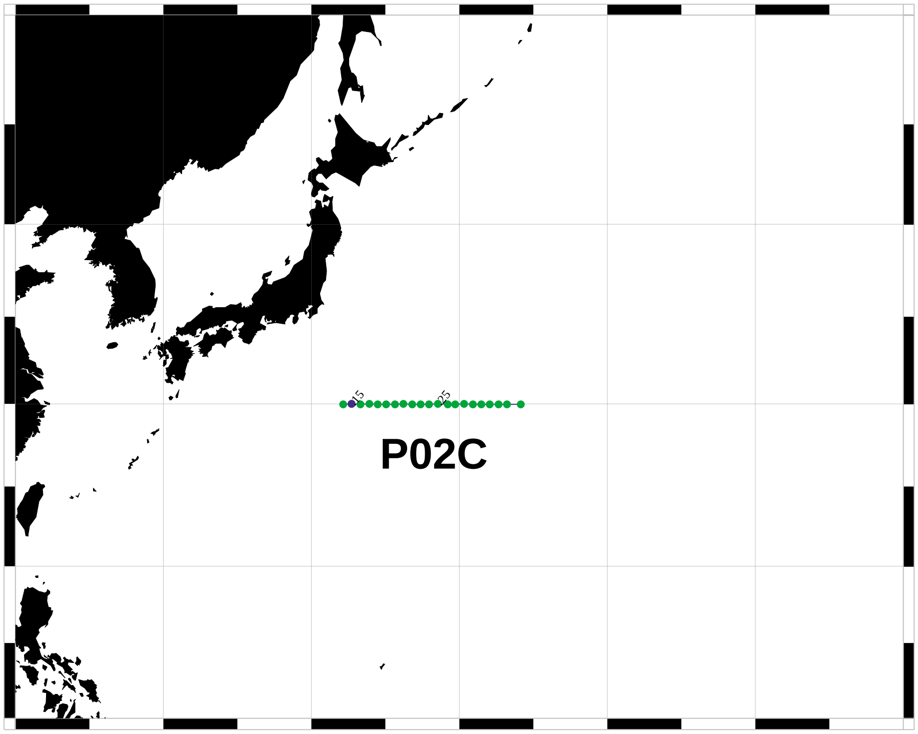
A. Cruise Narrative: P02C



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**P02C**
Expedition designation (EXPOCODE)	**49EWBO9401_1**
Chief Scientist(s) and their affiliation	**Masao Fukasawa/JAMSTEC***
Dates	1994.JAN.15 - 1994.FEB.04
Ship	R/V BOSEI MARU NO. 2
Ports of call	Shimizu, Japan to Shimizu, Japan
Geographic boundaries of the stations	29° 58.98' N 142° 10.02' E 154° 10.9714' W 29° 58.98' N
Number of stations	21
Floats and drifters deployed	unknown
Moorings deployed or recovered	unknown
Contributing Authors:	Masao Fukasawa

* **Chief Scientist** • Senior Scientist • Tokai University • Ocean Research Department
Faculty Of Marine Science & Technology
2-15 Natsushima, Yokosuka Kanagawa 237-0061 • Japan
Phone: 81-468-67-3431 • Fax: 81-468-65-3202 • Email: fksw@jamstec.go.jp

WHP Cruise and Data Information

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

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
	Salinity
Principal Investigators for all measurements	**Acknowledgments**
Cruise Participants	
	Data Status Notes

A.2. Cruise Summary

P02 was composed of four different cruises which were carried out during the period from October 14, 1993 to November 14, 1994 utilizing three different observation ships. No large volume sampling was carried out. Most of the observation line is located on 30°N. But west of 134.5 E, the line goes northwest toward Cape Ashizuri along the PCM5 line. Also, east of 123°W the line bends northeast to avoid Mexican territory.

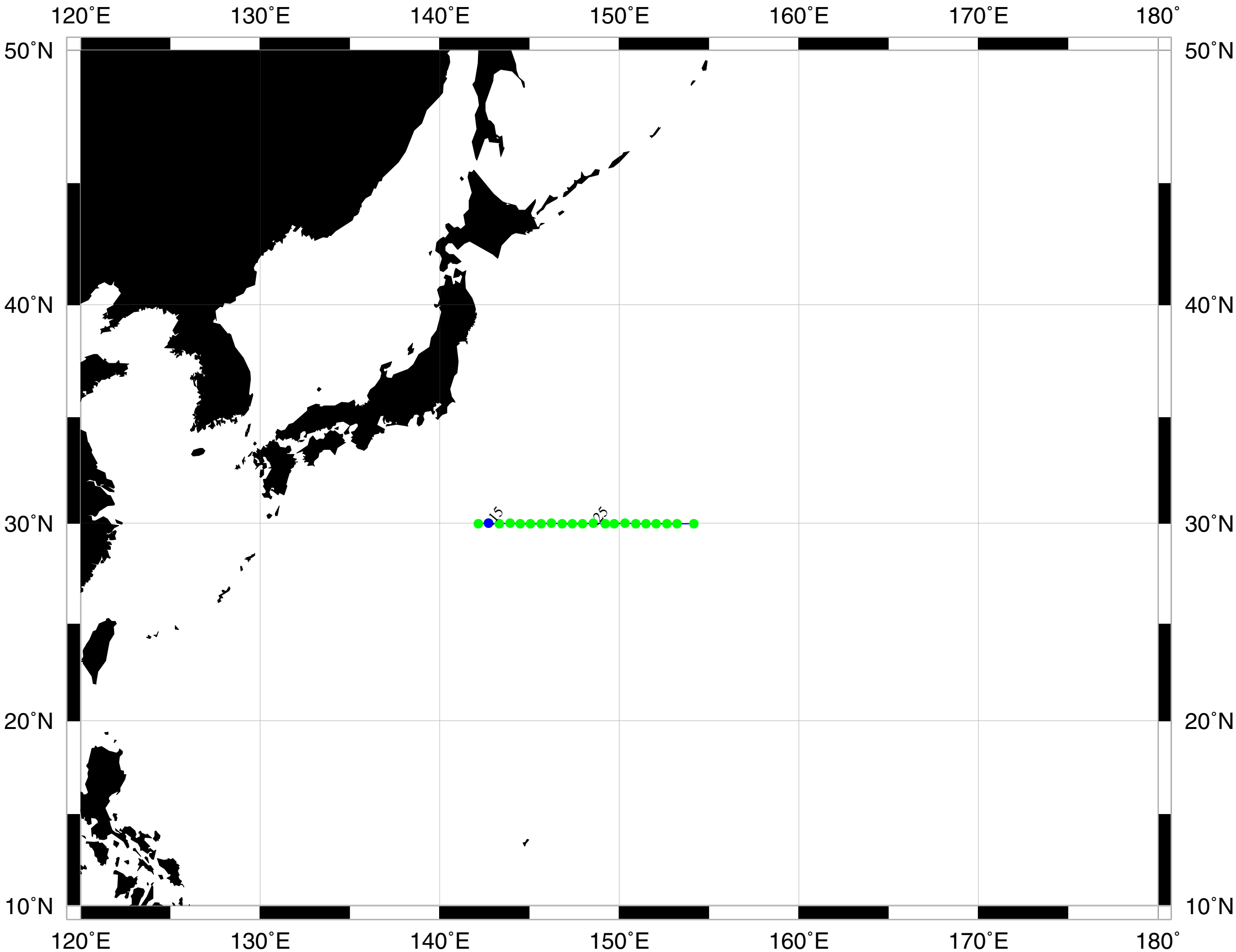
Two of the four cruise were intended to get high-quality CTD data on high density observation stations. For example, the shortest interval between stations is 30 nautical miles around some topographic features, with small volume water sampling for nutrient analysis (Salinity, Dissolved oxygen, Silicate, Phosphate, Nitrate, (Nitrite) and pH). These two cruises compose the central and eastern part of P02, and the western most part of P02, respectively. The first cruise began on 14 October 1993 and the latter began on the 15th of January, 1994. The third cruise planned to get nutrient and chemical tracers data (Freon, Total Carbon, Tritium, Radioactive carbon/sampling only, pC02) mainly at 32 depths with CTD-ROSSETE 101 system. This cruise started on the 7th January, 1994. The fourth and final cruise, which measured ctd data as well as discreet salinity and oxygen data, began on November 1, 1994.

Standards for nutrient is controlled by PIs among these three cruises. Standards used for these cruise was re-standardized at Scripps institution of Oceanography in the course of first cruise.

A.3. List of Principal Investigators

Parameter	Principal Investigator(s)	Affiliation
CTD02/rosette	Masao Fukasawa	School of Marine Science, Tokai Univ.
	Ichiro Yasuda	Tohoku Regional Fisheries Research Laboratory
	Hiroyuki Yoritaka	Hydrographic Department, MSA
T,S	Hiroyuki Yoritaka	Hydrographic Department, MSA
02	Yoshihisa Kato	School of Marine Science, Tokai Univ.
	Katsumi Yokouchi	Tohoku Regional Fisheries Research Laboratory
N03, NO2, NH4	Hiromi Kasai	Hokkaido Regional Fisheries Research Laboratory
P04, SiO2	Chizuru Saito	National Institute for Environmental Studies
3H, Δ14C, CFC	Yutaka Watanabe	National Institute for Resources and Environment
∑C02, pH, Alkali., pCO2	Tsuneo Ono	Faculty of Fisheries, Hokkaido University
T (underway), ADCP	Ichiro Yasuda	Tohoku Regional Fisheries Research Laboratory
S (underway)	Masao Fukasawa	School of Marine Science, Tokai Univ.
XBT	Hiroyuki Yoritaka	Hydrographic Department, MSA
Moorings	Masao Fukasawa	School of Marine Science, Tokai Univ.
Surface Drifters	Yutaka Michida	Hydrographic Department, MSA

Station locations for P02C FUKASAWA 1994 (JPN)



Produced from .sum file by WHPO-SIO

A.4. Scientific Goals

To get reliable dataset to estimate meridional transport of physical and chemical mass across 30°N. Especially, at relatively shallow depths, the zonal transport of total carbon and CFCs included in NPIW-corresponding layer and NPSTMW are object to be estimated. Also heat and fresh water (and/or salinity) fluxes across 30°N are subject to be estimated.

From 1991, WOCE-like observation programmes have been carried out along 32.5° N by the Hydrographic Department, Maritime Safety Agency and School of Marine Science, Tokai University. In these programmes current variations were checked by current meter moorings around the Shatsky Rise. Also, nutrient variations were examined through 5 different cruises. Results from these programmes show that eddies which are associated with the Shatsky Rise give so large effects on oceanic conditions around the region. The variation of nutrient profiles excess 20% of their mean structure at the intermediate depth in magnitude.

In P02 cross section, we encounter three large topographic features, the Shatsky Rise, the Emperor Seamount and the Hess Rise. As explained in foregoing section, same P02 line was repeated twice within three months. This strategy of operation will help us to know some standard errors in estimated fluxes through information about time-dependent oceanic structures.

A.5 Water Sampling Equipment and Underway Measurements

Small Volume Sampling:	24-place rosettes with 2.5-liter bottles.
Large Volume Sampling:	None
CTD System:	SeaBird SBE9/11, with 02 sensor and altimeter
Salinometer:	Guildline Autosals.
Nutrient Analysis:	T-800
Oxygen Analysis:	Carpenter method (automatic titration)
Underway Sampling:	75 kHz ADCP manufactured by SunWest

A.6 Cruise Track and Stations

Station positions are shown on Figure 1.

A.7 Cruise Participants

Participant	Affiliation	Responsibilities
Masao Fukasawa	Tokai Univ.	Chief Scientist
Oyaidu Masahisa	Tokai Univ.	CTDO, T, S, 0_2, PO4, SiO3, NO3
Ken-ichi Amaike	Tokai Univ.	CTDO, T, S, 0_2, PO4, SiO3, NO3

B. Underway Measurements

1) Navigation

2) Bathymetry

3) Acoustic Doppler Current Profiler (ADCP)

4) Thermosalinograph and related measurements

5) XBT and/or XCTD

6) Meteorological observations

7) **Atmospheric chemistry data**

(no data)

C.3 Hydrographic Measurement Techniques and Calibrations

C.3.1 Sample Salinity Measurements.

On T/V Bosei Maru cruise 9401, the salinity analysis of sampled water was carried out using an IOS DL Guildline Autosal salinometer model 8400B. In the room where the Autosal was placed, room temperature was controlled rather well but it changed within the range of 21 to 23°C. The sub-standard sample was prepared in two Cuby Tainer's (flexible vinyl container) which were placed near to the Autosal. The lot number of the Standard which we used was P121. Of other lots of Standard we kept, we decided to use P121 because of its nearest value to 2.00000 and the amount of number of samples. Sea water was sampled in 350ml glass bottle with a rubber cap. Before the measurement it was placed near to the Autosal with the sub standard sample. The intake of sample water into the conductivity cell was controlled by a peripheral pump between the sample bottle and Autosal. Autosal was standardized using the Standard. The standardization process was composed of the first standardization and the second confirmation. The first standardization was carried out following the Autosal manual. The second confirmation was introduced after a test measurement of the sub-standard sample. At each chance of the standardization, the first standardization was reconfirmed by the second confirmation. Samples which were taken at a station ware measured consequently. It took about 1 hour to complete the measurement for sampled of one station. Sub-standard samples were also measured both before and after the consequent measurement of samples to check the machine drift. In present cruise, the drift was 0.003 at maximum. The largest maximum of drift was brought by a fine bubbles trapped by the leftmost anode before the measurement for samples of station 16 started. Sensor was replaced and the standardization was carried out to recover the status of Autosal. Through out the cruise, Autosal performed very well. Nevertheless, rather many readings were regarded as erroneous ones. It is because there were bottle-leaks (supplemental nutrient analysis also showed the existence of the leakage) especially for samples of stations which were occupied during rough sea state. There were 66 pairs of replicate (i.e. from the same rosette bottle) samples. The standard deviation of the groups of sample pairs was 0.000846.

C.3.2 CTD Measurements Gantry and Winch Arrangements

The gantry of T/V Bosei Maru consists of a gallows and CTD fixing equipment which can be retrieve in a house where a water sampling and a preparation for CTD casting are carried out. The gallows was powered by electric oil pressure pump and was operated to hang CTD out of and into the ship. Every time after the CTD operation the CTD package is come into the CTD room and water samples are drawn out from Niskin bottles.

The winch system is driven by oil-pressure. Winch operation room is located above the boat deck from where the whole out-door CTD operation can be looked down. The wire tension, the wire length and the pressure from CTD is monitored both in the winch room and in a CTD operation room. During the cruise, the weather was always severe because of big lows passed 500km west of the observation region. Thus the wire speed was always slow to give an enough tension to the wire. But at the first station when CTD was retrieved, we found that CTD/Niskin under water unit was heavily entwined by CTD cable. Two bottles and four SiS thermometers were lost. More weights were added to the steel frame which encloses CTD and Niskin bottles to prevent the under water unit from such a case mentioned above, nevertheless we had to experience almost the same accident twice. The most serious problem was the fact that CTD cable longer than 200m had to be given up. Both a slow speed winch operation and a shortage of the CTD wire under a very rough sea condition made it impossible to lower CTD down to the bottom.

Equipment, Calibrations and Standards

1. Sea Bird 9/11 plus system with the oxygen sensor.
2. General Oceanics 5 liter 24 bottle rosette which was operated with 23 bottles in this cruise.
3. Four bottles were equipped with SiS thermometers and pressure gauges.

Backup equipment consisted of spare CTD-DO, Temperature, Conductivity sensors and three Niskin bottles.

The shipboard equipment consisted of an integral systems for an acquisition of CTD data as well as the Rosette firing. Demodulated signal which can be drawn out from the system could be back up by DAT recorder. Each system included the following major units:

1. Sea Bird 11/plus demodulator deck unit data terminal.
2. Pro-side 486D2 system which is compatible with IBM/DOS machine.
3. SONY DAT recorder.

Laboratory calibrations of the Sea Bird 9 temperature, conductivity and Dissolved oxygen sensors were carried out at Pacific Center of Sea Bird Inc. before (24 Jul. 93) and after (17 Mar 94) the Bosei-P2C cruise. The serial numbers of the temperature sensor and the conductivity sensor were 1028 and 695, respectively Temperature calibration results are tabulated in table C-3-6-1. In this table, even at the time of the post cruise calibration, the set of coefficients for frequency conversion which were decided at the time of the pre cruise calibration gave a good result. The changes in coefficients between at the times of the pre and the post cruise calibration (not shown here) was safely negligible over the whole temperature range as long as the WOCE criterion concerns. (see the column of Diff*1)

Table C-3-6-1. Results of temperature calibrations

pre-cruise Bath Temp. (°C)	Freq. (Hz)	Temp.*1 (°C)	Res.*1 (°C)	Temp.*2 (°C)	Diff.*2 (°C)
-1.4892	5732.81	-1.4893	-0.00014	-1.4881	0.0012
1.0185	6062.21	1.0187	0.00015	1.0200	0.0014
4.5056	6542.60	4.5058	0.00018	4.5073	0.0016
8.1009	7065.78	8.1008	-0.00013	8.1024	0.0017
11.5268	7591.41	11.5267	-0.00010	11.5284	0.0017
15.0811	8165.31	15.0810	-0.00011	15.0827	0.0017
18.5802	8759.38	18.5803	0.00006	18.5820	0.0017
22.0742	9381.94	22.0744	0.00016	22.0761	0.0017
25.6319	10046.56	25.6320	0.00012	25.6337	0.0017
29.0393	10712.64	29.0391	-0.00021	29.0408	0.0017
32.5702	11434.07	32.5704	0.00017	32.5721	0.0017***

Temp*1 Instrument temperature converted from the instrument frequency using new coefficients decided at the post cruise calibration.
Temp*2 Instrument temperature converted from the instrument frequency using old coefficients decided at the pre cruise calibration.
Res.*1 The residual computed using Temp*1
Diff*1 Difference between Temp*1 and Temp*2

As for the conductivity sensor, the result of calibration shows that a set of coefficient for the conversion from the frequency to the conductivity decided at the time of the post cruise calibration was much different from that decided at the time of pre cruise calibration. The difference of 0.001 Siemens/m was common over the conductivity rage from 3 to 5 Siemens/m with a tendency that the old coefficients gave a lower conductivity value.

Equipment Performance

General

As mentioned before, most problems arose always at the CTD-Rosette lowering operation. Rosette operation (firing) was carried out reliably, but some bottle-leaks were found at almost every station. The bottle leaks were detected not for specific bottles. The reason for the leak may be attributable to an unimaginably hard movement of the under water assembly. The rolling angle of the ship reached 30 degrees sometimes. The under water unit seemed to encounter so large fluctuation of the lowering speed. Or the CTD cable might hit the under water unit.

CTD

CTD performance was very good through the cruise. We calibrated the salinity values through the comparison with water sampled data. We tried to compared the CTD data with historical data of P3 and 35N CTD data because there was no cross-data point with a historical high quality observation. As a results our data did not show any inconsistency with them at least at depths deeper than 3500m. On the other hand, an inter comparison of our CTD data with Kaiyo-Maru P2 cruise showed some systematic discrepancy. As for this inter comparison, we are preparing an another short report specially.

24-Bottle Rosette System

If we focus our attention on the rosette system only, it performed very well without any misfiring. But as mentioned earlier, bottle-leaks were occurred frequently.

C.3.3 CTD Data Collection and Processing

Data Capture and Reporting

Full CTD data with 24 per second are stored in a PC and are processed with a CTD processing software provided by Sea Bird Inc. (Sea Soft ver.4.03) The procedure followed the instruction prepared by Sea Bird Inc. exactly but the data sampled at slower lowering speed than 0.4m/sec are rejected. Physical and chemical values of the pressure, the temperature, the conductivity and the dissolved oxygen are stored after a pressure average by 1db pitch.

Temperature Calibration

As mentioned in the performance section, the temperature out put from Sea Soft is considered to satisfy the WHP criterion without any calibration. The time drift of the temperature sensor was detected as small as about 0.0017°C between at the time of the post cruise calibration and at the time of pre cruise calibration. We did not take any assumption concerning the details of the time drift although some improvement might be expected. It may be notable here that our basic opinion toward the calibration was "we should not assume anything more than the simple statistical theories".

Pressure Calibration

We did not apply a laboratory calibration for the pressure sensor. Instead, SiS pressure gauges which used in the Rosette system were used as a simple i n situ calibration facility. Two SiS pressure gauges had been calibrated by SiS in October 1993 and other two SiS pressure gauges by National Institute of Measuring Japan in May and July 1993. As long as our in situ calibration concerns, there was no problem for the CTD pressure sensor, as was told by Pacific Center. It should be noted here that the air pressure which was measured by CTD in the air was taken into account when the salinity was calculated by the CTD processing software, Sea Soft.

Salinity Calibration

Salinity was calibrated by comparison with sample salinity. The laboratory calibration of the conductivity sensor showed that about 0.01 psu lower salinity was computed when the old set of conversion coefficient were used. It turned out to be the present case. Our calibration method uses sample salinity values and CTD salinity values (out put of the software Sea Soft) directly. The difference between the CTD values and the sample values was regarded as a function of the pressure. Then a cubic pressure function was fitted to the difference through the least-square method using a weight function of; w(p)=0.5+ P/2000 P denotes the pressure at which the sample was taken. The reason why we use the cubic function came from facts; (1)there is a marked inter mediate salinity minimum in the subtropical North Pacific although no marked structure exist at deeper depths. (2)our CTD/Rosette system is equipped with Niskin bottles 1m higher than the water intake tube of the conductivity sensor. (3)when the water was sampled, the under water unit had an upward velocity. (2) and (3) may produce a cubic distribution of systematic differences between the CTD salinity and the sample salinity under the situation of (1), and the use of a cubic function will prevent the calibrated salinity from having an artificial component in the vertical structure. As a results, at depths deeper than 2500m, rms residuals lower than 0.0015 was achieved at every station. On the other hands, rms residuals lower than 0.0022 and 0.01 were derived at depths between 1000m and 2500m and at depths shallower than 1000m, respectively at every station. Thus, the cubic error function was decided at each station and applied to the salinity output from the software, Sea Soft to make up the final CTD salinity data by 1db pitch.

Oxygen Calibration

Calibration for CTD oxygen were carried out using sample values using the formula(Owens and Millard, 1985). But it turned out that this calibration method did not work well for our data. We got the results of QC of the sample oxygen in August 1996. The result of the CTD oxygen calibration through a different method than we had tried will be reported again.

WHPO DATA PROCESSING NOTES

Date	Contact	Data Type	Data Status Summary
08/30/98	Talley	BTL	Data Update

replaced Bottle data file with two separate files from original files from WHOI/website that had QUAL codes. (LDT/SCD)

Date	Contact	Data Type	Data Status Summary
09/07/98	Fukasawa	CTD/BTL	Problems with data:

Lynne-Three weeks have passed since I came back from the sea to find your e-mails.I am sorry to have made you wait so long. Now , I will try to make answer to each of your question.

>>A number of years ago you sent me CTD data from Soyo-maru 1994, and our correspondence indicated that this was most likely the data set to complete the P2 section.

Yes, that was the case, I believe.

>>Is this still the case? If so, could we at the WHPO obtain the data files and begin to include the information in the 1-time Pacific survey maps and tables? The data do not need to be public, but it would be helpful to have them, and to also add a station map to our web data site.

I have been believed that Dr. Yoritaka, who was the PI of CTD on Syoyo-maru 1994 deposited CTD data from Syoyo-maru 1994 to WHPO though so many bad quality flags were included. (Isn't it the case?> Dr.Yoritaka)

>>We are also moving along on the Pacific atlas, for which the complete P2 stations would be needed. I can go ahead with things based on the CTD data set that you sent me before. Is this what I should do?

I think CTD data from Syoyo-1994 were useful to depict the water mass structure only down to the intermediate depths because Dr, Yoritaka told me that they could not carried out the post cruise calibration of CTD system. In fact, at depths deeper than, say, 3000db, we can find a good correspondence between temperature data from Bosei and Kaiyo but not between Syoyo-1994 and Kaiyo. Several years ago I surely sent the data for you to draw a map of the intermediate water masses. I may be not responsible to answer above question although I hope you go ahead on data I sent you before. Dr. Yoritaka will make the final decision and explanation of thing around the situation.

>>For oxygen sections and maps, I prefer to use the bottle values. For now I can use the p02w and p02ce data sets BO9401 and SY9310, and fill in with the Kaiyo Maru KY9401 for a few stations at the western end. If however there is a bottle data set for SY94, it might be preferable to use it with the BO9401 and SY9310 cruises. Can you let me know the status of the SY94 data set?

I think that even if the CTD data from Syoyo-1994 were not good quality controlled, bottle data are useful. Dr.Yoritaka- can' t you send bottle data

	from Syoyo-1994 to Lynne immediately?			
10/19/98	Thompson	DELC14	No Data Submitted	
	Masao Fukasawa/Tokai Univ. needs help processing C14 data			
04/13/99	Talley	SUM	Data Update	see note:
	Steve - I placed corrected versions of p02csu.txt and p02esu.txt in my ftp area at whpo. Please replace the online versions with these (and acknowledge). (What did I change - replaced P02C in the P02E file with P02E, replaced P02W in the P02C file with P02C). Lynne			
04/15/99	Bartolacci	SUM	Data Update	see note:
	I've replaced all of the p02.sum files (p02w, p02e, p02c) and updated the table to reflect this. In the case of p02c and p02e the sum file changes (via Lynne)were correcting the occurrances of the old line number designation with the new line number designation, and (by me) replacing the slashes in the expocode to underscores. (See Lynne's emails below). In the case of p02w the .sum file changes made (by Lynne) were converting decimal degrees into degrees and minutes in the lats and lons; the time was converted to GMT; station no. now has place holding zeros; cast type was changed from CTD to ROS; and height above bottom, wire out, and no. of bottles columns were also added. This conversion has shifted columns, however I ran sumchk on it with no errors. Slashes in the expocode were also replaced by underscores. I have also replaced the corrupted P2E119.WCT file with Lynne's updated version, and updated the table to reflect this. The table was also corrected to reflect the *bottle* data file being encrypted, NOT the .sum file (previously the table indicated the .sum file was Non- public and the bottle file was public).			
06/11/99	Talley	BTL	Data Update	See note:
	I received "corrected" p02c (expocode 49EWBO9401/1) bottle data from Masao Fukasawa on April 28 and did not have time to do anything with it until now. The file which you have in the WHPO directory has a number of errors, and must be replaced.			

09/29/99	Diggs	BTL	New file online/encrypted
	I have updated the bottle data file for p02c. It's encrypted until further notice and there are only the following parameters in the file:		

STNNBR		
CASTNO		
SAMPNO		
BTLNBR		*******
CTDPRS	DBAR	
CTDTMP	ITS-90	
CTDSAL	PSS-78	*******
CTDOXY	UMOL/KG	*******
THETA	ITS-90	
SALNTY	PSS-78	*******
OXYGEN	UMOL/KG	*******
QUALT1		
QUALT2		

	All tables have been updated.		
09/14/00	Fukasawa	CTD/BTL	Data are Public
	As for P02C data, I have no objection to open them.		
10/02/00	Fukasawa	NUTs/CFCs	Data Update
	NUTs sent to WHOI, CFCs not collected As for P2C and E, nutrients data were collected and Dr. Saito, who is the PI, reported me that data was submitted to WHOI. PI of CFCs is Dr. Watanabe although CFC data were note collected on neither P2C nor P2E.		
10/30/00	Huynh	DOC	Website Updated: pdf, txt versions online
02/21/01	Diggs	NUTs	Reformatted by WHPO
	Bottle: (ctdprs, silcat, no2 no3, phspht) nuts from Saito (via L. Talley) extracted from Excel files and reformatted into WOCE format. files in original directory with today's date		
02/21/01	Diggs	NUTs	Submitted
	I received P02C/E nutrients as well from Saito, and just reformatted them and placed them in the original directories for each line. I'll have Stacy merge them in.		
12/03/01	Diggs	CTD/BTL	Data ready to be merged
	NUTs ready to be merged, see note: BOTTLE Nutrients are ready to merge (S. Anfuso never got to them) BOTTLE & CTD encrypted. Aren't these data public yet?		
12/04/01	Diggs	CTD/BTL	Website Updated
	Data Unencrypted, new CSV files added Unencrypted BOTTLE and CTD files (they're public). Made exchange formatted couterparts (CTD,BOT) and placed online.		
01/16/02	Kappa	DOC	Compiled PDF and Text cruise reports