preliminary cruise report
may 23, 1995

A. Cruise narrative

A.1.a WOCE designation: PR24:A hydrographic section from Mindanao SE to Indonesia

Additional sections 6N: A hydrographic section from Mindanao SE to Palau
2N: A hydrographic section from 130 E to 134 E along 2 N
1N: A hydrographic section from 130 E to 135 E along 1 N
134E: A hydrographic section from 3 N to 6 14 N along 134 E

A.1.b Expedition designation:49XK9207/1: Section 6N
49XK9207/2: Sections PR24, 1N, and 2N
49XK9207/3: Section 134E

A.1.c Chief scientist:
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A.1.d Ship: R/V KAIYO

A.1.e Ports of call: Marakal to Marakal Palau via Bitung and Biak, Indonesia

A.1.f Cruise dates: 6 October to 29 October 1992

A.2. Cruise Summary Information
by T. Kawano (11 August 1994)

A.2.a. Geographic boundaries:

The 6N section is extended from 6 N, 134 E to 6 N, 126 35 E with station spacing of 60 nm or less. The PR24 section is from 6 N, 126 35 E to 2 21 N, 129 26 E and it can be divided into two sections, which are the northeast section and the southwest section. The 2N section is from 2 N, 130 E to 2 N, 134 E and the 1N section is from 1 N, 130 E to 1 N, 135 E. We also made CTD casts along 134 E from 3 N, 134 E to 6 14 N, 134 E.

The station interval from 6 N, 134 E to 6 N, 128 E was 60 nm and that from 6 N, 128 E to 6 N, 126-35E was 30 nm. Then the ship went to Bitung, Indonesia in order to pick Indonesian scientists and a security officer up and we continued the observation from 5 35 N, 126 51 E to 2 N, 130 E, which is equivalent to PR24. During the observation of this section, we deployed 2 moorings at 3 25 N, 127 44 E and 3 03 N, 128 17 E. After we observed section 2N and 1N, we went to Biak, Indonesia where Indonesian scientists and the security officer got off the ship. We made CTD casting with 60 nm interval on the way to Palau (from 3 N, 134 E to 6 N, 134 E).

A.2.b Stations occupied: We occupied 41 CTD stations and launched 63 XBTs.

A.2.c Floats and drifters deployed: None

A.2.d Moorings deployed or recovered:
by T. Kawano (10 August 1994)

Two moorings consisting of 3 current meters and 6 thermometers were deployed between Talaud Island and Morotai Island to determine the seasonal variation of the Indonesian Throughflow.

In order to estimate the seasonal change of the Indonesian Throughflow between the Talaud Island and the Morotai Island, we deployed 2 moorings, which consist of 3 current meters and 6 thermometers. The mooring lines are shown in Fig.10.1. The instruments are listed below.

(1) 3 28 N, 127 53 E, Depth 2,237 m
Thermometer: Sanyo-Sokki, Japan, model MTM1 and MTM2
MTM1 S/N 111,112,113,114
MTM2 S/N 29,54
Current meter: AANDERAA RCM5
S/N 8472, 64345, 64365
Acoustic Release: Nichiyu-Giken, Japan, model L-2
S/N 4266-3F

(2) 3 13 N, 128 27 E, Depth 2,340 m
Thermometer: Sanyo-Sokki, Japan, model MTM1 and MTM2
MTM1 S/N 115,116,117,118
MTM2 S/N 31, 55
Current meter: AANDERAA RCM5
S/N 8477, 64355, 81055
Acoustic Releaser: Nichiyu-Giken, Japan, model L-2
S/N 4265-3E

NOTE:
In spite of our best efforts, we could not recover these moorings during our next WOCE cruise executed in Feb. 1994. Details are written in the cruise report for PR1S and PR24 dated 28 April 1994.

A.3. List of Principal Investigators
by T. Kawano (10 August 1993)

TABLE 1: List of measured parameters, sampling group responsible for each and the Principal Investigator for each.

Parameter	Sampling Group	Principal investigator
CTD/Rosette	JAMSTEC	Yuji Kashino and T. Kawano
XBT	JAMSTEC	Yuji Kashino and T. Kawano
Salinity	JAMSTEC	T. Kawano
O2	STM	Hidetoshi Watanabe
Mooring	STM/JAMSTEC	Hidetoshi Watanabe and Noboru Takiwaki

A.4. Scientific Programme and Methods

We made hydrographic observations in the southernmost Philippine Sea in order to understand the oceanic structure and current field of this area. Our interest is mainly focused on the Indonesian Throughflow and the New Guinea Coastal Undercurrent.

We made XBT measurements just before each CTD cast. When the spacing of the CTD stations was more than 60 nm, we made XBT measurements halfway between the CTD stations.

A General Oceanics (GO) 12 position rosette water sampler with 5 liter Niskin bottles was used, and we planned to make water sample salinity measurements. However, our Autosal 8400B did not work well because of insufficient maintenance of the instrument. We also measured the dissolved oxygen, but the accuracy and precision of our method did not meet with the WOCE one-time standards. As a result we did not report these measurements. We deployed two moorings between Talaud Island and Morotai Island, however we could not recover these moorings during the next WOCE cruise done from 12 February to 3 March 1994.

The accuracies of CTD salinity and temperature were estimated only on the basis of the sensor calibration done at Seabird Electronics, Inc., and these measurements are probably accurate only to 0.01 PSU or less in salinity, and 0.002 C or more in temperature. As the result of our own calibration of the pressure sensor, the accuracy was less than 1 dbar.
Since we do not have enough water sample data for the calibration of CTD data, especially temperature and conductivity data, we report uncorrected data.

Results
by Yuji Kashino (8 August 1994)

The prominent features of salinity distribution are low salinity water located between Mindanao Island and Morotai Island (depth: 200-400 dbar) and high salinity water in the southern part of the observation area (depth: 100-300 dbar). The low salinity water (lower than 34.5 PSU) is North Pacific Intermediate Water (NPIW), which was also observed during WEPOCS III (Bingham and Lukas (1994)). The geostrophic velocity field shows that a part of the NPIW observed between Talaud Islands and Morotai Island comes from Indonesian seas. The high salinity water (higher than 35.0 PSU) is the Tropical Water transported by New Guinea Coastal Under Current trough the Vitiaz Strait (Tsuchiya et al., 1989). This water reaches 3 N-4 N on 134 E section and near Morotai Island. Near the north edge of this current, interleaving is observed.

The geostrophic velocity directions are southeastward between Mindanao Island and Talaud Islands and northwestward between Talaud Islands and Morotai Island above 500 dbar. Total geostrophic transport between Mindanao Island and Morotai Island is 6 Sv toward the Pacific.
We missed the volume transport of Mindanao Current because we did not take stations near Mindanao Island.

A.5. Major Problems and Goals Not Achieved
by T. Kawano (10 August 1994)

1) Rosette sampler
Our rosette sampler did not work well from Station 1 to Station 3. The reason was the power supply did not have enough voltage. We used a power transformer after Station 4.

2) Noise during CTD casts
There were two types of noise during the CTD casts. One was a shock-like noise and data of pressure, conductivity and temperature became meaningless, e.g., 9999.9. This noise occurred near surface (less than 10 m) at a few stations. The other type of noise was seen only in pressure data. It was spikelike and the data shifted abruptly 1 to 20 dbar and then became a normal (reasonable) value. This noise was seen several times at almost every station. We could not elucidate the cause of this noise.

3) Dissolved oxygen
We could not estimate the accuracy and precision of our dissolved oxygen data.
We did not have enough equipment for an accurate measurement of dissolved oxygen. Since we used nominal values of the all volumetric equipment, including oxygen bottles, and we did not make a blank determination of seawater as well as that of reagent, we guessed that our data did not meet with the WOCE one-time standards.

4) Sample water salinity measurement
Although our Autosal 8400B was set to use with 50 Hz AC, we used the instrument with 60 Hz AC. The frequency change caused an unstable reading

with a range of ±20 digits. It was impossible for us to standardize the instrument under those conditions and, consequently, we had to give up on accurate measurements. The accuracy and precision of our measurement might be within the order of 0.01 PSU.

A.6. Other Incidents of Note

None noted.

A.7 Cruise Participants

B. Underway Measurements

B.1 Navigation and Bathymetry

B.2 Acoustic Doppler Current Profiler

B.3 Thermosalinograph and underway dissolved oxygen, fluorometer,etc.

B.4. Expendable bathythermograph and salinity measurements

by Y. Kashino (9 August1994)

We deployed T7-XBTs (to 760 m depth) at 63 stations. Data was acquired through the data converter every 50 msec. When this data was saved into the floppy disk in our NEC PC-9801F, its sampling rate decreased to several times per second.

The first 10 records of data from the sea surface, and the data below 760 m, were neglected. The range of depth reported in XBT file is between 4 m and 760 m. We report the XBT temperature every 1 m. We didn't calibrate the depth values. The temperature values of each record were calculated by the cubic spline method.

We employed the following formula to convert duration into depth.

$$Zx = (6.472 \quad 0.00216t)\ t$$

where Zx is depth and t is time.

B.5. Meteorological observations

by T. Kawano and Y. Kashino (11 August 1994)

The southwesterly monsoon wind was dominant and the weather was mostly sunny during the period from 6 October to 23 October 1992. It was usual weather in the tropical equator. The observed wind direction, however, changed from southwesterly to northerly at the end of October 1992 and the weather became cloudy with showers.

The air temperature showed the diurnal variation, namely high in afternoon up to 28 to 31 C low in evening to morning at 27 to 28 C on sunny days. During heavy showers the air temperature dropped to 25 to 26 C.
During the observation along section 6N, the wind speed was around 5 m/s and the wave height was around 1 meter. The wind speed increased to 10 - 11 m/s and the wave height increased to around 2 meters during the stations along section PR24 north of 4 N. The southwesterly monsoon wind became weak, 2-8 m/s, at the stations in the southern part of PR24. As the ship sailed on section 1N and 2N, the SSW wind of 3-7 m/s was dominant and the wave height was below 1 meter. As the ship headed north along 134 E, the wind direction became northerly with velocities of 5-10 m/s, while the wave heights were sometimes higher than 2 meters.

C. Hydrographic measurements

D. Acknowledgments

E. References

Unesco, 1983. International Oceanographic tables. Unesco Technical Papers in

Marine Science, No. 44.

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

F. WHPO Summary

Several data files are associated with this report. They are the XK9207.sum, XK9207.hyd, XK9207.csl and *.wct files. The XK9207.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The XK9207.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 XK9207wct.zip. The XK9207.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 XK9207.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) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) j=2....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=fN2/g, where f is the coriolius parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy 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 44.

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

G. Data Quality Evulations