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1. Introduction

The Office of Health and Environmental Research, of the U.S. Department of Energy (DOE), actively supports global survey investigations of carbon dioxide in the oceans. This large scale study is in conjunction with the hydrographic program of the World Ocean Circulation Experiment (WOCE/HP). On ocean cruises operated by WOCE/HP, carbon dioxide analysis groups, from various oceanographic institutions, perform shipboard chemical measurements of the inorganic carbon system in the ocean. Measurements of total dissolved inorganic carbon (DIC) are of central importance to this carbon survey. Shipboard measurements of DIC were made by employing a coulometric technique developed by Johnson et al. [1985]. The majority of coulometric measurements were made on an integrated automatic device, the Single Operator Multi-Parameter Metabolic Analyzer (SOMMA) [Johnson et al., 1993; DOE, 1994]. In addition to DIC determinations, shipboard analytical groups measured at least one additional parameter of sea water carbon chemistry. This was done to more fully characterize the inorganic carbon system of the sea water sample. This added parameter was one of the following: 1. titration (or "total") alkalinity (ALK) or, 2. the fugacity of carbon dioxide (fCO_2).

In support of DOE's global carbon survey, the CO_2 Research Group (CDRG) at Scripps Institution of Oceanography (SIO), has received "replicate samples" of sea water, collected at sea, and sent to our shore laboratory for precisely calibrated determinations of DIC and ALK. The DIC measurements were produced by vacuum extraction/manometric analysis and the ALK values by potentiometric titration. Both measurements were performed in controlled laboratory conditions using standards. Samples were collected from the same Niskin bottles as were samples for shipboard analyses of DIC using the coulometric technique. The shore laboratory analyses of DIC employed a precise and proven methodology to provide information on the quality of the shipboard analyses done by other investigators.

The WOCE/HP Pacific legs on WOCE lines P16 and P17 were delayed, beginning only in late May 1991 and ending on October 1, 1991. The three legs, named TUNES Expedition Legs 1, 2, and 3 by SIO, were carried out on the SIO R/V *Thomas Washington* as a substitute for the larger R/V *Melville* or *Knorr* research ships because the latter ships were not ready in time. Replicate samples were collected on all three cruise legs. Shipboard analyses of carbon system parameters were conducted by scientists from Woods Hole Oceanographic Institution (WHOI), Lamont Doherty Earth Observatory (LDEO) and SIO. Replicate samples were additionally collected on two legs of the German research ship F/S *Meteor*, Leg Nos. 15 and 18 along WOCE Lines

A9 and A1E. Shipboard personnel of Brookhaven National Laboratory (BNL) measured carbon system parameters.

This technical data report presents DIC and ALK measurements performed in the SIO laboratory on replicate samples collected on the five expedition legs of the WOCE/HP cruises outlined above. A total of 907 replicate samples were collected and 349 of these were successfully analyzed for DIC at SIO. DIC and ALK measurements made on Certified Reference Materials, prepared by Dr. Andrew Dickson, also at SIO, are summarized in this report. Shore based salinity measurements on replicate sea water samples are also presented. Performance on each leg of the replicate sampling program and comparison of shore based to shipboard DIC measurements will be discussed.

2. Methods

2.1 *Sample collection*

2.1a Sample bottles

In preparation for the 1991 WOCE replicate sampling, 1400 (0.5 liter) reagent type borosilicate glass bottles were purchased and prepared for sample collection. Previous sampling was done with 1 liter bottles with greased stoppers closed with custom spring metal clips. New methods, however, for securing the bottle stoppers on the 0.5 liter bottles needed to be devised. Initially, a supply of 700 standard Corning 0.5 liter bottles were purchased. These are equipped with hollow stoppers of approximate standard taper 24/30 size. The bottle joints and stoppers were not of standard taper quality. All of these bottles were therefore hand lapped with carborundum grit and bottles and stoppers were correspondingly labelled. A custom aluminum bale type apparatus was devised to hold each stopper securely shut after the bottle was filled with water. A second approach was to fabricate bottles with standard taper quality joints and stoppers using the Rodaviss greased joint system. The outer joint on this system (a full size 24/40 standard taper joint) has glass threads molded onto the outside of the joint. A plastic knurled nut threads onto the bottle holding the stopper securely shut with an internal O-ring. Solid glass standard taper stoppers were purchased for this system. Bottle blanks were purchased and the glassblower assembled the Rodaviss joints onto the bottles, including a calibrated 5.0 ml air space section in the bottle's neck. These bottles were considerably more expensive than the standard bottles. However, the closure system and joint quality are superior to the standard bottles.

Bottles were packed, 20 to a plastic folding top crate, and equipped with custom made foam inserts to secure them. This proved to be an excellent system for not only protecting the bottles during storage and shipping, but also by providing insulation against short term temperature changes.

Following established procedures, each bottle was labeled with a sequential number and prefix; "S" for standard bottles with a custom closure device, and "R" for the Rodaviss joint bottles. Each sea water sample had a unique number. New labels and numbers were attached to the bottles when reused.

2.1b Sample collection procedure

From any given Niskin bottle, at least one sea water sample was collected for shipboard chemical analyses. Additionally, from the identical bottle, two replicate samples were sent to SIO for shore based comparative sea water analyses. Throughout this report, replicate samples refer to those sea water samples sent to SIO for shore based

analyses. Replicate samples were sequentially collected immediately following collection of the sample for shipboard DIC analysis. Established procedures [DOE, 1994] for DIC sample collection were followed. Mercuric chloride solution ($HgCl_2$) was added to prevent biological activity from occurring. The accepted quantity of $HgCl_2$ is approximately 14.0 ppm by weight of the final solution, which corresponds to 100 µl of a saturated aqueous $HgCl_2$ solution, per 0.5 liter bottle. The bottle stoppers were greased with Apiezon L grease and tightly secured into the bottle joints with the closure system. Samples were stored on the ship in a cool location (not frozen) and promptly air freighted to SIO. Precautions were taken to avoid exposure of the samples to high temperatures, which can cause deterioration of the greased seals (Appendix 6 for procedures).

2.1c Sample inspection and storage

Upon arrival at SIO, the bottles were carefully inspected for leaks of the greased seals and the bottles stored at 5.0°C until analyses are performed.

2.2 *Sample analysis procedure in the laboratory*

2.2a Vacuum extraction of CO_2 gas for total DIC

A 40 gram aliquot of seawater is subsampled into a flow-through pipette upon immediately opening the sample bottle. Procedures to eliminate any loss or gain of CO_2 gas from atmospheric exposure are rigorously observed. The pipette is weighed to 0.001 grams both before and after subsampling, and assembled onto a glass vacuum extraction line. The sample is completely acidified with dilute phosphoric acid and the evolved CO_2 gas quantitatively captured into a trap at liquid nitrogen temperature. CO_2 samples either remain frozen, while awaiting manometric analysis, or are sealed into glass break-off tubes prior to later manometric analysis. The vacuum gas extraction procedure is more fully described in Appendix 7.

2.2b Manometric measurement of extracted CO_2 gas sample

The extracted CO_2 gas sample is cryogenically transferred into a constant volume manometer where pressure and temperature are then measured. These measurements, along with the calibrated sample volume of the manometer provide for calculation of the number of moles of CO_2 gas using a virial equation of state. The number of moles of CO_2 gas analyzed, combined with the weight of the aliquot of sea water, directly yields the DIC in micromoles per kilogram of sea water.

Three different manometric systems are used in the SIO analyses. The primary system is a constant volume mercury manometer with a precision cathetometer which measures mercury height. This instrument provides the calibration standard for atmospheric CO_2 measurements for the network of base line monitoring stations associated with the World Meteorological Organization (WMO). This system and its calibration is detailed by Keeling et al., [1985]. The mercury manometric system is labelled "M" in this report.

The additional two manometers used for analyses at SIO are equipped with a quartz spiral manometer (manufactured by the Ruska Corporation) as the central element. A set of standard CO_2 gas samples are measured on both the mercury manometer and quartz spiral instruments. In this way, the response of the quartz spiral manometer is directly calibrated each day of operation.

The quartz spiral manometer, "S" in this report, was utilized from 1981 until early 1992. Here, samples were cryogenically transferred into a constant volume, comprising also the measurement quartz spiral of a Ruska XR38 manometer. This spiral actually unwinds with pressure and the amount of unwinding is mechanically tracked. In 1991 and 1992, this instrument episodically malfunctioned resulting in some erroneous WOCE sample measurements.

A newly constructed instrument, labelled "E" in this report (Electronic Constant Volume Manometer; ECVM), was first utilized for CO_2 extraction measurements of sea water in July, 1992. Here, the gas sample was cryogenically transferred into a constant volume comprising also one compartment of a Ruska differential pressure gauge. The pressure on the second compartment, separated from the first compartment by a diaphragm, was matched to the sample pressure by supplying pressure from a Ruska DDR6000 quartz spiral manometer configured as a pressure delivery source. The quartz spiral in the DDR6000 manometer is mechanically immobile, held in place by an opposing magnetic field from which the pressure is accurately calculated. The diaphragm position in the differential pressure transducer is additionally electrically detected to very high precision. This instrument was expected, and has proven, to be significantly more linear and precise in its operation than the previous system. It has now replaced the "S" manometer for the measurement of WOCE samples.

For all of the data here reported, the volume of the nominally 4 cc chamber in the mercury manometer was defined as 3.7955 cc, the result of the volume calibration of 1986 [Keeling et al., 1985]. Three manometric volume calibrations, determined in 1988, 1990 and 1993-4, indicate little appreciable drift in the volume. The precision of mercury manometric measurements is established by measurement of duplicate

reference gas samples, sea water gas extractions and volume calibration samples. The precision of a single mercury manometric measurement is consistently at, or less than, one part in 4000, or about 0.5 µmol/kg in DIC. Laboratory results also indicate that the other manometers, particularily the ECVM, have had as good or better precision.

2.2c Alkalinity measurement

After removal of the DIC analysis aliquot from the replicate sample bottle, additional aliquots of sea water are removed and potentiometrically titrated with dilute HCl solution to determine the total alkalinity of the sample. Two titration systems were employed for the data reported: 1. the gravimetric system, identified as system "G" in this report and, 2. the volumetric system, identified as system "V". With the gravimetric system, a weighed aliquot is titrated in a closed cell (Appendix 7). The original sample bottle is equipped with a spout dispenser and weighed before and after filling the cell. The aliquot is quantitatively flowed into the titration cell, using gas pressure. The volumetric system also uses a dispensing system to flow a known volume, from a glass syringe driven by a stepper motor, into the cell. This system was developed for shipboard work and used on two WOCE cruises, TUNES Leg 3 in 1991 and CGC92 in August, September and October of 1992. The volumetric system is described in the shipboard alkalinity report for TUNES Leg 3 [Guenther et al., 1994].

2.2d δC13 measurement

After manometric analyses, the CO_2 resulting from sea water extraction is sealed in a glass break off tube and stored for mass spectrometry analysis of the $^{13}C/^{12}C$ ratio. Isotopic analyses were run in the laboratory of Dr. Martin Wahlen at SIO. Isotopic values for all samples from TUNES Leg 3 and the majority of samples from Meteor Leg 15 were determined. A report summarizing the isotopic data is in preparation.

2.2e Salinity measurement

After DIC and ALK measurements are completed on each replicate sample, an aliquot of 100 to 250 ml is removed from the sample bottle for salinity determination. The SIO method of sea water collection preserves salinity to within several thousandths per mil. Comparison of shore based salinities at SIO to shipboard salinities helps to demonstrate that the sample was properly collected and stored. Agreement of shipboard and shore based results provide confirmation of salinity values used in the SIO calculations prior to the availability of the final WOCE salinities.

Salinity samples were analyzed to within 0.001 salinity units by the Oceanography Data Facility (ODF) at SIO with an inductive salinometer calibrated with standard sea water.

3. Results

Detailed tables of DIC, ALK, and salinity results and descriptive comments are presented in Appendix Tables 1-5.

3.1. *Sample collection*

3.1a Sample collection summary

Sample bottles were supplied for the five expedition legs according to the sampling plan originally proposed. The highest priority was given to WOCE legs in the Pacific Ocean on the R/V *Thomas Washington*, TUNES Legs 1, 2, and 3. A total of 1080 bottles were supplied for the three legs with the intention to fill 1044 bottles with collected sea water samples. For Legs 15 and 18 on the German research vessel, *Meteor*, 40 and 58 bottles, respectively, were provided to the Brookhaven National Laboratory CO_2 Analysis Group for replicate sampling. On *Meteor* Leg 15, the scientists also planned to collect additional samples in Dr. Andrew Dickson's Certified Reference Material (CRM) bottles after they had been emptied. For the five legs described (TUNES Legs 1, 2, 3 and *Meteor* Legs 15 and 18), the total number of sample collections was approximately 1200 from a proposed original of 1400.

The replicate sampling plan proposed for the three TUNES legs included collection of a partial depth profile of samples on every third station that was analyzed in full by the shipboard CO_2 analysis group. The following twelve depths (measured in meters) were identified for replicate sample collection: 0, 50, 100, 200, 300, 400, 600, 900, 1200, 1600, 2000, and 3000. Replicate samples were collected at the surface and at approximately 3000 m at the remaining two-thirds of the CO_2 stations on each leg. All replicate samples from Niskins were collected in duplicate.

A series of situations affected the final number of samples actually collected and the number of samples which were actually analyzed at the shore based SIO laboratory (Table 1 summarizes these results). On TUNES Leg 1, sampling was close to satisfying the objective of the sampling plan. Personnel problems on TUNES Leg 2 resulted in approximately 50% of the planned sampling actually being accomplished. On TUNES Leg 3, about 75% of the planned sampling was accomplished. On this leg, the intended percentage of replicate samples were collected but on fewer than originally planned shipboard CO_2 stations.

3.1b Discussion of problems

Personnel restrictions. As a result of utilizing the R/V *Thomas Washington*, which has a smaller capacity, in lieu of the R/V *Knorr* or R/V *Melville*, space was allocated for only two CO_2 scientists on the TUNES legs. On Legs 1 and 3, the CO_2

Table 1. Replicate Sample Collections During 1991

Expedition	WOCE Line Designation	Expedition Date	Number of Samples Planned*	Total Number of Samples Collected	Number of Samples Successfully Analyzed for DIC
TUNES Leg 1	P17C	Jun-Jul 1991	376	354	107
TUNES Leg 2	P16S, P17S	Jul-Aug 1991	384	220	23
TUNES Leg 3	P16C	Sep 1991	284	211	195
Meteor Leg 15	A9	Feb-Mar 1991	40+	66	12
Meteor Leg 18	A1E	Sep 1991	58	56	12
		Totals	1142	907	349

* Based upon the proposal to collect replicate samples from approximately 10% of the total number of Niskin samples analyzed at sea for DIC.

scientists were able to complete all of the CO_2 system sampling for shipboard and replicate sampling which, however, resulted in some curtailment of shipboard DIC and ALK analyses, especially on Leg 3. However, on Leg 2, a greater analytical work load by the shipboard CO_2 analysts prevented them from personally sampling for shipboard analyses. Thus, only 57% of the planned number of samples were actually collected.

Replicate sample bottle deficiencies. Upon completion of TUNES Legs 1 and 2, an inspection of the greased bottle seals revealed that those standard Corning bottles, equipped with custom aluminum closures frequently were not sealing. The required careful adjustment of the sample bottle closure device was not always realized by the shipboard samplers, occuring to the time constraints for the reduced staff on these legs. On Leg 3, replicate samples were collected only in bottles equipped with Rodaviss joint closures. (Further use of the standard bottles with custom closures was afterwards abandoned.)

On the first *Meteor* cruise (Leg 15), the experiment of refilling CRM bottles with collected sea water samples failed. These bottles were also standard Corning 0.5 liter bottles with custom rubber band closures, but were not supplied by SIO and were not hand lapped. The bottles invariably fail to seal after filling with water, resulting in gas exchange with the atmosphere.

The bottles with Rodaviss joint closures worked well in general, particularily on TUNES Leg 3. The bottles are fragile and can break at the joint when overtightened. On TUNES Leg 3, some bottle joints broke even though they were not overtightened, possibly indicating faulty joints. Some faulty seals still resulted using these bottles (e.g., those collected on Meteor Leg 18). This occurred when water was not entirely cleaned from the joint prior to closure, or if the Rodaviss closure was undertightened.

Bottle storage problems. The greased joints on replicate sample bottles are vulnerable to degradation and eventual leakage if they are exposed to high temperatures, especially greater than 30°C, for extended periods of time. Because of space limitations on the R/V *Thomas Washington*, crates of replicate samples were stored in a non air- conditioned hold. In equatorial regions, temperatures in the storage hold often reach 30°C. This possibly caused some of the leakage problems on the TUNES legs. After TUNES Leg 1, the sample crates were accidently stored in a warehouse in Papeete, Tahiti for two weeks prior to air shipment to San Diego. Shipment was made promptly following TUNES Legs 2 and 3. There were also possible problems with prompt shipping after the F/S *Meteor* Legs 15 and 18 and unknown storage conditions

on the F/S *Meteor*.

(Since the 1991 expedition legs, steps have been taken which have resulted in more appropriate storage of samples on the ship and prompt air shipment back to SIO following each leg.)

Bottle condition summary. Figure 1 is a bar graph displaying results of inspection of the sample bottles upon return to SIO. Those bottles which upon visible inspection appeared to be faulty (i.e., evidence of a leaked greased seal) were not usually analyzed. Serious problems were observed on four of the five legs. The sole exception was TUNES Leg 3. For comparison, inspection results from three previous collections of 1 liter shore replicate samples (which included profiles with depth) are also displayed in in Figure 1.

Evidence for lack of $HgCl_2$ treatment on replicate samples. A number of samples from TUNES Leg 3 indicated high bottle pair disagreement, greater than 10 µmol/kg. Since the greased seals were intact on these samples, it was suggested that the only likely explanation could be that the process of $HgCl_2$ sample treatment had been omitted. A chemical indicator test for the presence of $HgCl_2$ in these samples was then implemented. Small aliquots of sea water from each bottle, of a suspected bottle pair, were tested for $HgCl_2$. After precipitating excess chloride from the water by adding silver nitrate, a dilute solution of an azo dye (phenylazoformic acid 2-phenylhydrazide), was added and the development of a purple color observed. In some cases, a definite difference in color was noted, in which bottles with high DIC values showed little color development. These samples have been flagged with an "F" in the data summaries. As this test was used more frequently in the course of analyses, it became obvious that it was not entirely realiable. With enough time, color development intensified on all samples. Little positive difference was observed on some tests. Use of this test was then terminated. The flagged samples thus reflect erroneous values for which the cause would not be decisively established.

The alkalinity values in the suspected bottle pairs, in most cases, also showed poor agreement, although the differences were not always unidirectional. In these instances, it appeared as if the sea water sample was contaminated. In one case, the alkalinity bottle pair difference was good. Here, the incorrect DIC value was possibly attributed to an analytical mistake. The $^{13}C/^{12}C$ ratios measured on the CO_2 gas extractions from the suspected bottle pairs from TUNES Leg 3 provide yet another clue. In the majority of examples, the sample with the high DIC value had a correspondingly negative (light) $^{13}C/^{12}C$ result. This appeared erroneous when

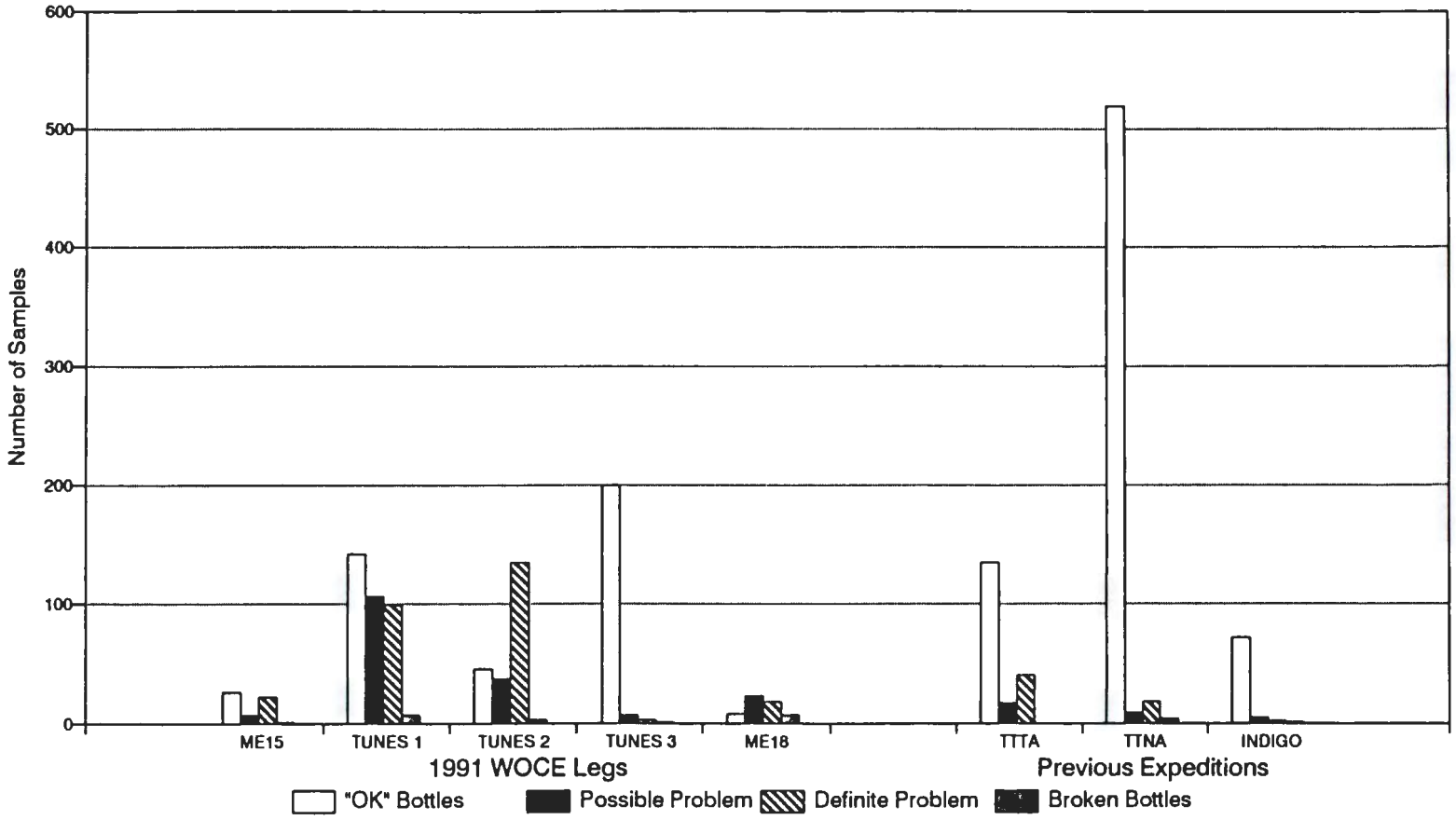

Figure 1. Replicate sampling quality summary. The quality of sample bottles is divided into four categories and is based upon visual inspection at SIO of the greased seals. Imperfect bottle joint seals are noted in the figure as *possible* or *definite* problem. As a basis for comparison, the quality of replicate samples from three prior expeditions are also represented. These three expeditions are: TTNA, Transient Tracers in the North Atlantic, 1980-1981; TTTA, Transient Tracers in the Tropical Atlantic, 1982-1983; and INDIGO, Indien Gaz Ocean 1 expedition on the French vessel Marion Dufresne in 1985.

compared to adjacent data sets. The contamination may have resulted from biological oxidation of organic carbon in the absence of mercury. A similar result may have been caused by contamination of the sample with atmospheric CO_2, either during sampling, storage (leaking), or due to an extraction error.

An explanation is lacking for the possible omission of $HgCl_2$ treatment in such a large number of samples as those collected on TUNES Leg 3, where the sampling was supervised by the senior author of this report. The micropipette used during this expedition leg specifically for the addition of $HgCl_2$ was detected sometimes to have failed to fill properly. It is possible that an air bubble line in the pipette tip made the tip appear as if it was actually filled with the $HgCl_2$ solution, and the improper fill was not noticed.

Other possible problems with samples. The possibility that poor results on TUNES Leg 3 were in some way due to the use of smaller bottles than those in previous sampling by the CDRG (0.5 liter instead of 1 liter), was also considered. Excellent results for samples collected with the smaller bottles on later expeditions has ruled out that possibility.

An explanation for inaccurate results on TUNES Legs 1 and 2 and both *Meteor* legs is incorrect sampling from the Niskin bottles. Examples of this type of problem include: 1) long periods of elapsed time after opening the Niskin bottle prior to sampling, 2) long periods of elapsed time after the shipboard sample was collected and prior to the replicate sample collection, and 3) sampling at the bottom of the Niskin bottle. Thus, lack of prompt sampling perhaps contributed to inaccurate results due to gas exchange with the atmosphere.

Analytical problems. Some of the inconsistent bottle pair agreement observed was perhaps a result of a malfunction in the quartz spiral manometer ("S"). Occasionally, this device produced an identified incorrect count. For example, an erroneous value was occasionally noted on standard CO_2 gas samples where the correct value is known. Such misreadings were sporadic and possibly undetected malfunctions occurred on some sea water extractions. In cases where evidence existed for this occurrence, the datum was flagged in the data set (the most common reason for the "EX" flag). After attempts to eliminate the malfunctioning proved unsuccessful, the quartz spiral manometer was abandoned and replaced (after a delay) by the electronic constant volume manometer ("E").

3.2 *Measurements of total dissolved inorganic carbon on Certified Reference*

Materials

Appendix Tables 1A-1L present all of the measurements of DIC by vacuum/extraction on Certified Reference Materials (CRM's) prepared in the laboratory of Dr. Andrew Dickson of SIO. These measurements constitute the certification of the DIC concentrations of the various batches of CRM's (Batches 1-13).

In any given batch of CRM, approximately 600 bottles were filled with homogeneous sea water. The majority of bottles in a batch were sent to sea for quality control measurements by shipboard CO_2 analysis groups. Approximately 10 bottles of each batch were reserved for certification of DIC at SIO.

Serious problems with biological contamination were encountered in the preparation of the natural sea water reference materials beginning with CRM Batches 4 and 5. DIC concentrations drifted upward with increasing storage time. As a temporary measure to produce stable batches, several (6, 7 and 11) were prepared in sodium chloride solution (artificial sea water). Stable DIC results for CRM's in natural sea water were obtained beginning with CRM Batch 10, following extensive cleaning of the preparation apparatus.

3.3 *Measurements of total alkalinity on Certified Reference Materials*

Appendix Tables 2A-2M present all of the measurements of ALK by potentiometric titration on Certified Reference Materials (CRM's) prepared in the laboratory of Dr. Andrew Dickson at SIO.

The measurements, in most cases, were made on the same bottles of CRM's measured for DIC and reported in Table 1. Although the CRM's have been titrated at sea as reference materials for quality control of shipboard ALK measurements, there is currently no certification of ALK for the CRM's.

ALK results were unstable for the biologically contaminated batches, beginning with CRM Batch 4. Typically, the ALK drifted downward with time as the DIC drifted upward. Very poor least squares fits to the titration data were also observed, as if proton donors, such as organic acids, were produced in the water by biological reactions. Stable ALK results for natural sea water batches were not obtained until CRM Batch 13. Several measurements made in 1993 on CRM Batch 13 are not listed in Appendix Table 2M. Complete results for CRM Batch 13 will be presented in the next report.

3.4 *Measurements of total dissolved inorganic carbon in replicate sea water samples*

Appendix Tables 3A-3E present all of the measurements of DIC by vacuum extraction/manometry on replicate sea water samples collected on the five expedition legs of 1991. Flags indicate measurements omitted from further consideration for experimental reasons. DIC results for bottle pairs collected from individual Niskin bottles are averaged and compared with shipboard DIC results. The shipboard DIC results are considered final (as reported to the Carbon Dioxide Information and Analysis Center) except for possible data adjustments to the *Meteor* Leg 18 expedition by the group at Brookhaven National Laboratory. The shipboard data are listed as reported by the shipboard analysis groups, to 0.1 μ mol/kg for the three TUNES legs and to 0.01 μmol/kg for the two *Meteor* legs. Inference should not be made regarding the precision of the shipboard data from the number of figures listed. Dr. Takahashi at Lamont Doherty Earth Observatory (LDEO) estimates that for TUNES Leg 2, the overall precision of the shipboard DIC data is ± 2 μmol/kg (one sigma for a single measurement). He has kindly allowed the LDEO data to be listed to one more significant figure for comparison purposes.

3.5 *Measurements of total alkalinity in replicate sea water samples*

Appendix Tables 4A-4E present all of the measurements of ALK by potentiometric titration on replicate sea water samples collected on the five expedition legs of 1991. Flags are indicated for measurements omitted from further consideration for experimental reasons. ALK results for bottle pairs collected from individual Niksin bottles are averaged and compared with shipboard ALK results when available. The shipboard ALK results listed for TUNES Leg 1, are considered to be final (as reported to the Carbon Dioxide Information and Analysis Center (CDIAC) by Dr. C. Goyet and co-workers at Woods Hole Oceanographic Institution). The shipboard ALK results for TUNES Leg 3 are also final, as reported to CDIAC [Guenther, et al., 1994]. Shipboard data for both legs are listed as reported to 0.01 μmol/kg of hydrogen ion equivalent (approximately two decimal figures beyond the accuracy of the measurements).

3.6 *Measurements of salinity in replicate sea water samples*

Appendix Tables 5A-5E present all of the measurements of salinity on replicate sea water samples collected on the expedition legs of 1991. These measurements were made by scientists of the Oceanographic Data Facility at SIO on subsamples of water from the same bottles analyzed for DIC and ALK. Measurements were made on an

inductive salinometer calibrated with standard sea water. Salinity results for bottle pairs collected from individual Niskin bottles are averaged and compared with preliminary shipboard salinity results as reported by the shipboard samplers. These preliminary shipboard salinities are, in some instances, obtained from the conductivity-temperature-depth profiler and in other instances from discrete shipboard salinometers. The shore based laboratory data will eventually be compared to the final shipboard salinometer results when they are released by the WOCE/HP.

4. Shipboard and shore based results

The performance of the replicate sampling program is appraised by estimating the precision of an SIO laboratory result, the average difference, and precision of the difference between the laboratory result and the shipboard result. Since samples are always collected in duplicate, the overall agreement of the pairs of measurements provides an estimate of the laboratory and sampling precisions. The overall average difference between the average SIO laboratory results and the shipboard results, for each cruise, is an estimate of the systematic difference between shipboard and shore based analyses. The variation in this difference provides an independent estimate of the combination of the shipboard and shore based precisions.

Bottle pair agreement. A replicate sample standard deviation (s) is calculated from the set of analyses on duplicate samples. The general equation for calculating the variance of a series of observations, divided into subgroups, is the following [Laitinen, 1969, p. 548]:

$$s^2 = \frac{1}{N-k} \sum_i \sum_i (x_i - \bar{x}_i)^2 \tag{1}$$

where there are N observations, k subgroups and $x_i - \bar{x}_i$ is the deviation of each observation from the average of its subgroup. For a series of *duplicate* observations, this equation reduces to:

$$s^2 = \frac{\Sigma \Delta_i^2}{2n} \tag{2}$$

where Δ_i (delta) is an individual duplicate observational *difference*, n is the total number of pairs of observations, and s is the sample standard deviation of an individual observation.

Comparison of shipboard and shore based measurements. The overall bias between shore based and shipboard measurements of DIC for an individual expedition leg is estimated by calculating the average difference between the shipboard results and the shore based results. The precision of an individual difference is estimated by calculating the sample standard deviation of the set of ship minus shore differences for a particular cruise. This is represented by:

$$s^2 = \frac{\Sigma d_i^2}{n-1} \tag{3}$$

where d_i is an individual deviation from the average difference for a cruise, n is the total number of ship minus shore comparisons, and s in this case is the sample standard deviation of an individual difference between shipboard and shore based measurements. In the following discussion, this s is expressed as a ±, following a calculated average difference. A *negative* difference means that the shipboard data is *lower* than the shore based.

Average DIC results: Tables 2 and 3. To calculate meaningful overall averages and statistical quantities for the individual cruise legs, some data are omitted. First, all data with specific experimental reasons for error are omitted. These are flagged in Appendix Tables 3a to 3e. Secondly, the "three sigma" criterion is used to omit possible outliers. For data described by a normal error curve, this criterion is the 99.7% confidence level. At SIO, the overall sample standard deviation s is calculated and bottle pair differences with delta's greater than $3s$ are omitted. The s is then recalculated.

Details of the calculations are discussed for each of the five expedition legs and presented in Tables 2 and 3 and Figures 2-8. Averages and statistics are first calculated for all available data from each leg. Additionally, for the TUNES legs, results are calculated and discussed for the following subsets of the data: 1. near surface (0-10 m) and deep (approx. 3000 m) data (this subset represents the replicate sampling plan adopted after 1991), and 2. profile data (this subset represents the originally proposed replicate sampling plan for 1991). Separate calculations are made for each station where replicate samples were collected from 12 depths.

4.1 TUNES Leg 1

All data. When all 50 unflagged bottle pair data sets are used in calculating the sample standard deviation (s, Equation 2) of an individual replicate DIC value, a result of 1.9 µmol/kg is calculated. If three pairs with delta's greater than three times the sample standard deviation (s) are omitted, then the resultant s is reduced to 1.34 µmol/kg. Table 2 presents the results with details of omitted data.

In Table 3, the comparison between the shipboard and shore based replicate results indicates a high sample standard deviation as calculated by Equation 3 and a significant systematic bias with shipboard values lower by 3-5 µmol/kg. The most reliable and best result is obtained by considering only unflagged comparisons with good replicate deltas (i.e., those not omitted in Table 2 for being greater than $3s$), and also by omitting one difference of -30.6, more than $3s$ from the average. The systematic bias then is -3.4 ± 4.0 µmol/kg for 40 comparisons.

Table 2. Replicate Sample Statistics (Shore Based DIC Results)

Expedition	All Unflagged Pairs		Omitting Δ's > 3*s*	
	s (μmol/kg)	No. of Pairs	*s* (μmol/kg)	No. of Pairs*
TUNES Leg 1	1.90	50	1.34	47(1)
TUNES Leg 2	1.43	11	-	-
TUNES Leg 3	1.25	74	1.01	71(2)
Meteor Leg 15	2.45	5	-	-
Meteor Leg 18	1.12	5	-	-

*** Notes**

"*s*" is the sample standard deviation of an individual replicate sample DIC, as calculated with Equation 2 for a single leg. "No. of Pairs" is the number of replicate pair data in the calculation of "*s*". "Δ" is the absolute difference between the DIC's of each sample of a bottle pair.

1. TUNES Leg 1: Three unflagged pairs with Δ's > 3*s* are omitted (7.04, 8.11, 8.64 μmol/kg).
2. TUNES Leg 3: Three unflagged pairs with Δ's > 3*s* are omitted (4.66, 4.89, 6.35 μmol/kg).

Table 3. DIC Comparisons (Shipboard Minus Shore Based Results)

Expedition	Shipboard Anal. Group	All Unflagged Comparisons Av. Diff. µmol/kg	*s* µmol/kg	No. of Comp.	Omitting Singlets and Replicates > 3*s* Av. Diff. µmol/kg	*s* µmol/kg	No. of Comp.*	Omitting Diff's > 3*s* Av. Diff. µmol/kg	*s* µmol/kg	No. of Comp.*
TUNES Leg 1	WHOI	-4.87	6.33	47	-4.07	5.80	41(1)	-3.41	4.00	40(2)
TUNES Leg 2	LDEO	-2.85	2.88	12	-3.47	1.97	11(3)	-	-	-
TUNES Leg 3	WHOI	-2.86	4.02	95	-2.36	2.90	68(4)	-2.08	2.41	66(5)
Meteor Leg 15	BNL	-3.16	5.68	7	-	-	-	-1.78	4.76	6(6)
Meteor Leg 18	BNL	-3.46	3.41	7	-	-	-	-2.32	1.74	6(7)

*** Notes**

"Av. Diff." is the average shipboard minus shore based DIC for a single leg. "*s*" is the sample standard deviation of an individual comparison difference. "No. of Comp." is the number of comparisons averaged.

1. Tunes Leg 1 omissions: 5 comparisons with "singlet" replicate samples (including one with flagged pair) and another with replicate Δ (8.64) greater than 3*s* (comparison = -6.12)
2. TUNES Leg 1 omissions: one additional comparison with difference greater than 3*s* (-30.6)
3. TUNES Leg 2 omissions: one comparison with "singlet" replicate sample
4. TUNES Leg 3 omissions: 24 comparisons with "singlet" replicate samples and 3 with replicate Δ's (4.89, 4.66, 6.35) greater than 3*s* (comparisons: +2.86, -6.71, -2.69)
5. TUNES Leg 3 omissions: 2 additional comparisons with differences greater than 3*s* (-12.12, -11.51)
6. *Meteor* Leg 15 omissions: one comparison with largest difference (-11.46); 2 "singlets" included
7. *Meteor* Leg 18 omissions: one comparison with difference greater than 3*s* (-10.31); 2 "singlets" included

Surface and deep data. Figure 2 displays, for TUNES Leg 1, the performance of the replicate sampling program for a subset of all data including only near surface (0-10 m) and deep (approx. 3000 m) data. The same data omissions are made as above and detailed in Table 3. Two data points with replicate sample singlets are omitted, as well as one with a ship minus shore difference of -30.6 µmol/kg, and one with a replicate delta greater than 4.0 µmol/kg.

For the 17 comparisons, the replicate s is 0.9 µmol/kg, similar to the s calculated for the entire data set. However, the average ship minus shore difference of -1.4 ± 3.2 µmol/kg is considerably less negative than that calculated for the entire data set. Figure 2 illustrates that the near surface data is in better agreement than the deep data. As 12 of the 17 comparisons are between surface data values, their better agreement weighs the subset such that there is lack of agreement with the entire data set.

Figure 2 illustrates better performance of the replicate sampling program at the onset of TUNES Leg 1, with more scatter of the data evident towards the end of the leg.

Profile data. Figure 3 displays three sets of profile differences from TUNES Leg 1. For Station 17, if three data points with ship minus shore differences greater than $3s$ are omitted as in Table 3 (next to last column), the average ship minus shore difference, for the remaining five comparisons (Fig. 3), is -4.4 ± 3.9 µmol/kg. Similarly for Station 26, with one singlet omitted, the average ship minus shore difference for the remaining 11 depths is -3.5 ± 3.4 µmol/kg. For Station 53, the difference for all eleven possible comparisons with no omissions is -4.4 ± 3.7 µmol/kg. The average ship minus shore result for the three profiles is essentially the same as that calculated above for the entire data set. Figure 3 also indicates that the ship minus shore difference is smaller for surface data and larger (i.e., shipboard measurements relatively lower) for deeper samples.

4.2 TUNES Leg 2

All data. For this small data set, a replicate s of 1.43 µmol/kg for eleven unflagged pairs, is calculated, with no delta's greater than $3s$.

The average ship minus shore difference is -3.5 ± 2.0 µmol/kg for eleven comparisons, omitting comparisons of singlet replicate samples.

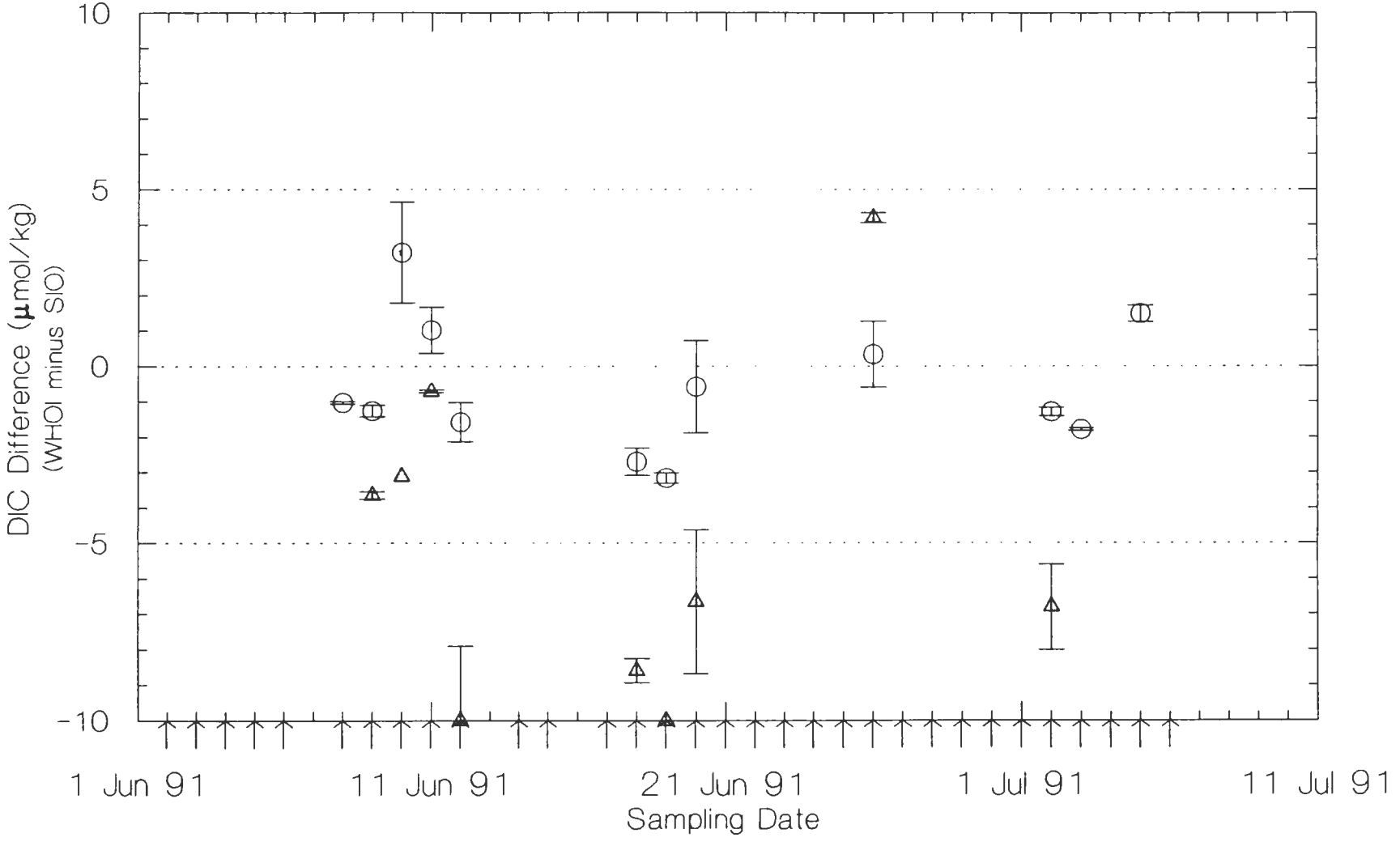

Figure 2. TUNES Leg 1: WHOI shipboard DIC minus shore based DIC versus date for surface and deep samples. Open circles represent shipboard minus average shore based DIC for near surface samples. Shaded triangles represent shipboard minus average shore based DIC for deep samples. Verticle bracketed lines represent replicate pair deltas. Arrows indicate dates when replicate samples were collected.

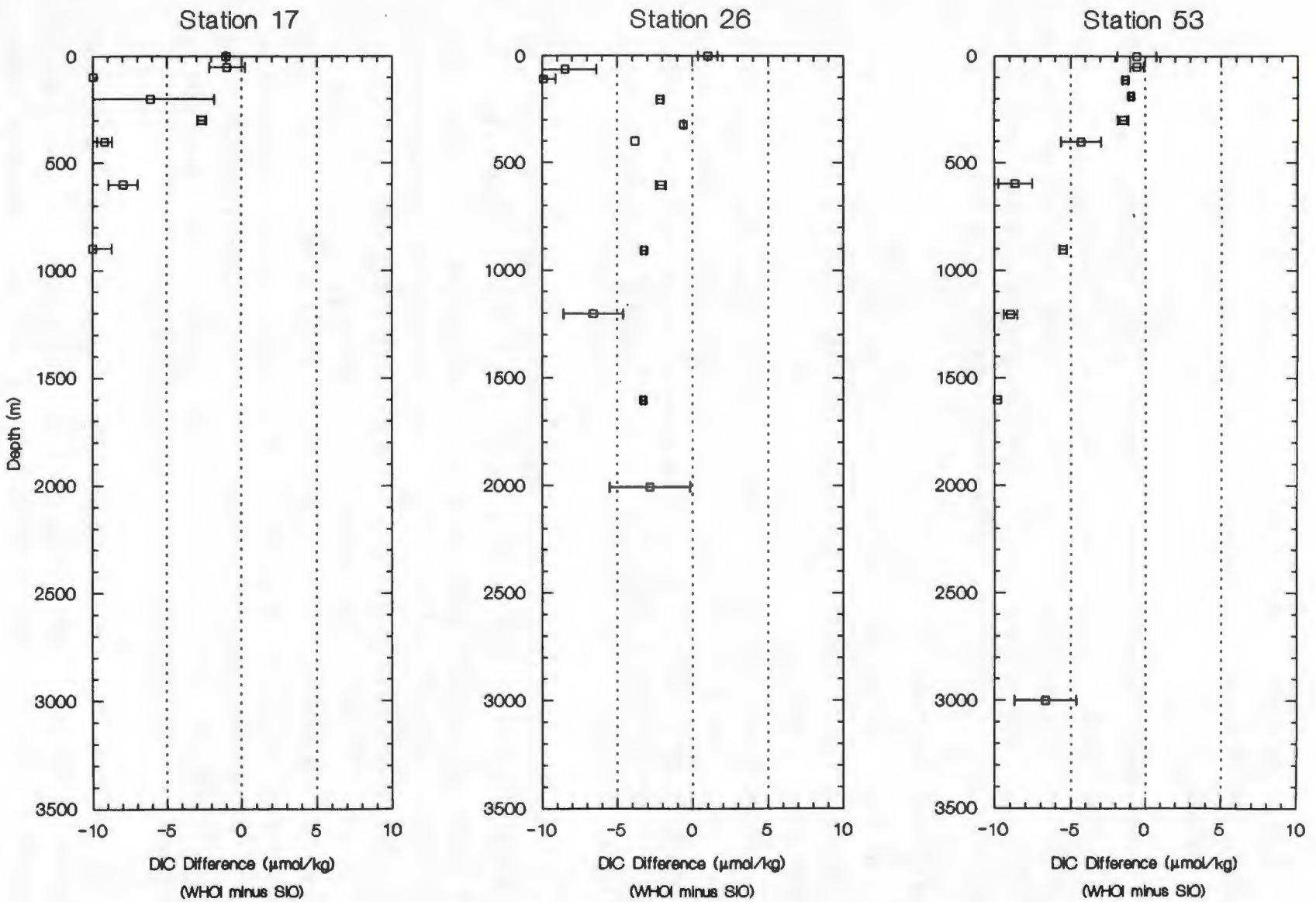

Figure 3. TUNES Leg 1: WHOI shipboard DIC minus shore based DIC versus depth for Stations 17, 26, and 53. Open squares indicate shipboard minus average shore based DIC. Horizontal bracketed lines represent replicate pair deltas.

Surface/deep data. Only two surface water and two deep water comparisons exist for TUNES Leg 2. This represents too few data points for meaningful comparative analysis.

Profile data. Figure 4 displays the one set of profile differences from TUNES Leg 2. There are eight comparisons from Niskins at 300 m and deeper. After omitting the one shallowest comparison (a replicate singlet), the remaining seven are characterized by an average difference of -4.3 ± 1.6 µmol/kg. The consistency of the four deeper comparisons, all with excellent bottle pair agreement, is striking.

4.3 TUNES Leg 3

All data. The replicate sample standard deviation for this large data set of 71 unflagged pairs is 1.0 µmol/kg, after omitting the three replicate pairs with delta's greater than 3s (Table 2).

Substantial reduction in the calculated s of the ship minus shore comparison is made (Table 3) by omitting 24 comparisons of singlet replicate samples, plus five more that are greater than 3s for either the replicate pairs or the comparison difference. For the 66 remaining comparisons, the average ship minus shore difference is -2.1 ± 2.4 µmol/kg.

Surface and deep data. Figure 5 displays the ship minus shore differences for all available surface and deep data from TUNES Leg 3. After omission of ten replicate singlet data points and two by the 3s criterion as shown in Table 2, the replicate s for eighteen bottle pairs is 1.1 µmol/kg. Two additional comparative differences are omitted in the calculation of the average difference as they are greater than 3s of the whole data set (Table 3). The remaining 16 comparisons (ten surface, six deep) are characterized by an average difference of -1.8 ± 2.3 µmol/kg. This result is in close approximation to the result for the entire data set (Table 3). Figure 5 illustrates an improvement in performance during the latter half of this leg. The plotted data in this figure indicates some surface relative to deep bias. Surface data are characterized by better agreement between the shipboard and shore based data.

Profile data. Figures 6, 7, and 8 are difference plots for the seven profile data sets from TUNES Leg 3. The average difference calculated for each station is sensitive to inclusion of replicate singlet comparisons. Details of the calculations are noted in the following table (omitted data are presented in Table 3).

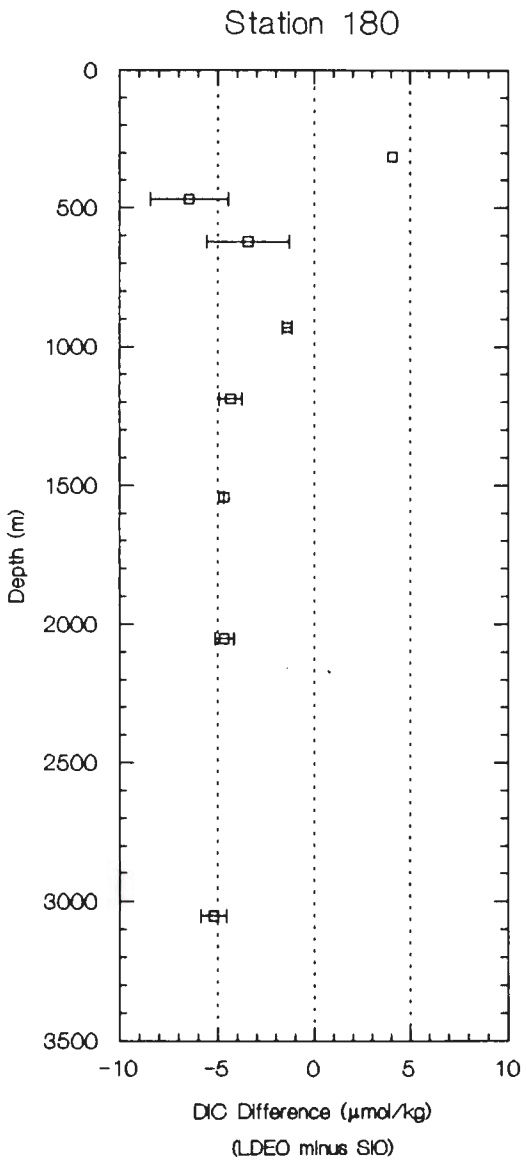

Figure 4. TUNES Leg 2: LDEO shipboard DIC minus shore based DIC versus depth for Station 180. Open squares represent shipboard minus average shore based DIC. Horizontal bracketed lines indicate replicate pair deltas.

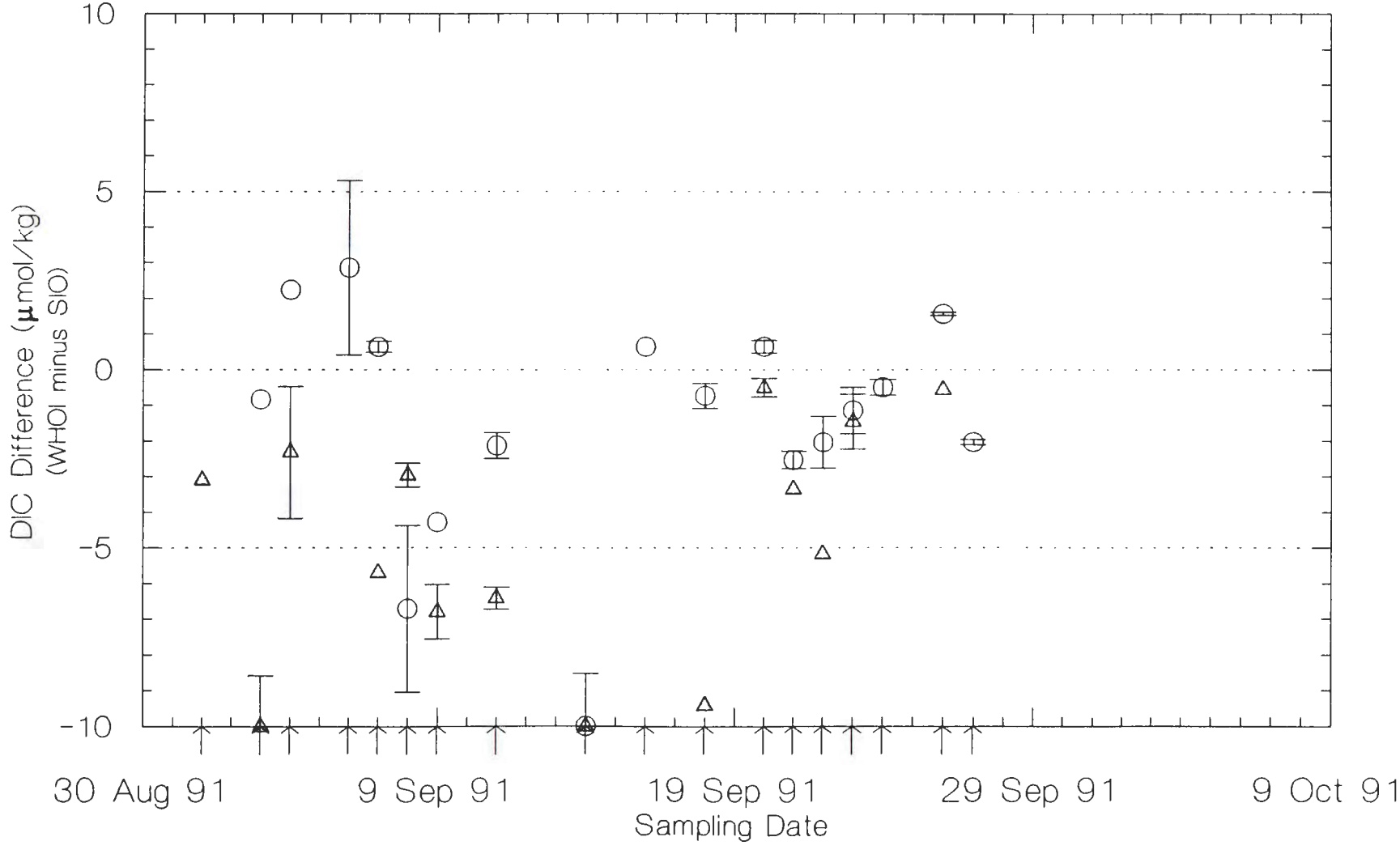

Figure 5. TUNES Leg 3: WHOI shipboard DIC minus shore based DIC versus date for surface and deep samples. Open circles represent shipboard minus average shore based DIC for near surface samples. Shaded triangles represent shipboard minus average shore based DIC for deep samples. Vertical bracketed lines represent replicate pair deltas. Arrows indicate dates when replicate samples were collected.

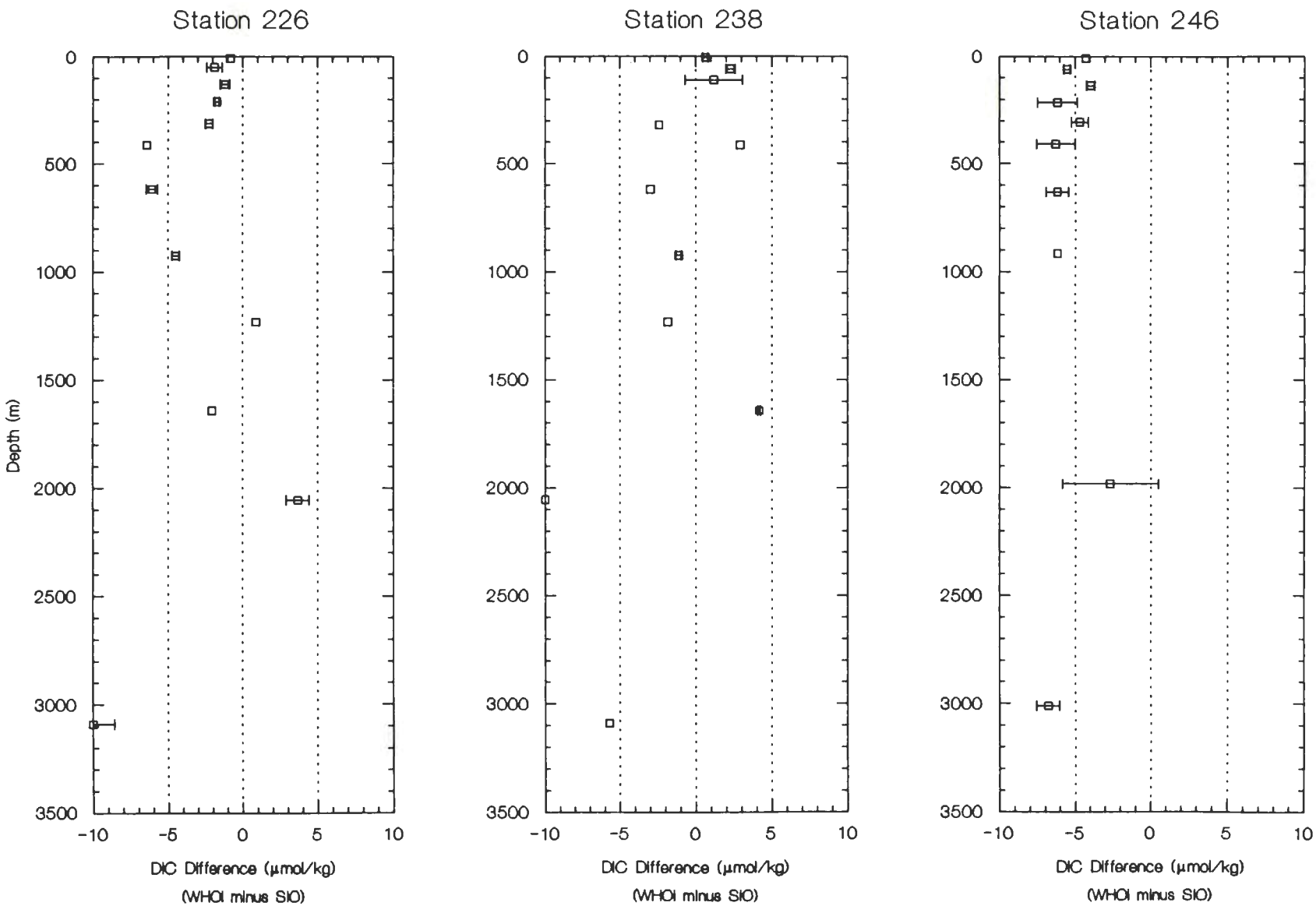

Figure 6: TUNES Leg 3: WHOI shipboard DIC minus shore based DIC versus depth for Stations 226, 238, and 246. Open squares represent shipboard minus average shore based DIC. Horizontal bracketed lines represent replicate pair deltas.

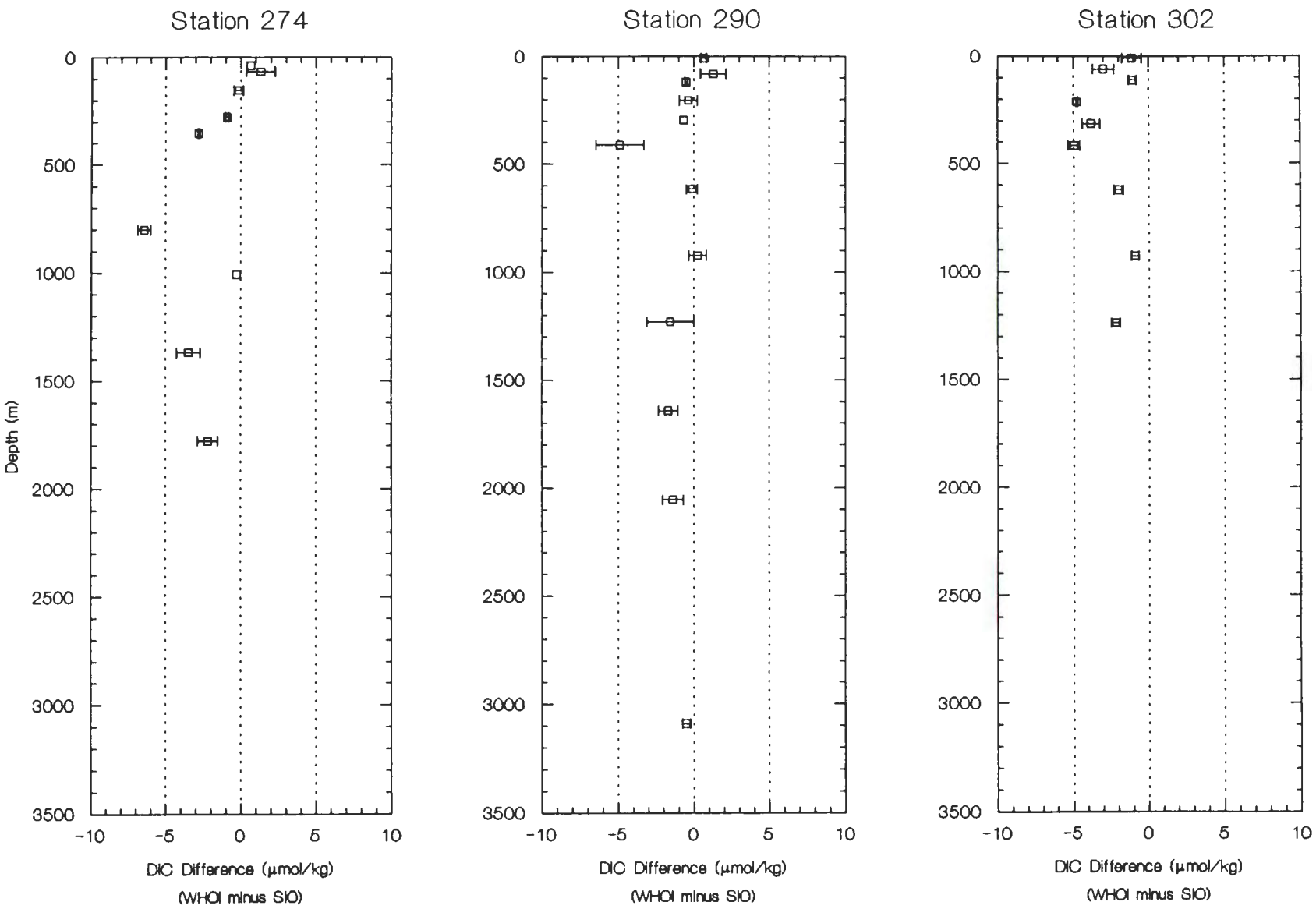

Figure 7. TUNES Leg 3: WHOI shipboard DIC minus shore based DIC versus depth for Stations 274, 290, and 302. Open squares represent shipboard minus average shore based DIC. Horizontal bracketed lines represent replicate pair deltas.

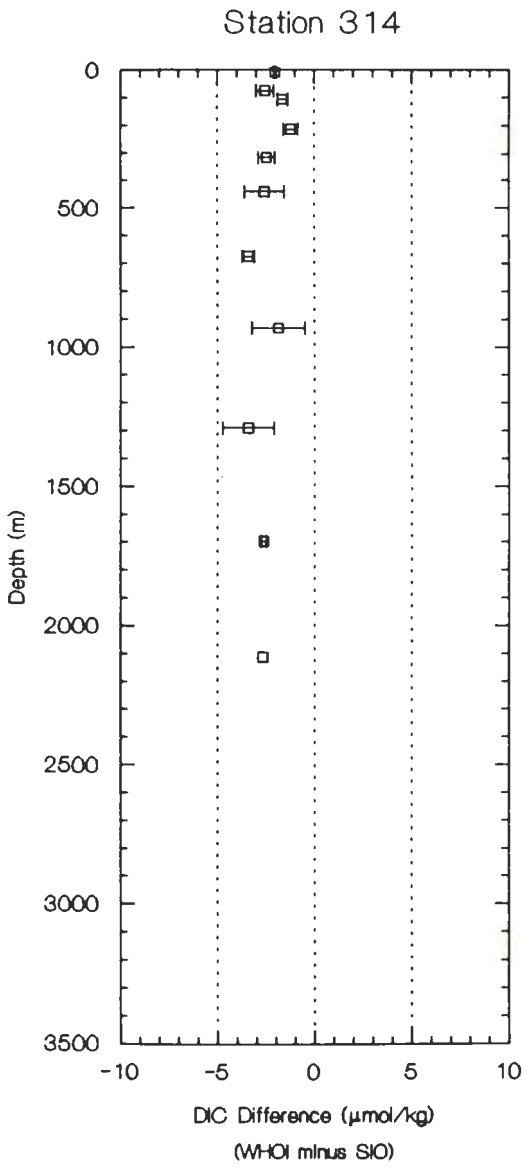

Figure 8. TUNES Leg 3: WHOI shipboard DIC minus shore based DIC versus depth for Station 314. Open squares represent shipboard minus average shore based DIC. Horizontal bracketed lines represent replicate pair deltas.

Station	Average Ship-Shore Difference (µmol/kg)	*s* (µmol/kg)	No. of Comparisons	Notes
226	-2.0	2.9	11	one bad comparison omitted four singlets included
238 (a)	-2.8	3.1	10	one bad singlet omitted
(b)	+1.4	2.0	5	five more singlets omitted
246 (a)	-5.3	1.3	10	one bad singlet omitted
(b)	-5.7	1.0	7	remaining two singlets and one bad replicate pair omitted
274 (a)	-1.6	2.4	9	two singlets included
(b)	-2.1	2.5	7	two singlets omitted
290	-0.8	1.6	12	one singlet included
302	-2.5	1.5	10	two singlets included
314	-2.4	0.7	11	one singlet included

Variation in performance of the replicate sampling program, from station to station, is evident. For five of the seven stations, the average difference is -2.0 to -3.0 µmol/kg. The precision improves toward the end of this leg. The shipboard data for Station 246 are much lower (less than -5.0 µmol/kg), yet the ship minus shore difference has a very low scatter. The data for Station 290 also have a low scatter but the average difference of the shipboard data with respect to the replicate shore data is -0.8 µmol/kg. As evidence is lacking for variation in the performance of the replicate sample data, these station to station differences must therefore represent differences in the performance of the shipboard SOMMA analysis system, perhaps attributed to daily calibration differences.

4.4 *Meteor* Leg 15

In this small data set, three of the five replicate pair delta's are greater than 4.00 µmol/kg. The calculated s is over 2.0 µmol/kg, with no omissions.

Scrutiny of the ship minus shore differences is not meaningful for such a small data set. If the two comparisons with replicate sample singlets are included and one ship minus shore difference of -11.46 is omitted, (although less than $3s$), an average difference of -1.8 ± 4.8 µmol/kg is obtained for six comparisons. There are insufficient data to allow separate considerations of surface/deep and profile data from this leg.

4.5 *Meteor* Leg 18

In this small data set of 5 replicate pairs, the calculated s is similar to that of the larger data sets, at 1.1 µmol/kg. As for the *Meteor* 15 data set, two comparisons, with replicate sample singlets, are included and one large comparison difference, -10.31, (about $3s$) is omitted to obtain an average difference of -2.3 ± 1.7 µmol/kg for six comparisons. There are insufficient data to allow separate considerations of surface/deep and profile data for this leg.

5. Conclusions

The replicate sampling program for the 1991 expedition legs was a mixed success. There were many unsatisfactory samples collected on which shore based analyses could not be done. Problems in the laboratory resulted in additional bad results that have to be omitted from statistical analyses and comparisons of the data. Most severely affected was TUNES Leg 2, where of 220 collected samples only 23 could be successfully analyzed. The smaller sample collections on the two Meteor cruises were also unsatisfactory, with only 5 good replicate pairs per leg obtained.

The replicate sampling programs on TUNES Legs 1 and 3 were more successful than on the other legs. After possibly outlying data are omitted, substantial data sets remain with replicate DIC sample precisions of 1.0 to 1.3 µmol/kg. The two cruises have substantially different results for the comparison between ship and shore results, even though the shipboard DIC analyses were carried out by the same shipboard CO_2 group with the same instrument. On Leg 1, the s of the ship minus shore difference, 4.0 µmol/kg, is higher than expected from the stated precisions of shore based and shipboard data, 1.3 µmol/kg and 2 µmol/kg, respectively. On Leg 3 the s of the ship minus shore difference, 2.4 µmol/kg, approaches what is expected. Viewing all three TUNES legs, the shipboard DIC data were on average 2.0 to 3.5 µmol/kg lower than the shore based data.

The sets of profile data comparisons shown for the TUNES legs (Figs. 3, 5, 6, 7, and 8) illustrate that collections of a number of samples through the water column at individual stations provides information on the station to station performance of the shipboard analyses. The surface and deep sample strategy now adopted for replicate sampling may not define the station to station performance clearly. For TUNES Leg 1 an overall bias in the results between near surface versus deeper samples is shown more clearly on the profile data. For TUNES Leg 3, data from the seven profile stations clearly show station to station differences in the shipboard analysis results.

These results indicate that for a given station (i.e., on a given analysis day at sea) the SOMMA can reach a precision of 1.5 μmol/kg or better. Averaged surface and deep data from the leg would indicate a precision of more than 2 μmol/kg.

It should be noted that the results of comparison of the shipboard and shore based DIC results are an improvement over previous efforts during the GEOSECS and Transect Tracers studies. For a limited set of replicate samples from the GEOSECS Indian Ocean Expedition in 1979-1980, the average difference between shipboard DIC by potentiometric titration and shore based DIC by vacuum extraction manometry was determined to be 17 ± 4.2 μmol/kg (reported at 1980 fall AGU meeting). For the Transient Tracers North Atlantic Study in 1981, improvements in the titration system had been made and a difference of -4.0 ± 2.9 μmol/kg was found for deep water comparisons [Brewer et al., 1986]. A considerably greater difference of -7.2 ± 5.9 μmol/kg was found for comparisons of upper water column data (surface to 1000m). The recent data strongly support that the coulometric method for shipboard DIC is a substantial improvement over the potentiometric titration method used formerly.

The shore replicate sampling program has continued beyond 1991 with changes in sampling strategy discussed above and with general improvement in the sample collections. The number of WOCE cruises with shipboard DIC analyses carried out by U.S. analytical groups has increased and replicate sample collections have been obtained from all of them. In summary, the results of the first year of the replicate sampling program demonstrate that this program provided valuable information on the performance of the shipboard DIC measurements and additionally for a better understanding of the inorganic carbon system in the central Pacific Ocean.

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Appendix Table 1. Summaries of Total Dissolved Inorganic Carbon Data for Certified Reference Materials

Tables 1A to 1L summarize DIC measurements on water from bottles of Certified Reference Materials (CRM's) prepared in the laboratory of Dr. Andrew Dickson of SIO. These measurements constitute the certification of the 12 batches of CRM's, numbered Batch 1 to Batch 13 (DIC measurements were not made on Batch 9). Not all of these batches were used as CRM's for shipboard DIC measurements. Natural sea water Batches 4 and 5 proved to be contaminated biologically. During solution of the contamination problem, Batches 6, 7 and later 11 were made of "artificial sea water", mixtures of sodium bicarbonate in a sodium chloride solution matrix. With Batch 10, uncontaminated batches of natural sea water stable for DIC were again produced.

Comments on each column in the table follow:

ANAL DATE	The date of manometric analysis of the CO2 gas extraction.
ANAL SYST	The manometric analysis system used to measure the CO2 gas extraction: M, the mercury manometer; and S, the Ruska XR38 quartz spiral manometric system. A number of samples were analyzed on both systems, first on the mercury and then on the quartz spiral. Beginning with Batch 11, CRM's were measured only on the mercury system.
SAMPLE BOTTLE	The number refers to the bottle number assigned by the Dickson laboratory: it corresponds to the order of filling of that bottle in its batch. The "P" and the following letter are codes for SIO laboratory use.
RUN	This refers to multiple manometric analyses of the same gas extraction. There are none in this data set. On the page with CRM Batch 2, bottle 143PB has two runs labelled 001B and 001A. These are "subruns", where the sample was measured twice but not transferred out of the mercury manometer between measurements.
FLAG	Very bad results are flagged with "EX" and omitted from consideration in calculation of averages, etc.
INDIV	The individual DIC result for each bottle.
AV(M)	The average DIC of all unflagged mercury manometric measurements.
STDEV(M)	The sample standard deviation calculated from the mercury manometric results, along with the number of mercury manometric results averaged.
AV(S)	The average DIC of all unflagged quartz spiral manometric measurements.
STDEV(S)	The sample standard deviation calculated from the quartz spiral manometric results, along with the number of quartz spiral manometric results averaged.

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 1 (Natural Sea Water)

TABLE 1A
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
900202	S	31PA	001		2021.20				
900202	S	41PA	001		2018.65				
900202	S	73PA	001		2019.83				
900202	S	78PA	001		2019.84				
900604	S	39PA	001		2021.67				
900604	S	40PA	001		2021.03				
900604	S	75PA	001		2019.62				
900604	S	81PA	001		2020.50				
900906	S	38PA	001		2019.88				
900906	S	34PA	001		2020.03				
900906	S	74PA	001		2019.29				
901121	S	32PA	001		2020.31				
901121	S	82PA	001	EX	2015.84			2020.15	0.85(of 12)

ANAL SYST:
S = QUARTZ SPIRAL MANOMETER

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 2 (Natural Sea Water)

TABLE 1B
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
901102	M	282PB	001		1977.67				
901102	M	21PB	001		1977.98				
901102	M	74PB	001		1977.29				
901107	S	282PB	001		1976.49				
901107	S	21PB	001		1977.71				
901107	S	74PB	001		1976.62				
910118	M	264PB	001		1978.60				
910118	M	143PB	001B		1979.99				
910118	M	143PB	001A		1978.96				
910123	S	264PB	001		1978.01				
910123	S	143PB	001		1979.28				
910131	M	125PB	001		1979.14				
910131	S	125PB	001		1979.43				
910201	M	22PB	001		1979.33				
910201	M	25PB	001	EX	2001.79				
910201	M	84PB	001		1979.54				
910201	M	73PB	001		1979.95				
910215	S	22PB	001		1978.18				
910215	S	25PB	001	EX	2001.36				
910215	S	84PB	001		1978.93				
910313	M	9PB	001		1980.07				
910314	M	152PB	001		1979.95				
910314	S	152PB	001		1979.90	1979.00	0.96(of 11)	1978.28	1.21(of 9)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 3 (Natural Sea Water)

TABLE 1C
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910115	M	73PC	001		2049.41				
910115	M	158PC	001		2049.22				
910116	M	273PC	001		2049.28				
910307	M	34PC	001		2052.66				
910308	M	150PC	001		2054.15				
910308	M	166PC	001		2054.03				
910314	S	150PC	001		2054.09				
910314	S	166PC	001		2053.67				
910314	S	34PC	001		2053.11	2051.46	2.42(of 6)	2053.62	0.49(of 3)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 4 (Natural Sea Water)

TABLE 1D
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910404	M	363PD	001		1994.20				
910404	S	363PD	001		1994.54				
910405	M	463PD	001		1994.56				
910405	M	467PD	001		1993.67				
910411	S	463PD	001		1993.65				
910411	S	467PD	001		1993.40				
910419	M	297PD	001		1998.33				
910419	M	481PD	001		1997.85				
910425	S	297PD	001		1996.79				
910502	M	4PD	001		2001.81				
910503	M	166PD	001		1996.82	1996.75	2.88(of 7)	1994.60	1.53(of 4)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 5 (Natural Sea Water)

TABLE 1E
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910510	M	7PE	001		1985.62				
910511	M	9PE	001		1984.74				
910517	M	5PE	001		1994.46				
910517	M	10PE	001		1994.13	1989.74	5.28(of 4)		

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 6 (Bicarbonate/NaCl solution)

TABLE 1F
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910605	M	403PF	001		2303.99				
910605	M	58PF	001		2304.52				
910628	M	116PF	001		2305.82				
910702	S	206PF	001		2304.41				
910702	S	116PF	001		2303.95				
910709	M	8PF	001		2307.99				
910709	M	349PF	001		2304.44				
910719	S	8PF	001	EX	2311.19				
910719	S	349PF	001		2301.93				
910803	M	97PF	001		2304.53				
910803	M	184PF	001		2303.53				
910906	S	220PF	001		2305.26				
910906	S	39PF	001		2305.02				
911010	M	121PF	001		2304.67				
911010	M	350PF	001		2302.25				
911010	S	121PF	001		2303.71				
911010	S	350PF	001		2303.45	2304.64	1.58(of9)	2303.96	1.11(of 7)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 7 (Bicarbonate/NaCl solution)

TABLE 1G
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910815	S	247PG	001		1925.07				
910815	S	73PG	001		1926.07				
910815	S	144PG	001	EX	1930.23				
910906	S	351PG	001		1925.62				
910906	S	202PG	001		1925.73				
910906	S	168PG	001		1927.00				
911010	S	8PG	001		1926.34				
911010	S	108PG	001		1927.75				
920123	M	82PG	001		1925.84				
920123	M	305PG	001		1925.92				
920212	S	305PG	001		1926.21				
920528	M	95PG	001		1927.80				
920528	M	352PG	001		1926.57				
920701	M	100PG	001		1926.85				
920701	M	317PG	001		1926.82	1926.85	0.72(of 6)	1926.19	0.84(of 8)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 8 (Natural Sea Water)

TABLE 1H
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
910906	S	287PH	001		1920.37				
910906	S	227PH	001		1919.78				
910906	S	371PH	001		1920.01			1920.05	0.30(of 3)

ANAL SYST:
S = QUARTZ SPIRAL MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 10 (Natural Sea Water)

TABLE 1I
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
920108	M	18PJ	001		1960.08				
920110	M	505PJ	001		1960.70				
920110	S	18PJ	001		1960.06				
920110	S	505PJ	001		1960.85				
920114	M	509PJ	001		1960.57				
920317	M	171PJ	001		1960.97				
920317	M	464PJ	001		1961.02				
920318	S	171PJ	001		1961.45				
920318	S	464PJ	001		1961.65				
920603	M	60PJ	001		1960.11				
920603	M	538PJ	001		1960.84	1960.61	0.38(of 7)	1961.03	0.72(of 4)

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER
S = QUARTZ SPIRAL MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 11 (Bicarbonate/NaCl solution)

TABLE 1J
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
920123	M	175PK	001		2188.25				
920124	M	202PK	001		2189.09				
920124	M	397PK	001		2188.30				
920317	M	10PK	001		2189.56				
920317	M	379PK	001		2188.63				
920617	M	86PK	001		2188.89				
920617	M	326PK	001		2189.48	2188.87	0.52(of 7)		

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 12 (Natural Sea Water)

TABLE 1K
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
920317	M	11PL	001		1984.48				
920318	M	314PL	001		1983.91				
920318	M	583PL	001		1983.31				
920528	M	176PL	001		1983.80				
920528	M	194PL	001		1984.74				
920804	M	56PL	001		1985.55				
920804	M	557PL	001		1984.02	1984.26	0.73(of 7)		

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material Batch 13 (Natural Sea Water)

TABLE 1L
SUMMARY OF DISSOLVED INORGANIC CARBON DATA

ANAL DATE	ANAL SYST	SAMPLE BOTTLE	RUN	FLAG	DIC(uM/kg) INDIV	AV(M)	STDEV(M)	AV(S)	STDEV(S)
920701	M	3PM	001		2014.50				
920702	M	241PM	001		2015.39				
920702	M	489PM	001		2014.94				
920805	M	18PM	001		2014.76				
920805	M	466PM	001		2014.76	2014.87	0.34(of 5)		

ANAL SYST:
M = CONSTANT VOLUME MERCURY MANOMETER

Appendix Table 2. Summaries of Total Alkalinity Data for Certified Reference Materials

Tables 2A to 2M summarize ALK measurements on water from bottles of Certified Reference Materials (CRM's) prepared in the laboratory of Dr. Andrew Dickson of SIO. These measurements in most cases were made on the same bottles measured for DIC and reported in Table 1, but DO NOT constitute a certification of the 13 batches of CRM's. Natural sea water Batches 4 and 5 proved to be contaminated biologically. During solution of the contamination problem, Batches 6, 7 and later 11 were made of "artificial sea water", mixtures of sodium bicarbonate in a sodium chloride solution matrix. With Batch 13, natural sea water batches stable for ALK were again produced. Several measurements made in 1993 on batch number 13 are not listed in Table 2M. Complete results for CRM batch 13 will be presented in the next report.

Comments on each column in the table follow:

ANAL DATE	The date of potentiometric titration of the CRM sample.
TITR SYST	The titration system used to measure the ALK: G, the gravimetric system, and V, the volumetric system.
SAMPLE BOTTLE	The number refers to the bottle number assigned by the Dickson laboratory: it corresponds to the order of filling of that bottle in its batch. The "P" and the following letter are codes for SIO laboratory use.
TRIAL	This number refers to multiple titrations on the same CRM bottle. In this table, all trials are given equal weight, meaning that all bottles of the batch are considered to contain the same water.
FLAG	Very bad results are flagged with "EX" and omitted from consideration in the calculation of averages.
INDIV	The individual ALK result for each titration trial.
AV(G)	The average ALK of all unflagged gravimetric titrator system measurements.
STDEV(G)	The sample standard deviation calculated from the gravimetric system results, along with the number of gravimetric trials averaged. No listing appears for batches 11 and 12 because only two gravimetric measurements were made.
AV(V)	The average ALK of all unflagged volumetric titrator system measurements.
STDEV(V)	The sample standard deviation calculated from the volumetric system results, along with the number of volumetric trials averaged. No listing appears for batch 13 because only two unflagged volumetric measurements were made.

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 1 (Natural Sea Water)

TABLE 2A
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
26FEB90	G	31PA	1		2296.11				
27FEB90	G	31PA	2		2298.23				
27FEB90	G	41PA	1		2295.30				
27FEB90	G	41PA	2		2297.00				
27FEB90	G	73PA	1		2299.20				
27FEB90	G	73PA	2		2299.66				
27FEB90	G	78PA	1		2299.95				
28FEB90	G	78PA	2		2298.79				
25MAY90	G	39PA	1		2300.59				
25MAY90	G	75PA	1		2301.45				
29MAY90	G	41PA	3		2292.26				
01JUN90	G	81PA	1		2298.95				
04JUN90	G	41PA	4		2296.58				
04JUN90	G	40PA	1		2300.04				
16JUL90	G	40PA	2	EX	2311.45				
06SEP90	G	38PA	1		2298.30				
07SEP90	G	34PA	1		2297.76				
07SEP90	G	74PA	1		2295.83				
030CT90	G	73PA	3		2296.19				
030CT90	G	73PA	4		2302.34				
030CT90	G	78PA	3		2300.13				
040CT90	G	78PA	4		2294.95				
290CT90	G	34PA	3		2295.86				
300CT90	G	34PA	4		2290.07				
14NOV90	G	38PA	3	EX	2305.84				
19NOV90	G	32PA	1		2297.69				
20NOV90	G	82PA	1		2305.84				
20NOV90	G	82PA	2		2297.67				
20NOV90	G	82PA	3		2298.78	2297.98	3.10(of 27)		

TITRATION SYSTEM:
G = GRAVIMETRIC

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 2 (Natural Sea Water)

TABLE 2B
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
14FEB90	G	22PB	3		2242.18				
19NOV90	G	282PB	1		2243.38				
20NOV90	G	21PB	1		2242.37				
21NOV90	G	74PB	1		2245.34				
21NOV90	G	74PB	2		2243.87				
16JAN91	V	143PB	1		2239.68				
17JAN91	V	264PB	1		2243.17				
17JAN91	V	151PB	1		2244.64				
17JAN91	V	250PB	1		2244.99				
30JAN91	V	30PB	1		2243.76				
30JAN91	V	164PB	1		2244.54				
01FEB91	V	25PB	1		2243.02				
01FEB91	V	84PB	1		2246.24				
01FEB91	V	72PB	1		2246.68				
05FEB91	G	73PB	1		2245.99				
07FEB91	V	125PB	1		2248.66				
07FEB91	G	125PB	2		2241.21				
07FEB91	G	125PB	3		2236.45				
07FEB91	V	125PB	4		2243.56				
07FEB91	V	22PB	1	EX	2263.26				
07FEB91	G	22PB	2		2243.23				
01MAR91	G	223PB	1		2244.35				
01MAR91	G	245PB	1		2244.86				
04MAR91	G	55PB	1		2244.45				
04MAR91	G	209PB	1		2244.65				
11MAR91	G	152PB	1		2243.72				
11MAR91	G	9PB	1		2242.59				
02APR91	G	192PB	1		2247.02				
02APR91	G	192PB	2		2246.59				
08MAY91	G	135PB	1		2243.37	2243.66	2.38(of 18)	2244.43	2.30(of 11)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 3 (Natural Sea Water)

TABLE 2C
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
15JAN91	V	73PC	1		2221.01				
15JAN91	V	73PC	2		2219.15				
15JAN91	V	158PC	1		2223.41				
15JAN91	V	158PC	2		2225.35				
16JAN91	V	273PC	1		2222.95				
16JAN91	V	273PC	2		2219.58				
07MAR91	G	150PC	1		2210.19				
07MAR91	G	34PC	1		2214.76				
07MAR91	G	34PC	2		2212.74				
08MAR91	G	150PC	2		2211.07				
08MAR91	G	166PC	1		2214.94				
08MAR91	G	166PC	2		2213.46	2212.86	1.93(of 6)	2221.91	2.41(of 6)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 4 (Natural Sea Water)

TABLE 2D
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
04APR91	G	363PD	1		2247.81				
05APR91	G	463PD	1		2245.96				
05APR91	G	467PD	1		2248.20				
22APR91	G	481PD	2		2235.29				
23APR91	G	297PD	1		2240.23				
02MAY91	G	4PD	1		2240.22				
03MAY91	G	4PD	2		2227.78				
03MAY91	G	166PD	1		2239.47	2240.62	6.89(of 8)		

TITRATION SYSTEM:
G = GRAVIMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 5 (Natural Sea Water)

TABLE 2E
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
09MAY91	G	7PE	1		2215.53				
09MAY91	G	9PE	1		2214.32				
10MAY91	G	9PE	2		2211.33				
17MAY91	G	5PE	1		2189.70				
17MAY91	G	10PE	1		2194.31	2205.04	12.10(of 5)		

TITRATION SYSTEM:
G = GRAVIMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 6 (Bicarbonate/NaCl solution)

TABLE 2F, PAGE 1
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
23MAY91	G	401PF	1		2379.37				
24MAY91	G	401PF	2		2378.96				
24MAY91	G	402PF	1		2379.19				
30MAY91	G	207PF	1		2376.41				
12JUN91	G	58PF	1		2376.84				
12JUN91	G	234PF	1		2379.10				
01JUL91	G	116PF	1		2382.07				
02JUL91	G	206PF	1		2376.67				
08JUL91	G	8PF	1		2380.17				
08JUL91	G	349PF	1		2383.14				
09JUL91	G	403PF	1		2383.87				
05AUG91	G	97PF	1		2382.28				
05AUG91	G	184PF	1		2381.98				
03SEP91	G	39PF	1		2380.94				
28OCT91	G	350PF	1		2375.43				
28OCT91	G	121PF	1		2381.45				
31OCT91	G	155PF	2		2385.09				
31OCT91	G	155PF	1		2383.31				
01NOV91	G	155PF	3		2377.60				
01NOV91	G	350PF	2		2379.59				
04NOV91	G	138PF	2		2381.67				
04NOV91	G	138PF	1		2379.80				
18NOV91	G	400PF	2		2384.21				
18NOV91	G	400PF	1		2380.17				
16DEC91	V	376PF	4		2382.07				
16DEC91	V	376PF	3		2384.98				
16DEC91	V	376PF	2		2383.19				
16DEC91	V	376PF	1		2385.08				
16DEC91	V	205PF	1	EX	2402.31				
16DEC91	V	205PF	4		2387.19				
16DEC91	V	205PF	3		2385.23				
16DEC91	V	205PF	2		2385.51				
17DEC91	V	291PF	3		2382.41				
17DEC91	V	291PF	2		2383.74				
17DEC91	V	291PF	1		2381.86				
17DEC91	V	307PF	3		2383.59				
17DEC91	V	307PF	2		2380.50				
17DEC91	V	307PF	1		2390.98				
26DEC91	V	351PF	4		2384.97				
26DEC91	V	351PF	3		2386.41				
26DEC91	V	351PF	2		2384.22				
26DEC91	V	351PF	1		2386.54				
07JAN92	V	333PF	4		2385.49				
07JAN92	V	333PF	3		2383.23				

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 6 (Bicarbonate/NaCl solution)

TABLE 2F, PAGE 2
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
07JAN92	V	333PF	2		2382.51				
07JAN92	V	391PF	4		2376.32				
07JAN92	V	391PF	3		2386.97				
07JAN92	V	391PF	2		2395.21				
09JAN92	V	28PF	2		2387.05				
09JAN92	V	28PF	1		2384.94				
13JAN92	V	132PF	3		2385.34				
13JAN92	V	132PF	2		2378.72				
13JAN92	V	132PF	1		2383.47				
13JAN92	V	509PF	1	EX	2247.25				
17JAN92	V	505PF	1	EX	2248.63				
27FEB92	V	139PF	3		2381.47				
27FEB92	V	139PF	2		2381.73				
27FEB92	V	139PF	1		2379.82				
27FEB92	V	387PF	3		2384.29				
27FEB92	V	387PF	2		2383.16				
27FEB92	V	387PF	1		2381.09				
19MAR92	V	232PF	2	EX	2407.16				
19MAR92	V	232PF	1		2384.47				
25MAR92	V	328PF	1		2396.99				
26MAR92	V	189PF	4		2381.18				
26MAR92	V	189PF	3		2382.05				
26MAR92	V	189PF	2		2380.39				
26MAR92	V	189PF	1		2376.76				
31MAR92	V	226PF	4		2383.83				
31MAR92	V	226PF	3		2382.82				
31MAR92	V	226PF	2		2398.94				
31MAR92	V	226PF	1		2386.55				
07APR92	V	23PF	4		2383.83				
07APR92	V	23PF	3		2384.18				
07APR92	V	23PF	2		2382.29				
07APR92	V	23PF	1		2382.39	2380.39	2.63(of 24)	2384.29	4.27(of 48)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 7 (Bicarbonate/NaCl solution)

TABLE 2G
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
13AUG91	G	247PG	1	1978.44				
13AUG91	G	73PG	1	1981.38				
13AUG91	G	144PG	2	1981.94				
13AUG91	G	144PG	1	1982.78				
03SEP91	G	351PG	1	1981.34				
04SEP91	G	202PG	2	1982.36				
04SEP91	G	168PG	1	1979.74				
09SEP91	G	168PG	2	1981.53				
23JAN92	V	82PG	1	1978.44				
23JAN92	V	305PG	1	1984.66				
08JUN92	V	95PG	1	1979.63				
08JUN92	V	352PG	1	1989.16				
09JUN92	V	352PG	2	1985.23				
06AUG92	G	100PG	1	1981.89				
07AUG92	G	317PG	1	1981.50	1981.29	1.28(of 10)	1983.42	4.39(of5)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 8 (Natural Sea Water)

TABLE 2H
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
03SEP91	G	371PH	1		2175.72				
04SEP91	G	227PH	1		2162.20				
05SEP91	G	287PH	1		2178.37	2172.10	8.67(of 3)		

TITRATION SYSTEM:
G = GRAVIMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 9 (Natural Sea Water)

TABLE 2I
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
24SEP91	G	6PI	1		2223.39				
24SEP91	G	13PI	1		1858.72				
25SEP91	G	4PI	1		2224.25				
25SEP91	G	11PI	1		2218.11				
25SEP91	G	13PI	2		1861.82				
08OCT91	G	20PI	1		2210.48				
18OCT91	G	43PI	1		2135.46				
31OCT91	G	32PI	2		2205.19				
31OCT91	G	32PI	1		2235.96	2130.38	155.83(of 9)		

TITRATION SYSTEM:
G = GRAVIMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 10 (Natural Sea Water)

TABLE 2J
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
20DEC91	V	380PJ	2		2258.57				
20DEC91	V	380PJ	4		2262.49				
13JAN92	V	509PJ	1		2258.98				
14JAN92	V	18PJ	1		2262.44				
17JAN92	V	505PJ	1		2261.09				
17JAN92	V	505PJ	2		2262.71				
17MAR92	V	464PJ	1		2267.51				
19MAR92	V	171PJ	1		2261.19				
26MAR92	V	464PJ	2		2242.14				
26MAR92	V	18PJ	2		2242.56				
31MAR92	V	171PJ	2		2257.26				
17JUN92	V	60PJ	1		2244.10				
17JUN92	V	538PJ	1		2247.12			2256.01	8.78(of 13)

TITRATION SYSTEM:
V = VOLUMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 11 (Bicarbonate/NaCl Solution)

TABLE 2K
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
23JAN92	V	175PK	1		2357.95				
23JAN92	V	202PK	1		2365.33				
23JAN92	V	397PK	1		2366.07				
19MAR92	V	10PK	1		2365.26				
19MAR92	V	379PK	1		2358.77				
26MAR92	V	379PK	2		2361.61				
31MAR92	V	10PK	2		2366.62				
07AUG92	G	86PK	1		2368.03				
10AUG92	G	326PK	1		2370.35	2369.19		2363.09	3.61(of 7)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 12 (Natural Sea Water)

TABLE 2L
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
19MAR92	V	11PL	1		2225.40				
19MAR92	V	314PL	1		2210.42				
19MAR92	V	583PL	1	EX	2278.11				
23APR92	V	11PL	2	EX	2239.22				
23APR92	V	314PL	2		2227.46				
17JUN92	V	176PL	1		2207.25				
17JUN92	V	194PL	1		2210.44				
07AUG92	G	56PL	1		2226.64				
10AUG92	G	557PL	1		2226.31	2226.48		2216.19	9.46(of 5)

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

FLAGS:
EX: Excluded from analysis

THE CARBON DIOXIDE PROJECT, SCRIPPS INSTITUTION OF OCEANOGRAPHY
Certified Reference Material, Batch 13 (Natural Sea Water)

TABLE 2M
SUMMARY OF ALKALINITY DATA

ANAL DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	ALK(uEQ/KG) INDIV	AV(G)	STDEV(G)	AV(V)	STDEV(V)
10MAR92	V	1PM	1		2206.56				
12MAR92	V	600PM	3		2205.78				
12MAR92	V	600PM	4	EX	2163.61				
07AUG92	G	3PM	1		2200.01				
07AUG92	G	18PM	1	EX	2223.18				
10AUG92	G	3PM	2		2195.55				
10AUG92	G	241PM	1		2198.06				
10AUG92	G	466PM	1		2204.61				
11AUG92	G	489PM	1		2195.11	2198.67	3.86(of 5)	2206.17	

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC

FLAGS:
EX: Excluded from analysis

Appendix Table 3. Summaries of Total Dissolved Inorganic Carbon Data for Replicate Sea Water Samples

Tables 3a to 3e summarize the laboratory DIC measurements by vacuum extraction/manometry on replicate samples of sea water collected on the five expedition legs of 1991, presented in the following order:

Table 3a.	TUNES Leg 1	WOCE Line	P17C
Table 3b.	TUNES Leg 2	WOCE Lines	P17S,P16S
Table 3c.	TUNES Leg 3	WOCE Line	P16C
Table 3d.	Meteor 15	WOCE Line	A9
Table 3e.	Meteor 18	WOCE Line	A1E

Comments on each column in the table follow:

LEG to SAMPLE STN DATE — The identifying information for each Niskin bottle sampled at sea.

EXTRAC DATE — The date of extraction of CO2 gas from an aliquot of sea water taken from a given sample bottle is listed.

ANALYSIS DATE — The date of manometric analysis of the extracted CO2 gas sample is listed. Usually, the date is within one week of the date of extraction. In a few case the intervening time period is longer. See, for example, several stations on TUNES Leg 3, such as Station 238. In April 1992, the quartz spiral manometer was malfunctioning and the new instrument was still under development. Gas extractions were stored for 2 to 3 months sealed in glass tubes before manometric analysis.

MANO TYPE — The manometric system used to analyze the CO2 gas extraction is identified: M, the mercury manometer; S, the Ruska XR38 quartz spiral manometric system; E, the electronic manometric system using the Ruska DDR6000 quartz spiral pressure source and differential pressure transducer.

SAMPLE BOTTLE — The label number for the individual replicate sample bottle filled at sea is listed. The prefix "S" indicates a standard 500 ml Corning borosilicate glass bottle with a hollow stopper (individually lapped to the bottle joint with carborundum grit) equipped with an aluminum bale type fixture for holding the stopper in its sealed position. The prefix "R" indicates a 500 ml borosilicate glass bottle equipped with a standard taper (24/40 size) joint and solid stopper with a Rodawiss plastic knurled nut system for holding the stopper.

RUN — This number indicates whether more than one manometric measurement of a given gas sample was made on each manometer. See, for example, TUNES Leg 2, Station 180, where two measurements on the electronic (E) manometer were made during its initial period of use.

Appendix Table 3. Summaries of Total Dissolved Inorganic Carbon Data for Replicate Sea Water Samples (cont.)

FLAG	The flag code identifies runs that are rejected from further consideration due to identifiable experimental reasons. The flags used have the following meanings: F, evidence indicated that the sample had no mercuric chloride added (see text for further discussion); G, the greased bottle seal showed signs of a severe bottle leak (usually, such bottles were not analyzed); EX, a general flag for some other experimental rejection, such as a procedural extraction error or an equipment malfunction.
S.I.O RUN	The DIC in micromoles per kilogram of sea water is listed for an individual manometric run of a CO2 gas extraction.
RUN DELTA	The run difference for two runs as discussed above, if both runs are unflagged.
BOTTLE DIC	The average bottle DIC for unflagged runs. In most cases (single runs), the S.I.O. RUN and the BOTTLE DIC are identical. In cases where gas extractions were analyzed on both the mercury manometer (first) and one of the other manometers, both DIC's are listed (see, for example, the data from TUNES Leg 1 on Table 3a from Station 74 on).
BOTTLE DELTA	The difference between two bottles collected from a single Niskin bottle is listed. As noted above for cases of measurement on two manometers, the differences for both manometers are listed. For further analysis and comparisons of data, the mercury manometer data are selected.
"NISKIN" AVG	Here is listed the average S.I.O. laboratory DIC result for water from a particular Niskin bottle sampled at sea. Again, as discussed above, the averages for both manometers are listed for those cases where gas samples were measured on two manometers.
{INSTITUTION} DIC	This column lists the shipboard DIC result from a SOMMA or other coulometric system. The institution abbreviations indicate the shipboard CO2 analytical group operating on that expedition leg, as follows: WHOI, the group of Dr. Catherine Goyet, P.I., and Dr. Edward Peltzer of Woods Hole Oceanographic Institution; LDEO, the group of Drs. Taro Takahashi, P. I., and David Chipman of Lamont Doherty Earth Observatory; BNL, the group of Dr. Douglas Wallace, P.I., and Mr. Ken Johnson, of Brookhaven National Laboratory. No inference should be made from the listed data as to the imprecision of the data. Dr. Takahashi estimates the overall imprecision of the LDEO shipboard DIC data as +/- 2. umol/kg (one sigma for a single measurement). Here we choose to list data to one more place than is significant, and thank Dr. Takahashi for his indulgence.
{INSTITUTION} - S.I.O.	The difference between the shipboard DIC result and the laboratory replicate sample average is listed. Note again that for cases where gas samples are measured on two manometers, the differences for both manometers are listed.

Appendix Table 3. Summaries of Total Dissolved Inorganic Carbon Data for Replicate Sea Water Samples (cont.)

NOTE: Dilution Factor

At the end of the Table 3 section for each leg is a note detailing the multiplicative dilution factor applied to account for the addition of the $HgCl_2$ poison solution to the S.I.O. replicate sample bottles. The nominally 500 ml bottles actually hold about 585 ml. Thus for the addition of 0.1 ml of saturated aqueous $HgCl_2$, a dilution factor of 1.00017 is calculated. The shipboard data listed in the last two columns have also been appropriately corrected for dilution by each shipboard analysis group.

SUMMARY OF DISSOLVED INORGANIC CARBON DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
1 5	35-33N 122-52W	1 1	1	Ø3JUN91	2ØAUG91	22AUG91	S	S3750	ØØ1		1982.51		1982.51				
					21AUG91	22AUG91	S	S3751	ØØ1		1983.22		1983.22	+Ø.71	1982.86		
1 8	34-49N 124-35W	1 1	1	Ø4JUN91	21AUG91	22AUG91	S	S3772	ØØ1		1984.63		1984.63				
					22AUG91	22AUG91	S	S3773	ØØ1		1982.71		1982.71	-1.92	1983.67		
		1 3	66		21AUG91	22AUG91	S	S3770	ØØ1		2027.65		2027.65				
					21AUG91	22AUG91	S	S3771	ØØ1		2028.92		2028.92	+1.27	2028.29		
1 11	34-35N 127-38W	1 29	2896	Ø5JUN91	22AUG91	28AUG91	S	S3774	ØØ1		2377.63		2377.63		2377.63		
1 14	34-35N 131-19W	1 1	2	Ø7JUN91	22AUG91	28AUG91	S	S3781	ØØ1		1993.44		1993.44				
					23AUG91	28AUG91	S	S3782	ØØ1		1986.40		1986.40	-7.04	1989.92		
1 17	34-36N 134-58W	2 1	1	Ø8JUN91	Ø9SEP91	12SEP91	S	S3806	ØØ1		1988.39		1988.39				
					1ØSEP91	12SEP91	S	S3807	ØØ1		1988.47		1988.47	+Ø.Ø8	1988.43	1987.4	-1.Ø3
		2 2	52		1ØSEP91	12SEP91	S	S3804	ØØ1		1982.28		1982.28				
					Ø9SEP91	12SEP91	S	S3805	ØØ1		1984.65		1984.65	+2.37	1983.47	1982.5	-Ø.97
		2 4	98		Ø9SEP91	12SEP91	S	S3802	ØØ1		1993.5Ø		1993.5Ø		1993.5Ø	1975.9	-17.6Ø
		2 8	2Ø1		29AUG91	29AUG91	S	S3800	ØØ1		2Ø98.6Ø		2Ø98.6Ø				
					29AUG91	29AUG91	S	S3801	ØØ1		2107.24		2107.24	+8.64	2102.92	2Ø96.8	-6.12
		2 1Ø	3ØØ		28AUG91	29AUG91	S	S3798	ØØ1		2179.95		2179.95				
					28AUG91	29AUG91	S	S3799	ØØ1		2180.55		2180.55	+Ø.6Ø	2180.25	2177.6	-2.65
		2 12	4Ø1		26AUG91	29AUG91	S	S3796	ØØ1		2235.29		2235.29				
					26AUG91	29AUG91	S	S3797	ØØ1		2234.32		2234.32	-Ø.97	2234.81	2225.6	-9.21
		2 14	6Ø1		26AUG91	28AUG91	S	S3794	ØØ1		2309.78		2309.78				
					26AUG91	29AUG91	S	S3795	ØØ1		2311.76		2311.76	+1.98	2310.77	2302.8	-7.97
		2 17	899		26AUG91	28AUG91	S	S3792	ØØ1		2365.29		2365.29				
					26AUG91	28AUG91	S	S3793	ØØ1		2367.9Ø		2367.9Ø	+2.61	2366.59	2351.1	-15.49
		2 19	12ØØ		23AUG91	28AUG91	S	S3790	ØØ1		2373.67		2373.67				
					23AUG91	28AUG91	S	S3791	ØØ1		2373.97		2373.97	+Ø.3Ø	2373.82		
		2 21	16ØØ		23AUG91	28AUG91	S	S3788	ØØ1		2377.93		2377.93				
					23AUG91	28AUG91	S	S3789	ØØ1		2386.Ø4		2386.Ø4	+8.11	2381.99		

MANOMETER TYPE:
  S = QUARTZ SPIRAL MANOMETER DATUM
  M = CONSTANT VOLUME MERCURY MANOMETER DATUM
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
  EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
1	33- 4N	1 1	1	09JUN91	20SEP91	26SEP91	S	S3810	001		2002.42		2002.42				
20	135-00W				20SEP91	26SEP91	S	S3811	001		2002.10		2002.10	-0.32	2002.26	2001.0	-1.26
		1 28	2798		17SEP91	20SEP91	S	S3808	001		2362.65		2362.65				
					19SEP91	20SEP91	S	S3809	001		2362.85		2362.85	+0.20	2362.75	2359.1	-3.65
1	31-32N	1 1	0	10JUN91	24SEP91	26SEP91	S	S3814	001		2007.87		2007.87				
23	135- 0W				24SEP91	26SEP91	S	S3815	001		2010.70		2010.70	+2.83	2009.29	2012.5	3.21
		1 28	3003		24SEP91	26SEP91	S	S3813	001		2356.61		2356.61		2356.61	2353.5	-3.11
1	30- 2N	2 1	1	11JUN91	19AUG91	22AUG91	S	R4478	001		2021.92		2021.92				
26	134-57W				19AUG91	22AUG91	S	R4479	001		2020.63		2020.63	-1.29	2021.28	2022.3	1.02
		2 2	64		09AUG91	12AUG91	S	R4476	001		2031.34		2031.34				
					09AUG91	12AUG91	S	R4477	001		2027.18		2027.18	-4.16	2029.26	2020.8	-8.46
		2 4	109		08AUG91	12AUG91	S	R4474	001		2032.43		2032.43				
					08AUG91	12AUG91	S	R4475	001		2030.79		2030.79	-1.64	2031.61	2021.7	-9.91
		2 7	206		06AUG91	07AUG91	S	R4472	001		2044.07		2044.07				
					08AUG91	12AUG91	S	R4473	001		2043.64		2043.64	-0.43	2043.85	2041.7	-2.15
		2 10	324		06AUG91	07AUG91	S	R4470	001		2099.91		2099.91				
					06AUG91	07AUG91	S	R4471	001		2099.87		2099.87	-0.04	2099.89	2099.3	-0.59
		2 11	400		05AUG91	07AUG91	S	R4468	001	EX	2166.40						
					05AUG91	07AUG91	S	R4469	001		2149.91		2149.91		2149.91	2146.1	-3.81
		2 13	606		05AUG91	07AUG91	S	R4466	001		2283.85		2283.85				
					05AUG91	07AUG91	S	R4467	001		2284.53		2284.53	+0.68	2284.19	2282.1	-2.09
		2 16	909		26SEP91	26SEP91	S	S3824	001		2354.87		2354.87				
					26SEP91	26SEP91	S	S3825	001		2354.57		2354.57	-0.30	2354.72	2351.5	-3.22
		2 18	1202		27SEP91	02OCT91	S	S3822	001		2374.15		2374.15				
					27SEP91	02OCT91	S	S3823	001		2370.18		2370.18	-3.97	2372.17	2365.6	-6.57
		2 20	1605		25SEP91	26SEP91	S	S3820	001		2372.06		2372.06				
					27SEP91	02OCT91	S	S3821	001		2371.81		2371.81	-0.25	2371.94	2368.7	-3.24

MANOMETER TYPE:
  S = QUARTZ SPIRAL MANOMETER DATUM
  M = CONSTANT VOLUME MERCURY MANOMETER DATUM
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
 EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
											(UMOLES/KG SW)						
1	30- 2N	2 22	2007	11JUN91	25SEP91	26SEP91	S	S3818	001		2366.87		2366.87				
26	134-57W				26SEP91	26SEP91	S	S3819	001		2372.19		2372.19	+5.32	2369.53	2366.7	-2.83
		2 27	3000		25SEP91	26SEP91	S	S3816	001		2356.27		2356.27				
					25SEP91	26SEP91	S	S3817	001		2356.34		2356.34	+0.07	2356.31	2355.6	-0.71
1	28-30N	1 1	1	12JUN91	20AUG91	22AUG91	S	R4482	001		2021.52		2021.52				
29	135-00W				20AUG91	22AUG91	S	R4483	001		2022.63		2022.63	+1.11	2022.08	2020.5	-1.58
		1 31	2951		20AUG91	22AUG91	S	R4480	001		2382.18		2382.18				
					20AUG91	22AUG91	S	R4481	001		2378.02		2378.02	-4.16	2380.10	2349.5	-30.60
1	19-30N	1 1	0	18JUN91	10SEP91	12SEP91	S	R4486	001		1979.78		1979.78				
47	135- 0W				10SEP91	13SEP91	S	R4487	001		1979.01		1979.01	-0.77	1979.40	1976.7	-2.70
		1 27	3005		10SEP91	12SEP91	S	S3884	001		2350.86		2350.86				
					10SEP91	12SEP91	S	S3885	001		2351.54		2351.54	+0.68	2351.20	2342.6	-8.60
1	18- 0N	1 1	0	19JUN91	11SEP91	13SEP91	S	R4490	001		1950.81		1950.81				
50	135- 0W				11SEP91	13SEP91	S	R4491	001		1951.11		1951.11	+0.30	1950.96	1947.8	-3.16
		1 27	2999		11SEP91	13SEP91	S	R4488	001		2368.76		2368.76		2368.76	2347.1	-21.66
1	16-30N	1 1	0	20JUN91	02OCT91	02OCT91	S	S3894	001		1944.28		1944.28				
53	135- 0W				04OCT91	10OCT91	S	S3895	001		1946.88		1946.88	+2.60	1945.58	1945.0	-0.58
		1 2	50		01OCT91	02OCT91	S	S3892	001		1944.71		1944.71				
					01OCT91	02OCT91	S	S3893	001		1943.80		1943.80	-0.91	1944.26	1943.7	-0.56
		1 4	112		30SEP91	02OCT91	S	S3890	001		2018.80		2018.80				
					30SEP91	02OCT91	S	S3891	001		2018.45		2018.45	-0.35	2018.63	2017.3	-1.33
		1 8	188		30SEP91	02OCT91	S	S3888	001		2159.93		2159.93				
					30SEP91	02OCT91	S	S3889	001		2160.18		2160.18	+0.25	2160.05	2159.1	-0.95
		1 10	300		26SEP91	02OCT91	S	S3886	001		2261.14		2261.14				
					27SEP91	02OCT91	S	S3887	001		2260.40		2260.40	-0.74	2260.77	2259.3	-1.47
		1 12	402		19SEP91	20SEP91	S	R4504	001		2287.13		2287.13				
					19SEP91	20SEP91	S	R4505	001		2284.44		2284.44	-2.69	2285.78	2281.5	-4.28

MANOMETER TYPE:
  S = QUARTZ SPIRAL MANOMETER DATUM
  M = CONSTANT VOLUME MERCURY MANOMETER DATUM
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
  EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
											(UMOLES/KG SW)						
1	16-30N	1 14	597	20JUN91	18SEP91	20SEP91	S	R4502	001		2314.33		2314.33				
53	135- 0W				18SEP91	20SEP91	S	R4503	001		2316.53		2316.53	+2.20	2315.43	2306.8	-8.63
		1 17	904		17SEP91	20SEP91	S	R4500	001		2343.16		2343.16				
					17SEP91	20SEP91	S	R4501	001		2342.63		2342.63	-0.53	2342.90	2337.4	-5.50
		1 19	1205		16SEP91	20SEP91	S	R4498	001		2360.09		2360.09				
					17SEP91	20SEP91	S	R4499	001		2359.18		2359.18	-0.91	2359.64	2350.7	-8.94
		1 21	1602		13SEP91	13SEP91	S	R4496	001		2369.00		2369.00		2369.00	2359.2	-9.80
		1 23	2008		13SEP91	13SEP91	S	R4494	001		2368.43		2368.43				
					13SEP91	13SEP91	S	R4495	001		2367.86		2367.86	-0.57	2368.15		
		1 28	3000		12SEP91	13SEP91	S	R4492	001		2357.88		2357.88				
					13SEP91	13SEP91	S	R4493	001		2353.83		2353.83	-4.05	2355.85	2349.2	-6.65
1	6- 0N	1 1	-1	26JUN91	05DEC91	05DEC91	M	R4522	001		1914.53		1914.53				
74	135-00W				05DEC91	12DEC91	S	R4522	001		1915.16		1915.16				
					05DEC91	06DEC91	M	R4523	001		1916.39		1916.39	+1.86	1915.46	1915.8	0.34
					05DEC91	12DEC91	S	R4523	001		1916.71		1916.71	+1.55	1915.94	1915.8	-0.14
		1 29	2992		05DEC91	05DEC91	M	R4520	001		2353.96		2353.96				
					05DEC91	09DEC91	S	R4520	001		2353.74		2353.74				
					05DEC91	05DEC91	M	R4521	001		2354.24		2354.24	+0.28	2354.10	2358.3	4.20
					05DEC91	09DEC91	S	R4521	001		2354.81		2354.81	+1.07	2354.28	2358.3	4.02
1	1-00S	1 1	0	03JUL91	09DEC91	10DEC91	M	S3986	001		2017.01		2017.01				
104	135- 0W				09DEC91	13DEC91	S	S3986	001		2017.31		2017.31				
					09DEC91	10DEC91	M	S3987	001		2016.77		2016.77	-0.24	2016.89	2015.6	-1.29
					09DEC91	13DEC91	S	S3987	001		2016.76		2016.76	-0.55	2017.04	2015.6	-1.44
		1 30	2999		06DEC91	06DEC91	M	R4544	001		2340.10		2340.10				
					06DEC91	12DEC91	S	R4544	001		2339.57		2339.57				
					06DEC91	06DEC91	M	R4545	001		2342.51		2342.51	+2.41	2341.31	2334.5	-6.81
					06DEC91	12DEC91	S	R4545	001		2342.36		2342.36	+2.79	2340.97	2334.5	-6.47
1	1-58S	1 30	2998	04JUL91	06DEC91	06DEC91	M	S3988	001		2332.03		2332.03				
110	135- 0W				06DEC91	12DEC91	S	S3988	001		2331.71		2331.71				
					06DEC91	06DEC91	M	S3989	001		2331.95		2331.95	-0.08	2331.99	2330.2	-1.79
					06DEC91	12DEC91	S	S3989	001		2332.40		2332.40	+0.69	2332.05	2330.2	-1.85

MANOMETER TYPE:
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BOTTLE TYPE:
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FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
  EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
1	4-00S	1 1	0	05JUL91	10DEC91	10DEC91	M	S4019	001		2004.84		2004.84				
119	135- 0W				10DEC91	13DEC91	S	S4019	001		2006.22		2006.22				
					10DEC91	11DEC91	M	S4020	001		2004.38		2004.38	-0.46	2004.61	2006.1	1.49
					10DEC91	13DEC91	S	S4020	001		2006.65		2006.65	+0.43	2006.44	2006.1	-0.34
		1 29	3001		10DEC91	10DEC91	M	S4017	001		2329.60		2329.60				
					10DEC91	13DEC91	S	S4017	001		2328.97		2328.97				
					10DEC91	10DEC91	M	S4018	001		2327.62		2327.62	-1.98	2328.61		
					10DEC91	13DEC91	S	S4018	001		2327.83		2327.83	-1.14	2328.40		

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THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
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SUMMARY OF DISSOLVED INORGANIC CARBON DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	LDEO DIC	LDEO -S.I.O.
											(UMOLES/KG SW)						
2	23-43S	1 19	909	01AUG91	11DEC91	11DEC91	M	S4158	001		2208.25		2208.25				
160	132-33W				11DEC91	20DEC91	S	S4158	001		2208.73		2208.73				
					11DEC91	12DEC91	M	S4159	001		2207.96		2207.96	-0.29	2208.10	2206.1	-2.00
					11DEC91	20DEC91	S	S4159	001		2208.23		2208.23	-0.50	2208.48	2206.1	-2.38
2	30-32S	1 61	4	06AUG91	03DEC91	04DEC91	M	R4548	001		2023.46		2023.46				
174	134-20W				03DEC91	09DEC91	S	R4548	001		2022.97		2022.97				
					03DEC91	04DEC91	M	R4549	001		2023.77		2023.77	+0.31	2023.61	2024.2	0.59
					03DEC91	09DEC91	S	R4549	001		2024.61		2024.61	+1.64	2023.79	2024.2	0.41
		1 33	3081		03DEC91	03DEC91	M	R4546	001		2301.42		2301.42				
					03DEC91	06DEC91	S	R4546	001		2303.27		2303.27				
					03DEC91	03DEC91	M	R4547	001		2302.64		2302.64	+1.22	2302.03	2299.0	-3.03
					03DEC91	06DEC91	S	R4547	001		2302.94		2302.94	-0.33	2303.10	2299.0	-4.10
2	37-30S	2 69	315	12AUG91	04DEC91	06DEC91	S	R4565	001		2121.42		2121.42		2121.42	2125.5	4.08
180	150-30W																
		2 11	469		11DEC91	11DEC91	M	R4562	001		2134.64		2134.64				
					11DEC91	19DEC91	S	R4562	001		2133.70		2133.70				
					11DEC91	11DEC91	M	R4563	001		2130.68		2130.68	-3.96	2132.66	2126.2	-6.46
					11DEC91	19DEC91	S	R4563	001		2129.14		2129.14	-4.56	2131.42	2126.2	-5.22
		2 13	622		16DEC91	17DEC91	M	R4560	001		2138.07		2138.07				
					16DEC91	20DEC91	S	R4560	001		2137.74		2137.74				
					16DEC91	17DEC91	M	R4561	001		2133.80		2133.80	-4.27	2135.94	2132.5	-3.44
					16DEC91	20DEC91	S	R4561	001		2134.91		2134.91	-2.83	2136.32	2132.5	-3.82
		2 16	931		06MAY92	17JUL92	E	R4558	001		2169.51						
					06MAY92	17JUL92	E	R4558	002		2168.19	-1.32	2168.85				
					06MAY92	17JUL92	E	R4559	001		2168.22						
					06MAY92	17JUL92	E	R4559	002		2168.53	+0.31	2168.38	-0.47	2168.61	2167.2	-1.41
		2 18	1188		05MAY92	17JUL92	E	R4556	001		2207.85						
					05MAY92	17JUL92	E	R4556	002		2207.82	-0.03	2207.84				
					05MAY92	17JUL92	E	R4557	001		2207.12						
					05MAY92	17JUL92	E	R4557	002		2206.20	-0.92	2206.66	-1.18	2207.25	2202.9	-4.35
		2 20	1543		04DEC91	04DEC91	M	R4554	001		2258.59		2258.59				
					04DEC91	09DEC91	S	R4554	001		2259.74		2259.74				
					04DEC91	05DEC91	M	R4555	001		2258.58		2258.58	-0.01	2258.59	2253.9	-4.69
					04DEC91	09DEC91	S	R4555	001		2257.71		2257.71	-2.03	2258.73	2253.9	-4.83

MANOMETER TYPE:
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BOTTLE TYPE:
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FLAGS:
F: No Hg found in bottle
G: Severe bottle leak
EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	LDEO DIC	LDEO -S.I.O.
2	37-30S	2 22	2052	12AUG91	05MAY92	10JUL92	E	R4552	001	EX	2299.71						
180	150-30W				05MAY92	10JUL92	E	R4552	002		2294.57		2294.57				
					05MAY92	10JUL92	E	R4553	001		2295.61						
					05MAY92	10JUL92	E	R4553	002		2295.46	-0.15	2295.54	+0.97	2295.06	2290.4	-4.66
		2 26	3051		04MAY92	10JUL92	E	R4550	001		2309.37						
					04MAY92	10JUL92	E	R4550	002		2309.74	+0.37	2309.56				
					04MAY92	10JUL92	E	R4551	001		2308.23						
					04MAY92	10JUL92	E	R4551	002	EX	2299.35		2308.23	-1.33	2308.90	2303.7	-5.20
2	21- 0S	1 3	62	23AUG91	12DEC91	13DEC91	M	S4118	001		1997.57		1997.57				
213	150-30W				12DEC91	19DEC91	S	S4118	001		1998.22		1998.22				
					12DEC91	13DEC91	M	S4119	001		1995.37		1995.37	-2.20	1996.47	1992.9	-3.57
					12DEC91	20DEC91	S	S4119	001		1995.98		1995.98	-2.24	1997.10	1992.9	-4.20

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SUMMARY OF DISSOLVED INORGANIC CARBON DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
3	17- 0S	1 36	6	01SEP91	09OCT91	10OCT91	S	R4568	001		1989.51		1989.51				
222	150-30W				09OCT91	10OCT91	S	R4569	001		1990.76		1990.76	+1.25	1990.14		
		1 5	3055		08OCT91	10OCT91	S	R4566	001		2301.30		2301.30				
					08OCT91	10OCT91	S	R4567	001	F	2313.12				2301.30	2298.2	-3.10
3	15- 0S	1 36	7	03SEP91	06NOV91	06NOV91	S	R4592	001		2000.03		2000.03				
226	150-50W				06NOV91	06NOV91	S	R4593	001	EX	1996.88				2000.03	1999.2	-0.83
		1 35	50		06NOV91	06NOV91	S	R4590	001		2001.19		2001.19				
					06NOV91	06NOV91	S	R4591	001		2002.20		2002.20	+1.01	2001.69	1999.8	-1.89
		1 33	130		25OCT91	28OCT91	S	R4588	001		2028.37		2028.37				
					25OCT91	28OCT91	S	R4589	001		2028.99		2028.99	+0.62	2028.68	2027.5	-1.18
		1 31	211		24OCT91	28OCT91	S	R4586	001		2083.06		2083.06				
					24OCT91	28OCT91	S	R4587	001		2082.77		2082.77	-0.29	2082.92	2081.2	-1.72
		1 29	313		24OCT91	28OCT91	S	R4584	001		2105.52		2105.52				
					24OCT91	28OCT91	S	R4585	001		2106.01		2106.01	+0.49	2105.77	2103.5	-2.27
		1 27	413		23OCT91	28OCT91	S	R4582	001		2177.34		2177.34				
					23OCT91	28OCT91	S	R4583	001	F	2202.68				2177.34	2170.9	-6.44
		1 23	618		21OCT91	22OCT91	S	R4580	001		2210.90		2210.90				
					21OCT91	28OCT91	S	R4581	001		2211.69		2211.69	+0.79	2211.29	2205.2	-6.09
		1 18	926		21OCT91	22OCT91	S	R4578	001		2251.25		2251.25				
					21OCT91	22OCT91	S	R4579	001		2250.72		2250.72	-0.53	2250.99	2246.5	-4.49
		1 16	1232		17OCT91	22OCT91	S	R4576	001		2273.12		2273.12				
					17OCT91	22OCT91	S	R4577	001	F	2322.69				2273.12	2274.0	0.88
		1 14	1642		16OCT91	22OCT91	S	R4574	001		2295.35		2295.35				
					16OCT91	22OCT91	S	R4575	001	F	2316.44				2295.35	2293.3	-2.05
		1 12	2056		15OCT91	22OCT91	S	R4572	001		2304.49		2304.49				
					15OCT91	22OCT91	S	R4573	001		2302.96		2302.96	-1.53	2303.73	2307.4	3.67
		1 7	3090		09OCT91	10OCT91	S	R4570	001		2308.10		2308.10				
					09OCT91	10OCT91	S	R4571	001		2310.94		2310.94	+2.84	2309.52	2297.4	-12.12

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BOTTLE TYPE:
  R = RODAVISS S = S TYPE

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
 EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
3	13- 0S	1 36	7	04SEP91	08NOV91	11NOV91	S	R4596	001		1995.36		1995.36				
230	151- 0W				08NOV91	11NOV91	S	R4597	001	F	2008.06				1995.36	1997.6	2.24
		1 7	3139		08NOV91	11NOV91	S	R4594	001		2323.77		2323.77				
					08NOV91	11NOV91	S	R4595	001		2320.07		2320.07	-3.70	2321.92	2319.6	-2.32
3	10-30S	4 36	6	06SEP91	11NOV91	11NOV91	S	R4600	001		1985.69		1985.69				
235	151- 0W				11NOV91	11NOV91	S	R4601	001		1990.58		1990.58	+4.89	1988.14	1991.0	2.86
		4 9	3007		11NOV91	11NOV91	S	R4598	001	EX	2345.77						
					11NOV91	11NOV91	S	R4599	001	F	2358.27					2335.8	
3	9- 0S	1 36	6	07SEP91	30APR92	08JUL92	E	R4624	001		1987.25						
238	151- 0W				30APR92	08JUL92	E	R4624	002		1987.16	-0.09	1987.21				
					04MAY92	08JUL92	E	R4625	001		1987.50						
					04MAY92	08JUL92	E	R4625	002		1987.53	+0.03	1987.52	+0.31	1987.36	1988.0	0.64
		1 34	60		30APR92	08JUL92	E	R4622	001		1986.11						
					30APR92	08JUL92	E	R4622	002		1986.48	+0.37	1986.30				
					30APR92	08JUL92	E	R4623	001	EX	1988.45						
					30APR92	08JUL92	E	R4623	002		1986.93		1986.93	+0.63	1986.62	1988.9	2.28
		1 32	111		29APR92	07JUL92	E	R4620	001		1996.73						
					29APR92	07JUL92	E	R4620	002		1996.12	-0.61	1996.43				
					29APR92	07JUL92	E	R4621	001		1999.51						
					29APR92	07JUL92	E	R4621	002		2000.85	+1.34	2000.18	+3.75	1998.31	1999.5	1.19
		1 26	321		28APR92	07JUL92	E	R4616	001	EX	2234.40						
					28APR92	07JUL92	E	R4616	002	EX	2233.41						
					28APR92	07JUL92	E	R4617	001		2212.72						
					28APR92	07JUL92	E	R4617	002		2212.66	-0.06	2212.69		2212.69	2210.3	-2.39
		1 24	414		27APR92	07JUL92	E	R4614	001		2221.31						
					27APR92	07JUL92	E	R4614	002		2216.45	-4.86	2218.88		2218.88	2221.8	2.92
		1 21	619		27APR92	06JUL92	E	R4612	001		2242.28						
					27APR92	06JUL92	E	R4612	002		2248.68	+4.40	2244.48		2244.48	2241.5	-2.98
		1 18	925		23APR92	30JUN92	E	R4610	001		2277.16						
					23APR92	30JUN92	E	R4610	002		2276.67	-0.49	2276.92				
					23APR92	30JUN92	E	R4611	001		2277.54						
					23APR92	30JUN92	E	R4611	002		2277.07	-0.47	2277.31	+0.39	2277.11	2276.0	-1.11

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BOTTLE TYPE:
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FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
 EX: Data excluded from analysis

SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
3	9- ØS	1 15	1233	Ø7SEP91	23APR92	24APR92	S	R4608	ØØ1		2296.51		2296.51				
238	151- ØW				23APR92	24APR92	S	R4609	ØØ1	EX	2307.46				2296.51	2294.7	-1.81
		1 12	1643		22APR92	24APR92	S	R4606	ØØ1		2314.42		2314.42				
					22APR92	24APR92	S	R4607	ØØ1		2314.25		2314.25	-Ø.17	2314.33	2318.5	4.17
		1 1Ø	2Ø55		2ØAPR92	22APR92	S	R4604	ØØ1		2328.73		2328.73				
					2ØAPR92	22APR92	S	R4605	ØØ1	EX	2333.18				2328.73	2316.1	-12.63
		1 5	3Ø88		2ØAPR92	22APR92	S	R4602	ØØ1		2325.5Ø		2325.5Ø				
					2ØAPR92	22APR92	S	R4603	ØØ1	EX	2349.12				2325.5Ø	2319.8	-5.7Ø
3	7- ØS	1 36	7	Ø8SEP91	17DEC91	18DEC91	M	R4628	ØØ1		1986.28		1986.28				
242	151- ØW				17DEC91	18DEC91	M	R4629	ØØ1		1990.94		1990.94	+4.66	1988.61	1981.9	-6.71
		1 1Ø	3Ø18		16DEC91	17DEC91	M	R4626	ØØ1		2325.Ø9		2325.Ø9				
					16DEC91	17DEC91	M	R4627	ØØ1		2324.42		2324.42	-Ø.67	2324.76	2321.8	-2.96
3	5- ØS	2 36	8	Ø9SEP91	15APR92	22APR92	S	R4652	ØØ1		1997.78		1997.78				
246	151- ØW				15APR92	22APR92	S	R4653	ØØ1	EX	2ØØ7.45				1997.78	1993.5	-4.28
		2 35	6Ø		15APR92	16APR92	S	R4650	ØØ1		1999.52		1999.52				
					15APR92	16APR92	S	R4651	ØØ1		1999.95		1999.95	+Ø.43	1999.73	1994.2	-5.53
		2 33	137		14APR92	16APR92	S	R4648	ØØ1		2Ø78.98		2Ø78.98				
					14APR92	16APR92	S	R4649	ØØ1		2Ø79.55		2Ø79.55	+Ø.57	2Ø79.27	2Ø75.3	-3.97
		2 31	215		14APR92	16APR92	S	R4646	ØØ1		2186.68		2186.68				
					14APR92	16APR92	S	R4647	ØØ1		2184.Ø5		2184.Ø5	-2.63	2185.36	2179.2	-6.16
		2 29	3Ø7		1ØAPR92	1ØAPR92	S	R4644	ØØ1		22Ø2.1Ø		22Ø2.1Ø				
					1ØAPR92	1ØAPR92	S	R4645	ØØ1		22Ø3.25		22Ø3.25	+1.15	22Ø2.68	2198.Ø	-4.68
		2 27	4Ø9		Ø9APR92	1ØAPR92	S	R4642	ØØ1		2266.96		2266.96				
					1ØAPR92	1ØAPR92	S	R4643	ØØ1		2264.42		2264.42	-2.54	2265.69	2259.4	-6.29
		2 23	631		Ø9APR92	1ØAPR92	S	R4640	ØØ1		2260.93		2260.93				
					Ø9APR92	1ØAPR92	S	R4641	ØØ1		2262.44		2262.44	+1.51	2261.69	2255.5	-6.19
		2 2Ø	917		Ø7APR92	Ø8APR92	S	R4638	ØØ1	G	2279.81						
					Ø7APR92	Ø8APR92	S	R4639	ØØ1		2282.19		2282.19		2282.19	2276.Ø	-6.19

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SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
											(UMOLES/KG SW)						
3	5- 0S	2 16	1629	09SEP91	03APR92	08APR92	S	R4634	001	EX	2344.53						
246	151- 0W				03APR92	08APR92	S	R4635	001		2350.01		2350.01		2350.01	2327.2	-22.81
		2 14	1982		02APR92	06JUL92	E	R4632	001		2335.41						
					02APR92	06JUL92	E	R4632	002		2335.60	+0.19	2335.51				
					02APR92	06JUL92	E	R4633	001		2341.49						
					02APR92	06JUL92	E	R4633	002		2342.23	+0.74	2341.86	+6.35	2338.69	2336.0	-2.69
		2 9	3012		02APR92	22JUN92	E	R4630	001		2334.38						
					02APR92	22JUN92	E	R4630	002		2334.91	+0.53	2334.65				
					02APR92	22JUN92	E	R4631	001		2333.27						
					02APR92	22JUN92	E	R4631	002		2333.01	-0.26	2333.14	-1.51	2333.90	2327.1	-6.80
3	3- 0S	1 36	6	11SEP91	30MAR92	19JUN92	E	R4656	001	EX	2013.31						
250	151- 0W				30MAR92	19JUN92	E	R4656	002		2010.17		2010.17				
					30MAR92	19JUN92	E	R4657	001	EX	2036.46						
					30MAR92	19JUN92	E	R4657	002		2010.88		2010.88	+0.71	2010.53	2008.4	-2.13
		1 8	3084		26MAR92	19JUN92	E	R4654	001		2336.35						
					26MAR92	19JUN92	E	R4654	002		2335.67	-0.68	2336.01				
					26MAR92	19JUN92	E	R4655	001	EX	2348.74						
					26MAR92	19JUN92	E	R4655	002		2336.62		2336.62	+0.61	2336.32	2329.9	-6.42
3	1- 0S	1 36	7	14SEP91	01APR92	22JUN92	E	R4660	001		2011.31						
262	151- 0W				01APR92	22JUN92	E	R4660	002		2010.97	-0.34	2011.14				
					01APR92	22JUN92	E	R4661	001		2014.10						
					01APR92	22JUN92	E	R4661	002		2014.07	-0.03	2014.08	+2.94	2012.61	2001.1	-11.51
		1 8	2980		01APR92	06JUL92	E	R4659	001		2355.34						
					01APR92	06JUL92	E	R4659	002	EX	2442.14						
					01APR92	06JUL92	E	R4659	003	EX	2363.41		2355.34		2355.34	2338.1	-17.24
3	1- 0N	1 34	38	16SEP91	26MAR92	18JUN92	E	R4682	001		1985.80						
274	151- 0W				26MAR92	18JUN92	E	R4682	002		1985.49	-0.31	1985.65				
					26MAR92	18JUN92	E	R4683	001	EX	2022.66						
					26MAR92	18JUN92	E	R4683	002	EX	2022.20				1985.65	1986.3	0.65
		1 33	67		24MAR92	18JUN92	E	R4680	001		2007.19						
					24MAR92	18JUN92	E	R4680	002		2006.66	-0.53	2006.93				
					24MAR92	18JUN92	E	R4681	001		2004.94						
					24MAR92	18JUN92	E	R4681	002		2005.10	+0.16	2005.02	-1.91	2005.98	2007.3	1.32

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SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC (UMOLES/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
3	1- ØN	1 3Ø	154	16SEP91	2ØMAR92	12JUN92	E	R4678	ØØ1	EX	2107.1Ø						
274	151- ØW				2ØMAR92	12JUN92	E	R4678	ØØ2		2104.63		2104.63				
					2ØMAR92	12JUN92	E	R4679	ØØ1	EX	2106.93						
					2ØMAR92	12JUN92	E	R4679	ØØ2		2105.27		2105.27	+Ø.64	2104.95	2104.8	-Ø.15
		1 27	278		2ØMAR92	12JUN92	E	R4676	ØØ1		2202.72						
					2ØMAR92	12JUN92	E	R4676	ØØ2		2202.77	+Ø.Ø5	2202.75				
					2ØMAR92	12JUN92	E	R4677	ØØ1		2203.11						
					2ØMAR92	12JUN92	E	R4677	ØØ2		2202.77	-Ø.34	2202.94	+Ø.19	2202.84	2201.9	-Ø.94
		1 25	354		Ø6MAR92	Ø8JUN92	E	R4674	ØØ1		2242.33		2242.33				
					Ø6MAR92	Ø8JUN92	E	R4675	ØØ1		2242.49		2242.49	+Ø.16	2242.41	2239.6	-2.81
		1 18	8Ø1		Ø6MAR92	Ø8APR92	S	R4670	ØØ1		2287.11		2287.11				
					Ø6MAR92	Ø8APR92	S	R4671	ØØ1		2287.96		2287.96	+Ø.85	2287.54	2281.1	-6.44
		1 16	1ØØ7		Ø5MAR92	18MAR92	S	R4668	ØØ1	EX	2305.69						
					Ø5MAR92	Ø8APR92	M	R4669	ØØ1		2298.18		2298.18		2298.18	2297.9	-Ø.28
					Ø5MAR92	18MAR92	S	R4669	ØØ1		2300.8Ø		2300.8Ø		2300.8Ø	2297.9	-2.9Ø
		1 14	1368		Ø5MAR92	18MAR92	S	R4666	ØØ1		2333.58		2333.58				
					Ø5MAR92	18MAR92	S	R4667	ØØ1		2332.ØØ		2332.ØØ	-1.58	2332.79	2329.3	-3.49
		1 12	1778		Ø3MAR92	Ø6MAR92	M	R4664	ØØ1		2346.37		2346.37				
					Ø3MAR92	Ø4MAR92	S	R4664	ØØ1		2346.29		2346.29				
					Ø3MAR92	Ø6MAR92	M	R4665	ØØ1		2345.Ø2		2345.Ø2	-1.35	2345.7Ø	2343.5	-2.2Ø
					Ø3MAR92	Ø4MAR92	S	R4665	ØØ1	EX	2353.84				2346.29	2343.5	-2.79
3	3- ØN	1 35	7	18SEP91	18DEC91	19DEC91	M	R4690	ØØ1		1964.98		1964.98				
286	151- ØW				18DEC91	19DEC91	M	R4691	ØØ1		1964.28		1964.28	-Ø.7Ø	1964.63	1963.9	-Ø.73
		1 1Ø	3Ø84		17DEC91	18DEC91	M	R4687	ØØ1		2352.51		2352.51				
					17DEC91	18DEC91	M	R4688	ØØ1	F	2388.23				2352.51	2343.1	-9.41
3	5- ØN	1 36	8	2ØSEP91	27FEB92	28FEB92	S	R4714	ØØ1		1911.47		1911.47				
29Ø	151- ØW				27FEB92	28FEB92	S	R4715	ØØ1		1911.83		1911.83	+Ø.36	1911.65	1912.3	Ø.65
		1 34	81		27FEB92	28FEB92	S	R4712	ØØ1		1987.Ø7		1987.Ø7				
					Ø2MAR92	Ø4MAR92	S	R4713	ØØ1		1988.76		1988.76	+1.69	1987.92	1989.2	1.28
		1 33	12Ø		27FEB92	28FEB92	S	R4710	ØØ1		2010.32		2010.32				
					27FEB92	28FEB92	S	R4711	ØØ1		2010.48		2010.48	+Ø.16	2010.4Ø	2009.9	-Ø.5Ø

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3	5- 0N	1 31	205	20SEP91	25FEB92	26FEB92	S	R4708	001		2183.54		2183.54				
290	151- 0W				25FEB92	26FEB92	S	R4709	001		2184.77		2184.77	+1.23	2184.16	2183.8	-0.36
		1 29	296		25FEB92	26FEB92	S	R4706	001	G	2200.77						
					25FEB92	26FEB92	S	R4707	001		2198.48		2198.48		2198.48	2197.8	-0.68
		1 27	411		24FEB92	26FEB92	S	R4704	001		2228.90		2228.90				
					24FEB92	26FEB92	S	R4705	001		2232.08		2232.08	+3.18	2230.49	2225.6	-4.89
		1 23	616		20FEB92	21FEB92	S	R4702	001		2285.54		2285.54				
					20FEB92	21FEB92	S	R4703	001		2286.29		2286.29	+0.75	2285.92	2285.8	-0.12
		1 20	924		20FEB92	21FEB92	S	R4700	001		2317.36		2317.36				
					20FEB92	21FEB92	S	R4701	001		2318.51		2318.51	+1.15	2317.94	2318.2	0.26
		1 18	1230		20FEB92	21FEB92	S	R4698	001		2332.71		2332.71				
					20FEB92	21FEB92	S	R4699	001		2329.61		2329.61	-3.10	2331.16	2329.6	-1.56
		1 16	1642		18FEB92	19FEB92	S	R4696	001		2351.26		2351.26				
					18FEB92	19FEB92	S	R4697	001		2352.54		2352.54	+1.28	2351.90	2350.2	-1.70
		1 14	2054		18FEB92	19FEB92	S	R4694	001		2356.78		2356.78				
					18FEB92	19FEB92	S	R4695	001		2355.39		2355.39	-1.39	2356.08	2354.7	-1.38
		1 9	3089		18FEB92	19FEB92	S	R4692	001		2350.14		2350.14				
					18FEB92	19FEB92	S	R4693	001		2350.66		2350.66	+0.52	2350.40	2349.9	-0.50
3	6-58N	1 36	10	21SEP91	13FEB92	14FEB92	S	R4718	001		1876.38		1876.38				
294	151-22W				13FEB92	14FEB92	S	R4719	001		1876.88		1876.88	+0.50	1876.63	1874.1	-2.53
		1 10	3191		14FEB92	18FEB92	M	R4716	001	F	2370.05						
					14FEB92	14FEB92	S	R4716	001	F	2370.11						
					14FEB92	14FEB92	S	R4717	001		2351.85		2351.85		2351.85	2348.5	-3.35
3	8-56N	1 36	16	22SEP91	11FEB92	14FEB92	S	R4722	001		1874.30		1874.30				
298	151-45W				11FEB92	14FEB92	S	R4723	001		1875.76		1875.76	+1.46	1875.03	1873.0	-2.03
		1 9	3058		10FEB92	12FEB92	S	R4720	001		2356.37		2356.37				
					10FEB92	12FEB92	S	R4721	001	F	2372.85				2356.37	2351.2	-5.17

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SUMMARY OF DISSOLVED INORGANIC CARBON DATA (cont)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	WHOI DIC	WHOI -S.I.O.
											(UMOLES/KG SW)						
3	10-54N	1 36	8	23SEP91	06FEB92	07FEB92	S	R4746	001		1883.39		1883.39				
302	152- 7W				06FEB92	07FEB92	S	R4747	001		1882.09		1882.09	-1.30	1882.74	1881.6	-1.14
		1 34	60		06FEB92	12FEB92	S	R4744	001		2019.82		2019.82				
					06FEB92	12FEB92	S	R4745	001		2018.41		2018.41	-1.41	2019.11	2016.1	-3.01
		1 32	110		04FEB92	07FEB92	S	R4742	001		2105.50		2105.50				
					04FEB92	07FEB92	S	R4743	001		2106.06		2106.06	+0.56	2105.78	2104.7	-1.08
		1 29	212		04FEB92	07FEB92	S	R4740	001		2256.50		2256.50				
					04FEB92	07FEB92	S	R4741	001		2256.63		2256.63	+0.13	2256.56	2251.8	-4.76
		1 27	314		03FEB92	05FEB92	S	R4738	001		2269.21		2269.21				
					03FEB92	05FEB92	S	R4739	001		2268.05		2268.05	-1.16	2268.63	2264.8	-3.83
		1 26	416		03FEB92	05FEB92	S	R4736	001		2283.28		2283.28				
					03FEB92	05FEB92	S	R4737	001		2284.03		2284.03	+0.75	2283.66	2278.7	-4.96
		1 24	621		30JAN92	31JAN92	S	R4734	001		2306.12		2306.12				
					30JAN92	31JAN92	S	R4735	001		2306.76		2306.76	+0.64	2306.44	2304.4	-2.04
		1 21	928		30JAN92	31JAN92	S	R4732	001		2337.18		2337.18				
					30JAN92	31JAN92	S	R4733	001		2336.67		2336.67	-0.51	2336.93	2336.0	-0.93
		1 19	1237		29JAN92	31JAN92	S	R4730	001		2346.32		2346.32				
					29JAN92	31JAN92	S	R4731	001		2346.92		2346.92	+0.60	2346.62	2344.4	-2.22
		1 17	1647		29JAN92	31JAN92	M	R4728	001		2356.28		2356.28				
					29JAN92	03FEB92	M	R4729	001		2356.63		2356.63	+0.35	2356.46		
		1 15	2058		28JAN92	31JAN92	M	R4726	001		2358.55		2358.55				
					28JAN92	31JAN92	M	R4727	001		2358.78		2358.78	+0.23	2358.67		
		1 10	3086		28JAN92	30JAN92	M	R4724	001		2352.68		2352.68				
					28JAN92	31JAN92	M	R4725	001		2354.21		2354.21	+1.53	2353.45	2352.0	-1.45
3	12-52N	1 36	9	24SEP91	10FEB92	12FEB92	S	R4750	001		1902.07		1902.07				
306	152-30W				10FEB92	12FEB92	S	R4751	001		1902.50		1902.50	+0.43	1902.29	1901.8	-0.49
3	14-50N	1 36	9	26SEP91	19DEC91	20DEC91	M	R4754	001		1905.97		1905.97				
310	152-53W				19DEC91	20DEC91	M	R4755	001		1905.89		1905.89	-0.08	1905.93	1907.5	1.57

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3	14-50N	1 12	3081	26SEP91	18DEC91	19DEC91	M	R4752	001		2350.86		2350.86				
310	152-53W				18DEC91	19DEC91	M	R4753	001	EX	2289.18				2350.86	2350.3	-0.56
3	16-48N	2 36	9	27SEP91	22JAN92	23JAN92	M	R4778	001		1945.09		1945.09				
314	153-16W				22JAN92	23JAN92	M	R4779	001		1944.96		1944.96	-0.13	1945.03	1943.0	-2.03
		2 34	76		21JAN92	22JAN92	M	R4776	001		1969.99		1969.99				
					21JAN92	22JAN92	M	R4777	001		1969.09		1969.09	-0.90	1969.54	1967.0	-2.54
		2 33	107		21JAN92	22JAN92	M	R4774	001		1992.20		1992.20				
					21JAN92	22JAN92	M	R4775	001		1991.67		1991.67	-0.53	1991.94	1990.3	-1.64
		2 30	216		17JAN92	17JAN92	M	R4772	001		2119.99		2119.99				
					17JAN92	17JAN92	M	R4773	001		2119.22		2119.22	-0.77	2119.60	2118.4	-1.20
		2 28	318		16JAN92	17JAN92	M	R4770	001		2203.32		2203.32				
					16JAN92	17JAN92	M	R4771	001		2204.20		2204.20	+0.88	2203.76	2201.3	-2.46
		2 25	442		16JAN92	17JAN92	M	R4768	001		2290.49		2290.49				
					16JAN92	17JAN92	M	R4769	001		2288.47		2288.47	-2.02	2289.48	2286.9	-2.58
		2 22	676		15JAN92	16JAN92	M	R4766	001		2317.23		2317.23				
					15JAN92	16JAN92	M	R4767	001		2316.61		2316.61	-0.62	2316.92	2313.5	-3.42
		2 20	933		15JAN92	16JAN92	M	R4764	001		2339.44		2339.44				
					15JAN92	16JAN92	M	R4765	001		2336.69		2336.69	-2.75	2338.06	2336.2	-1.86
		2 18	1291		14JAN92	16JAN92	S	R4762	001		2351.69		2351.69				
					14JAN92	16JAN92	S	R4763	001		2354.33		2354.33	+2.64	2353.01	2349.6	-3.41
		2 16	1698		08JAN92	16JAN92	S	R4760	001		2360.20		2360.20				
					08JAN92	16JAN92	S	R4761	001		2360.46		2360.46	+0.26	2360.33	2357.7	-2.63
		2 14	2113		08JAN92	10JAN92	S	R4758	001		2361.29		2361.29		2361.29	2358.6	-2.69
		2 9	3201		07JAN92	16JAN92	S	R4757	001	EX	2279.37					2346.1	

MANOMETER TYPE:
  S = QUARTZ SPIRAL MANOMETER DATUM
  E = ELECTRONIC CONSTANT-VOLUME MANOMETER DATUM
  M = CONSTANT VOLUME MERCURY MANOMETER DATUM
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
 EX: Data excluded from analysis

NOTE: Dilution factor of 1.000170 has been applied.

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg M15 1991 Atlantic WOCE Line A9 Table 3d

SUMMARY OF DISSOLVED INORGANIC CARBON DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	BNL DIC	BNL -S.I.O.
											(UMOLES/KG SW)						
	19-00S	3 18	1593	16FEB91	05JUL91	19JUL91	S	R4934	001		2172.24		2172.24				
143	30-01W				09JUL91	19JUL91	S	R4935	001		2170.89		2170.89	-1.35	2171.56	2174.21	2.65
		3 12	2995		26JUL91	07AUG91	S	R4933	001		2183.44		2183.44		2183.44	2180.38	-3.06
	19-00S	2 24	8	21FEB91	28JUN91	02JUL91	S	R4938	001		2093.52		2093.52				
154	23-15W				01JUL91	02JUL91	S	R4939	001		2097.64		2097.64	+4.12	2095.58	2084.12	-11.46
	19-12S	2 24	7	03MAR91	05JUL91	19JUL91	S	R4956	001		2073.47		2073.47				
187	08-12W				31JUL91	07AUG91	S	R4957	001		2077.70		2077.70	+4.23	2075.58	2073.05	-2.53
		3 18	1194		09JUL91	19JUL91	S	R4962	001		2220.12		2220.12				
					09JUL91	19JUL91	S	R4963	001		2215.44		2215.44	-4.68	2217.78	2212.87	-4.91
		3 12	2492		05JUL91	19JUL91	S	R4961	001		2183.74		2183.74		2183.74	2188.71	4.97
	19-00S	2 2	898	07MAR91	01JUL91	02JUL91	S	R4964	001		2228.93		2228.93				
199	01-54W				01JUL91	02JUL91	S	R4965	001		2227.83		2227.83	-1.10	2228.38	2220.60	-7.78

MANOMETER TYPE:
  S = QUARTZ SPIRAL MANOMETER DATUM

BOTTLE TYPE:
  R = RODAVISS S = S TYPE

NOTE: Dilution factor of 1.000170 has been applied.

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
  EX: Data excluded from analysis

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg M18 1991 Atlantic WOCE Line A1E Table 3e

SUMMARY OF DISSOLVED INORGANIC CARBON DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	EXTRAC DATE	ANALYSIS DATE	MANO TYPE	SAMPLE BOTTLE	RUN	FLAG	S.I.O. RUN	RUN DELTA	BOTTLE DIC	BOTTLE DELTA	"NISKIN" AVG	BNL DIC	BNL -S.I.O.
											(UMOLES/KG SW)						
	59- 1N	1 24	11	09SEP91	14FEB94	02MAR94	E	R4830	001		2087.98		2087.98		2087.98	2088.09	0.11
575	32-46W																
		1 13	1101		11FEB94	02MAR94	E	R4828	A001		2154.58						
					11FEB94	02MAR94	E	R4828	B001		2155.11	+0.53	2154.85				
					11FEB94	02MAR94	E	R4829	A001		2154.44						
					11FEB94	02MAR94	E	R4829	B001		2154.04	-0.40	2154.24	-0.61	2154.55	2153.12	-1.43
	58-19N	1 23	28	10SEP91	16FEB94	02MAR94	E	R4842	001		2093.78		2093.78				
580	29-56W				16FEB94	02MAR94	E	R4843	001		2095.39		2095.39	+1.61	2094.58	2084.27	-10.31
		1 1	2333		14FEB94	02MAR94	E	R4839	001		2160.00		2160.00		2160.00	2155.10	-4.90
	58-11N	1 2	2008	10SEP91	27JAN94	02FEB94	E	R4844	A001		2158.71						
581	29-37W				27JAN94	02FEB94	E	R4844	B001		2158.91	+0.20	2158.81				
					27JAN94	02FEB94	E	R4845	A001		2158.41						
					27JAN94	02FEB94	E	R4845	B001		2158.89	+0.48	2158.65	-0.16	2158.73	2156.52	-2.21
	45-22N	1 14	689	14SEP91	15FEB94	02MAR94	E	R4874	001		2169.27		2169.27				
596	25-57W				15FEB94	02MAR94	E	R4875	001		2166.20		2166.20	-3.07	2167.74	2165.86	-1.88
	52-51N	1 1	3984	16SEP91	15FEB94	02MAR94	E	R4878	001		2204.03		2204.03				
603	22-23W				15FEB94	02MAR94	E	R4879	001		2203.65		2203.65	-0.38	2203.84	2200.24	-3.60

MANOMETER TYPE:
  E = ELECTRONIC CONSTANT-VOLUME MANOMETER DATUM

BOTTLE TYPE:
  R = RODAVISS S = S TYPE

NOTE: Dilution factor of 1.000170 has been applied.

FLAGS:
  F: No Hg found in bottle
  G: Severe bottle leak
  EX: Data excluded from analysis

Appendix Table 4. Summaries of Titration Alkalinity Data for Replicate Sea Water Samples

Tables 4a to 4e summarize the laboratory ALK measurements by potentiometric titration of replicate samples collected on the five expedition legs of 1991, presented in the following order:

Table 4a.	TUNES Leg 1	WOCE Line	P17C
Table 4b.	TUNES Leg 2	WOCE Lines	P17S,P16S
Table 4c.	TUNES Leg 3	WOCE Line	P16C
Table 4d.	Meteor 15	WOCE Line	A9
Table 4e.	Meteor 18	WOCE Line	A1E

Comments on each column in the table follow:

LEG to SAMPLE STN DATE — The identifying information for each Niskin bottle sampled at sea.

ANALYSIS DATE — The date of potentiometric titration of an aliquot of sea water taken from a replicate sample bottle. After the aliquot for DIC extraction was removed from a bottle, the bottle was immediately resealed and stored at room temperature for short periods of time or refrigerated for longer periods of time until titration.

TITR SYST — The system used for titration is identified: G, the gravimetric system; V, the volumetric system. Sometimes aliquots from the same bottle were titrated on both systems.

SAMPLE BOTTLE — The label number for the individual replicate sample bottle filled at sea. The prefix "S" indicates a standard 500 ml Corning borosilicate glass bottle with a hollow stopper (individually lapped to the bottle joint with carborundum grit) equipped with an aluminum bale type fixture for holding the stopper in its sealed position. The prefix "R" indicates a 500 ml borosilicate glass bottle equipped with a standard taper (24/40 size) joint and solid stopper with a Rodawiss plastic knurled nut system for holding the stopper.

TRIAL — This number indicates whether more than one titration was made on water from a replicate sample bottle. Sometimes titrations were deleted before reaching the data base at all, for example if the titration cell was filled improperly. Quite often, one or more of multiple trials are flagged in the data set: usually multiple trials were made because of a problem with the first trial.

FLAG — The flag code identifies trials that are rejected from further consideration due to identifiable experimental reasons. The flags used have the following meanings: F, evidence indicated that the sample had no mercuric chloride added (see text for further discussion); X, the titrator malfunctioned for some definable reason; EX, a general flag for some other experimental rejection, such as a very poor fit of the titration data.

Appendix Table 4. Summaries of Titration Alkalinity Data for Replicate Sea Water Samples (cont.)

S.I.O TRIAL	The ALK in micromoles per kilogram of sea water of hydrogen ion equivalent is listed for an individual trial titration.
TRIAL DELTA	The trial difference for two trials as discussed above, if both trials are unflagged.
BOTTLE ALK	The average bottle ALK for unflagged trials. In most cases (single trials), the S.I.O. TRIAL and the BOTTLE ALK are identical.
BOTTLE DELTA	The difference in ALK between two bottles collected from a single Niskin bottle is listed.
"NISKIN" AVG	Here is listed the average S.I.O. laboratory ALK result for water from a particular Niskin bottle sampled at sea. If two titration systems were used (see TUNES Leg 3, station 222, bottle number R4569), the averages for both systems are listed.
{INSTITUTION} ALK	The shipboard ALK result from a shipboard titration. The institution abbreviations indicate the shipboard CO2 analytical group operating on that expedition leg, as follows: WHOI, the group of Dr. Catherine Goyet, P.I., of Woods Hole Oceanographic Institution, on TUNES Leg 1; CDRG, the group of Dr. Charles Keeling, P.I., of Scripps Institution of Oceanography, on TUNES Leg 3. The data for both legs are considered to be final, as reported to the Carbon Dioxide Information and Analysis Center. The remaining legs had no shipboard ALK measured by the U.S. CO2 group on board. No inference should be made from the listed data as to the imprecision of the data. Here we choose to list data to more places than are significant.
{INSTITUTION} - S.I.O.	The difference between the shipboard ALK result and the average laboratory replicate sample ALK. Note again that for the case discussed above, the differences for both systems are listed.
NOTE: Dilution Factor	At the end of the Table 4 section for each leg is a note detailing the multiplicative dilution factor applied to account for the addition of the HgCl2 poison solution to the S.I.O. replicate sample bottles. The nominally 500 ml bottles actually hold about 585 ml. Thus for the addition of 0.1 ml of saturated aqueous HgCl2, a dilution factor of 1.00017 is calculated. The shipboard data listed in the last two columns have also been appropriately corrected for dilution by each shipboard analysis group.

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
TUNES Leg 1 1991 Pacific WOCE Line P17C

SUMMARY OF ALKALINITY DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	WHOI ALK	WHOI -S.I.O.
										(UEQUIV/KG SW)						
1	35-33N	1 1	1	03JUN91	22AUG91	G	S3750	1		2204.15		2204.15				
5	122-52W				29AUG91	G	S3751	1		2205.13		2205.13	+0.98	2204.64		
1	34-49N	1 1	1	04JUN91	22AUG91	G	S3772	1	EX	2316.17						
8	124-35W				22AUG91	G	S3772	2		2209.65		2209.65				
					22AUG91	G	S3773	1		2203.60		2203.60	-6.05	2206.63		
		1 3	66		29AUG91	G	S3770	1		2220.45		2220.45				
					30AUG91	G	S3771	1		2219.65		2219.65	-0.80	2220.05		
1	34-35N	1 29	2896	05JUN91	30AUG91	G	S3774	1		2435.74		2435.74		2435.74		
11	124-35W															
1	34-35N	1 1	2	07JUN91	30AUG91	G	S3781	1		2218.35		2218.35				
14	131-19W				23AUG91	G	S3782	1		2217.58		2217.58	-0.77	2217.97		
1	34-36N	2 1	1	08JUN91	10SEP91	G	S3806	1		2220.01		2220.01				
17	134-58W				10SEP91	G	S3807	1		2218.75		2218.75	-1.26	2219.38	2240.88	21.50
		2 2	52		11SEP91	G	S3804	1	X	2222.88						
					09SEP91	G	S3805	1		2217.63		2217.63		2217.63	2228.51	10.88
		2 4	98		09SEP91	G	S3802	1		2223.61		2223.61				
					09SEP91	G	S3803	1		2222.49		2222.49	-1.12	2223.05		
		2 8	201		30AUG91	G	S3800	1		2228.37		2228.37				
					30AUG91	G	S3801	1		2224.11		2224.11	-4.26	2226.24	2237.92	11.68
		2 10	300		28AUG91	G	S3798	1		2265.57		2265.57				
					28AUG91	G	S3799	1		2266.51		2266.51	+0.94	2266.04	2285.16	19.12
		2 12	401		28AUG91	G	S3796	1		2285.54		2285.54				
					28AUG91	G	S3797	1		2281.77		2281.77	-3.77	2283.66		
		2 14	601		26AUG91	G	S3794	1		2315.58		2315.58				
					28AUG91	G	S3795	1	EX	2333.46						
					28AUG91	G	S3795	2	EX	2325.05				2315.58		
		2 17	899		26AUG91	G	S3792	1		2364.40		2364.40				
					26AUG91	G	S3793	1		2364.20		2364.20	-0.20	2364.30		
		2 19	1200		30AUG91	G	S3790	1		2398.41		2398.41				
					30AUG91	G	S3791	1		2390.65		2390.65	-7.76	2394.53		

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC
BOTTLE TYPE:
R = RODAVISS S = S TYPE

FLAGS:
F: No Hg found in bottle
X: Titrator malfunction
EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK (UEQUIV/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI ALK	WHOI -S.I.O.
1	34-36N	2 21	1600	08JUN91	30AUG91	G	S3788	1		2411.69		2411.69				
17	134-58W				30AUG91	G	S3789	1		2411.69		2411.69	+0.00	2411.69		
1	33- 4N	1 1	1	09JUN91	20SEP91	G	S3810	1		2248.16		2248.16				
20	135-00W				25SEP91	G	S3811	1		2247.08		2247.08	-1.08	2247.62	2257.66	10.04
		1 28	2798		17SEP91	G	S3808	1	EX	2432.87						
					19SEP91	G	S3809	1		2443.29		2443.29		2443.29		
1	31-32N	1 1	0	10JUN91	25SEP91	G	S3814	1		2271.47		2271.47				
23	135- 0W				25SEP91	G	S3815	1		2268.13		2268.13	-3.34	2269.80		
		1 28	3003		25SEP91	G	S3812	1		2433.30		2433.30				
					25SEP91	G	S3813	1		2433.64		2433.64	+0.34	2433.47		
1	30- 2N	2 1	1	11JUN91	20AUG91	G	R4478	1		2293.17		2293.17				
26	134-57W				20AUG91	G	R4479	1		2300.12		2300.12	+6.95	2296.65	2312.16	15.51
		2 2	64		09AUG91	G	R4476	1		2300.65		2300.65				
					13AUG91	G	R4477	1		2301.02		2301.02	+0.37	2300.83	2310.21	9.38
		2 4	109		09AUG91	G	R4474	1		2305.69		2305.69				
					12AUG91	G	R4475	1		2302.70		2302.70	-2.99	2304.20	2311.85	7.65
		2 7	206		06AUG91	G	R4472	1		2265.51		2265.51				
					09AUG91	G	R4473	1		2264.61		2264.61	-0.90	2265.06	2277.49	12.43
		2 10	324		06AUG91	G	R4470	1		2256.03		2256.03				
					06AUG91	G	R4471	1		2256.65		2256.65	+0.62	2256.34	2262.15	5.81
		2 11	400		12AUG91	G	R4468	1		2261.41		2261.41				
					12AUG91	G	R4469	1		2262.53		2262.53	+1.12	2261.97	2276.06	14.09
		2 13	606		05AUG91	G	R4466	1		2304.68		2304.68				
					06AUG91	G	R4467	1		2304.19		2304.19	-0.49	2304.44		
		2 16	909		30SEP91	G	S3824	2		2355.35		2355.35				
					26SEP91	G	S3825	1		2323.83		2323.83	-31.52	2339.59		
		2 18	1202		30SEP91	G	S3822	1		2393.21		2393.21				
					02OCT91	G	S3823	1		2385.28		2385.28	-7.93	2389.25		

TITRATION SYSTEM:
 G = GRAVIMETRIC
 V = VOLUMETRIC
BOTTLE TYPE:
 R = RODAVISS S = S TYPE

FLAGS:
 F: No Hg found in bottle
 X: Titrator malfunction
 EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	WHOI ALK	WHOI -S.I.O.
										(UEQUIV/KG SW)						
1	30- 2N	2 20	1605	11JUN91	26SEP91	G	S3820	1		2407.50		2407.50				
26	134-57W				01OCT91	G	S3821	1		2407.56		2407.56	+0.06	2407.53		
		2 22	2007		02OCT91	G	S3818	1		2414.88		2414.88				
					26SEP91	G	S3819	1		2417.05		2417.05	+2.17	2415.97		
		2 27	3000		25SEP91	G	S3816	1		2439.46		2439.46				
					25SEP91	G	S3817	1		2432.16		2432.16	-7.30	2435.81		
1	28-30N	1 1	1	12JUN91	21AUG91	G	R4482	1		2294.95		2294.95				
29	135-00W				21AUG91	G	R4483	1		2290.86		2290.86	-4.09	2292.91	2306.02	13.11
		1 31	2951		20AUG91	G	R4480	1		2442.89		2442.89				
					20AUG91	G	R4481	1	X	2432.56						
					21AUG91	G	R4481	2		2435.40		2435.40	-7.49	2439.15		
1	19-30N	1 1	0	18JUN91	10SEP91	G	R4486	1		2290.66		2290.66				
47	135- 0W				10SEP91	G	R4487	1		2294.47		2294.47	+3.81	2292.56	2298.90	6.34
		1 27	3005		10SEP91	G	S3884	1		2435.33		2435.33				
					10SEP91	G	S3885	1		2434.26		2434.26	-1.07	2434.80		
1	18- 0N	1 1	0	19JUN91	11SEP91	G	R4490	1		2269.78		2269.78				
50	135- 0W				11SEP91	G	R4491	1		2277.37		2277.37	+7.59	2273.58	2282.90	9.32
		1 27	2999		11SEP91	G	R4488	1		2396.89		2396.89				
					12SEP91	G	R4489	1		2393.93		2393.93	-2.96	2395.41		
1	16-30N	1 1	0	20JUN91	23OCT91	G	S3894	1		2272.47		2272.47				
53	135- 0W				23OCT91	G	S3895	1		2272.31		2272.31	-0.16	2272.39	2254.90	-17.49
		1 2	50		22OCT91	G	S3893	1		2270.20		2270.20		2270.20	2286.90	16.70
		1 4	112		02OCT91	G	S3890	1		2294.04		2294.04				
					22OCT91	G	S3891	1		2298.05		2298.05	+4.01	2296.05	2316.90	20.85
		1 8	188		01OCT91	G	S3888	1		2266.82		2266.82				
					02OCT91	G	S3889	1		2263.21		2263.21	-3.61	2265.02	2270.60	5.58
		1 10	300		01OCT91	G	S3886	1		2293.99		2293.99				
					02OCT91	G	S3887	1		2294.72		2294.72	+0.73	2294.35	2300.90	6.55
		1 12	402		19SEP91	G	R4504	1		2304.53		2304.53				
					19SEP91	G	R4505	1		2306.77		2306.77	+2.24	2305.65	2311.00	5.35

TITRATION SYSTEM:
 G = GRAVIMETRIC
 V = VOLUMETRIC
BOTTLE TYPE:
 R = RODAVISS S = S TYPE

FLAGS:
 F: No Hg found in bottle
 X: Titrator malfunction
 EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK (UEQUIV/KG SW)	BOTTLE DELTA	"NISKIN" AVG	WHOI ALK	WHOI -S.I.O.
1 53	16-30N 135- 0W	1 14	597	20JUN91	19SEP91	G	R4502	1		2328.49		2328.49				
					19SEP91	G	R4503	1		2323.91		2323.91	-4.58	2326.20	2330.90	4.70
		1 17	904		17SEP91	G	R4500	1		2363.87		2363.87				
					17SEP91	G	R4501	1		2360.56		2360.56	-3.31	2362.22		
		1 19	1205		19SEP91	G	R4498	1		2370.66		2370.66				
					19SEP91	G	R4499	1		2377.91		2377.91	+7.25	2374.28		
		1 21	1602		18SEP91	G	R4496	1		2407.97		2407.97		2407.97		
		1 23	2008		13SEP91	G	R4494	1	EX	2428.50						
					18SEP91	G	R4494	2		2417.21		2417.21				
					17SEP91	G	R4495	1		2417.42		2417.42	+0.21	2417.31		
		1 28	3000		12SEP91	G	R4492	1		2424.59						
					13SEP91	G	R4492	2		2424.81	+0.22	2424.70				
					13SEP91	G	R4493	1		2439.80		2439.80	+15.10	2432.25		
1 74	6- 0N 135-00W	1 1	-1	26JUN91	09JAN92	V	R4522	1		2255.26		2255.26				
					09JAN92	V	R4523	1		2268.50		2268.50	+13.24	2261.88	2251.00	-10.88
		1 29	2992		09JAN92	V	R4520	1		2436.85		2436.85				
					09JAN92	V	R4521	1		2429.18		2429.18	-7.67	2433.02		
1 104	1-00S 135- 0W	1 1	0	03JUL91	13JAN92	V	S3986	1		2324.91		2324.91				
					13JAN92	V	S3987	1		2324.52		2324.52	-0.39	2324.72	2328.50	3.78
		1 30	2999		13JAN92	V	R4544	1		2418.96		2418.96				
					13JAN92	V	R4545	1		2416.92		2416.92	-2.04	2417.94		
1 110	1-58S 135- 0W	1 30	2998	04JUL91	17JAN92	V	S3988	1		2425.00		2425.00				
					17JAN92	V	S3989	1		2421.67		2421.67	-3.33	2423.33		
1 119	4-00S 135- 0W	1 1	0	05JUL91	20JAN92	V	S4019	1		2321.88		2321.88				
					20JAN92	V	S4020	1		2320.64		2320.64	-1.24	2321.26	2331.10	9.84
		1 29	3001		28JAN92	V	S4017	2		2420.98		2420.98				
					28JAN92	V	S4018	2		2422.30		2422.30	+1.32	2421.64		

TITRATION SYSTEM:
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BOTTLE TYPE:
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NOTE: Dilution factor of 1.000170 has been applied.

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
TUNES Leg 2 1991 WOCE Pacific Line P17S/P16S Table 4b

SUMMARY OF ALKALINITY DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK (UEQUIV/KG SW)	BOTTLE DELTA	"NISKIN" AVG
2	23-43S	1 19	909	01AUG91	20JAN92	V	S4158	1		2300.18		2300.18		
160	132-33W				20JAN92	V	S4159	1		2302.05		2302.05	+1.87	2301.11
2	30-32S	1 61	4	06AUG91	10JAN92	V	R4548	1		2318.15		2318.15		
174	134-20W				10JAN92	V	R4549	1		2324.19		2324.19	+6.04	2321.17
		1 33	3081		10JAN92	V	R4546	1		2395.78		2395.78		
					10JAN92	V	R4547	1		2396.62		2396.62	+0.84	2396.20
2	37-30S	2 69	315	12AUG91	14JAN92	V	R4564	1		2277.74		2277.74		
180	150-30W				14JAN92	V	R4565	1		2280.79		2280.79	+3.05	2279.27
		2 11	469		14JAN92	V	R4562	1		2275.55		2275.55		
					14JAN92	V	R4563	1		2273.45		2273.45	-2.10	2274.50
		2 13	622		17JAN92	V	R4560	1		2275.23		2275.23		
					17JAN92	V	R4561	1		2281.82		2281.82	+6.59	2278.53
		2 16	931		22JUN92	V	R4558	1		2290.65		2290.65		
					22JUN92	V	R4559	1		2285.23		2285.23	-5.42	2287.94
		2 18	1188		22JUN92	V	R4556	1		2304.57		2304.57		
					22JUN92	V	R4557	1		2304.45		2304.45	-0.12	2304.51
		2 20	1543		13JAN92	V	R4554	1		2343.31		2343.31		
					13JAN92	V	R4555	1		2343.93		2343.93	+0.62	2343.62
		2 22	2052		18JUN92	V	R4552	1		2380.77		2380.77		
					18JUN92	V	R4553	1		2382.52		2382.52	+1.75	2381.65
		2 26	3051		18JUN92	V	R4550	1		2403.47		2403.47		
					18JUN92	V	R4551	1		2404.50		2404.50	+1.03	2403.99
2	21- 0S	1 3	62	23AUG91	20JAN92	V	S4118	1		2365.81		2365.81		
213	150-30W				20JAN92	V	S4119	1		2366.34		2366.34	+0.53	2366.08

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SUMMARY OF ALKALINITY DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	17- ØS	1 36	6	Ø1SEP91	18OCT91	G	R4568	1		2369.35		2369.35				
222	15Ø-3ØW				22OCT91	G	R4569	1		2365.81		2365.81	-3.54	2367.58	2365.35	-2.23
					Ø3JUN92	V	R4569	5		2347.46		2347.46		2347.46	2365.35	17.89
		1 5	3Ø55		18OCT91	G	R4566	1		2393.48		2393.48				
					18OCT91	G	R4567	1	F	2373.14				2393.48	2397.81	4.33
3	15- ØS	1 36	7	Ø3SEP91	18NOV91	G	R4592	1		2386.17		2386.17				
226	15Ø-5ØW				18NOV91	G	R4593	1		2386.4Ø		2386.4Ø	+Ø.23	2386.28	2387.72	1.44
		1 35	5Ø		15NOV91	G	R4590	1		2383.16		2383.16				
					15NOV91	G	R4591	1		2382.72		2382.72	-Ø.44	2382.94	2383.89	Ø.95
		1 33	13Ø		15NOV91	G	R4588	1		2393.34						
					18NOV91	G	R4588	2	X	2358.2Ø		2393.34				
					15NOV91	G	R4589	1	X	2413.61						
					18NOV91	G	R4589	2		2384.26		2384.26	-9.Ø8	2388.8Ø	2392.11	3.31
		1 31	211		15NOV91	G	R4586	1		2376.32		2376.32				
					15NOV91	G	R4587	1		2375.48		2375.48	-Ø.84	2375.9Ø	2378.91	3.Ø1
		1 29	313		24OCT91	G	R4584	1		2320.91		2320.91				
					24OCT91	G	R4585	1		2314.79		2314.79	-6.12	2317.85	2315.96	-1.89
		1 27	413		13NOV91	G	R4582	1		2285.19		2285.19				
					15NOV91	G	R4583	1		2286.84		2286.84	+1.65	2286.Ø2	2293.26	7.24
		1 23	618		25OCT91	G	R4580	1		2301.78		2301.78				
					13NOV91	G	R4581	1		2300.4Ø		2300.4Ø	-1.38	2301.Ø9	2303.62	2.53
		1 18	926		23OCT91	G	R4578	1		2326.9Ø		2326.9Ø				
					25OCT91	G	R4579	1		2331.31		2331.31	+4.41	2329.1Ø	2333.74	4.64
		1 16	1232		23OCT91	G	R4576	1		2360.Ø6		2360.Ø6				
					23OCT91	G	R4577	1	F	2369.57				2360.Ø6	2358.Ø8	-1.98
		1 14	1642		23OCT91	G	R4574	1		2371.Ø3						
					Ø7NOV91	G	R4574	2		2369.53	-1.5Ø	2370.28				
					23OCT91	G	R4575	1	F	2363.83				2370.28	2379.26	8.98
		1 12	2Ø56		23OCT91	G	R4572	1		2386.19		2386.19				
					23OCT91	G	R4573	1		2390.19		2390.19	+4.ØØ	2388.19	2393.68	5.49

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SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	15- 0S	1 7	3090	03SEP91	22OCT91	G	R4570	1		2399.27		2399.27				
226	150-50W				22OCT91	G	R4571	1		2391.76		2391.76	-7.51	2395.52	2403.40	7.88
3	13- 0S	1 36	7	04SEP91	19NOV91	G	R4596	1		2385.08		2385.08				
230	151- 0W				20NOV91	G	R4597	1		2383.29		2383.29	-1.79	2384.19	2384.49	0.30
		1 7	3139		19NOV91	G	R4594	1		2393.57						
					19NOV91	G	R4594	2		2394.24	+0.67	2393.91				
					19NOV91	G	R4595	1		2400.67		2400.67	+6.76	2397.29	2423.83	26.54
3	10-30S	4 36	6	06SEP91	20NOV91	G	R4600	1		2359.32		2359.32				
235	151- 0W				20NOV91	G	R4601	1		2348.53		2348.53	-10.79	2353.93	2360.71	6.78
		4 9	3007		20NOV91	G	R4598	1		2385.09		2385.09				
					20NOV91	G	R4599	1	F	2424.77				2385.09	2417.51	32.42
3	9- 0S	1 34	60	07SEP91	24JUN92	V	R4622	1		2362.92		2362.92				
238	151- 0W				25JUN92	V	R4623	1		2365.34		2365.34	+2.42	2364.13	2364.03	-0.10
		1 32	111		24JUN92	V	R4620	1		2370.45		2370.45				
					24JUN92	V	R4621	1		2365.87		2365.87	-4.58	2368.16	2371.07	2.91
		1 29	200		24JUN92	V	R4618	1		2371.74		2371.74				
					24JUN92	V	R4619	1		2372.88		2372.88	+1.14	2372.31	2374.63	2.32
		1 26	321		24JUN92	V	R4616	1		2306.75		2306.75				
					24JUN92	V	R4617	1		2297.02		2297.02	-9.73	2301.89	2306.48	4.59
		1 24	414		23JUN92	V	R4614	1		2302.86		2302.86				
					24JUN92	V	R4615	1		2302.18		2302.18	-0.68	2302.52	2302.42	-0.10
		1 21	619		23JUN92	V	R4612	1		2304.82		2304.82				
					23JUN92	V	R4613	1		2309.67		2309.67	+4.85	2307.25	2308.84	1.59
		1 18	925		23JUN92	V	R4611	1		2339.78		2339.78		2339.78	2342.26	2.48
		1 15	1233		29APR92	V	R4608	1		2361.81		2361.81		2361.81	2366.40	4.59
		1 12	1643		28APR92	V	R4606	1		2388.43		2388.43				
					28APR92	V	R4607	1		2397.44		2397.44	+9.01	2392.94	2390.19	-2.75
		1 10	2055		29APR92	V	R4604	1		2386.94		2386.94		2386.94	2402.30	15.36

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SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	9- 0S	1 5	3088	07SEP91	28APR92	V	R4602	1		2415.77		2415.77				
238	151- 0W				29APR92	V	R4603	1		2417.29		2417.29	+1.52	2416.53	2415.99	-0.54
3	7- 0S	1 36	7	08SEP91	14JAN92	V	R4628	1		2322.81		2322.81				
242	151- 0W				14JAN92	V	R4629	1		2313.68		2313.68	-9.13	2318.25	2322.75	4.50
		1 10	3018		27DEC91	V	R4626	1		2423.34						
					09JAN92	V	R4626	3		2421.54	-1.80	2422.44				
					27DEC91	V	R4627	1		2420.80						
					09JAN92	V	R4627	2		2417.63	-3.17	2419.22	-3.22	2420.83	2421.18	0.35
3	5- 0S	2 36	8	09SEP91	29APR92	V	R4652	1		2322.37		2322.37				
246	151- 0W				29APR92	V	R4653	1		2324.68		2324.68	+2.31	2323.53	2330.83	7.30
		2 35	60		28APR92	V	R4650	1		2324.31		2324.31				
					29APR92	V	R4651	1		2324.93		2324.93	+0.62	2324.62	2328.31	3.69
		2 33	137		28APR92	V	R4648	1		2391.43		2391.43				
					28APR92	V	R4649	1		2388.40		2388.40	-3.03	2389.92	2389.52	-0.40
		2 31	215		27APR92	V	R4646	1		2317.16		2317.16				
					28APR92	V	R4647	1		2319.68		2319.68	+2.52	2318.42	2315.70	-2.72
		2 29	307		27APR92	V	R4644	1		2303.79		2303.79				
					28APR92	V	R4645	1		2302.89		2302.89	-0.90	2303.34	2304.36	1.02
		2 27	409		27APR92	V	R4642	1		2296.21		2296.21				
					27APR92	V	R4643	1		2303.38		2303.38	+7.17	2299.79	2305.37	5.58
		2 23	631		27APR92	V	R4640	1		2308.46		2308.46				
					27APR92	V	R4641	1		2305.95		2305.95	-2.51	2307.21	2309.65	2.44
		2 20	917		16APR92	V	R4638	1		2338.21		2338.21				
					16APR92	V	R4639	1		2334.98		2334.98	-3.23	2336.59	2340.55	3.96
		2 18	1221		14APR92	V	R4636	1		2363.64		2363.64				
					15APR92	V	R4637	1		2363.65		2363.65	+0.01	2363.65	2370.72	7.07
		2 16	1629		14APR92	V	R4634	1		2375.49		2375.49				
					14APR92	V	R4635	1		2368.65		2368.65	-6.84	2372.07	2394.26	22.19
		2 14	1982		14APR92	V	R4632	1		2405.05		2405.05				
					14APR92	V	R4633	1		2397.61		2397.61	-7.44	2401.33	2407.34	6.01

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SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	5- ØS	2 9	3Ø12	Ø9SEP91	14APR92	V	R4630	1		2424.18		2424.18				
246	151- ØW				14APR92	V	R4631	1		2421.44		2421.44	-2.74	2422.81	2424.76	1.95
3	3- ØS	1 36	6	11SEP91	Ø9APR92	V	R4656	1		2333.21		2333.21				
25Ø	151- ØW				Ø9APR92	V	R4657	1		2330.49		2330.49	-2.72	2331.85	2328.62	-3.23
		1 8	3Ø84		Ø9APR92	V	R4654	1		2422.52		2422.52				
					Ø9APR92	V	R4655	1		2424.76		2424.76	+2.24	2423.64	2422.56	-1.Ø8
3	1- ØS	1 36	7	14SEP91	14APR92	V	R4660	1		2321.75		2321.75				
262	151- ØW				14APR92	V	R4661	1		2317.14		2317.14	-4.61	2319.45	2330.Ø3	1Ø.58
		1 8	2980		27APR92	V	R4658	1		2378.73		2378.73				
					27APR92	V	R4659	1		2409.39		2409.39	+3Ø.66	2394.Ø6	2426.59	32.53
3	1- ØN	1 34	38	16SEP91	16APR92	V	R4682	1		2293.37		2293.37				
274	151- ØW				16APR92	V	R4683	1		2300.63		2300.63	+7.26	2297.Ø0	2292.15	-4.85
		1 33	67		15APR92	V	R4680	1	EX	2322.63						
					16APR92	V	R4680	2		2300.09		2300.09				
					16APR92	V	R4681	1		2303.56		2303.56	+3.47	2301.83	2301.7Ø	-Ø.13
		1 3Ø	154		15APR92	V	R4679	1		2297.45		2297.45		2297.45	2298.73	1.28
		1 27	278		14APR92	V	R4676	1		2308.1Ø		2308.1Ø				
					14APR92	V	R4677	1		2307.77		2307.77	-Ø.33	2307.94	2292.87	-15.Ø7
		1 25	354		16MAR92	V	R4674	1		2303.65		2303.65				
					17MAR92	V	R4675	1	EX	2321.29						
					17MAR92	V	R4675	2		2305.28		2305.28	+1.63	2304.47	2303.44	-1.Ø3
		1 36	393		27APR92	V	R4684	1		2306.Ø2		2306.Ø2				
					27APR92	V	R4685	1		2306.93		2306.93	+Ø.91	2306.48	2303.34	-3.14
		1 18	8Ø1		16MAR92	V	R4670	1		2334.23		2334.23				
					16MAR92	V	R4671	1		2335.95		2335.95	+1.72	2335.Ø9	2334.68	-Ø.41
		1 16	1ØØ7		1ØMAR92	V	R4668	1		2351.71		2351.71				
					16MAR92	V	R4669	1		2353.33		2353.33	+1.62	2352.52	2350.88	-1.64
		1 14	1368		1ØMAR92	V	R4666	1		2383.81		2383.81				
					1ØMAR92	V	R4667	1		2383.55		2383.55	-Ø.26	2383.68	2388.33	4.65

TITRATION SYSTEM:
 G = GRAVIMETRIC
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BOTTLE TYPE:
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FLAGS:
 F: No Hg found in bottle
 X: Titrator malfunction
 EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	1- ØN	1 12	1778	16SEP91	Ø6MAR92	V	R4664	1		2403.7Ø		2403.7Ø				
274	151- ØW				Ø6MAR92	V	R4665	1		2405.Ø1		2405.Ø1	+1.31	2404.35	2407.9Ø	3.55
		1 4	3126		14APR92	V	R4662	1		2408.86		2408.86		2408.86	2425.46	16.6Ø
3	3- ØN	1 35	7	18SEP91	27DEC91	V	R4690	1		2291.47						
286	151- ØW				Ø7JAN92	V	R4690	2		2286.62	-4.85	2289.Ø5				
					27DEC91	V	R4691	1		2291.21						
					Ø7JAN92	V	R4691	2		2285.21	-6.ØØ	2288.21	-Ø.84	2288.63	2267.16	-21.47
		1 1Ø	3084		17JAN92	V	R4687	1		2425.61						
					23JAN92	V	R4687	2		2419.23	-6.38	2422.42				
					17JAN92	V	R4688	1	F	2438.13				2422.42	2434.43	12.Ø1
3	5- ØN	1 36	8	2ØSEP91	Ø6MAR92	V	R4714	1		2268.77		2268.77				
29Ø	151- ØW				Ø6MAR92	V	R4715	1		2270.13		2270.13	+1.36	2269.45	2264.5Ø	-4.95
		1 34	81		Ø6MAR92	V	R4712	1		2301.23		2301.23				
					Ø6MAR92	V	R4713	1		2298.33		2298.33	-2.9Ø	2299.78	2297.21	-2.57
		1 33	12Ø		Ø6MAR92	V	R4710	1		2302.51		2302.51				
					Ø6MAR92	V	R4711	1		2295.19		2295.19	-7.32	2298.85	2288.69	-1Ø.16
		1 31	2Ø5		Ø6MAR92	V	R4708	1		2290.66		2290.66				
					Ø6MAR92	V	R4709	1		2292.Ø9		2292.Ø9	+1.43	2291.38	2290.49	-Ø.89
		1 29	296		16MAR92	V	R4706	2		2306.Ø2		2306.Ø2				
					16MAR92	V	R4707	1		2303.56		2303.56	-2.46	2304.79	2303.65	-1.14
		1 27	411		1ØMAR92	V	R4704	1		2306.81						
					16MAR92	V	R4704	2		2308.3Ø	+1.49	2307.56				
					1ØMAR92	V	R4705	1		2293.86						
					16MAR92	V	R4705	2		2298.58	+4.72	2296.22	-11.34	2301.89	2307.Ø5	5.16
		1 23	616		27FEB92	V	R4702	1		2317.84		2317.84				
					27FEB92	V	R4703	1	EX	2327.72						
					Ø5MAR92	V	R4703	2		2315.42		2315.42	-2.42	2316.63	2317.3Ø	Ø.67
		1 2Ø	924		27FEB92	V	R4700	1		2344.Ø9		2344.Ø9				
					27FEB92	V	R4701	1		2341.15		2341.15	-2.94	2342.62	2348.Ø5	5.43
		1 18	1230		24FEB92	V	R4698	1		2377.21		2377.21				
					24FEB92	V	R4699	1		2375.96		2375.96	-1.25	2376.58	2374.76	-1.82

TITRATION SYSTEM:
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BOTTLE TYPE:
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FLAGS:
 F: No Hg found in bottle
 X: Titrator malfunction
 EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	5- ØN	1 16	1642	20SEP91	24FEB92	V	R4696	1		2404.42		2404.42				
290	151- ØW				24FEB92	V	R4697	1		2398.55		2398.55	-5.87	2401.49	2402.59	1.10
		1 14	2054		24FEB92	V	R4694	1		2423.76		2423.76				
					24FEB92	V	R4695	1		2417.42		2417.42	-6.34	2420.59	2420.37	-0.22
		1 9	3089		24FEB92	V	R4692	1		2435.17		2435.17				
					24FEB92	V	R4693	1		2432.69		2432.69	-2.48	2433.93	2424.62	-9.31
3	6-58N	1 36	10	21SEP91	Ø5MAR92	V	R4718	1		2223.80		2223.80				
294	151-22W				Ø5MAR92	V	R4719	1	EX	2230.37						
					Ø6MAR92	V	R4719	2		2227.42		2227.42	+3.62	2225.61	2227.81	2.20
		1 10	3191		Ø5MAR92	V	R4716	1		2397.31		2397.31				
					Ø5MAR92	V	R4717	1	F	2424.67				2397.31	2433.57	36.26
3	8-56N	1 36	16	22SEP91	Ø5MAR92	V	R4722	1		2212.18		2212.18				
298	151-45W				Ø5MAR92	V	R4723	1		2211.53		2211.53	-Ø.65	2211.85	2220.89	9.04
		1 9	3058		11FEB92	V	R4720	1		2428.54		2428.54				
					11FEB92	V	R4721	1	F	2410.73				2428.54	2438.32	9.78
3	10-54N	1 36	8	23SEP91	10FEB92	V	R4746	1		2224.68		2224.68				
302	152- 7W				10FEB92	V	R4747	1		2226.17		2226.17	+1.49	2225.43	2219.76	-5.67
		1 34	60		10FEB92	V	R4744	1	EX	2300.11						
					11FEB92	V	R4744	2		2289.12		2289.12				
					10FEB92	V	R4745	1		2289.56		2289.56	+Ø.44	2289.34	2283.64	-5.70
		1 32	110		10FEB92	V	R4742	1		2274.25		2274.25				
					10FEB92	V	R4743	1		2274.71		2274.71	+Ø.46	2274.48	2272.33	-2.15
		1 29	212		Ø7FEB92	V	R4740	1		2299.76		2299.76				
					Ø7FEB92	V	R4741	1		2301.09		2301.09	+1.33	2300.43	2296.16	-4.27
		1 27	314		Ø7FEB92	V	R4738	1		2308.10		2308.10				
					Ø7FEB92	V	R4739	1		2309.66		2309.66	+1.56	2308.88	2305.98	-2.90
		1 28	416		Ø7FEB92	V	R4736	1		2317.30		2317.30				
					Ø7FEB92	V	R4737	1		2316.15		2316.15	-1.15	2316.73	2317.13	Ø.40

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EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	10-54N	1 24	621	23SEP91	07FEB92	V	R4734	1		2334.50		2334.50				
302	152- 7W				07FEB92	V	R4735	1		2335.57		2335.57	+1.07	2335.04	2336.44	1.40
		1 21	928		03FEB92	V	R4732	1		2364.78		2364.78				
					03FEB92	V	R4733	1		2365.34		2365.34	+0.56	2365.06	2364.30	-0.76
		1 19	1237		03FEB92	V	R4730	1		2390.20		2390.20				
					03FEB92	V	R4731	1		2390.43		2390.43	+0.23	2390.31	2385.24	-5.07
		1 17	1647		03FEB92	V	R4728	1		2411.42		2411.42				
					03FEB92	V	R4729	1		2411.27		2411.27	-0.15	2411.34	2409.52	-1.82
		1 15	2058		03FEB92	V	R4726	1		2432.61		2432.61				
					03FEB92	V	R4727	1		2427.58		2427.58	-5.03	2430.10	2423.75	-6.35
		1 10	3086		03FEB92	V	R4724	1		2430.97		2430.97				
					03FEB92	V	R4725	1		2432.61						
					03FEB92	V	R4725	2	EX	2436.95		2432.61	+1.64	2431.79	2436.79	5.00
3	12-52N	1 36	9	24SEP91	10FEB92	V	R4750	1		2244.44		2244.44				
306	152-30W				10FEB92	V	R4751	1		2246.90		2246.90	+2.46	2245.67	2242.78	-2.89
3	14-50N	1 36	9	26SEP91	09JAN92	V	R4754	2		2245.92		2245.92				
310	152-53W				09JAN92	V	R4755	1		2245.93		2245.93	+0.01	2245.93	2245.64	-0.29
		1 12	3081		20JAN92	V	R4752	1		2432.55		2432.55				
					20JAN92	V	R4753	1		2431.47		2431.47	-1.08	2432.01	2432.67	0.66
3	16-48N	2 36	9	27SEP91	23JAN92	V	R4778	1		2283.39		2283.39				
314	153-16W				23JAN92	V	R4779	1		2282.56		2282.56	-0.83	2282.98	2280.22	-2.76
		2 34	76		23JAN92	V	R4776	1		2301.59		2301.59				
					23JAN92	V	R4777	1		2302.10		2302.10	+0.51	2301.85	2301.07	-0.78
		2 33	107		23JAN92	V	R4774	1		2311.76		2311.76				
					23JAN92	V	R4775	1		2313.75		2313.75	+1.99	2312.76	2308.02	-4.74
		2 30	216		21JAN92	V	R4772	1		2271.88		2271.88				
					21JAN92	V	R4773	1		2272.54		2272.54	+0.66	2272.21	2269.72	-2.49
		2 28	318		21JAN92	V	R4770	1		2281.47		2281.47				
					21JAN92	V	R4771	1		2280.45		2280.45	-1.02	2280.96	2280.18	-0.78

TITRATION SYSTEM:
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 EX: Data excluded from analysis

SUMMARY OF ALKALINITY DATA (cont.)

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG	CDRG ALK	CDRG -S.I.O.
										(UEQUIV/KG SW)						
3	16-48N	2 25	442	27SEP91	20JAN92	V	R4768	1		2312.17						
314	153-16W				27JAN92	V	R4768	2		2312.34	+0.17	2312.26				
					20JAN92	V	R4769	1		2312.81						
					27JAN92	V	R4769	2		2312.05	-0.76	2312.43	+0.17	2312.34	2311.23	-1.11
		2 22	676		20JAN92	V	R4766	1		2334.20		2334.20				
					20JAN92	V	R4767	1		2339.02		2339.02	+4.82	2336.61	2338.89	2.28
		2 20	933		20JAN92	V	R4764	1		2362.07		2362.07				
					20JAN92	V	R4765	1		2365.13		2365.13	+3.06	2363.60	2364.57	0.97
		2 18	1291		20JAN92	V	R4762	1		2392.43		2392.43				
					20JAN92	V	R4763	1		2389.57		2389.57	-2.86	2391.00	2394.61	3.61
		2 16	1698		20JAN92	V	R4760	1	EX	2416.26						
					21JAN92	V	R4760	2		2410.51		2410.51				
					20JAN92	V	R4761	1		2409.25		2409.25	-1.26	2409.88	2410.49	0.61
		2 14	2113		21JAN92	V	R4758	1		2415.97		2415.97				
					21JAN92	V	R4759	1		2420.93		2420.93	+4.96	2418.45	2422.00	3.55
		2 9	3201		21JAN92	V	R4756	1		2429.71		2429.71				
					21JAN92	V	R4757	1		2429.92		2429.92	+0.21	2429.81	2432.03	2.22

TITRATION SYSTEM:
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 V = VOLUMETRIC
BOTTLE TYPE:
 R = RODAVISS S = S TYPE

FLAGS:
 F: No Hg found in bottle
 X: Titrator malfunction
 EX: Data excluded from analysis

NOTE: Dilution factor of 1.000170 has been applied.

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg M15 1991 Atlantic WOCE Line A9 Table 4d

SUMMARY OF ALKALINITY DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK (UEQUIV/KG SW)	BOTTLE DELTA	"NISKIN" AVG
	19-00S	3 18	1593	16FEB91	05JUL91	G	R4934	1		2315.05		2315.05		
143	30-01W				09JUL91	G	R4935	1		2313.39		2313.39	-1.66	2314.22
		3 12	2995		19JUL91	G	R4932	1		2328.89		2328.89		
					29AUG91	G	R4933	1		2334.56		2334.56	+5.67	2331.73
	19-00S	2 24	8	21FEB91	03JUL91	G	R4938	1		2431.92		2431.92		
154	23-15W				05JUL91	G	R4939	1		2423.85				
					08JUL91	G	R4939	2		2424.59	+0.74	2424.22	-7.70	2428.07
	19-12S	2 24	7	03MAR91	05JUL91	G	R4956	1		2391.57		2391.57		
187	08-12W				06AUG91	G	R4957	1		2391.07		2391.07	-0.50	2391.32
		3 18	1194		09JUL91	G	R4962	1		2298.10		2298.10		
					19JUL91	G	R4963	1		2312.57		2312.57	+14.47	2305.34
		3 12	2492		08JUL91	G	R4961	1		2328.74		2328.74		2328.74
	19-00S	2 2	898	07MAR91	08JUL91	G	R4964	1		2294.07		2294.07		
199	01-54W				08JUL91	G	R4965	1		2297.84		2297.84	+3.77	2295.96

TITRATION SYSTEM:
 G = GRAVIMETRIC
 V = VOLUMETRIC
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

NOTE: Dilution factor of 1.000170 has been applied.

FLAGS:
  F: No Hg found in bottle
  X: Titrator malfunction
  EX: Data excluded from analysis

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg M18 1991 Atlantic WOCE Line A1E Table 4e

SUMMARY OF ALKALINITY DATA

LEG STN	LAT. LONG.	CAST NISK	DEPTH (M)	SAMPLE DATE	ANALYSIS DATE	TITR SYST	SAMPLE BOTTLE	TRIAL	FLAG	S.I.O. TRIAL	TRIAL DELTA	BOTTLE ALK	BOTTLE DELTA	"NISKIN" AVG
										(UEQUIV/KG SW)				
	59- 1N	1 24	11	09SEP91	05AUG94	G	R4830	1		2287.54		2287.54		
575	32-46W				05AUG94	G	R4831	1		2282.66		2282.66	-4.88	2285.10
		1 13	1101		27APR94	G	R4828	1		2290.34				
					29APR94	G	R4828	2		2291.33	+0.99	2290.84		
					28APR94	G	R4829	1		2295.18		2295.18	+4.34	2293.01
	58-19N	1 23	28	10SEP91	27JUL94	G	R4842	1		2300.05		2300.05		
580	29-56W				01AUG94	G	R4843	1		2294.31		2294.31	-5.74	2297.18
		1 1	2333		28APR94	G	R4838	1		2301.97		2301.97		
					29APR94	G	R4839	1		2303.89		2303.89	+1.92	2302.93
	58-11N	1 2	2008	10SEP91	09FEB94	V	R4844	1		2301.35		2301.35		
581	29-37W				09FEB94	V	R4845	1		2300.71		2300.71	-0.64	2301.03
	45-22N	1 14	689	14SEP91	05MAY94	G	R4874	1		2304.69		2304.69		
596	25-57W				05MAY94	G	R4875	1		2304.81		2304.81	+0.12	2304.75
	52-51N	1 1	3984	16SEP91	05MAY94	G	R4878	1		2352.52		2352.52		
603	22-23W				05MAY94	G	R4879	1		2351.55		2351.55	-0.97	2352.04

TITRATION SYSTEM:
G = GRAVIMETRIC
V = VOLUMETRIC
BOTTLE TYPE:
R = RODAVISS S = S TYPE

FLAGS:
F: No Hg found in bottle
X: Titrator malfunction
EX: Data excluded from analysis

NOTE: Dilution factor of 1.000170 has been applied.

Appendix Table 5. Summaries of Salinity Data for Replicate Sea Water Samples

Tables 5a to 5e summarize the laboratory salinity measurements of replicate samples of sea water collected on the five expedition legs of 1991. The measurements were made on an inductive salinometer calibrated with standard sea water and were made by personnel of the Oceanographic Data Facility (ODF) at SIO. The data for the five legs are presented in the following order:

Table 5a.	TUNES Leg 1	WOCE Line P17C
Table 5b.	TUNES Leg 2	WOCE Lines P17S,P16S
Table 5c.	TUNES Leg 3	WOCE Line P16C
Table 5d.	Meteor 15	WOCE Line A9
Table 5e.	Meteor 18	WOCE Line A1E

Comments on each column in the table follow:

LEG to DEPTH (M)	The identifying information for each Niskin bottle sampled at sea.
SAMPLE BOTTLE	The label number for the individual replicate sample bottle filled at sea is listed. The prefix "S" indicates a standard 500 ml Corning borosilicate glass bottle with a hollow stopper (individually lapped to the bottle joint with carborundum grit) equipped with an aluminum bale type fixture for holding the stopper in its sealed position. The prefix "R" indicates a 500 ml borosilicate glass bottle equipped with a standard taper (24/40 size) joint and solid stopper with a Rodawiss plastic knurled nut system for holding the stopper.
SAMPLE DATE	The date of collection of the replicate sample at sea.
EXTRAC DATE	The date of extraction of CO2 gas from an aliquot of sea water taken from a given sample bottle is listed.
STORAGE (E-S)	The number of days between the sample date and the extraction date. This indicates the storage time of a sample in the replicate sample bottle before it is first opened. The sample remains in the partially full replicate bottle until ALK measurements have been completed and then a subsample is taken into a 200 ml salinity bottle. The amount of storage time in this bottle varies from days to months.
ANALYS. DATE	The date of laboratory analysis for salinity by ODF. Subsamples are normally sent to ODF in batches of 100.
SALINITY o/oo	The individual shore salinity for a bottle.
BOTTLE DELTA	The difference in salinity units between shore analyses on the replicate bottle pair from a Niskin bottle.
BOTTLE AVG o/oo	The average shore salinity for a bottle pair collected from a Niskin bottle.

Appendix Table 5. Summaries of Salinity Data for Replicate Sea Water Samples (cont.)

SHIPBOARD SALINITY o/oo	A PRELIMINARY shipboard Niskin salinity provided by the replicate sampler at sea. This salinity may be from the CTD or may be a preliminary discrete salinity determined on an inductive salinometer at sea. This will be replaced by the final salinity when released by the WOCE/HP. For TUNES Leg 3, the listed salinity is in fact the final value, rounded to .001 salinity units.
DELTA (SHIP-SHORE)	The difference between the PRELIMINARY shipboard salinity and the average shore salinity for a Niskin bottle.

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
TUNES Leg 1 1991 Pacific WOCE Line P17C Table 5a, Page 1

COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD (ON DIC SAMPLE DATE) AND ON SHORE (ON DIC EXTRACTION DATE)

				CAST					SHORE DATA						SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	NISK		DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
1	5	35-33N	122-52W	1	1	1	S3750	910603	910820	78	911017	32.841				
							S3751	910603	910821	79	911017	32.838	+0.003	32.840	32.843	+0.003
1	8	34-49N	124-35W	1	1	1	S3772	910604	910821	78	911017	32.839				
							S3773	910604	910822	79	911017	32.859	-0.020	32.849	32.833	-0.016
1	8	34-49N	124-35W	1	3	66	S3770	910604	910821	78	911017	33.133				
							S3771	910604	910821	78	911017	33.143	-0.010	33.138	33.133	-0.005
1	11	34-35N	127-38W	1	29	2896	S3774	910605	910822	78	911017	34.661		34.661	34.655	-0.006
1	14	34-35N	131-19W	1	1	2	S3781	910607	910822	76	911017	33.062				
							S3782	910607	910823	77	911017	33.065	-0.003	33.064	33.064	+0.000
1	17	34-36N	134-58W	2	1	1	S3806	910608	910909	93	911017	33.063				
							S3807	910608	910910	94	911017	33.061	+0.002	33.062	33.068	+0.006
1	17	34-36N	134-58W	2	2	52	S3804	910608	910910	94	911017	33.104				
							S3805	910608	910909	93	911017	33.078	+0.026	33.091	33.078	-0.013
1	17	34-36N	134-58W	2	4	98	S3802	910608	910909	93	911017	33.246				
							S3803	910608	910909	93	911017	33.235	+0.011	33.241	33.220	-0.021
1	17	34-36N	134-58W	2	8	201	S3800	910608	910829	82	911017	33.433				
							S3801	910608	910829	82	911017	33.432	+0.001	33.433	33.433	+0.000
1	17	34-36N	134-58W	2	10	300	S3798	910608	910828	81	911017	33.991				
							S3799	910608	910828	81	911017	33.992	-0.001	33.992	33.972	-0.020
1	17	34-36N	134-58W	2	12	401	S3796	910608	910826	79	911017	34.022				
							S3797	910608	910826	79	911017	33.998	+0.024	34.010	33.997	-0.013
1	17	34-36N	134-58W	2	14	601	S3794	910608	910826	79	911017	34.091				
							S3795	910608	910826	79	911017	34.109	-0.018	34.100	34.089	-0.011
1	17	34-36N	134-58W	2	17	899	S3792	910608	910826	79	911017	34.370				
							S3793	910608	910826	79	911017	34.385	-0.015	34.378	34.370	-0.008
1	17	34-36N	134-58W	2	19	1200	S3790	910608	910823	76	911017	34.497				
							S3791	910608	910823	76	911017	34.525	-0.028	34.511	34.497	-0.014

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BOTTLE TYPE:
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STORAGE:
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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
1	17	34-36N	134-58W	2 21	1600	S3788	910608	910823	76	911017	34.562				
						S3789	910608	910823	76	911017	34.563	-0.001	34.563	34.561	-0.002
1	20	33- 4N	135-00W	1 1	1	S3810	910609	910920	103	920318	33.681				
						S3811	910609	910920	103	920318	33.679	+0.002	33.680	33.682	+0.002
1	20	33- 4N	135-00W	1 28	2798	S3808	910609	910917	100	920318	34.657				
						S3809	910609	910919	102	920318	34.650	+0.007	34.654	34.655	+0.001
1	23	31-32N	135- 0W	1 1	0	S3814	910610	910924	106	920318	34.201				
						S3815	910610	910924	106	920318	34.186	+0.015	34.194	34.196	+0.002
1	23	31-32N	135- 0W	1 28	3003	S3812	910610	910920	102	920318	34.671				
						S3813	910610	910924	106	920318	34.661	+0.010	34.666	34.663	-0.003
1	26	30- 2N	134-57W	2 1	1	R4478	910611	910819	69	911017	34.660				
						R4479	910611	910819	69	911017	34.665	-0.005	34.663	34.669	+0.006
1	26	30- 2N	134-57W	2 2	64	R4476	910611	910809	59	911017	34.747				
						R4477	910611	910809	59	911017	34.750	-0.003	34.749	34.751	+0.002
1	26	30- 2N	134-57W	2 4	109	R4474	910611	910808	58	911017	34.801				
						R4475	910611	910808	58	911017	34.789	+0.012	34.795	34.801	+0.006
1	26	30- 2N	134-57W	2 7	206	R4472	910611	910806	56	911017	34.335				
						R4473	910611	910808	58	911017	34.329	+0.006	34.332	34.339	+0.007
1	26	30- 2N	134-57W	2 10	324	R4470	910611	910806	56	911017	34.021				
						R4471	910611	910806	56	911017	34.016	+0.005	34.019	34.028	+0.009
1	26	30- 2N	134-57W	2 11	400	R4468	910611	910805	55	911017	34.015				
						R4469	910611	910805	55	911017	34.012	+0.003	34.014	34.019	+0.005
1	26	30- 2N	134-57W	2 13	606	R4466	910611	910805	55	911017	34.086				
						R4467	910611	910805	55	911017	34.084	+0.002	34.085	34.093	+0.008
1	26	30- 2N	134-57W	2 16	909	S3824	910611	910926	107	920318	34.364				
						S3825	910611	910926	107	920318	34.360	+0.004	34.362	34.365	+0.003
1	26	30- 2N	134-57W	2 18	1202	S3822	910611	910927	108	920318	34.493				
						S3823	910611	910927	108	920318	34.482	+0.011	34.488	34.495	+0.007

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
1	26	30- 2N	134-57W	2 20	1605	S3820	910611	910925	106	920318	34.563				
						S3821	910611	910927	108	920318	34.570	-0.007	34.567	34.571	+0.004
1	26	30- 2N	134-57W	2 22	2007	S3818	910611	910925	106	920318	34.601				
						S3819	910611	910926	107	920318	34.611	-0.010	34.606	34.615	+0.009
1	26	30- 2N	134-57W	2 27	3000	S3816	910611	910925	106	920318	34.655				
						S3817	910611	910925	106	920318	34.662	-0.007	34.659	34.665	+0.006
1	29	28-30N	135-00W	1 1	1	R4482	910612	910820	69	911017	34.623				
						R4483	910612	910820	69	911017	34.628	-0.005	34.626	34.633	+0.007
1	29	28-30N	135-00W	1 31	2951	R4480	910612	910820	69	911017	34.666				
						R4481	910612	910820	69	911017	34.664	+0.002	34.665	34.665	+0.000
1	47	19-30N	135- 0W	1 1	0	R4486	910618	910910	84	911017	34.735				
						R4487	910618	910910	84	911017	34.722	+0.013	34.729	34.739	+0.010
1	47	19-30N	135- 0W	1 27	3005	S3884	910618	910910	84	911017	34.676				
						S3885	910618	910910	84	911017	34.660	+0.016	34.668	34.669	+0.001
1	50	18- 0N	135- 0W	1 1	0	R4490	910619	910911	84	920318	34.500				
						R4491	910619	910911	84	911017	34.495	+0.005	34.498	34.501	+0.003
1	50	18- 0N	135- 0W	1 27	2999	R4488	910619	910911	84	911017	34.663				
						R4489	910619	910911	84	920318	34.664	-0.001	34.664	34.670	+0.006
1	53	16-30N	135- 0W	1 1	0	S3894	910620	911002	104	920318	34.505				
						S3895	910620	911004	106	920318	34.499	+0.006	34.502	34.499	-0.003
1	53	16-30N	135- 0W	1 2	50	S3892	910620	911001	103	920318	34.490				
						S3893	910620	911001	103	920318	34.500	-0.010	34.495	34.499	+0.004
1	53	16-30N	135- 0W	1 4	112	S3890	910620	910930	102	920318	34.654				
						S3891	910620	910930	102	920318	34.659	-0.005	34.657	34.660	+0.003
1	53	16-30N	135- 0W	1 8	188	S3888	910620	910930	102	920318	34.274				
						S3889	910620	910930	102	920318	34.274	+0.000	34.274	34.286	+0.012
1	53	16-30N	135- 0W	1 10	300	S3886	910620	910926	98	920318	34.519				
						S3887	910620	910927	99	920318	34.518	+0.001	34.519	34.517	-0.002

DATES:
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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA				SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
1	53	16-30N	135- 0W	1 12	402	R4504	910620	910919	91	920318	34.479				
						R4505	910620	910919	91	920318	34.480	-0.001	34.480	34.490	+0.010
1	53	16-30N	135- 0W	1 14	597	R4502	910620	910918	90	920318	34.440				
						R4503	910620	910918	90	920318	34.450	-0.010	34.445	34.455	+0.010
1	53	16-30N	135- 0W	1 17	904	R4500	910620	910917	89	920318	34.505				
						R4501	910620	910917	89	920318	34.506	-0.001	34.506	34.516	+0.010
1	53	16-30N	135- 0W	1 19	1205	R4498	910620	910916	88	920318	34.547				
						R4499	910620	910917	89	920318	34.555	-0.008	34.551	34.556	+0.005
1	53	16-30N	135- 0W	1 21	1602	R4496	910620	910913	85	920318	34.597		34.597	34.599	+0.002
1	53	16-30N	135- 0W	1 23	2008	R4494	910620	910913	85	920318	34.623				
						R4495	910620	910913	85	920318	34.622	+0.001	34.623	34.630	+0.007
1	53	16-30N	135- 0W	1 28	3000	R4492	910620	910912	84	920318	34.658				
						R4493	910620	910913	85	920318	34.662	-0.004	34.660	34.671	+0.011
1	74	6- 0N	135-00W	1 1	-1	R4522	910626	911205	162	920428	34.239				
						R4523	910626	911205	162	920428	34.242	-0.003	34.241	34.248	+0.007
1	74	6- 0N	135-00W	1 29	2992	R4520	910626	911205	162	920428	34.673				
						R4521	910626	911205	162	920428	34.669	+0.004	34.671	34.675	+0.004
1	104	1-00S	135- 0W	1 1	0	S3986	910703	911209	159	920428	35.355				
						S3987	910703	911209	159	920428	35.356	-0.001	35.356	35.357	+0.001
1	104	1-00S	135- 0W	1 30	2999	R4544	910703	911206	156	920428	34.664				
						R4545	910703	911206	156	920428	34.669	-0.005	34.667	34.682	+0.015
1	110	1-58S	135- 0W	1 30	2998	S3988	910704	911206	155	920721	34.675				
						S3989	910704	911206	155	920428	34.674	+0.001	34.675	34.676	+0.001
1	119	4-00S	135- 0W	1 1	0	S4019	910705	911210	158	920428	35.264				
						S4020	910705	911210	158	920428	35.255	+0.009	35.260	35.268	+0.008
1	119	4-00S	135- 0W	1 29	3001	S4017	910705	911210	158	920721	34.668				
						S4018	910705	911210	158	920721	34.676	-0.008	34.672	34.676	+0.004

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THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD (ON DIC SAMPLE DATE) AND ON SHORE (ON DIC EXTRACTION DATE)

										SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST	NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
2	160	23-43S	132-33W	1	19	909	S4158	910801	911211	132	920428	34.347				
							S4159	910801	911211	132	920428	34.339	+0.008	34.343	34.340	-0.003
2	174	30-32S	134-20W	1	61	4	R4548	910806	911203	119	920428	35.377				
							R4549	910806	911203	119	920428	35.378	-0.001	35.378	35.370	-0.008
2	174	30-32S	134-20W	1	33	3081	R4546	910806	911203	119	920428	34.670				
							R4547	910806	911203	119	920428	34.668	+0.002	34.669	34.670	+0.001
2	180	37-30S	150-30W	2	61	4	S4072	910812	920508	271						
							S4073	910812	920508	270					34.740	
2	180	37-30S	150-30W	2	2	49	S4070	910812	920507	269						
							S4071	910812	920507	269					34.740	
2	180	37-30S	150-30W	2	3	96	S4068	910812	920507	269						
							S4069	910812	920507	269					34.740	
2	180	37-30S	150-30W	2	7	233	S4066	910812	920506	268						
							S4067	910812	920506	268					34.560	
2	180	37-30S	150-30W	2	69	315	R4564	910812	911204	113	920428	34.483				
							R4565	910812	911204	114	920428	34.490	-0.007	34.487	34.490	+0.003
2	180	37-30S	150-30W	2	11	469	R4562	910812	911211	121	920428	34.443				
							R4563	910812	911211	121	920428	34.440	+0.003	34.442	34.440	-0.002
2	180	37-30S	150-30W	2	13	622	R4560	910812	911216	126	920428	34.383				
							R4561	910812	911216	126	920428	34.382	+0.001	34.383	34.380	-0.003
2	180	37-30S	150-30W	2	16	931	R4558	910812	920506	269	930107	34.320				
							R4559	910812	920506	268	930107	34.323	-0.003	34.322	34.320	-0.002
2	180	37-30S	150-30W	2	18	1188	R4556	910812	920505	267	930107	34.360				
							R4557	910812	920505	267	930107	34.355	+0.005	34.358	34.360	+0.002
2	180	37-30S	150-30W	2	20	1543	R4554	910812	911204	113	920428	34.515				
							R4555	910812	911204	114	920428	34.518	-0.003	34.517	34.520	+0.003
2	180	37-30S	150-30W	2	22	2052	R4552	910812	920505	268	930107	34.622				
							R4553	910812	920505	267	930107	34.620	+0.002	34.621	34.620	-0.001

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA						SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
2	180	37-30S	150-30W	2 26	3051	R4550	910812	920504	266	930107	34.670				
						R4551	910812	920504	266	930107	34.670	+0.000	34.670	34.670	+0.000
2	213	21- 0S	150-30W	1 3	62	S4118	910823	911212	110	920428	35.970				
						S4119	910823	911212	111	920428	35.969	+0.001	35.970	35.970	+0.000

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BOTTLE TYPE:
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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD (ON DIC SAMPLE DATE) AND ON SHORE (ON DIC EXTRACTION DATE)

									SHORE DATA						SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST	NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	222	17- 0S	150-30W	1	36	6	R4568	910901	911009	38	920318	35.965				
							R4569	910901	911009	38	920318	35.970	-0.005	35.968	35.977	+0.009
3	222	17- 0S	150-30W	1	5	3055	R4566	910901	911008	37	920318	34.667				
							R4567	910901	911008	37	920318	34.670	-0.003	34.669	34.679	+0.010
3	226	15- 0S	150-50W	1	36	7	R4592	910903	911106	64	920318	36.196				
							R4593	910903	911106	64	920318	36.204	-0.008	36.200	36.231	+0.031
3	226	15- 0S	150-50W	1	35	50	R4590	910903	911106	64	920318	36.203				
							R4591	910903	911106	64	920318	36.201	+0.002	36.202	36.213	+0.011
3	226	15- 0S	150-50W	1	33	130	R4588	910903	911025	52						
							R4589	910903	911025	52	920318	36.297		36.297	36.297	+0.000
3	226	15- 0S	150-50W	1	31	211	R4586	910903	911024	51	920318	36.145				
							R4587	910903	911024	51	920318	36.149	-0.004	36.147	36.155	+0.008
3	226	15- 0S	150-50W	1	29	313	R4584	910903	911024	51	920318	35.222				
							R4585	910903	911024	51	920318	35.219	+0.003	35.221	35.233	+0.012
3	226	15- 0S	150-50W	1	27	413	R4582	910903	911023	50	920318	34.654				
							R4583	910903	911023	50	920318	34.664	-0.010	34.659	34.670	+0.011
3	226	15- 0S	150-50W	1	23	618	R4580	910903	911021	48	920318	34.460				
							R4581	910903	911021	48	920318	34.460	+0.000	34.460	34.466	+0.006
3	226	15- 0S	150-50W	1	18	926	R4578	910903	911021	48	920318	34.479				
							R4579	910903	911021	48	920318	34.486	-0.007	34.483	34.499	+0.016
3	226	15- 0S	150-50W	1	16	1232	R4576	910903	911017	44	920318	34.542				
							R4577	910903	911017	44	920318	34.534	+0.008	34.538	34.553	+0.015
3	226	15- 0S	150-50W	1	14	1642	R4574	910903	911016	43	920318	34.586				
							R4575	910903	911016	43	920318	34.582	+0.004	34.584	34.599	+0.015
3	226	15- 0S	150-50W	1	12	2056	R4572	910903	911015	42	920318	34.624				
							R4573	910903	911015	42	920318	34.622	+0.002	34.623	34.639	+0.016
3	226	15- 0S	150-50W	1	7	3090	R4570	910903	911009	36	920318	34.666				
							R4571	910903	911009	36	920318	34.668	-0.002	34.667	34.678	+0.011

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	230	13- 0S	151- 0W	1 36	7	R4596	910904	911108	65	920318	36.170				
						R4597	910904	911108	65	920318	36.182	-0.012	36.176	36.172	-0.004
3	230	13- 0S	151- 0W	1 7	3139	R4594	910904	911108	65	920318	34.674				
						R4595	910904	911108	65	920318	34.669	+0.005	34.672	34.680	+0.008
3	235	10-30S	151- 0W	4 36	6	R4600	910906	911111	66	920318	35.826				
						R4601	910906	911111	66	920318	35.825	+0.001	35.826	35.834	+0.008
3	235	10-30S	151- 0W	4 9	3007	R4598	910906	911111	66	920318	34.670				
						R4599	910906	911111	66	920318	34.675	-0.005	34.673	34.679	+0.006
3	238	9- 0S	151- 0W	1 36	6	R4624	910907	920430	237						
						R4625	910907	920504	240					35.792	
3	238	9- 0S	151- 0W	1 34	60	R4622	910907	920430	236						
						R4623	910907	920430	236					35.860	
3	238	9- 0S	151- 0W	1 32	111	R4620	910907	920429	235						
						R4621	910907	920429	235					35.976	
3	238	9- 0S	151- 0W	1 29	200	R4618	910907	920429	235	930107	36.022				
						R4619	910907	920429	235				36.022	36.026	+0.004
3	238	9- 0S	151- 0W	1 26	321	R4616	910907	920428	234	930107	34.838				
						R4617	910907	920428	234	930107	34.834	+0.004	34.836	34.835	-0.001
3	238	9- 0S	151- 0W	1 24	414	R4614	910907	920427	233	930107	34.686				
						R4615	910907	920427	233	930107	34.687	-0.001	34.687	34.690	+0.003
3	238	9- 0S	151- 0W	1 21	619	R4612	910907	920427	233	930107	34.577				
						R4613	910907	920427	233	930107	34.576	+0.001	34.577	34.580	+0.003
3	238	9- 0S	151- 0W	1 18	925	R4610	910907	920423	229	930107	34.522				
						R4611	910907	920423	229	930107	34.524	-0.002	34.523	34.530	+0.007
3	238	9- 0S	151- 0W	1 15	1233	R4608	910907	920423	229	920721	34.563				
						R4609	910907	920423	229	920721	34.570	-0.007	34.567	34.573	+0.006
3	238	9- 0S	151- 0W	1 12	1643	R4606	910907	920422	228	920721	34.605				
						R4607	910907	920422	228	920721	34.602	+0.003	34.604	34.607	+0.003

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	238	9- 0S	151- 0W	1 10	2055	R4604	910907	920420	226	920721	34.637				
						R4605	910907	920420	226				34.637	34.643	+0.006
3	238	9- 0S	151- 0W	1 5	3088	R4602	910907	920420	226	920721	34.677				
						R4603	910907	920420	226	920721	34.682	-0.005	34.680	34.679	-0.001
3	242	7- 0S	151- 0W	1 36	7	R4628	910908	911217	99	920428	35.306				
						R4629	910908	911217	100	920428	35.306	+0.000	35.306	35.309	+0.003
3	242	7- 0S	151- 0W	1 10	3018	R4626	910908	911216	99						
						R4627	910908	911216	99	920428	34.672		34.672	34.678	+0.006
3	246	5- 0S	151- 0W	2 36	8	R4652	910909	920415	220	920721	35.402				
						R4653	910909	920415	219	920721	35.401	+0.001	35.402	35.403	+0.001
3	246	5- 0S	151- 0W	2 35	60	R4650	910909	920415	219	920721	35.401				
						R4651	910909	920415	219	920721	35.399	+0.002	35.400	35.399	-0.001
3	246	5- 0S	151- 0W	2 33	137	R4648	910909	920414	218	920721	36.297				
						R4649	910909	920414	218	920721	36.290	+0.007	36.294	36.297	+0.003
3	246	5- 0S	151- 0W	2 31	215	R4646	910909	920414	218	920721	35.115				
						R4647	910909	920414	218	920721	35.113	+0.002	35.114	35.117	+0.003
3	246	5- 0S	151- 0W	2 29	307	R4644	910909	920410	214	920721	34.852				
						R4645	910909	920410	214	920721	34.848	+0.004	34.850	34.850	+0.000
3	246	5- 0S	151- 0W	2 27	409	R4642	910909	920409	213	920721	34.715				
						R4643	910909	920410	214	920721	34.721	-0.006	34.718	34.732	+0.014
3	246	5- 0S	151- 0W	2 23	631	R4640	910909	920409	213	920721	34.587				
						R4641	910909	920409	213	920721	34.585	+0.002	34.586	34.589	+0.003
3	246	5- 0S	151- 0W	2 20	917	R4638	910909	920407	211	920721	34.537				
						R4639	910909	920407	211	920721	34.534	+0.003	34.536	34.537	+0.001
3	246	5- 0S	151- 0W	2 18	1221	R4636	910909	920407	211	920721	34.569				
						R4637	910909	920407	211	920721	34.568	+0.001	34.569	34.569	+0.000

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SHIPBOARD SALINITY o/oo	DELTA (SHIP-SHORE)
3	246	5- ØS	151- ØW	2 16	1629	R4634	910909	920403	207	920721	34.607				
						R4635	910909	920403	207	920721	34.608	-0.001	34.608	34.609	+0.001
3	246	5- ØS	151- ØW	2 14	1982	R4632	910909	920402	206	920721	34.631				
						R4633	910909	920402	206	920721	34.636	-0.005	34.634	34.635	+0.001
3	246	5- ØS	151- ØW	2 9	3012	R4630	910909	920402	206	920721	34.676				
						R4631	910909	920402	206	920721	34.674	+0.002	34.675	34.679	+0.004
3	250	3- ØS	151- ØW	1 36	6	R4656	910911	920330	201	920721	35.418				
						R4657	910911	920330	201	920721	35.419	-0.001	35.419	35.421	+0.002
3	250	3- ØS	151- ØW	1 8	3084	R4654	910911	920326	197	920721	34.672				
						R4655	910911	920326	197	920721	34.670	+0.002	34.671	34.673	+0.002
3	262	1- ØS	151- ØW	1 36	7	R4660	910914	920401	200	920721	35.419				
						R4661	910914	920401	200	920721	35.421	-0.002	35.420	35.421	+0.001
3	262	1- ØS	151- ØW	1 8	2980	R4658	910914	920401	200	920721	34.685				
						R4659	910914	920401	200	920721	34.674	+0.011	34.680	34.674	-0.006
3	274	1- ØN	151- ØW	1 34	38	R4682	910916	920326	192	930107	34.868				
						R4683	910916	920326	192	930107	34.876	-0.008	34.872	34.869	-0.003
3	274	1- ØN	151- ØW	1 33	67	R4680	910916	920324	190	920721	35.037				
						R4681	910916	920324	190	920721	35.032	+0.005	35.035	35.033	-0.002
3	274	1- ØN	151- ØW	1 30	154	R4678	910916	920320	186	920721	34.807				
						R4679	910916	920320	186	920721	34.798	+0.009	34.803	34.805	+0.002
3	274	1- ØN	151- ØW	1 27	278	R4676	910916	920320	186	920721	34.833				
						R4677	910916	920320	186	920721	34.832	+0.001	34.833	34.836	+0.003
3	274	1- ØN	151- ØW	1 25	354	R4674	910916	920306	172	920721	34.788				
						R4675	910916	920306	172	920721	34.792	-0.004	34.790	34.792	+0.002
3	274	1- ØN	151- ØW	1 36	393	R4684	910916	920318	184	930107	34.750				
						R4685	910916	920318	184				34.750	34.754	+0.004
3	274	1- ØN	151- ØW	1 18	801	R4670	910916	920306	172	920721	34.544				
						R4671	910916	920306	172	920721	34.544	+0.000	34.544	34.548	+0.004

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

								SHORE DATA						SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	274	1- 0N	151- 0W	1 16	1007	R4668	910916	920305	171	920721	34.549				
						R4669	910916	920305	171	920721	34.553	-0.004	34.551	34.555	+0.004
3	274	1- 0N	151- 0W	1 14	1368	R4666	910916	920305	171	920428	34.588				
						R4667	910916	920305	171	920428	34.584	+0.004	34.586	34.590	+0.004
3	274	1- 0N	151- 0W	1 12	1778	R4664	910916	920303	169	920428	34.620				
						R4665	910916	920303	169	920428	34.622	-0.002	34.621	34.625	+0.004
3	274	1- 0N	151- 0W	1 4	3126	R4662	910916	920303	169	920721	34.678		34.678	34.677	-0.001
3	286	3- 0N	151- 0W	1 35	7	R4690	910918	911218	90	920428	34.757				
						R4691	910918	911218	91	920428	34.754	+0.003	34.756	34.755	-0.001
3	286	3- 0N	151- 0W	1 10	3084	R4687	910918	911217	90	920428	34.674				
						R4688	910918	911217	90	920428	34.676	-0.002	34.675	34.674	-0.001
3	290	5- 0N	151- 0W	1 36	8	R4714	910920	920227	161	920428	34.482				
						R4715	910920	920227	160	920428	34.485	-0.003	34.484	34.483	-0.001
3	290	5- 0N	151- 0W	1 34	81	R4712	910920	920227	160	920428	34.975				
						R4713	910920	920302	164	920428	34.974	+0.001	34.975	34.977	+0.002
3	290	5- 0N	151- 0W	1 33	120	R4710	910920	920227	160	920721	34.920				
						R4711	910920	920227	160	920428	34.922	-0.002	34.921	34.925	+0.004
3	290	5- 0N	151- 0W	1 31	205	R4708	910920	920225	158	920428	34.626				
						R4709	910920	920225	158	920428	34.621	+0.005	34.624	34.625	+0.001
3	290	5- 0N	151- 0W	1 29	296	R4706	910920	920225	158	920721	34.632				
						R4707	910920	920225	158	920721	34.647	-0.015	34.640	34.655	+0.015
3	290	5- 0N	151- 0W	1 27	411	R4704	910920	920224	157	920721	34.637				
						R4705	910920	920224	157	920721	34.648	-0.011	34.643	34.645	+0.002
3	290	5- 0N	151- 0W	1 23	616	R4702	910920	920220	153	920428	34.597				
						R4703	910920	920220	153	920428	34.593	+0.004	34.595	34.601	+0.006
3	290	5- 0N	151- 0W	1 20	924	R4700	910920	920220	153	920428	34.551				
						R4701	910920	920220	153	920428	34.547	+0.004	34.549	34.554	+0.005

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

								SHORE DATA						SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	290	5- 0N	151- 0W	1 18	1230	R4698	910920	920220	153	920428	34.571				
						R4699	910920	920220	153	920428	34.569	+0.002	34.570	34.574	+0.004
3	290	5- 0N	151- 0W	1 16	1642	R4696	910920	920218	151	920428	34.606				
						R4697	910920	920218	151	920428	34.608	-0.002	34.607	34.611	+0.004
3	290	5- 0N	151- 0W	1 14	2054	R4694	910920	920218	151	920428	34.636				
						R4695	910920	920218	151	920428	34.638	-0.002	34.637	34.640	+0.003
3	290	5- 0N	151- 0W	1 9	3089	R4692	910920	920218	151	920428	34.670				
						R4693	910920	920218	151	920428	34.673	-0.003	34.672	34.678	+0.006
3	294	6-58N	151-22W	1 36	10	R4718	910921	920213	145	920428	33.931				
						R4719	910921	920213	145	920428	33.940	-0.009	33.936	33.934	-0.002
3	294	6-58N	151-22W	1 10	3191	R4716	910921	920214	146	920428	34.675				
						R4717	910921	920214	146	920428	34.674	+0.001	34.675	34.679	+0.004
3	298	8-56N	151-45W	1 36	16	R4722	910922	920211	142	920428	33.795				
						R4723	910922	920211	142	920428	33.797	-0.002	33.796	33.797	+0.001
3	298	8-56N	151-45W	1 9	3058	R4720	910922	920210	141	920428	34.670				
						R4721	910922	920210	141	920428	34.669	+0.001	34.670	34.672	+0.002
3	302	10-54N	152- 7W	1 36	8	R4746	910923	920206	136	920428	33.814				
						R4747	910923	920206	136	920428	33.816	-0.002	33.815	33.818	+0.003
3	302	10-54N	152- 7W	1 34	60	R4744	910923	920206	136	920428	34.486				
						R4745	910923	920206	136	920428	34.479	+0.007	34.483	34.480	-0.003
3	302	10-54N	152- 7W	1 32	110	R4742	910923	920204	134	920428	34.421				
						R4743	910923	920204	134	920428	34.425	-0.004	34.423	34.422	-0.001
3	302	10-54N	152- 7W	1 29	212	R4740	910923	920204	134	920428	34.594				
						R4741	910923	920204	134	920428	34.594	+0.000	34.594	34.597	+0.003
3	302	10-54N	152- 7W	1 27	314	R4738	910923	920203	133	920428	34.587				
						R4739	910923	920203	133	920428	34.587	+0.000	34.587	34.591	+0.004
3	302	10-54N	152- 7W	1 26	416	R4736	910923	920203	133	920428	34.555				
						R4737	910923	920203	133	920428	34.557	-0.002	34.556	34.558	+0.002

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COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

										SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	302	10-54N	152- 7W	1 24	621	R4734	910923	920130	129	920428	34.512				
						R4735	910923	920130	129	920428	34.513	-0.001	34.513	34.518	+0.005
3	302	10-54N	152- 7W	1 21	928	R4732	910923	920130	129	920428	34.545				
						R4733	910923	920130	129	920428	34.544	+0.001	34.545	34.548	+0.003
3	302	10-54N	152- 7W	1 19	1237	R4730	910923	920129	128	920428	34.577				
						R4731	910923	920129	128	920428	34.576	+0.001	34.577	34.580	+0.003
3	302	10-54N	152- 7W	1 17	1647	R4728	910923	920129	128	920428	34.608				
						R4729	910923	920129	128	920428	34.608	+0.000	34.608	34.611	+0.003
3	302	10-54N	152- 7W	1 15	2058	R4726	910923	920128	127	920428	34.639				
						R4727	910923	920128	127	920428	34.639	+0.000	34.639	34.646	+0.007
3	302	10-54N	152- 7W	1 10	3086	R4724	910923	920128	127	920428	34.673				
						R4725	910923	920128	127	920428	34.675	-0.002	34.674	34.675	+0.001
3	306	12-52N	152-30W	1 36	9	R4750	910924	920210	139	920428	34.093				
						R4751	910924	920210	139	920428	34.094	-0.001	34.094	34.093	-0.001
3	310	14-50N	152-53W	1 36	9	R4754	910926	911219	83	920428	34.156				
						R4755	910926	911219	84	920428	34.157	-0.001	34.157	34.158	+0.001
3	310	14-50N	152-53W	1 12	3081	R4752	910926	911218	83	920428	34.670				
						R4753	910926	911218	83	920428	34.670	+0.000	34.670	34.673	+0.003
3	314	16-48N	153-16W	2 36	9	R4778	910927	920122	118	920428	34.572				
						R4779	910927	920122	117	920428	34.569	+0.003	34.571	34.572	+0.001
3	314	16-48N	153-16W	2 34	76	R4776	910927	920121	116	920428	34.861				
						R4777	910927	920121	116	920428	34.862	-0.001	34.862	34.863	+0.001
3	314	16-48N	153-16W	2 33	107	R4774	910927	920121	116	920428	34.980				
						R4775	910927	920121	116	920428	34.980	+0.000	34.980	34.982	+0.002
3	314	16-48N	153-16W	2 30	216	R4772	910927	920117	112	920428	34.352				
						R4773	910927	920117	112	920428	34.352	+0.000	34.352	34.355	+0.003

DATES:
  SAMPLE DATE = DATE OF THE DIC AND SHIPBOARD SALINITY SAMPLE
  EXTRACTION DATE = DATE OF DIC EXTRACTION AND DATE OF
    SUBSAMPLE FOR SHORE SALINITY
 ANALYSIS DATE = DATE OF SHORE SALINITY ANALYSIS BY ODF
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

STORAGE:
  E-S = (DIC EXTRACTION DATE - DIC SAMPLE DATE), IN DAYS

COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD AND ON SHORE (cont.)

									SHORE DATA					SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
3	314	16-48N	153-16W	2 28	318	R4770	910927	920116	111	920428	34.166				
						R4771	910927	920116	111	920428	34.166	+0.000	34.166	34.168	+0.002
3	314	16-48N	153-16W	2 25	442	R4768	910927	920116	111	920428	34.487				
						R4769	910927	920116	111	920428	34.480	+0.007	34.484	34.484	+0.000
3	314	16-48N	153-16W	2 22	676	R4766	910927	920115	110	920428	34.476				
						R4767	910927	920115	110	920428	34.474	+0.002	34.475	34.479	+0.004
3	314	16-48N	153-16W	2 20	933	R4764	910927	920115	110	920428	34.503				
						R4765	910927	920115	110	920428	34.508	-0.005	34.506	34.517	+0.011
3	314	16-48N	153-16W	2 18	1291	R4762	910927	920114	109	920428	34.562				
						R4763	910927	920114	109	920428	34.557	+0.005	34.560	34.563	+0.003
3	314	16-48N	153-16W	2 16	1698	R4760	910927	920108	103	920428	34.605				
						R4761	910927	920108	103	920428	34.598	+0.007	34.602	34.604	+0.002
3	314	16-48N	153-16W	2 14	2113	R4758	910927	920108	103	920428	34.630				
						R4759	910927	920108	103	920428	34.626	+0.004	34.628	34.635	+0.007
3	314	16-48N	153-16W	2 9	3201	R4756	910927	920107	102	920428	34.670				
						R4757	910927	920107	102	920428	34.669	+0.001	34.670	34.673	+0.003

DATES:
  SAMPLE DATE = DATE OF THE DIC AND SHIPBOARD SALINITY SAMPLE
  EXTRACTION DATE = DATE OF DIC EXTRACTION AND DATE OF
    SUBSAMPLE FOR SHORE SALINITY
 ANALYSIS DATE = DATE OF SHORE SALINITY ANALYSIS BY ODF
BOTTLE TYPE:
  R = RODAVISS S = S TYPE

STORAGE:
  E-S = (DIC EXTRACTION DATE - DIC SAMPLE DATE), IN DAYS

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg M15 1991 Atlantic WOCE Line A9 Table 5d

COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD (ON DIC SAMPLE DATE) AND ON SHORE (ON DIC EXTRACTION DATE)

				CAST	DEPTH	SAMPLE	SAMPLE	SHORE DATA EXTRAC	STORAGE	ANALYS.	SALINITY	BOTTLE	BOTTLE AVG	SHIPBOARD SALINITY	DELTA (SHIP-
LEG	STATION	LAT.	LONG.	NISK	(M)	BOTTLE	DATE	DATE	(E-S)	DATE	o/oo	DELTA	o/oo	o/oo	SHORE)
	143	19-00S	30-01W	3 18	1593	R4934	910216	910705	139	911017	34.921				
						R4935	910216	910709	143	911017	34.931	-0.010	34.926	34.940	+0.014
	143	19-00S	30-01W	3 12	2995	R4932	910216	910709	143	911017	34.897				
						R4933	910216	910726	160	911017	34.904	-0.007	34.901	34.921	+0.020
	154	19-00S	23-15W	2 24	8	R4938	910221	910628	127	911017	37.168				
						R4939	910221	910701	130	911017	37.175	-0.007	37.172	37.217	+0.045
	187	19-12S	08-12W	2 24	7	R4956	910303	910705	124	911017	36.561				
						R4957	910303	910731	150	911017	36.518	+0.043	36.540	36.553	+0.013
	187	19-12S	08-12W	3 18	1194	R4962	910303	910709	128	911017	34.672				
						R4963	910303	910709	128	911017	34.676	-0.004	34.674	34.697	+0.023
	187	19-12S	08-12W	3 12	2492	R4961	910303	910705	124	911017	34.878		34.878	34.912	+0.034
	199	19-00S	01-54W	2 2	898	R4964	910307	910701	116	911017	34.506				
						R4965	910307	910701	116	911017	34.505	+0.001	34.506	34.513	+0.007

DATES:
  SAMPLE DATE = DATE OF THE DIC AND SHIPBOARD SALINITY SAMPLE
  EXTRACTION DATE = DATE OF DIC EXTRACTION AND DATE OF
    SUBSAMPLE FOR SHORE SALINITY
 ANALYSIS DATE = DATE OF SHORE SALINITY ANALYSIS BY ODF
BOTTLE TYPE:
   R = RODAVISS   S = S TYPE

STORAGE:
  E-S = (DIC EXTRACTION DATE - DIC SAMPLE DATE), IN DAYS

THE CARBON DIOXIDE PROJECT OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY
F/S Meteor Leg 18 1991 Atlantic WOCE Line A1E Table 5e

COMPARISON OF SALINITY DATA FOR SUBSAMPLES TAKEN SHIPBOARD (ON DIC SAMPLE DATE) AND ON SHORE (ON DIC EXTRACTION DATE)

										SHORE DATA			SHIPBOARD	DELTA
LEG	STATION	LAT.	LONG.	CAST NISK	DEPTH (M)	SAMPLE BOTTLE	SAMPLE DATE	EXTRAC DATE	STORAGE (E-S)	ANALYS. DATE	SALINITY o/oo	BOTTLE DELTA	BOTTLE AVG o/oo	SALINITY o/oo	(SHIP-SHORE)
	575	59- 1N	32-46W	1 24	11	R4830	910909	940214	889	941013	34.727				
						R4831	910909	940214	889	941013	34.729	-0.002	34.728	34.721	-0.007
	575	59- 1N	32-46W	1 13	1101	R4828	910909	940211	886	940715	34.950				
						R4829	910909	940211	886	940715	34.912	+0.038	34.931	34.901	-0.030
	580	58-19N	29-56W	1 23	28	R4842	910910	940216	890	941013	34.964				
						R4843	910910	940216	890	941013	34.963	+0.001	34.964	34.948	-0.016
	580	58-19N	29-56W	1 1	2333	R4838	910910	940214	888	940715	34.984				
						R4839	910910	940214	888	940715	34.983	+0.001	34.984	34.977	-0.007
	581	58-11N	29-37W	1 2	2008	R4844	910910	940127	870	940715	34.979				
						R4845	910910	940127	870	940715	34.992	-0.013	34.986	34.975	-0.011
	596	45-22N	25-57W	1 14	689	R4874	910914	940215	885	940715	35.013				
						R4875	910914	940215	885	940715	34.996	+0.017	35.005	34.991	-0.014
	603	52-51N	22-23W	1 1	3984	R4878	910916	940215	883	940715	34.904				
						R4879	910916	940215	883	940715	34.914	-0.010	34.909	34.915	+0.006

DATES:
  SAMPLE DATE = DATE OF THE DIC AND SHIPBOARD SALINITY SAMPLE
  EXTRACTION DATE = DATE OF DIC EXTRACTION AND DATE OF SUBSAMPLE FOR SHORE SALINITY
 ANALYSIS DATE = DATE OF SHORE SALINITY ANALYSIS BY ODF
BOTTLE TYPE:
   R = RODAVISS   S = S TYPE

STORAGE:
  E-S = (DIC EXTRACTION DATE - DIC SAMPLE DATE), IN DAYS

APPENDIX 6

SIO Shore Based CO_2 Sampling Instructions

30 MAY 91
Keeling-Guenther Total Carbon

SIO SHORE BASED CO_2 SAMPLING INSTRUCTIONS for Pacific WOCE Legs 1 - 3 on R/V *Thomas Washington*, May to October, 1991

GENERAL PRECAUTIONS

Draw samples immediately following the shipboard CO_2 samples, as soon as possible after the Niskin bottle is opened.

Fill the two glass 500 ml sample bottles one after the other as quickly as possible to minimize the loss of CO_2 gas.

The chief concern in the collection of these stored samples is the prevention of leakage. The following steps must be done correctly: (1) An air space of 5 cc is left in the bottle. (2) The bottle joint is prepared and greased properly. (3) The stopper holder is attached properly.

There are two kinds of stopper holders on the bottles. Most have a metal "bail" assembly (called "Standard Corning Bottles" in these instructions) and require special attention before and after collection of the samples. NOTE ESPECIALLY STEPS (1) AND (13).

STEP BY STEP PROCEDURES

(1) SELECT AND PREPARE THE BOTTLES

Please try to use the boxes in numerical order (1 -19 on Leg 1, 1 - 20 on Leg 2 and 1 - 15 on Leg 3). Within each box fill the bottles in the "usual" order from left to right beginning with the marked position at the upper left.

Glass bottles are numbered on yellow labels. Record these numbers in correlation with Niskin cast and bottle numbers.

(a) **Standard Corning Bottles**. Bottle numbers begin with an "S". These bottles have hollow stoppers held on with a metal "bail" type stopper holder. The stoppers have been ground individually to fit the bottles and must not be interchanged (stopper and bottle have matching numbers on decals). The metal bail assemblies have been tightened prior to shipment. Use the supplied Allen wrench to loosen the assemblies on all bottles to be used on the upcoming station.

(b) **"Rodaviss" Joint Bottles**. Bottle numbers begin with an "R". These have solid stoppers held on with a plastic knurled nut assembly.

(2) CHECK THE ACCESSORIES

The following accessories are required:

(a) Saturated aqueous $HgCl_2$ solution

(b) 100-microliter Eppendorf pipette with yellow tip (or other device to add this amount of solution)

(c) Plastic pipette with bulb ("kitchen baster")

(d) One sample data sheet for each station sampled.

(e) Paper cleansing tissues (Kimwipes) and a Kimwipe wrapped around an applicator stick.

(f) Tygon drawing tube (pretreat by soaking in clean sea water for at least one day)

(g) Apiezon "L" grease in a plastic 20ml syringe (refill from supplied tubes of grease when empty)

(h) "Loctite" for Step (13) after all bottles from station are collected.

(3) GREASE THE STOPPER

When you are ready to sample, temporarily remove the stopper from the first bottle, and wipe the stopper with a Kimwipe to remove as much grease as possible. Then regrease the stopper with four thin vertical strips of grease using the syringe, spaced equidistant around the stopper. Set the stopper aside so that the grease does not get disturbed. (NOTE: If conditions do not allow this, do the greasing immediately prior to stopper insertion (Step (9)). *Do not remove the grease from the bottle opening. (see step (8)).*

(4) ATTACH THE DRAWING TUBE TO THE NISKIN BOTTLE

The Tygon tubing must be long enough to reach to the bottom of the sample bottle. Check that the vent is open on the top of the Niskin bottle.

(5) FILL THE SAMPLE BOTTLE

First enter the present time on the data sheet for the bottle (first or second) being filled. Then open the Niskin bottle drain. Flush the drawing tube with about 50ml of water. Then flow another 50ml water into the bottle. Swirl the water around and discard it. Then begin filling the bottle from the bottom. Determine with a watch the time it takes to fill the bottle. Allow the bottle to overflow for at least one-half the filling time.

(6) REMOVE EXCESS WATER

Using the plastic pipette, suck out the water in the sample bottle so that an air space of about 5 cc will remain in the bottle after replacing the stopper.

(a) **Standard Corning Bottles.** Lines have been drawn on the bottles to show the 5 cc air space. Adjust the bottle volume so that the

meniscus is centered on this line, as viewed from the top.

(b) **"Rodaviss" Joint Bottles.** The "bulging" vertical section of the bottle between the greased joint and the sloping shoulder of the bottle holds a 5 cc air space.

(7) ADD MERCURY SOLUTION

Using the Eppendorf pipette, add 100μl of the saturated aqueous $HgCl_2$ solution to the sample bottle. If a glass medicine dropper must be used, add 2 drops.

(8) SWAB THE SAMPLE BOTTLE JOINT

Remove any water remaining on the pregreased bottle neck. (Normally this water will be beaded up in a few small droplets.) Use the Kimwipe wrapped on the applicator stick.

(9) INSERT AND SECURE THE STOPPER

Insert the previously greased stopper straight into the sample bottle neck. Squeeze the air out of the grease to make a good seal. Do not turn the stopper until the grease has spread completely around the joint. Check that an air space of about 5 cc remains in the bottle.

(a) **Standard Corning Bottles.** After the greased seal has been made, secure the stopper by tightening the top screw on the bail firmly down onto the stopper. *Finger tight is sufficient at this point.*

(b) **"Rodaviss" Joint Bottles.** Simply insert the stopper into the the joint and screw down the nut firmly finger tight to slightly compress the enclosed O - ring.

(10) REPEAT THE PROCEDURE

Go immediately to step (3) to fill the second sample bottle. (The beginning of filling of the second bottle should be within 3 minutes of the beginning of the filling of the first bottle.) (Skip Step (4).) Do steps (5) through (9). Then proceed to instruction (11) below.

(11) FILL OUT THE DATA SHEET

Please enter the station particulars at the top of the sheet and identify all bottles filled with Niskin cast and bottle numbers and nominal depths. Enter preliminary water temperature and salinity if known. Please report any deviations in procedure or problems, for example a delay in filling the second bottle, in the "Remarks" section.

(12) REPACK THE BOTTLES

Shake the bottles gently to disperse the $HgCl_2$ solution. Check that the stoppers are firmly installed. Return the bottles to their packing box. Place the data sheet into the box with the bottles.

(13) TIGHTEN STOPPER HOLDERS

After the station is over, the bail assemblies on the **Standard Corning Bottles** need to be tightened. First add a drop of "Loctite" to the screw just above the bail as shown on the diagram. Then, using the Allen wrench, tighten the screw about one half turn beyond finger tight. The bail assembly should be firmly in place and not easily turned.

If a stopper holder breaks or doesn't work, please wrap several turns of electrical tape around the bottle from top to bottom to secure the stopper.

(14) STORE THE BOXES

The samples ideally should be stored refrigerated, but not frozen, to best preserve the greased stopper seals and to slow down reactions with the glass surface. If this is impossible, please store them in a cool, air conditioned area of the ship. Since light is also detrimental to the grease, the samples are best stored within their boxes at all times. Before stowing the boxes, secure the box lids with the enclosed "tie wraps."

SUMMARY OF SAMPLING INSTRUCTIONS

Keeling-Guenther Total Carbon
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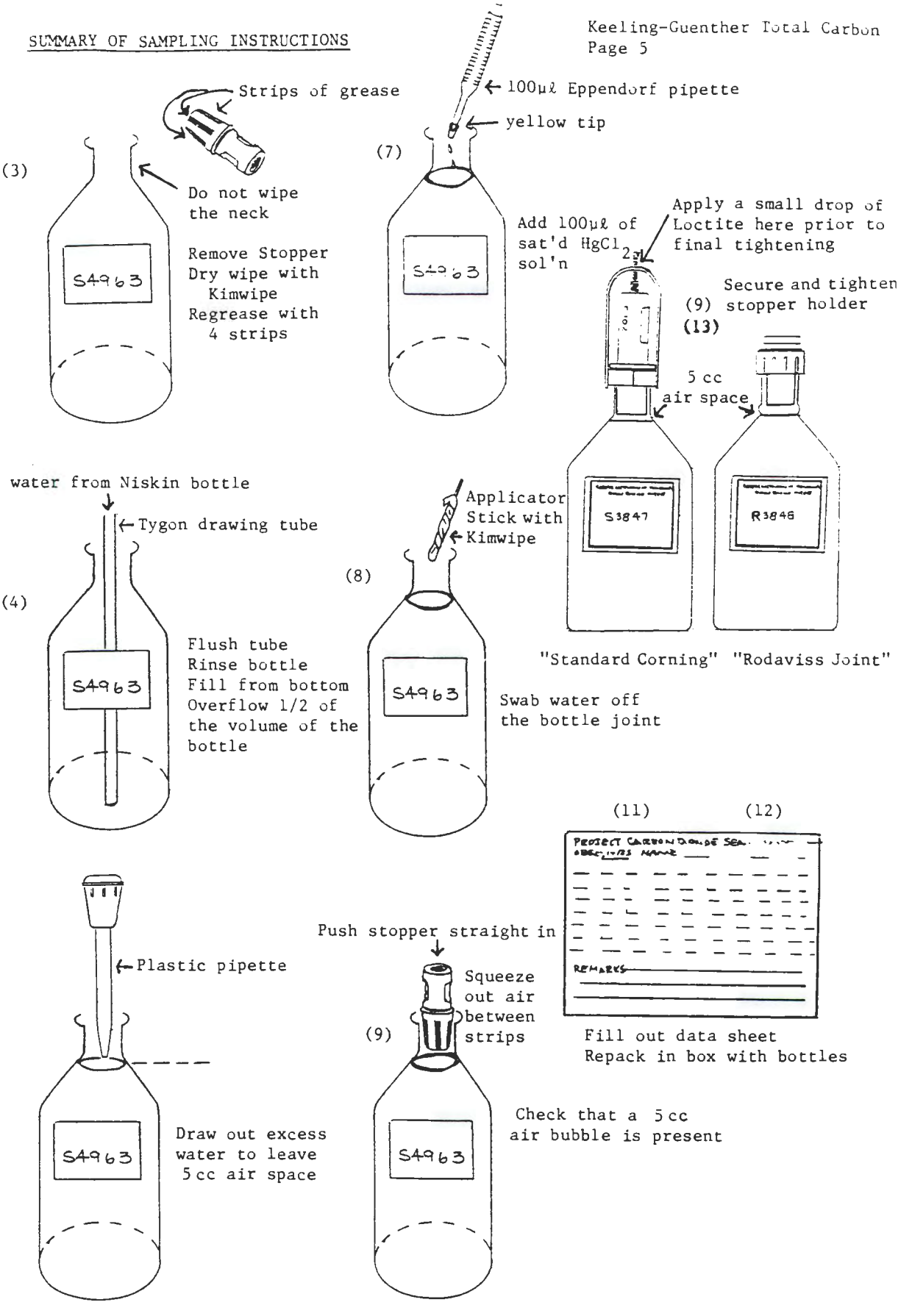


APPENDIX 7

Laboratory method for total dissolved inorganic carbon and titration alkalinity

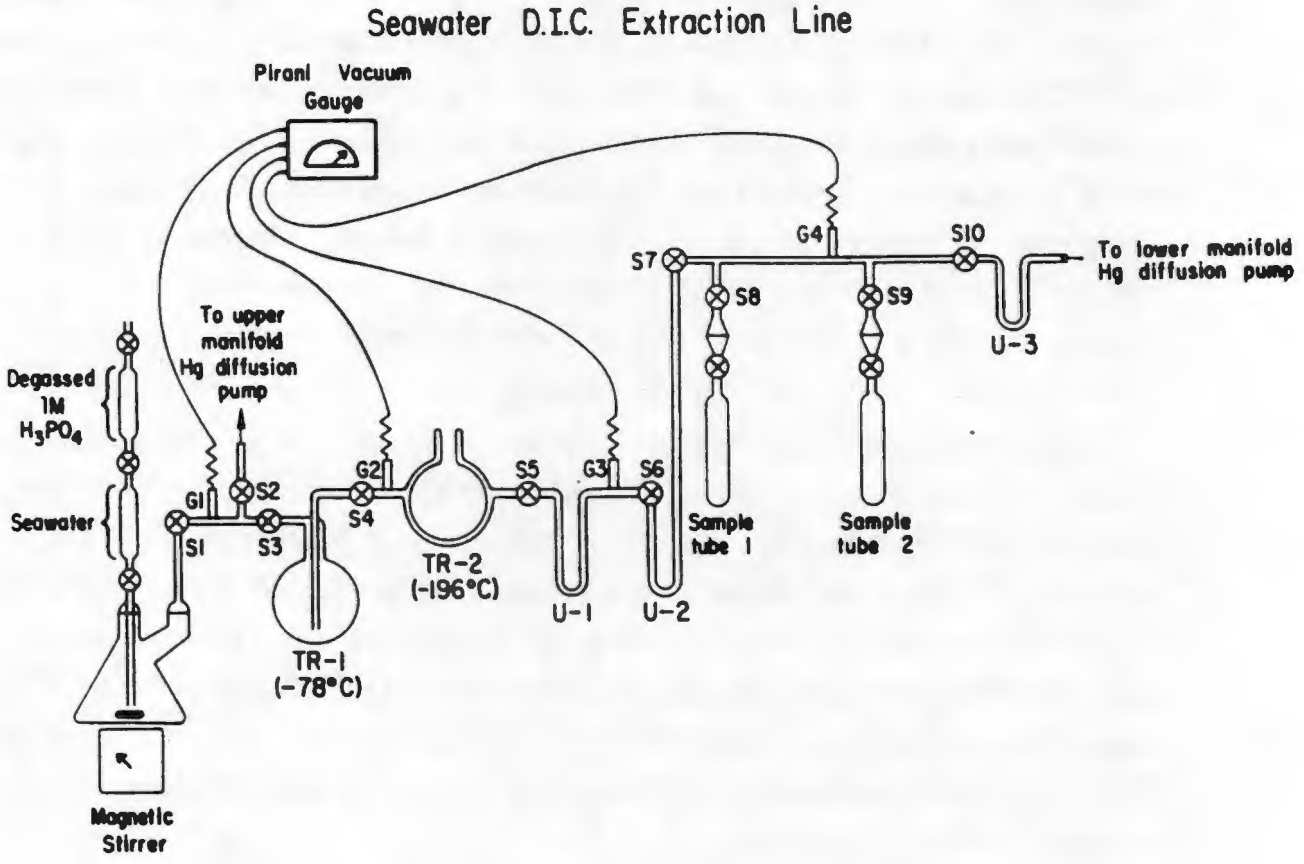
Determination of DIC in sea water

We have developed a manometric procedure for measuring dissolved inorganic carbon (DIC), based on initial work of C. S. Wong [1970] in our laboratory. Water samples collected at sea in borosilicate reagent bottles are stored at 5°C, then warmed to 20°C just prior to analysis. Pipettes equipped with vacuum stopcocks are evacuated, cleaned, and weighed to ± 1 mg. The sample bottle is opened and an aliquot of about 40 g of seawater is taken from the bottle by forcing water under pressure of compressed air through the pipette. The pipette is flushed, by displacing one extra volume of water, and then closed off, cleaned, dried, and reweighed. The sample weight, about 40 g, is determined to 1 part in 40,000, and the pipette is attached to a vacuum extraction system, as shown in Figure 1.

After evacuating the system to a pressure of about 1 mTorr, the seawater is flowed into an extraction chamber, followed by 40 ml of a degassed one-molar solution of phosphoric acid which converts all carbonate and bicarbonate of the DIC to CO_2 gas. The gas is then sucked slowly through a trap cooled with dry ice in ethanol, which removes most of the water vapour and then through a trap cooled with liquid nitrogen, which freezes out the CO_2. Additional vacuum sublimations purify the CO_2, after which the gas is transferred into a glass storage tube. The amount of extracted CO_2 gas is determined using either a constant volume, mercury column manometer and/or a quartz spiral manometer.

If the mercury manometer is used, the CO_2 gas sample is transferred into the appropriate chamber of the manometer and brought to constant temperature. The mercury level in the manometer is raised into near contact with a glass pointer, at which time the heights of the this mercury column and a connecting reference column under vacuum are measured to a precision of about 5 micromoles using a special cathetometer mounted on a precisely calibrated screw. The amount of CO_2 gas is calculated from the manometric data using a virial equation of state. The DIC concentration in μm/kg is calculated from the amount of CO_2 gas and the weight of seawater extracted.

If the quartz spiral manometer is used, the sample is similarly transferred and brought to constant temperature. The manometer then measures the pressure of the CO_2 gas sample to high precision relative to a set of gas samples which are



Appendix 7, Figure 1. Schematic of vacuum line used to extract CO_2 gas quantitatively from dissolved inorganic carbon (DIC) in sea water.

periodically measured on the constant volume mercury manometer.

Precision of DIC Analyses

The constant volume mercury manometer has been exhaustively calibrated in connection with the atmospheric CO_2 program at SIO. The quartz spiral manometer is calibrated with standards measured on the constant volume manometer. For each day in which quartz spiral measurements are made, a factor is determined which relates the pressure on an arbitrary counter scale to the number of moles of gas in the manometric standards. This factor then relates the pressure of a given seawater sample to the amount of gas in that sample. Many seawater samples from our time-series stations have been measured on both the mercury manometer and the original quartz spiral manometer in use from 1981 to 1992. These data provide a definitive basis for calculating the imprecision of the quartz spiral manometer compared to the constant volume mercury manometer. For 136 samples measured on both manometers the standard deviation for individual differences is 0.75 μmole/kg.

Additional estimates of the imprecision of the DIC analyses are obtained from data on replicate sea water samples (usually pairs) summarized as follows:

Year	Station/ Cruise	Ocean	No. of Bottle Pairs	Standard Deviation of Individual Analysis (μM/kg)	Device
1983-1989	BERMUDA TIME SERIES	N. Atlantic	101	0.71	CV
1979-1987	NEAR TAHITI TIME SERIES	S. Pacific	68	0.70	CV
1988	SAVE legs 1-3	S. Pacific	52	0.69	QS
1988	WECOMA	Equatorial Pacific	14	0.82	QS
1989	ROUNDABOUT	Equatorial Pacific	31	0.69	QS

Note: CV = constant volume manometer, QS = quartz spiral manometer

Accuracy of DIC Analysis. The constant volume manometer has been exhaustively calibrated in connection with measurements of atmospheric CO_2. As a further check, we carried out a series of assays of Baker's Ultrex sodium carbonate which had first been brought to constant weight following recommended procedures. Each weighed carbonate sample was placed in the extraction apparatus used routinely for sea water samples. It was acidified with the same acid solution, and the evolved CO_2 was then analyzed manometrically. The mean of 11 assays was 100.50 ± .05%; thus a systematic error of 1 part in 2000.

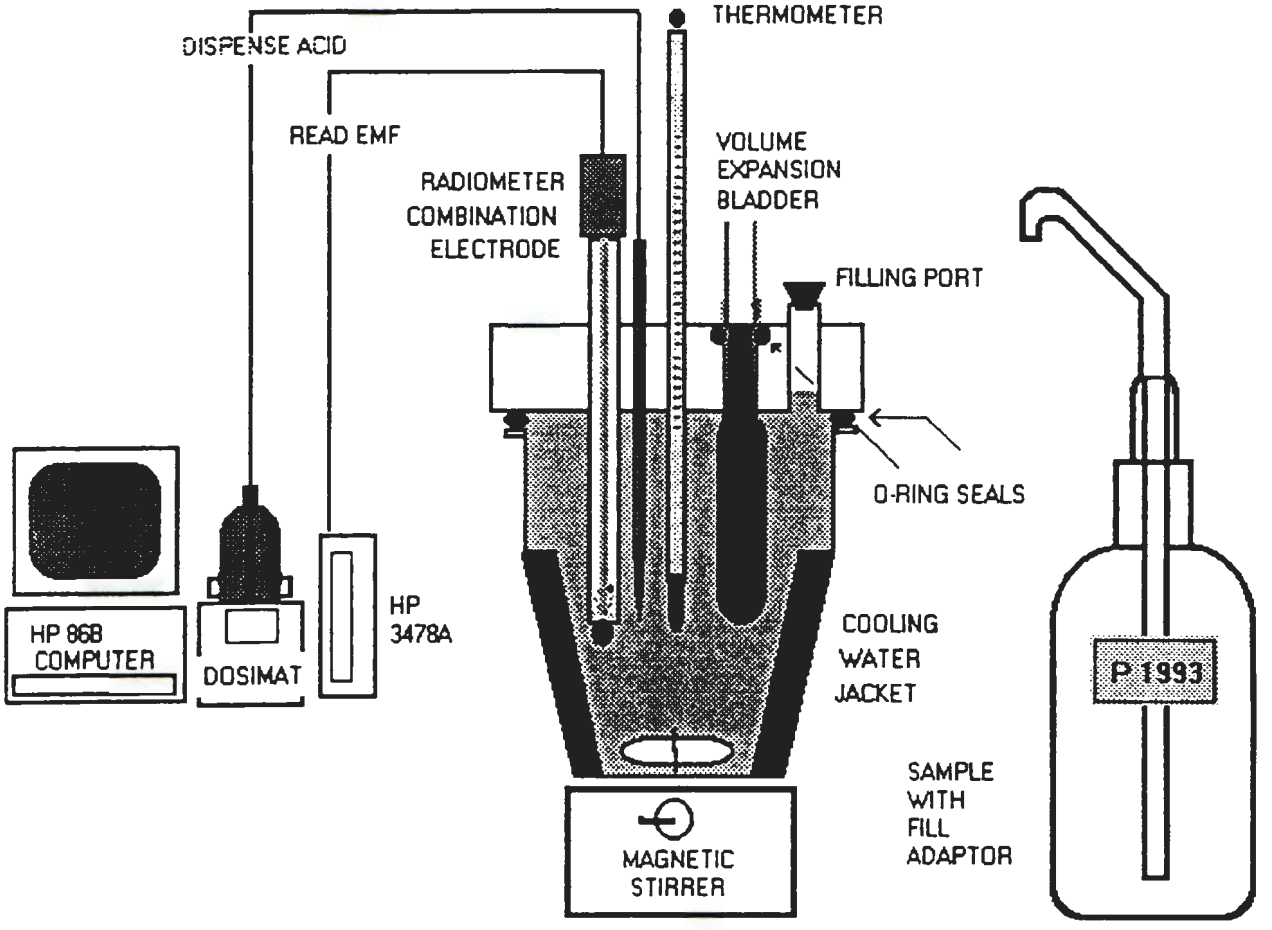
Our accuracy of analysis is thus likely to be within a factor two of our precision. This result is made possible because of the fundamental simplicity of our method: we remove CO_2 quantitatively from an accurately weighed amount of sea water, and we determine the evolved gas with a manometer which is calibrated to such high accuracy with respect to volume, temperature and pressure that we achieve an overall accuracy of 1 part in 2000 and a precision of 1 part in 4000.

Determination of ALK in sea water (gravimetric method)

The development of the instrumentation and procedure for measuring alkalinity followed the work of Dickson [1981] and his cited predecessors. The sea water samples remaining after analysis of aliquots for DIC as described above were titrated in a closed, jacketed glass cell manufactured by Metrohm (#EA 880 T-V). Figure 2 illustrates the system. A Dosimat burette system (Metrohm model 655) with a precision glass tip delivered titrant to the cell. The reversible cell potential (emf) was measured in the solution by either an Orion combination electrode (model 81-02) or a Radiometer combination electrode (model GK2402C), a high impedence voltage follower, and a Hewlett Packard (HP) voltmeter (model 3478A) with one microvolt sensitivity. The cell was designed to compensate for the additional titrant volume by compressing a vinyl bladder inserted into the solution.

The titrations were controlled using an HP 86B desktop computer connected to the Dosimat with an HP 82940A GP-IO interface, and to the voltmeter with an IEEE 488 interface. For each step in the titration, the computer activated the Dosimat and recorded the acid volume, emf data, and time at one second intervals.

The hydrochloric acid, used as titrant, was prepared in batches of 4 to 20 liters using a concentrated HCl solution (Fisher cat # SA49) and Milli-Q water, at a concentration of about 0.22 mol/kg. Reagent grade sodium chloride (Fisher #S271-10) was added to the acid to give a total ionic strength of 0.7 [Dyrssen and Sillén, 1967].



Appendix 7, Figure 2. Diagram of gravimetric titration alkalinity system.

Titration Procedure

Each sample bottle was first wiped dry and a filling adapter inserted into the greased joint, as shown in Figure 2. This bottle assembly was weighed on a digital top-loading balance to a precision of 0.01 grams. The titration cell, rinsed with Milli-Q water and wiped dry after the previous titration, was assembled with the thermometer and the burette tip. The sample was dispensed into the cell by pressurizing the head space with nitrogen gas while observing the solution level through an opening in the cell top. When nearly full, the pressure in the bottle was released, and the cell top was stoppered, trapping about 5 cc of air in contact with the solution. The bottle was weighed again, and the weight of solution dispensed into the cell was determined by difference, typically 170-180 grams. After recording the temperatures of the cell and acid and measuring the emf for 3 to 5 minutes, the titrant was added in 0.100 ml increments until a final volume of 2.2 ml was attained. Shortly before the bicarbonate equivalence point was attained, the titrant increments were reduced to 0.020 ml to obtain more closely spaced data.

During the titration the emf was recorded once per second, beginning two seconds after addition of acid. The extent of reaction, observed as the rate of change in emf, was plotted for each titration step. A change in emf not greater than 10 microvolts over a 5 second interval was considered to indicate that the solution had attained equilibrium with the titrant, and after 4 such increments were recorded, the next titrant dose was delivered. A complete titration took about 40 minutes.

The measurements of emf with respect to each volume of HCl titrant were processed using a non-linear least squares minimization procedure described by Dickson [1981].

Sea water standards for DIC and Alkalinity.

Our primary standards consist of sodium carbonate and sodium chloride dissolved together in highly purified water. The carbonate is brought to constant weight at 275°C. We assay the salt for total carbon by evolving CO_2 which is afterwards measured manometrically. The titration alkalinity of each individual standard is determined immediately after preparation and compared to the value expected from the gravimetric data. Using various proportions of carbonate and chloride salts we have established that the sodium chloride which we use contains a small fraction of alkaline impurities which we treat as a constant alkaline blank. We compare the alkalinity of these primary standards with the results of differential titrations of sodium borate decahydrate, and we use the resulting data from both types of standards to assign a normality to the

hydrochloric acid solution used in our titrations.

Our secondary standards consist of sodium carbonate and sodium chloride, dissolved in purified water, and converted to lower pH and to ambient pCO_2 by bubbling laboratory air through the solution. The standard solutions, prepared in 20 to 50 liter batches, are stored in glass 1-liter bottles of vitreous quartz or borosilicate. We immediately determine the titration alkalinity and DIC on approximately 8 aliquots drawn from two such bottles. We analyze the remaining solutions periodically with respect to both DIC and alkalinity, and we overlap batches to provide continuity.

We have achieved a combined bottle and analysis imprecision (1 sigma) of 1.38 μM/kg for DIC and 1.45 μEq/kg for titration alkalinity on replicate bottles of our secondary standards analyzed repetitively over periods as long as 1 year. These results, taken together with comparable results for pairs of sea water sample analyzed for DIC and alkalinity up to two years apart, indicate our secondary standards are stable over that period of time.

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