

preliminary data report
may 19, 1995
A. Cruise Narrative

A.1 Highlights

- A.1.a WOCE Designation PR19
- A.1.b EXPOCODE 49TU9110/3 (PR19)
- A.1.c Chief Scientist Eiichi Moriyama, NMO
- A.1.d Ship R/V Chofu Maru
- A.1.e Ports of Call Leg 3 Ishigaki to Naze
- A.1.f Cruise Date November 5 to November 11, 1991

A.2 Cruise Summary

- A.2.a Geographic boundaries
- A.2.b Total number of stations occupied
- A.2.c Floats and drifters deployed
- A.2.d Moorings deployed or recovered

A.3 List of Principal Investigators

Table 1: List of Principal Investigators

Table 1. Principal Investigators for All Measurements

| Name | Responsibility | Affiliation |
|--------------------|----------------------|-------------|
| Yoshisuke Tomiyama | CTD, S | NMO |
| Michio Aoyama | O2, Nutrients | NMO |
| Nobuaki Shikama | Mooring | MRI |
| Keizou Sakurai | Maritime Meteorology | NMO |

A.4 Scientific Programme and Methods

Observation of PR19 were carried out on the R/V Chofu Maru Cruise NC9110. The ship sailed from Nagasaki at 0600 UTC on 16 October 1991 and finished the observation PR18. By 2140 UTC on 23 October the ship was at the first station of section PR19.

The observation was cut at the station IS-6a and course was set for Amami Is. to avoid the typhoon "T9123". After we let it go past, the ship called at Naze and Ishigaki. The ship sailed for the ADCP mooring at east Taiwan at 0500 UTC on 5 November. The ADCP mooring was deployed on 6 November, then the ship sailed for NS-1. However, the observation was stopped at the station NS-6 to avoid the coming typhoon "T9124" again. The observation of PR19 ended at 1800 UTC on 7 November.

Water sampling on the cruise included measurements of salinity both by CTD and water bottle samples, CTD temperature, bottle sample oxygen determination, and nutrients (nitrate, nitrite, and phosphate).

During the cruise CTD stations were occupied using a 12 bottle rosette equipped with 1.7 liter Niskin water sampling bottles.

- A.5 Major Problems and Goals not achieved
- A.6 Other incidents of Note
- A.7 List of Cruise Participants

| Name | Responsibility | Affiliation |
|--------------------|-------------------------------|-------------|
| Eiichi Moriyame | Chief Scientist | NMO |
| S. Michio Aoyama | O2,Nutrients | NMO |
| Tomoaki Hinata | CTD Hardware, CTD Software | NMO |
| Hitomi Kamiya | Watch Stander | NMO |
| Junichi Jifuku | O2,Nutrients | NMO |
| Toshihiro Ishihara | Watch Stander | NMO |
| Takao Shimizu | O2,Nutrients | NMO |
| Shoji Shiraishi | CTD Software | NMO |
| Keizou Sakurai | Maritime Meteorology | NMO |

B. Underway Measurements

- B.1 Navigation and Bathymetry
- B.2 Acoustic Doppler Current Profiler (ADCP)
- B.3 Thermosalinograph and underway dissolved oxygen, fluorometer, etc
- B.4 XBT and XCTD
- B.5 Meteorological observations
- B.6 Atmospheric chemistry

C. Hydrographic Measurements

CTD Measurements

The EG&G NBIS Mark III B CTD (6500 dbar sensor, without oxygen sensor) mounted in the 12 x 1.7 liter General Oceanics rosette multisampler frame was used for all of the vertical CTD work. In general at the CTD stations of which depth are shallower than 100 meters and than 4000 meters, the package was lowered to within 5 meters of the bottom and lowered to the depth of 95 percents of the bottom depth, respectively, because unable to use the acoustic pinger on DSF-6000 fathometer.

The performance of the CTD and multisampler was good throughout the cruise.

A Hewlett Packard HP9000-320 with a 2 MByte of memory was used as a primary data collection device and all CTD data was backed up onto the audio tape. The original sampling rate is 31.25 samples per second, however, our software can get around 20 samples per second and compress it one tenth of the collected data due to the limitation of the memory. All of the CTD data of our observatory was loaded on the basis of the compressed data described above.

The results of the laboratory calibration for the temperature and pressure are shown in Tables 3, however, these were not used because the calibration methods for temperature and pressure are not decided.

Table 3. CTD calibration constants at laboratory

| Temperature; linear fit | | | |
|---|-------------|-----------|-----------|
| | Time | Bias | Slope |
| Pre -Cruise | 12 Mar.1991 | 0.0067286 | 0.9998651 |
| Post-Cruise | 13 Jan.1992 | 0.0090696 | 0.9996329 |
| Pressure Increasing (0-6000 dbar range); linear fit | | | |
| | Time | Bias | Slope |

| | | | |
|-------------|-------------|--------|----------|
| Pre -Cruise | 11 Oct.1991 | 3.9799 | 1.000511 |
| Post-Cruise | 13 Jan.1992 | 2.5492 | 1.000661 |

The conductivity scaling factor given in Table 4 is derived from not a linear fit but a ratio of CTD data to water sample data and were used for the final data load. The salinity determination of the water sample with the Guildline PORTASAL 8410. Standard Seawater batch of P114 was used to standardize the PORTASAL. The precisions of the salinity determination were 0.0006 PSS for 16 water samples from the same bottle.

Table 4. The conductivity scaling factor

| | | |
|-------------|------|---------|
| Station No. | Bias | Slope |
| PN-1 - PN-9 | - | 0.99977 |

Oxygen measurements

The determination of dissolved oxygen was done by the modified version of the Winkler method described in "Kaiyou kansoku shishin (Manual of Oceanographic Observation)" published by the Oceanographical Society of Japan (1970). The reagent blank was not subtracted. The results of the estimation of precision are shown in Table 5. No estimation of accuracy has been made.

Table 5. The precision of the oxygen analyses by three analyst

| | | |
|---------------|---------------|---------------|
| | Experiment A | Experiment B |
| Sample Number | 17 | 21 |
| Average | 214.41 umol/l | 222.56 umol/l |
| One sigma | 0.25 umol/l | 0.46 umol/l |
| precision | 0.11 % | 0.21 % |

Nutrient analyses

The nutrients analyses were done by the Technicon Auto Analyzer II described in "Kaiyou kansoku shishin (Manual of Oceanographic Observation)" published by the Oceanographical Society of Japan (1970).

Sampling for nutrients followed that for dissolved oxygen on average 10-20 minutes after the casts were on deck. Samples were drawn into 10 cm³ glass, narrow mouth, screw-capped bottles. Then they were immediately introduced on the sampler tray of the Technicon Auto Analyzer II for the analysis and generally the analyses were begun within one hour after the casts were on deck. if the delays were anticipated to be more than one hour, the samples were refrigerated. Samples were refrigerated and stored up to one hour on stations PN-3, PN-6 and PN-8.

The precisions of the onboard Nitrate and Nitrite analyses estimated from the standard deviation of the five samples from the same working standard solution on each analysis are shown in Table 5. The precision of the onboard Phosphate analysis estimated from the standard deviation of the four samples from the same working standard solutions are also shown in Table 6. The concentrations of the working standard of nitrate, nitrite and phosphate were 40 umol/l, 2 umol/l and 3 umol/l, respectively. No

estimation of accuracy have been made.

Table 6. The median and the range (in the parentheses) of the precision of the onboard nutrients analyses throughout PR18 and PR19.

| unit:% | | |
|-------------|-------------|-------------|
| Nitrate | Nitrite | Phosphate |
| 1.20 | 0.40 | 1.20 |
| (0.10-5.00) | (0.06-2.80) | (0.40-2.50) |

The concentrations in umol/kg of oxygen, nitrate, nitrite and phosphate were converted from the concentrations in umol/l using the density calculated from the room temperature and salinity of the water samples. The laboratory temperature for each station are given in Table 7.

Table 7. Laboratory temperature for each station.

| Station | Temp. | Station | Temp. | Station | Temp. |
|---------|-------|---------|-------|---------|-------|
| PN- 1 | 22. | PN- 2 | 24. | PN- 3 | 25. |
| PN- 3' | 24. | PN- 4 | 24. | PN- 4' | 26. |
| PN- 5 | 28. | PN- 6 | 28. | PN- 7 | 28. |
| PN- 8 | 28. | PN- 9 | 28. | | |

Notes for the --.SUM,--.SEA and --.CTD files

The first 2 characters of the file name of --.SUM, --.SEA and --.CTD files are NC for R/V Chofu Maru of Nagasaki Marine Observatory. These characters are followed by the last two digits of year, the month and character R (R for PR18) or character S (S for PR19) for the --.SUM and --.SEA files. In addition, the leg of the cruise is appended in the file name of --.SEA files. For the --.CTD files The characters NC are followed by the unique station number and the cast number given in the Comments.

The file names of the --.SUM and --.SEA for this cruise are as follows;

NC9110R.SUM,
NC9110R1.SEA

--.SUM

Since some of the time at the bottom (BO) and completion (EN) of the cast, the positions at the beginning (BE), bottom (BO) and the completion (EN) of the cast and the water depth of station were not recorded, we leave the column of them blank.

Since the surface water samplings were by a stainless steel water bucket, "Number of bottles" includes this bucket sampling.

The unique station numbers given by the Japan Meteorological Agency with the cast numbers, which are used as the --.CTD files name, are given in the "Comments".

--.SEA

We leave "the sample number (SAMPNO)" blank because the sample numbers are different among the salinity, oxygen and nutrients on our assignments.

Since the surface water samplings were by a stainless steel water bucket, we leave the column of "The Bottle Number (BTLNBR)" at the surface layer blank.

All water sample quality flags for the oxygen during this cruise were "3" because the precision did not exceed the WOCE standard of 0.1% and no estimation of accuracy has been made.

--.CTD

The number of samples averaged at the pressure level, NUMBER, was the estimated value because original CTD data were lost in the processing described in "Section 2. CTD".

- D. Acknowledgements
- E. References

Oceanographical Society of Japan, 1970. Kaiyou kansoku shishin (Manual of Oceanographic Observation). Ed. by the Japan Meteorological Agency. (in Japanese)

Unesco, 1983. International Oceanographic tables. Unesco Technical Papers in Marine Science, No. 44.

Unesco, 1991. Processing of Oceanographic Station Data, 1991. By JPOTS editorial panel.

- F. WHPO Summary

Several data files are associated with this report. They are the tu91103.sum, tu91103.hyd, tu91103.csl and *.wct files. The tu91103.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The tu91103.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called tu91103wct.zip. The tu91103.csl file is a listing of ctd and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the tu91103.csl file:

Salinity, Temperature and Pressure: These three values were smoothed from the individual CTD files over the N uniformly increasing pressure levels. using the following binomial filter-

$$t(j) = 0.25t_i(j-1) + 0.5t_i(j) + 0.25t_i(j+1) \quad j=2\dots N-1$$

When a pressure level is represented in the *.csl file that is not contained within the ctd values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta(SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3): These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the Unesco publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature (GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and Fortran routines are described in Unesco publication 44.

Gradient Salinity (GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and Fortran routines are described in Unesco publication 44.

Potential Vorticity (POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. $pv=fN^2/g$, where f is the coriolius parameter, N is the bouyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Bouyancy Frequency (B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and Fortran routines are described in Unesco publication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. Equations and Fortran routines are described in Unesco publication, Processing of Oceanographic station data.

Neutral Density (GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

G. Data Quality Evulation