples (5.91).

## **APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

### **Station 055**

116 Oxygen: May be high, forgot to add acid before stirring. Oxygen (6.02) @2562db deleted.

### **Station 056**

124 Sample log: Upper lid hung up on cross bar, did not close, no sample. CTD data @491ldb reported to augment temperature and salinity profile.

### **Station 057**

101 Sample log: Bottle not tripped-malfunction. Surface sample @11db; therefore CTD data level not necessary.

102 Sample log: Bottle not tripped-malfunction. Surface sample @11db; therefore CTD data level not necessary.

103 Sample log: Bottle not tripped-malfunction. Surface sample @11db, therefore CTD data level not necessary.

### **Station 058**

101 Sample log: No sample, ramp shaft looks like it is caught between #1 and #2. CTD data reported @ 3db to augment station temperature and salinity profile.

### **Station 059**

101 Sample log: Did not fire. CTD data reported @14db to augment station temperature and salinity profile.

102 Salt (35.464) deleted @39db, bad but reason unknown. Oxygen ok.

### **Station 061**

101-11 Sample log: Did not trip.

119 Sample log: Lanyard caught in bottom lid, bad leak when spigot opened. Salt (35.796), oxygen (5.15) deleted because bottle apparently leaked @3601db.

201-08 Water samples were not taken from these bottles. Data reported for surface from bottle 9 @4db.

### **Station 062**

101-11 Sample log: Did not trip, wire problems.

116 Salinity (35.755), oxygen (5.18) @2524db deleted because lanyard caught in bottom lid.

201 Sample log: G-ring pinched in bottom lid - leaky. Salinity (35.648). oxygen (4.73) @1197db deleted because battle leaked. CTD data not included, duplicate with samples @3db.

202-08 No bottles tripped.

## **APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

### **Station 063**

- 101-11 Sample log: Trip problems, no fire. CTD data reported to augment station profile for temperature and salinity.
- 112 Oxygen @ 1060db deleted because of analyst. Oxygen (5.20) too high.
- 202 Sample log: Did not trip. Surface value @ 10db reported with bottle 4 data.
- 203 Sample log: Did not trip. Surface value @ 10db reported with bottle 4 data.

### **Station 064**

- 101  $\Delta$ -S @5204db is .0064. Salinity was 34.894; salt bottle #3135. Slightly high as compared with adjacent stations. Oxygen appears a little high but agrees with next station, but also high compared with previous station. Delete salinity.
- 102 Sample log: Did not trip. CTD data not reported.
- 103 Sample log: Did not trip. CTD data not reported.

### **Station 065**

- 102 Sample log: Did not trip. No bottle information necessary, no samples taken.
- 103 Sample log: Did not trip. No bottle information necessary, no samples taken.
- 106  $\Delta$ -S @ 159db is -.1585. Leave oxygen value, delete bottle salinity, 36.028.
- 118 Salinity @2914db .02 low, looks like a sampling error. Oxygen and nutrients okay. Delete bottle salinity, 34.921.
- 201-24 No salts, deck crew did not realize salts had not been drawn and drained niskin bottles in preparation of next cast.

### **Station 067**

- 101 Sample log: Did not trip. CTD data not necessary for station profile.
- 102 Sample log: Did not trip. CTD data not necessary for station profile.
- 103 Sample log: Did not trip. CTD data not necessary for station profile.

### **Station 069**

- 101-06 Sample log: Did not close, tripping problem. Surface data from bottles 7 & 8 @12db, therefore these bottle numbers were not used.
- 109 Oxygen @37db appears high. Does not agree with CTD data. Delete bottle oxygen (5.85).

### **Station 070**

- 101 Sample log: Bottle did not close. No water samples, CTD data not reported.

### **Station 071**

- 101 Bottle did not trip. No water samples, CTD data not reported.

**APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

**Station 075**

106 Sample log: Feels warmer than #5. Salinity (36.679) and oxygen (4.80) deleted @5319db because of pre or post trip.

**Station 078**

115 Sample log: Bottle empty after SF6 drawn no salinity or oxygen. CTD salinity reported @587db, duplicate. Level necessary for Freon shore-based samples.

**Station 081**

113 Sample log: Lower lid leaking-maybe O-ring out of groove. Not enough water for salts, therefore CTD salinity reported. Oxygen @ 310db looks okay.

116 Sample log: Lanyard in lower lid, no samples. CTD data reported @810db to augment temperature and salinity profile.

**Station 083**

104  $\Delta$ -S @4892db is .0061. Salinity was 34.892; salt bottle #15a. Delete salinity, oxygen appears to be okay.

**Station 085**

106 Oxygen data analyst suspects this sample @5384db is high. Delete high oxygen (5.67), salinity looks okay.

117 Oxygen @1045db appears to be too high. Value agrees with 118; suspect drawing error. Delete value of 4.37; 31 July 1990.

**Station 086**

104  $\Delta$ -S @4737db is .0068. Salinity was 34.893; salt bottle #15a. This salinity bottle was found to be leaking. Delete salinity.

122  $\Delta$ -S @2496db is .0043. Salinity was 34.981; salt bottle #t86. Delete salinity; suspect an analysis problem.

**Station 090**

103  $\Delta$ -S @3662db is -.0043. Salinity was 34.899; salt bottle #4508. Delete salinity, oxygen and nutrients look reasonable, probably analysis error or poor sampling.

**Station 093**

102 Sample log: Leak around bottom lid, samples not taken. CTD data reported @40db to augment temperature and salinity profile.

## **APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

### **Station 094**

123 Oxygen (5.74) @5240db deleted because of stirring problem. Oxygen: Poor stirring, two stir bars.

### **Station 100**

112  $\Delta$ -S @985db is .053. Salinity was 34.766; salt bottle #3694. Oxygen is a little high as compared with CTD data. Delete salinity and oxygen (3.12), this bottle had a large difference on Stations 106 and 100 also.

### **Station 103**

122 Salt (34.902) deleted @3814db because of bad salt bottle (15a).

### **Station 105**

112  $\Delta$ -S @913db is .0792. Salinity was 34.715; salt bottle #3694. Oxygen looks reasonable agrees with CTD data. Delete salinity, this bottle had a large difference on stations 106 and 100 also.

### **Station 106**

112  $\Delta$ -S @ 702db is .0594. Salinity was 34.688; salt bottle #3986. CTD indicates salinity minimum for 700 db. Other parameters look good, contamination must only be in salinity. Delete salinity.

### **Station 107**

107 Sample log: Bottle did not close - ramp shaft is in correct position. Some biological stuff on rosette. CTD data @247db reported to augment temperature and salinity profile.

122 Salinity (34.898) @3910db deleted because of bad salt bottle (15a).

### **Station 108**

107 Sample log: Bottle did not fire. No water samples. CTD data @250db reported to augment temperature and salinity profile.

### **Station 113**

117 Sample log: Lanyard in lower lid, no water. CTD data @1164db reported to augment temperature and salinity profile.

**APPENDIX B** Remarks for deleted or missing samples from OCEANUS 202 (MCTT).

**Station 115**

107 Sample log: Did not close. CTD data reported @207db to augment temperature and salinity profile.

**Station 116**

107 Sample log: Did not close. CTD data reported @207db to augment temperature and salinity profile.

**Station 118**

107 Sample log: Did not close. CTD data reported @204db to augment temperature and salinity profile.

**Station 119**

116  $\Delta$ -S @ 1403db is .0092. Salinity was 34.939; salt bottle #3538. Oxygen looks reasonable. Salinity @ 1403db deleted because water sample only 1/5 full.

**Station 122**

124 Sample log: Water feels warmer than 23. Oxygen (3.92) and salinity (35.700) @4999db deleted because bottle leaked. CTD data reported to augment temperature and salinity profile.

**Station 124**

106 Sample log: Not enough water for salts. CTD salinity @209db reported.

**Station 126**

122 Salinity, 34.883, @4903db deleted because of drift. Salt bottle #15a which has caused trouble before.

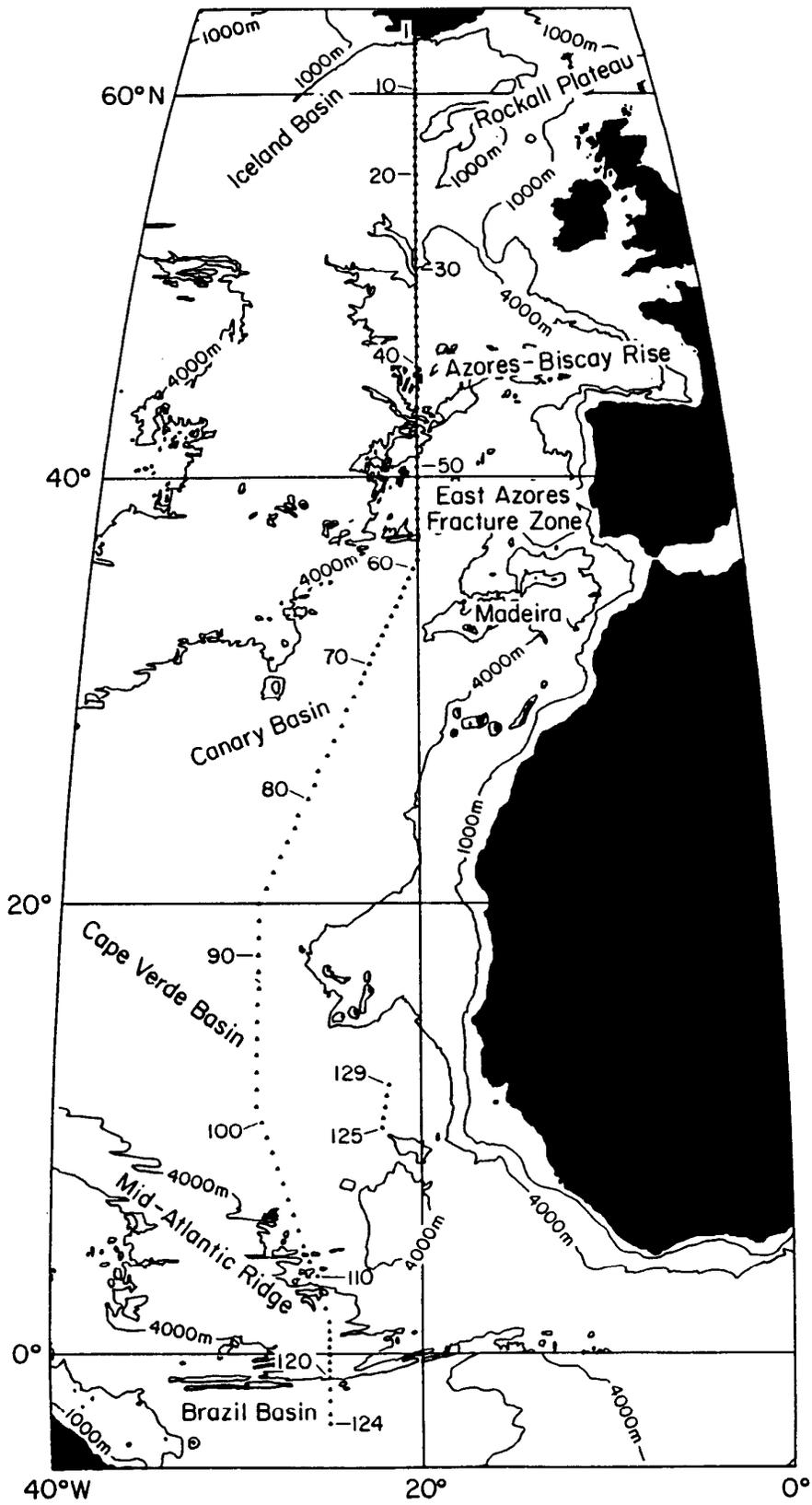
**Station 127**

123 Oxygen: Bubble in flask. Oxygen @5190db .04 high as compared with duplicate samples. Delete oxygen sample (5.53).

**Station 129**

112 Bottle deleted because of suspected leak. Salinity was 34.979, oxygen was 4.24. CTD data reported @ 1476db to augment temperature and salinity profile.

# Cruise Track



## Station and Cast Descriptions

Station/ Cast	Date	Time gmt	Latitude	Longitude	Ocean Depth	Maximum Sampling Depth	DAB M	Comments	Samples
1/01	23 Jul 88	2118	63° 19.8'N	019° 59.9'W	199	194		*	*F
2/01	23 Jul 88	2301	63° 12.6'N	020° 00.3'W	621	627	5	* 16 bottles	*F
3/01	24 Jul 88	0056	63° 08.0'N	020° 00.4'W	927	940	7	* 23 bottles	*
4/01	24 Jul 88	0321	62° 59.3'N	020° 00.7'W	1237	1231	7	*	*F,H,Tr
5/01	24 Jul 88	0620	62° 40.3'N	019° 59.9'W	1481	1480	5	*	*
6/01	24 Jul 88	0935	62° 19.8'N	020° 00.1'W	1909	1809	7	* 17 bottles	*F
7/01	24 Jul 88	1409	61° 49.6'N	020° 01.3'W	1769	1710	10	*	*
8/01	24 Jul 88	1825	61° 19.6'N	020° 00.8'W	2350	2345	12	* 23 bottles	*F
9/01	24 Jul 88	2257	60° 49.5'N	019° 58.9'W	2361	2354	8	* 21 bottles	*
10/01	25 Jul 88	0421	60° 19.6'N	019° 59.9'W	2619	2610	15	*	*F
11/01	25 Jul 88	0820	59° 50.2'N	019° 59.6'W				* ABORTED	*
11/02	25 Jul 88	1042	59° 50.6'N	019° 59.2'W	2730	2721	18	*	*F
12/01	25 Jul 88	1903	59° 23.6'N	019° 59.2'W	2765	2760	10	*	*F
13/01	26 Jul 88	0052	59° 49.4'N	020° 00.8'W	2866	2866	5	*	*F,H,Tr
14/01	26 Jul 88	0538	58° 22.5'N	020° 00.8'W	2163	2160	8	*	*F
15/01	26 Jul 88	0932	57° 59.6'N	020° 00.8'W	1660	1659	5	* 21 bottles	*F
16/01	26 Jul 88	1347	57° 29.5'N	020° 00.6'W	1158	1163	10	* 19 bottles	*
17/01	26 Jul 88	1758	56° 59.2'N	020° 01.2'W	982	977	10	* 17 bottles	*F
18/01	27 Jul 88	0054	56° 29.2'N	020° 01.2'W	1366	1363	5	* 21 bottles	*
19/01	27 Jul 88	0513	55° 59.3'N	020° 01.8'W	1415	1456	10	* 22 bottles	*
20/01	27 Jul 88	0929	55° 29.3'N	020° 00.6'W	1251	1243	10	* 21 bottles	*F,H,Tr
21/01	27 Jul 88	1408	54° 59.1'N	019° 59.8'W		1640		* 23 bottles	*
22/01	27 Jul 88	1850	54° 29.2'N	020° 00.8'W	1380	1381	5	* 20 bottles	*F
23/01	27 Jul 88	2248	53° 59.0'N	020° 00.8'W	1443	1421	10	* 19 bottles	*F
24/01	28 Jul 88	0320	53° 30.0'N	020° 00.6'W	2285	2283	10	*	*
25/01	28 Jul 88	0750	52° 59.1'N	020° 01.1'W	2695	2700	5	*	*F
26/01	28 Jul 88	1150	52° 29.1'N	020° 00.3'W	2813	2810	6	*	*F
27/01	28 Jul 88	1624	51° 59.1'N	019° 59.6'W	3727	3731	0	*	*F
28/01	28 Jul 88	2137	51° 29.2'N	020° 00.9'W	3638	3632	8	*	*F
29/01	29 Jul 88	0225	50° 58.9'N	019° 59.9'W	3633	3640	5	*	*F,H,Tr
30/01	29 Jul 88	0708	50° 28.4'N	020° 01.3'W	4039	4007	10	*	*
31/01	29 Jul 88	1149	50° 04.6'N	019° 59.4'W	4434	4430	10	*	*
32/01	29 Jul 88	1717	49° 28.1'N	020° 00.2'W	3790	3821	10	*	*
33/01	29 Jul 88	2222	48° 58.7'N	020° 00.7'W	4401	4391	21	*	*F
34/01	30 Jul 88	0303	48° 30.3'N	019° 59.6'W	4018	4028	10	*	*
35/01	30 Jul 88	0737	47° 59.8'N	020° 00.6'W	4347	4346		*	*F,Tr
36/01	30 Jul 88	1221	47° 29.2'N	020° 01.4'W	4551	4540		*	*
37/01	30 Jul 88	1716	46° 59.3'N	019° 59.4'W	4494	4519	10	*	*F
38/01	30 Jul 88	2229	46° 29.4'N	019° 58.4'W	4854	4840	10	*	*F,H,Tr
39/01	31 Jul 88	0546	45° 58.8'N	020° 00.2'W	4843	4834		*	*
40/01	31 Jul 88	1053	45° 29.1'N	020° 00.7'W	4530	4528	8	*(altimeter)	*
41/01	31 Jul 88	1600	44° 59.4'N	019° 59.7'W	4398	4355	9	*	*F,H,Tr
42/01	31 Jul 88	2123	44° 29.6'N	019° 59.6'W	4213	4210	12	* 23 bottles	*F
43/01	01 Aug 88	0255	43° 59.8'N	019° 59.1'W	4029	4004	14	*	*F
44/01	01 Aug 88	0729	43° 29.7'N	020° 02.5'W	3958	3993	11	*	*F,H,Tr
45/01	01 Aug 88	1229	43° 00.1'N	020° 01.4'W	5163	5248	10	*	*
46/01	01 Aug 88	1712	42° 30.7'N	020° 00.7'W	4177	4186		*	*

## Station and Cast Descriptions

Station/ Cast	Date	Time gmt	Latitude	Longitude	Ocean Depth	Maximum Sampling Depth	DAB M	Comments	Samples
47/01	01 Aug 88	2138	42° 00.8'N	020° 00.5'W	2649	2690	15	*	*F,Tr
48/01	02 Aug 88	0142	41° 29.9'N	020° 01.3'W	2514	2508	11	*	*
49/01	02 Aug 88	0620	41° 00.8'N	019° 59.6'W	4691	4687	10	*	*F
50/01	02 Aug 88	1206	41° 30.9'N	020° 01.8'W	4870	4948	10	*	*F,Tr
51/01	02 Aug 88	1654	40° 01.1'N	019° 59.7'W	4655	4777	12	*(altimeter)	*F,Tr
52/01	02 Aug 88	2228	39° 31.1'N	020° 00.6'W	4593	4630	9	*	*F
53/01	03 Aug 88	0451	38° 59.5'N	020° 00.8'W	4731	4712	10	*	*F,Tr
54/01	03 Aug 88	1127	38° 31.6'N	020° 02.3'W	4444	4488	11	*	*
55/01	03 Aug 88	1654	38° 01.1'N	019° 59.1'W	5149	5136	10	*	*F
56/01	03 Aug 88	2158	37° 30.0'N	020° 00.3'W	4812	4824	10	*	*F,Tr
57/01	04 Aug 88	0231	37° 00.2'N	020° 00.4'W	3741	3766	10	*	*
58/01	04 Aug 88	0710	36° 29.7'N	020° 00.4'W	5169	5156	10	*	*F
59/01	04 Aug 88	1156	36° 00.3'N	020° 01.4'W	5267	5318	9	*	*F,Tr
60/01	04 Aug 88	1650	35° 34.9'N	020° 16.8'W	5252	5250	9	*	*
61/01	04 Aug 88	2300	35° 06.0'N	020° 33.4'W	5226	5217	10	*	*F
61/02	05 Aug 88	2023	35° 05.8'N	020° 32.1'W		1193		*formerly cast 11	*
62/01	05 Aug 88	0515	34° 40.4'N	020° 48.6'W	5154	5154	10	*	*Tr
62/02	05 Aug 88	2353	34° 39.3'N	020° 48.7'W		1186		*formerly cast 11	*
63/01	05 Aug 88	1109	34° 12.8'N	020° 03.9'W	5231	5227	10	*	*
63/02	06 Aug 88	0342	34° 12.9'N	021° 04.4'W		1895		*formerly cast 11	*
64/01	06 Aug 88	0807	33° 45.8'N	021° 18.9'W	5097	5109	12	*	*F,Tr
65/01	06 Aug 88	1256	33° 19.3'N	021° 36.4'W	5304	5297	8	*	*
65/02	11 Aug 88	0415	32° 51.0'N	021° 19.9'W		1978		*formerly cast 11	*
66/01	11 Aug 88	0823	32° 49.9'N	021° 52.6'W	5247	5246	8	*	*
67/01	11 Aug 88	1305	32° 23.4'N	022° 08.5'W	5185	5179	9	*	*F,Tr
68/01	11 Aug 88	1755	31° 56.9'N	022° 23.8'W	5158	5161	8	*	*
69/01	12 Aug 88	0004	31° 30.0'N	022° 41.7'W	5252	5247	8	*	*F
70/01	12 Aug 88	0458	31° 03.0'N	022° 54.9'W	5262	5250	8	*	*H,Tr
71/01	12 Aug 88	0956	30° 36.1'N	023° 10.4'W	5292	5294	8	*	*
72/01	12 Aug 88	1437	30° 09.1'N	023° 24.7'W	5292	5283	9	*	*
73/01	12 Aug 88	2027	29° 29.1'N	023° 48.0'W	5215	5217	10	*	*F,H,Tr
74/01	13 Aug 88	0218	28° 50.7'N	024° 13.0'W	5215	5217	8	*	*
75/01	13 Aug 88	0821	28° 07.2'N	024° 30.7'W	5225	5224	10	*	*
76/01	13 Aug 88	1415	27° 25.1'N	024° 55.5'W	5236	5234	8	*	*
77/01	13 Aug 88	1954	26° 44.9'N	025° 16.5'W	5153	5168	9	*	*F,H,Tr
78/01	14 Aug 88	0141	26° 02.1'N	025° 49.5'W	5246	5272	8	*	*SF6
79/01	14 Aug 88	0727	25° 23.4'N	026° 00.2'W	5359	5359	9	*	*
80/01	14 Aug 88	1307	24° 43.9'N	026° 21.1'W	5406	5404	8	*	*
81/01	14 Aug 88	1850	24° 00.2'N	026° 54.7'W	5448	5444	9	*	*Tr
82/01	15 Aug 88	0048	23° 23.8'N	027° 05.5'W	5501	5501	8	*	*
83/01	15 Aug 88	0654	22° 43.6'N	027° 28.6'W	5516	5511	9	*	*
84/01	15 Aug 88	1254	22° 04.3'N	027° 51.1'W	5449	5450	8	*	*
85/01	15 Aug 88	1848	21° 22.7'N	028° 14.8'W	5190	5289	8	*	*F,H,Tr
86/01	16 Aug 88	0057	20° 41.0'N	028° 36.7'W	5165	5166	8	*	*F
87/01	16 Aug 88	0646	20° 00.4'N	029° 00.9'W	4794	4790	8	*	*
88/01	16 Aug 88	1231	19° 15.4'N	029° 00.2'W	4517	4524	8	*	*
89/01	16 Aug 88	1845	18° 30.7'N	029° 00.6'W	4671	4659	9	*	*H,Tr

## Station and Cast Descriptions

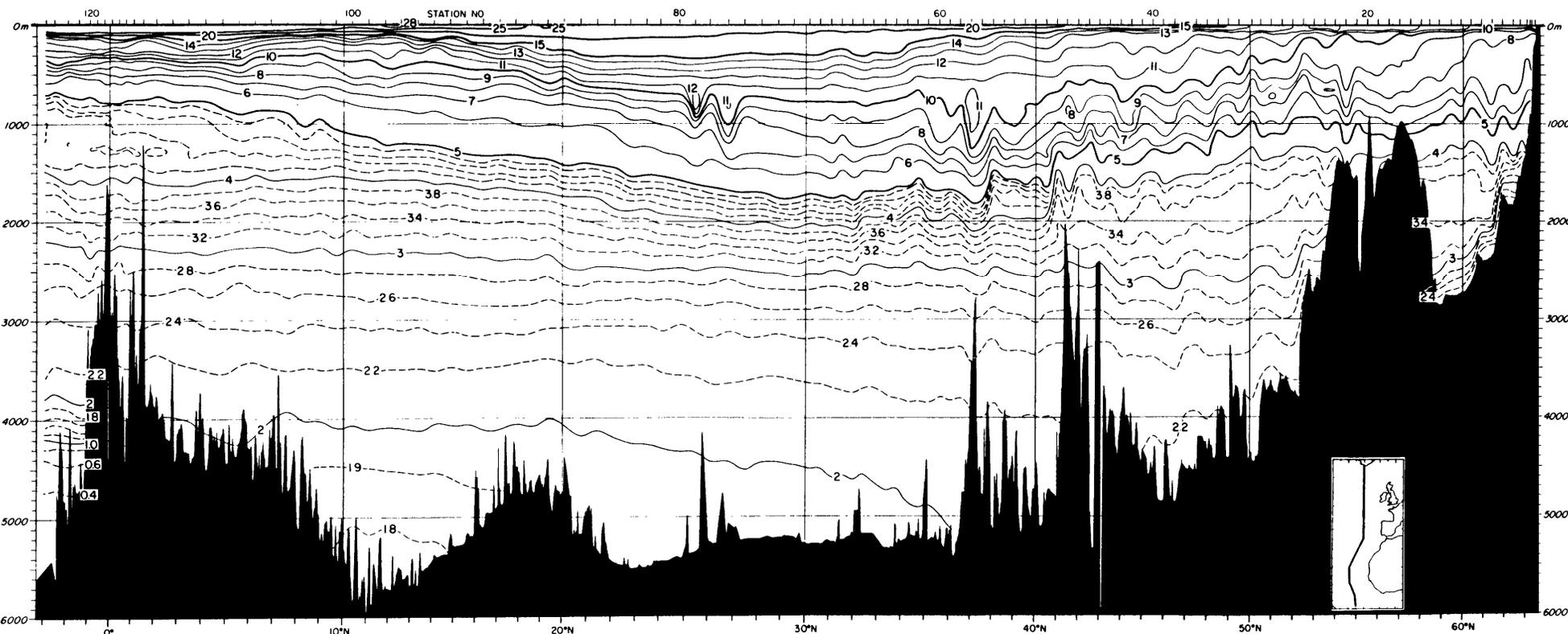
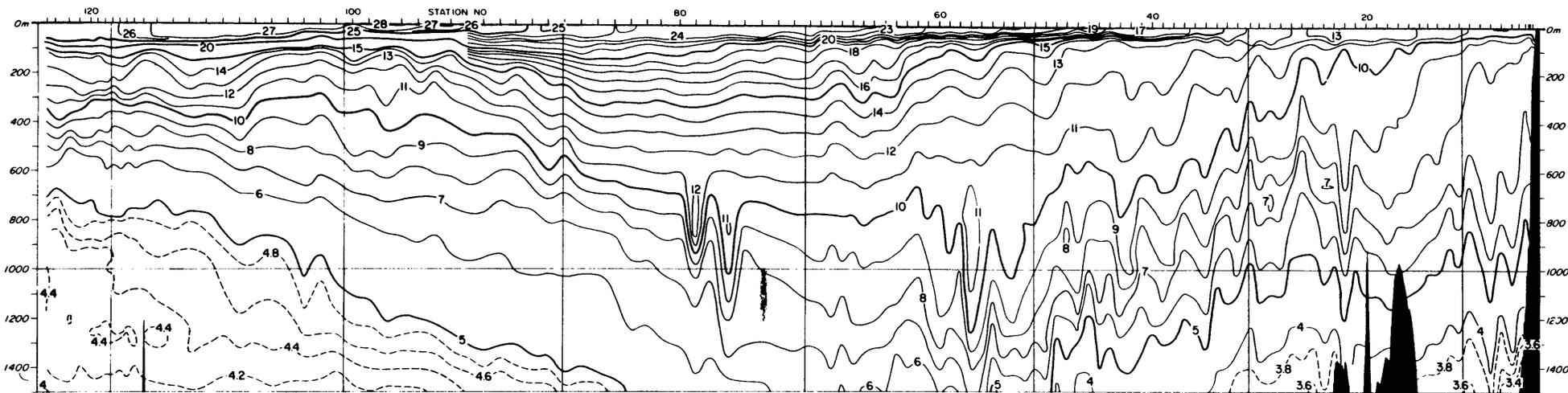
Station/ Cast	Date	Time gmt	Latitude	Longitude	Ocean Depth	Maximum Sampling Depth	DAB M	Comments	Samples
90/01	17 Aug 88	0038	17° 44.9'N	029° 00.5'W		4408	9	*	*
91/01	17 Aug 88	0622	17° 01.0'N	028° 59.9'W	4871	4867	8	*	*
92/01	17 Aug 88	1214	16° 15.3'N	028° 56.7'W	5108	5103	8	*	*
93/01	17 Aug 88	1800	15° 30.7'N	029° 00.3'W	5252	5249	9	*	*H,Tr
94/01	17 Aug 88	2352	14° 45.4'N	029° 01.1'W	5299	5342	10	*	*
95/01	18 Aug 88	0545	14° 00.1'N	029° 00.0'W	5439	5433	11	*	*
96/01	18 Aug 88	1147	13° 15.7'N	029° 00.7'W	5522	5628	10	*	*
97/01	18 Aug 88	1741	12° 29.6'N	028° 59.3'W	5496	5507	8	*	*Tr
98/01	18 Aug 88	2338	11° 45.6'N	028° 59.1'W	5729	5728	10	*	*
99/01	19 Aug 88	0546	10° 59.2'N	028° 59.4'W	5959	5957	10	*	*
100/01	19 Aug 88	1150	10° 17.5'N	028° 40.9'W	5755	5706	10	*	*
101/01	19 Aug 88	1747	09° 35.3'N	028° 24.2'W	5517	5536	8	*	*Tr
102/01	19 Aug 88	2339	08° 55.7'N	028° 05.8'W	4987	4999	10	*	*
103/01	20 Aug 88	0521	08° 13.5'N	027° 49.3'W	4230	4205	9	*	*
104/01	20 Aug 88	1106	07° 32.2'N	027° 31.4'W	4230	4195	10	*	*
105/01	20 Aug 88	1659	06° 50.1'N	027° 15.2'W	4219	4216	8	*	*Tr
106/01	20 Aug 88	2240	06° 09.3'N	026° 55.9'W	4614	4607	9	*	*
107/01	21 Aug 88	0422	05° 27.6'N	026° 40.0'W	4358	4362	9	*	*
108/01	21 Aug 88	1015	04° 46.1'N	026° 23.8'W	4307	4204	9	*	*δN <sup>15</sup>
109/01	21 Aug 88	1614	04° 03.9'N	026° 04.5'W		4496	10	*	*H
110/01	21 Aug 88	2204	03° 24.5'N	025° 39.8'W	4340	4340	9	*	*
111/01	22 Aug 88	0404	02° 41.5'N	025° 29.8'W	4199	4186	9	*	*
112/01	22 Aug 88	0952	02° 00.2'N	025° 12.9'W	3878	3874	9	*	*F
113/01	22 Aug 88	1552	01° 25.9'N	025° 00.9'W	1960	2034	10	*	*H
114/01	22 Aug 88	1924	01° 00.2'N	025° 00.2'W	3054	3161	9	*	*
115/01	22 Aug 88	2325	00° 39.4 'N	024° 58.7'W	4250	4269	9	*	*Tr
116/01	23 Aug 88	0251	00° 20.0'N	025° 00.1'W	3572	3584	8	*	*
117/01	23 Aug 88	0602	00° 00.3'N	024° 59.8'W	3049	3165	9	*	*H,Tr
118/01	23 Aug 88	0915	00° 19.9'S	025° 00.8'W	3005	3093	9	*	*
119/01	23 Aug 88	1222	00° 40.1'S	025° 00.0'W	3213	3234	8	*	*Tr
120/01	23 Aug 88	1525	01° 00.1'S	025° 00.3'W	3067	3188	8	*	*
121/01	23 Aug 88	2012	01° 30.2'S	024° 59.8'W	4743	4760	9	*	*H,Tr
122/01	24 Aug 88	0041	02° 00.3'S	024° 59.2'W	4922	4919	8	*	*
123/01	24 Aug 88	0638	02° 37.8'S	024° 59.8'W	5431	5430	9	*	*
124/01	24 Aug 88	1243	03° 01.7'S	024° 58.8'W	5540	5543	5	*	*H
125/01	27 Aug 88	0500	10° 02.0'N	022° 08.0'W	5026	5026	8	*	*
126/01	27 Aug 88	0937	10° 29.0'N	022° 04.0'W	5140	5136	8	*	*
127/01	27 Aug 88	1403	10° 58.0'N	021° 57.0'W	5103	5101	8	*	*
128/01	27 Aug 88	1819	11° 27.3'N	021° 51.5'W	5031	5029	8	*	*
129/01	27 Aug 88	2238	11° 57.0'N	021° 44.0'W	4954	4950	9	*	*

F: Freon  
Tr: Tritium  
H: Helium

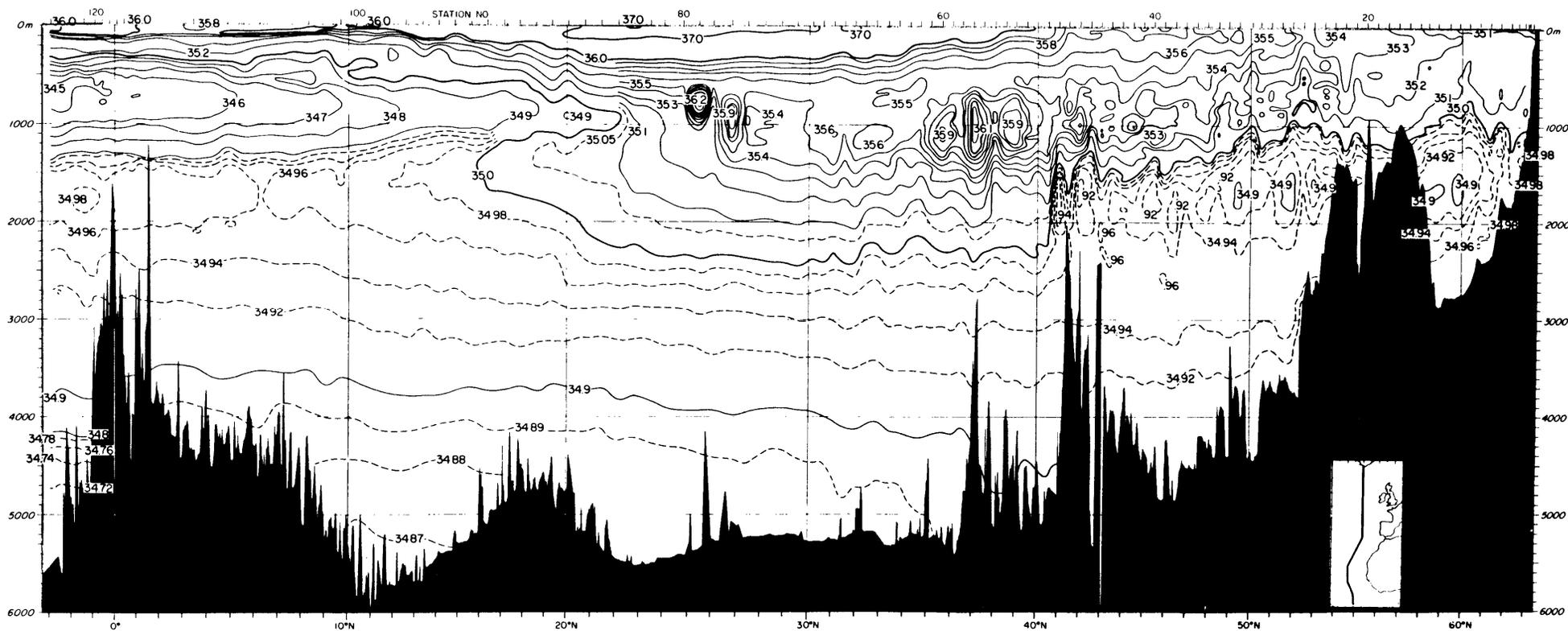
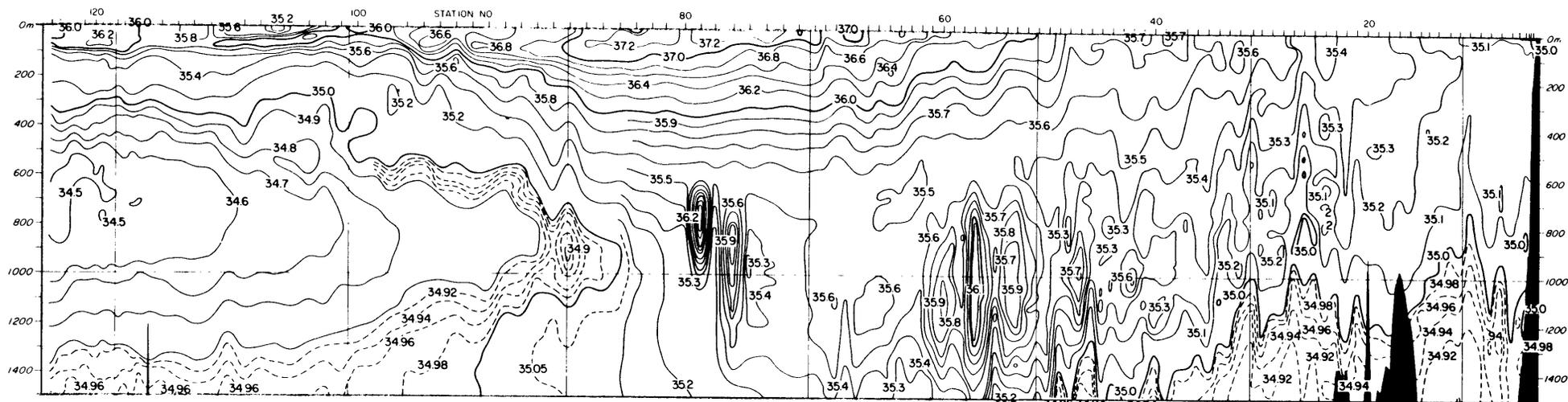
Samples for salinity, oxygen and nutrients were collected at every station.

## List of Participants

<b>Michael McCartney</b>	<b>WHOI</b>	<b>Chief Scientist</b>	
<b>Lynne Talley</b>	<b>SIO</b>	<b>Co-Chief Scientist</b>	<b>23 JUL - 9 AUG 1988</b>
<b>Mizuki Tsuchiya</b>	<b>SIO</b>	<b>Co-Chief Scientist</b>	<b>9 AUG - 1 SEP 1988</b>
<b>Paul Howland</b>	<b>WHOI</b>	<b>Ship's Captain</b>	
Frederick Bingham	SIO		
John Bullister	WHOI		
Nancy Collins	SIO		
Ruth Curry	WHOI		
Frank M. Delahoyde	ODF/SIO		
Scott Doney	WHOI		
Lee Goodell	ODF		
Joe Jennings	ODF		
Chris Johnston	WHOI		
Leonard Lopez	ODF/SIO		
Forrest K. Mansir	ODF/SIO		
Ronald G. Patrick	ODF/SIO		
Kean Stump	ODF		
Robert T. Williams	ODF/SIO		
		ODF: Oceanographic Data Facility	
		OSU: Oregon State University	
		SIO: Scripps Institution of Oceanography	
		WHOI: Woods Hole Oceanographic Institution	

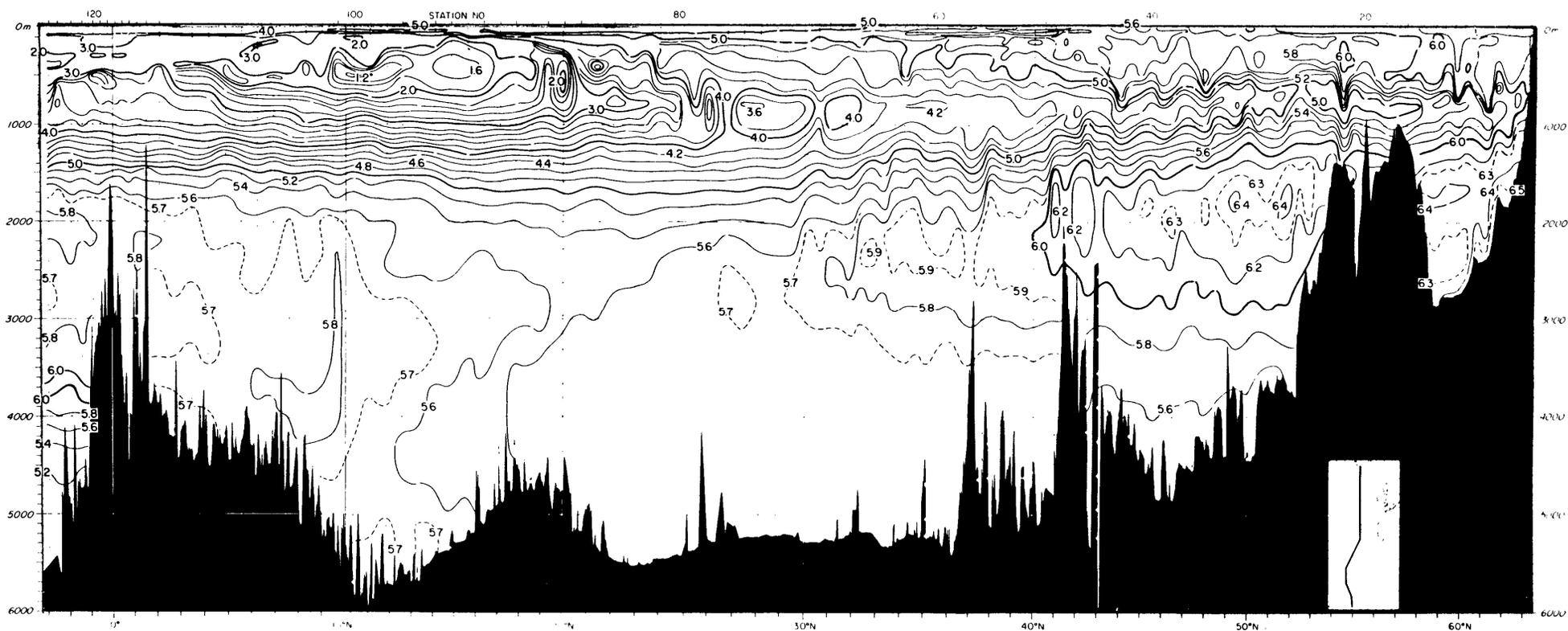
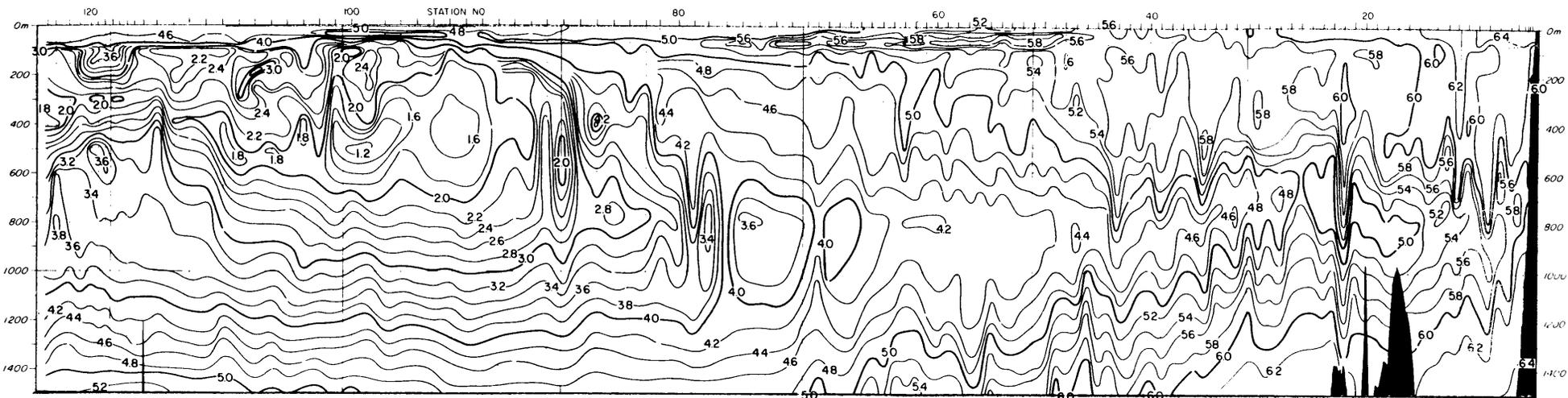


Potential Temperature

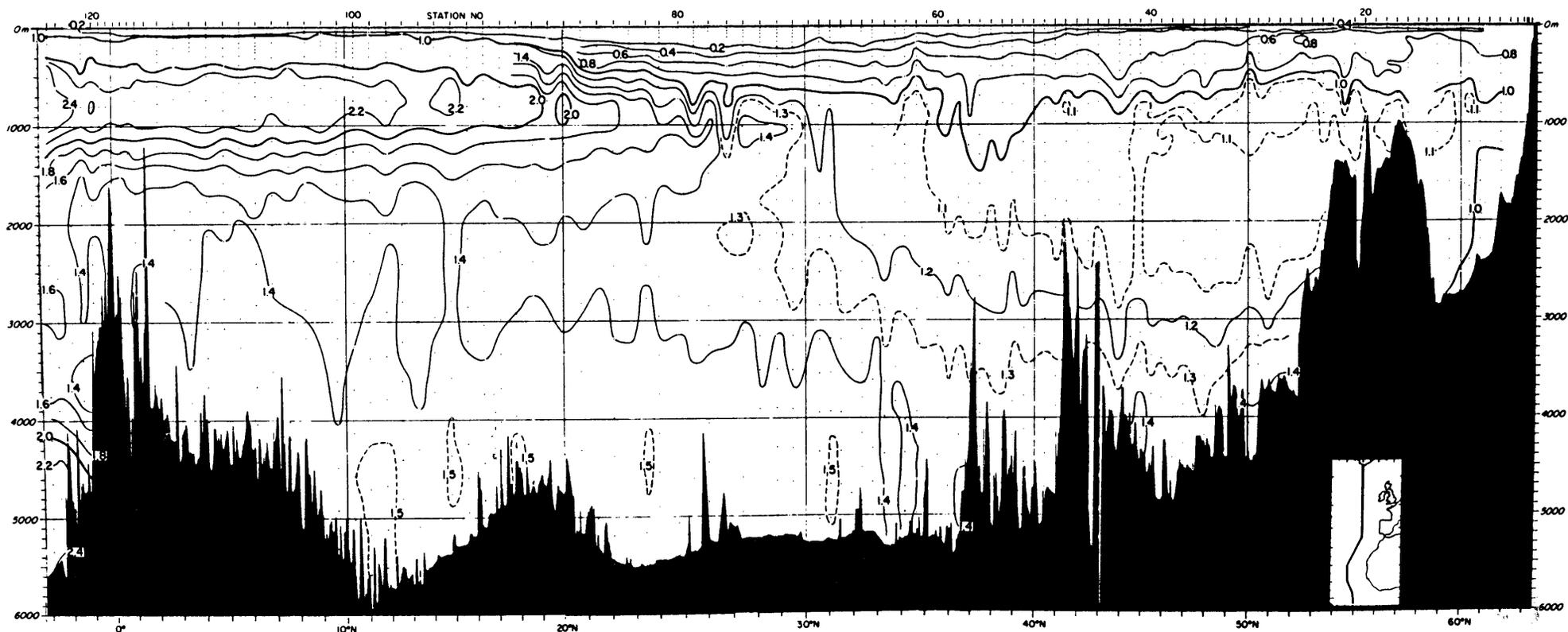
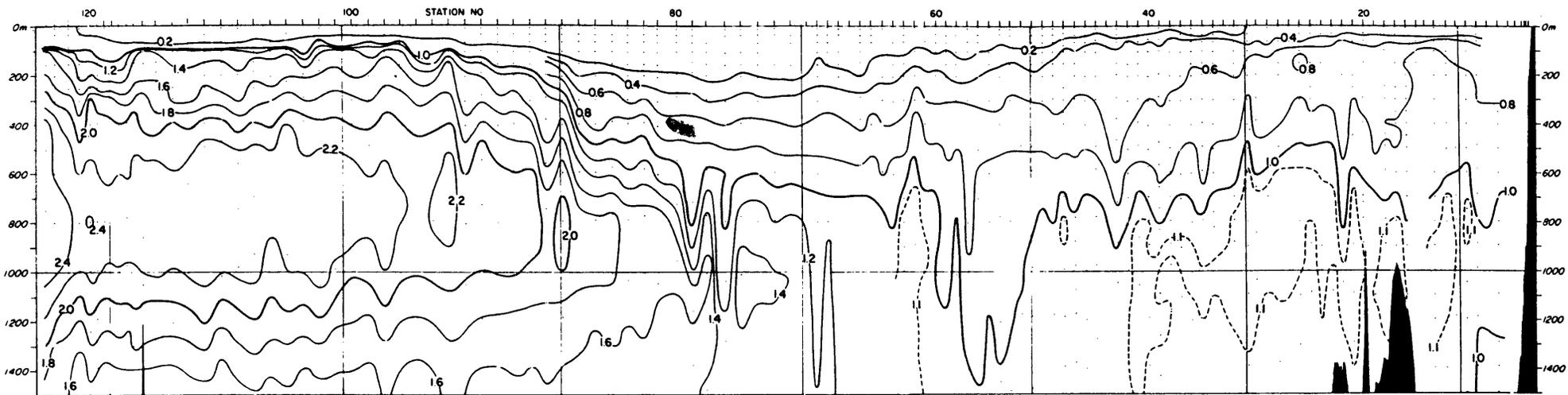


Salinity

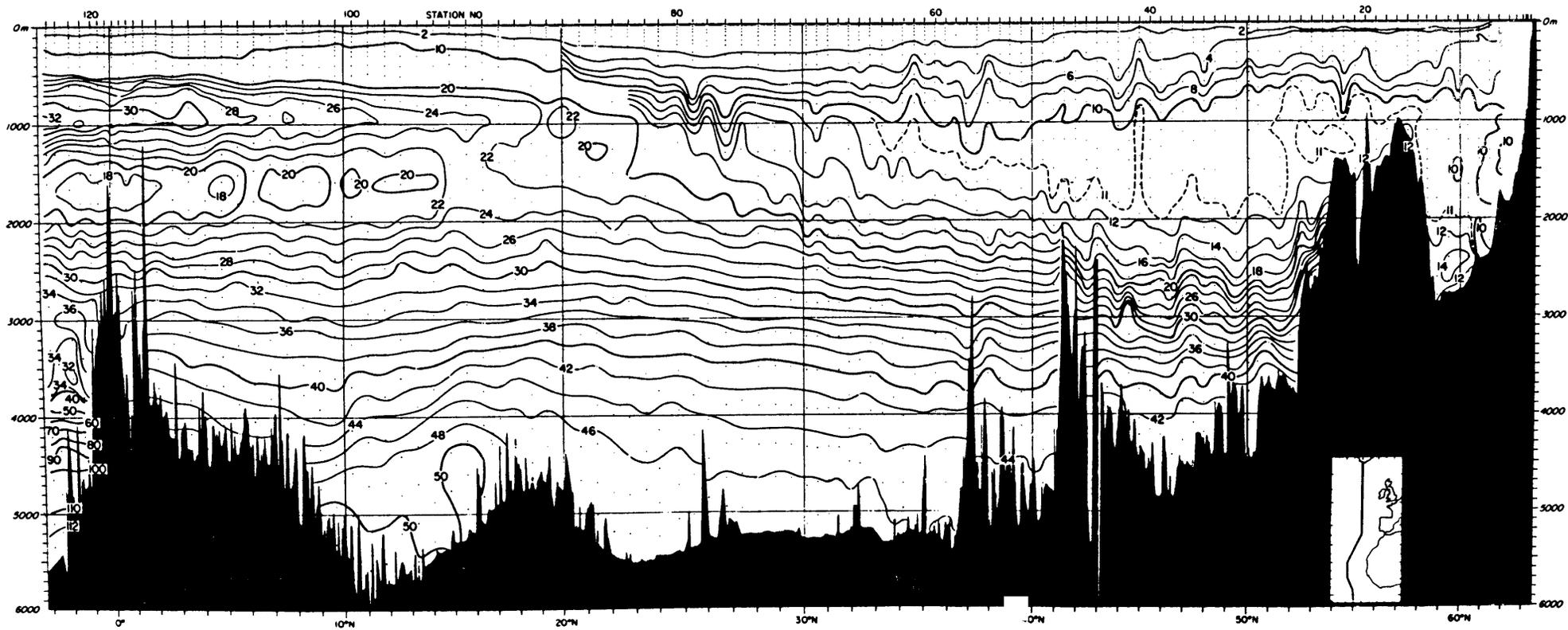
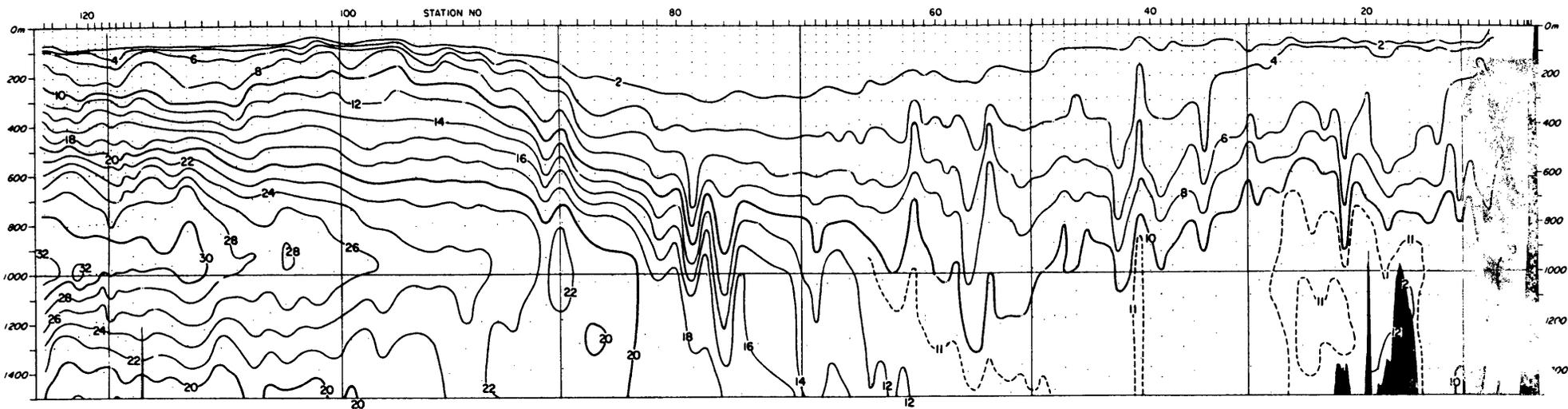




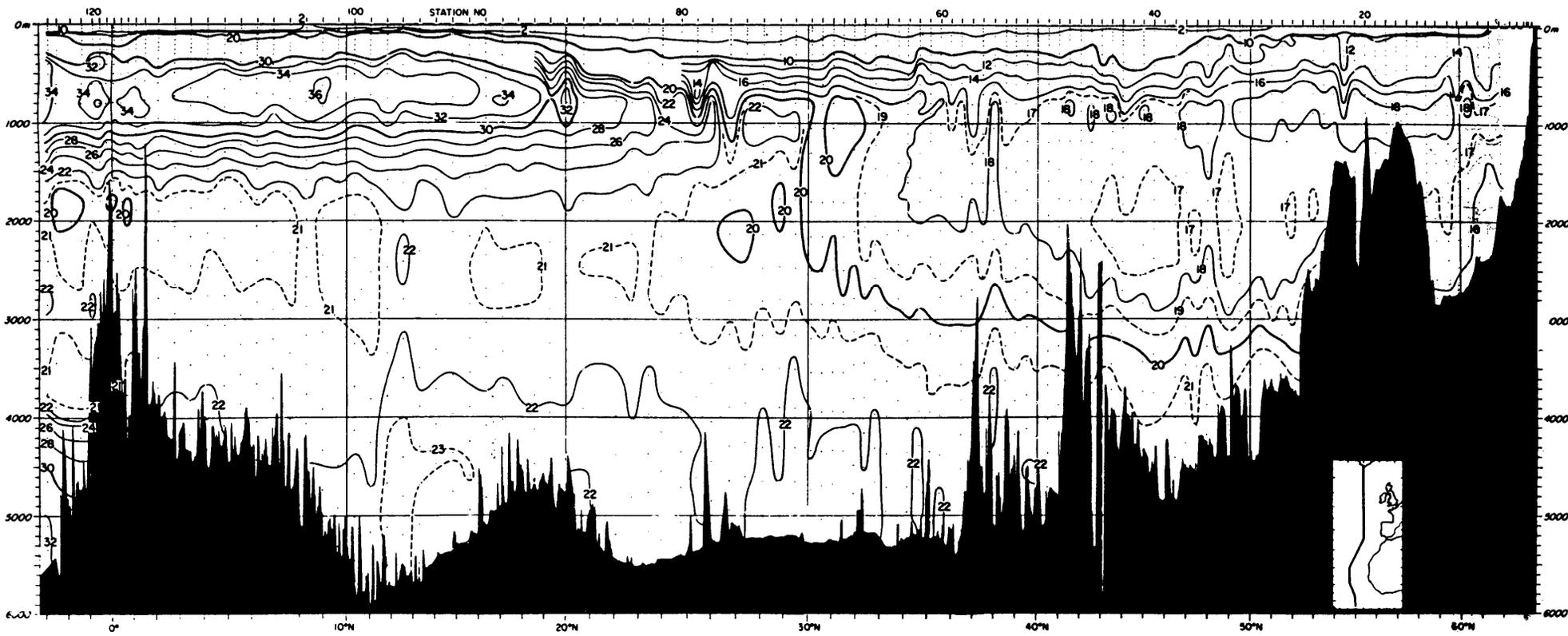
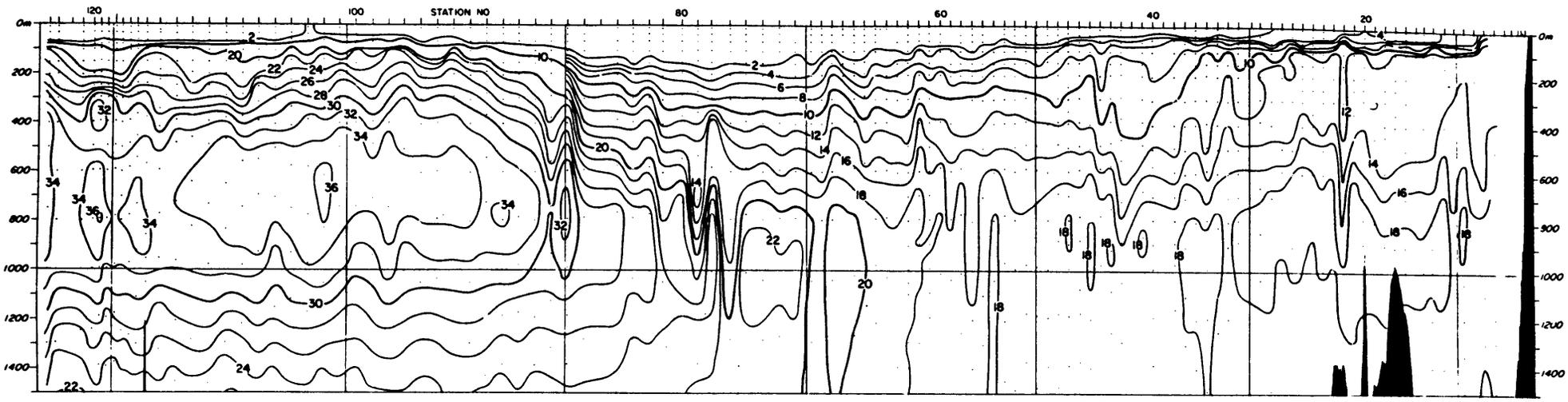
Oxygen



Phosphate



Silicate



Nitrate

## CTD Data Consistency Check

The WHP-Exchange format bottle and/or CTD data from this cruise have been examined by a computer application for contents and consistency. The parameters found for the files are listed, a check is made to see if all CTD files for this cruise contain the same CTD parameters, a check is made to see if there is a one-to-one correspondence between bottle station numbers and CTD station numbers, a check is made to see that pressures increase through each file for each station, and a check is made to locate multiple casts for the same station number in the bottle data. Results of those checks are reported in this '\_check.txt' file.

When both bottle and CTD data are available, the CTD salinity data (and, if available, CTD oxygen data) reported in the bottle data file are subtracted from the corresponding bottle data and the differences are plotted for the entire cruise. Those plots are not available for this cruise

Following parameters found for bottle file:

EXPCODE	DATE	CTDTMP	NITRAT
SECT_ID	TIME	CTDSAL	NITRIT
STNNBR	LATITUDE	SALNTY	PHSPHT
CASTNO	LONGITUDE	CTDOXY	CFC-11
SAMPNO	DEPTH	OXYGEN	CFC-11_FLAG_W
BTLNBR	CTDPRS	SILCAT	CFC-12
			CFC-12_FLAG_W

- All ctd parameters match the parameters in the reference station.
- Station #1 exists in a16n\_hy1.csv, but does not have a corresponding CTD file.
- No bottle pressure inversions found.
- Bottle file pressures are increasing.
- a16n\_hy1.csv contains stations with multiple casts:
  - station 61: 2 casts
  - station 62: 2 casts
  - station 63: 2 casts
  - station 65: 2 casts

## Data Processing Notes

Date	Contact	Data Type	Data Status Summary
04/16/99	Jenkins	He/Tr	Projected Submission Date 1999.09.15 (disk crashed; must reprocess)
06/16/99	Talley	DOC	Data Update; See note: I don't see the file anywhere. I had a subset of my 9-track tapes read off several years ago, but none of them have the A16 (MCTT) documentation and so I suspect it is on one of the existing 9- tracks, which we no longer can read since there is no equipment here to do it. so it will have to be typed or scanned in. Lynne
02/14/00	Huynh	DOC	Doc Update; pdf, txt versions online
03/13/00	Sandborn	BTL	Update Needed; See note: Because of the problems that were found in the distribution of OCEANUS 202 on the WHPO site, I am proposing to send John Bullister the data transmittal file that ODF has in it's archives. I have reformatted the file to be similar to the WHP format. Differences are: <ul style="list-style-type: none"> <li>• CTDTMP ODF file is to 3 decimal places</li> <li>• THETA ODF file is to 3 decimal places</li> <li>• SALNTY ODF file is to 3 decimal place</li> <li>• QUALTI ODF file has no coding</li> </ul> I believe my solution will assist John and not hold up his data submission. I had reviewed the WHPO data file with ODF data file and was at a point that I could easily have added the bottle numbers. I opted not to do that because of the pressure differences. If it is not a problem that the temperature and salinity are reported to thousandths and someone at WHPO must add the data coding, then all is good. I tried to download the "raw" data files and create a WHP format report. Unfortunately, some of the archive tapes were unreadable. Listed below are problems that I found in the WHPO file: <ol style="list-style-type: none"> <li>1 The pressures in the WHPO file are off by ~5db at ~4000db. The pressures are also reported to tenths, the current transmittal file reports the pressure to whole values. &gt;&gt; I was able to cut and paste in the pressures to tenths from an ODF file.</li> <li>2 Theta is calculated to 4 decimal places. ODF's current file is to 3 decimal places.</li> <li>3 The oxygen and nutrients do not match ODF files. It appears that WHPO converted liter units to kilograms and this accounts for the difference.</li> <li>4 There are added levels, one at the bottom evidently from the CTD data. Some stations have extra levels also appears to be from the CTD that are not in ODF's current data set. &gt;&gt;I was able to add these extra levels from an ODF file.</li> <li>5 The WHPO file has lost part of Station 122 and all of Stations 123-129. &gt;&gt; These are in the file sent to John.</li> <li>6 It appears that the data on the WHPO was from an older distribution of the data. Fortunately, it appears that there were no major changes in the data that is archived by ODF other than the added levels. Unfortunately, the conversion from depth to pressure was done incorrectly and the conversion from liters to kilograms resulted in differences. This conversion resulted in data that was reasonable unlike pressure.</li> </ol>

## Data Processing Notes

Date	Contact	Data Type	Data Status Summary
04/20/00	Bullister	CFCs	Submitted along with CFC DOC file
05/22/00	Huynh	DOC	Online, CFC report added to pdf & txt docs
08/07/00	Bullister	CFCs	Data are Public
			I was the CFC PI on A16N and sent the data to the WHPO in April 2000. The data should have been made publicly available, but have not been so far.
08/09/00	Bartolacci	CFCs	Data Reformatted; See note:
			file submitted by K. Sanborn was edited to conform to WOCE format and had CFC columns added to the file by gen_dummy_cfc.pl to aid in merging incoming CFCs. This edited file called a16nhy_new.txt.
08/10/00	Anderson	BTL	Website Updated; see merge notes:
			<p>Merging process started jointly between DMB and SRA. Merging completed by SRA.</p> <ul style="list-style-type: none"> <li>• A16Ncfc.dat - removed first four lines of data. Edited file called A16Ncfc_edt.dat</li> <li>• A16Ncfc_edt.dat - Swapped columns 2 (samp) and 3 (cast) for mrgsea to merge data. Removed cast number "2" from sample numbers (e.g. sample #01 was called 201, not same nomenclature as hyd file) on stations 11, 61, 62, 63, 65 (all cast 2).</li> </ul> <p>2000.10.14 SRA</p> <ul style="list-style-type: none"> <li>• a16nhy_rplcd_2000.08.15.txt - this is outdated working bottle data file. Moved original dir and replace with current bottle data file containing CFCs.</li> </ul> <p>2000.08.15 SRA</p> <p>***Ran ~danie/tools/wocecvt on updated bottle file. (2000.08.15 SRA)</p> <p>***NOTE: SANBORN bottle data file and CFC data file both had data for station 11 cast 02, but WHOI .sum file only listed station 11 cast 01 (no cast 02). Will leave as is and document.</p> <p>2000.08.15 SRA</p> <p>a16nhy_new.txt - new bottle file obtained from:          ../original/FROM_STS_2000.03.13_SANBORN</p>
08/15/00	Bartolacci	BTL/SUM	cast discrepancy, station 11, See note:
			<p>Please note, cast discrepancy between sumfile and new odf bottle file for station 11. Sumfile has station 11, cast 1 while bottle file and CFC file has station 11 cast 2. All merging notes are in original subdirectory under:</p> <p style="text-align: center;">2000.04.20_A16N_CFC_BULLISTER</p>
08/15/00	Anfuso	CFCs	Website Updated; CFC 11 & 12 merged
			into new BTL file Merged CFC11 and CFC12 into new ODF version of bottle file. Note: Quality flags are for CFC11 and CFC12.

## Data Processing Notes

Date	Contact	Data Type	Data Status Summary
11/03/00	Bartolacci	SUM	Reformatted SUM file online
			<p>The current online sumfile has been replaced with the newly reformatted sumfile, completed by S. Anderson on 2000.11.03.</p> <p>The following changes were made as per the notes.a16n readme accompanying the file:</p> <ul style="list-style-type: none"> <li>• Reformatted to conform with the accepted WHPO format.</li> <li>• Latitude and longitude minutes were xx.x changed to xx.x0.</li> <li>• Station 11 - .sum had cast 1, .hyd had cast 2. Changed .sum to cast 2 per data report (SIO ref. 91-16).</li> </ul> <p>All references have been updated to reflect this change.</p>
06/20/01	Uribe	BTL	Website Updated
			file in exchange format has been linked to website.
06/21/01	Uribe	CTD/BTL	CTD EXCHANGE File Added to website
			BTL EXCHANGE file modified The exchange bottle file name in directory and index file was modified to lower case. CTD exchange files were put online.
08/27/01	Swift	He/Tr	Data requested by
			WHPO records indicate he/tr data not yet submitted. Request for earliest possible submission sent to Bill Jenkins.
12/20/01	Hajrasuliha	CTD	Internal DQE completed
			Created *check.pl for this cruise. No *.ps files created for this cruise.
12/20/01	Uribe	CTD	Website Updated; EXCHANGE File Added
			CTD has been converted to exchange using the new code and put online. Sumfile has a station 11 cast 2 and CTDs have a file for a station 11 cast 1 only. For this reason and for the purpose of the conversion, the 2 was made a 1 to allow for the code to work.
08/27/03	Bullister	CTD/SUM/BTL/DOC	Permission given to post data on Web site
			You have my permission to obtain the data from Frank and post them at the website. You should include the caveats that these data are the raw shipboard version, are still preliminary and will be updated.
08/29/03	Coartney	DOC	Website Updated; New text doc online
04/30/04	Kappa	DOC	PDF and TEXT Cruise Reports Updated
			<ul style="list-style-type: none"> <li>• Added cruise summary pages</li> <li>• Added SIO-generated station plot</li> <li>• Added SIO-generated CTD Data Consistency Check</li> <li>• Added these Data Processing Notes to PDF and TEXT reports</li> </ul>