WHP Cruise Summary Information

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

WHP Cruise and Data Information

Instructions: Click on items below to locate primary reference(s) or use navigation tools above.

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
	Salinity
	Oxygen
	Nutrients
	CFCs
Cruise Participants	
Problems and goals not achieved	
Other incidents of note	
	Acknowledgments
	References
	Data Status Notes

WOCE HYDROGRAPHIC PROGRAMME OFFICE

Cruise Report A16N
Expocode: 320C202/1
R/V Oceanus 202

NOTE: The following is excerpted. For full text and figures, please refer to the published report, SIO Reference 91-16 (May 1991)

Physical, Chemical, and CTD Data
23 July - 1 September 1988
R/V Oceanus

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SIO Reference 91-16 ODF Publication No. 229

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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 63º19.7'N, 19º59.9'W to a depth of 195 meters. The first leg ended at Station 65 on August 6, 1988 at 33º18'N, 21º37'W. After a brief port stop in Funchal, Madeira, work resumed with a reoccupation of Station 65 (at 32º51'N, 21º20'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 the 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 50ºN), 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)Is/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_3 NO_2 PO_4 and SiO_3 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 Autosal 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 Autosal 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 this 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 $Mn(OH)_2$ 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 mount 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 KIO_3 is the ultimate limitation on the accuracy of this methodology. The assay of the finest quality KIO_3 available to ODF is 100%, ±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 ±0.1 to 0.2%. The overall accuracy of the data is estimated to be ±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.

Case	Phosphate	Nitrate+Nitrite	Silicic Acid	Nitrite	DF
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, 0.002ºC, 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 0.2/0.5ºC to a maximum of 8830 psi, and at 28.5/28.1ºC 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 5ºC.

The CTD PRT temperature transducer was calibrated pre- and post-cruise in a temperature controlled bath with a NBLS 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 31ºC 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 ±3dbar, 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 +0.0035ºC shift for PRT #1. and an average +0.0030ºC 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. Bemuse there was far less scatter in the pre-cruise results, the pre-cruise calibration coefficients were used, plus an additional +0.002ºC offset to balance out the pre-/post-cruise difference.

While the PRT laboratory calibration is thought to be accurate to within ±0.001ºC 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 ±0.002ºC.

3.4. CTD Conductivity Corrections

Check-sample conductivities were calculated from the battle 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:

newC = oldC – 6.34e-6*pressure + (Coffset 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 Θ-S relationship from station to station.

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

	mean conductivity difference (btl-CTD)	standard deviation	# values in mean
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_2 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_2 response. Oxygen partial pressure is then calculated taking into account the dissolved O_2 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_2 conversion, and the offset of O_2 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 miring 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 crime, 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 shies 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 O2 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_2 SAT, (Weiss, 1970), SIO_3, PO_4, NO_3, and NO_2 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^3 referenced to pressure=0, from which 1000 has been subtracted. Potential temperature, θ, (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, tormally (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

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 σ_θ is contoured on the 0-1500 meter panel, while σ_2 is contoured from 0-3000 meters and σ_4 is contoured from 3000-6000 meters on the full-depth panel. The oxygen, silica, nitrate and phosphate sections are band on discrete data; the CTD profiles were used to resolve some difficulties in contouring oxygen.

5. ACKNOWLEDGEMENTS

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A16N (OC202) CHLOROFLUOROCARBON ANALYSIS METHODS

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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 anomolous CFC-11 and/or CFC-12 concentrations relative to adjacent samples. These anomolous 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 give 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. Replicate F-11 Samples

Station	Sample	F-11	Station	Sample	F-11
13	24	1.699	61	23	0.030
13	24	1.705	62	15	0.189
14	14	1.709	62	15	0.209
14	14	1.692	62	17	0.091
20	6	3.321	62	17	0.108
20	6	3.292	62	18	0.090
20	22	1.463	62	18	0.019
20	22	1.477	62	18	0.032
35	22	0.102	62	18	0.063
35	22	0.097	62	19	0.027
35	23	0.058	62	19	0.010
35	23	0.039	62	19	0.013
36	22	0.075	62	20	0.043
36	22	0.082	62	20	0.028
36	24	0.023	62	20	0.029
36	24	0.019	62	21	0.007
37	23	0.117	62	21	0.015
37	23	0.067	62	21	0.000
37	24	0.060	62	23	0.032
37	24	0.060	62	23	0.015
41	20	0.162	65	1	0.099
41	20	0.161	65	1	0.070
42	20	0.276	65	1	0.058
42	20	0.197	65	20	0.039
42	21	0.264	65	20	0.007
42	21	0.278	65	21	0.017
42	22	0.094	65	21	0.071
42	22	0.138	65	21	0.003
43	22	0.119	65	22	0.017
43	22	0.098	65	22	0.013

Station	Sample	F-11	Station	Sample	F-11
43	22	0.084	65	22	0.038
43	23	0.058	65	23	0.040
43	23	0.055	65	23	0.043
43	24	0.055	65	23	0.097
43	24	0.096	65	24	0.046
47	22	0.191	65	24	0.077
47	22	0.168	65	24	0.027
47	23	0.173	69	20	0.026
47	23	0.171	69	20	0.001
47	23	0.166	69	21	0.007
49	4	2.654	69	21	-0.002
49	4	2.771	69	22	0.011
50	6	2.694	69	22	-0.032
50	6	2.625	69	23	0.010
50	24	0.047	69	23	-0.022
50	24	0.040	69	24	-0.006
50	24	0.033	69	24	-0.030
51	22	0.028	72	1	2.036
51	22	0.040	72	1	1.984
55	21	0.033	72	2	2.080
55	21	0.029	72	2	1.995
55	23	0.045	72	3	2.170
55	23	0.061	72	3	2.228
55	24	0.059	72	4	2.124
55	24	0.038	72	4	2.264
59	2	2.445	72	5	2.252
59	2	2.409	72	5	2.263
61	20	0.023	124	19	0.011
61	20	0.062	124	19	0.018
61	20	0.001	124	24	-0.013
61	21	0.000	124	24	0.010
61	21	0.011	125	21	0.023
61	21	0.002	125	21	0.017
61	22	0.035	127	14	-0.018
61	22	0.020	127	14	-0.018
61	23	0.040			

Table 1b. Replicate F-12 Samples

Station	Sample	F-12	Station	Sample	F-12
13	24	0.724	61	21	-0.001
13	24	0.719	61	21	0.007
14	14	0.747	61	21	0.007
14	14	0.816	61	22	0.011
20	6	1.540	61	22	0.003

Station	Sample	F-12	Station	Sample	F-12
20	6	1.551	61	22	0.003
20	22	0.681	61	23	-0.001
20	22	0.801	61	23	0.003
35	22	0.023	61	23	0.007
35	22	0.026	62	15	0.072
35	23	0.031	62	15	0.101
35	23	0.036	62	17	0.026
36	22	0.011	62	17	0.023
36	22	0.021	62	18	0.037
36	23	0.024	62	18	0.028
36	23	0.011	62	18	0.023
36	24	0.043	62	18	0.033
36	24	0.007	62	19	0.003
36	24	0.014	62	19	0.007
36	24	0.025	62	19	0.003
37	22	0.027	62	20	0.007
37	22	0.018	62	20	0.010
37	23	0.022	62	20	0.007
37	23	0.011	62	21	0.003
37	24	0.025	62	21	0.006
37	24	0.020	62	21	0.007
37	24	0.019	62	22	0.006
38	23	0.052	62	22	0.014
38	23	0.046	62	23	0.007
41	20	0.059	62	23	0.003
41	20	0.071	62	24	0.011
41	22	0.033	62	24	0.003
41	22	0.049	65	1	0.017
42	20	0.122	65	1	0.006
42	20	0.142	65	1	-0.001
42	21	0.090	65	20	0.003
42	21	0.110	65	20	0.007
42	22	0.057	65	20	0.016
42	22	0.047	65	21	0.006
43	22	0.032	65	21	-0.001
43	22	0.035	65	21	0.006
43	22	0.028	65	22	0.003
43	23	0.025	65	22	0.003
43	23	0.011	65	22	0.007
47	22	0.103	65	23	-0.001
47	22	0.088	65	23	0.007
47	23	0.080	65	23	0.006
47	23	0.079	65	24	0.010
47	23	0.093	65	24	0.010
49	4	1.277	65	24	0.017

Station	Sample	F-12	Station	Sample	F-12
49	4	1.320	69	20	-0.001
50	6	1.241	69	20	0.002
50	6	1.246	69	21	0.002
50	24	0.023	69	21	0.002
50	24	0.043	69	22	0.002
50	24	0.020	69	22	0.002
51	22	0.003	69	23	-0.001
51	22	0.007	69	23	-0.001
51	23	-0.001	69	24	0.002
51	23	0.003	69	24	-0.001
53	23	0.003	72	1	0.974
53	23	0.003	72	1	0.959
55	20	0.022	72	2	0.947
55	20	0.017	72	2	0.963
55	21	0.027	72	3	1.039
55	21	0.027	72	3	1.065
55	21	0.026	72	4	1.009
55	22	0.035	72	4	1.087
55	22	0.027	72	5	1.072
55	22	0.040	72	5	1.072
55	23	0.024	124	19	0.008
55	23	0.035	124	19	0.012
55	23	0.023	124	20	0.005
55	24	0.007	124	20	0.002
55	24	0.014	124	21	0.005
55	24	0.021	124	21	0.002
59	2	1.145	124	22	-0.001
59	2	1.129	124	22	0.005
59	21	0.014	124	24	0.002
59	21	0.020	124	24	0.005
59	24	0.011	125	21	0.011
59	24	0.003	125	21	0.008
61	20	-0.001	127	14	0.017
61	20	0.003	127	14	0.017
61	20	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

DATE	TIME (hhmm)	LATITUDE	LONGITUDE	F11 PPT	F12 PPT
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 values (interpolated to station locations)

STATION NUMBER	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

STATION NUMBER	LATITUDE	LONGITUDE	DATE	F11 PPT	F12 PPT
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
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

STATION NUMBER	LATITUDE	LONGITUDE	DATE	F11 PPT	F12 PPT
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
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: lost signal/gaps, down and up 13 levels (1916 of data) missing 6 single levels interpolated: 1298, 1306, 1318, 1344, 1542, 2430 dbars 2 multiple levels interpolated: 1550 thru 1552 dbars (2 consecutive levels) 1568 thru. 1576 dbars (5 consecutive levels)
11	2	new end termination prior to aborted cast 1; data begins after in water (6 dbars); signal dropouts down from 1330 dbars, major signal dropouts below 2000 dbars down and up; no bottles above 500 dbars 71 levels (5% of data) missing 3 single levels interpolated: 2106,2438, 2700 dbars 10 multiple levels extrapolated/interpolated- 0 thru 2 dbars (2 consecutive levels) 686 thru 690 dbars (3 consecutive levels) 1342 thru, 1344 dbars (2 consecutive levels) 1348 thru. 1362 dbars (8 consecutive levels) 1366 thru. 1374 dbars (5 consecutive levels) 1828 thru. 1940 dbars (7 consecutive levels) 1982 thru, 2028 dbars (24 consecutive levels) 2034 thru. 2044 dbars (6 consecutive levels) 2082 thru 2094 dbars (7 consecutive levels) 2114 thru, 2116 dbars (2 consecutive levels) 2694 thru 2696 dbars (2 consecutive levels)
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
22	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
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	
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 battles above 1180 dbars; unusual low CTD oxygen area 1450-2750 dbars
61	2	

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
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
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	

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
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: 2318 thru 2424 dbars (54 consecutive levels) 2760 thru. 2762 dbars (2 consecutive levels) 3410 thru. 3412 dbars (2 consecutive levels) 3498 thru. 3506 dbars (5 consecutive levels) 3510 thru 3514 dbars (3 consecutive levels) 3520 thru, 3522 dbars (2 consecutive levels) 3880 thru 3882 dbars (2 consecutive levels)
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
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	I	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 Δ-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 Δ-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 Δ-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 Δ-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.

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 Δ-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 Δ-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.

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

Station 026

123 Δ-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 Δ-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.

Station 040

101 Sample log: Leaked when rosette was brought out of water. Salinity was not drawn @5db; oxygen is reasonable.

107 Δ-S @510db is -.0199. Salt bottle #3049. Suspect drawing error. Delete bottle salinity (35.408).

124 Δ-S @4610db is .0037. Salt bottle #3078. Suspect analysis error. Delete bottle salinity (34.913).

Station 041

107 Δ-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). Δ-S @ 1269db is .0058. Delete bottle salinity (35.161).

121 Δ-S @3204db is .0040. Salinity: Leaker - salt bottle #3526. Delete bottle salinity (34.941).

Station 048

120 Δ-S @1810db is .0044. 34.993; salt bottle #3398. Delete bottle salinity.

121 Δ-S @2015db is .0044. Salinity was 34.983; salt bottle #3908. Delete bottle salinity.

124 Δ-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 Δ-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).

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.

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 Δ-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 Δ-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.

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

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

Station 090

103 Δ-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.

Station 094

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

Station 100

112 Δ-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 Δ-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 Δ-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.

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 Δ-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.

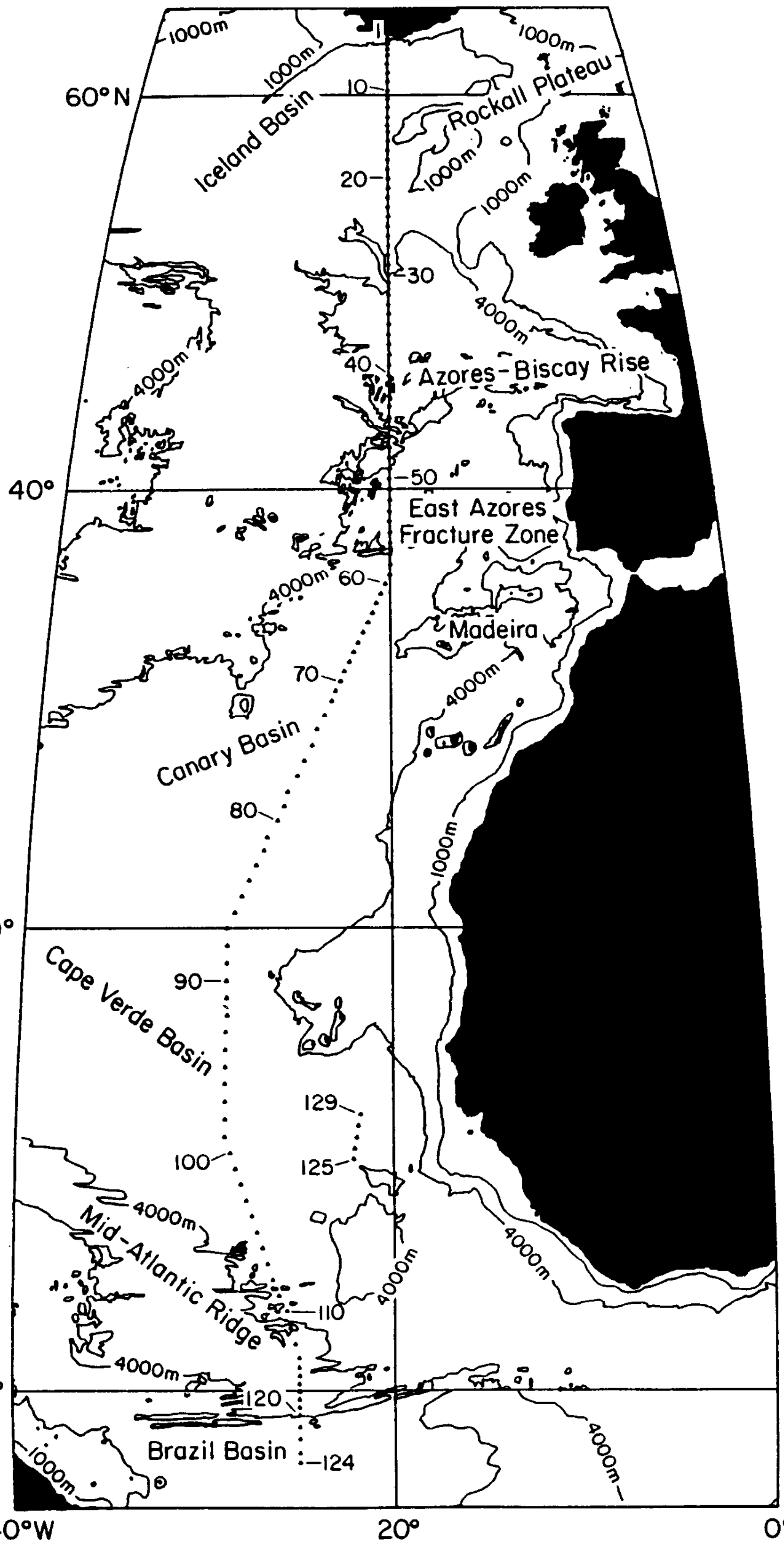
Station 127

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



OCEANUS 202 (McTT) R/V OCEANUS 11 JUL- 1 SEP 1988

Station/ cast	Date	Time gmt	Latitude	Longitude	Ocean Depth	Maximum Sampling Depth	DAB M	Comments	Samples
1/01	23 Jul 88	2118	63º 19.8'N	019º 59.9'W	199	194		*	*F
2/01	23 Jul 88	2301	63º 12.6'N	020º 00.3'W	621	627	5	* 16 bottles	*F
3/01	24 Jul 88	0056	63º 08.0'N	020º 00.4'W	927	940	7	* 23 bottles	*
4/01	24 Jul 88	0321	62º 59.3'N	020º 00.7'W	1237	1231	7	*	*F,H,Tr
5/01	24 Jul 88	0620	62º 40.3'N	019º 59.9'W	1481	1480	5	*	*
6/01	24 Jul 88	0935	62º 19.8'N	020º 00.1'W	1909	1809	7	* 17 bottles	*F
7/01	24 Jul 88	1409	61º 49.6'N	020º 01.3'W	1769	1710	10	*	*
8/01	24 Jul 88	1825	61º 19.6'N	020º 00.8'W	2350	2345	12	* 23 bottles	*F
9/01	24 Jul 88	2257	60º 49.5'N	019º 58.9'W	2361	2354	8	* 21 bottles	*
10/01	25 Jul 88	0421	60º 19.6'N	019º 59.9'W	2619	2610	15	*	*F
11/01	25 Jul 88	0820	59º 50.2'N	019º 59.6'W				* ABORTED	*
11/02	25 Jul 88	1042	59º 50.6'N	019º 59.2'W	2730	2721	18	*	*F
12/01	25 Jul 88	1903	59º 23.6'N	019º 59.2'W	2765	2760	10	*	*F
13/01	26 Jul 88	0052	59º 49.4'N	020º 00.8'W	2866	2866	5	*	*F,H,Tr
14/01	26 Jul 88	0538	58º 22.5'N	020º 00.8'W	2163	2160	8	*	*F
15/01	26 Jul 88	0932	57º 59.6'N	020º 00.8'W	1660	1659	5	* 21 bottles	*F
16/01	26 Jul 88	1347	57º 29.5'N	020º 00.6'W	1158	1163	10	* 19 bottles	*
17/01	26 Jul 88	1758	56º 59.2'N	020º 01.2'W	982	977	10	* 17 bottles	*F
18/01	27 Jul 88	0054	56º 29.2'N	020º 01.2'W	1366	1363	5	* 21 bottles	*
19/01	27 Jul 88	0513	55º 59.3'N	020º 01.8'W	1415	1456	10	* 22 bottles	*
20/01	27 Jul 88	0929	55º 29.3'N	020º 00.6'W	1251	1243	10	* 21 bottles	*F,H,Tr
21/01	27 Jul 88	1408	54º 59.1'N	019º 59.8'W		1640		* 23 bottles	*
22/01	27 Jul 88	1850	54º 29.2'N	020º 00.8'W	1380	1381	5	* 20 bottles	*F
23/01	27 Jul 88	2248	53º 59.0'N	020º 00.8'W	1443	1421	10	* 19 bottles	*F
24/01	28 Jul 88	0320	53º 30.0'N	020º 00.6'W	2285	2283	10	*	*
25/01	28 Jul 88	0750	52º 59.1'N	020º 01.1'W	2695	2700	5	*	*F
26/01	28 Jul 88	1150	52º 29.1'N	020º 00.3'W	2813	2810	6	*	*F
27/01	28 Jul 88	1624	51º 59.1'N	019º 59.6'W	3727	3731	0	*	*F
28/01	28 Jul 88	2137	51º 29.2'N	020' 00.9'W	3638	3632	8	*	*F
29/01	29 Jul 88	0225	50º 58.9'N	019º 59.9'W	3633	3640	5	*	*F,H,Tr
30/01	29 Jul 88	0708	50º 28.4'N	020º 01.3'W	4039	4007	10	*	*
31/01	29 Jul 88	1149	50º 04.6'N	019º 59.4'W	4434	4430	10	*	*
32/01	29 Jul 88	1717	49º 28.1'N	020º 00.2'W	3790	3821	10	*	*
33/01	29 Jul 88	2222	48º 58.7'N	020º 00.7'W	4401	4391	21	*	*F
34/01	30 Jul 88	0303	48º 30.3'N	019º 59.6'W	4018	4028	10	*	*
35/01	30 Jul 88	0737	47º 59.8'N	020º 00.6'W	4347	4346		*	*F,Tr
36/01	30 Jul 88	1221	47º 29.2'N	020º 01.4'W	4551	4540		*	*
37/01	30 Jul 88	1716	46º 59.3'N	019º 59.4'W	4494	4519	10	*	*F
38/01	30 Jul 88	2229	46º 29.4'N	019º 58.4'W	4854	4840	10	*	*F,H,Tr
39/01	31 Jul 88	0546	45º 58.8'N	020º 00.2'W	4843	4834		*	*
40/01	31 Jul 88	1053	45º 29.1'N	020º 00.7'W	4530	4528	8	*(altimeter)	*
41/01	31 Jul 88	1600	44º 59.4'N	019º 59.7'W	4398	4355	9	*	*F,H,Tr
42/01	31 Jul 88	2123	44-º 29.6'N	019º 59.6'W	4213	4210	12	* 23 bottles	*F
43/01	01 Aug 88	0255	43º 59.8'N	019º 59.1'W	4029	4004	14	*	*F
44/01	01 Aug 88	0729	43º 29.7'N	020º 02.5'W	3958	3993	11	*	*F,H,Tr
45/01	01 Aug 88	1229	43º 00.1'N	020º 01.4'W	5163	5248	10	*	*
46/01	01 Aug 88	1712	42º 30.7'N	020º 00.7'W	4177	4186		*	*
47/01	01 Aug 88	2138	42º 00.8'N	020º 00.5'W	2649	2690	15	*	*F,Tr
48/01	02 Aug 88	0142	41º 29.9'N	020º 01.3'W	2514	2508	11	*	*

OCEANUS 202 (McTT) R/V OCEANUS 11 JUL- 1 SEP 1988

Station/ cast	Date	Time gmt	Latitude	Longitude	Ocean Depth	Maximum Sampling Depth	DAB M	Comments	Samples
49/01	02 Aug 88	0620	41º 00.8'N	019º 59.6'W	4691	4687	10	*	*F
50/01	02 Aug 88	1206	41º 30.9'N	020º 01.8'W	4870	4948	10	*	*F,Tr
51/01	02 Aug 88	1654	40º 01.1'N	019º 59.7'W	4655	4777	12	*(altimeter)	*F,Tr
52/01	02 Aug 88	2228	39º 31.1'N	020º 00.6'W	4593	4630	9	*	*F
53/01	03 Aug 88	0451	38º 59.5'N	020º 00.8'W	4731	4712	10	*	*F,Tr
54/01	03 Aug 88	1127	38º 31.6'N	020º 02.3'W	4444	4488	11	*	*
55/01	03 Aug 88	1654	38º 01.1'N	019º 59.1'W	5149	5136	10	*	*F
56/01	03 Aug 88	2158	37º 30.0'N	020º 00.3'W	4812	4824	10	*	*F,Tr
57/01	04 Aug 88	0231	37º 00.2'N	020º 00.4'W	3741	3766	10	*	*
58/01	04 Aug 88	0710	36º 29.7'N	020º 00.4'W	5169	5156	10	*	*F
59/01	04 Aug 88	1156	36º 00.3'N	020º 01.4'W	5267	5318	9	*	*F,Tr
60/01	04 Aug 88	1650	35º 34.9'N	020º 16.8'W	5252	5250	9	*	*
61/01	04 Aug 88	2300	35º 06.0'N	020º 33.4'W	5226	5217	10	*	*F
61/02	05 Aug 88	2023	35º 05.8'N	020º 32.1'W		1193		*formerly cast 11	*
62/01	05 Aug 88	0515	34º 40.4'N	020º 48.6'W	5154	5154	10	*	*Tr
62/02	05 Aug 88	2353	34º 39.3'N	020º 48.7'W		1186		*formerly cast 11	*
63/01	05 Aug 88	1109	34º 12.8'N	020º 03.9'W	5231	5227	10	*	*
63/02	06 Aug 88	0342	34º 12.9'N	021º 04.4'W		1895		*formerly cast 11	*
64/01	06 Aug 88	0807	33º 45.8'N	021º 18.9'W	5097	5109	12	*	*F,Tr
65/01	06 Aug 88	1256	33º 19.3'N	021º 36.4'W	5304	5297	8	*	*
65/02	11 Aug 88	0415	32º 51.0'N	021º 19.9'W		1978		*formerly cast 11	*
66/01	11 Aug 88	0823	32º 49.9'N	021º 52.6'W	5247	5246	8	*	*
67/01	11 Aug 88	1305	32º 23.4'N	022º 08.5'W	5185	5179	9	*	*F,Tr
68/01	11 Aug 88	1755	31º 56.9'N	022º 23.8'W	5158	5161	8	*	*
69/01	12 Aug 88	0004	31º 30.0'N	022º 41.7'W	5252	5247	8	*	*F
70/01	12 Aug 88	0458	31º 03.0'N	022º 54.9'W	5262	5250	8	*	*H,Tr
71/01	12 Aug 88	0956	30º 36.1'N	023º 10.4'W	5292	5294	8	*	*
72/01	12 Aug 88	1437	30º 09.1'N	023º 24.7'W	5292	5283	9	*	*
73/01	12 Aug 88	2027	29º 29.1'N	023º 48.0'W	5215	5217	10	*	*F,H,Tr
74/01	13 Aug 88	0218	28º 50.7'N	024º 13.0'W	5215	5217	8	*	*
75/01	13 Aug 88	0821	28º 07.2'N	024º 30.7'W	5225	5224	10	*	*
76/01	13 Aug 88	1415	27º 25.1'N	024º 55.5'W	5236	5234	8	*	*
77/01	13 Aug 88	1954	26º 44.9'N	025º 16.5'W	5153	5168	9	*	*F,H,Tr
78/01	14 Aug 88	0141	26º 02.1'N	025º 49.5'W	5246	5272	8	*	*SF6
79/01	14 Aug 88	0727	25º 23.4'N	026º 00.2'W	5359	5359	9	*	*
80/01	14 Aug 88	1307	24º 43.9'N	026º 21.1'W	5406	5404	8	*	*
81/01	14 Aug 88	1850	24º 00.2'N	026º 54.7'W	5448	5444	9	*	*Tr
82/01	15 Aug 88	0048	23º 23.8'N	027º 05.5'W	5501	5501	8	*	*
83/01	15 Aug 88	0654	22º 43.6'N	027º 28.6'W	5516	5511	9	*	*
84/01	15 Aug 88	1254	22º 04.3'N	027º 51.1'W	5449	5450	8	*	*
85/01	15 Aug 88	1848	21º 22.7'N	028º 14.8'W	5190	5289	8	*	*F,H,Tr
86/01	16 Aug 88	0057	20º 41.0'N	028º 36.7'W	5165	5166	8	*	*F
87/01	16 Aug 88	0646	20º 00.4'N	029º 00.9'W	4794	4790	8	*	*
88/01	16 Aug 88	1231	19º 15.4'N	029º 00.2'W	4517	4524	8	*	*
89/01	16 Aug 88	1845	18º 30.7'N	029º 00.6'W	4671	4659	9	*	*H,Tr
90/01	17 Aug 88	0038	17' 44.9'N	029º 00.5'W		4408	9	*	*
91/01	17 Aug 88	0622	17º 01.0'N	028º 59.9'W	4871	4867	8	*	*
92/01	17 Aug 88	1214	16º 15.3'N	028º 56.7'W	5108	5103	8	*	*
93/01	17 Aug 88	1800	15º 30.7'N	029º 00.3'W	5252	5249	9	*	*H,Tr

OCEANUS 202 (McTT) R/V OCEANUS 11 JUL- 1 SEP 1988

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

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

F -freon
Tr -tritium
H -helium

List of Participants

Ship's Captain:	Paul Howland	Woods Hole Oceanographic Institution
Chief Scientist:	Michael McCartney	Woods Hole Oceanographic Institution

Co-Chief Scientist 23 July - 9 August 1988:

	Lynne Talley	Scripps Institution of Oceanography

Co-chief Scientist 9 August - 1 September 1988:

	Mizuki Tsuchiya	Scripps Institution of Oceanography

Oregon State University:
Joe Jennings
Lee Goodell
Kean Stump

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Frank M. Delahoyde
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Ronald G. Patrick
Robert T. Williams

Scripps Institution of Oceanography:
Frederick Bingham
Nancy Collins

Woods Hole Oceanographic Institution:
John Bullister
Ruth Curry
Scott Doney
Chris Johnston

318MHYDR4
A16c (HYDROS 4, pre-WOCE)
Talley/Tsuchiya

318MSAVE5
A16 (HYDROS3, SAVE5, pre-WOCE)
Smethie/McCartney

32OC202-1
A16 (MCTT - N. Atlantic, pre-WOCE)
McCartney/Talley/Tsuchiya

Data status: public. CTD data do not seem to be available in WHP format except for 32OC202-1, although they are all available at NODC

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sum: no errors for all three

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hyd: no need to sort since Gerard casts are not included
no CFC's, tritium or helium included