Preliminary Report

of

The Hakuhō Maru Cruise KH-83-4

(BIOMASS)

Nov. 22, 1983—Feb. 24, 1984

The Southern Ocean and The Antarctic Sea

Ocean Research Institute
University of Tokyo
1985

ERATA

Preliminary report of the Hakuho Maru Cruise KH-83-4, Ocean Research Institute, University of Tokyo, 1985

Page	for	read
P. 10	Fig. 4 Thermosteric anomary (cl/ton) along Section I.	Fig. 3 Salinity along Section I.
	Fig. 3 Salinity (x 10^{-3}) along Section I.	Fig. 4 Thermosteric anomary (cl/ton) along Section I.
P. 12	Fig. 9 Thermosteric anomary (cl/ton) along Section II.	Fig. 8 Salinity along Section II.
	Fig. 8 Salinity (x10^{-3}) along along Section II.	Fig. 9 Thermosteric anomary (cl/ton) along Section II.

Preliminary Report
of
The Hakuhō Maru Cruise KH-83-4
(BIOMASS)

Nov. 22, 1983—Feb. 24, 1984

The Southern Ocean and The Antarctic Sea

by

The Scientific Members of the Expedition
Edited by
Takahisa NEMOTO
Makoto TERAZAKI

1985

Preface

The BIOMASS* programme has been conducted in the Antarctic Ocean since 1977 as a ten year international project for the study of the 'Antarctic ecosystem and its living resources'. The BIOMASS programme has had two highlights of multiship co-operative studies in 1980/81 (FIBEX) and 1983-1985 (SIBEX: Second International BIOMASS Experiment).

This cruise of the Hakuhō Maru formed the SIBEX phase-I (1983/84) activity in the Pacific sector of the Antarctic along with another ship, the Umitaka Maru of the Tokyo University of Fisheries. The studies carried out on the Hakuhō Maru include those on the Antarctic pelagic ecosystem and its dynamics especially on krill dominating waters. Studies on the interaction among krill, copepods, salps, phytoplankton, bacteria and larger predators have been successfully carried out. Some new approaches on the ecology of bacteria, and an assessment of krill abundance are also worked out.

Besides 30 scientists from 9 organizations, one formal observer (from the People's Republic of China) to the Japanese Antarctic operation joined the cruise.

On behalf of the scientists aboard, I wish to express our sincere thanks to Captain I. Tadama, officers and crew members of the Hakuhō Maru for their co-operation and capable assistance throughout this cruise.

The hospitality shown us by Australian scientists and citizens when we visited ports of Australia between the legs of cruise is also gratefully acknowledged.

Takahisa Nemoto

Chief Scientist

* BIOMASS: Biological Investigations of Marine Antarctic Systems and Stocks

Contents

Outline of the cruise

Under the BIOMASS SIBEX phase-I, the Hakuhō Maru operated mostly in the southern oceans of Australia including the Antarctic Ocean. The following research items were investigated: (1) Studies on distribution, specific compositions and production of plankton and micronekton, (2) Studies on the grazing activity of zooplankton such as copepods, euphausiids and thaliaceans on phytoplankton, (3) Ecological studies on marine bacteria, (4) Studies on the characteristics of biological activities under low temperature and illumination conditions, (5) Assessments of krill abundance by fish finder, (6) Measurements of gravity and magnetics, (7) Sightings of marine mammals (especially whales) and sea birds, (8) Measurements of physical, and chemical environmental components.

The cruise consisted of five legs as shown in Table 1 and Fig. 1. Two legs from Sydney to Hobart and Hobart to Fremantle were scientific, with all works having been done in these two legs.

The names of the scientists and observers who participated in this cruise and their specialities are listed in Table 2.

Table 1. Cruise itinerary

	Arrival	Departure
Tokyo	-	Nov. 22, 1983
Sydney	Dec. 7, 1983	Dec. 11, 1983
Hobart	Jan. 3, 1984	Jan. 8, 1984
Fremantle	Jan. 31, 1984	Feb. 4, 1984
Cebu	Feb. 13, 1984	Feb. 17, 1984
Tokyo	Feb. 24, 1984	-

Table 2. Scientists aboard

Takahisa NEMOTO Chief Scientist	Ocean Res. Inst., Univ. of Tokyo	Plankton
Mitsuru EGUCHI	Fac. of Agri., Univ. of Kyoto	Bacteria
Kimio FUMAKI	Ocean Res. Inst., Univ. of Tokyo	Bacteria
Ken FURUYA	Ocean Res. Inst., Univ. of Tokyo	Plankton
Nobuhiko HANDA	Water Res. Inst., Nagoya Univ.	Geochemistry
Tesuo HARA	Japan Coop. Whaling Co.	Sighting of Mammals
Ko HARADA	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Masamichi HASIGUCHI	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Hiroshi HASUMOTO	Ocean Res. Inst., Univ. of Tokyo	Biology
Nobuhito HOSAKA	Ocean Res. Inst., Univ. of Tokyo	Plankton
Chiaki IMADA	Ocean Res. Inst., Univ. of Tokyo	Bacteria
Tadashi INAGAKI	Ocean Res. Inst., Univ. of Tokyo	Fish. ecology
Hisayuki INOUE	Meteor. Res. Inst.	Geochemistry
Nozomu IWASAKI	Ocean Res. Inst., Univ. of Tokyo	Plankton
Akito KAWAMURA	Fac. Fisheries, Hokkaido Univ.	Plankton
Kazuhiro KOGURE	Ocean Res. Inst., Univ. of Tokyo	Bacteria
Kuo-Tien Lee	Ocean Res. Inst., Univ. of Tokyo	Fish. ecology
Hidekazu MATSUEDA	Water Res. Inst., Nagoya Univ.	Geochemistry
Kensaku MURAOKA	Kanagawa Prefectural Museum	Plankton
Toshisuke NAKAI	Ocean Res. Inst., Univ. of Tokyo	Physical oceanography
Shiro NISHIDA	Nara Kyoiku Univ.	Plankton
Shuhei NISHIDA	Ocean Res. Inst., Univ. of Tokyo	Plankton
Usio SIMIDU	Ocean Res. Inst., Univ. of Tokyo	Bacteria
Kazunori TAGUCHI	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Makoto TERAZAKI	Ocean Res. Inst., Unov. of Tokyo	Plankton
Atsushi TSUDA	Ocean Res. Inst., Univ. of Tokyo	Plankton
Tamiji YAMAMOTO	Fac. Agr. Sci., Tohoku Univ.	Primary production
Shihua CHEN	Second Inst. of Oceanography, China	Biology

Hydrographic characteristics

T. Nakai, H. Hasumoto and T. Nemoto

In the austral summer of 1983-84, routine hydrographic observations were carried out on the Australasian sector of the Southern Ocean. At each hydrographic station, casts of CTDO (Neil Brown MARK III-B) with Rosette Multi-Sampler (General Oceanics Inc., 5 x 24), were made to collect information on water temperature, salinity, dissolved oxygen and inorganic nutrients. Some XBT observations were also made between hydrographic stations. Unfortunately, the CTDO casts were restricted within a depth of 2000 m, due to trouble with the winch cable. The two meridional sections observed were named I and II. Section I was occupied along 150°E between 40°S and 65°S on Leg 2, and section II was along 115°E on Leg 3 (Fig. 1).

According to recent studies, the three oceanic fronts have become generally known as the Antarctic Polar Front, Subantarctic Front and Subtropical Convergence.

(1) Section I

Fig. 2 shows the vertical section of temperature. In the section, 26 XBT and 4 CTDO casts (1, 2, 2-2 and 4) were carried out on the forward cruise and the another 6 CTDO casts (3-1, 3, 2-3, AC, 1-1 and STC) on the return cruise.

The Polar Front is identified at 56.5°S as the northern limit of a minimum subsurface temperature of about 2°C. A strong surface temperature gradient was observed in this front. At 49°S, the Subantarctic Front also seemed to have a strong horizontal temperature gradient. The Subtropical Convergence is well marked by a southern limit of surface saline water, which coincides with a surface thermal frontal feature at 47°S (Fig. 2, Fig. 3).

The area extending from the Polar Front to the Antarctic Continent is called the Antarctic Zone, and is covered with the Antarctic Surface Water, which is characterized by a low temperature value of below 0°C and a low salinity value of less than 34×10^{-3}. The subsurface temperature minimum layer becomes deep towards the north extending to a depth of 50 m to 200 m at the boundary of the Polar Front. Below the Antarctic Surface Water, the Antarctic Circumpolar Deep Water, which has salinity value a little above 34.7×10^{-3} and a temperature value between 2° and 1°C, occupied thickly about at 2000 m depth in the vicinity of the Polar Front. The water rises southernly to near the surface layer in the vicinity of 65°S. It is presumed that the Antarctic Divergence Zone exists around 65°S, but this zone is not clear.

The frontal zone between the Subantarctic Front and the Polar Front is named the Antarctic Polar Frontal Zone or the Complex Zone. This zone is fairly wide and is constituted in a mesoscale (200-300 Km) structure with several horizontal temperature gradients in the subsurface. According to the salinity section (Fig. 3), the Antarctic Intermediate Water with low salinity extends towards the north like a tongue from the upper layer to the midlayer. The deeper water has the same character as the bulk of the Antarctic Circumpolar Deep Water.

The area between the Subtropical Convergence and the Subantarctic Front is called the Subantactic Zone and is covered with the Subantactic Surface Water. The Subtropical Surface Water, with a temperature in excess of 12°C and salinity of more than 35×10^{-3}, is formed in the upper layer on the northern side of the Subtropical Convergence.

The features of the thermosteric-anomaly section (Fig. 4) are similar to the temperature section. The largest part of the isopleth seems to move upward in the south. So the direction of geostrophic flow is easterly as a rule, and the flow is generally called the Antarctic Circumpolar Current. Particularly, in the vicinity of the fronts, the horizontal gradients of thermosteric-anomaly were very intense. Between 47°S and 49°S, and between 56°S and 58°S, the current speed becomes faster than in other regions.

In the surface layer, dissolved oxygen was comparatively rich, especially in the southern section of the Polar Front; its value ranged about 7 to 8 ml/l (Fig. 5). The core of oxygen minimum less than 4ml/l was found in the shallow depths, about 200-500 m, in the Antarctic Zone. In the vicinity of the Polar Front, this core jumps from 500 to 1000 m and gradually deepens northward. This oxygen minimum coincides with the depth of the upper part of the Antarctic Circumpolar Deep Water.

In the Antarctic Zone, the concentrations of inorganic phosphate in the surface layer were detected to be about 1.9 µg-at/l. The lowest value of 0.3 µg-at/l was found at Stn. 1 in the subtropical area (Fig. 6). The phosphate concentrations increased with depth and attained a maximum, but the maximum values of concentrations and depths vary with each zone. In the surface layer, the concentrations of silicate seem to polewardly increase from almost zero at Stn. 1 in the Subtropical Zone to in excess of 50 μg-at/l at Stn. 4 in the Antarctic Zone. Furthermore, its values increased one-sidedly from the surface to the deep layer, but an outstanding difference of distribution is revealed among the boundaries of each zone. The distribution of nitrate is similar to the above nutrient.

(2) Section II

The features of each parameter in Section II resemble those in Section I, because they are meridional transections of the same latitudes. Only the characteristics which are different from those in Section I are described.

The Polar Front is found at 55°S as the northern limit of a 2°C isotherm in the subsurface minimum (Fig. 7). The northern part of this area also shows a separate patch colder than 2°C. It is suggested that double fronts or mesoscale eddies may have existed in this region. The Subantarctic Front is found at 47°S as an account of intense thermal discontinuity. The Subtropical Convergence seems not so clear judging from the temperature structure of the midlayer, but it is considered to be located at 43-44°S for this section, which coincides with a weak surface front. The water between the Subantarctic Front and the Subtropical Convergence is thermally homogeneous with a mean temperature value of about 9.5°C. This thermostad is called the Subantarctic Mode Water. Further south, it seems that the Antarctic Divergence Zone exists around 63°S, as shown by the temperature profile.

The low salinity of the upper water which continued to the Antarctic Intermediate Water, sinks between 47°S and 48°S. The water sinking seems narrower and more clear than in Section I (Fig. 8). The Antarctic

Circumpolar Deep Water with a weak salinity maximum and with a thermosteric-anomaly as 30 cl/ton, lies widely in the deep layer.

The section of thermosteric-anomaly shows an eastward flow for the most part (Fig. 9). Especially, this Circumpolar Current is strong between 45°S and 50°S.

The dissolved oxygen content in the surface layer is richer than that in Section I (Fig. 10). Water with a value above 7 ml/l extends far north to 50°S. The dissolved oxygen minimum water lies widely and thickly in the upper part of the Antarctic Circumpolar Deep Water.

The approximate features of each nutrient section (Fgi. 11) are similar to those in Section I. In the northern side of the Subtropical Convergence, nutrients were hardly detected in the surface water. And further south, it is considered that high concentrations of these nutrients result from the upwelling due to the surface divergence.

Continuous measurements of sea surface temperature and salinity

H. Hasumoto and T. Nakai

Sea surface temperature and salinity were continuously measured using a T-S meter (Type ST-MK-15, Union Ltd.) in the Antarctic. The records of temperature and salinity read at one-hour intervals are reproduced in Figs. 14 and 15.

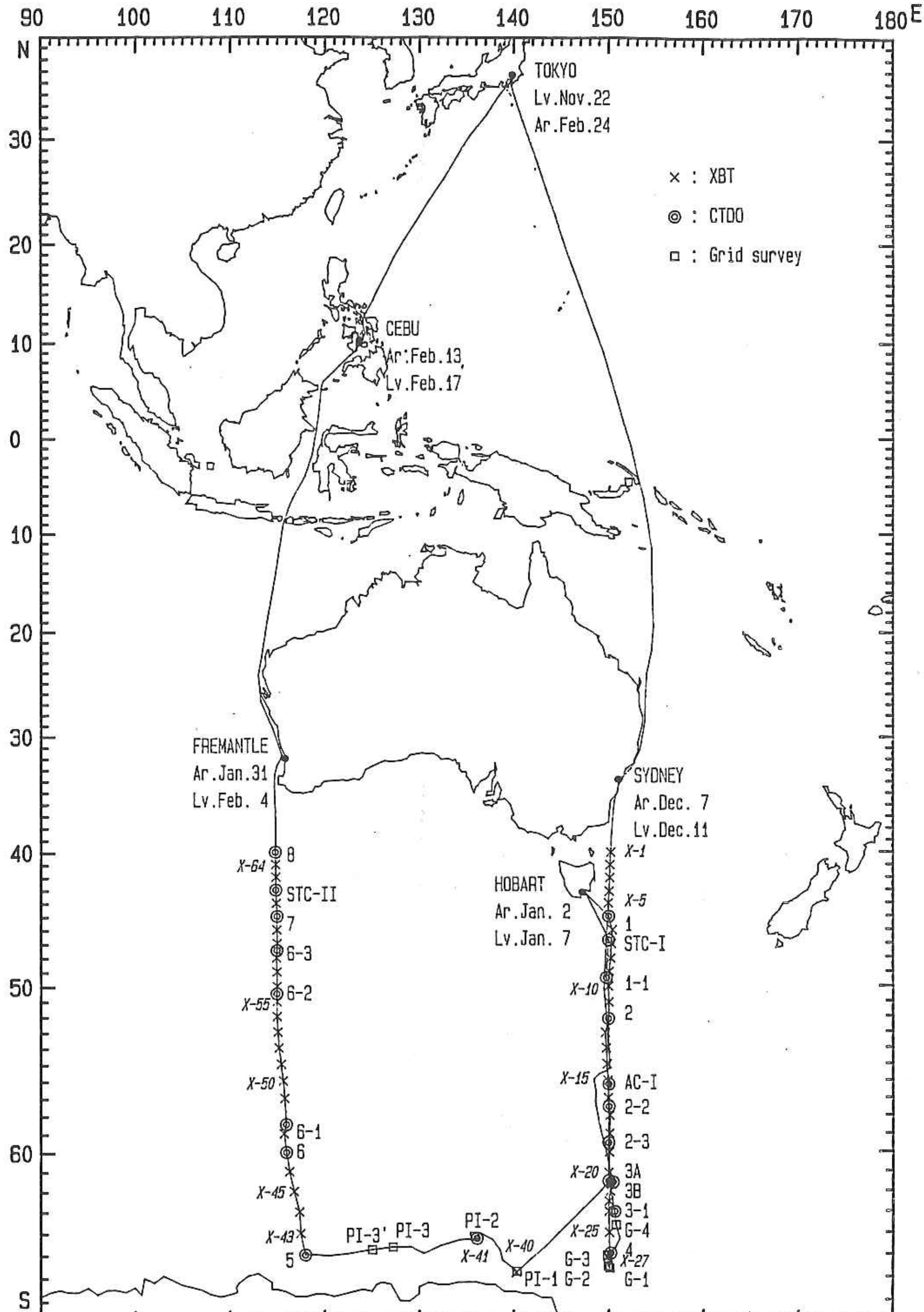

Fig. 1 Track chart and observation stations of the KH-83-4 cruise of the Hakuho-maru.

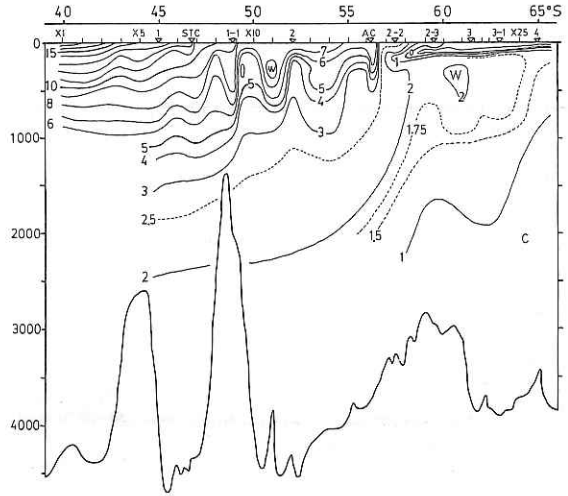

Fig. 2 Water temperature (°C) along Section I.

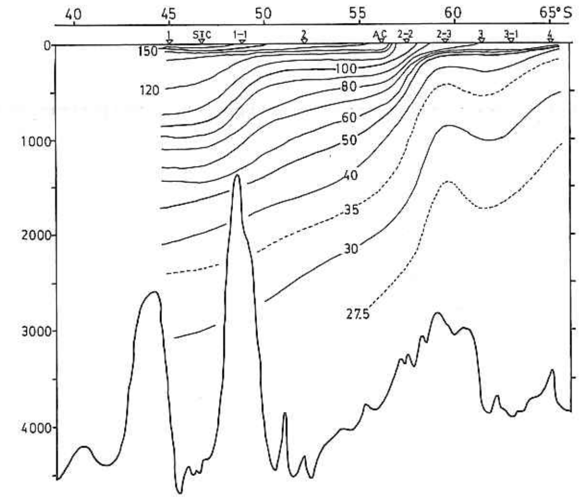

Fig. 3 Salinity ($\times 10^{-3}$) along Section I.

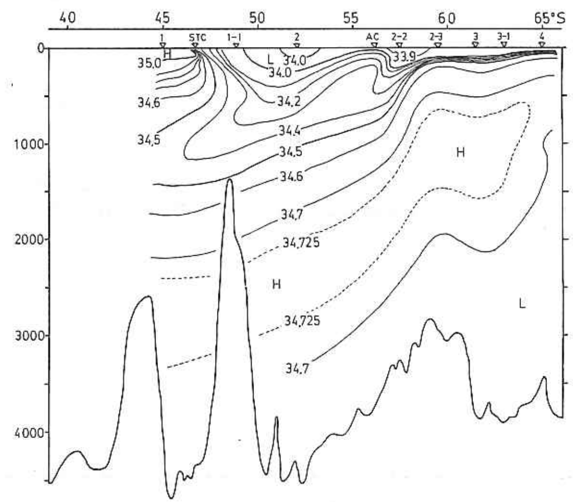

Fig. 4 Thermosteric anomary (cl/ton) along Section I.

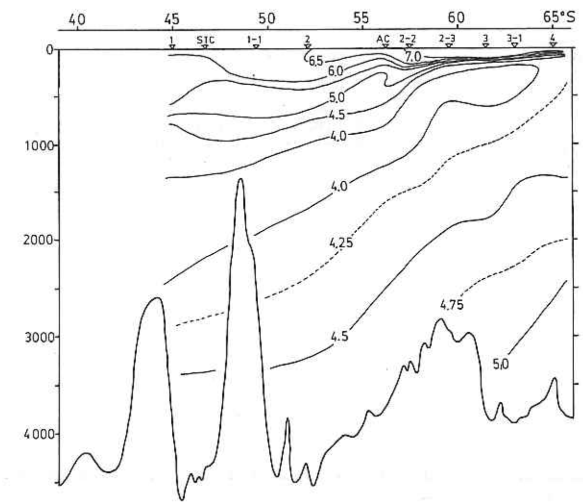

Fig. 5 Dissolved oxygen (ml/l) along Section I.

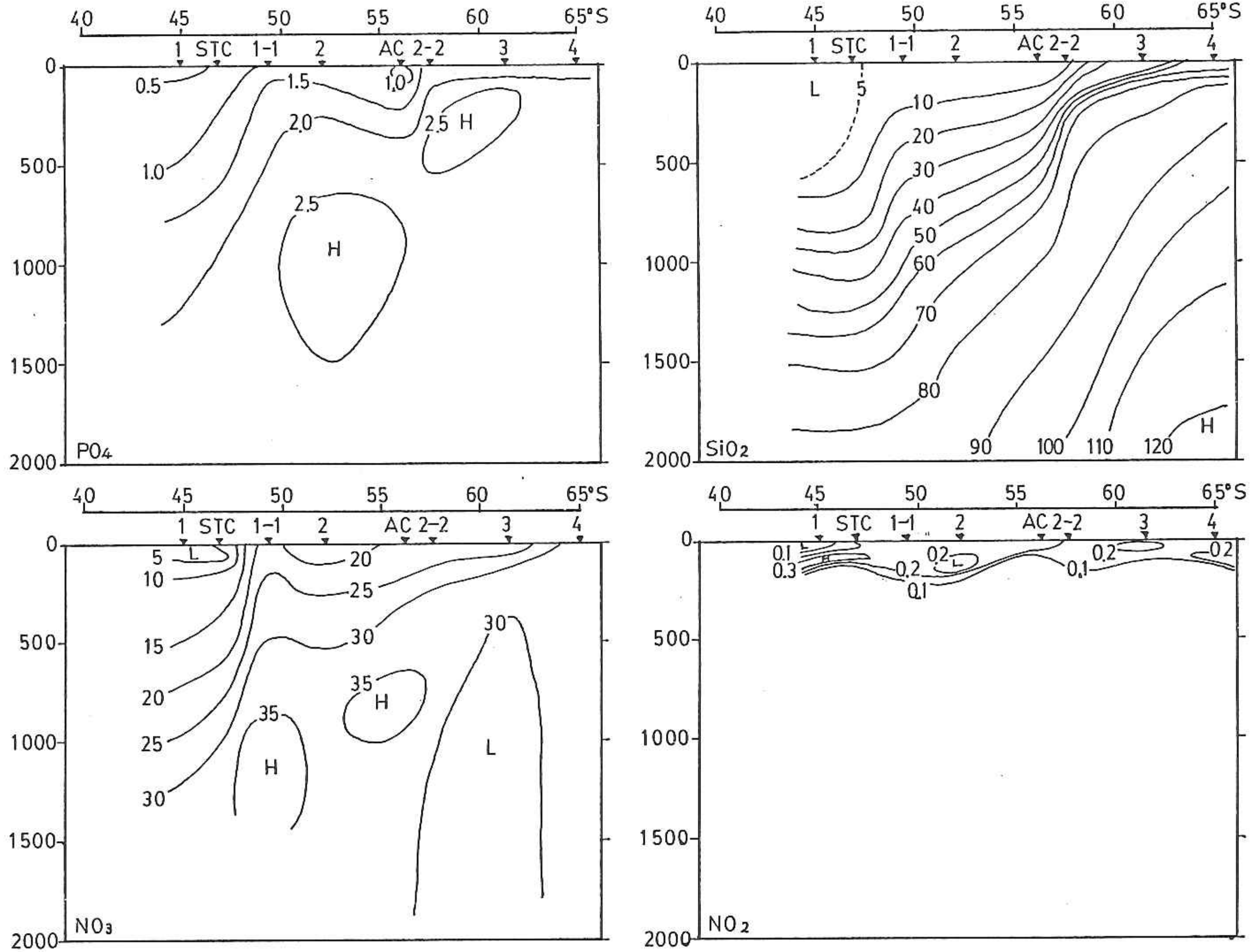

Fig. 6 Nutrient salts (μg-at/l) along Section I.

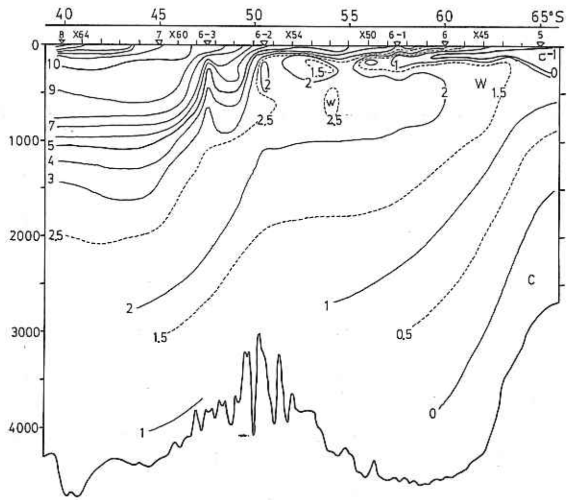

Fig. 7 Water temperature (°C) along Section II.

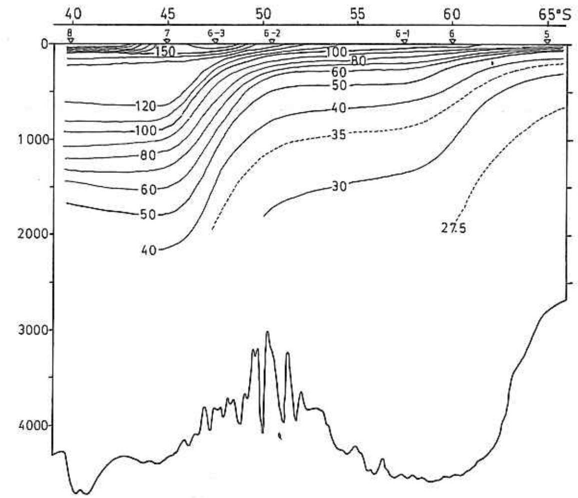

Fig. 8 Salinity ($x10^{-3}$) along Section II.

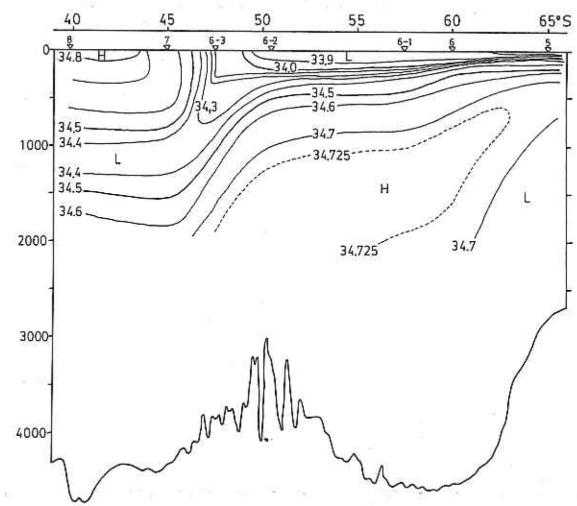

Fig. 9 Thermosteric anomary (cl/ton) along Section II.

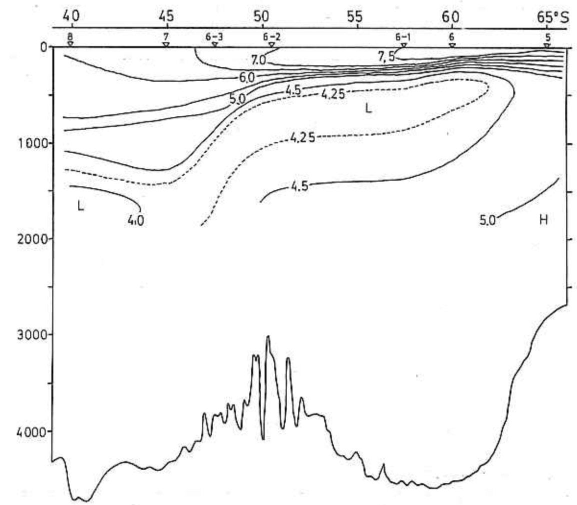

Fig. 10 Dissolved oxygen (ml/l) along Section II.

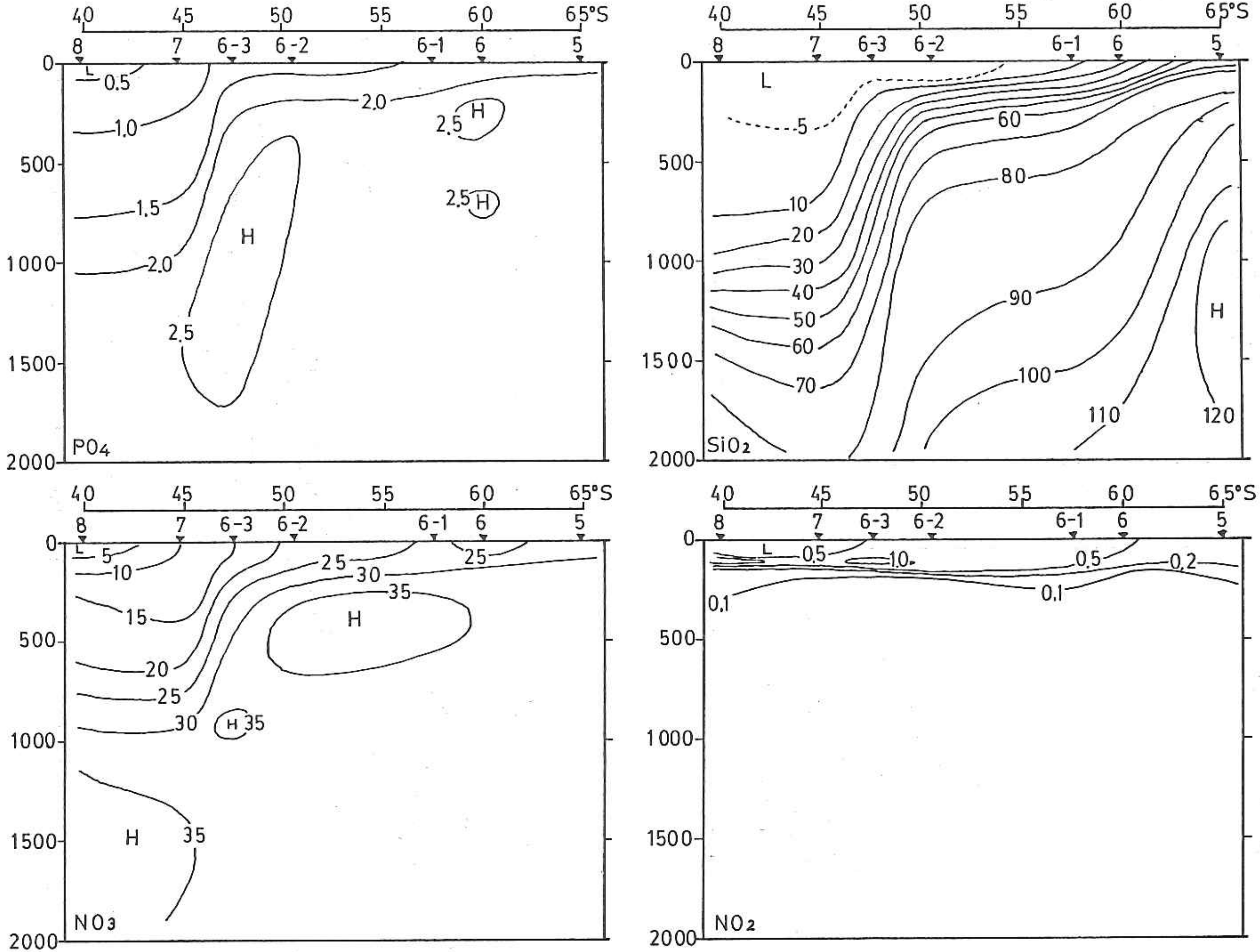

Fig. 11 Nutrient salts (µg-at/l) along Section II.

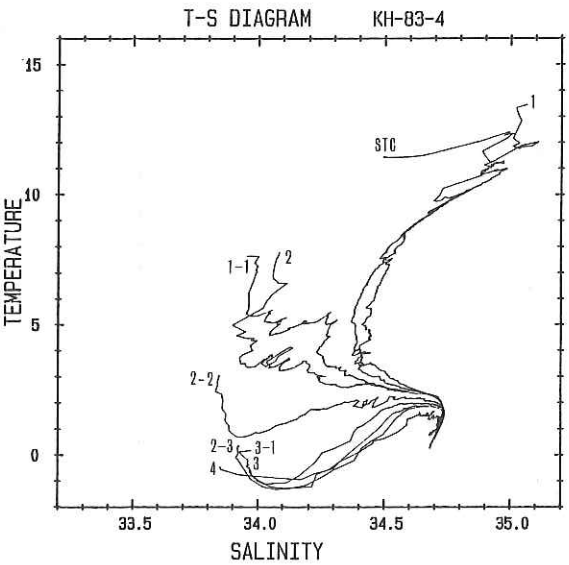

Fig. 12 T-S diagrams for CTD stations on Leg 2.

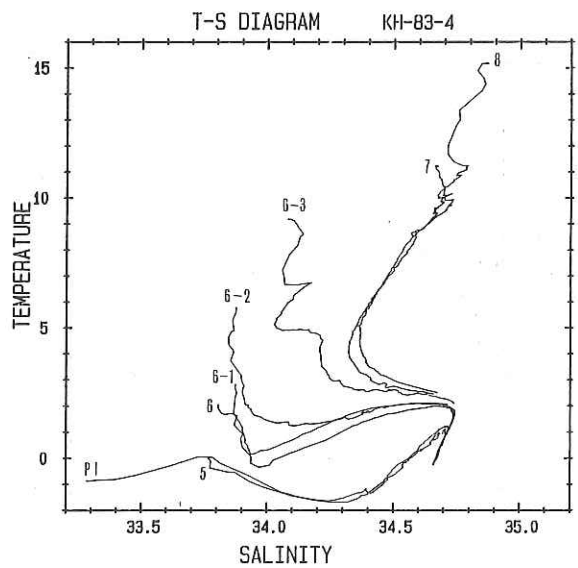

Fig. 13 T-S diagrams for CTD stations on Leg 3.

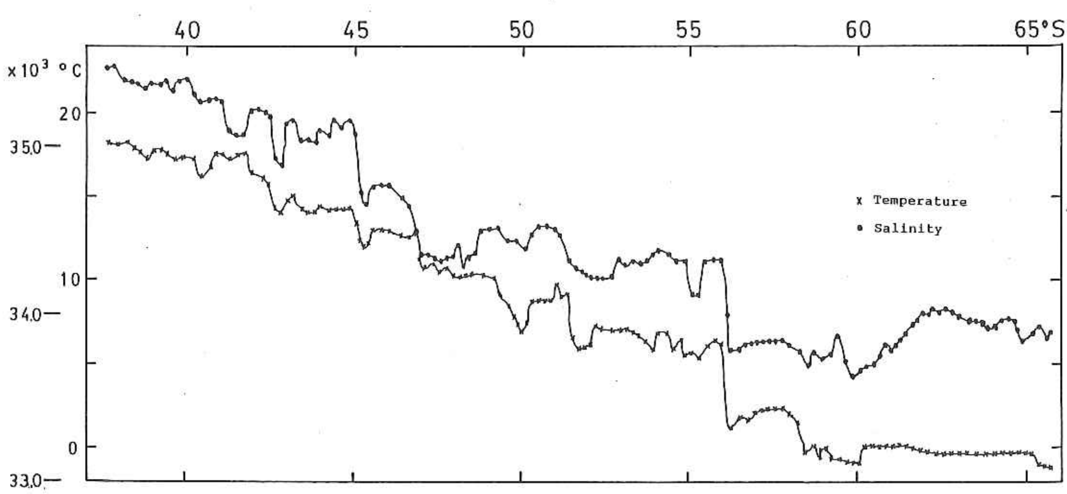

Fig. 14. Profiles of sea surface temperature and salinity along 150°E.

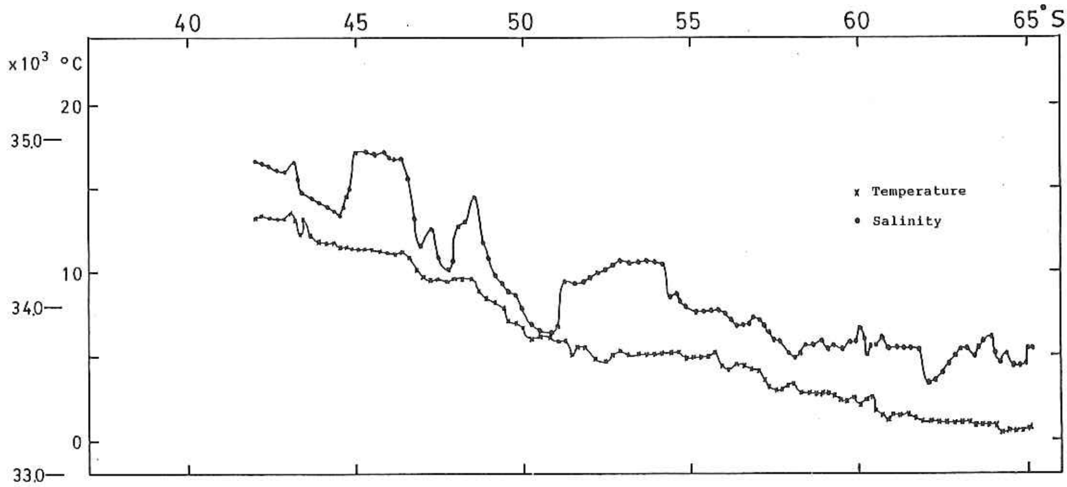

Fig. 15. Profiles of sea surface temperature and salinity along 115°E.

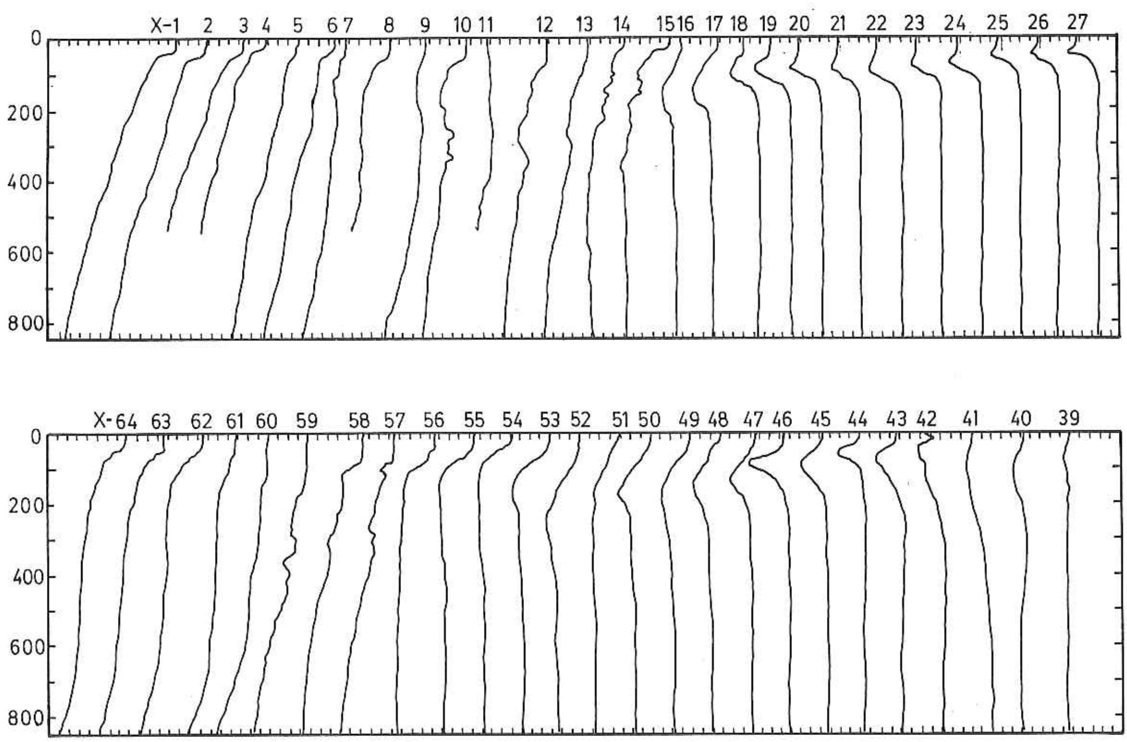

Fig. 16 XBT profiles.

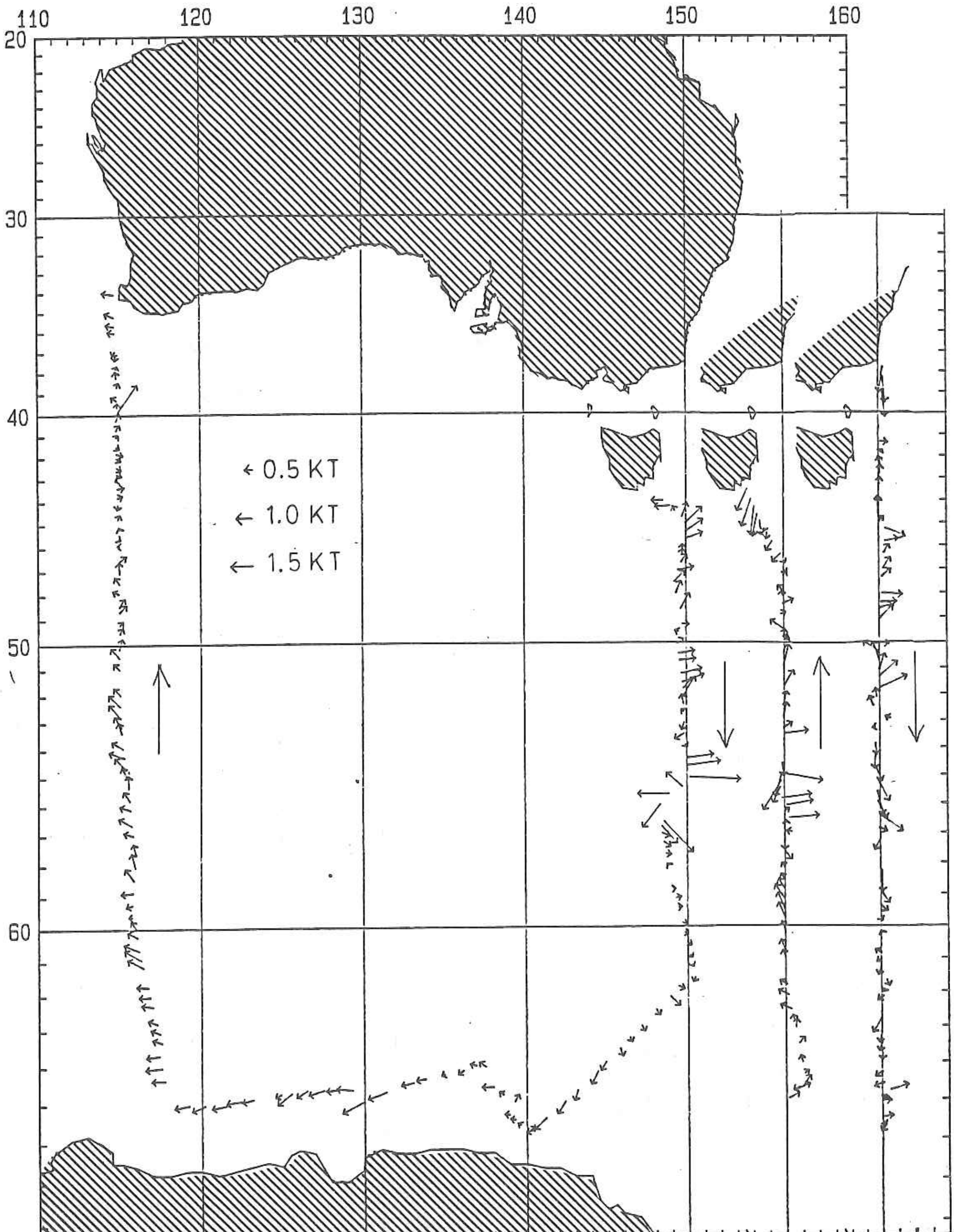

Fig. 17 Surface currents estimated from the ship's drift by NNSS

Geochemical studies of chemical substances in seawater and air in the Southern Ocean Area

H. Inoue

(1) Carbon dioxide in the atmosphere and in the surface seawater

The partial pressure of CO_2 in the atmosphere ($_pCO_2^{air}$) and in the surface seawater ($_pCO_2^{sea}$) was measured continuously by the automatic CO_2 analyzer which consists of NDIR and a gas-liquid equilibrator (Preliminary Report of the Hakuhō Maru Cruise KH-71-5).

Carbon dioxide in the air and in the surface seawater (ΣCO_2) was separated from the sample on board at the liquid nitrogen temperature for the study of the carbon isotopic composition.

The carbon isotopic ratio was measured on a triple ion collector mass spectrometer at our laboratory (Inoue and Sugimura).

Figure 18 shows the meridional distribution of $_pCO_2^{air}$ and $_pCO_2^{sea}$ for Leg 1 (from Tokyo to Sydney) and Leg 2 (from Sydney to Hobart). The partial pressure of CO_2 in the surface seawater varies in the range from 280 ppm to 420 ppm, and is generally supersaturated in the Equatorial and Antarctic regions. In the Antarctic Ocean $_pCO_2^{sea}$ varies considerably from place to place. On the other hand, $_pCO_2^{air}$ is nearly constant in the southern hemisphere and decreases slightly from north to south in the northern hemisphere.

The carbon isotopic ratio of CO_2 (per mil deviation from the PDB standard) in the air ranged from -7.3 ‰ to -8.0 ‰. Time and spatial variation in the relationship between $_pCO_2^{air}$ and carbon isotopic ratio will be discussed in relation to the air-sea and/or air-biota interaction.

(2) Trace constituents in the air

CF_2Cl_2 and $CFCl_3$: Air samples for the determination of halogenated hydrocarbons were collected in 135 ml gas collecting tubes of glass made on board during the cruise. Analysis of halogenated hydrocarbons was carried out at the laboratory on land by cryogenic preconcentration and Gas Chromatography-Quadrupole Mass Spectrometry (Fushimi and Sugimura).

The results of the determination of the concentration are as follows:

	North of 10°S	South of 10°S
CF_2Cl_2	350 ± 8 pl l^{-1}	214 ± 11 pl l^{-1}
$CFCl_3$	305 ± 10 pl l^{-1}	180 ± 13 pl l^{-1}

^{85}Kr: To evaluate the north-south transport of tropospheric air, samples were collected in iron cylinders during Leg 1 and Leg 2 at every 15° latitude by using an air compressor. At the laboratory on land, Kr in the sample was separated at liquid nitrogen temperature and the radioactivity of ^{85}Kr was measured on a low background liquid scintillation counter (Suzuki, Inoue, Katsuragi and Sugimura).

In the northern hemisphere, the concentration of ^{85}Kr is about 23 $_pCi/m^3$ and in the south of ITCZ, the concentration decreased to about 14 $_pCi/m^3$.

(3) Chemical composition of maritime airborne particles

In order to study the tranportation of continental materials to the ocean and the contribution of the sea salt on the global airborne particles, were collected on board continuously using a high volume air sampler at the rate of 1000 l/min. The filter was changed every 24 hrs. The chemical compositions were determined by ion chromatography, atomic absorption spectrometry, x-ray fluorescence spectrometry, and α-spectrometry (Hirose, Dokiya, and Sugimura).

(4) Artificial radionuclides in the surface seawater

To study the surface distribution of the nuclides produced by nuclear testing, surface water samples for the measurements of $^{239+240}Pu$, ^{137}Cs, and ^{90}Sr were collected on board and subjected to the analysis.

$^{239+240}Pu$: Plutonium was collected from 400 liters of seawater by the method of coprecipitation on board (13 samples). After the electrodeposition of $^{239+240}Pu$ on a stainless steel disk, the content of $^{239+240}Pu$ was later measured by the α-ray spectrometric method in the laboratory on land (Hirose and Sugimura).

The concentration of the particulate $^{239+240}Pu$ was in the range from 0.2×10^{-4} $_p$Ci/l to 0.4×10^{-4} $_p$Ci/l.

^{137}Cs and ^{90}Sr: The method employed in this study was the same as described in the previous report (Preliminary Report of the Hakuhō Maru Cruise KH-68-4).

(5) Total and organic nitrogen dissolved in seawater

Total and organic nitrogen were determined by using high temperature catalytic oxidation method. The concentration of total nigrogen in the surface water ranged from 40 to 50 μM/l and in the deeper layer the concentration shows a fairly uniform value in both vertical and horizontal directions (50 μM/l).

In the subtropical water, the concentration of organic nitrogen is high in the surface (30 to 35 μM/l) and low in deep (17 to 20 μM/l). In the Antarctic water, however, the concentration of organic nitrogen is fairly uniform with depth and low in comparison with those in the subtropical waters (Suzuki and Sugimura).

Molecular size distributions of organic nitrogen were also examined by using gel exclusion method. An example of vertical distributions of total and organic nitrogen is given in Fig. 19.

(6) Metallic elements: chemical form, concentration, and distribution

Surface and deep water were collected by the non-metallic sampler. Immediately after sampling, they were filtered through a membrane filter. The filtrate was stored in the dark until analysis.

The determination of total and organic form metals will be done by using preconcentration technique of XAD-oxine and XAD-2 adsorption method (Suzuki and Sugimura).

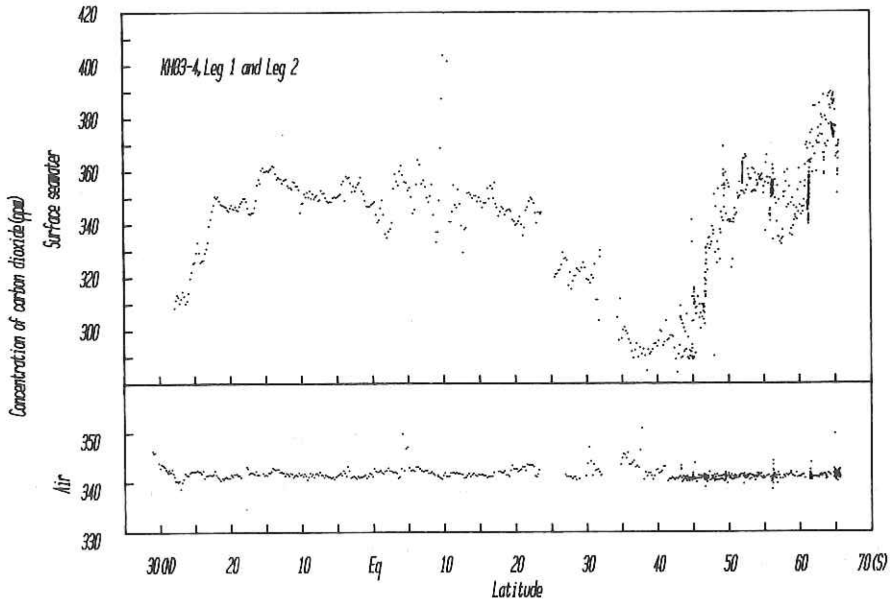

Fig. 18. Meridional distribution of pCO_2^{air} and pCO_2^{sea} in Leg 1 and Leg 2 in KH-83-4 cruise.

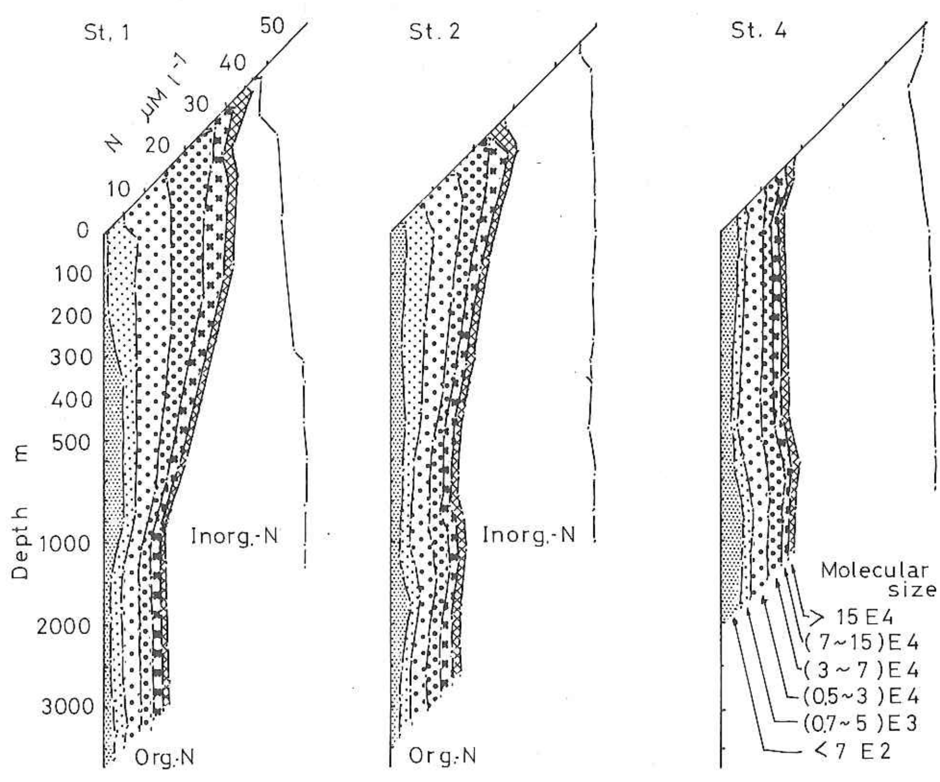

Fig. 19. Vertical distribution of total and organic nitrogen.

Chemical studies of the Antarctic Ocean

K. Harada and K. Taguchi

As a part of the BIOMASS project we studied the Antarctic Ocean from its chemical aspect by using sediment traps and radiochemical tracers.

(1) Sediment trap experiments

Two arrays of sediment traps were moored in the Antarctic Ocean. One comprised from five NH type traps was deployed at Stn. 3A (61°33'S, 150°27'E; water depth 3580 m) for 24 days starting 20 Dec. 1983. The other array of two D type traps was deployed at Stn. 3B (61°30'S, 150°02'E; 3920 m) for 40 days from 25 Dec. 1983 to 3 Feb. 1984, when it was retrieved by R/V Umitaka-Maru. Each D type trap collected four samples in time series and thus the sampling period was ten days each.

The total mass fluxes obtained were shown in Figs. 20 and 21. These samples will be analyzed for major inorganic components, trace metals and radionuclides.

(2) Radionuclides in sea water

Surface and subsurface water samples were collected at nine stations by using a submersible pump down to 100 m. The concentrations of ^{226}Ra, ^{210}Pb, ^{210}Po, ^{234}Th and other TH isotopes were determined.

(3) Chemical studies of sediments

At Stn. 3B, a sediment core (35 cm long) was obtained with a box corer. Inorganic components and radionuclides in these sediments were measured.

These works were conducted in collaboration with S. Tsunogai, S. Noriki, Y. Watanabe and N. Ishimori, Faculty of Fisheries, Hokkaido University.

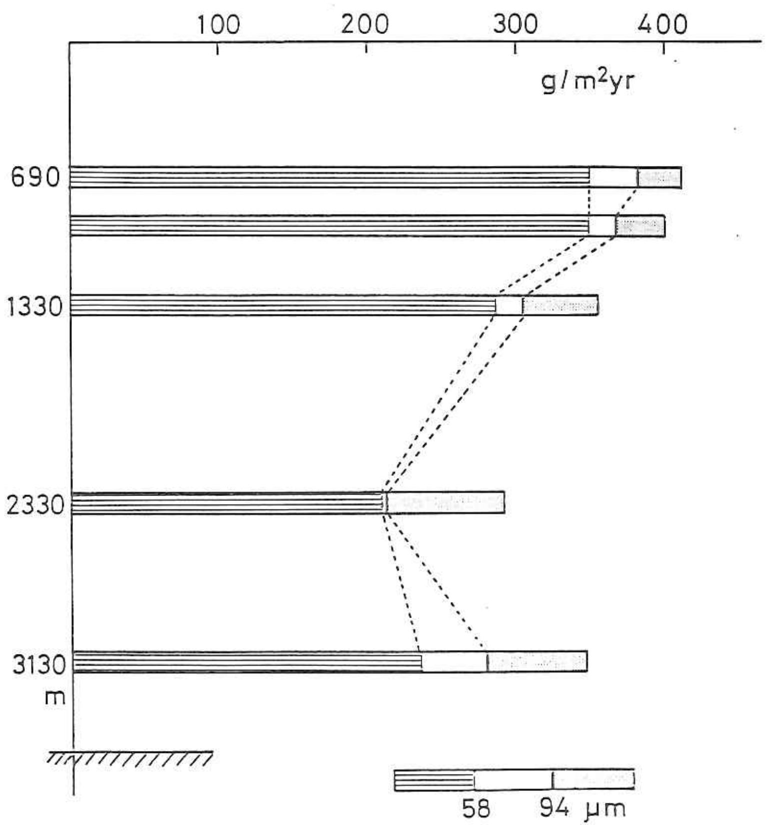

Fig. 20. Mass fluxes obtained with NH traps.
The samples were separated into three fractions
by using XX13 and XX25 plankton nets.

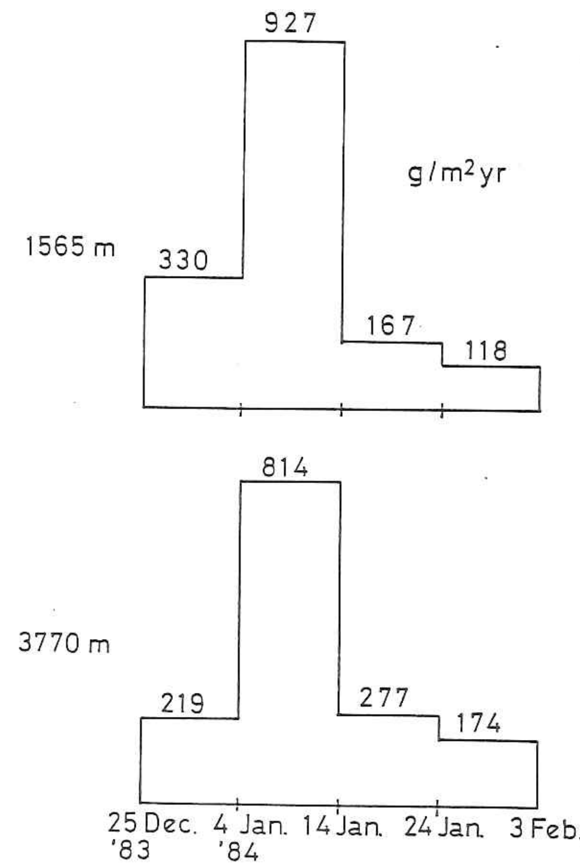

Fig. 21. The change of the total mass fluxes
obtained with D traps.

Geochemical studies of organic matter in the Antarctic Ocean

N. Handa and H. Matsueda

(1) Determination of vertical flux of organic matter and chemistry of sinking particles

An array of sediment traps was moored at the station located at 61° 34.1'S, 150°23.3'E in the Antarctic Ocean. Particles deposited into the sediment trap were collected to PVC bottles (volume: 300 ml), which were kept frozen at -20°C until analysis.

After thawing, samples were centrifuged to collect sinking particles, which were analyzed for total fluxes of gross mass and organic carbon and nitrogen. Sinking particles were also analyzed for lipid materials, amino acids, proteins and carbohydrates to deduce their potentialities of dissolved oxygen consumption in the deep sea environments.

Further detailed analyses of cycloalkenes, polyunsaturated fatty acids, carbohydrates and amino acids and proteins were conducted to determine the source of organic materials of the sinking particles by combined gas chromatography and mass spectrometry.

Scanning electron microscopy was applied to identify microorganisms occurring in the fecal pellets of zooplankton. Preliminary investigation of the sinking particles by SEM indicated that diatoms were dominant in the particle samples.

(2) Chemistry of suspended particles

Two systems were applied for the collection of suspended particles. Niskin bottles were used for the collection of seawater samples (100 l) from the surface to 3000 m depth at Stns. 3, 4, 5 and 6. Suspended particles were collected by filtration of the seawater samples onto glass fiber filter (GF/C) and analyzed for carbohydrates. Fatty acid methyl esters, glycerides and free fatty acids of the samples were analyzed by gas chromatography.

In situ filtration system was applied for the collection of large amounts of suspended particles from the depths of 800 and 2000 m at Stn. 3B. *Ca* 10 mgC of organic matter were obtained in each of the depths of the station and analyzed for hydrocarbons, wax esters, glycerides, polyaromatic hydrocarbons and sterols.

(3) Chemistry and production of particulate organic matter in the surface waters

Sixty eight samples of particulate matter were collected from surface waters in the Southern Ocean in Legs 2 (Sydney to Hobart) and 3 (Hobart to Fremantle). The samples were analyzed for chlorophyll-*a*, particulate organic carbon, carbohydrates, lipid materials and amino acids and proteins to draw the variabilities of particulate organic matter in time and space in the Southern Ocean. The photosynthetic production rate of particulate organic matter was determined using $NaH^{13}CO_3$ as a tracer. Turnover rate of particulate organic matter in the Antarctic Ocean was tentatively able to be calculated.

(4) Organic chemistry of sediment

Sediment samples were collected at Stn. 3B by box corer. A stainless steel barrel was directly inserted into the bottom sediment collected by the corer. Core samples obtained were sectioned at every 1 or 2 cm depth and the samples were kept frozen at -20°C until analysis.

Phytoplankton studies of the Southern Ocean

K. Furuya, N. Hosaka and T. Nemoto

(1) Community structure and biomass of phytoplankton

Phytoplankton collected with Rosette samplers fitted with OCTOPUS (Ishimaru et al., 1984) were treated after Tsuji and Yanagita (1981) and microscopic specimens were prepared. Specimens were observed with an epifulorescence microscope. Only photosynthetic forms were enumerated and their cell volume was measured with an image analyzing system (Furuya, 1982), and converted to phytoplankton carbon content. Size distribution of phytoplankton biomass in terms of carbon was obtained for the upper 200-m water column at every OCTOPUS station. The rest of the water samples were transferred to the laboratory for microscopic examination of phytoplankton species.

(2) Growth experiments of phytoplankton

Culture experiments were conducted using natural phytoplankton populations in order to measure the growth rate and the effects of various nutrient additions and increase in temperature. At Stns. 2, 4, 5, and 7, surface water was collected and filtered through 100 μ mesh to remove larger zooplankton, and introduced into 5 liter polycarbonate bottles. Various nutrients, PO_4(plus 1.8 μM), NH_4(1.5 μM), NO_3(16 μM), Fe(III)(0.7 μM), vitamin B_{12}(10 ng/l) and silicate (10 μM), were added into the bottles and incubated for ca. three days in running surface seawater. At the same time three bottles were incubated at 3°C higher under the same light condition.

Algal growth was monitored by chlorophyll a. After 24 hrs, enhancement of carbon uptake was measured using ^{14}C method.

References

Furuya, K. (1982): Measurement of phytoplankton standing stock using an image analyzer system. Bull. Plankton Soc. Japan, 29: 131-132.

Ishimaru, T., H. Otobe, T. Saino, H. Hasumoto and T. Nakai (1984): OCTOPUS, an octo parameter underwater sensor, for use in biological oceanography studies. J. oceanogr. Soc. Japan, 40: 207-212.

Tsuji, T. and T. Yanagita (1981): Improved fluorescent microscopy for measuring the standing stock of phytoplankton including fragile components. Mar. Biol., 64: 207-211.

Effect of temperature on
photosynthetic activity in Antarctic phytoplankton

T. Yamamoto

Phytoplankton biomass and productivity are fairly low in the Antarctic waters in spite of high nutrient concentrations and ample light. It is suggested that the low temperature and deep mixing layer are the two most important factors affecting phytoplankton production in this area (Saijo and Kawashima, 1964). The purpose of this study is to investigate if marine phytoplankton living in the Antarctic waters are not able to make full use of their photosynthetic ability due to extremely low ambient temperature.

Surface seawater was dispensed into two transparent and one DCMU-added (ca. 10^{-5} mole/l) bottles, and 5 uCi $NaH^{14}CO_3$ was added for each bottle. Three sets of them were incubated under three different temperature conditions and illuminated with ca. 9800 lux fluorescent lamps. These experiments were operated at 10 stations during the cruise (Table 3).

The results were divided into three regions; a) north of the Subtropical Convergence, b) between the Subtropical and Antarctic Convergence, and c) south of the Antarctic Convergence. All data obtained in the three regions were plotted in Fig. 22 as ^{14}C fixation rates at different temperatures relative to the values at ambient temperatures. Phytoplankton living in the Antarctic waters (Fig. 22) did not show the maximum photosynthetic activity at ambient temperature, while those in the other two regions did. The maximum photosynthetic activity of phytoplankton in the Antarctic waters was found at around 10-12°C, and it was about 1.5 times higher than that of *in situ*. It is considered that extremely low temperature might depress the photosynthetic activity of phytoplankton in the Antarctic sea.

References

Saijo, Y. and T. Kawashima (1964): Primary production in the Antarctic Ocean. J. oceanogr. Soc. Japan, 19: 22-28.

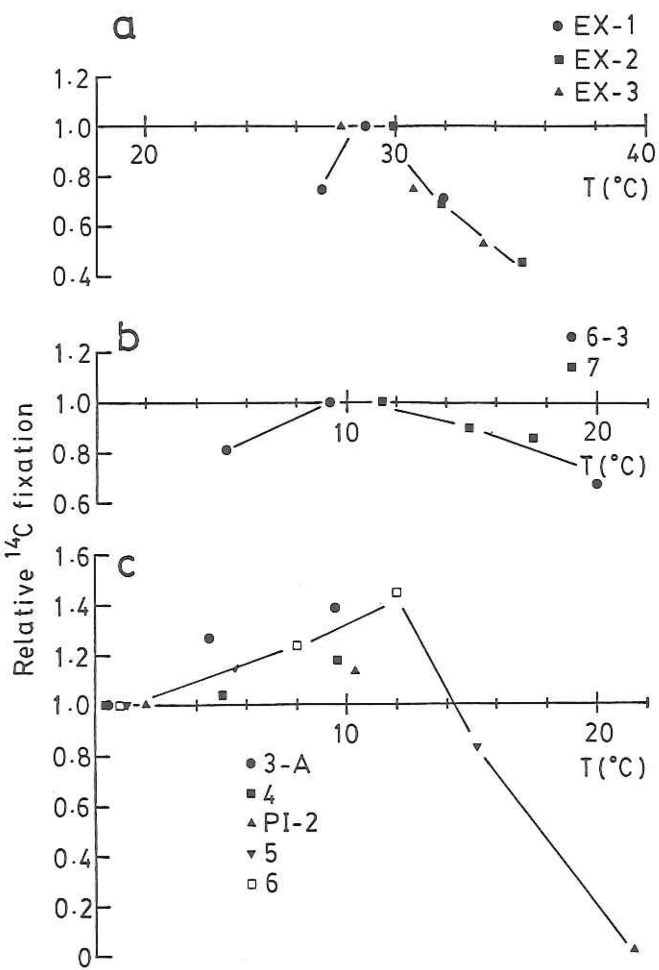

Fig. 22. ^{14}C fixation rates at different temperatures relative to the values at ambient temperatures. (a) north of the STC, (b) between the STC and AC and (c) south of the AC.

Table 3. List of stations occupide for measurements of photosynthetic activity.

Station	Date	Location
3-A	Dec. 20 '83	61°33.3'S 150°27.5'E
4	Dec. 23	64°51.0'S 150°32.9'E
PI-2	Jan. 16 '84	64°15.5'S 136°07.7'E
5	Jan. 19	65°02.1'S 118°14.8'E
6	Jan. 22	59°59.0'S 115°52.8'E
6-3	Jan. 25	46°30.0'S 115°00.1'E
7	Jan. 26	45°00.9'S 114°59.6'E
EX-1	Feb. 6	19°56.4'S 113°50.2'E
EX-2	Feb. 7	16°11.2'S 114°28.7'E
EX-3	Feb. 10	1°38.8'S 118°44.7'E

Phytoplankton standing crop and photosynthetic activity at the oceanic fronts in the Southern Ocean

T. Yamamoto

While phytoplankton standing crop and/or photosynthetic activity at the oceanic fronts in the northern hemisphere has been reported to be high (Yamamoto et al., 1981; Yoder et al., 1981), there is little information concerning those in the southern hemisphere. This study was conducted to elucidate the variation of phytoplankton standing crop and photosynthetic activity in and around the Antarctic (AC) and Subtropical Convergences (STC).

Sea water was pumped up from ca. 5 m depth and pooled in a 5 l polyethylene tank. Twenty samples were obtained across each front. Salinity, essential nutrients and chlorophyll a were determined for each sample. A 500 ml aliquot for each sample was fixed with formalin. The temperature at 5 m depth was monitored on board using a thermo-recorder. These observations were carried out once across the AC (56°30.1'S, 150°10.4'E - 56°08.7'S, 149°59.3'E) and twice across the STC (STC-I; 46°59.6'S, 150°00.4'E - 46°20.0'S, 149°48.2'E and STC-II; 43°24.0'S, 114°54.1'E - 43°01.7'S, 114° 52.1'E). Sampling intervals were ca. 1 n. mile for AC and STC-II, and ca. 2 n. miles for STC-I, respectively. Photosynthetic activity was also measured during the two crossings of STC in the same manner as above.

The results obtained are summarized in Tables 4, 5 and 6. Higher chlorophyll a concentrations were found in the midst of the transverse lines of AC and STC-I (Tables 4 and 5). Photosynthetic activity was also high at the front of STC-I (Table 5). Although the mechabism for the formation of the dense phytoplankton communities at the fronts has not yet been made clear, close examination of phytoplankton species for formalin fixed samples might solve the question.

References

Yamamoto, T., A. Taniguchi and S. Nishizawa (1981): Microplankton distribution at an oceanic front formed in the Sanriku waters off northeast Japan. Bull. Plankton Soc. Japan, 28: 111-120.

Yoder, J. A., L. P. Atkinson, T. N. Lee, H. H. Kim and C. R. McClain (1981): Role of Gulf Stream frontal eddies in forming phytoplankton patches on the outer southeastern shelf. Limnol. Oceanogr., 26: 1103-1110.

Table 4. Chlorophyll a and environmental data from the surface layer (ca. 5 m depth) across the AC taken on Dec. 29, 1983.

Sample no.	Temp. (°C)	Sal. (‰)	Nitrate (μg-at/l)	Nitrite (μg-at/l)	Ammonia (μg-at/l)	Phosphate (μg-at/l)	Silicate (μg-at/l)	Chl a (μg/l)
1	3.6	33.80	27.6	0.29	0.97	1.70	17.6	0.165
2	3.8	33.75	28.3	0.31	0.87	1.68	13.4	0.097
3	3.8	33.76	28.1	0.31	0.78	1.64	15.0	0.083
4	3.8	33.75	28.0	0.30	0.74	1.64	15.3	0.071
5	3.9	33.75	25.7	0.30	0.74	1.63	15.3	0.071
6	4.0	33.76	28.6	0.31	0.80	1.63	13.7	0.088
7	4.2	33.77	29.1	0.31	0.84	1.65	13.1	0.070
8	4.4	33.80	28.4	0.30	0.89	1.65	10.5	0.127
9	4.7	33.81	27.2	0.23	0.74	1.64	8.9	0.085
10	5.2	33.86	26.2	0.23	0.86	1.60	7.9	0.151
11	5.6	33.91	25.3	0.22	0.92	1.59	9.2	0.185
12	5.9	33.90	25.1	0.22	0.79	1.57	8.6	0.048
13	6.3	33.93	24.9	0.21	0.86	1.57	8.6	0.058
14	6.6	33.99	23.8	0.21	0.78	1.52	8.6	0.057
15	6.8	34.02	22.6	0.23	0.77	1.47	7.9	0.059
16	7.1	34.08	22.0	0.23	0.75	1.45	7.6	0.053
17	7.3	34.16	21.2	0.24	0.77	1.42	8.3	0.072
18	7.3	34.11	20.8	0.24	0.68	1.40	7.0	0.067
19	7.4	34.10	21.0	0.24	0.72	1.41	7.3	0.053
20	7.4	34.12	20.9	0.23	0.71	1.41	7.6	0.052

Table 5. Carbon fixation and environmental data from the surface layer (ca. 5 m depth) across the STC taken on Jan. 1, 1984.

Sample no.	Temp. (°C)	Sal. (‰)	Nitrate (μg-at/l)	Nitrite (μg-at/l)	Ammonia (μg-at/l)	Phosphate (μg-at/l)	Silicate (μg-at/l)	Chl a (μg/l)	^{14}C fix. (ave.) (μgC/l/h)
1	10.9	34.40	9.4	0.23	1.16	0.86	2.3	0.078	0.664 0.668 (0.666)
2	11.0	34.40	9.8	0.23	1.25	0.86	1.4	0.081	
3	10.3	34.40	9.7	0.23	1.06	0.86	1.7	0.083	
4	11.0	34.40	9.6	0.23	1.04	0.85	1.7	0.095	0.669 0.607 (0.638)
5	11.1	34.40	9.2	0.22	1.09	0.85	0.8	0.128	
6	11.1	34.40	9.2	0.22	1.09	0.83	1.1	0.112	
7	11.2	34.41	8.9	0.22	1.13	0.81	1.1	0.133	0.674 0.715 (0.695)
8	11.3	34.45	8.6	0.22	0.94	0.81	0.8	0.126	
9	11.7	34.53	7.4	0.22	1.16	0.79	1.1	0.167	1.104 1.003 (1.054)
10	12.2	34.63	5.7	0.22	1.16	0.73	0.8	0.202	
11	12.4	34.68	4.0	0.20	1.00	0.64	0.8	0.239	1.645 1.533 (1.589)
12	12.5	34.73	3.5	0.18	1.05	0.57	0.5	0.266	
13	12.6	34.73	3.1	0.17	0.96	0.55	0.8	0.282	1.570 1.757 (1.664)
14	12.7	34.80	2.8	0.17	1.23	0.54	0.8	0.276	
15	12.6	34.66	2.6	0.17	1.03	0.51	1.1	0.309	1.518 1.738 (1.628)
16	12.4	34.68	3.1	0.17	0.93	0.51	1.1	0.189	
17	12.2	34.63	3.9	0.18	1.05	0.57	1.1	0.206	1.072 1.073 (1.073)
18	11.9	34.56	4.7	0.19	0.94	0.59	1.1	0.221	
19	12.4	34.66	5.3	0.20	1.16	0.61	1.1	0.248	
20	12.6	34.74	5.9	0.21	1.03	0.63	1.1	0.188	1.063 0.954 (1.009)

Table 6. Carbon fixation and environmental data from the surface layer (ca. 5 m depth) across the STC taken on Jan. 27, 1984.

Sample no.	Temp. (°C)	Sal. (‰)	Nitrate (μg-at/l)	Nitrite (μg-at/l)	Ammonia (μg-at/l)	Phosphate (μg-at/l)	Silicate (μg-at/l)	Chl a (μg/l)	^{14}C fix. (ave.) (μgC/l/h)
1	12.5	34.61	8.1	0.40	4.01	0.94	2.2	0.061	0.354 0.364 (0.359)
2	12.3	34.59	7.9	0.40	3.40	0.92	2.5	0.064	
3	12.2	34.59	8.1	0.40	3.49	0.94	2.5	0.071	0.374 0.449 (0.412)
4	12.2	34.59	8.0	0.39	3.33	0.93	2.8	0.066	
5	12.2	34.61	8.2	0.40	3.93	0.95	2.5	0.077	0.403 0.423 (0.413)
6	12.2	34.61	7.9	0.40	3.83	0.93	3.1	0.079	
7	12.6	34.61	8.0	0.40	3.68	0.92	2.8	0.077	0.464 0.474 (0.469)
8	12.8	34.64	7.1	0.38	4.01	0.88	2.8	0.059	
9	12.7	34.66	6.9	0.37	4.46	0.85	2.2	0.060	0.439 0.414 (0.427)
10	12.5	34.66	5.6	0.33	3.50	0.80	2.2	0.055	
11	12.7	34.61	6.6	0.37	3.71	0.86	2.5	0.063	0.425 0.414 (0.420)
12	13.0	34.61	7.5	0.39	3.89	0.91	2.5	0.076	
13	14.2	34.66	5.5	0.34	3.33	0.80	2.2	0.070	
14	14.4	34.69	4.4	0.28	3.40	0.74	1.5	0.068	0.550 0.527 (0.539)
15	14.1	34.72	4.1	0.25	3.91	0.77	1.5	0.062	
16	14.3	34.71	4.2	0.26	3.28	0.74	1.5	0.066	
17	14.4	34.69	6.0	0.31	5.43	1.05	1.8	0.056	0.482 0.552 (0.517)
18	14.4	34.71	4.2	0.27	3.30	0.74	1.5	0.060	
19	14.4	34.71	4.3	0.27	3.41	0.73	1.5	0.067	
20	14.5	34.71	4.3	0.26	3.76	0.74	1.5	0.057	0.535 0.529 (0.532)

Taxonomy and ecology of nannoplankton

Shiro Nishida

The present study is intended to clarify the distribution and ecology of nannoplankton in meridian section extending from Tokyo to Antarctica, and especially their ecological significance in Antarctic Ocean.

During the cruise, surface nannoplankton samples were collected with a bucket at a 1 to 4 hrs interval. Numbers of collected samples are as follows;

Leg 1 (Tokyo-Sydney)	135
Leg 2 (Sydney-Hobart)	176
Leg 3 (Hobart-Fremantle)	212
Leg 4 (Fremantle-Cebu)	164
Leg 5 (Cebu-Tokyo)	107

In Legs 2 and 3, vertical water column nannoplankton samplings were carried out at all routine hydrographic stations. Except two stations, sample water was taken normally at nine layers in euphotic layer with a Niskin bottle sampler attached to CTD. On these occasions sampling depths were 0, 10, 20, 30, 50, 75, 100, 125 and 150 meters. At Stn. CTD-PI-2 and Stn. 5, seventeen layer samples were taken and their maximum depth was 2000 meters.

Collected water was filtered with a Millipore filter (0.8 μm pore size) and washed with filtered water to remove salt. Nannoplankton collected on the filter were dried at room temperature, brought back in a plastic case to the laboratory, sectioned to obtain a definite area with a punch, coated with gold by an ion spattering method and examined under a scanning electron microscope (SEM). Nannoplankton were identified under SEM, and at the same time the number of nannoplankton specimens in a unit area was counted to get a nannoplankton population in a unit volume of sea water.

Through the present project I have collected more than 900 filtered samples and will observe them for about two to three years.

Ecology of zooplankton and micronekton

T. Nemoto, M. Terazaki, S. Nishida, N. Iwasaki and A. Tsuda

One of principal purposes of this cruise was to describe the zooplankton and micronekton fauna of the Pacific sector of the Southern Ocean in terms of taxonomy, biomass, geographical distribution and vertical distribution. The following stuides and sampling were carried out. Detailed data regarding the collections have been recorded in the Plankton Record (KH-83-4) deposited in the Plankton Laboratory, Ocean Research Institute.

(1) Collection of zooplankton and micronekton

A NORPAC-twin net constructed of a 0.10 mm-mesh and a 0.33 mm-mesh net was towed vertically from a depth of 150 m to the surface mostly at night to collect large phytoplankton and epipelagic zooplankton.

A Motoda horizontal net (MTD net) was towed day and night mostly in 10-20 different strata between 1000 m and the surface by two series of tows; a shallow series and a deep one. Two types of nets with mesh sizes of 0.10 mm and 0.33 mm were used to cover a wide range of animals from smaller zooplankton to fish larvae.

A Longhurst-Hardy plankton recorder (LHPR; both the conical net and the rolled gauze with 0.33 mm-mesh) was used to study the small-scale vertical distribution of zooplankton.

To collect large zooplankton and micronekton, an ORI-69 net (0.69 mm-mesh) was towed obliquely in the layer between 1000 m and the surface.

A Bongo net was used to study the geographical distribution of zooplankton.

A 10-ft IKMT (5 mm mesh) or with electronic multiple plankton sampler (EMPS) having opening and closing system with five codend nets, was towed obliquely in the layer between a depth of 1000 m and the surface to collect micronekton.

(2) Zooplankton and micronekton fauna and their biomass

The measurement of biomass of each taxonomic group is being made for the samples collected with a ORI-69 net and IKMT. Table 7 shows the wet weight of each taxonomic group collected with IKMT. The value of total wet weight of zooplankton was high in the Antarctic Ocean and low in the Pacific Subtropical Ocean.

(3) Vertical distribution and diurnal migration of zooplankton

Day-night vertical distribution of copepods, euphausiids, chaetognaths and salps was studied with MTD net at Stns. 2, 3B, 4, 5 and 7.

(4) Feeding habit of copepods

The food items and feeding rhythm of copepods have been analyzed with MTD net and ORI-69 net collections, accompanied by analyses of the phytoplankton composition of water samples. The size selectivity of living copepods fed natural plankton was measured with a Coulter Counter.

(5) Characteristic of particle matters caught by the sediment trap

Samples were collected from five NH type traps which was deployed at Stn. 3A. The particle matters included degraded phytoplankton pigments, which suggests that rapid transportation of the pigment through the feeding and excretion by zooplankton in the surface layer. The dead shell of foraminifera, diatom and integment of zooplankton and krill are also observed.

Table 7. Wet Weight (g/1000 m^3) of Zooplankton and Micronekton Collected by Oblique Hauls of 10-feet IKMT (5-mm mesh)

Station	1[1]	2	3	4	3B	1'	3'	PI-2	5	6	7	8
Location (Middle point) S	45-06.8	52-07.3	61-27.0	64-56.4	61-25.6	44-58.7	61-31.9	64-13.5	65-01.6	60-00.3	44-48.4	39-57.7
E	150-09.9	149-52.3	150-29.6	150-10.4	150-00.1	150-00.4	150-26.0	135-43.1	118-12.2	116-00.3	114-57.3	114-51.5
Date	Dec14'83	Dec16'83	Dec19'83	Dec21'83	Dec26'83	Jan 9'84	Jan13'84	Jan17'84	Jan19'84	Jan22'84	Jan27'84	Jan28'84
Time	0934 -1345	1301 -1516	1522 -1752	1051 -1325	0018 -0304	0100 -0140	1615 -1818	2008 -2145	0343 -0548	0130 -0410	0045 -0310	1714 -1932
Sampling layer (m)	0-1050	0-905	0-870	0-670	0-860	0-97	0-535	0-875	0-780	0-862	0-980	0-863
COELENTERATA	2.28	38.59	59.05	12.74	71.43	0.10	19.37	39.83	89.98	39.06	5.42	2.20
CTENOPHORA						0.72						0.09
MOLLUSCA												
Pteropoda	0.03	0.09	0.10	0.04	0.24		0.07	0.03	0.32	0.88	0.02	0.01
Cephalopoda	0.46	0.49		0.04	0.22			0.04	1.17	0.66	0.23	0.69
POLYCHAETA			0.01	0.02	0.39		0.06	0.01	0.19	0.62		0.02
CRUSTACEA												
Ostracoda	0.08	0.50	0.76	0.03	0.56		0.03		0.64	0.17		+
Copepoda	0.01	0.33	+		0.01			0.01	0.22	0.04	0.01	0.04
Leptostraca											+	
Mysidacea	0.05	0.10	0.09	0.06	0.05				0.06	0.03	0.02	0.23
Amphipoda	0.17	1.60	0.10	0.02	0.28	0.03	0.10	0.03	0.45	0.25	0.30	0.79
Euphausiacea	1.03	10.79	1.22	1.50	1.86	0.22	7.58	0.58	16.96	2.21	2.87	0.79
Natantia	1.73	3.46	0.74	0.01	0.49	0.14		+	0.70	0.83	2.35	0.95
larvae	0.03	+								0.09	+	
unidentified	0.07											
CHAETOGNATHA	0.67	1.58	0.26	0.29	1.34	+	0.56	0.31	5.30	1.55	6.12	0.25
TUNICATA												
Pyrosomata	16.65					2554.85						0.12
Thaliacea	10.40	111.16	10.97	1.06	26.11	25.55	116.24	2.71	0.82	88.01	2.05	5.40
PISCES	7.22	10.42	6.53	0.98	6.93	1.64	0.99	1.93	33.48	5.26	19.55	7.28
unidentified organism	+	0.06										
Total	40.88	179.17	79.83	16.79	109.91	2583.24	144.10	45.48	150.29	139.66	38.94	18.86

1) IKMT-EMPS (oblique haul)

Distribution and abundance of amphipods and brachyuran larvae (Crustacea)

K. Muraoka

The purpose of this work is to investigate the classification, zoogeographical distribution and species composition of amphipods and brachyuran larvae in the Antarctic Ocean. The zooplankton were collected by an ORI-100 net from a total of 16 stations. The net was towed horizontally at the sea surface at two knots.

In the amphipods, the specimens were distinguished into two taxonomic groups, Gammaridea and Hyperiidea. The former was extremely slight in the number of individuals, and moreover, only two kinds of Gammarids, *Eusirus* sp. and *Gondogeneia* sp., were found. They occurred separately at Stns. PI-2 and 5 in high latitudes. The latter was quantitatively abundant at most stations. The specimens were divided into 7 species in 5 genera, and the most dominant species was a kind of hyperrid, *Parathemisto* (*Euthemisto*) *gaudichaudi*. The wet weight value was high at Stn. 6. These sampling data are shown in Table 8. In the brachyura, the larvae were taken only at Stn. 1 at night. It seems that all of these specimens are zoeae and megalops of xanthid species.

Table 8 Data on pelagic amphipods collected by surface tow with an ORI-100 net.

Station	Date	Time	Position Latitude	Position Longitude	No. of Amphipods	g in wet weight/1000m^3
1	Dec. 14	02:37-03:07	44-59.7S	150-04.7E	165	0.88
2	Dec. 16	13:14-13:44	52-08.2S	149-54.2E	0	0
2	Dec. 17	01:35-02:05	52-08.6S	149-40.3E	1136	2.78
CTD-2	Dec. 18	12:44-13:04	57-34.5S	150-05.6E	89	0.18
3	Dec. 19	17:10-17:40	61-24.8S	150-29.2E	1081	1.17
4	Dec. 22	16:12-16:42	64-57.8S	150-08.3E	0	0
4	Dec. 23	10:04-10:34	64-49.4S	150-33.9E	0	0
3-B	Dec. 26	09:26-09:56	61-22.2S	149-53.0E	53	0.06
3-B	Dec. 26	18:25-18:55	61-18.3S	150-00.6E	1823	2.09
STC-1-C	Jan. 1	02:22-02:54	46-46.7S	150-05.4E	118	1.26
PI-2	Jan. 16	23:15-23:25	64-17.6S	135-48.3E	58	0.99
5	Jan. 19	04:45-05:15	65-01.7S	118-14.7E	9	0.04
5	Jan. 20	01:03-01:33	65-05.1S	117-50.7E	159	0.65
6	Jan. 22	00:01-00:11	60-03.1S	116-04.5E	3676	58.89
7	Jan. 26	03:54-04:24	45-02.9S	115-00.6E	62	0.09
8	Jan. 28	18:34-19:04	39-56.2S	114-52.7E	352	0.77

Zooplankton sampling and a phytoplankton culture experiment conducted during the Hakuhō Maru Cruise KH-83-4

A. Kawamura

(1) Zooplankton sampling

Three different zooplankton samplings were carried out during the expedition; 1) Standard sampling with a twin NORPAC net through a vertical column from 150 m to surface (Table 9), 2) 10-minute horizontal surface tow with a larval-fish net (Table 10), and 3) Vertical divided hauls with a Discovery's N70V type closing net (Table 11). Sampling of the first two series will provide a general distribution pattern of zooplankton biomass in the upper productive layer of the Southern oceans, and also these may be expected to provide a basis for the better understanding of inter-oceanic differences in marine biological characteristics existing between the northern North Pacific and the Southern oceans. With an aim to compare the results directly with those obtained by the British Discovery Investigations (e.g. Foxton, 1956; Discovery Repts., XXVIII), the N70V net tows were carried out with a hope of observing a difference or change of zooplankton distributions which might possibly have taken place during the last half decade in accordance with considerable large-scale changes in the Antarctic ecosystems.

(2) Phytoplankton culture experiment

At eleven hydrographic stations occupied, surface phytoplankton was cultured under laboratory conditions using four kinds of culturing media enriched by the Yashima I (plus silicate), Yashima II, Guillard f/2 (plus clewat 32), and the Guillard h/2. This culture was a preliminary experiment relating the growth of phytoplankton populations under different concentrations or compositions of nutrients. The principal aim of the experiment focused on the understanding of different nutrient requirements by diatom species. If there exists specific differences in uptake characteristics, for example, the result would be expected to explain a heterogeneous distribution pattern of diatom populations on a species and/or community basis in small scale spatial areas that are often encountered in the Southern oceans (e.g. Kawamura and Ichikawa: Mem. Nat. Inst. Polar Res., in press). Since there is no appreciable data to be shown on the phytoplankton experiment obtained at this stage, details of the experiment itself were abbreviated from this report.

Table 9. Wet weight biomass of plankton collected with a twin Norpac net through 150 - 0m water column.

Station	Date	Time (LST)	Sunrise / Sunset	Location	Water column sampled (m)	Wet weight (mg/m³) XX13	Wet weight (mg/m³) GG54	Principal organisms
1	XII/13 1983	2117- 2120	0517 2041	44-59.7S 150-00.8E	150-0	96.7[1)]	78.5	Euphausiacea, Chaetognatha, Salpa sp.
2	XII/17 1983	0339- 0347	0435 2134	52-07.5S 149-38.4E		685.4[2)]	5731.9[3)]	Salpa sp. Amphipoda
CTD2-2	XII/18 1983	1132- 1140	0407 2219	57-31.6S 150-02.9E	150.1-0	1947.9	1372.7	Diatoms
4	XII/22 1983	1847- 1855	0158 2346	64-56.4S 150-12.8E		281.3	102.8	Diatoms
3-B	XII/25 1983	2252- 2300	0314 2243	61-24.8S 150-05.7E	150.4-0	1074.5	715.2	Diatoms
AC-I-C	XII/28 1983	1235- 1239	0413 2152	56-11.5S 150-05.2E	150-0	34.4	27.7	Copepoda
CTD-1-1	XII/30 1983	2020- 2028	0442	49-24.1S 149-45.6E	149.6-0	112.4	62.5	Copepoda(GG54), Chaetognatha(XX13)
STC-1-C	XII/31 1983	2027- 2033	0500 2057	46-45.9S 150-00.7E	150.3-0	216.9	101.4[4)]	Chaetognatha(GG54), Diatoms(XX13)
PI-2	I/16 1984	1411- 1419	0316 2259	64-16.3S 136-06.8E	150.4-0	121.9	76.3	Clione(GG54), Diatoms(XX13)
5	I/18 1984	2215- 2219	0400 2350	65-00.3S 117-59.5E	149.5-0	680.5	169.8	Diatoms, Copepoda(GG54), Diatoms(XXL3)
6	I/21 1984	1531- 1539	0419 2213	60-00.4S 116-02.2E	149.7-0	660.5	235.0	Diatoms, Copepoda(GG54), Diatoms(XX13)
6-1	I/23 1984	0758- 0806	0500 2147	57-29.7S 115-58.9E	150.1-0	1726.2	540.2	Diatoms
CTD-6-2	I/24 1984	1844- 1852	0535 2118	50-29.7S 114-59.3E	149.7-0	530.9	182.3	Diatoms
CTD-6-3	I/25 1984	1045- 1051	0554 2102	47-29.8S 115-00.0E	149.5-0	238.2	277.3	Chaetognatha, Copepoda
7	I/26 1984	1839- 1847	0607 2057	44-49.3S 114-54.4E	150 -0	456.7	340.7	Copepoda
8	I/28 1984	2003- 2011	0617 2043	39-54.8S 114-54.4E	150 -0	386.1	444.8	Salpa sp.

1) 4 large Pyrosoma were removed before weighing
2) 4 large Salpa sp. were removed before weighing
3) 102 large Salpa sp. were removed before weighing
4) 2 larege Chaetognaths and 1 large Pyrosoma were removed before weighing

Table 10. Wet weight biomass of zooplankton collected with a fish-larva net* in a 10-minute surface tow.

Station	Date	Time (LST)	Sunrise Sunset	Location	Wet weight (mg/m3)	Principal organisms
1	XII/14 1983	0222- 0232	0507 2042	44-59.7S 150-05.4E	26.2	Euphausiacea, Chaetognatha, Pyrosoma
2	XII/17 1983	0215- 0225	0435 2134	52-08.3S 149-38.7E	133.0	Salpa sp.
CTD-2	XII/18 1983	1223- 1238	0407 2219	57-33.4S 150-05.3E	65.0	Diatoms
3	XII/19 1983	1652- 1702	0320 2244	61-25.9S 150-29.0E	123.3	Diatoms
4	XII/22 1983	1554- 1604	0158 2346	64-58.2S 150-05.0E	4.4	Diatoms
4	XII/23 1983	1044- 1054	0211 2329	64-47.7S 150-34.6E	16.8	Diatoms
3-B	XII/26 1983	1003- 1013	0314 2244	61-21.0S 149-55.1E	19.5	Diatoms
3-B	XII/26 1983	1902- 1912	0314 2244	61-17.5S 150-01.8E	119.1	Diatoms
AC-I-N	XII/28 1983	0152- 0202	0413 2152	55-59.1S 150-10.4E	21.4	Chaetognatha, Jelly-fish
AC-I-S	XII/28 1983	2159- 2210	0413 2152	56-23.3S 149-59.2E	14.4	Chaetognatha, Copepoda, Diatoms
STC-I-C	XII/31 1983	0227- 0217	0500 2057	46-45.8S 150-05.7E	53.1	Squid larva, Euphausiacea
PI-2	I/16 1984	2222- 2232	0316 2259	64-19.6S 135-50.9E	220.3	Pteropoda, Euphausiacea
5	I/19 1984	0526- 0536	0329 2308	65-02.4S 118-16.2E	2.78	Chaetognatha, Pteropoda
5	I/20 1984	0043- 0053	0332 2238	65-04.3S 117-51.1E	26.6	Copepoda, Euphausiacea, Chaetognatha
6	I/21 1984	2342- 2352	0419 2213	60-03.2S 116-05.7E	126.9*	Pteropoda, Euphausiacea, Polychaeta
7	I/26 1984	0433- 0443	0607 2057	45-02.6S 114-59.7E	15.2	Chaetognatha, Euphausiacea
8	I/28 1984	1907- 1918	0617 2043	39-55.5S 114-53.3E	228.6	Salpa sp.

*) Unusual large 47 individuals of Salpa sp. and 2 individuals of squids were removed before weighing

Table 11. Wet weight zooplankton biomass collected with a 'Discovery' type N70V net* in a vertical divided hauls.

Station	Date	Time	Location	Estimated water column fished (m)	Plankton biomass per haul (g)	Sunrise (LST)	Sunset	Organisms removed before weighing (No. of individuals)
1	XII/14 1983	2045-2143	45-16.1S 150-21.4E	38.5 - 0	4.37	0507	2042	Jelly-fish(1) Pyrosoma(45)
				79 -47.4	3.24			
				79 -39.5	0.19			
				118.5 - 82.2	1.58			Salpa(1)
2	XII/16 1983	1730-1845	52-04.2S 149-43.1E	47.5 - 0	1.12	0441	2118	
				99.8 - 49.9	1.13			Salpa(1)
				249.9 - 99.9	5.01			Salpa(3)
				490 -245.4	7.01			Salpa(25)
4	XII/23 1983	1947-2042	64-40.6S 150-42.6E	49 - 0	7.85	0211	2329	
				99.9 - 49.9	0.76			
				245 - 98	0.07			
				492 -246	4.07			
3-B	XII/25 1983	0450-0701	61-27.1S 150-03.9E	49.3 - 0	17.22	0314	2243	
				98.8 - 0	25.0			
				99.6 - 51.8	10.12			
				248.6 - 99.5	1.12			{Chaetognatha(1) Salpa(103)
				494 -247.6	1.30			{Salpa(49) Chaetognatha(3)
				741 -494	0.03*			
				745.9 -500.2	1.49			
AC-I-C	XII/28 1983	0825-0955	56-11.4S 150-03.6E	46.7 - 0	0.85	0413	2152	
				92.7 - 49.1	0.85			Salpa(1)
				213 - 90.7	0.66			Salpa(1)
				441.5 - 219.9	2.84			
				649.5 - 433	1.43			Squid(1) Pyrosoma(1)
STC-I-C	I/1 1984	0012-0145	46-44.7S 150-05.2E	49.7 - 0	6.10	0507	2055	Chaetognatha(2)
				100 - 50	0.37			Decapoda(1)
				249.5 - 100.8	1.70			Jelly-fish(1)
				500 - 268	1.05			Decapoda(1)
				749.3 - 499.5	1.04			
PI-2	I/16 1984	1011-1154	64-10.7S 136-13.7E	49.8 - 0	2.94	0316	2259	Jelly-fish(1)
				97.4 - 46.8	1.07			
				243.5 - 97.4	1.03			
				480.5 - 244.1	1.92			
				746.3 - 497.5	0.02*			
5	I/19 1984	0607-0756	65-02.4S 118-16.9E	45.3 - 0	1.10	0329	2308	Salpa(1)
				95.6 - 46.8	2.94			
				234.9 - 94.9	1.26			
				500 - 252	1.51			
				727.5 - 491.8	61.19			Myctophids(1)
6	I/21 1984	1708-1857	60-01.2S 116-04.7E	50 - 0	4.61	0419	2213	
				99.6 - 48.8	2.61			
				248.8 - 100.5	1.30			Salpa(7)
				489 - 248.4	1.53			Chaetognatha(2)
				747 - 498	2.16			Salpa(5)
7	I/26 1984	2028-2213	44-50.2S 114-56.0E	40 - 0	1.24	0607	2057	Salpa(3) Chaetognatha(1)
				87.5- 41.1	0.82			Chaetognatha(3)
				216.5- 87.5	1.42			
				419.5- 211.4	1.58			
				599.3- 399.5	1.37			Chaetognatha(1) Jelly-fish(2)
8	I/28 1984	2145-2308	39-54.1S 114-55.5E	46.1- 0	7.49	0617	2043	Salpa(1)
				95.1- 46.6	4.87			Salpa(1)
				233.5- 117.7	1.09			
				470 - 241.6	1.05			Jelly-fish(3)
				709.5- 485.3	0.78			

*) Doubtful due to the ill working of the closing device.

Ammonium uptake measurement by the ^{15}N technique

H. Hasumoto

In the Antarctic Ocean, the relationship between the cell size of diatom and their ammonium uptake rate was studied and at the same time, the possibility of the ammonium assimilation by the intestinal bacteria including in the body of euphausiids was examined. Ammonium uptakes were measured at 4 stations in the Antarctic using a ^{15}N technique. Plankton samples were collected with ORI, IKMT and Norpac nets by surface towing and Euphausia superba, Thysanoessa macurura and Thalassiothrix antarctica were manually selected. These samples were supplemented with 0.9970 μg. at.N/ml of ^{15}N-labelled ammonium and incubated for several hours at surface water temperature under illumination with daylight fluorescent lamps at 10,000 lux. Incubation was terminated by the addition of 1 ml of 0.1 % $HgCl_2$ solution. The plankton were collected on a glass fiber filter, washed three times with filtered sea water and dried at 60°C for later mass spectrometric determination of ^{15}N.

Distribution of heterotrophic bacteria

U. Simidu, K. Kogure, K. Fukami and C. Imada

Vertical distribution of heterotrophic bacteria was surveyed at Stns. 1, 3A, 3B, 5, 6 and 7. Seawater samples were collected at several depths using Niskin bacteriological water samplers (butterfly- and chopstick-type water samplers, General Oceanics Ltd.). Total bacterial counts were determined by the direct microscopic method. Plate counts were carried out by the surface spreading method and the filter method. For the surface spreading method, water samples ranging from 0.1 to 0.5 ml were applied on agar plates of ORI medium. The composition of the ORI medium is given in Table 12. For the filter method, Nuclepore filters (General Electric Ltd.) having 0.2 μ pore size were used. The plates were incubated at 2°C and 20°C, and the colonies which developed were counted up to 30 days.

The results obtained are shown in Table 13. The results show that the surface spreading method gave much higher colony numbers than the filter method. However, the accuracy of the surface spreading method is limited since only a few colonies developed on the plates for the samples of deeper water layers. A remarkable feature of the bacterial population of the Antarctic seawater is that it gives fairly high proportions of plate counts compared with total counts. This feature was particularly clear for the samples from surface water layers of Stn. 5. The result suggests that most of the heterotrophic bacteria in these water layers are in the actively growing state. Another feature is that most of the bacteria in the Antarctic waters could not grow at the higher temperature of 20°C.

Clearly the bacterial population of the Antarctic Ocean is more psychrophilic in nature than the bacteria from the northern sampling stations (Stns. 1 and 7).

The dominant bacteria in the Antarctic waters were red- or yellow-pigmented species. Detailed taxonomical studies on the isolated strains are now in progress.

Table 12. Composition of ORI medium

Proteose Peptone No.3(Difco)	1,000 mg
Bacto Yeast Extract(Difco)	1,000
Phytone(BBL) ------------	500
Ferric citrate ------------	40
Sodium thiosulfate -------	200
Sodium sulfite ---------	50
Bacto Agar(Difco) ------	15.0 g
Aged seawater ---------	900 ml
Distilled water ---------	100

Table 13. Bacterial numbers in seawater.
TC: total counts, PC: plate counts,
spr: surface spread method.

St 1

depth	TC	PC 2°	PC 20°
0 m	2.2×10^{6}	1.0×10^{0}	2.6×10^{1}
100	5.8×10^{5}	1.0×10^{-1}	1.7×10^{1}
200	3.5×10^{5}	2.4×10^{-1}	5.5×10^{0}
300	1.6×10^{5}	1.6×10^{-1}	1.5×10^{1}
500	8.0×10^{5}	3.0×10^{-2}	1.2×10^{1}
800	2.2×10^{5}	1.9×10^{-1}	3.9×10^{0}
1400	1.3×10^{5}	1.9×10^{-1}	3.6×10^{0}
2000	4.1×10^{5}	1.6×10^{-1}	1.5×10^{0}

St 3A

depth	TC	PC 2°	PC 20°
0 m	9.5×10^{4}	2.1×10^{1}	6.7×10^{-1}
20	1.3×10^{5}	1.8×10^{1}	5.0×10^{-1}
100	9.3×10^{4}	2.4×10^{1}	6.4×10^{-1}
200	7.4×10^{4}	4.5×10^{0}	1.7×10^{0}
300	7.1×10^{4}	2.8×10^{0}	5.6×10^{0}
500	5.4×10^{4}	2.5×10^{0}	7.8×10^{-1}
800	1.3×10^{5}	1.4×10^{1}	1.3×10^{-1}
1200	7.9×10^{4}	5.2×10^{0}	4.2×10^{-1}
1500	4.0×10^{4}	6.8×10^{-1}	1.0×10^{-2}

St 3B

depth	TC	PC 2°	PC 20°
0 m	1.1×10^{5}	3.0×10^{0}	3.7×10^{0}
20	1.6×10^{5}	5.8×10^{0}	4.4×10^{0}
50	1.0×10^{5}	4.6×10^{0}	2.1×10^{1}
75	1.1×10^{5}	1.1×10^{0}	2.0×10^{0}
100	9.9×10^{4}	4.0×10^{0}	1.4×10^{1}
125	1.1×10^{5}	1.1×10^{1}	2.0×10^{0}
150	9.8×10^{4}	2.9×10^{1}	1.0×10^{2}
200	6.2×10^{4}	1.2×10^{1}	1.5×10^{1}
500	6.3×10^{4}	4.5×10^{1}	4.7×10^{0}

St 5

depth	TC	PC 2°	PC 2°(spr)	PC 20°
0 m	3.7×10^{5}	4.3×10^{1}	1.1×10^{3}	3.4×10^{-1}
20	3.6×10^{5}	3.6×10^{1}	1.8×10^{3}	1.0×10^{-1}
100	4.5×10^{5}	3.4×10^{1}	3.1×10^{2}	1.3×10^{0}
150	2.7×10^{5}	3.2×10^{1}	3.3×10^{2}	1.1×10^{0}
300	2.8×10^{5}	2.9×10^{1}	1.0×10^{3}	7.0×10^{-1}
500	2.3×10^{5}	2.7×10^{1}	2.1×10^{2}	2.6×10^{-1}
1400	8.6×10^{4}	5.6×10^{0}	2.1×10^{1}	1.1×10^{0}
2000	6.3×10^{4}	1.3×10^{0}	2.6×10^{1}	2.3×10^{0}

St 6

depth	TC	PC 2°	PC 2°(spr)	PC 20°
0 m	1.9×10^{5}	6.5×10^{0}	2.8×10^{2}	2.6×10^{0}
20	1.5×10^{5}	2.5×10^{0}	2.3×10^{2}	4.8×10^{-1}
50	2.8×10^{5}	2.1×10^{0}	1.4×10^{2}	
100	1.8×10^{5}		2.0×10^{1}	0.4×10^{-2}
200	1.3×10^{5}	7.6×10^{-1}	5.0×10^{0}	4.4×10^{-1}
300	1.2×10^{5}		1.5×10^{1}	2.0×10^{-2}
500	1.2×10^{5}	5.5×10^{-1}	1.3×10^{1}	7.0×10^{-2}
800	1.4×10^{5}	9.0×10^{-1}	4.0×10^{1}	6.3×10^{-1}
1400	8.6×10^{4}	5.9×10^{-1}		9.9×10^{-1}

St 7

depth	TC	PC 2°	PC 20°
0 m	1.4×10^{6}	1.7×10^{0}	1.7×10^{1}
20	1.4×10^{6}	3.0×10^{0}	5.0×10^{0}
50	1.6×10^{6}	7.5×10^{0}	5.0×10^{0}
100	6.6×10^{5}	3.4×10^{0}	5.9×10^{0}
150	4.5×10^{5}	7.2×10^{0}	6.9×10^{0}
200	2.3×10^{5}	2.6×10^{0}	4.6×10^{0}
300	2.5×10^{5}	1.6×10^{0}	3.0×10^{0}
500	3.0×10^{5}	9.2×10^{-1}	2.0×10^{0}
800	1.1×10^{5}	2.0×10^{-1}	1.0×10^{0}
1400	9.3×10^{4}	2.2×10^{0}	4.1×10^{0}
2000	7.1×10^{4}	2.9×10^{-1}	3.5×10^{-1}

Bacterial abundance and production rate in the Antarctic Ocean

K. Kogure, K. Fukami and U. Simidu

Among living organisms in natural seawater, bacteria play a major role in decomposing organic matter and regenerating nutrients, which in turn are utilized by phytoplankton. Bacteria are also regarded as food sources for protozoa or small zooplankton. Therefore, the estimation of their abundance and production rate is important to clarify the processes in the natural ecosystem. Bacterial production rates are directly related to the decomposition rate of organic matter present. The purpose of this investigation is to clarify the abundance and growth rate of bacterioplankton in the Antarctic Ocean.

Bacterial numbers were obtained by the epifluorescence microscopic technique (Hobbie et al., 1977). The bacterial growth rate was measured by the (3-H) labelled thymidine uptake method (Fuhrman et al., 1982). In brief, the sample seawater (20 ml) was incubated with (methyl-3H) thymidine (5 nM) at the ambient temperature for 4 to 6 hrs on board. The sample was then chilled in ice-water and added to cold trichloroacetic acid (TCA, final conc. 5 %). Most samples were incubated at 0°C, so TCA was added just after incubation. After 5 minutes, the sample was filtered through a Millipore GS filter (pore size 0.22 μm) and rinsed at least 3 times with ice-cold 5 % TCA solution. The radioactivity of the filter was counted by a LKB Wallace liquid scintillation counter.

Results are shown in Table 14. The number of bacteria was about $3x10^8$ cells/l. The number decreased with depth but was rather constant horizontally. The production rate was about 3.4×10^7 cells/l/day. So the apparent doubling time of bacteria in the Antarctic was up to ten days in the surface water, which was as high as that obtained in the equatorial area during the cruise. As a conclusion, bacterial production rate is rather high and comparable with those in other marine environments. Bacteria are well adapted to the low-temperature environment and the coldness cannot be the limiting factor for them. By comparing the biological data of the cruise, the significance and contribution of the bacterial population will be clarified.

Table 14. Bacterial numbers and production rate in the Antarctic.

Station	Temp.	T.C.*	cells** produced	doubling time(day)
1	13	220	52	3.2
2	8	54	3.6	10
CTD-2-2	3	26	5.2	3.8
3A- 0m	0	9.5	3.3	2.3
- 100m	0	9.3	3.7	2.1
- 200m	0	7.4	0.72	7.3
- 300m	0	7.1	0.16	35
3N	3	43	3.9	7.3
3N-2	3	52	5.3	7.3
PI-2'	0	27	2.2	9.0
CTD-6-2'	6.5	68	5.7	9.0
STCII-S	11.5	120	8.5	10
STCII-C	12.5	76	(3.5)	-
STCII-N	12.5	86	6.1	10
leg4-1	30	76	2.2	24
leg4-2	26.5	74	2.7	18

*Total count: $\times 10^7$ cells/l
**Cells produced: $\times 10^7$ cells/l/day

Decomposition of chitin by bacteria

K. Fukami and U. Simidu

Decompsotion of chitin by the Antarctic microorganisms was investigated under laboratory conditions. Flakes of chitin were prepared from the exoskeleton of the Antarctic krill, *Euphausia superba* (BL about 3 cm). Two types of chitin flake, "crude chitin" and "pure chitin", were used for the decomposition experiment. "Crude chitin" is the one on which there still remains a small amount of protein. "Pure chitin" is the one from which the protein is almost completely removed by soaking in 1 N NaOH solution. Into bottles containing 7.0 mg dry weight of either type of chitin flake, 100 ml of sample seawater was added. The seawater was collected at 20 m depth of Stn. PI-2 (64°17'S, 136°06'E). Each sample was incubated at 2°C in the dark. At time intervals, the bottles were opened one by one and the samples were used for the chemical and microbiological analyses.

Fig. 23 shows the decrease of the dry weight of chitin. "Crude chitin" was decomposed rapidly during the 10th to the 20th day, and the dry weight of chitin remained almost constant after the 60th day. After 2 months, about 80 % of "crude chitin" initially present was decomposed or solubilized. On the other hand, decomposition of "pure chitin" was much slower than that of "crude chitin" and it had a long lag time before the decomposition process started. After the 20th day, the dry weight of chitin decreased gradually until the 60th day. However, only less than 30 % of initial weight of "pure chitin" was decomposed after 121 days.

Fig. 24 shows the fluctuation of the viable count of bacteria attached to the chitin flake. Along with the rapid decrease of the weight of "crude chitin", the number of bacteria increased sharply until the 30th day. In the experiment using "pure chitin", however, the growth of bacteria was not as fast as that of "crude chitin" until the 15th day, which coincided with the lag time of the apparent decomposition of chitin.

During the observation of the decomposition process, the community of attached bacteria changed remarkably. Table 15 indicates the fluctuation of the chromogenic bacteria. Although the orange-yellow pigmented bacteria predominated when the decomposition was still in lag phase, colorless white bacteria occupied almost all the colonies as the decomposition proceeding. Detailed study of this problem is under investigation.

From the results of the experiment, it is suggested that the exoskeleton of the krill is decomposed within 1 or 2 months even at the lower temperature of the Antarctic Ocean, and the decomposition rate is promoted if the chitinous exoskeleton contains some protein. In addition, the decomposition of chitin was mainly due to the characteristic community of bacteria.

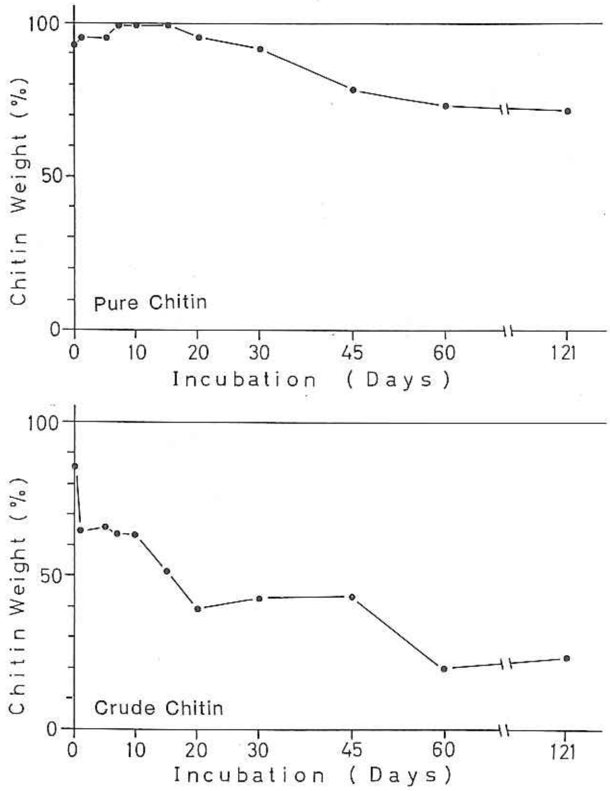

Fig. 23.

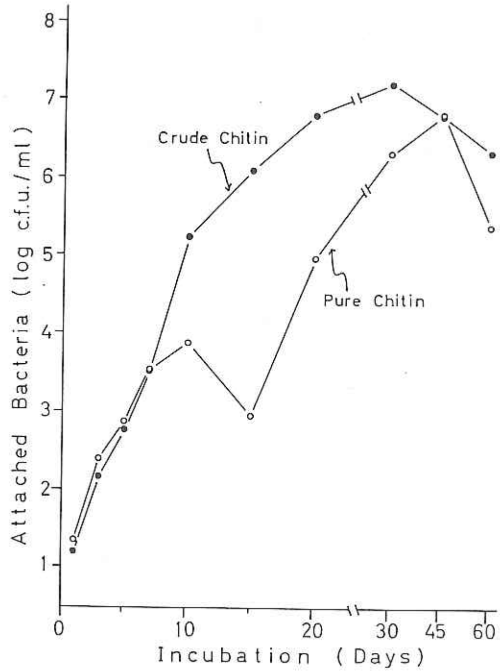

Fig. 24.

Table 15. Percentage of chromogenic bacteria during the decomposition of chitin

Days	Crude Chitin		Pure Chitin	
	Attached	Free-living	Attached	Free-living
0	—	67.5	—	67.5
1	27.3	40.3	37.5	64.8
3	100	54.2	11.8	71.1
5	25.0	62.0	20.0	92.9
7	27.3	79.7	90.9	87.8
10	0	67.8	57.7	72.0
15	0	3.5	4.8	61.9
20	0	≒0	0	0
30	0	11.1	0	28.6
45	0	11.3	0	0.4
60	2.0	9.1	2.4	50.0

Assimilation activity of bacteria in the Antarctic Ocean

K. Fukami and U. Simidu

Assimilation activity of the Antarctic bacteria was investigated. A small amount (0.1 μCi=48 ng amino acid) of uniformly labelled ^{14}C-amino acid mixture (RCC Amersham) was added to a 40 ml seawater sample and incubated at in situ temperature for 4 to 6 hrs. The samples were then filtered with Millipore GS (pore size 0.22 μm) filters to measure the total assimilation activity. The activity of attached bacteria was determined by filtering seawater samples with 5.0 μm Millipore filters.

The result (Table 16) shows that the assimilation activity of the Antarctic bacteria was equivalent to or higher than that in tropical seawater (Stn. Leg 4-1). Turn over times (Tt) of the amino acid in the Antarctic Ocean were usually less than 20 days at the surface layer. The high activity of bacteria, however, was only observed in the upper 100 m, and below 100 m the activity was quite low. This result is consistent with the tymidine incorporation activity.

In the Antarctic region, the contribution of attached bacteria to the total assimilation activity was considerably high; it reached more than 50 % of total activity. Although the number of attached bacteria (A), which was determined by the epifluorescence microscopic method, made up only a few percent of the total bacterial (T) number, the activity of attached bacteria was quite high. This result suggests that the attached bacteria have a much higher per-cell specific activity than that of free-living bacteria. However, moving north from the Antarctic region, the assimilation activity of attached bacteria gradually decreased. The percentage of attached bacterial activity to the total activity was about 10 % in the tropical region.

These results suggest that even in the low temperature environment of the Antarctic Ocean, bacteria have a heterotrophic activity as high as those in the tropical region, with attached bacteria making a significant contribution to the decomposition of organic matter.

Table 16.

Stn.	depth	Temp*	DPM			Cell Number**			Tt
	(m)	(°C)	A	T	A/T***	A	T	A/T***	(days)
3B	0	0	1982	3479	57.0	4.4	110	4.2	20.2
	20	0	2044	5781	34.8	4.1	160	2.6	12.1
	50	0	202	2387	8.5	4.6	100	4.5	29.4
	100	0	249	390	63.8	5.7	99	5.8	180
	500	0	107	312	34.3	1.9	63	3.0	225
3N	0	3	3247	5160	62.9	16	430	3.7	13.6
PI-2´	0	0	1946	3827	50.8	4.9	270	1.8	18.3
CTD6-2´	0	6.5	2655	5557	47.8	16	680	2.3	12.6
STCII-S	0	11.5	1642	12794	12.8	19	1200	1.6	5.48
STCII-C	0	12.5	2026	8357	24.2	12	760	1.6	8.39
STCII-N	0	12.5	1309	6582	19.9	9.8	860	1.1	10.7
Leg4-1	0	30	515	3737	13.8	8.4	760	1.1	18.8
Leg4-2	0	26.5	2258	16211	13.9	12	740	1.7	4.32

*: Incubation Temperature

**: $\times 10^3$ cells/ml

***: Attached/Total (%)

Physio-ecological study on oligotrophic bacteria in the Antarctic Ocean

M. Eguchi and Y. Ishida

We made an attempt to make clear some of the ecological significance of heterotrophic bacteria in the Antarctic Ocean. The distribution and activity of the oligotrophic bacteria, a dominant population in oligotrophic waters (Ishida and Kadota, 1979, 1980, 1981), were determined by ^{14}C-MPN method, an extremely low nutrient medium containing five kinds of ^{14}C-labelled compounds (glutamate, glucose, acetate, glycolate and glycine).

The number of heterotrophs in surface waters ranged from 1.7×10^2 to 2.4×10^4 cells/ml, which were dominantly occupied by the obligate oligotroph. According to size fractionation of surface water, the oligotrophic bacteria were likely to be in the free living state. They preferred glutamate and glycine to glucose, and preferred glycolate and acetate less. The *in situ* uptake experiments using ^{14}C-labelled organic compounds showed that the uptake rates of glutamate and glycine were considerably high in all cases, as compared with those of glycolate and acetate.

Further ecological and physiological studies of the oligotrophic bacteria are being continued now.

Acoustic survey of Antarctic krill and other organisms

T. Inagaki, K. T. Lee and T. Aoyama

(1) Introduction

To investigate the distribution and the abundance of Antarctic krill, _Euphausia superba_ Dana, was one of the most important subjects of the SIBEX expedition. In this investigation, the acoustic survey was a very useful method, because we were able to search over a large area during a short period.

The subjects of the acoustic survey in this cruise were as follows.

a. Distribution of krill on a large scale

b. Distribution of krill on a small scale

c. Comparative observations of the characteristics of echo scattering between krill and other organisms

d. Frequency comparisons of the characteristics of echo scattering between krill and other organisms in the 50 to 200 KHz range

(2) Materials and methods

The acoustic system used in the cruise was composed of the following equipment.

a. Scientific echo sounder FQ 50 Furuno

b. Data processor FQ 570 Furuno

c. Color video sounder Furuno

This system can calculate the mean scattering volume strength (SV dB/m^3) automatically in real time at each specified depth range and each ship's log interval. The output is printed out on a line printer and transferred onto a 5 inch disket. At the same time, the scattering profile is displayed on a color CRT with 6 colors corresponding to the intensity of reflected sounds.

On November 11, 1983, the electric calibration of this system was carried out, before leaving Tokyo, on such items as the source level radiated and the transformer efficiency of the transducer. The setting condition of the system for standard operation is shown in Table 17.

The survey course on a large scale is shown in Fig. 25, and an example of a small scale one in Fig. 26. A parallel grid survey method (course length 4 n. mile, spacing interval 1 n. mile) was adopted for the small scale survey. Some IKMT net haulings followed the echo survey in order to confirm which organisms constituted the main source of scattering.

(3) Some results

The values of SV derived were stored on 23 diskets together with the time and ship's position, course and speed.

Fig. 26 shows an example of results of the grid survey at 200 KHz carried out near 65°S and 140°E. The bottom gradient in the area was relatively large. The shallower part was located in the southern region, and the deeper part located in the northern region.

Depth range of the system was set from 0 to 200 m. Many scattering layers appeared between the 10 to 100 m layers, but only a few layers appeared in the deeper range.

IKMT nets were towed zigzag between 0 and 100 m three times and it was found that main organism of scattering was krill.

In Fig. 26, the plotted value on the ship's course shows the mean SV. The vertical and horizontal scale of the unit section proccessed are 90 m (from 10 to 100 m) and 0.2 n. mile respectively.

Most of the scatterers formed "aggregations", and it was recognized that "patches" smaller than 30 m in width were mixed in the "aggregations" in the deeper region. The high SV value, i.e. high density of krill, appeared in regions between 300 and 400 m in depth. The SV level was generally low in other regions, and in regions shallower than 300 m, scatterers appeared very rarely.

Table 17. Setting condition of the system for standard operation.

Frequency	: 50 and 200 KHz
Depth range	: 0 200 m
Pulse duration	: 0.6 msec.
Sounding ratio	: 75 pulse/min.
Attenuator(gain)	: 0 or 10 dB
Horizontal integral interval	: 0.2 n.mile
No. of vertical integral layers	: 10 layers(20 m interval)

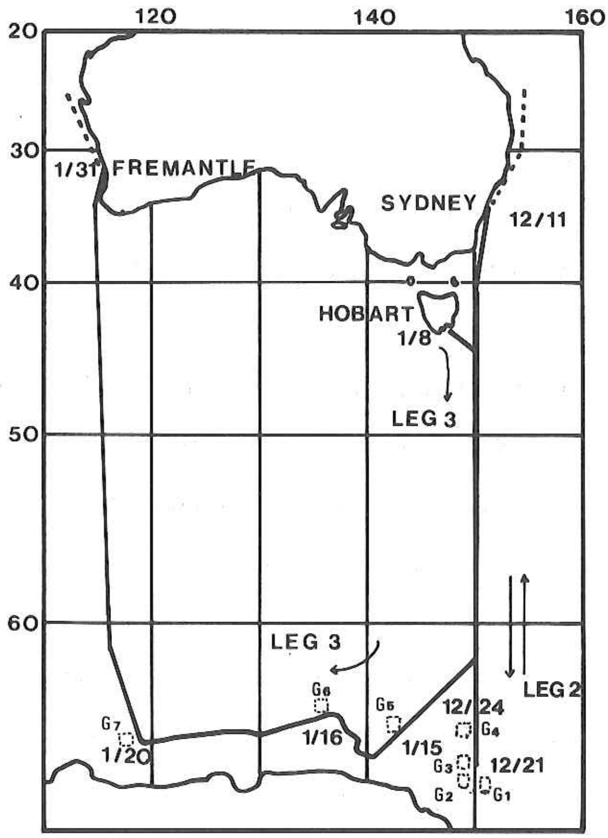

Fig. 25. The cource of acoustic survey by the system:
Solid line shows cource of large scale survey, dotted area (G1～G7) shows area of small scale survey.

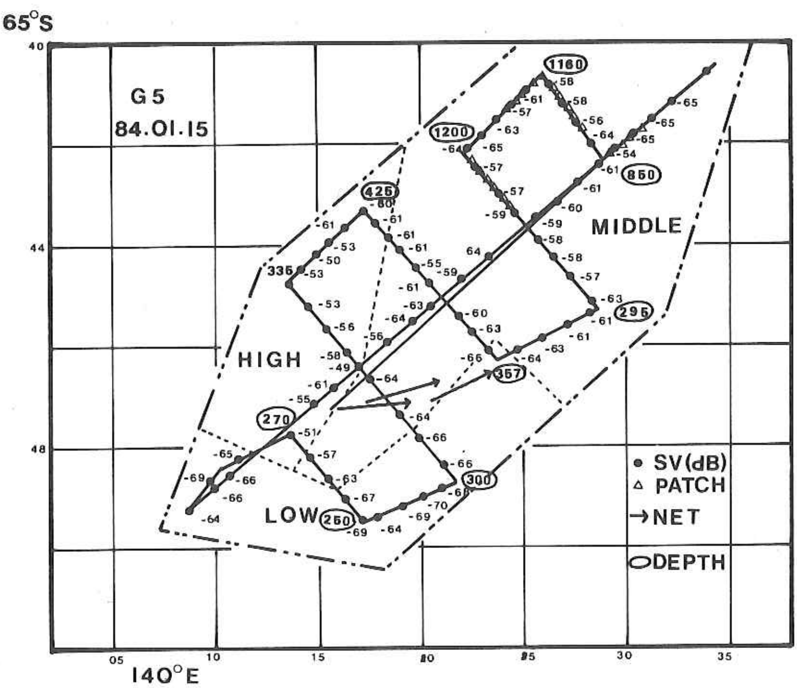

Fig. 26. Results of the grid survey at 03:00 to 11:30 (JST+1) on 15th January 1984.

Sighting records of sea birds

Y. Tanaka, K. Nanba, Y. Kaneko and S. Suzuki

Observations on sea birds were made on the Hakuhō Maru during the period from November 22, 1983 to February 24, 1984, especially during December 11 to January 31, we have observed continuously for ten minutes every four hrs in the Southern Ocean as a survey of sea birds in the BIOMASS programme.

A total of 62 species were observed during the whole period (Table 18); 21 species in the northern hemisphere, 46 species in the southern hemisphere, and 37 species in the Subtropical, Subantarctic and Antarctic regions.

Table 19 shows the latitudinal distribution of the species and the number of sea birds, and Table 20, the northernmost and southernmost occurrences of the principal species of sea birds on the 150°E and 120°E lines. As shown in Table 19, Puffinus tenuirostris which were observed in Storm Bay of Tasmania were the most abundant in number, Puffinus griseus occurred in all areas and were predominant in the section of 55°S to 60°S. Fulmarus glacialoides, Thalassoica antarctica, Pagodroma nivea and Sterna paradisaea were found within the limits of 60°S and southward to the border of the pack ice (Tables 19, 20). While the ship proceeded westward from 150°E to 120°E, Diomedea melanophris, Phoebetria palpebrata, Macronectes giganteus, F. glacialoides, T. antarctica, Daption capense, P. nivea, Pterodroma inexpectata, Pachyptila spp., P. griseus, Oceanites oceanicus, Fregetta tropica, S. paradisaea and Catharacta maccormicki were sighted on the border of the pack ice.

Two points which should be emphasized were: 1) *P. palpebrata* were found in large numbers in areas between 60°S and 65°S, particularly in flocks consisting of more than 100 individuals at 63°40'S, 150°50'E on December 24. In these areas there were many patches of krill, and these birds were frequently found feeding or resting. 2) Only 7 individuals of *P. nivea* were recorded. Among them, one was readily attracted by the ship at 61°27'S, 150°04'E on December 25, it flew around the ship and occasionally showed a behavior of feeding and resting on the sea surface during 2 hrs of observation.

On this expedition, we have observed 11 species of the genus *Pterodroma*: *P. hypoleuca*, *P. externa cervicalis* and *P. nigripennis* in the northern hemisphere, *P. rostrata* and *P. cooki* in the vicinity of Eastern Australia, *P. solandri* and *P. leucoptera* in the Tasmanian waters, *P. lessoni* and *P. inexpectata* in areas from 43°S to 65°S, *P. mollis* along a course on 120°E, and *P. macroptera* in the northern part of the Subtropical waters adjacent to Western Australia. The relationship between observed numbers of the genus *Pterodroma* and surface water temperatures are shown in Table 21. *P. hypoleuca*, *P. e. cervicalis*, *P. nigripennis* and *P. rostrata* were found in the Tropical and Subtropical waters where surface water temperatures ranged from 22°C to 27°C. However, we could see only small numbers of these species, because it was the breeding season. *P. solandri* and *P. leucoptera* were found in areas whose temperatures were 13-17°C. *P. lessoni* and *P. inexpectata* were observed in waters colder than 14°C, that is, *P.*

lessoni was distributed in areas between the southern part of Subtropical Convergence and the northern part of Antarctic Convergence. Especially, the highest density was in waters of 11°C along 120°E, and P. inexpectata were particularly abundant in waters of approximately 0°C and found to be solitary on the border of the pack ice.

Table 18 List of the scientific and common names of sea birds observed during this expedition.

Diomedeidae	
Diomedea immutabilis	Laysan albatross
Diomedea nigripes	Black-footed albatross
Diomedea exulans	Wandering albatross
Diomedea melanophris	Black-browed albatross
Diomedea cauta	White-capped albatross
Diomedea chrysostoma	Gray-headed albatross
Diomedea chlororhynchos	Yellow-nosed albatross
Phoebetria palpebrata	Light-mantled sooty albatross
Phoebetria fusca	Sooty albatross
Procellariidae	
Macronectes giganteus	Southern giant petrel
Macronectes halli	Northern giant petrel
Fulmarus glacialoides	Southern fulmar
Thalassoica antarctica	Antarctic petrel
Pagodroma nivea	Snow petrel
Daption capense	Cape pigeon
Calonectris leucomelas	Streaked shearwater
Pterodroma hypoleuca	Bonin petrel
Pterodroma nigripennis	Black-winged petrel
Pterodroma externa cervicalis	White-necked petrel
Pterodroma macroptera	Great-winged petrel
Pterodroma lessoni	White-headed petrel
Pterodroma mollis	Soft-pulmaged petrel
Pterodroma inexpectata	Mottled petrel
Pterodroma solandri	Solander's petrel
Pterodroma rostrata	Tahiti petrel
Pterodroma leucoptera	White-winged petrel
Pterodroma cooki	Cook's petrel
Pachyptila spp.	Prions
Halobaena caerulea	Blue petrel
Procellaria aequinoctialis	White-chinned petrel
Procellaria cinerea	Gray petrel
Puffinus griseus	Sooty shearwater
Puffinus tenuirostris	Short-tailed shearwater
Puffinus carneipes	Pale-footed shearwater
Procellariidae	
Puffinus pacificus	Wedge-tailed shearwater (Lt.ph.)
Puffinus pacificus	Wedge-tailed shearwater (Dk.ph.)
Puffinus assimilis	Little shearwater
Puffinus nativitatis	Christmas shearwater
Bulweria bulwerii	Bulwer's petrel
Hydrobatidae	
Oceanodroma tristrami	Sooty storm-petrel
Oceanites oceanicus	Wilson's storm-petrel
Fregetta tropica	Black-bellied storm-petrel
Fregetta grallaria	White-bellied storm-petrel
Pelagodroma marina	White-faced storm-petrel
Pelecanoididae	
Pelecanoides spp.	Diving petrels
Phaethontidae	
Phaethon lepturus	White-tailed tropicbird
Phaethon rubricauda	Red-tailed tropicbird
Sulidae	
Sula leucogaster	Brown booby
Sula sula	Red-footed booby
Sula dactylatra	Blue-faced booby
Sula serrator	Australasian gannet
Fregatidae	
Fregata minor	Great frigatebird
Fregata ariel	Lesser frigatebird
Phalaropodidae	
Phalaropus fulicarius	Gray phalarope
Stercorariidae	
Stercorarius pomarinus	Pomarine skua
Catharacta maccormicki	South polar skua
Catharacta antarctica	Brown skua
Laridae	
Sterna fuscata	Sooty tern
Gygis alba	White tern
Anous stolidus	Brown noody
Anous tenuirostris	Black noody
Sterna paradisaea	Arctic tern

Table 19 Latitudinal distribution of the species and the number of sea birds that occurred during ten minutes every four hours in the Southern Ocean.

Species	Latitude (°S)							
	35-40	40-45	45-50	50-55	55-60	60-65	65-70	Total
Diomedea exulans	8	25	53	21	4			111
Diomedea melanophris	4	4	24	14	1	100	3	150
Diomedea cauta		14	12					26
Diomedea chrysostoma		2		1	1	1		5
Diomedea chlororhynchos	5							5
Phoebetria palpebrata			9	1	4	181	9	204
Phoebetria fusca			1					1
Macronectes giganteus		4	7	10	7	45	32	105
Fulmarus glacialoides						78	27	105
Thalassoica antarctica						352	235	587
Daption capense		1	3	1	5	145	20	175
Pagodroma nivea						1		1
Pterodroma macroptera	7	3						10
Pterodroma lessoni		9	17	22	5	8		61
Pterodroma mollis	1			1		1		3
Pterodroma inexpectata			5	6	12	73	18	114
Pterodroma solandri	6	2						8
Pterodroma leucoptera		8	1					9
Pachyptila spp.		140	49	21	75	439	1	725
Procellaria aequinoctialis	8	9	54	15	2	1		89
Procellaria cinerea			1					1
Puffinus griseus	4	66	176	421	5978	1305	752	8702
Puffinus tenuirostris		13000	7					13007
Puffinus carneipes	2							2
Puffinus pacificus	2							2
Oceanites oceanicus		4	12	1	1	10	1	29
Fregetta tropica		12	8	11	22	12	6	71
Fregetta grallaria		6	1					7
Pelagodroma marina	4							4
Pelecanoides spp.			1	1	5	1		8
Catharacta antarctica			1					1
Sterna paradisaea						1		1

Table 20 The northernmost and southernmost occurrences of the principal species.

Species	Northernmost occurrence			Southernmost occurrence		
	Date	Position	Sea temp.	Date	Position	Sea temp.
D. exulans	Dec. 6, 1983	31°-51'S 153°-09'E	23.7°C	Dec. 20, 1983	61°-33'S 150°-23'E	0.1°C
	Jan. 28, 1984	39°-55'S 114°-51'E	15.4	Jan. 24, 1984	53°-09'S 115°-06'E	5.2
D. melanophris	Dec. 12, 1983	38°-03'S 150°-17'E	15.6	Dec. 21, 1983	65°-34'S 150°-10'E	- 1.1
	Jan. 27, 1984	43°-28'S 114°-55'E	12.1	Jan. 15, 1984	65°-26'S 138°-30'E	- 0.3
				Jan. 25, 1984	47°-34'S 114°-58'E	9.5
D. cauta	Jan. 8, 1984	43°-15'S 147°-31'E	16.5	Dec. 16, 1983	52°-03'S 150°-02'E	6.0
	Jan. 24, 1984	50°-50'S 115°-00'E	5.8	Jan. 24, 1984	51°-13'S 115°-00'E	6.0
D. chrysostoma	Dec. 17, 1983	52°-07'S 149°-37'E	7.2	Dec. 18, 1983	57°-31'S 150°-00'E	2.2
	Jan. 27, 1984	44°-43'S 114°-55'E	11.6	Jan. 21, 1984	61°-39'S 116°-39'E	1.4
D. chlororhynchos	Jan. 28, 1984	39°-55'S 114°-51'E	15.4	Jan. 28, 1984	41°-48'S 114°-52'E	14.1
P. palpebrata	Dec. 31, 1983	47°-18'S 150°-01'E	10.2	Dec. 22, 1983	65°-36'S 150°-10'E	- 1.3
	Jan. 28, 1984	41°-09'S 114°-51'E	14.3	Jan. 15, 1984	65°-20'S 138°-58'E	- 0.3
				Jan. 20, 1984	64°-55'S 117°-56'E	0.4
P. fusca	Jan. 26, 1984	44°-54'S 114°-58'E	11.5	Jan. 25, 1984	46°-33'S 115°-00'E	10.9
M. giganteus	Jan. 8, 1984	43°-30'S 147°-54'E	17.0	Dec. 22, 1983	65°-31'S 149°-56'E	- 1.1
	Jan. 27, 1984	44°-09'S 114°-55'E	11.8	Jan. 15, 1984	65°-33'S 139°-32'E	- 0.7
				Jan. 19, 1984	65°-03'S 118°-02'E	0.4
F. glacialoides	Dec. 24, 1983	62°-53'S 150°-30'E	0.7°C	Dec. 21, 1983	65°-34'S 150°-10'E	- 1.1°C
	Jan. 20, 1984	64°-55'S 117°-59'E	0.7	Jan. 15, 1984	65°-40'S 140°-35'E	- 0.9
				Jan. 20, 1984	65°-00'S 118°-01'E	0.5
T. antarctica	Dec. 26, 1983	61°-18'S 150°-00'E	0.5	Dec. 21, 1983	65°-34'S 150°-10'E	- 1.1
	Jan. 20, 1984	64°-32'S 117°-50'E	0.5	Jan. 15, 1984	65°-45'S 140°-26'E	- 0.5
				Jan. 19, 1984	65°-03'S 118°-02'E	0.4
D. capense	Dec. 13, 1983	44°-20'S 149°-58'E	14.2	Dec. 22, 1983	65°-07'S 149°-50'E	- 0.3
	Jan. 20, 1984	64°-32'S 117°-50'E	0.5	Jan. 15, 1984	65°-45'S 140°-26'E	- 0.5
				Jan. 20, 1984	65°-03'S 118°-02'E	0.7
P. nivea	Dec. 25, 1983	61°-27'S 150°-04'E	0.6	Jan. 17, 1984	64°-55'S 129°-36'E	- 0.6
P. aequinoctialis	Dec. 12, 1983	38°-32'S 150°-17'E	14.7	Dec. 26, 1983	61°-26'S 149°-52'E	0.5
	Jan. 28, 1984	41°-09'S 114°-51'E	14.3	Jan. 24, 1984	52°-20'S 115°-01'E	4.7
O. oceanicus	Dec. 13, 1983	44°-34'S 149°-59'E	14.1	Dec. 22, 1983	65°-00'S 149°-40'E	- 0.3
	Jan. 27, 1984	44°-02'S 114°-55'E	11.8	Jan. 17, 1984	64°-56'S 129°-39'E	- 0.6
				Jan. 19, 1984	65°-03'S 118°-02'E	0.4
F. tropica	Jan. 8, 1984	44°-05'S 148°-41'E	15.3	Dec. 23, 1983	64°-42'S 150°-41'E	0.0
	Jan. 27, 1984	43°-16'S 114°-55'E	12.2	Jan. 19, 1984	65°-03'S 118°-02'E	0.4
F. grallaria	Dec. 30, 1983	49°-59'S 150°-00'E	8.4	Jan. 13, 1984	60°-11'S 149°-50'E	1.0
	Jan. 27, 1984	43°-47'S 114°-55'E	12.1	Jan. 26, 1984	45°-02'S 114°-59'E	11.5

Table 21 The relationship between observed numbers of the genus *Pterodroma* and surface water temperatures.

	P. solandri	P. leucoptera	P. lessoni	P. inexpectata
- 2.0°C				1
- 1.0				74
0.0			8	131
1.0			2	29
2.0			14	23
3.0			6	11
4.0			12	10
5.0			31	8
6.0			25	17
7.0			5	
8.0			5	16
9.0			35	26
10.0			16	3
11.0			78	2
12.0			12	
13.0	1	19	11	5
14.0	16	15	7	2
15.0				
16.0				
17.0		45		
18.0				

	P. hypoleuca	P. e. cervicalis	P. nigripennis	P. rostrata
20.0°C				
21.0				
22.0	3			
23.0				
24.0				13
25.0				10
26.0				
27.0	26	10	46	
28.0				
29.0				
30.0				

Gravimetry and bathymetry

M. Hashiguchi

Gravity measurement at sea was carried out by use of the equipment described below.

Gravity meter system: T.S.S.G.

Gravity meter: Model Z-68-7-14 (string type)

Vertical gyro: Model 82-A (a pair of single freedom gyros)

Data processing system: Model 76-1 (0.05 sec. sampling rate)

Position fixing: Loran C, NNSS

Fig. 27 shows an example of profiles of gravity anomalies and topography over a seamount (46°20'S, 150°E).

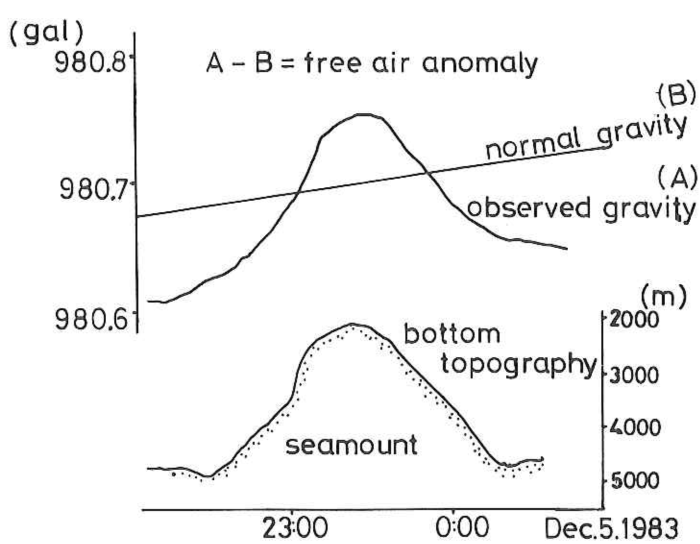

Fig. 27. An example of profiles of gravity anomalies and topography over a seamount (46°20'S, 150°E).

Table 22 Particulate organic carbon (POC), nitrogen (PON) and their ratio (C/N).

Stn-1

Depth (m)	POC (µg/l)	PON (µg/l)	C/N
0	231	30.4	7.60
10	149	25.3	5.89
20	129	23.5	5.49
30	112	21.1	5.31
50	44.0	8.08	5.45
75	29.7	4.68	6.35
100	27.7	4.00	6.93
125	24.1	3.35	7.19
150	29.8	3.49	8.54
175	19.9	2.32	8.58
200	23.9	3.02	7.91
288	7.93	0.883	8.98
481	6.31	0.522	12.1
774	6.38	0.566	11.3
968	5.64	0.440	12.8
1316	-	-	-
1678	4.07	0.210	19.4
2512	5.49	0.237	23.2
3290	5.04	0.112	45.0

Stn-2

Depth (m)	POC (µg/l)	PON (µg/l)	C/N
0	45.1	7.41	6.09
10	-	-	-
20	46.3	7.11	6.51
30	43.9	7.18	6.11
50	39.5	6.66	5.93
75	39.3	6.59	5.96
100	22.0	3.70	5.95
125	19.9	2.72	7.32
150	19.3	2.60	7.42
175	18.1	1.82	9.95
200	20.3	2.26	8.98
292	9.99	1.11	9.00
487	5.82	0.735	7.92
780	8.12	0.610	13.3
978	8.00	0.461	17.4
1768	4.72	0.419	11.3
2233	2.85	0.396	7.20
2652	-	-	-
3049	5.07	0.714	7.10
3444	9.05	0.465	19.5

Stn-3A

Depth (m)	POC (µg/l)	PON (µg/l)	C/N
0	188	34.1	5.51
10	210	36.0	5.83
20	155	27.8	5.58
30	201	34.3	5.86
50	130	23.7	5.49
75	108	17.3	6.24
100	89.2	14.0	6.37
125	35.0	4.63	7.56
150	33.7	4.31	7.82
175	-	-	-
200	95.4	13.9	6.86
497	8.49	0.482	17.6
869	6.45	0.594	10.9
1083	6.22	0.545	11.4
1311	-	-	-
1649	5.54	0.475	11.7
2185	4.07	0.320	12.7

Stn-3B

Depth (m)	POC (µg/l)	PON (µg/l)	C/N
0	84.6	15.9	5.32
10	87.6	16.6	5.28
20	93.1	17.8	5.23
30	138	27.0	5.11
50	154	29.4	5.24
75	89.4	13.3	6.72
100	64.9	11.7	5.55
125	24.0	3.06	7.84
150	17.3	2.01	8.61
175	43.0	4.11	10.5
200	32.7	3.44	9.51
296	12.8	-	-
485	9.54	1.22	7.82
788	12.4	0.871	14.2
986	5.44	0.466	11.7
1971	4.87	0.667	7.30
2957	3.98	0.429	9.28

Stn-4

Depth (m)	POC	PON	C/N
	—— μg/l ——		
0	49.1	9.81	5.01
10	54.0	10.8	5.00
20	50.8	9.76	5.20
30	50.9	9.94	5.12
50	59.4	11.5	5.17
85	44.4	8.18	5.43
100	24.2	3.95	6.13
125	19.8	2.30	8.61
150	16.0	2.10	7.62
175	19.5	2.20	8.86
200	12.1	1.48	8.18
969	15.4	1.26	12.2
1948	4.62	0.443	10.4
2927	6.85	0.479	14.3

Stn-5

Depth (m)	POC	PON	C/N
	—— μg/l ——		
0	96.6	17.6	5.49
10	92.6	18.7	4.95
20	99.4	18.7	5.32
30	96.3	17.9	5.38
50	56.7	9.14	6.20
75	16.3	2.06	7.91
100	17.7	2.37	7.47
125	69.3	5.24	13.2
150	19.9	2.71	7.34
175	24.2	2.91	8.32
200	30.8	3.60	8.56
495	4.84	0.424	11.4
991	-	-	-
1487	3.30	0.448	7.37
1967	4.24	0.649	6.53

Stn-6

Depth (m)	POC	PON	C/N
	—— μg/l ——		
0	73.5	12.9	5.70
10	71.4	13.1	5.45
20	73.7	11.9	6.19
30	79.6	14.4	5.53
50	113	19.9	5.68
75	103	17.4	5.92
100	42.4	6.53	6.49
125	24.3	3.33	7.30
150	17.8	2.59	6.87
175	12.9	1.93	6.68
200	11.9	1.43	8.32
300	10.3	1.39	7.41
489	7.94	1.14	6.96
984	4.82	0.674	7.15
1478	3.40	0.355	9.58
1972	5.55	0.305	18.2

Stn-7

Depth (m)	POC	PON	C/N
	—— μg/l ——		
0	84.3	15.1	5.58
10	75.6	14.0	5.40
20	67.6	12.2	5.54
30	78.0	13.1	5.95
50	45.3	7.94	5.71
75	55.4	8.29	6.68
100	74.2	8.77	8.46
125	45.9	5.41	8.48
150	21.1	2.58	8.18
175	32.5	3.90	8.33
200	42.5	-	-
300	28.3	5.45	5.19
432	10.3	1.23	8.37
696	10.1	1.15	8.78
881	6.98	0.766	9.11
1236	7.50	0.773	9.70
1804	7.80	0.792	9.85

Table 23 Summary of hydrographic data.

Abbreviations and symbols used: D, depth (meter)
T, temperature (°C)
S, salinity
Dst, $\Delta(S,t)$ ($10^{-8}m^3kg^{-1}$)
O, dissolved oxygen ($m\ell\ \ell^{-1}$)
O-%, percent oxygen saturation
D-D, ΔD ($10\ m^2sec^{-2}$)
Nutrient salts in μM

Station 1	Date 1983-12-13	Lat. 44-59.7 S	Air T. 11.9°C	Weather Fine
Depth 3810 m	TIME 20:21-23:35	Long.150-01.5 E	Barro. 1020.8 mb	Wind NW 2.5 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	13.45	35.046	168.1	6.10	104.0	0.38	0.0	1.9	0.08		
10	13.39	35.049	166.8	6.06	103.1	0.35	0.0	1.9	0.09		
20	13.32	35.041	166.0	6.06	103.0	0.33	0.0	1.9	0.08		
30	13.12	35.035	162.6	6.11	103.4	0.44	0.0	2.1	0.07		
50	11.95	35.013	142.3	5.88	97.1	0.40	0.4	1.9	0.07		
75	11.75	35.019	138.3	5.79	95.2	0.66	1.1	5.0	0.25		
100	11.22	34.935	135.1	5.94	96.5	0.72	1.5	6.2	0.38		
125	11.49	35.033	132.6	5.61	91.7	0.77	2.2	7.5	0.34		
150	11.21	35.009	129.5	5.51	89.6	0.78	2.5	8.3	0.05		
175	11.04	34.987	128.1	5.47	88.6	0.84	3.1	9.1	0.02		
200	10.95	34.988	126.5	5.45	88.1	0.87	2.3	10.0	0.01		
300	10.03	34.815	123.9	5.71	90.3	0.89	3.6	10.5	0.00		
400	9.27	34.686	121.3	5.55	86.3	0.97	4.7	11.6	0.00		
500	8.60	34.583	118.8	5.55	84.9	1.17	4.7	15.0	0.00		
600	8.16	34.533	116.1	5.49	83.2	1.31	6.6	17.5	0.00		
700	7.76	34.541	109.9	4.62	69.3	1.42	12.9	19.5	0.00		
800	7.07	34.506	103.1	4.27	63.1	1.68	19.0	23.7	0.00		
1000	5.28	34.433	86.6	4.14	58.6	1.85	35.8	26.5	0.00		
1250	3.64	34.408	71.5	4.21	57.2	2.19	50.8	30.5	0.00		
1500	3.03	34.518	57.7	3.70	49.6	2.31	----	33.5	0.00		
2000	2.32	34.681	39.5	3.89	51.3	2.24	84.6	33.5	0.00		
2500	1.94	34.728	33.1	4.14	54.0	2.34	97.6	34.0	0.00		
3000	1.64	34.722	31.4	4.31	55.8	2.27	107.0	33.2	0.00		
3500	1.20	34.717	28.8	4.49	57.5	2.26	117.0	33.0	0.00		
3750	1.04	34.710	28.3	4.56	58.2	----	121.0	33.3	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	13.45	35.060	6.09	167.2	0.0000
10	13.45	35.061	6.03	167.1	0.0167
20	13.45	35.059	6.04	167.1	0.0334
30	13.33	35.020	6.01	167.7	0.0502
50	12.84	35.041	6.04	156.8	0.0828
75	11.91	35.058	5.78	138.4	0.1200
100	11.89	35.043	5.66	139.1	0.1552
125	11.19	34.972	5.72	131.9	0.1897
150	10.84	34.909	5.70	130.5	0.2232
175	10.99	34.978	5.61	127.8	0.2564
200	10.91	34.968	5.57	127.3	0.2893
300	10.03	34.812	5.77	124.1	0.4203
400	9.39	34.702	5.65	122.1	0.5504
500	8.73	34.602	5.67	119.3	0.6796
600	8.43	34.573	5.47	117.0	0.8077
700	7.82	34.542	4.83	110.6	0.9326
800	7.23	34.515	4.47	104.6	1.0522
1000	5.35	34.444	4.11	86.6	1.2672
1250	3.63	34.395	4.11	72.4	1.4922
1500	3.02	34.518	3.70	57.6	1.6788
2000	2.33	34.671	3.83	40.4	1.9730
2500	1.94	34.729	4.06	33.0	2.2071
3000	1.57	34.729	4.30	30.3	2.4153
3500	1.20	34.718	4.59	28.7	2.6073

Station 2	Date 1983-12-16	Lat. 52-04.5 S	Air T. 7.3°C	Weather Shower
Depth 4380 m	TIME 16:30-18:48	Long.149-43.5 E	Barro. 999.0 mb	Wind WNW 6.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	7.78	34.104	142.7	6.50	97.3	1.51	5.2	17.2	0.20		
10	7.79	34.089	143.9	6.53	97.8	1.47	6.3	17.1	0.19		
20	7.78	34.086	144.0	6.50	97.3	1.48	5.0	17.2	0.20		
30	7.70	34.087	142.8	6.55	97.9	1.48	6.3	17.0	0.19		
50	7.42	34.084	139.2	6.54	97.1	1.48	5.6	17.2	0.19		
75	6.82	34.084	131.3	6.64	97.2	1.49	6.3	18.2	0.27		
100	6.30	34.065	126.2	6.72	97.2	1.54	5.5	17.4	0.16		
125	5.47	34.052	117.3	6.59	93.5	1.57	8.5	----	----		
150	4.46	33.968	112.7	6.80	94.1	1.66	9.6	21.9	0.16		
175	4.42	33.997	110.1	6.73	93.0	1.87	10.0	22.2	0.20		
200	4.04	34.069	100.9	6.74	92.3	1.92	10.0	23.0	0.21		
300	4.18	34.115	98.8	6.00	82.5	2.10	17.4	25.3	0.01		
400	3.59	34.156	90.1	5.68	77.0	2.25	24.0	27.3	0.00		
500	3.13	34.196	82.9	5.43	72.8	2.49	31.3	29.1	0.00		
600	2.83	34.240	77.0	5.15	68.5	2.48	38.3	30.4	0.00		
700	2.70	34.293	71.9	4.77	63.3	2.56	46.2	31.4	0.00		
800	2.68	34.391	64.4	4.48	59.5	----	51.5	----	----		
1000	2.63	34.496	56.0	3.97	52.7	2.65	67.7	32.1	0.00		
1250	2.41	34.588	47.3	3.93	51.9	2.49	74.5	31.8	0.00		
1500	2.33	34.670	40.4	4.03	53.1	2.53	78.7	30.6	0.00		
2000	2.04	34.730	33.7	4.22	55.2	2.44	86.0	29.0	0.00		
2233	1.94	34.728	33.1	4.23	55.2	2.13	91.0	32.0	0.00		
2650	1.60	34.725	30.8	4.41	57.1	2.13	102.0	32.2	0.00		
3051	1.24	34.701	30.2	4.42	56.7	2.17	103.0	32.3	0.00		
3444	1.04	34.684	30.2	4.52	57.6	2.19	114.0	32.4	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	7.77	34.084	6.48	144.0	0.0000
10	7.77	34.085	6.44	143.9	0.0144
20	7.77	34.085	6.40	143.9	0.0288
30	7.70	34.083	6.40	143.2	0.0431
50	7.06	34.081	6.50	136.1	0.0711
75	6.67	34.077	6.52	129.9	0.1045
100	6.14	34.052	6.55	125.2	0.1366
125	4.73	33.950	6.59	116.9	0.1672
150	4.39	33.990	6.49	110.4	0.1958
175	3.84	33.938	6.41	108.8	0.2235
200	3.47	33.948	6.51	104.7	0.2505
300	3.72	34.058	6.01	98.7	0.3538
400	3.60	34.175	5.74	88.8	0.4500
500	3.16	34.199	5.41	82.9	0.5388
600	2.84	34.243	5.07	76.9	0.6219
700	2.61	34.325	4.62	68.8	0.6982
800	2.70	34.391	4.33	64.5	0.7688
1000	2.65	34.490	3.91	56.6	0.8999
1250	2.42	34.576	3.80	48.3	1.0460
1500	2.33	34.665	3.89	40.8	1.1749
2000	2.04	34.725	4.18	34.0	1.4030

Station 2-2	Date 1983-12-18	Lat. 57-31.6 S	Air T. 3.0°C	Weather Overcast
Depth 3350 m	TIME 10:36-12:18	Long.150-02.9 E	Barro. 1005.0 mb	Wind NNW 9.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	3.04	33.844	108.7	7.05	94.1	1.61	5.2	22.6	0.17		
10	3.07	33.860	107.8	7.04	94.0	1.61	5.0	22.7	0.16		
20	3.03	33.857	107.6	7.04	93.9	1.60	5.2	22.9	0.16		
30	3.02	33.856	107.6	7.04	93.9	1.61	5.0	22.8	0.15		
50	2.84	33.857	106.0	7.00	92.9	1.62	5.2	22.7	0.15		
75	2.26	33.871	100.4	6.98	91.3	1.84	14.4	24.5	0.16		
100	2.05	33.878	98.3	6.96	90.6	1.87	17.3	24.7	0.16		
125	1.43	33.894	92.8	6.94	88.9	2.01	22.5	25.5	0.14		
150	.72	33.937	85.1	6.90	86.8	2.10	28.9	27.6	0.11		
175	.74	33.988	81.4	6.67	84.0	2.15	31.9	28.5	0.08		
200	.93	34.059	77.1	6.33	80.1	2.24	36.1	29.8	0.06		
300	2.06	34.376	60.6	4.81	62.8	2.45	60.3	33.4	0.00		
400	2.18	34.499	52.2	4.13	54.2	2.50	71.0	33.4	0.00		
500	2.13	34.548	48.1	3.89	51.0	2.51	74.7	33.2	0.00		
600	2.16	34.612	43.5	3.79	49.7	2.46	77.2	32.5	0.00		
700	2.19	34.652	40.7	3.79	49.8	2.40	80.9	31.8	0.00		
800	2.07	34.680	37.7	3.83	50.1	2.38	83.0	31.3	0.00		
1000	2.00	34.724	33.8	3.95	51.6	2.28	83.3	30.0	0.00		
1250	1.86	34.746	31.1	4.18	54.5	2.25	86.8	29.3	0.00		
1500	1.67	34.747	29.7	4.27	55.4	2.20	92.4	29.0	0.00		
2000	1.18	34.727	27.9	4.47	57.2	2.30	109.0	29.5	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	3.04	33.843	7.05	108.7	0.0000
10	3.04	33.842	7.03	108.9	0.0109
20	3.01	33.842	7.04	108.6	0.0217
30	3.00	33.843	7.04	108.5	0.0326
50	2.84	33.841	7.00	108.1	0.0542
75	2.31	33.854	6.98	102.1	0.0805
100	2.06	33.858	6.96	99.8	0.1057
125	1.33	33.867	6.94	94.1	0.1300
150	0.72	33.912	6.90	87.1	0.1526
175	0.88	33.991	6.67	82.0	0.1736
200	1.18	34.085	6.33	76.7	0.1935
300	2.06	34.367	4.81	61.3	0.2630
400	2.00	34.458	4.13	54.0	0.3218
500	2.14	34.550	3.89	48.1	0.3746
600	2.18	34.605	3.79	44.2	0.4232
700	2.17	34.641	3.79	41.4	0.4689
800	2.09	34.672	3.83	38.4	0.5122
1000	2.00	34.709	3.95	35.0	0.5935
1250	1.85	34.731	4.18	32.2	0.6890
1500	1.64	34.735	4.27	30.4	0.7799
2000	1.21	34.721	4.47	28.5	0.9523

Station 4	Date 1983-12-22	Lat. 64-56.1 S	Air T. 0.1°C	Weather Overcast
Depth 3260m	TIME 18:00-20:00	Long.150-12.6 E	Barro. 982.2 mb	Wind ENE 9.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	-0.47	33.888	83.1	7.67	93.5	1.95	51.7	30.7	0.17		
10	-0.48	33.879	83.7	7.62	92.8	1.98	51.5	30.8	0.16		
20	-0.48	33.876	84.0	7.63	92.9	----	51.5	30.7	0.17		
30	-0.48	33.875	84.0	7.59	92.5	1.95	51.5	30.7	0.16		
50	-0.59	33.877	83.4	7.60	92.3	1.96	51.9	30.6	0.16		
75	0.77	34.249	61.7	6.39	80.7	2.16	63.0	32.2	0.08		
100	0.80	34.497	43.0	4.82	61.0	1.95	76.5	28.7	0.24		
125	0.88	34.555	39.7	4.52	57.5	2.35	80.2	35.0	0.05		
150	0.55	34.646	30.2	4.06	51.1	2.33	80.9	34.7	0.03		
175	1.10	34.668	31.8	4.00	51.1	2.08	----	32.1	0.13		
200	1.17	34.635	34.8	4.41	56.4	2.34	83.1	35.2	0.01		
300	1.30	34.684	31.9	4.44	57.0	2.27	88.5	34.5	0.01		
400	1.43	34.708	31.0	4.33	55.8	2.28	92.1	33.5	0.00		
500	1.39	34.720	29.8	4.33	55.7	2.28	94.3	33.6	0.00		
600	1.35	34.729	28.8	4.38	56.3	2.22	97.0	33.6	0.00		
700	1.28	34.726	28.6	4.47	57.4	2.27	100.0	33.7	0.00		
800	1.20	34.728	27.9	4.48	57.4	2.22	103.0	33.6	0.00		
1000	0.97	34.713	27.6	4.54	57.8	2.27	106.0	33.3	0.00		
1250	0.87	34.715	26.8	4.56	57.9	2.26	113.0	34.1	0.00		
1500	0.65	34.701	26.6	4.65	58.7	2.28	119.0	34.4	0.00		
2000	0.29	34.686	25.7	4.82	60.3	2.32	126.0	34.7	0.00		
2448	0.04	34.683	24.7	4.99	62.0	----	120.0	----	----		
2937	-0.10	34.678	24.4	5.20	64.3	----	107.0	----	----		

CTD-data

D	T	S	O	Dst	D-D
0	-0.47	33.847	7.58	86.3	0.0000
10	-0.47	33.847	7.49	86.2	0.0086
20	-0.48	33.850	7.34	86.0	0.0172
30	-0.55	33.853	7.25	85.4	0.0257
50	-0.51	34.296	6.21	51.7	0.0393
75	0.63	34.495	4.94	42.2	0.0510
100	1.42	34.605	4.23	38.8	0.0611
125	1.54	34.638	4.08	37.0	0.0706
150	1.51	34.646	4.06	36.2	0.0798
175	1.59	34.668	4.00	35.1	0.0887
200	1.57	34.687	4.05	33.5	0.0974
300	1.47	34.699	4.17	31.9	0.1307
400	1.37	34.703	4.17	31.0	0.1630
500	1.41	34.714	4.22	30.3	0.1948
600	1.32	34.718	4.28	29.5	0.2261
700	1.17	34.714	4.35	28.8	0.2567
800	1.20	34.722	4.32	28.4	0.2870
1000	0.82	34.688	4.51	28.5	0.3470
1250	0.88	34.709	4.43	27.3	0.4209
1500	0.67	34.699	4.53	26.9	0.4930
2000	0.29	34.681	4.73	26.1	0.6295

Station 3-1	Date 1983-12-24	Lat. 62-59.8 S	Air T. 1.7°C	Weather Fog
Depth 3820 m	TIME 12:25-13:48	Long.150-33.9 E	Barro. 986.2 mb	Wind WNW 1.5 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	-0.35	33.963	77.8	7.49	91.6	----	----	----	----		
10	-0.47	33.963	77.3	7.43	90.6	----	----	----	----		
20	-0.50	33.986	77.0	7.33	89.3	----	----	----	----		
30	-0.55	33.967	76.7	7.21	87.7	----	----	----	----		
50	-0.64	33.966	76.4	7.10	86.1	----	----	----	----		
75	-0.98	33.994	73.1	7.04	84.7	----	----	----	----		
100	-0.54	34.302	51.1	6.09	74.3	----	----	----	----		
125	1.18	34.527	43.0	4.88	62.4	----	----	----	----		
150	1.62	34.572	42.7	4.23	54.7	----	----	----	----		
175	1.74	34.593	41.8	3.97	51.5	----	----	----	----		
200	1.79	34.607	41.1	3.89	50.6	----	----	----	----		
300	1.85	34.666	37.1	3.87	50.4	----	----	----	----		
400	1.84	34.693	35.0	3.91	50.9	----	----	----	----		
500	1.81	34.712	33.3	4.05	52.7	----	----	----	----		
600	1.78	34.721	32.3	4.08	53.1	----	----	----	----		
700	1.71	34.730	31.3	4.16	54.0	----	----	----	----		
800	1.64	34.733	30.5	4.22	54.6	----	----	----	----		
1000	1.49	34.735	29.3	4.38	56.5	----	----	----	----		
1250	1.28	34.729	28.3	4.48	57.2	----	----	----	----		
1500	1.09	34.721	27.8	4.53	57.9	----	----	----	----		

CTD-data

D	T	S	O	Dst	D-D
0	-0.35	33.963	7.49	77.8	0.0000
10	-0.47	33.963	7.43	77.3	0.0077
20	-0.50	33.866	7.33	77.0	0.0154
30	-0.55	33.867	7.21	76.7	0.0231
50	-0.64	33.866	7.10	76.4	0.0383
75	-0.98	33.994	7.04	73.1	0.0568
100	-0.54	34.302	6.09	51.1	0.0722
125	1.18	34.527	4.88	43.0	0.0839
150	1.62	34.572	4.23	42.7	0.0947
175	1.74	34.593	3.97	41.8	0.1053
200	1.78	34.607	3.89	41.1	0.1158
300	1.85	34.666	3.87	37.1	0.1556
400	1.84	34.693	3.91	35.0	0.1928
500	1.81	34.712	4.05	33.3	0.2286
600	1.76	34.721	4.08	32.3	0.2634
700	1.71	34.730	4.16	31.3	0.2975
800	1.64	34.733	4.22	30.5	0.3310
1000	1.49	34.735	4.38	29.3	0.3968
1250	1.28	34.729	4.46	28.3	0.4766
1500	1.09	34.721	4.53	27.8	0.5547

Station 38	Date 1983-12-25	Lat. 61-24.8 S	Air T. -0.3°C	Weather Snow
Depth 3810 m	TIME 21:54-23:45	Long. 150-05.7 E	Barro. 989.8 mb	Wind SW 12.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2	NH4	
0	0.19	33.982	78.9	7.89	97.9	1.84	32.0	24.2	0.20		
10	0.11	33.977	78.9	7.84	97.1	----	----	----	----		
20	0.04	33.977	78.5	7.91	97.8	1.81	32.0	24.3	0.19		
30	0.20	33.978	79.2	8.01	99.4	1.82	32.2	24.6	0.18		
50	-0.26	33.978	77.1	7.75	95.0	----	----	----	----		
75	-0.87	33.997	73.2	7.74	93.4	2.12	39.7	25.7	0.16		
100	-0.58	34.165	61.5	6.49	79.0	2.39	53.0	29.0	0.12		
125	0.59	34.319	55.3	5.30	66.6	2.51	61.9	30.9	0.06		
150	0.57	34.473	43.5	4.80	60.4	----	----	----	----		
175	1.79	34.483	50.5	4.14	53.7	2.60	72.8	32.2	0.01		
200	1.91	34.557	45.8	4.02	52.4	2.59	75.6	31.8	0.01		
300	1.99	34.587	44.1	3.96	51.7	2.50	79.9	30.7	0.00		
400	1.98	34.616	41.8	4,13	53.9	2.43	83.0	29.7	0.00		
500	1.97	34.702	35.3	4.17	54.5	2.40	84.7	29.0	0.00		
600	1.93	34.713	34.1	4.20	54.8	2.33	86.8	28.6	0.00		
700	1.88	34.724	32.9	4.27	55.7	2.32	88.2	28.3	0.00		
800	1.81	34.731	31.9	4.37	56.9	2.31	92.6	27.9	0.00		
1000	1.66	34.726	31.2	4.45	57.7	2.30	98.7	28.0	0.00		
1250	1.46	34.721	30.2	4.54	58.5	2.30	106.0	28.0	0.00		
1500	1.25	34.715	29.2	4.64	59.5	2.36	116.0	28.4	0.00		
2000	0.84	34.701	27.7	4.81	58.5	2.35	114.0	28.3	0.00		
2468	0.50	34.687	26.8	4.76	59.8	2.39	122.0	28.5	0.00		
2950	0.26	34.674	26.5	4.95	61.8	2.40	123.0	28.2	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	0.19	33.970	8.42	79.8	0.0000
10	0.19	33.969	8.29	79.9	0.0080
20	0.19	33.969	8.15	79.9	0.0159
30	0.13	33.922	8.10	83.2	0.0240
50	-0.22	33.960	8.09	78.6	0.0401
75	-0.60	33.972	8.04	76.1	0.0594
100	-1.04	34.116	7.69	63.5	0.0767
125	0.56	34.366	6.22	51.6	0.0909
150	1.58	34.473	5.12	49.8	0.1036
175	1.82	34.515	4.47	48.4	0.1160
200	1.96	34.557	4.26	46.1	0.1279
300	1.97	34.616	4.08	41.8	0.1726
400	1.98	34.666	4.10	38.1	0.2138
500	1.96	34.695	4.15	35.8	0.2525
600	1.92	34.709	4.22	34.3	0.2897
700	1.87	34.723	4.29	32.9	0.3259
800	1.80	34.733	4.36	31.7	0.3611
1000	1.63	34.738	4.45	30.1	0.4293
1250	1.44	34.736	4.52	28.9	0.5120
1500	1.24	34.730	4.60	28.1	0.5925
2000	0.84	34.709	4.71	27.1	0.7473

Station 2-3	Date 1983-12-27	Lat. 59-28.9 S	Air T. 0.4°C	Weather Overcast
Depth 2460 m	TIME 03:58-05:26	Long. 149-58.8 E	Barro. 1001.0 mb	Wind SW 10.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	0.36	33.923	84.3	7.31	91.1	----	----	----	----		
10	0.36	33.922	84.3	7.29	90.8	----	----	----	----		
20	0.35	33.922	84.3	7.31	91.0	----	----	----	----		
30	0.35	33.924	84.1	7.33	91.3	----	----	----	----		
50	0.05	33.921	82.9	7.34	90.7	----	----	----	----		
75	-0.42	33.937	79.5	7.31	89.2	----	----	----	----		
100	-1.28	34.105	63.6	7.00	83.5	----	----	----	----		
125	0.22	34.378	48.8	6.17	76.8	----	----	----	----		
150	1.68	34.548	44.8	4.94	64.0	----	----	----	----		
175	1.77	34.580	43.0	4.53	58.8	----	----	----	----		
200	1.85	34.607	41.6	4.31	56.1	----	----	----	----		
300	1.89	34.659	37.9	3.97	51.8	----	----	----	----		
400	1.87	34.692	35.3	3.94	51.4	----	----	----	----		
500	1.85	34.715	33.4	3.98	51.8	----	----	----	----		
600	1.78	34.723	32.3	4.03	52.4	----	----	----	----		
700	1.71	34.732	31.1	4.11	53.4	----	----	----	----		
800	1.65	34.737	30.3	4.15	53.8	----	----	----	----		
1000	1.51	34.737	29.3	4.24	54.7	----	----	----	----		
1250	1.28	34.729	28.2	4.33	55.5	----	----	----	----		
1500	1.08	34.721	27.6	4.42	56.5	----	----	----	----		
2000	0.62	34.698	28.7	4.60	58.0	----	----	----	----		

CTD-data

D	T	S	O	Dst	D-D
0	0.36	33.923	7.31	84.3	0.0000
10	0.36	33.922	7.29	84.3	0.0084
20	0.35	33.922	7.31	84.3	0.0168
30	0.35	33.924	7.33	84.1	0.0252
50	0.05	33.921	7.34	82.9	0.0418
75	-0.42	33.937	7.31	79.5	0.0620
100	- 1.28	34.105	7.00	63.6	0.0797
125	0.22	34.378	6.17	48.8	0.0936
150	1.68	34.548	4.94	44.8	0.1053
175	1.77	34.580	4.53	43.0	0.1164
200	1.85	34.607	4.31	41.6	0.1271
300	1.89	34.659	3.97	37.9	0.1676
400	1.87	34.692	3.94	35.3	0.2054
500	1.85	34.715	3.98	33.4	0.2414
600	1.78	34.723	4.03	32.3	0.2763
700	1.71	34.732	4.11	31.1	0.3103
800	1.65	34.737	4.15	30.3	0.3435
1000	1.51	34.737	4.24	29.3	0.4089
1250	1.28	34.729	4.33	28.2	0.4887
1500	1.06	34.721	4.42	27.6	0.5662
2000	0.62	34.698	4.60	28.7	0.7141

Station AC-1	Date 1983-12-28	Lat. 56-11.8 S	Air T. 5.7°C	Weather Rain
Depth 3620 m	TIME 11:00-12:55	Long. 150-02.0 E	Barro. 1010.9 mb	Wind W 11.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	6.20	33.991	130.5	6.84	95.8	1.05	7.7	22.8	0.19
10	6.61	33.979	136.5	6.58	95.8	0.89	8.0	22.7	0.18
19	6.65	33.985	136.5	6.64	96.8	0.86	8.1	22.5	0.19
28	7.04	34.103	132.7	6.54	98.3	0.87	7.2	20.9	0.20
47	7.20	34.151	131.3	6.47	95.6	0.83	7.5	20.3	0.22
71	6.62	34.166	122.6	6.35	92.6	0.98	8.5	21.7	0.21
94	6.30	34.171	118.3	6.26	90.6	1.05	9.9	22.9	0.04
118	6.57	34.240	118.5	5.89	87.3	1.04	9.7	22.8	0.02
142	6.71	34.292	114.4	5.55	81.2	1.10	11.4	23.5	0.01
165	6.33	34.271	111.2	5.69	82.5	1.19	12.2	24.2	0.01
188	6.43	34.330	108.0	5.30	77.0	1.29	14.6	25.0	0.01
283	5.29	34.338	93.9	4.80	69.3	1.68	23.9	29.1	0.00
376	3.60	34.257	82.5	5.13	69.6	1.98	33.3	31.6	0.01
470	3.05	34.285	75.5	4.82	64.5	2.14	42.9	32.8	0.01
695	2.68	34.454	59.8	4.25	58.4	2.45	63.8	36.6	0.01
913	2.40	34.557	49.5	3.85	50.8	2.52	77.5	37.1	0.01
1125	2.29	34.674	39.8	3.99	52.5	2.24	80.9	34.6	0.00
1338	2.18	34.717	35.7	4.09	53.7	2.13	83.8	33.5	0.00
1744	1.89	34.741	31.7	4.34	58.6	2.08	93.2	32.5	0.00

Interpolated

D	T	S	O	Dst	D-D
0	6.20	33.991	6.84	130.5	0.0000
10	6.61	33.979	6.58	136.5	0.0133
20	6.69	33.997	6.63	136.1	0.0269
30	7.09	34.115	6.53	132.5	0.0404
50	7.14	34.155	6:46	130.3	0.0667
75	6.54	34.165	6.34	121.6	0.0984
100	6.34	34.186	6.21	117.7	0.1285
125	6.65	34.260	5.84	115.9	0.1581
150	6.58	34.284	5.60	113.3	0.1871
175	6.35	34.293	5.55	109.8	0.2155
200	6.37	34.344	5.18	106.2	0.2431
300	4.86	34.322	4.94	91.4	0.3447
400	3.39	34.258	5.07	80.6	0.4335
500	2.96	34.305	4.73	73.2	0.5132
600	2.75	34.378	4.47	65.9	0.5859
700	2.67	34.457	4.24	59.3	0.6521
800	2.53	34.506	4.01	54.4	0.7130
1000	2.35	34.608	3.88	45.2	0.8218
1250	2.23	34.705	4.05	37.0	0.9384
1500	2.08	34.736	4.18	33.5	1.0426
2000	1.65	34.717	4.54	31.8	1.2403

Station 1-1	Date 1983-12-30	Lat. 49-24.0 S	Air T. 8.8°C	Weather Rain
Depth 2210 m	TIME 19:35-21:30	Long. 149-45.6 E	Barro. 1015.8 mb	Wind W 10.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	7.65	34.021	147.0	6.55	97.7	1.45	7.2	22.2	0.18
10	7.75	34.022	148.3	6.59	98.6	1.42	8.0	22.1	0.18
20	7.75	34.017	148.7	6.48	96.9	1.42	7.5	21.9	0.18
30	7.69	34.026	147.2	6.55	97.8	1.43	7.5	21.8	0.18
50	7.20	34.011	141.7	6.59	97.3	1.44	7.7	22.1	0.16
75	5.82	33.998	125.4	6.61	94.5	1.51	8.1	22.8	0.17
100	5.57	34.027	120.3	6.51	92.5	1.63	9.6	24.4	0.24
125	5.58	34.079	116.6	6.34	90.2	1.64	9.2	24.9	0.20
150	5.30	34.061	114.7	6.30	89.0	1.66	9.7	25.0	0.19
175	5.09	34.061	112.4	6.34	89.1	1.70	10.5	25.6	0.21
200	5.04	34.065	111.6	6.37	89.4	1.72	10.7	25.9	0.16
300	4.87	34.115	106.0	5.98	83.6	1.80	14.0	27.3	0.02
400	5.50	34.307	98.6	5.08	72.2	1.93	19.3	29.0	0.00
500	4.82	34.297	91.8	4.97	69.5	2.04	24.3	30.9	0.00
600	3.85	34.242	86.0	5.17	70.6	2.14	29.1	32.3	0.00
700	3.62	34.241	83.9	4.98	67.6	2.22	33.3	33.2	0.00
800	3.37	34.316	76.0	4.65	62.8	2.33	41.5	34.4	0.00
1000	2.95	34.392	66.6	4.26	56.9	2.44	55.3	36.0	0.00
1250	2.58	34.509	54.6	3.83	52.1	2.43	69.3	35.4	0.00
1500	2.48	34.602	46.8	3.87	51.2	2.44	76.2	35.3	0.00
2000	2.21	34.715	36.1	4.02	52.8	2.30	86.1	31.2	0.00

CTD-data

D	T	S	O	Dst	D-D
0	7.65	33.964	6.53	151.3	0.0000
10	7.65	33.967	6.43	151.0	0.0151
20	7.65	33.987	6.40	149.5	0.0301
30	7.63	34.003	6.31	148.0	0.0450
50	7.26	34.001	6.34	143.3	0.0742
75	7.03	33.997	6.35	140.6	0.1099
100	5.61	33.962	6.46	125.7	0.1434
125	5.48	34.039	6.34	118.4	0.1741
150	5.13	34.024	6.31	115.6	0.2037
175	5.12	34.049	6.32	113.6	0.2327
200	5.22	34.094	6.23	111.3	0.2613
300	4.87	34.120	6.13	105.6	0.3722
400	5.28	34.272	5.44	98.4	0.4778
500	4.68	34.274	5.24	92.0	0.5776
600	3.86	34.243	5.25	86.0	0.6714
700	3.62	34.260	5.09	82.5	0.7607
800	3.32	34.311	4.79	75.9	0.8453
1000	2.92	34.396	4.34	66.0	0.9986
1250	2.57	34.511	3.97	54.4	1.1650
1500	2.47	34.610	3.88	48.1	1.3089
2000	2.21	34.716	4.09	38.0	1.5579

Station STC-I	Date 1983-12-31	Lat. 46-45.9 S	Air T. 9.9°C	Weather Overcast
Depth 4250 m	TIME 19:30-21:30	Long.150-00.6 E	Barro. 1025.4 mb	Wind SE 2.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	11.45	34.512	170.3	6.23	101.5	0.68	0.3	7.8	0.18		
10	11.54	34.524	171.0	6.25	102.0	0.67	0.6	7.8	0.18		
20	11.64	34.670	162.0	6.28	103.0	0.57	0.4	6.2	0.17		
30	12.24	34.877	157.6	6.27	104.1	0.48	0.6	4.3	0.16		
50	12.38	35.004	150.5	5.92	98.6	0.46	0.1	3.9	0.17		
75	12.34	35.013	149.5	5.83	97.1	0.50	0.3	4.2	0.18		
100	10.66	34.829	133.3	5.93	95.1	0.79	1.5	6.4	0.34		
125	10.94	34.943	129.6	5.71	92.2	0.77	2.2	8.1	0.06		
150	9.86	34.733	127.2	5.65	92.2	0.91	3.4	10.7	0.05		
175	9.91	34.777	124.7	5.72	90.2	0.92	3.6	10.9	0.01		
200	9.50	34.692	124.5	5.94	92.8	1.01	3.6	11.6	0.01		
300	9.30	34.674	122.7	5.78	89.8	1.02	3.9	12.2	0.01		
400	9.06	34.652	120.6	5.29	81.8	1.19	5.8	15.1	0.01		
500	8.55	34.591	117.5	5.31	81.2	1.28	8.9	16.5	0.00		
600	8.16	34.546	115.2	5.08	77.0	1.43	8.8	18.4	0.00		
700	7.49	34.499	109.3	4.67	69.6	1.59	13.2	21.5	0.00		
800	6.68	34.442	102.8	4.55	66.6	1.76	17.9	23.9	0.00		
1000	5.04	34.391	87.1	4.34	61.0	2.07	33.3	28.0	0.00		
1250	3.69	34.416	71.4	4.09	55.7	2.29	52.8	31.0	0.00		
1500	2.86	34.498	57.8	3.84	51.2	2.40	68.8	32.5	0.00		
2000	2.40	34.656	42.1	3.94	52.0	2.30	81.6	31.2	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	11.45	34.494	6.23	171.6	0.0000
10	11.44	34.507	6.26	170.5	0.0171
20	11.51	34.650	6.30	161.2	0.0337
30	12.42	34.990	6.24	152.7	0.0494
50	12.35	35.000	6.09	150.8	0.0799
75	12.34	35.007	6.01	149.9	0.1178
100	11.09	34.933	5.88	133.0	0.1536
125	9.98	34.718	5.86	130.2	0.1871
150	9.91	34.739	5.84	127.5	0.2199
175	10.20	34.842	5.72	124.7	0.2523
200	9.77	34.754	5.74	124.2	0.2843
300	9.39	34.702	5.74	122.1	0.4123
400	8.93	34.631	5.41	120.2	0.5400
500	8.44	34.570	5.39	117.4	0.6670
600	7.97	34.518	5.27	114.6	0.7925
700	7.43	34.492	4.82	108.9	0.9148
800	6.56	34.428	4.68	102.3	1.0316
1000	5.01	34.383	4.43	87.4	1.2432
1250	3.63	34.409	4.11	71.4	1.4671
1500	2.87	34.486	3.88	58.8	1.6532
2000	2.40	34.650	3.87	42.5	1.9548

Station PI-2	Date 1984-1-16	Lat. 64-16.8 S	Air T. 1.0°C	Weather Overcast
Depth 2820 m	TIME 14:27-16:26	Long.136-06.3 E	Barro. 998.1 mb	Wind E 2.5 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	-0.86	33.270	128.9	7.97	95.7	1.90	53.7	28.8	0.30		
10	-0.84	33.774	90.4	7.80	94.0	1.97	55.5	29.8	0.26		
20	-0.66	33.821	87.5	7.79	94.4	1.96	55.5	30.0	0.28		
30	0.05	33.936	81.7	7.72	95.4	1.99	56.3	30.4	0.25		
50	-1.29	34.162	59.2	7.28	86.9	----	60.2	31.1	0.29		
75	-1.59	34.280	49.3	6.92	82.0	2.18	63.5	33.8	0.16		
100	-1.23	34.392	41.7	6.51	78.0	2.23	70.3	33.7	0.09		
125	-1.31	34.421	39.3	6.52	77.9	2.23	70.6	33.7	0.03		
150	-0.73	34.484	36.5	6.21	75.5	2.23	75.8	33.8	0.02		
175	-0.03	34.559	33.8	5.68	70.4	2.27	80.8	34.1	0.02		
200	0.52	34.608	32.9	5.28	66.4	2.27	85.2	34.2	0.02		
300	0.97	34.681	30.0	4.85	61.7	2.27	92.6	33.9	0.00		
400	1.04	34.712	28.1	4.75	60.6	2.27	97.5	33.8	0.00		
500	0.98	34.714	27.6	4.70	59.8	2.27	102.3	34.2	0.01		
600	1.00	34.724	26.9	4.69	59.8	2.27	106.3	33.5	0.01		
700	0.93	34.722	26.7	4.73	60.2	2.27	109.6	33.6	0.00		
800	0.85	34.720	26.3	4.74	60.2	2.29	112.4	33.4	0.01		
1000	0.66	34.708	26.1	4.79	60.5	2.31	115.8	33.5	0.01		
1250	0.42	34.701	25.3	4.84	60.7	2.35	122.1	33.4	0.01		
1500	0.25	34.695	24.8	4.96	61.9	2.35	127.3	33.2	0.00		
2000	-0.09	34.684	24.0	5.22	64.6	2.31	122.5	32.5	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	-0.86	33.283	7.91	128.0	0.0000
10	-0.84	33.318	7.80	125.4	0.0126
20	-0.66	33.474	7.76	114.0	0.0246
30	0.05	33.722	7.69	98.1	0.0351
50	-1.29	34.053	7.69	67.5	0.0516
75	-1.52	34.301	7.11	47.9	0.0659
100	-1.27	34.382	6.71	42.4	0.0770
125	-1.35	34.407	6.58	40.2	0.0871
150	-1.12	34.442	6.52	38.3	0.0967
175	-0.72	34.482	6.28	36.6	0.1058
200	-0.17	34.542	6.04	34.4	0.1146
300	0.47	34.634	5.49	30.7	0.1468
400	1.12	34.704	4.97	29.2	0.1771
500	1.03	34.701	4.87	28.9	0.2069
600	0.96	34.705	4.85	28.2	0.2363
700	0.96	34.709	4.81	27.8	0.2653
800	0.88	34.707	4.81	27.5	0.2941
1000	0.71	34.696	4.82	27.3	0.3511
1250	0.51	34.692	4.85	26.5	0.4206
1500	0.27	34.682	4.94	25.9	0.4869
2000	-0.06	34.668	5.18	25.3	0.6107

Station 5	Date 1984-1-18	Lat. 65-00.3 S	Air T. -1.2°C	Weather Overcast
Depth 2750 m	TIME 22:19-00:12	Long. 117-59.6 E	Barro. 1007.9 mb	Wind SW 5.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	0.05	33.812	91.2	8.19	101.1	1.80	59.4	25.8	0.31
10	-0.01	33.809	91.1	8.05	99.3	1.73	59.6	25.7	0.29
20	-0.30	33.838	87.6	8.03	98.3	1.81	59.1	25.7	0.26
30	-0.53	33.887	82.9	8.07	98.2	1.85	58.9	25.8	0.24
50	-1.57	34.196	55.8	7.34	87.0	2.10	68.1	28.6	0.14
75	-1.72	34.322	45.7	6.95	82.1	2.19	72.5	30.0	0.14
100	-1.69	34.342	44.3	6.89	81.5	2.21	73.2	30.4	0.12
125	-1.70	34.366	42.4	6.84	80.9	2.22	72.5	30.6	0.15
150	-1.59	34.393	40.6	6.76	80.2	2.24	73.6	30.9	0.07
175	-0.95	34.448	38.4	6.27	75.7	2.26	78.7	31.1	0.08
200	-0.34	34.517	35.6	5.72	70.2	2.29	83.8	31.5	0.04
300	1.14	34.698	29.8	4.60	58.8	2.33	97.3	31.6	0.01
400	1.25	34.721	28.8	4.54	58.2	2.33	100.8	31.8	0.00
500	1.14	34.722	28.0	4.58	58.6	2.32	104.8	31.6	0.01
600	1.04	34.721	27.4	4.59	58.5	2.31	109.1	31.4	0.01
700	0.89	34.714	27.0	4.81	61.1	2.32	111.8	31.7	0.00
800	0.74	34.707	26.7	4.65	59.8	2.33	115.8	31.9	0.00
1000	0.48	34.695	26.1	4.72	59.3	2.36	121.5	32.1	0.00
1250	0.21	34.684	25.5	4.86	60.6	2.41	125.1	32.0	0.00
1500	0.02	34.683	24.6	5.06	62.8	2.36	125.8	31.9	0.00
2000	-0.24	34.672	24.2	5.27	65.0	2.33	116.8	31.8	0.00

CTD-data

D	T	S	O	Dst	D-D
0	0.05	33.781	7.72	93.5	0.0000
10	0.01	33.764	7.62	94.7	0.0094
20	-0.37	33.772	7.64	92.3	0.0187
30	-0.53	33.867	7.63	84.4	0.0275
50	-1.44	34.095	7.48	63.9	0.0422
75	-1.68	34.283	6.93	48.8	0.0561
100	-1.64	34.329	6.72	45.4	0.0677
125	-1.48	34.370	6.54	42.7	0.0785
150	-1.30	34.403	6.43	40.6	0.0887
175	-0.50	34.492	6.11	36.8	0.0982
200	-0.15	34.532	5.79	35.3	0.1070
300	1.15	34.689	4.74	30.6	0.1399
400	1.24	34.712	4.59	29.3	0.1705
500	1.13	34.716	4.56	28.4	0.2003
600	1.01	34.712	4.56	27.9	0.2294
700	0.87	34.704	4.58	27.7	0.2582
800	0.72	34.698	4.64	27.2	0.2865
1000	0.45	34.685	4.73	26.7	0.3416
1250	0.20	34.674	4.91	26.2	0.4079
1500	0.02	34.670	5.01	25.6	0.4710
2000	-0.23	34.658	5.27	25.3	0.5892

Station 6	Date 1984-1-21	Lat. 60-00.6 S	Air T. 3.0°C	Weather Fog
Depth 4540 m	TIME 15:12-16:56	Long. 116-02.1 E	Barro. 1000.5 mb	Wind ENE 7.5 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	2.04	33.810	103.4	7.75	100.8	1.57	18.2	25.1	0.31
10	2.08	33.807	103.9	7.73	100.6	1.61	17.9	24.2	0.46
20	2.08	33.808	103.8	7.75	100.9	1.61	17.9	24.1	0.46
30	2.01	33.816	102.7	7.80	101.4	1.61	17.7	24.2	0.45
50	1.91	33.843	99.9	7.76	100.6	1.62	16.3	24.2	0.45
75	0.43	33.927	84.3	7.82	97.6	1.94	24.0	25.6	0.39
100	-0.13	33.981	77.4	7.57	93.1	2.09	32.8	27.3	0.35
125	0.00	34.057	72.2	7.05	87.1	2.19	41.2	29.2	0.25
150	0.65	34.211	63.9	5.96	75.0	2.36	53.3	31.9	0.04
175	1.35	34.371	56.0	4.92	63.1	2.50	65.8	33.9	0.01
200	1.51	34.428	52.7	4.65	59.9	2.51	70.8	34.1	0.01
300	1.87	34.556	45.6	4.19	54.5	2.50	78.4	33.9	0.01
400	1.94	34.630	40.5	4.14	54.0	2.42	82.2	33.1	0.00
500	1.99	34.677	37.3	4.15	54.2	2.35	83.8	32.2	0.00
600	1.96	34.698	35.5	4.28	55.9	2.32	85.0	31.7	0.00
700	1.93	34.724	33.3	4.29	56.0	2.54	86.9	31.3	0.00
800	1.87	34.730	32.4	4.38	57.1	2.28	88.2	30.9	0.01
1000	1.67	34.737	30.4	4.50	58.3	2.27	93.5	30.9	0.00
1250	1.51	34.744	28.8	4.60	59.4	2.30	98.7	30.6	0.00
1500	1.29	34.738	27.7	4.61	59.2	2.24	105.2	30.8	0.00
2000	0.88	34.712	27.1	4.74	60.2	2.34	117.6	31.4	0.00

CTD-data

D	T	S	O	Dst	D-D
0	2.04	33.806	7.66	103.7	0.0000
10	2.04	33.805	7.66	103.7	0.0103
20	2.01	33.805	7.59	103.5	0.0207
30	1.97	33.804	7.62	103.3	0.0310
50	1.68	33.830	7.66	99.3	0.0512
75	0.76	33.894	7.68	88.6	0.0747
100	-0.18	33.934	7.62	80.8	0.0957
125	0.20	34.090	7.08	70.7	0.1146
150	1.10	34.310	6.18	59.0	0.1307
175	1.41	34.383	5.41	55.5	0.1451
200	1.62	34.446	4.98	52.1	0.1586
300	1.85	34.558	4.35	45.3	0.2079
400	1.95	34.630	4.21	40.5	0.2520
500	2.00	34.673	4.18	37.7	0.2928
600	1.98	34.698	4.24	35.6	0.3317
700	1.93	34.716	4.29	33.9	0.3690
800	1.86	34.728	4.36	32.5	0.4052
1000	1.71	34.735	4.47	30.9	0.4753
1250	1.51	34.736	4.56	29.3	0.5600
1500	1.28	34.729	4.59	28.3	0.6419
2000	0.89	34.708	4.69	27.4	0.7990

Station 6-1	Date 1984-1-23	Lat. 57-29.1 S	Air T. 3.1°C	Weather Overcast
Depth 4570 m	TIME 07:42-09:38	Long.115-59.1 E	Barro. 996.1 mb	Wind SE 7.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	2.82	33.884	103.8	7.60	100.9	1.57	8.8	26.6	0.54
10	2.88	33.890	103.9	7.59	100.9	1.54	8.8	26.5	0.54
20	2.87	33.888	103.9	7.59	100.9	1.52	8.5	26.5	0.54
30	2.86	33.885	104.1	7.64	101.5	1.51	8.5	26.6	0.53
50	2.62	33.892	101.6	7.63	100.8	1.53	9.2	26.4	0.52
75	1.56	33.909	92.5	7.73	99.4	1.72	13.5	27.1	0.48
100	0.87	33.928	86.7	7.68	97.0	1.93	22.3	28.0	0.45
125	0.51	33.937	84.0	7.71	96.5	1.96	25.4	28.3	0.44
150	0.22	33.955	81.1	7.63	94.7	2.00	28.6	28.7	0.42
175	0.45	34.042	75.7	7.06	88.3	2.11	35.5	31.0	0.25
200	0.98	34.160	69.7	6.11	77.5	2.28	46.4	33.5	0.07
300	1.95	34.433	55.5	4.49	58.5	2.48	68.8	36.2	0.00
400	2.02	34.499	51.0	4.25	55.5	2.49	74.2	36.1	0.00
500	2.08	34.584	45.0	3.94	51.6	2.45	78.9	35.5	0.00
600	2.11	34.638	41.2	4.06	53.2	2.40	81.6	34.2	0.00
700	2.08	34.679	37.8	4.13	54.1	2.34	84.2	33.2	0.00
800	2.04	34.707	35.4	4.21	55.1	2.31	85.5	33.5	0.00
1000	1.94	34.733	32.7	4.37	57.0	2.24	88.3	31.5	0.00
1250	1.78	34.744	30.7	4.47	58.1	2.21	93.7	31.0	0.00
1500	1.57	34.745	29.1	4.55	58.8	2.20	99.8	30.8	0.00
2000	1.13	34.726	27.6	4.71	60.2	2.25	112.7	31.2	0.00

CTD-data

D	T	S	O	Dst	D-D
0	2.82	33.873	7.50	104.7	0.0000
10	2.82	33.874	7.53	104.6	0.0104
20	2.82	33.874	7.52	104.6	0.0209
30	2.81	33.874	7.51	104.5	0.0313
50	2.61	33.875	7.51	102.8	0.0520
75	1.40	33.890	7.59	92.9	0.0765
100	0.92	33.909	7.51	88.4	0.0991
125	0.49	33.923	7.47	84.9	0.1207
150	0.18	33.935	7.42	82.4	0.1415
175	0.35	34.011	7.20	77.5	0.1614
200	0.93	34.141	6.56	70.9	0.1799
300	1.93	34.417	4.89	56.5	0.2440
400	2.02	34.489	4.42	51.7	0.2993
500	2.08	34.568	4.17	46.2	0.3500
600	2.10	34.640	4.09	40.9	0.3959
700	2.08	34.671	4.13	38.4	0.4383
800	2.04	34.699	4.20	35.9	0.4788
1000	1.93	34.724	4.33	33.3	0.5556
1250	1.76	34.736	4.46	31.1	0.6471
1500	1.56	34.736	4.55	29.7	0.7351
2000	1.13	34.719	4.67	28.1	0.9030

Station 6-2	Date 1984-1-24	Lat. 50-29.5 S	Air T. 5.9°C	Weather Cloudy
Depth 3180 m	TIME 18:37-20:29	Long.114-59.4 E	Barro. 1005.8 mb	Wind S 12.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	5.77	33.877	133.9	7.06	100.7	2.05	0.9	22.7	0.57
10	5.75	33.872	134.0	7.05	100.5	1.52	1.2	23.1	0.57
20	5.75	33.877	133.7	7.07	100.8	1.55	1.5	23.0	0.57
30	5.74	33.860	134.8	7.06	100.6	1.52	1.5	22.7	0.57
50	5.13	33.870	127.2	7.11	99.9	1.53	1.5	23.0	0.52
75	4.63	33.883	120.8	7.24	100.5	1.60	1.5	22.8	0.50
100	3.55	33.909	108.3	7.27	98.3	1.84	2.0	23.7	0.49
125	2.75	33.927	100.0	7.22	95.7	2.01	7.0	25.0	0.47
150	2.18	33.931	95.2	7.37	96.3	1.99	18.5	27.0	0.64
175	2.06	33.936	94.0	7.27	94.7	1.98	19.5	27.5	0.74
200	1.57	33.963	88.4	7.11	91.5	2.10	29.1	29.9	0.04
300	1.48	34.267	64.8	5.40	69.4	2.42	55.1	35.9	0.03
400	1.85	34.406	56.8	4.60	59.8	2.54	67.2	36.2	0.01
500	2.02	34.506	50.5	4.29	56.0	2.53	74.3	36.2	0.02
600	2.10	34.580	45.5	4.09	53.6	2.48	78.1	35.5	0.02
700	2.07	34.624	41.9	4.14	54.2	2.52	80.5	34.8	0.01
800	2.13	34.667	39.1	4.15	54.4	2.40	81.7	33.8	0.00
1000	2.08	34.714	35.2	4.24	55.5	2.34	83.6	32.7	0.00
1250	1.90	34.734	32.3	4.40	57.4	2.25	87.7	32.0	0.00
1500	1.74	34.743	30.5	4.54	59.0	2.47	93.2	31.7	0.00
2000	1.29	34.738	27.7	4.64	59.6	2.38	108.3	31.9	0.00

CTD-data

D	T	S	O	Dst	D-D
0	5.78	33.873	6.98	134.2	0.0000
10	5.77	33.876	6.96	133.9	0.0134
20	5.76	33.877	6.88	133.8	0.0268
30	5.74	33.874	6.86	133.7	0.0401
50	5.04	33.865	6.94	126.6	0.0662
75	4.15	33.863	7.06	117.4	0.0968
100	3.05	33.897	7.00	104.8	0.1247
125	2.31	33.908	6.98	98.0	0.1501
150	2.05	33.914	7.04	95.5	0.1743
175	1.88	33.936	7.05	92.7	0.1979
200	1.55	33.980	6.88	87.0	0.2205
300	1.44	34.265	5.68	64.7	0.2967
400	1.83	34.419	4.85	55.7	0.3577
500	2.05	34.518	4.34	49.8	0.4120
600	2.09	34.576	4.17	45.7	0.4620
700	2.07	34.621	4.10	42.1	0.5086
800	2.11	34.663	4.14	39.3	0.5526
1000	2.06	34.710	4.25	35.3	0.6353
1250	1.90	34.732	4.38	32.5	0.7320
1500	1.73	34.744	4.50	30.3	0.8239
2000	1.31	34.731	4.60	28.4	0.9980

Station 6-3	Date 1984-1-25	Lat. 47-29.7 S	Air T. 7.2°C	Weather Overcast
Depth 3800 m	TIME 10:28-12:31	Long. 115-00.0 E	Barro. 1011.0 mb	Wind W 7.2 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	9.19	34.085	164.7	6.52	100.8	1.39	1.9	15.1	0.43
10	9.25	34.084	165.6	6.45	99.8	1.29	2.0	15.0	0.45
20	9.24	34.081	165.7	6.56	101.5	1.31	2.2	15.0	0.42
30	9.21	34.081	165.3	6.55	101.3	1.30	2.2	15.1	0.42
50	9.21	34.083	165.1	6.72	103.9	1.30	2.2	15.1	0.42
75	9.21	34.074	165.8	6.41	99.1	1.30	2.2	14.9	0.43
100	7.57	34.094	140.5	6.54	97.5	1.53	4.4	16.7	0.51
125	6.64	34.112	126.9	6.72	98.0	1.61	7.5	18.0	1.17
150	6.65	34.169	122.8	6.53	95.3	1.57	8.0	19.5	0.55
175	5.92	34.049	122.8	6.58	94.3	1.66	8.3	21.4	0.02
200	5.40	34.050	116.7	6.65	94.1	1.73	16.9	22.8	0.02
300	4.92	34.151	103.8	5.93	83.0	2.05	17.4	27.0	0.02
400	4.31	34.209	93.1	5.56	76.7	2.22	23.6	29.5	0.01
500	3.61	34.213	86.0	5.55	75.3	2.31	29.8	31.1	0.00
600	3.10	34.237	79.6	5.34	71.5	2.45	37.1	32.4	0.00
700	2.88	34.288	73.8	5.01	66.8	2.56	46.0	33.6	0.00
800	2.62	34.342	67.6	4.72	62.5	2.64	53.7	34.7	0.00
1000	2.64	34.485	56.9	4.27	56.6	2.64	67.6	35.1	0.00
1250	2.48	34.599	47.0	4.14	54.7	2.59	75.4	34.3	0.00
1500	2.31	34.679	39.6	4.30	56.6	2.55	78.9	32.8	0.00
2000	2.10	34.734	33.8	4.50	59.0	2.42	85.0	31.6	0.00

CTD-data

D	T	S	O	Dst	D-D
0	9.19	34.082	7.06	164.9	0.0000
10	9.19	34.081	6.83	164.9	0.0165
20	9.19	34.082	6.80	164.9	0.0330
30	9.19	34.082	6.76	164.9	0.0495
50	9.19	34.082	6.76	164.9	0.0826
75	8.99	34.116	6.74	159.3	0.1233
100	7.84	34.087	6.75	144.7	0.1616
125	6.71	34.139	6.69	125.8	0.1958
150	6.56	34.142	6.62	123.6	0.2274
175	5.82	34.070	6.60	120.0	0.2583
200	5.37	34.037	6.57	117.3	0.2885
300	4.93	34.157	6.01	103.5	0.4013
400	4.20	34.207	5.60	92.1	0.5022
500	3.56	34.214	5.51	85.4	0.5944
600	3.10	34.245	5.27	78.9	0.6802
700	2.82	34.296	4.99	72.7	0.7598
800	2.62	34.348	4.70	67.1	0.8338
1000	2.60	34.487	4.18	56.5	0.9670
1250	2.47	34.603	4.03	46.7	1.1109
1500	2.30	34.689	4.13	38.8	1.2354
2000	2.10	34.740	4.39	33.3	1.4573

Station 7	Date 1984-1-26	Lat. 44-49.2 S	Air T. 12.6°C	Weather Drizzle
Depth 4340 m	TIME 18:10-20:24	Long. 114-54.2 E	Barro. 1000.4 mb	Wind NNW 14.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2
0	11.24	34.661	155.6	6.23	101.1	0.77	2.8	9.6	0.35
10	11.22	34.665	155.0	6.27	101.7	0.77	3.1	9.7	0.35
20	11.22	34.669	154.7	6.24	101.2	0.79	2.8	10.5	0.35
30	11.22	34.666	154.9	6.23	101.1	0.78	3.1	10.4	0.35
50	11.16	34.666	153.9	6.17	100.0	0.77	3.0	10.3	0.35
75	11.04	34.667	151.7	6.11	98.7	0.79	3.0	10.4	0.38
100	10.66	34.684	144.0	6.09	97.6	0.83	3.1	10.5	0.49
125	10.34	34.685	138.6	6.07	96.6	0.88	3.7	11.1	0.87
150	10.21	34.696	135.6	6.06	96.2	0.90	3.7	12.3	0.39
175	9.89	34.688	131.0	6.02	94.9	0.93	4.2	13.3	0.03
200	9.93	34.715	129.7	6.03	95.1	0.94	4.2	13.1	0.01
300	9.79	34.702	128.4	6.05	95.1	1.09	4.2	13.5	0.01
400	9.54	34.660	127.5	5.96	93.2	1.05	5.2	15.0	0.01
500	9.34	34.663	124.1	5.77	89.8	1.14	5.5	16.2	0.01
600	8.94	34.619	121.3	5.60	86.4	1.24	6.6	18.0	0.02
700	8.28	34.572	115.0	4.99	75.8	1.55	11.3	22.8	0.01
800	7.22	34.494	106.0	4.76	70.5	1.77	16.8	25.9	0.01
1000	4.85	34.332	89.5	4.94	69.1	2.13	27.5	30.8	0.01
1250	3.51	34.343	75.2	4.61	62.4	2.38	44.6	34.2	0.00
1500	2.82	34.451	61.0	4.29	57.2	2.50	61.8	35.7	0.00
2000	2.44	34.667	41.5	4.17	55.1	2.35	76.9	33.8	0.00

CTD-data

D	T	S	O	Dst	D-D
0	11.23	34.667	6.34	155.0	0.0000
10	11.23	34.669	6.32	154.9	0.0155
20	11.23	34.666	6.14	155.0	0.0310
30	11.23	34.667	6.14	155.0	0.0465
50	11.22	34.663	6.22	155.2	0.0777
75	11.08	34.670	6.28	152.1	0.1164
100	10.67	34.687	6.19	144.0	0.1538
125	10.37	34.702	6.15	137.8	0.1896
150	10.09	34.693	6.09	133.9	0.2242
175	9.85	34.682	6.12	130.8	0.2581
200	9.78	34.689	6.13	129.1	0.2915
300	9.57	34.664	6.21	127.6	0.4248
400	9.48	34.663	6.17	126.3	0.5586
500	9.32	34.666	5.97	123.6	0.6923
600	8.95	34.629	5.71	120.7	0.8250
700	8.25	34.576	5.07	114.2	0.9542
800	7.21	34.503	4.87	105.3	1.0761
1000	4.90	34.344	4.84	89.1	1.2932
1250	3.50	34.350	4.65	74.5	1.5222
1500	2.86	34.458	4.21	60.8	1.7140
2000	2.45	34.660	4.09	42.1	2.0201

Station 8	Date 1984-1-28	Lat. 39-54.8 S	Air T. 15.4°C	Weather Clear
Depth 4630 m	TIME 19: 43-21: 45	Long.114-54.5 E	Barro. 1020.1 mb	Wind NW 4.0 m/s

Observed

D	T	S	Dst	O	O-%	PO4	Si	NO3	NO2		
0	15.18	34.889	214.7	5.93	104.6	0.40	1.1	4.4	0.16		
10	15.04	34.866	213.5	5.93	104.3	0.43	1.7	4.5	0.16		
20	14.55	34.871	203.0	6.02	104.0	0.39	1.1	4.0	0.14		
30	14.38	34.068	199.7	6.06	105.1	0.43	0.9	3.8	0.13		
50	14.21	34.861	196.8	5.99	103.6	0.44	1.1	4.1	0.15		
75	12.28	34.737	168.7	6.07	100.8	0.61	3.0	7.4	0.28		
100	11.03	34.767	144.2	6.05	97.0	0.64	2.8	7.3	1.25		
125	10.94	34.790	140.9	5.96	96.2	0.66	3.0	8.8	0.15		
150	10.54	34.746	137.4	6.01	96.1	0.72	3.0	10.0	0.09		
175	10.37	34.723	136.3	6.03	96.1	0.76	3.4	11.0	0.03		
200	10.08	34.694	133.6	6.07	96.1	0.82	3.6	12.1	0.02		
300	9.58	34.711	124.3	5.85	91.6	0.99	5.6	15.7	0.01		
400	9.18	34.661	121.8	5.76	89.3	1.07	5.2	17.3	0.00		
500	8.99	34.644	120.2	5.78	89.3	1.09	5.6	17.9	0.01		
600	8.79	34.619	119.0	5.78	88.9	1.10	5.9	19.1	0.00		
700	8.50	34.586	117.1	5.48	83.7	1.30	7.7	21.3	0.00		
800	7.81	34.535	111.0	4.92	73.9	1.55	12.2	26.4	0.01		
1000	5.54	34.398	92.2	4.67	66.5	1.99	26.7	33.5	0.00		
1250	3.71	34.406	72.4	4.36	59.4	2.33	50.4	38.3	0.00		
1500	3.00	34.505	58.5	3.96	53.0	2.46	69.0	39.9	0.00		
2000	2.50	34.604	40.7	3.89	51.5	2.41	90.2	38.6	0.00		

CTD-data

D	T	S	O	Dst	D-D
0	15.17	34.869	6.30	215.9	0.0000
10	14.89	34.827	6.36	213.1	0.0214
20	14.56	34.852	6.44	204.5	0.0423
30	14.51	34.853	6.48	203.5	0.0628
50	14.38	34.859	6.53	200.3	0.1033
75	12.78	34.744	6.19	177.4	0.1509
100	11.30	34.754	6.06	149.8	0.1923
125	10.96	34.752	5.90	144.2	0.2296
150	10.68	34.736	5.86	140.5	0.2659
175	10.37	34.699	5.86	137.9	0.3015
200	10.07	34.672	5.89	135.2	0.3366
300	9.68	34.719	5.66	125.3	0.4718
400	9.21	34.659	5.83	122.4	0.6025
500	9.00	34.635	5.84	120.9	0.7326
600	8.77	34.603	5.95	119.8	0.8632
700	8.47	34.573	5.70	117.6	0.9937
800	7.75	34.520	5.10	111.3	1.1210
1000	5.52	34.309	4.68	92.6	1.3499
1250	3.65	34.309	4.37	73.1	1.5839
1500	2.97	34.502	3.94	58.4	1.7722
2000	2.50	34.673	3.81	41.6	2.0729