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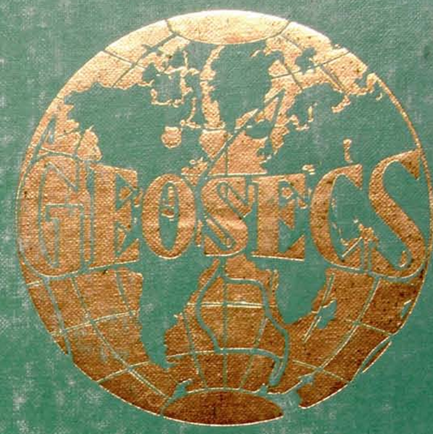

ATLANTIC EXPEDITION

Volume 2

Sections and Profiles

National Science Foundation · Washington, D.C.

GEOSECS
ATLANTIC EXPEDITION

Volume 2
SECTIONS and PROFILES

By
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Project Director, GEOSECS Operations Group

Sponsored by
International Decade of Ocean Exploration
National Science Foundation

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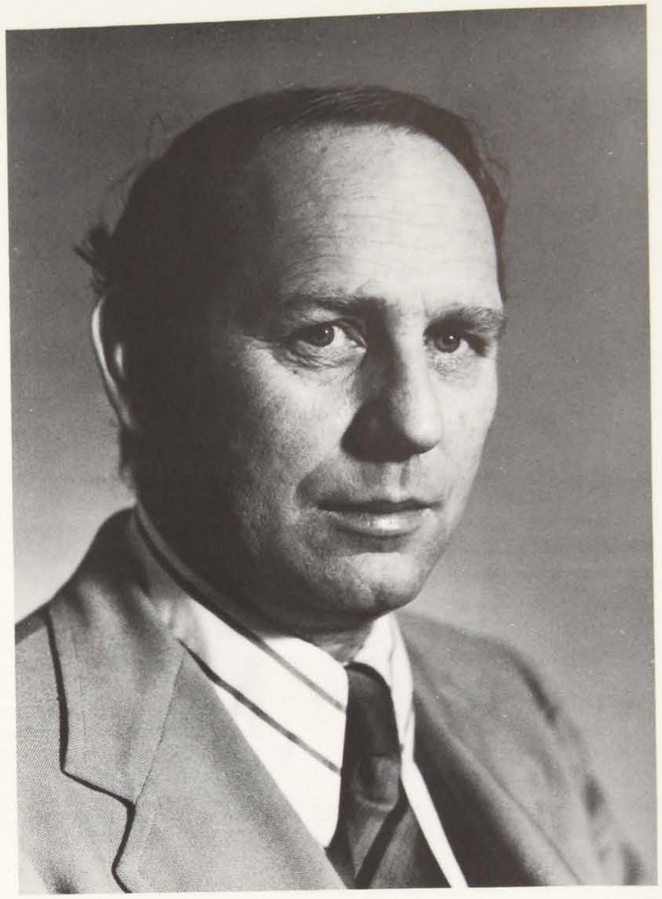

ARNOLD E. BAINBRIDGE

December 16, 1930—February 27, 1979

In memory of friendship and the pleasure of his company, in recognition of his many contributions to the GEOSECS program:

This book, which is primarily the result of his efforts, is gratefully and affectionately dedicated by his colleagues and shipmates.

Foreword

The GEOSECS Program was conceived by a handful of far-sighted geochemists and physical oceanographers in 1967. They successfully organized their scientific colleagues, developed a solid scientific and logistics plan, and carried out preliminary field work so that the Program was ready to begin simultaneously with the initiation of the International Decade of Ocean Exploration in 1970.

The members of that original GEOSECS panel were as follows:

Wallace S. Broecker, *Lamont-Doherty Geological Observatory*
Harmon Craig, *Scripps Institution of Oceanography*
H. Gote Ostlund, *University of Miami*
P. Kilho Park, *Oregon State University*
Joseph L. Reid, *Scripps Institution of Oceanography*
Derek W. Spencer, *Woods Hole Oceanographic Institution*
Henry M. Stommel, *Massachusetts Institute of Technology*
Taro Takahashi, *Lamont-Doherty Geological Observatory*
Karl K. Turekian, *Yale University*
Herbert L. Volchok, *Atomic Energy Commission*

The objective of the program was "the study of the geochemical properties of the ocean with respect to large-scale circulations problems." The goals for measurement accuracies, which the scientists set for themselves, were so rigorous that each shipboard and shoreside laboratory measurement was at the very forefront of the technology. Nevertheless, within the eighteen months between the start of the program in January 1971 and the start of the Atlantic transect in July 1972, the shipboard sampling and analytical tools were designed, constructed, and installed, and the shoreside laboratory construction and improvements were completed. The analytical goals were met or exceeded in all cases.

The responsibilities for upgrading the shoreside laboratories were assumed by the individual scientist at each institution. But, the responsibility for the shipboard equipment rested entirely with one man, Mr. Arnold E. Bainbridge of the Scripps Institution of Oceanography. The oceanographic community owes Mr. Bainbridge and his highly skilled technicians who formed GEOSECS Operations Group a debt of gratitude for their heroic efforts in preparation of the ships for the work to be done at sea, and for the excellence of the shipboard sampling and analyses.

These Atlas volumes were compiled by Mr. Bainbridge and the other GEOSECS scientists with the same care that typifies the collection and analyses of samples. They are now ready to take their place in oceanographic literature along with the volumes of the CHALLENGER and METEOR.

The National Science Foundation and, in particular, the International Decade of Ocean Exploration, is privileged to have played a role in this historic venture.

Feenan D. Jennings
Head, International Decade
of Ocean Exploration
National Science Foundation
Washington, D.C.
May 1976

Acknowledgements

The idea of carrying out a cooperative ocean-wide survey of radioisotopes and geochemical tracers in the sea originated with Henry Stommel; he, George Veronis, and Klaus Wyrtki have provided advice, encouragement, and strong support throughout the GEOSECS program.

With the exception of some early planning grants, funding for the program has been provided by the National Science Foundation Office of International Decade of Ocean Exploration. Feenan Jennings, head of the NSF-IDOE office from 1971 to 1978, provided leadership, wisdom and advice that played a crucial role in the success of GEOSECS. During the formative years of the program, funds were provided for planning by the National Science Foundation (Oceanography Section) and the U.S. Atomic Energy Commission (now Department of Energy). The assistance of Drs. Hugh McClellan and Charles Osterberg of these agencies is acknowledged with many thanks.

Three test and calibration cruises were a very important part of the development of GEOSECS. During these early preparations, the GEOSECS Operations Group was ably assisted by John Goddard of LDGO, and Susan Kadar and Peter Sachs of WHOI. Shale Niskin of General Oceanics, Inc. provided designs, equipment, and cheerful assistance at sea on three cruises. Credit for the development of the equipment used on the test cruises and the major expeditions goes to many people. The principal role was taken by Arnold Bainbridge, Project Director of the GEOSECS Operations Group. He personally supervised many aspects of instrument development and data flow from acquisition to final corrected and calibrated results. In all this work he was assisted by Rick Ackermann, electronics engineer; Tom Digre and Jack Spiegelberg, computer programmers, Bob Williams and Arnold Mantyla, chief analysts, Len Cunningham, chief marine technician, and Fred Dixon, development technician. These individuals, together with the other GOG staff members, developed the most modern, versatile and efficient seagoing data and sampling system ever used for geochemical and hydrographic studies of the ocean.

The GEOSECS Atlantic Expedition was carried out on R/V KNORR. Captains Emerson Hiller and Mike Palmieri, and the crew of the KNORR contributed to all aspects of the seagoing operation. Jerry Cotter, the KNORR's boatswain, deserves special mention for his cheerful endurance of long hours of work and little sleep. Assistance with the logistics of the Atlantic expedition was provided by Bill Jouris of WHOI. Major credit for the Alantic shipboard data belongs to the technicians and analysts of GOG (listed below) who worked with great skill and dedication throughout the voyage.

During the entire period of the Atlantic and Pacific expeditions, Phyllis Laking of WHOI served as Administrative Assistant to the Executive Committee. She handled proposals, organized meetings, filed the quarterly reports, and shouldered the most onerous burdens of the administrative program. Ms. Laking was aided in her efforts by Ellen Coxe of LDGO, Sandra Cajero and Kris Stewart of SIO, Barbara Stickney of RSMAS, and Bruna Jain and Harry Grow of GOG.

Drs. P. M. Fye and W. Nierenberg, Directors of WHOI and SIO respectively, strongly encouraged the development of the GEOSECS proposal and contributed to the solution of many problems in planning and execution. Special praise goes to the staffs of the Port Office and Shop Facilities at WHOI and the Marine Facilities Group at SIO. Without the efforts and dedication of all these people and many others at both institutions, our shipboard work would have been much more difficult.

W. S. Broecker, LDGO
H. Craig, SIO
D. W. Spencer, WHOI
H. G. Ostlund, RSMAS
Executive Committee,
Geochemical Ocean Sections Study

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Bruce W. Waldorf
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Introduction

These atlas volumes contain the record of the oceanographic measurements made during the Geochemical Ocean Sections Study (GEOSECS), a program of the International Decade of Ocean Exploration (IDOE), 1970-1980. The Geochemical Ocean Sections Study, or "GEOSECS" as the program has become known, was conceived as a cooperative multi-national and multi-institutional study of the oceans, based on the concept of a global survey of radioisotopes and other geochemical tracers accompanied by high-precision measurements of temperature, salinity, and density in both continuous and discrete-sample profiles.

The work reported in these atlas volumes includes the shipboard measurements made on the United States expeditions in the Atlantic, Pacific, and Indian Oceans, and the laboratory measurements performed on samples collected by these expeditions of scientists from the United States and other countries. The U.S. shipboard program was carried out on the Woods Hole Oceanographic Institution ship R/V KNORR and the Scripps Institution of Oceanography ship R/V MELVILLE, during three expeditions which were at sea for a total of 24 months. The Atlantic field work was done on R/V KNORR during the nine-month period from July 1972, to April 1973. Shortly afterwards, the Pacific expedition was carried out on R/V MELVILLE during the ten months from August 1973 to June 1974, and in December 1977, the MELVILLE began a five-month Indian Ocean expedition.

In addition to the U.S. Atlantic, Pacific, and Indian Ocean expeditions, scientists from West Germany and Japan have carried out associated GEOSECS studies aboard the German vessel METEOR in the Atlantic and the Japanese ship HAKUHŌ-MARU in the Pacific and Indian Oceans. The results of these allied investigations are being published separately and are not included in these volumes.

The GEOSECS program began with the recognition by Henry Stommel that the full potential of geochemical tracers for the study of circulation and mixing processes in the world oceans could only be realized by a large-scale collaborative effort in which simultaneous studies of the most significant properties were made over large sections of the oceans. A preliminary meeting involving Dr. Stommel, Drs. W.S. Broecker, H. Craig, and K. K. Turekian was held at Woods Hole in July of 1968 for the purpose of planning such a program. Shortly afterwards, P. Kilho Park, J. L. Reid, and H. G. Ostlund were added to this group and an initial proposal for a geochemical expedition was prepared. In the following year, the group was enlarged to a formal Scientific Advisory Committee by the addition of Drs. D. W. Spencer, T. Takahashi, and H. Volchok. Arnold Bainbridge was selected as Project Director of the GEOSECS Operations Group with the responsibility for shipboard operations and data processing.

During this initial phase of the program, the National Science Foundation and the Office of Naval Research supported several testing and intercalibration seagoing efforts in order to establish the feasibility of the proposed program. The "GEOSECS I" station in the Pacific off Baja California was occupied for a week of testing and equipment trials in September 1969 on Scripps R/V WASHINGTON; and "GEOSECS II", an Atlantic station off Bermuda, was occupied by R/V KNORR in August 1970. A full-scale dress rehearsal was then run on Leg 15 of SIO's Antipode Expedition in the southwest Pacific, aboard R/V MELVILLE in August 1971. On this expedition, the deep-water CTD developed by Neil Brown of WHOI was used successfully for the first time to depths of 5000 meters, and the combination of precise geochemical and hydrographic data with continuous CTD profiling resulted in the discovery of a major oceanographic feature—the benthic front, or density discontinuity, between the Pacific Deep Water and the Antarctic Bottom Water.

Antipode Expedition Leg 15, and two further trials—the GOGO I and GOGO II reoccupations of the GEOSECS I station in November 1971 and April 1972—set the basic style of the GEOSECS shipboard sampling and hydrographic program for the future expeditions. For hydrographic measurements and "normal-sized" water samples, Shale Niskin of General Oceanics had developed the rosette sampler, which holds 12 thirty-liter nonmetallic sampling bottles with reversing thermometers. The rosettes were equipped by A.E. Bainbridge and the GEOSECS Operations Group (GOG) with modified versions of the Neil Brown CTD, new dissolved-oxygen probes and nephelometers. A new hydrographic winch with conducting wire for CTD, rosette triggering, and other signals, was constructed and used with the rosettes.

For large volume water samples, required for the measurements of ^{14}C, ^{226}Ra, and other radionuclides, nine 270-liter Gerard-Ewing samplers, developed at LDGO, were constructed from stainless steel and used as multiple sampling devices on the trawl wire. Large-volume near-surface water sampling was done with a "seasucker," a pumping system designed for obtaining large quantities of water from depths down to about 350 meters. During 1971 and early 1972, necessary improvements were made to

the shorebased laboratory facilities needed for the analysis of the expedition samples.

The final selection of tracers and of participating laboratories was made by the Scientific Advisory Committee, and was based on three criteria established at the inception of the GEOSECS program:

1) Demonstration of a significant and reliably measurable variability in the oceanic concentration of a proposed tracer, a variability which would be correlated with circulation, mixing, and non-conservative processes.
2) Selection of a target sampling and analytical precision for each proposed tracer, and demonstration that such precision could be routinely achieved.
3) In almost all cases, the participation of more than one laboratory for the analysis of each tracer, with intercalibrations at selected stations as a continuing control on the quality of the data.

A list of the components selected as tracers which met the above criteria follows.

1) *Long-lived radioisotopes*

The three nuclides in this category are the oceanic "timekeepers": ^{14}C (radiocarbon), ^{226}Ra, and ^{32}Si. Two of these components, ^{14}C and ^{32}Si, have naturally-occurring stable isotopic species for calibration of non-conservative effects, but ^{226}Ra does not. Hence barium was included as a trace-element component for analysis because of its possible role as a chemical analogue for radium.

2) *Short-lived radioisotopes*

The initial selection of tracers in this category included ^{3}H (tritium), ^{228}Ra, and ^{222}Rn, the latter extracted from surface and bottom waters, and measured at sea because of its short half-life. The fission-product isotopes, ^{90}Sr and ^{137}Cs, were included for study at selected depths and locations in order to compare the distribution of these tracers to tritium. Later additions to this list included ^{210}Pb, after the discovery of the large disequilibrium between ^{210}Pb, and ^{226}Ra in deep waters, and ^{210}Po and ^{228}Th for further studies of the effects of particulate scavenging.

3) *Stable isotopes*

These tracers included D/H and $^{18}O/^{16}O$ ratios in seawater, ^{18}O in dissolved oxygen, phosphate, and sulphate, ^{13}C in dissolved inorganic carbon, and ^{13}C and ^{18}O in atmospheric CO_2.

4) *Dissolved gases*

Primary emphasis in this program was on the distribution of ^{3}He in seawater, because the injection of "excess ^{3}He" into deep water on oceanic rises provides a unique deep-sea tracer for circulation and mixing. ^{4}He and Ne concentrations were also measured, for calibration of the atmospheric ^{3}He component. In near-surface waters, the association of ^{3}H and ^{3}He provided a unique new parent-daughter isotopic pair for circulation studies. A shipboard measurement program for dissolved N_2 and Ar was also included in the program, for further control on the atmospheric "air-injection" component in deep water.

5) *Trace elements*

As noted above, the most important of these is barium, which can be measured mass spectrometrically with very high precision. Other trace elements included Sr, Cu, Ni, and other heavy metals.

6) *Particulates*

In addition to mineralogical and chemical studies on particulate material filtered from surface and deep water, thorium isotopes, ^{210}Pb, ^{226}Ra, ^{239}Pu, and ^{14}C in particulates, were analyzed in order to provide information on rates of settling of suspended material and on the chemistry of the scavenging processes associated with particles.

A complete list of the institutions participating in the analytical programs and the components studied by each is included in Table 1.

The regular GEOSECS expedition work began with the departure of R/V KNORR from Woods Hole on July 18, 1972, for the nine-leg Atlantic expedition. At this time, the program was directed by an Executive Committee consisting of W. S. Broecker, H. Craig, D. W. Spencer (appointed in 1970), together with a Scientific Advisory Committee consisting of these

Table 1—Major Participating Institutions, Principal Investigators, and Scientific Programs (Atlantic and Pacific Expeditions)

INSTITUTION	PRINCIPAL INVESTIGATORS	SCIENTIFIC PROGRAMS
Atomic Energy Commission (from 1975 Health & Safety Laboratory, ERDA)	H. Volchok	Fallout studies
Centre des Faibles Radio-activités Gif-sur-Yvette, France	R. Chesselet	Particulate analysis (trace elements)
Lamont-Doherty Geological Observatory of Columbia University	W. S. Broecker, P. E. Biscaye, H. W. Feely	^{222}Rn, ^{226}Ra, ^{228}Ra, ^{228}Th; Particulate studies
Louisiana State University	L. H. Chan	Ba
Massachusetts Institute of Technology	J. M. Edmond	Ba; Trace elements
McMaster University Hamilton, Ontario, Canada	W. B. Clarke	^{3}He, He, Ne
Oregon State University	P. K. Park, L. I. Gordon	Nutrients, pH
Queens College, City University of New York	T. Takahashi	Atmospheric CO_2, pCO_2
Scripps Institution of Oceanography University of California at San Diego	H. Craig, Y. Chung, J. E. Lupton, R. F. Weiss	^{2}H and ^{18}O (H_2O); ^{13}C (CO_2); ^{3}He, He, Ne; ^{226}Ra, ^{210}Pb; N_2O, N_2, Ar; ΣCO_2 (gas chromatography)
Scripps Institution of Oceanography University of California at San Diego GEOSECS Operations Group	A. E. Bainbridge, A. W. Mantyla, R. T. Williams	Salinity, nutrients, O_2, CTD, ΣCO_2 (titration), alkalinity
Tata Institute Bombay, India (from 1973 Physical Research Laboratory) Ahmedabad, India	D. Lal, B.L.K. Somayajulu, S. Krishnaswami	^{32}Si; Particulate studies; ^{14}C, Th isotopes, ^{210}Pb, ^{226}Ra, and ^{239}Pu in particulates
U.S. Naval Oceanographic Office (from 1976 University of South Carolina)	W. S. Moore	^{228}Ra
Universita di Pisa, Pisa, Italy Laboratorio di Geologia Nucleare	A. Longinelli	$^{18}0$ (SO_4, PO_4)
Université Libre de Bruxelles Bruxelles, Belgium	J. Jedwab	Particulate analysis (trace elements)
University of Hawaii	P. Kroopnick	^{13}C (ΣCO_2); $^{18}0$ (dissolved O_2)
University of Miami	H. G. Ostlund	^{3}H, ^{14}C
University of Southern California	T-L. Ku	^{226}Ra
University of Washington	M. Stuiver	^{14}C
Woods Hole Oceanographic Institution	D. W. Spencer, P. G. Brewer, V. Bowen	Particulate studies; I; ^{90}Sr, ^{137}Cs
Yale University	K. K. Turekian	Sr; ^{210}Pb, ^{210}Po

three together with A. Gordon, H. G. Ostlund, P. K. Park, J. L. Reid, H. Stommel, T. Takahashi, K. K. Turekian, H. Volchok, and K. Wyrtki. The Atlantic expedition, coordinated by D. W. Spencer of Woods Hole, lasted nine months. The KNORR returned to WHOI on April 4, 1973, after having occupied 116 Atlantic stations from 75°N in the Greenland Sea to 61°S in the Drake Passage. More than 10,000 water samples, ranging in size from small glass ampoules to 100-liter plastic drums, were stored in the Woods Hole "GEOSECS Water Library" facility, and winch, vans, computer, and the complete inventory of deck gear and analytical equipment were immediately transferred to the Scripps Institution of Oceanography for the Pacific expedition work on R/V MELVILLE.

The Pacific expedition work began at Scripps on August 22, 1973. Administrative changes at this time included the addition of H. G. Ostlund to the GEOSECS Executive Committee, and of J. Edmond to the Scientific Advisory Committee. H. Craig was the Expedition Coordinator for the ten-leg Pacific expedition, which ended on June 10, 1974, after occupying 147 Pacific stations.

Following the Pacific work, there was a three and one-half year delay in seagoing work while the shorebased laboratories in the U.S. and other countries concentrated on the analysis of Atlantic and Pacific samples. In 1975, P. E. Biscaye, P. G. Brewer, and R. F. Weiss were added to the Scientific Advisory Committee to help prepare the Indian Ocean program. The Indian Ocean expedition work began with R/V MELVILLE leaving Alexandria, Egypt, on 15 December 1977. A. E. Bainbridge acted as Expedition Coordinator for this expedition.

The scientific program on the GEOSECS expeditions changed only slightly from its inception on the Atlantic legs in 1972-73. The shipboard analytical program included the standard hydrographic parameters, temperature, salinity, oxygen, and nutrients (nitrate, phosphate, and silica), together with total dissolved inorganic carbon measured by two techniques: titration (which also gave alkalinity), and shipboard gas chromatography. Ancillary shipboard programs included the measurement of radon activity in surface mixed layer and bottom water profiles, measurement of dissolved nitrogen and argon by shipboard gas chromatography, and measurement of atmospheric and surface water CO_2 partial pressure using an infrared analyzer. In addition to these discrete parameters, continuous profiles of temperature, salinity, dissolved oxygen, and particulate concentration by nephelometry, were obtained on station in real time, using the probes mounted on the sampling rosette.

Particulate samples were collected in several ways. Water samples from the thirty-liter rosette samplers were filtered to provide small particulate sample profiles for U.S. investigators. Continuous filtration of surface water (the "J-underway program") was carried out to provide large-volume surface particulate samples throughout the oceans. In the Pacific, deep-water particulate profiles were obtained at one station per leg by pumping up to 5000 liters of water through battery-operated filtration units suspended on the wire. These large-scale particulate sampling programs were instituted by the Physical Research Laboratory of Ahmedabad, India. Additional particulate profiles (one per leg) were also obtained for ^{210}Pb analysis in the Pacific by filtering 200 liters of water collected in the Gerard barrels.

The GEOSECS station plan in the Atlantic and Pacific consisted of alternate "large volume" and "small volume" stations. At both types of stations, water samples were collected at approximately 50 depths in the nonmetallic thirty-liter sampling bottles, using a pair of the sampling rosettes on the conducting hydrographic wire for each rosette cast. There were generally three rosette casts: a "bottom rosette" cast which included a bottom-radon profile, and a "deep rosette" and "shallow rosette" cast. At some stations, only one or two rosette casts were taken and the shallow rosette was replaced by a shallow Niskin bottle cast with bottles attached to the wire at predetermined intervals. In the Atlantic work, the rosette casts were supplemented by metal Nansen bottle casts for duplicate salinity and temperature profiles, but this practice was discontinued at the end of the Atlantic expedition.

At the "large volume" stations, additional sampling included use of the 270-liter Gerard barrels, usually in three casts of six samples each, to collect the large volume water samples for ^{14}C, ^{228}Ra, and other radioisotope studies. In some cases, these "Gerard casts" were supplemented with large-volume samples collected at shallow depths with the "seasucker" pumping system.

In certain areas of special interest such as equatorial crossings, CTD casts were made at supplementary station positions; these stations are labeled "SDT stations." In most cases, these CTD casts were made with a single rosette, so that discrete temperature, salinity, and, in some cases, oxygen data were measured at approximately 10 depths for calibration purposes. These discrete sample data, together with supplementary salinity and temperature data extracted from the continuous CTD record,

are tabulated for the "SDT stations"; for example, stations 43-45 and 47 in the equatorial Atlantic on Atlantic Leg 4.

In general, the first cast made at a station was a "bottom rosette" or "deep rosette" cast, so that the actual hydrographic structure of the entire water column could be displayed by the shipboard computer system at the beginning of station work. The scientist at the data console controlled the lowering rate of the rosette package by voice communication with the winch operator, while observing a set of profiles and plots on the four CRT displays in the control room. Thus the temperature, salinity, dissolved oxygen, density, and light scattering profiles, together with plots such as potential temperature vs. salinity, could be studied as the sensor package went down. During this time, the discrete sampling scheme relative to the various significant features of the water mass structure was laid out. Discrete sampling was then carried out during the ascent of the rosette system by manual triggering of rosette bottles at the desired depths. (For the Pacific expedition, the exact position of the rosette package on each profile or property plot was continually indicated on the displays). In this way, it was possible to obtain accurate core properties and precise gradients for the geochemical parameters being mapped, and at the same time, to adjust the sampling density according to the gradients in temperature, salinity, density, dissolved oxygen or particulate concentration, as desired.

The importance of the "real-time" sampling system for a program such as GEOSECS is amply demonstrated by the profiles of nutrient data and geochemical parameters obtained across sharp discontinuities such as the "benthic front" in the South Pacific, and in the very subtle but beautifully defined vertical structures observed in the North Atlantic Deep Water profiles, especially in the equatorial and south Atlantic. These profiles reveal significant core structures and gradients, which, although never previously observed, are readily correlated from property to property, as shown, for example, in the potential temperature, salinity, oxygen, silica, and nutrient profiles for stations 40 and 48 at 4° north and south of the equator in the Atlantic (see Figures 1 and 2).

"An ocean is forever asking questions," wrote Edwin Arlington Robinson, "and writing them aloud along the shore." The data presented in these volumes may answer some old questions, and pose new ones yet unasked, but they will surely contribute new dimensions to our understanding of the intricate chemical and physical processes which govern the distribution of geochemical parameters in the sea.

FIGURE 1
GEOSECS ATLANTIC EXPEDITION
STATION 40

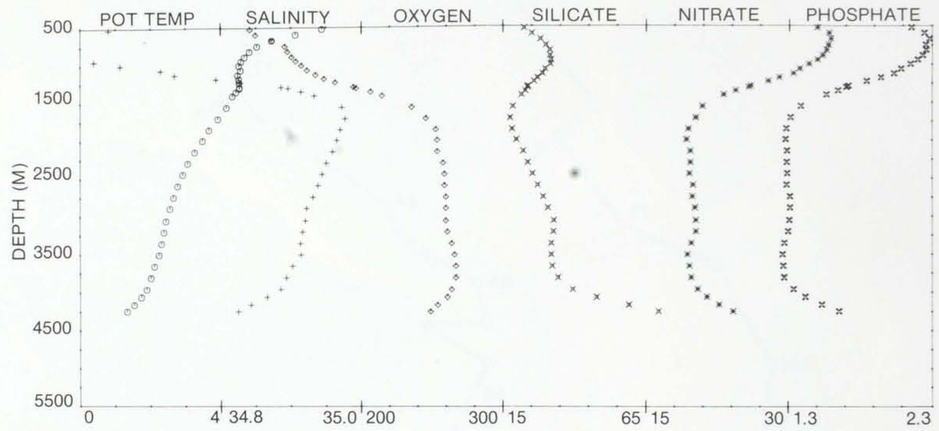
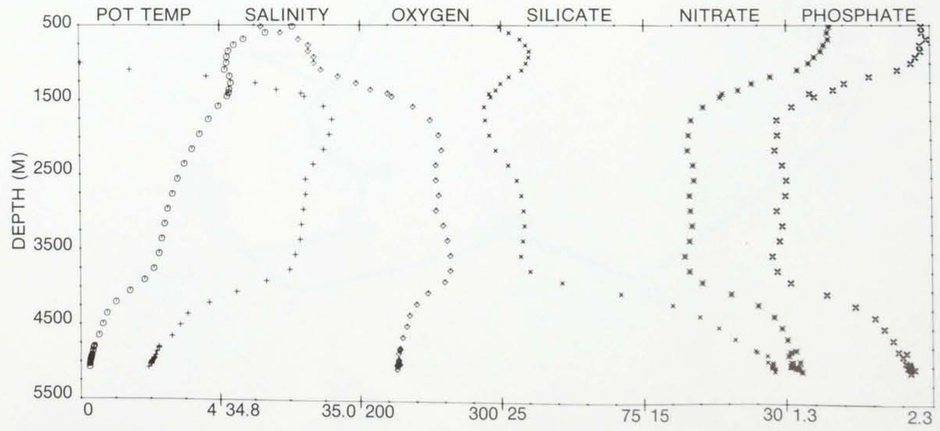


FIGURE 2
GEOSECS ATLANTIC EXPEDITION
STATION 48



Itinerary of R/V KNORR

	DEPART	ARRIVE
LEG 1	Woods Hole, Massachusetts 18 July 1972	Reykjavik, Iceland 1 August 1972
LEG 2	Reykjavik, Iceland 12 August 1972	Reykjavik, Iceland 30 August 1972
LEG 3	Reykjavik, Iceland 4 September 1972	Bridgetown, Barbados 1 October 1972
LEG 4	Bridgetown, Barbados 9 October 1972	Recife, Brazil 31 October 1972
LEG 5	Recife, Brazil 4 November 1972	Buenos Aires, Argentina 28 November 1972
LEG 6	Buenos Aires, Argentina 2 December 1972	Ushuaia, Argentina 22 December 1972
LEG 7	Ushuaia, Argentina 30 December 1972	Capetown, Republic of South Africa 5 February 1973
LEG 8	Capetown, Republic of South Africa 10 February 1973	Dakar, Senegal 7 March 1973
LEG 9	Dakar, Senegal 10 March 1973	New York, New York 1 April 1973

TRACK OF R/V KNORR, GEOSECS ATLANTIC EXPEDITION, 1972-73

TRACK OF R/V KNORR, GEOSECS ATLANTIC EXPEDITION, 1972-73

PLATE 1

Bathymetry of the Atlantic Ocean. The isobaths shown on this Lambert equal area projection were taken primarily from the Mercator projection of Chase (1975). The Arctic bathymetry north of 75° N was simplified from Pinther (1975); Antarctic details south of 70° S were taken from Heezen and Bentley (1972). Shuran (1966) was used to augment the bathymetry of the Mediterranean Sea. Only those features needed to illustrate the major topography of the Atlantic Ocean are reproduced on this chart. Changes in color intensity occur at the 1 kilometer isobath, and at 1 kilometer intervals from 3 to 6 kilometers. The 2 kilometer isobath is omitted except in areas where features of interest are not adequately described by the 1 or 3 kilometer contours. Prepared by GEOSECS Operations Group.

REFERENCES

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Pinther, M., Chief Cartographer, 1975, *Map of the Arctic Region*, American Geographical Society, Sheet 14 of the Series

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Shuran, E.M., Editor, 1966, *Mediterranean Sea*, Central Administration of the Geodesic and Cartographic Ministry of Geology, Moscow, U.S.S.R.

CHAPTER 1

Vertical Sections and Profiles

The vertical distributions of hydrographic and chemical properties measured aboard the R/V KNORR during the GEOSECS Atlantic Expedition are illustrated on the following pages. Vertical sections appear on each right-hand page. On the facing page, the individual property values are plotted against depth, station by station, each station offset along the horizontal axis by a constant increment of the property.

The selection of the stations from which the sections were produced was, for the most part, determined by simple geographical considerations and the ship's track. Where choices were possible, primarily the high latitude regions, stations were selected to best illustrate features of the deep and bottom waters. A number of variations were suggested and tried, particularly at the southern end of the Western Atlantic section in the Drake Passage-Circumpolar Current region. Each of the variations resulted in artificial waves in the contours, induced by crossing and recrossing the meandering Circumpolar Current. Neither the station locations nor spacing are suitable to best illustrate the Circumpolar Current; the sections with that title simply present the data acquired along the southern portion of the ship's track.

The vertical sections in this atlas are neither meridional nor latitudinal projections. The spaces between adjacent stations on the sections are directly proportional to the great circle distances between the geographic station positions. The vertical exaggeration of the 0-6000 meter sections is 1000:1. Expanded sections of the upper kilometer were made with a vertical exaggeration of 2500:1. Tick marks along the bottoms of the sections indicate the locations of either latitudes or meridians, depending on the orientation of the section. Spacing of the tick marks may be irregular because of the irregular nature of the ship's track. Station locations were selected to best characterize deep ocean circulation rather than to produce meridional or latitudinal sections. The station numbers are given at the upper border of each section.

Bottom depth soundings were not routinely made while underway between stations, except on Legs 7, 8 and 9. The ocean bottom contours shown on the vertical sections have been drawn to illustrate features which may influence deep circulation. Data sources include Uchupi (1), Lonardi and Ewing (2), and Udentsev (3). In those areas where no prominent features were apparent, a smooth line was drawn between the plotted bottom depths recorded by the ship's precision sounding equipment while on station.

The chemical data presented in this volume are derived from measurements made on seawater samples collected, with few exceptions, in 30-liter polyvinyl-chloride Niskin bottles. Stations 104, 106, 108, 110 and 112 were sampled with Teflon-lined brass Nansen bottles. Occasional unexplainable anomalies in the Nansen phosphate and dissolved oxygen data indicate that the uncoated brass sampling valve, and possible pinholes in the Teflon, may have introduced errors in the metal-sensitive analyses.

In most cases, pressure and temperature data are taken from records generated by a CTD calibrated by comparison with high precision deep sea reversing thermometers. Occasionally, temperatures and pressures were measured solely by reversing thermometers where weather, cast scheduling or electronic problems precluded the use of the CTD. Salinities were determined on all samples by a University of Washington conductive bridge salinometer. In rare instances where salinity values appeared erratic or uncertain, CTD-derived salinities have been substituted.

Dissolved oxygen was determined by a modified Winkler technique (4). The nutrients, phosphate, nitrate and silicate, were measured with a modified Technicon AutoAnalyzer II®. Alkalinity and total CO_2 were calculated from potentiometric acid titration data obtained from computer-controlled titrators (5,6). The density anomalies, sigma theta and sigma 4, were calculated by the equation of Cox *et al.*(7), from the measured salinity and the potential temperature referenced to 0 and 4000 decibars respectively.

Both manual and computer techniques were combined in the production of the sections. Work sheets were first prepared by a computer at the GEOSECS Operations Group facility. On these sheets were plotted the sampling levels at each station, and the value of the parameter at each level. The computer output was then hand-contoured in pencil. Data points flagged with a "U" (indicating uncertain value) in the tabular data were ignored in contouring.

Potential temperature, salinity, the two density parameters, and dissolved oxygen were contoured almost literally. The precision of these data was such that little or no smoothing by the artist was necessary. The

same may be said of the three nutrients, phosphate, nitrate, and silicate, with very few exceptions where rounding or smoothing, typically below the ±1% level, produced a more realistic interpretation.

Natural deep water alkalinity and total CO_2 variations, either within a single station or from station to station, seldom exceed 2% of the background level. If sections of these properties were to be contoured literally they would require data of a precision higher than was possible at the time the GEOSECS Atlantic Expedition was completed. These sections have therefore been contoured with slightly more interpretation than the others. With one exception, however, smoothing or rounding of alkalinity and total CO_2 data was not necessary above the ±0.5% level. The total CO_2 data taken on Leg 3 (Stations 28-34) have been systematically modified, for contouring purposes only, by the subtraction of 17 μEq/kg from each data point. The tabulated total CO_2 data given in Volume I of the GEOSECS Atlantic Atlas are the original values.

Potential temperature, salinity and sigma theta are interdependent; therefore an attempt was made to maintain internal consistency in the contours of these properties, particularly in the upper kilometer between stations. The individual parameter contours cross each station at the point indicated by the data. The locations of extrema or inflections in salinity contours between stations, where no data are available, were based as well as possible on the shape of the potential temperature and sigma theta contours.

The contour intervals used throughout the Atlantic sections are those which appeared most appropriate for the Western Atlantic section. Major and minor intervals indicated by bold and light solid lines, respectively, were selected for all parameters and appear consistently on all sections. Smaller contouring intervals, using dashed lines, were employed on a slightly more subjective basis, and were generally not used extensively in the upper kilometer, or in deeper areas where no additional detail would be shown.

After the contouring was finalized, computer-produced blank sections were used as overlays, and contours were transferred to the blank by applying solid black or dashed slit tape. The sections were labeled, arranged in the proper atlas page format and photographically reproduced at 23% of their original size.

The colors representing the ranges of the various parameters were selected after reviewing a number of oceanographic atlases (8-12) in order to preserve any conventions that may have been established. The choice of red for warm and blue for cold temperatures was unanimous. No color schemes for the other properties were well established, but Reid (9) and Stommel *et al.* (10) were in close agreement on the colors for salinity, oxygen and phosphate. For this reason it was decided to follow the color scheme of the Scorpio sections (10) where possible, and to use other combinations of those same colors for the remaining properties. The GEOSECS Atlas color scheme is given in Table 2.

Either 3 or 4 shades of each color were used for all properties, varying from 100% of the base color, representing one extreme in the range of the property to a 20% shade at some intermediate value of the property. The isolines where color or shade changes occur were selected to illustrate the major water masses of the Western Atlantic section. For comparative purposes, the color or shade separations of all other sections were maintained along the same isolines, with the result that not all shades, or even both colors, appear on all sections of the same property.

The profiles on the pages facing the sections offer a different visual representation of the vertical property distributions. Extrema are frequently more obvious in the profiles than on the sections. The horizontal axis scales for any given property will vary from one set of profiles to another because the overall width of the plot matches the width of the corresponding section, and that dimension is governed solely by the distance between the stations. Fewer stations along a section permit a greater scale expansion on the profile plots. The property-property plots in Chapter 2 should be used for comparing profiles from stations which appear on different sections.

Two sets of profiles, from the surface to 1000 meters depth and from the surface to 6000 meters, were prepared for those properties which vary only slightly in the deep water relative to the variations in the shallower regions. In other cases, where the range of natural variation is similar throughout the water column, only the 0-6000 meter profiles are included.

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TABLE 2
VERTICAL SECTION COLOR SCHEME

POTENTIAL TEMPERATURE (°C)

- Greater than 20
- 10 to 20
- 6 to 10
- 4 to 6
- 3 to 4
- 2 to 3
- 0 to 2
- Less than 0

SALINITY (°/₀₀)

- Greater than 36.0
- 35.5 to 36.0
- 35.0 to 35.5
- 34.9 to 35.0
- 34.7 to 34.9
- 34.5 to 34.7
- 34.3 to 34.5
- Less than 34.3

SIGMA THETA

- Less than 26.5
- 26.5 to 27.0
- 27.0 to 27.5
- 27.5 to 27.8
- 27.8 to 27.9
- 27.9 to 28.0
- Greater than 28.0

SIGMA 4

- Less than 44.0
- 44.0 to 45.5
- 45.5 to 45.8
- 45.8 to 46.0
- 46.0 to 46.1
- Greater than 46.1

OXYGEN (μM/kg)

- Greater than 310
- 280 to 310
- 260 to 280
- 240 to 260
- 200 to 240
- 140 to 200
- Less than 140

SILICATE (μM/kg)

- Less than 10
- 10 to 25
- 25 to 50
- 50 to 100
- 100 to 120
- Greater than 120

PHOSPHATE (μM/kg)

- Less than 0.5
- 0.5 to 1.0
- 1.0 to 1.3
- 1.3 to 1.6
- 1.6 to 2.0
- Greater than 2.0

NITRATE (μM/kg)

- Less than 8
- 8 to 16
- 16 to 20
- 20 to 26
- 26 to 32
- Greater than 32

ALKALINITY (μEq/kg)

- Less than 2300
- 2300 to 2320
- 2320 to 2340
- 2340 to 2370
- 2370 to 2400
- Greater than 2400

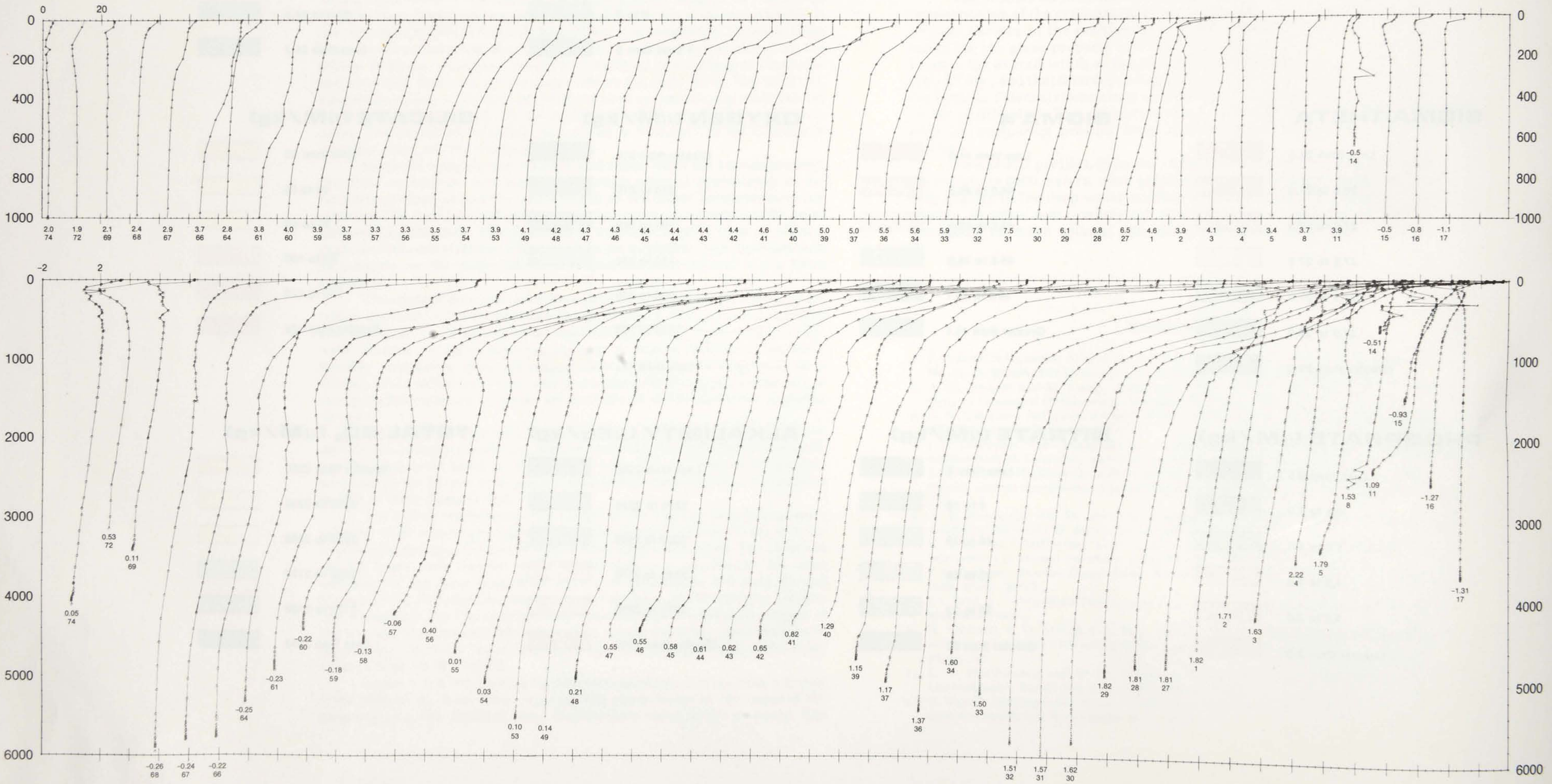
TOTAL CO_2 (μM/kg)

- Greater than 2260
- 2260 to 2230
- 2230 to 2200
- 2200 to 2170
- 2170 to 2100
- Less than 2100

PLATE 2

Vertical distribution of Potential Temperature (°C) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC



θ

WESTERN ATLANTIC

PLATE 3

Vertical distribution of Potential Temperature (°C) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

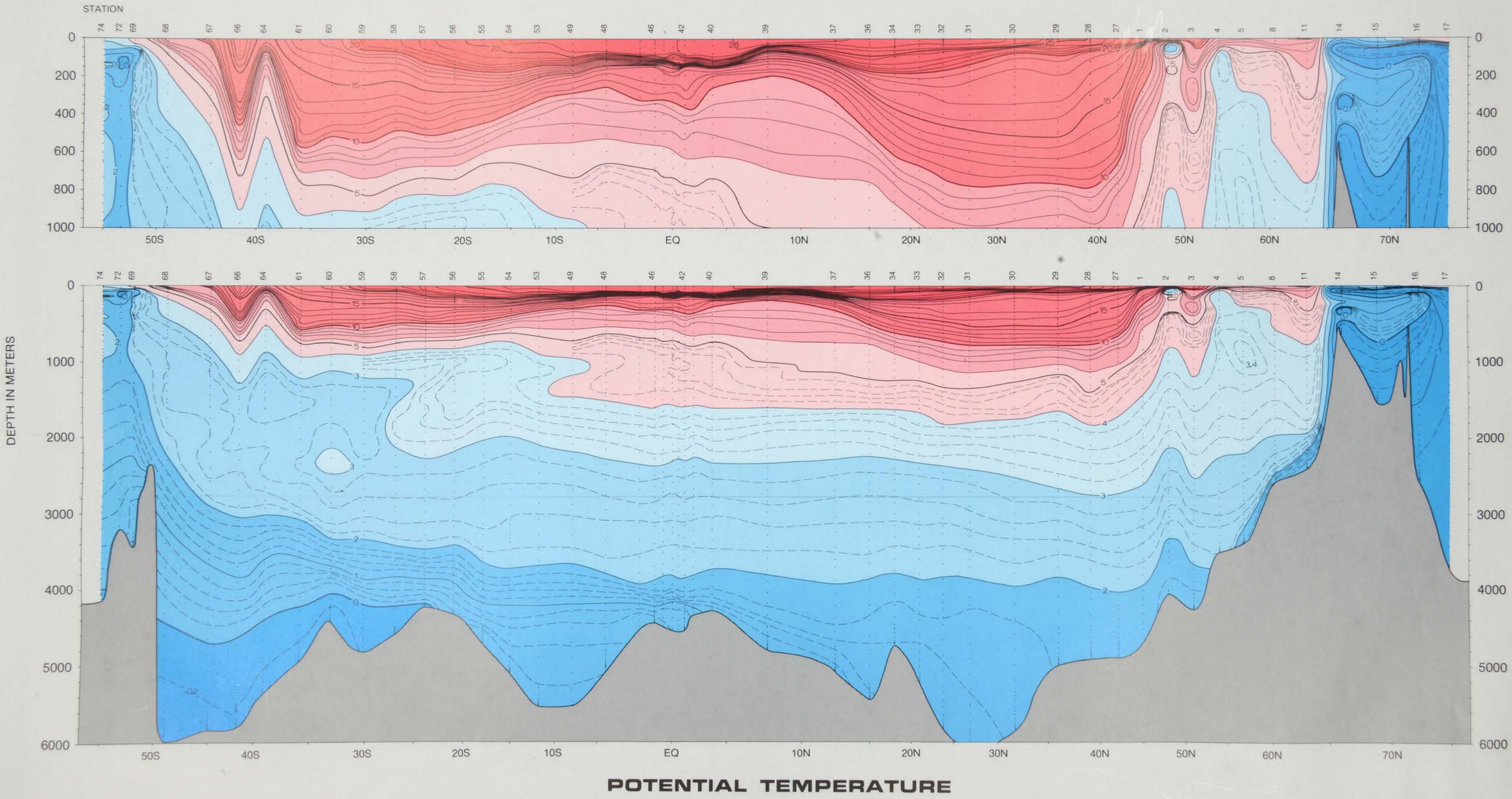
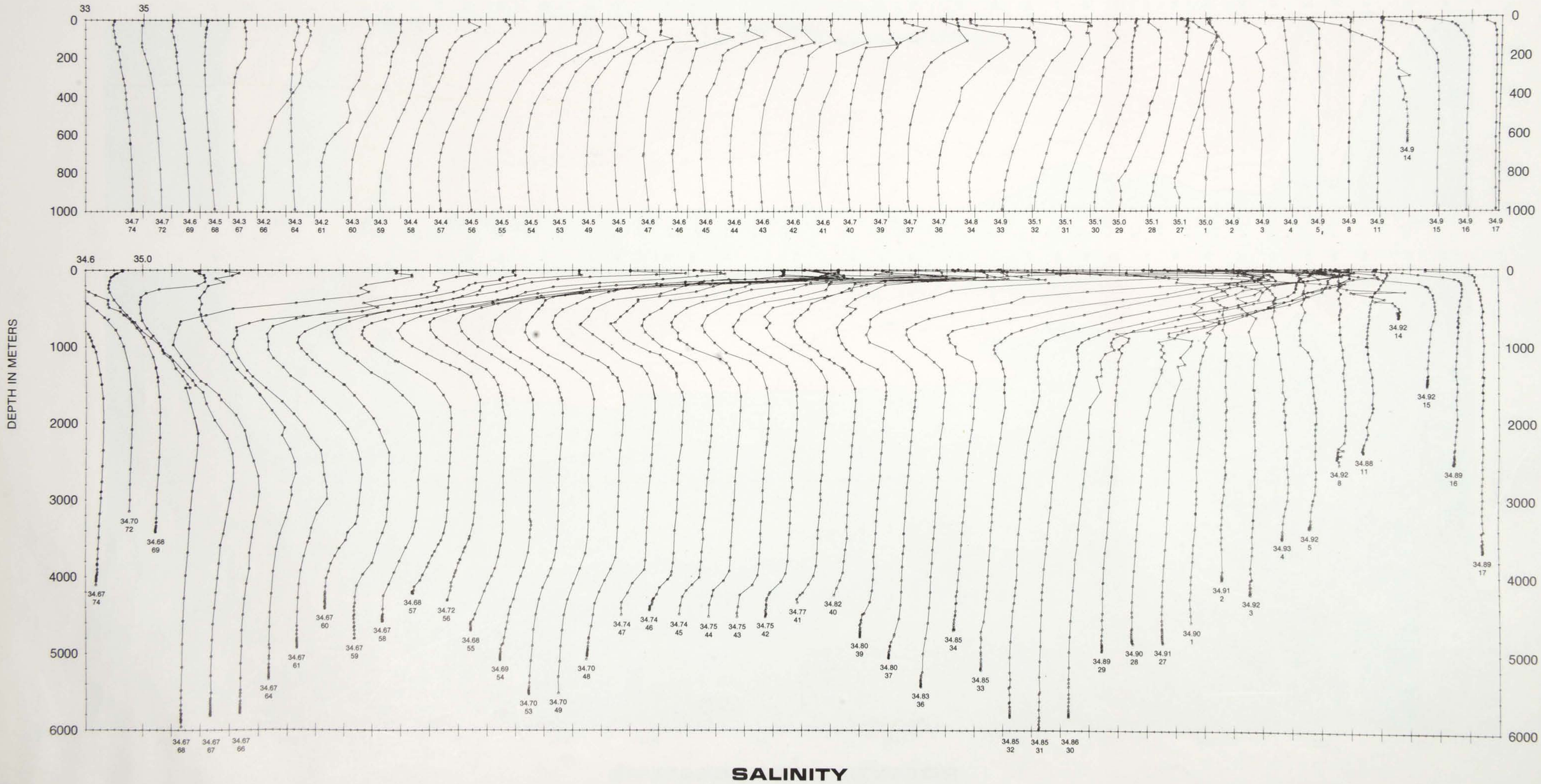


PLATE 4

Vertical distribution of Salinity (‰) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC



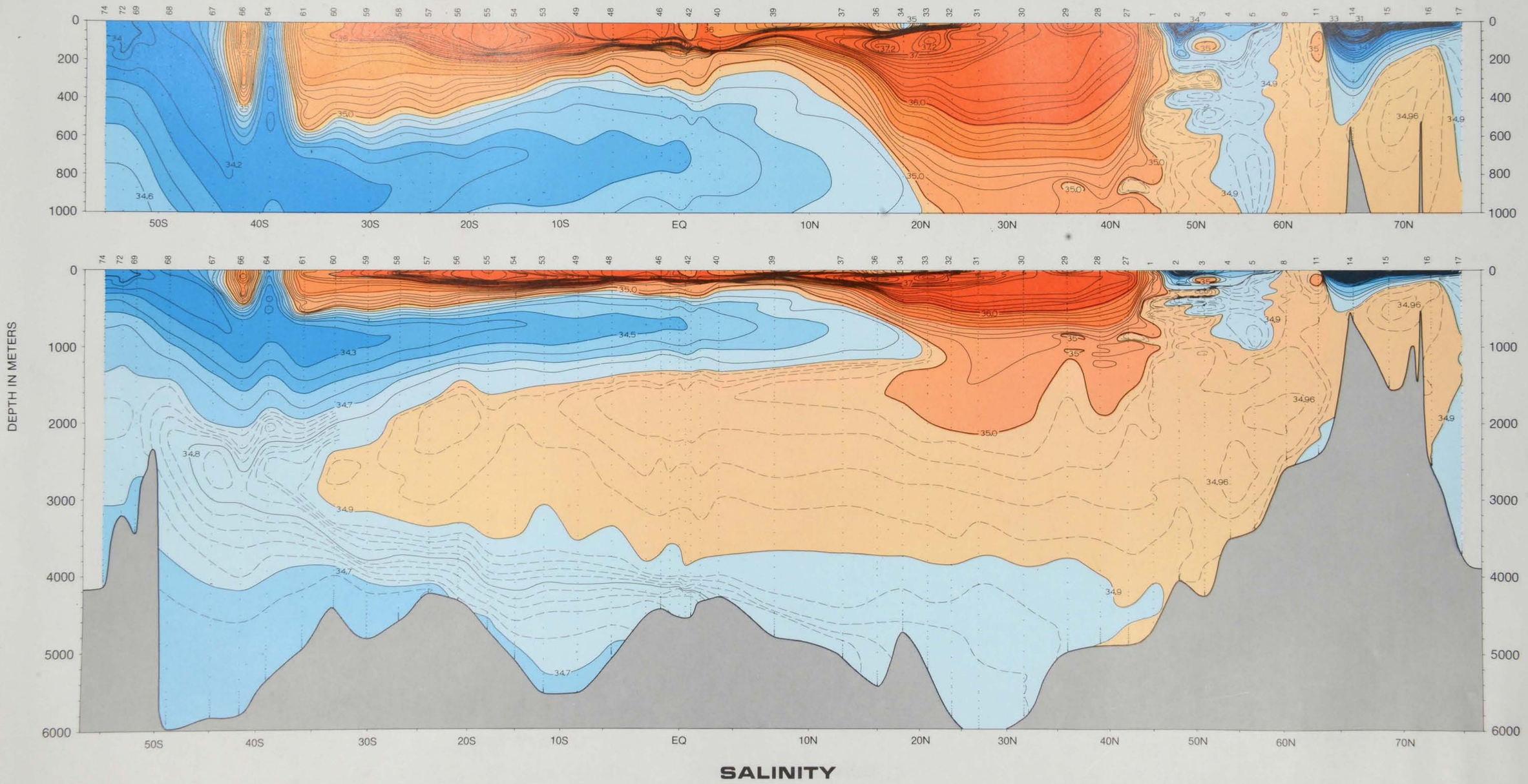
S

WESTERN ATLANTIC

PLATE 5

Vertical distribution of Salinity (‰) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

STATION



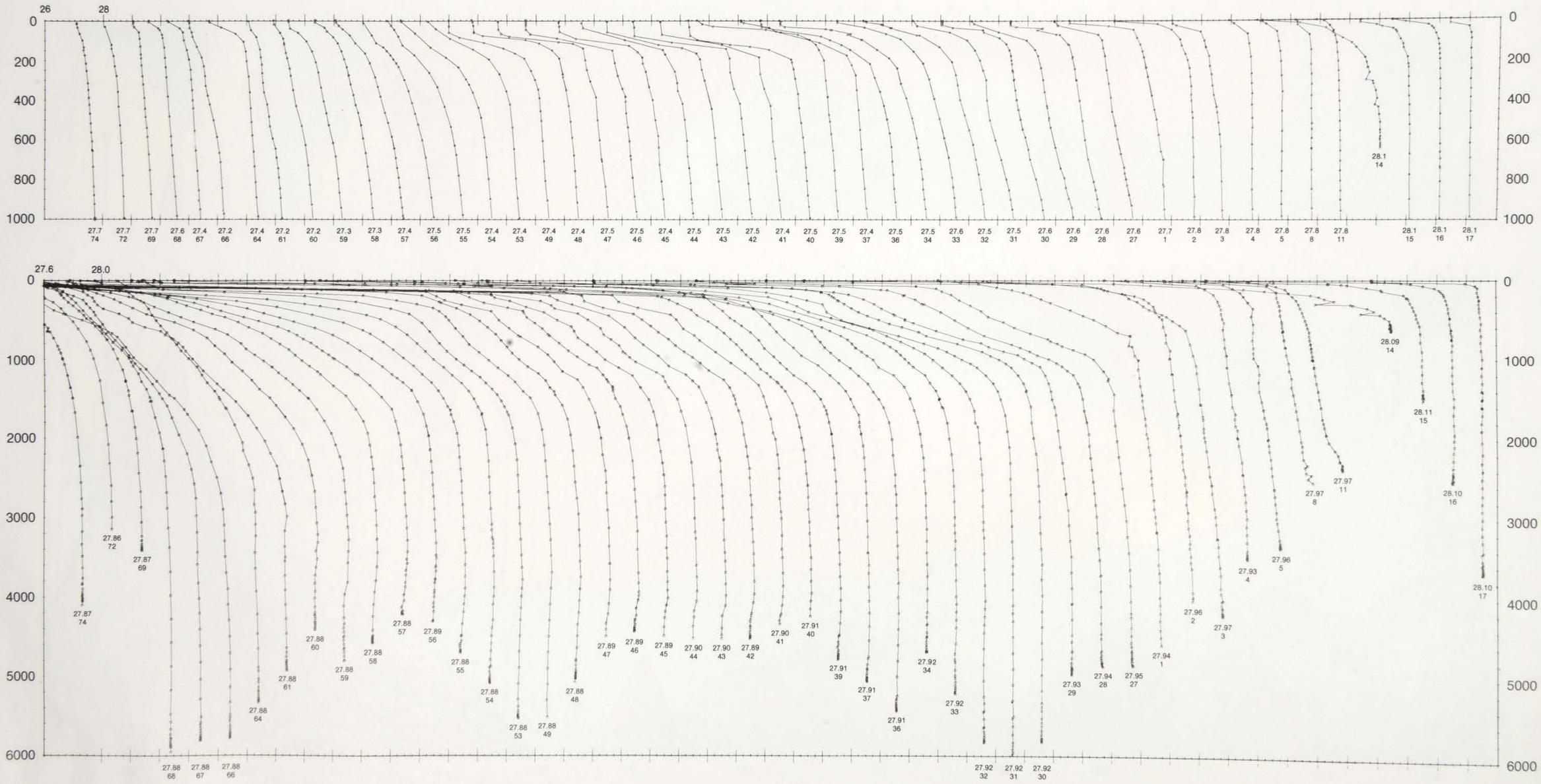
SALINITY

S

PLATE 6

Vertical distribution of Sigma Theta in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC

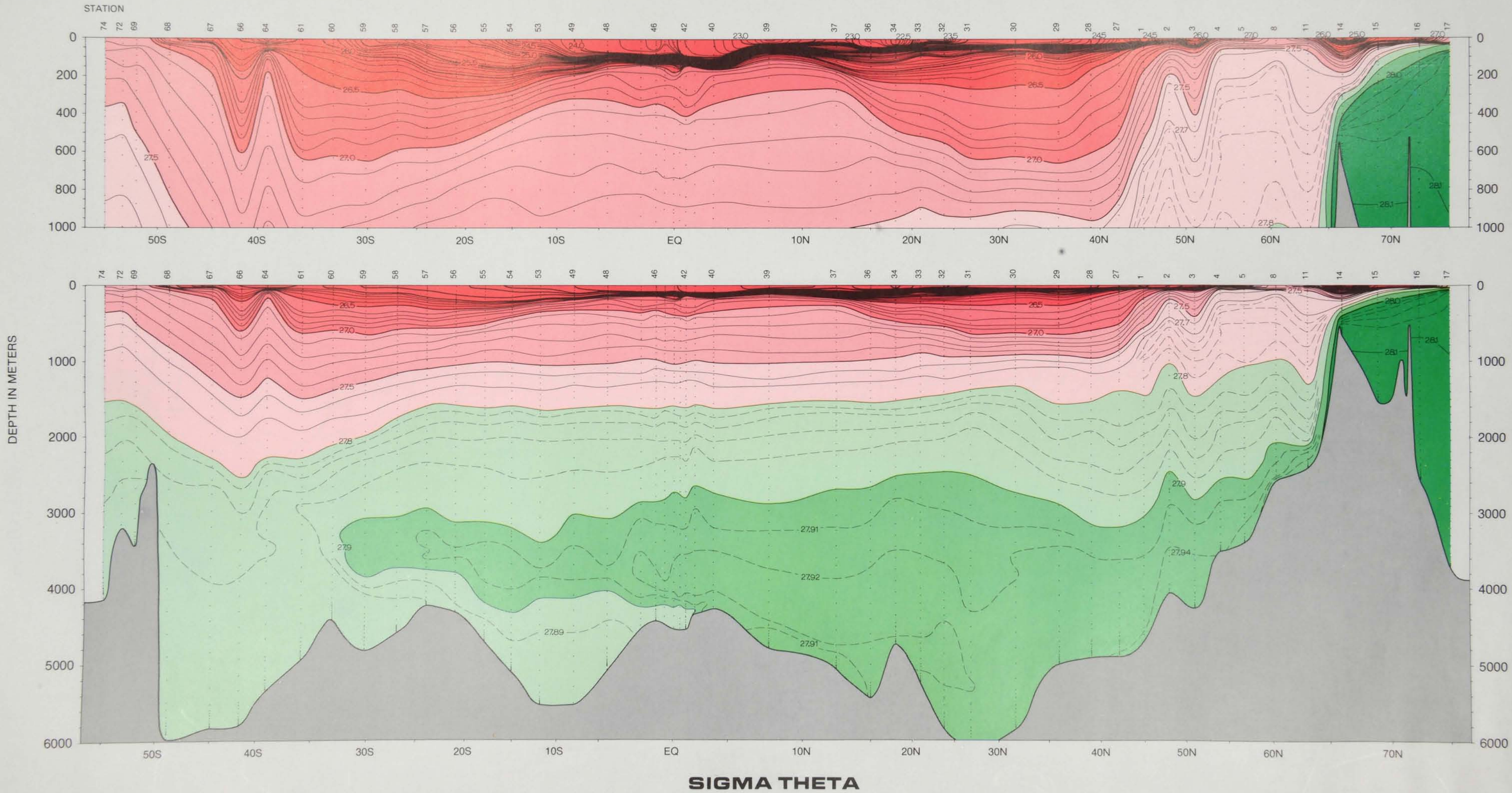


σ_θ

WESTERN ATLANTIC

PLATE 7

Vertical distribution of Sigma Theta in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.



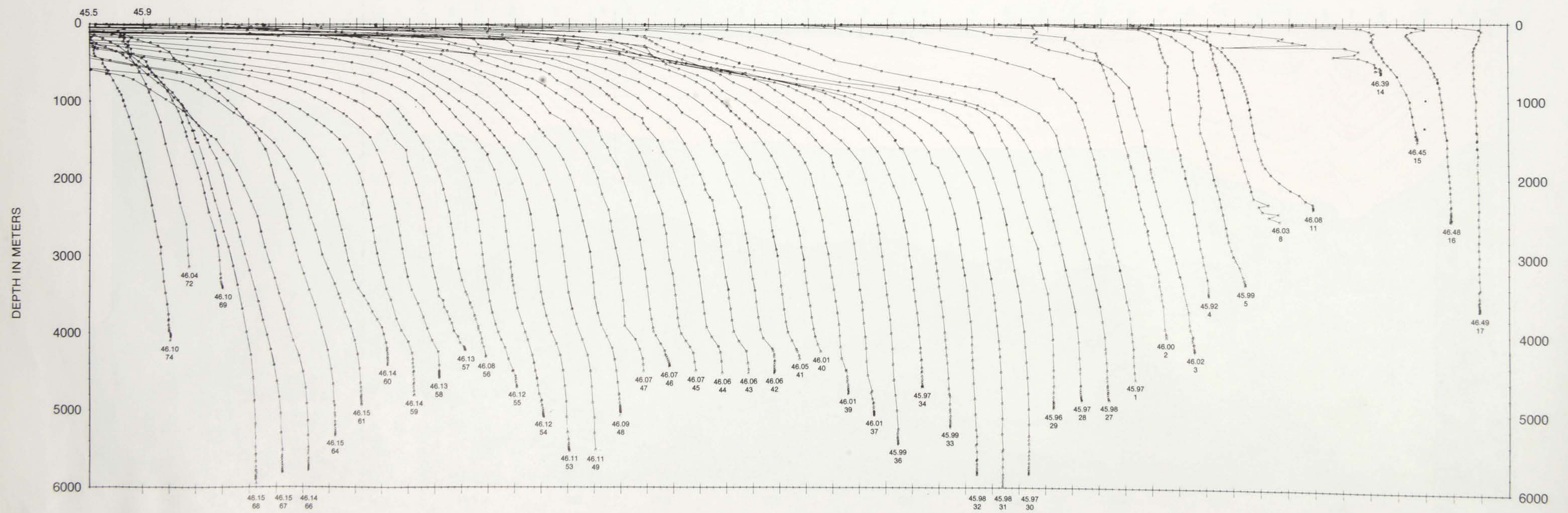
SIGMA THETA

σ_θ

PLATE 8

Vertical distribution of Sigma 4 in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC

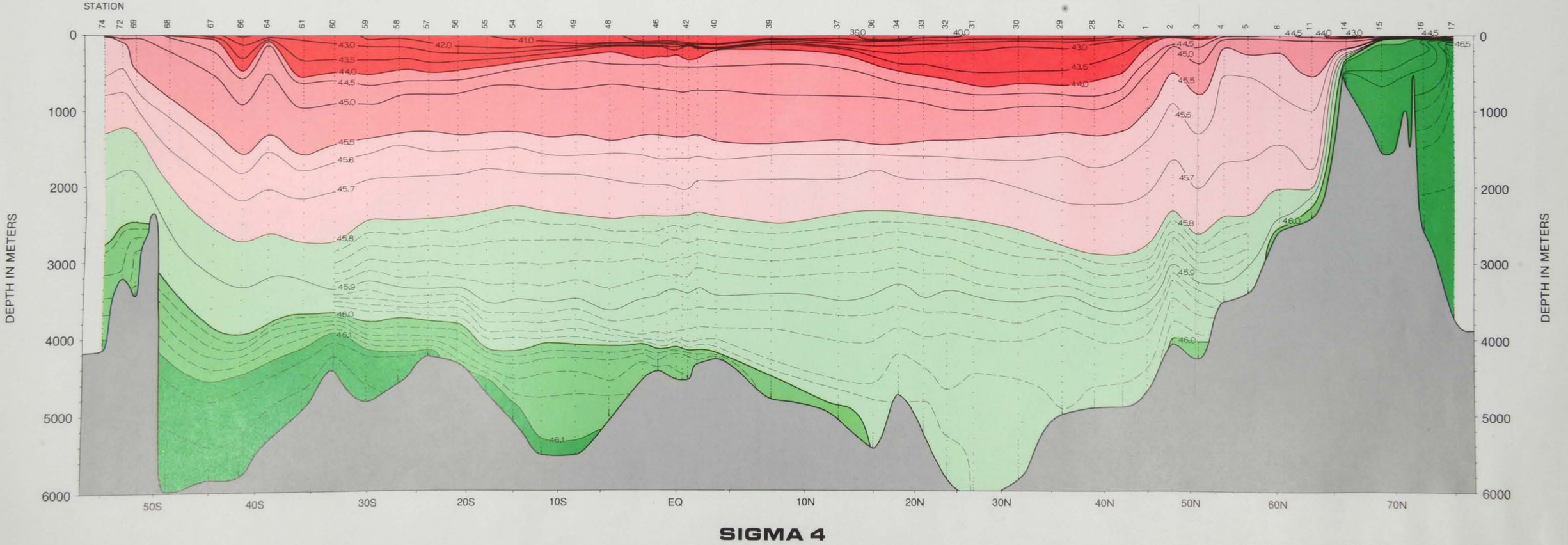


SIGMA 4

WESTERN ATLANTIC

PLATE 9

Vertical distribution of Sigma 4 in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.

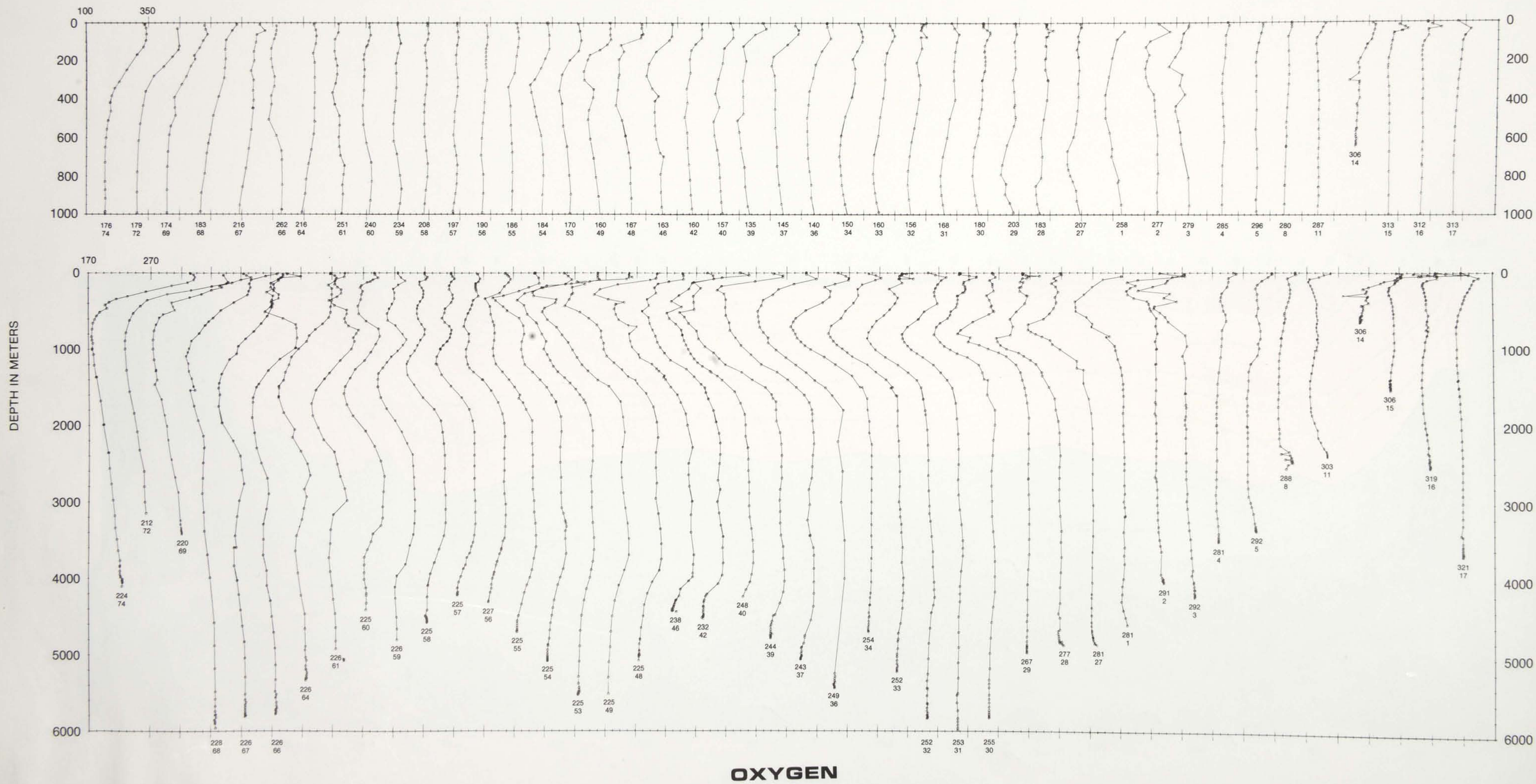


SIGMA 4

PLATE 10

Vertical distribution of Oxygen (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC

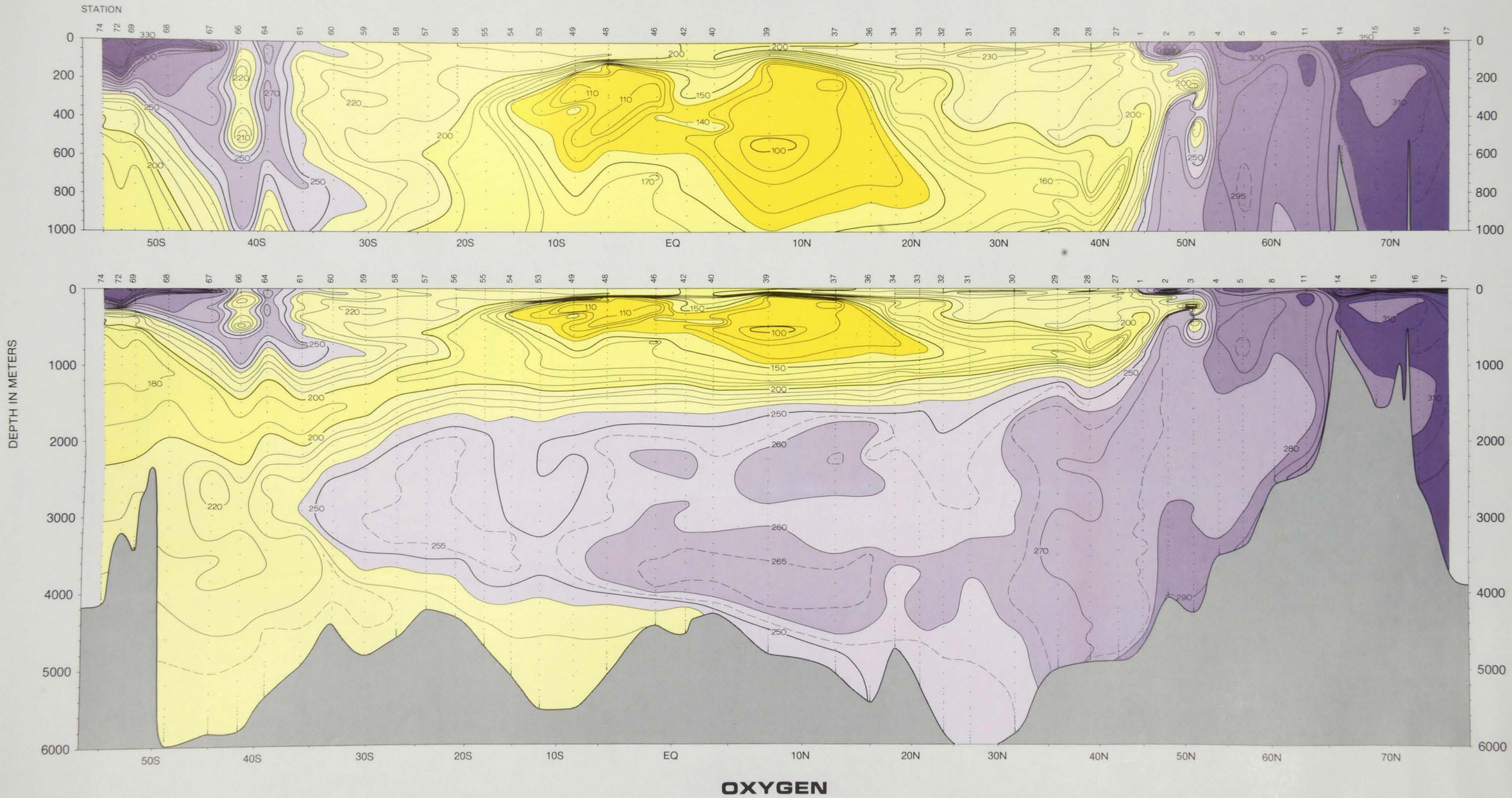


OXYGEN

WESTERN ATLANTIC

PLATE 11

Vertical distribution of Oxygen (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

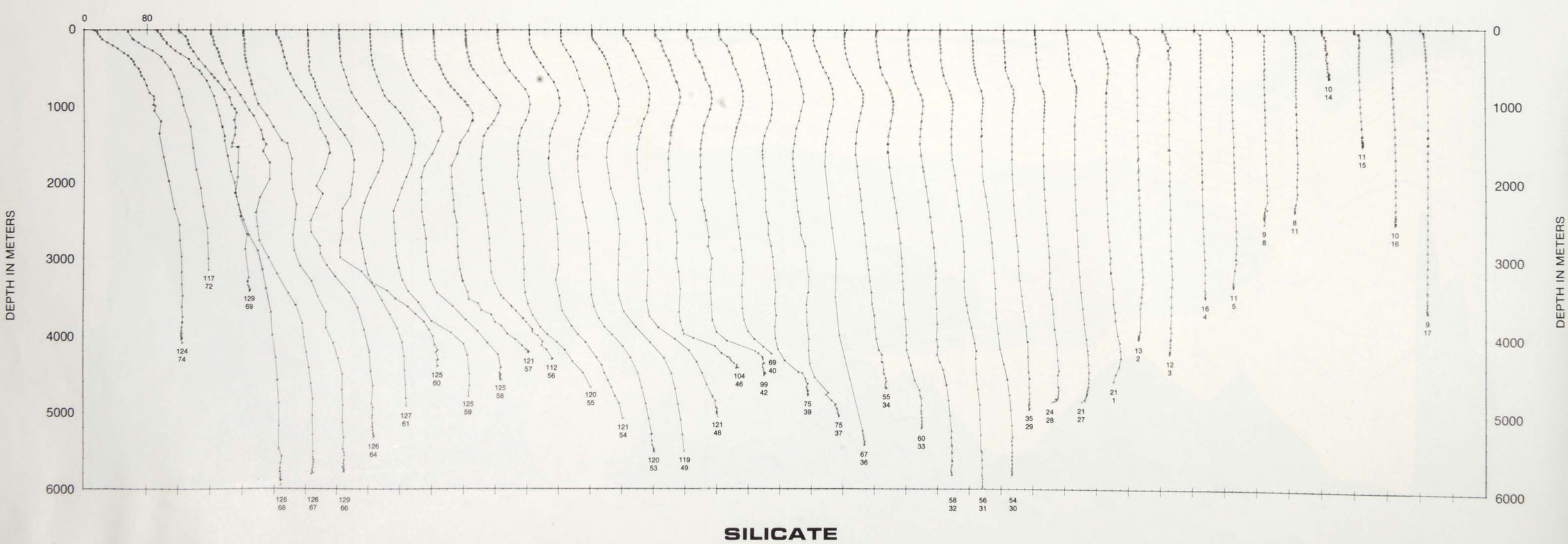


OXYGEN

PLATE 12

Vertical distribution of Silicate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC



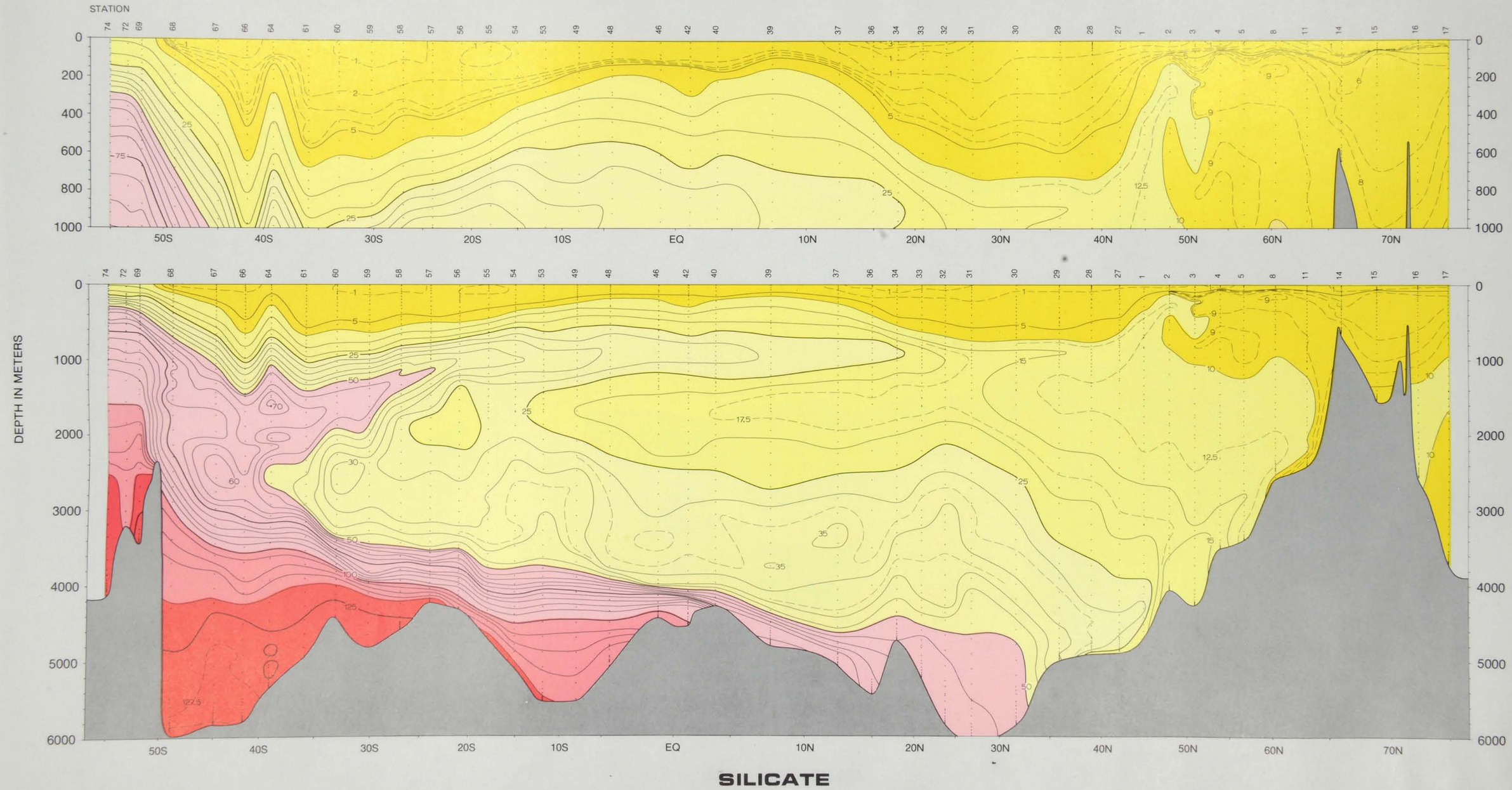
SILICATE

SiO_3

WESTERN ATLANTIC

PLATE 13

Vertical distribution of Silicate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.



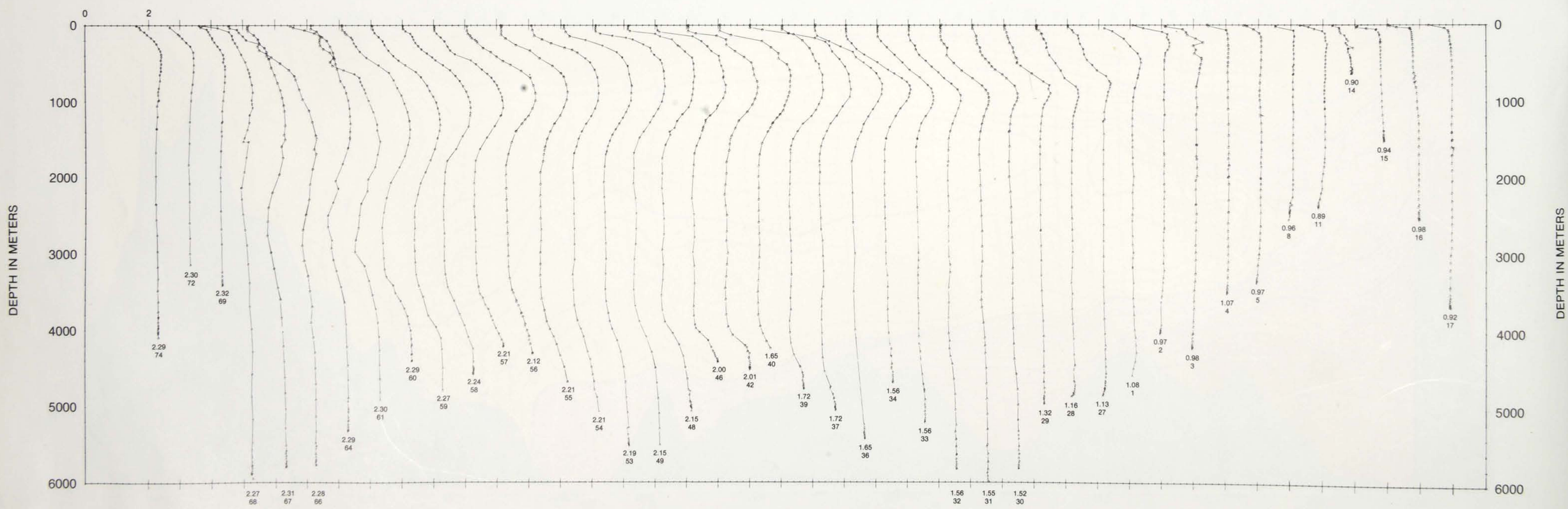
SILICATE

SiO_3

PLATE 14

Vertical distribution of Phosphate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC



WESTERN ATLANTIC

PLATE 15

Vertical distribution of Phosphate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

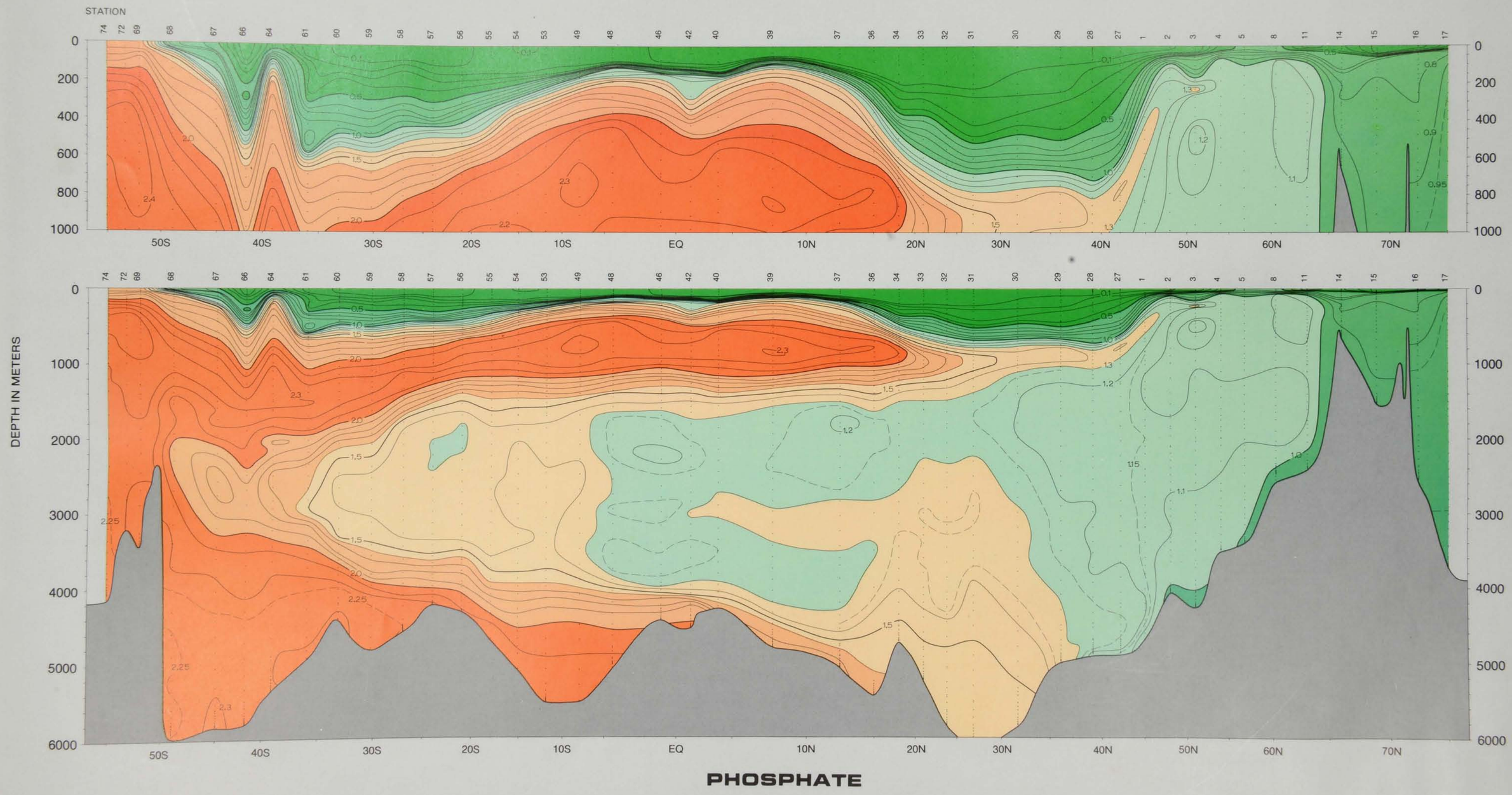
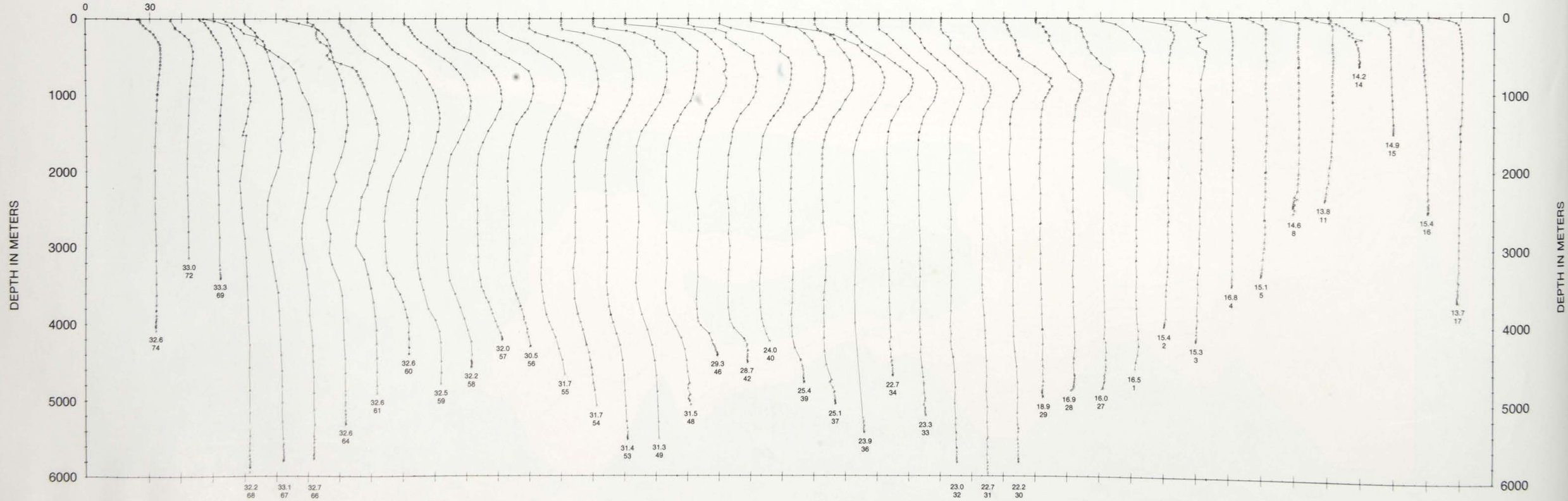


PLATE 16

Vertical distribution of Nitrate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

WESTERN ATLANTIC



WESTERN ATLANTIC

PLATE 17

Vertical distribution of Nitrate (μM/kg) in the Western Atlantic, July to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

STATION

74 72 69 68 67 66 64 61 60 59 58 57 56 55 54 53 49 48 46 42 40 39 37 36 34 33 32 31 30 29 28 27 1 2 3 4 5 8 11 14 15 16 17

0 200 400 600 800 1000

50S 40S 30S 20S 10S EQ 10N 20N 30N 40N 50N 60N 70N

DEPTH IN METERS

0 1000 2000 3000 4000 5000 6000

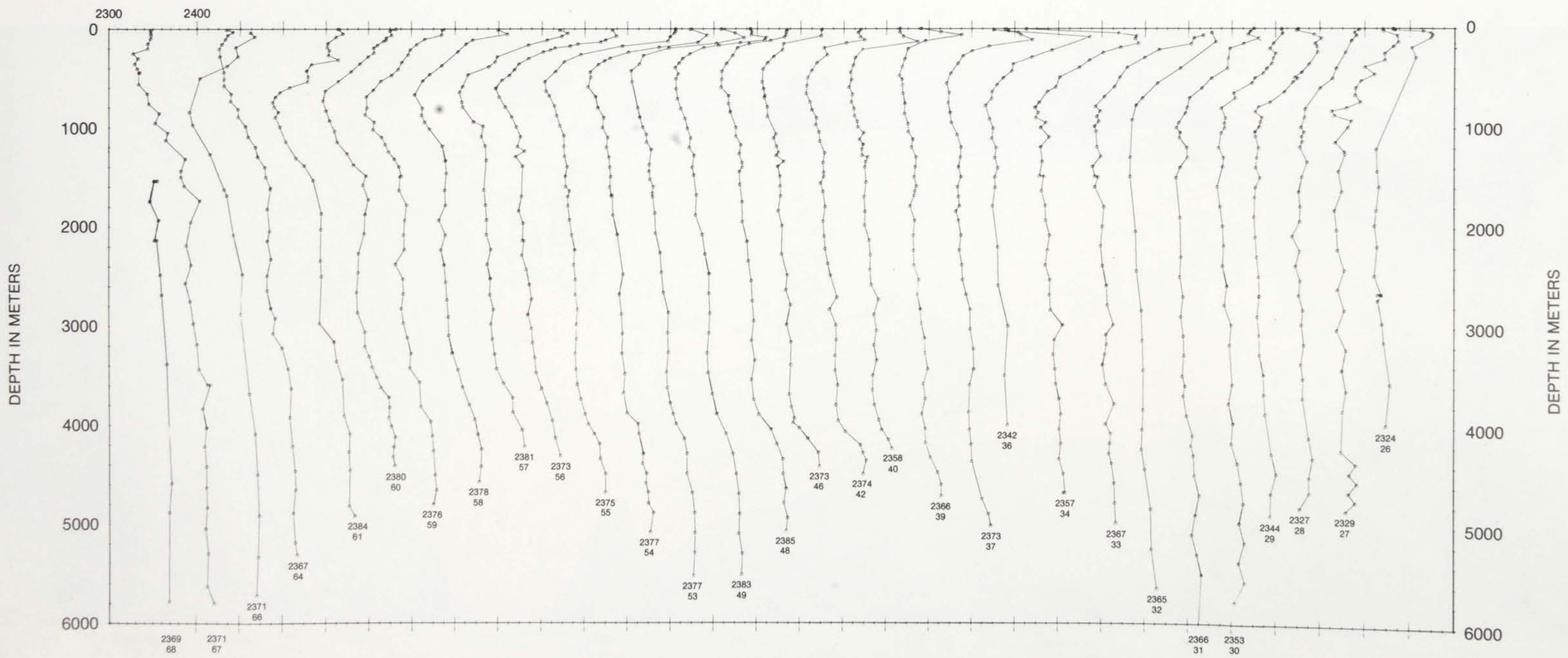
NITRATE

NO_3

PLATE 18

Vertical distribution of Alkalinity (μEq/kg) in the Western Atlantic, September to December, 1972. GEOSECS Atlantic Expeditions: R/V KNORR.

WESTERN ATLANTIC



WESTERN ATLANTIC

PLATE 19

Vertical distribution of Alkalinity (μEq/kg) in the Western Atlantic, September to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR Vertical exaggeration is 1000:1.

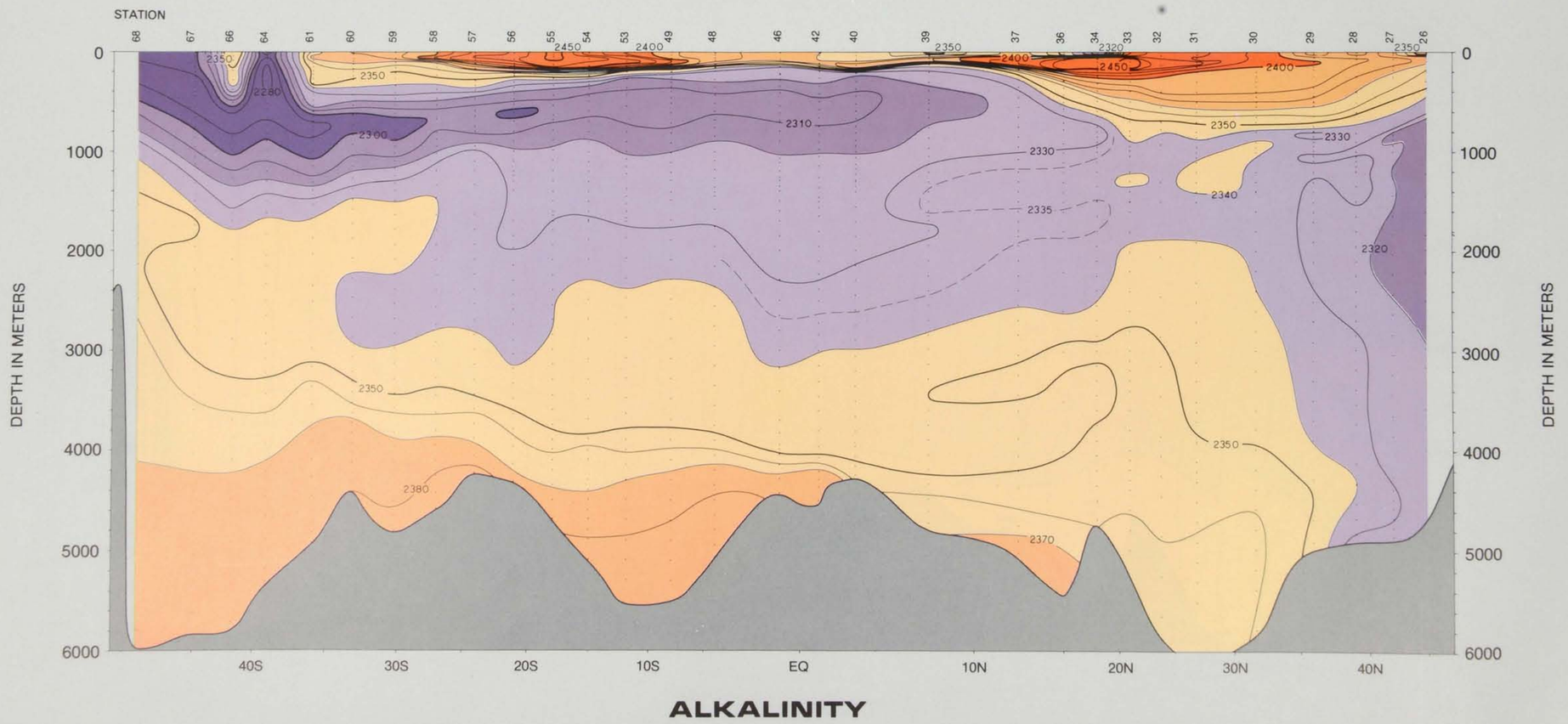
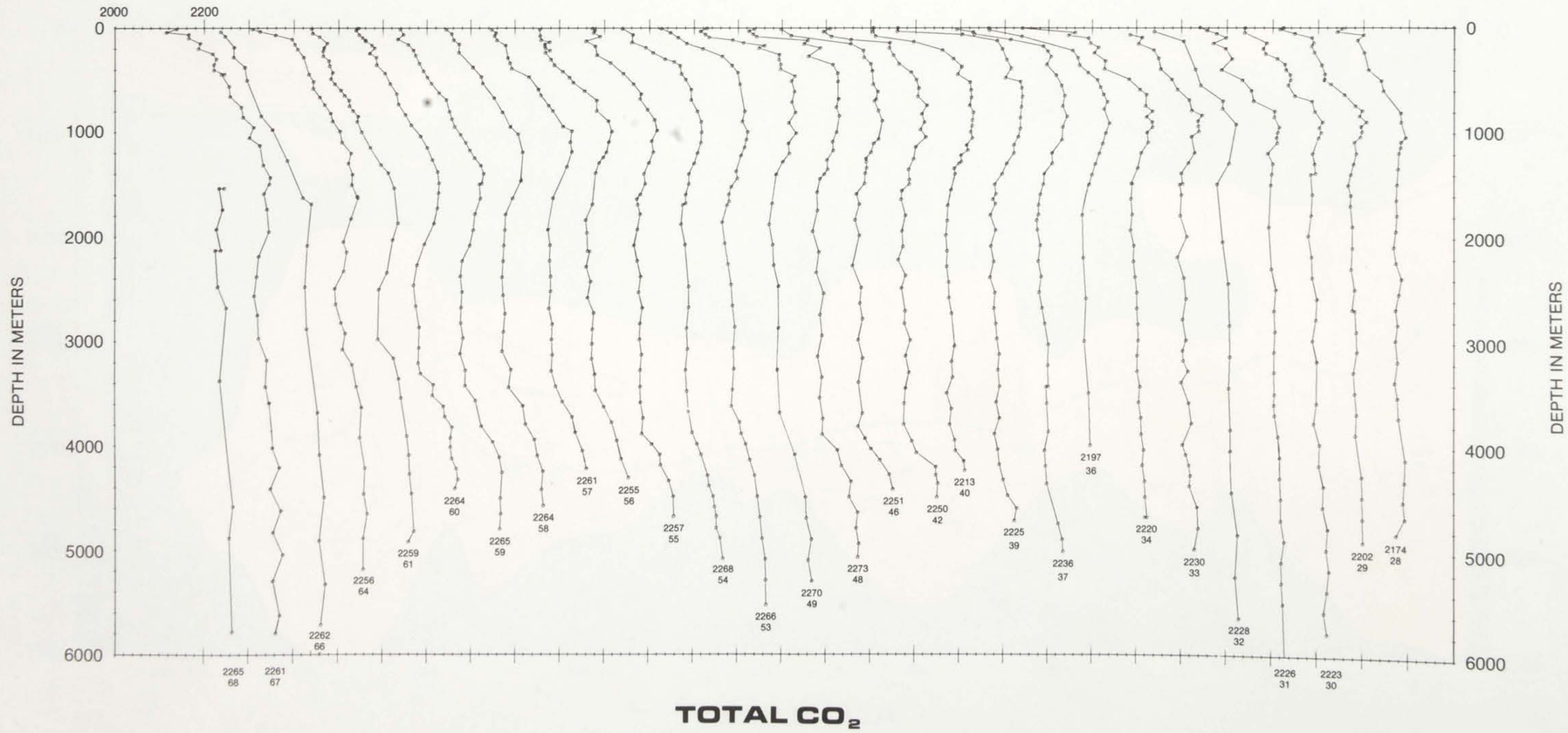


PLATE 20

Vertical distribution of Total CO_2 (μM/kg) in the Western Atlantic, September to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

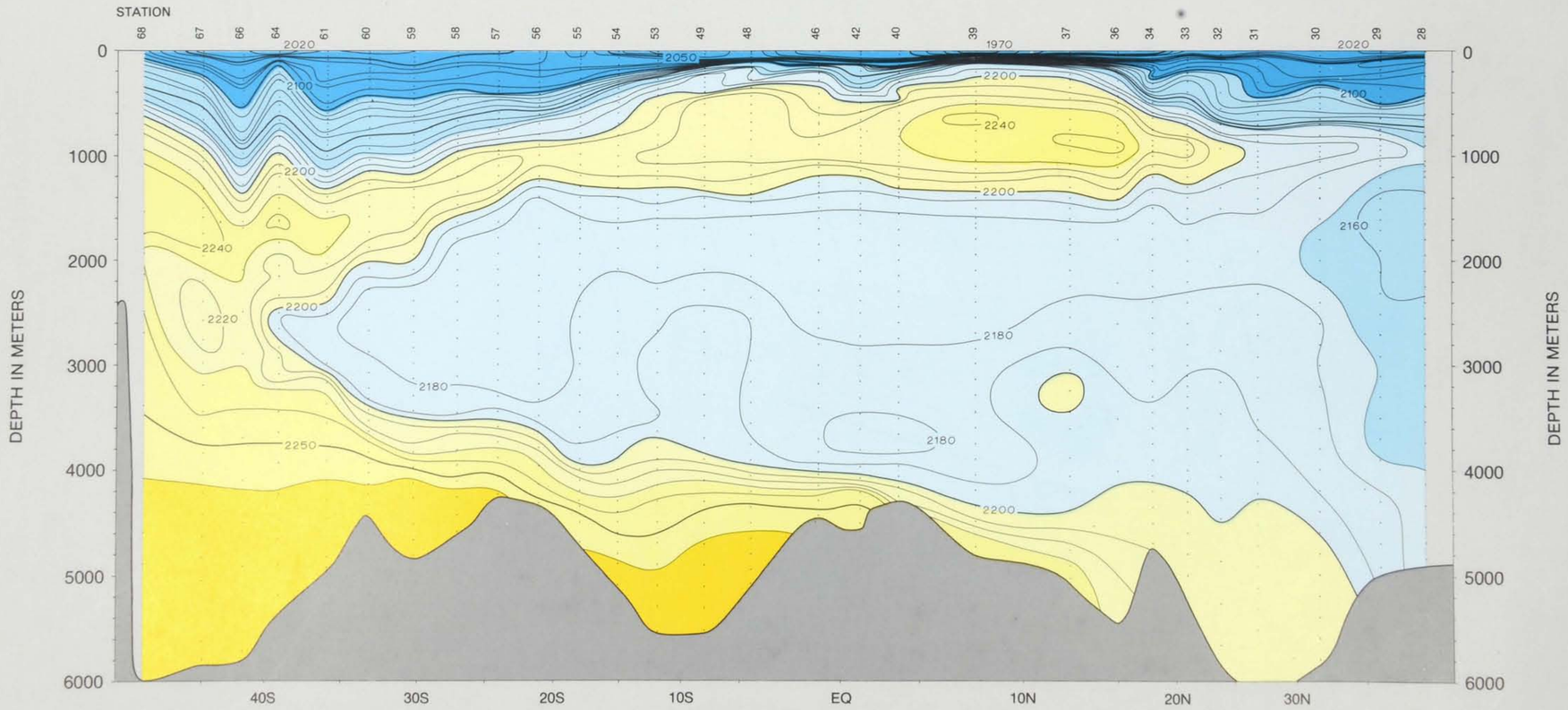
WESTERN ATLANTIC



WESTERN ATLANTIC

PLATE 21

Vertical distribution of Total CO_2 (μM/kg) in the Western Atlantic, September to December, 1972. GEOSECS Atlantic Expedition: R/V KNORR Vertical exaggeration is 1000:1.

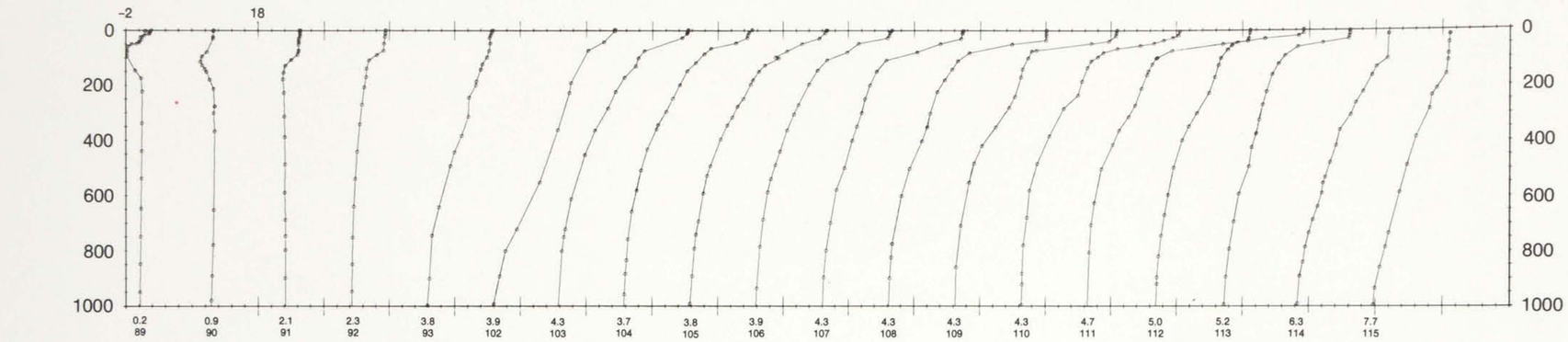


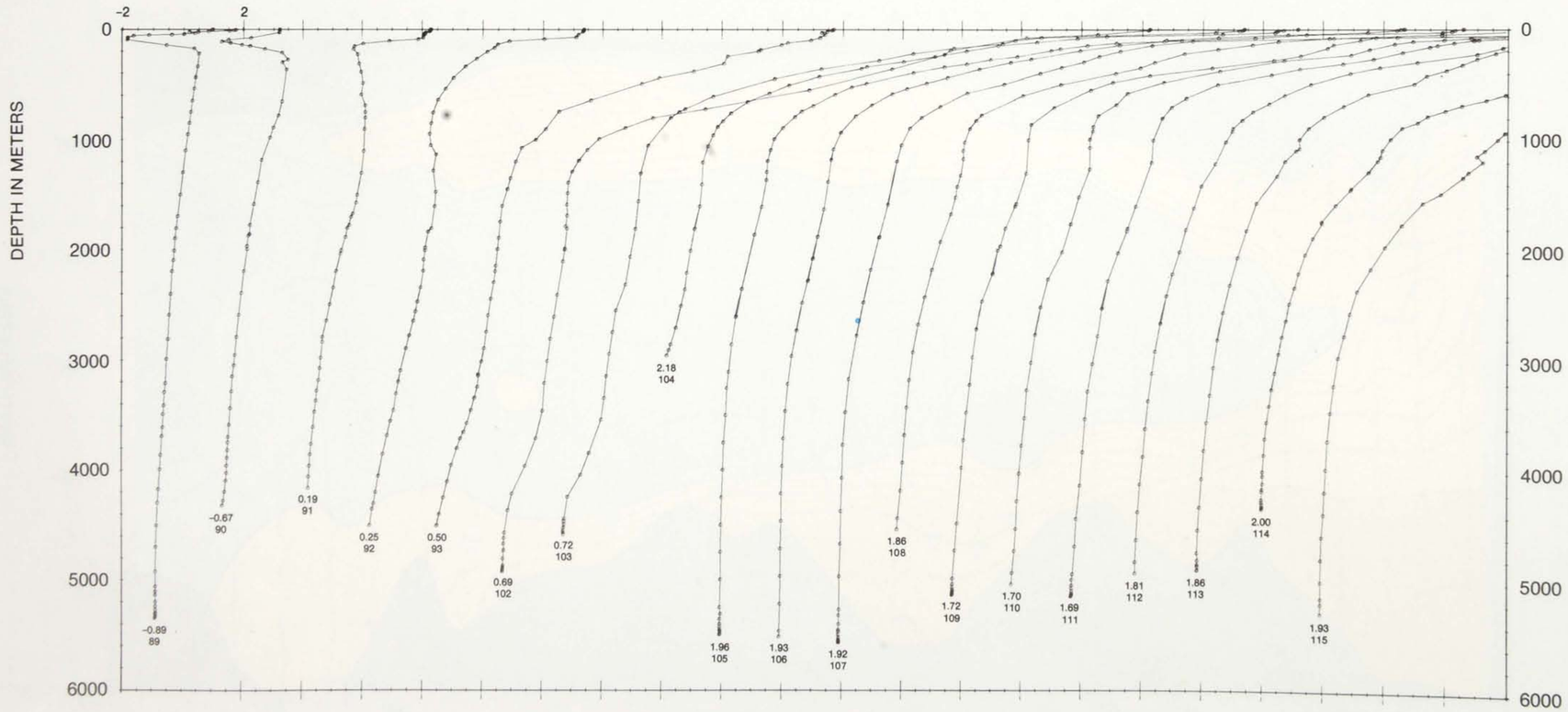
TOTAL CO_2

PLATE 22

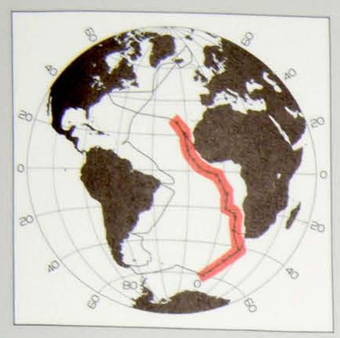
Vertical distribution of Potential Temperature (°C) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC





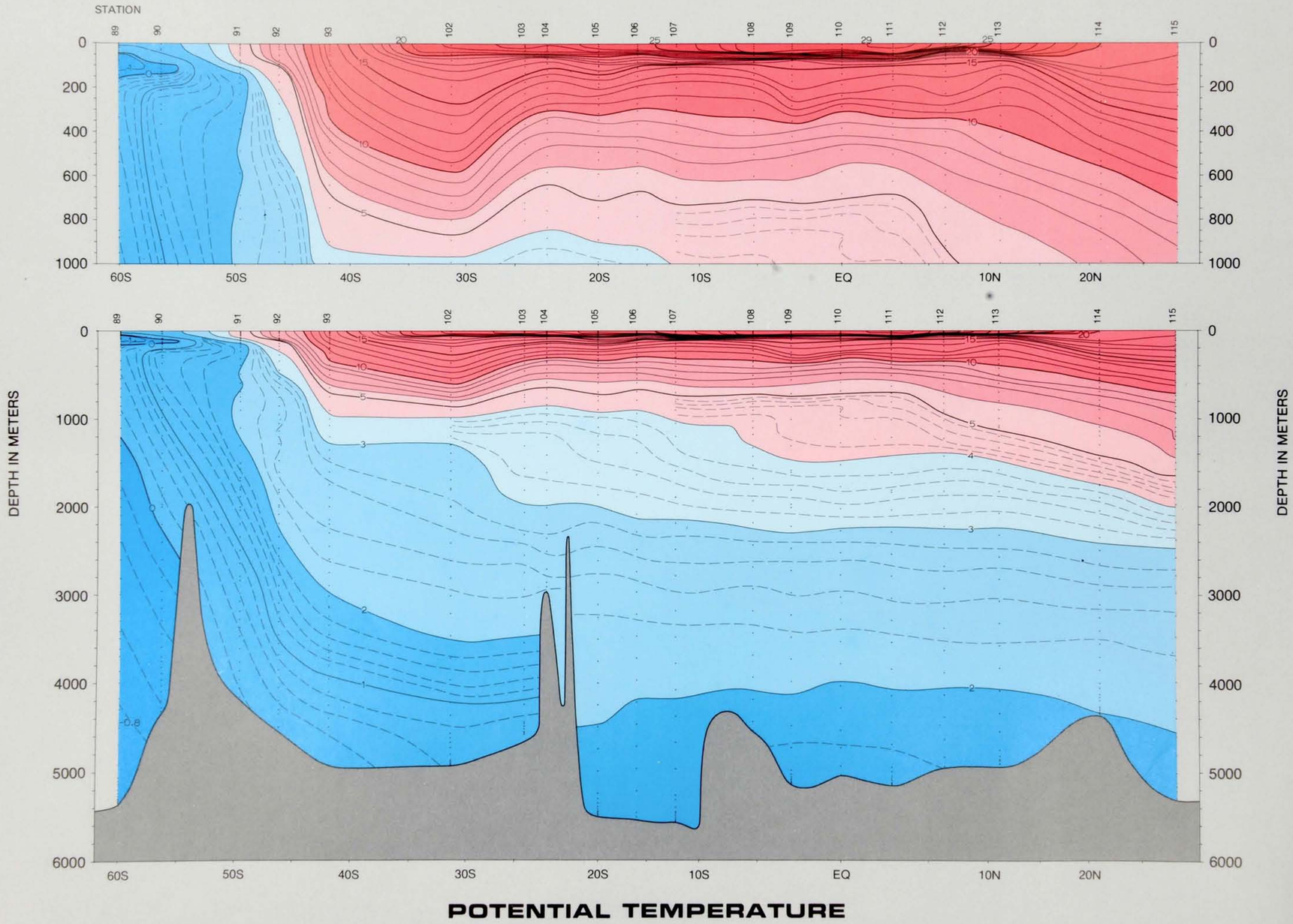
POTENTIAL TEMPERATURE



EASTERN ATLANTIC

PLATE 23

Vertical distribution of Potential Temperature (°C) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

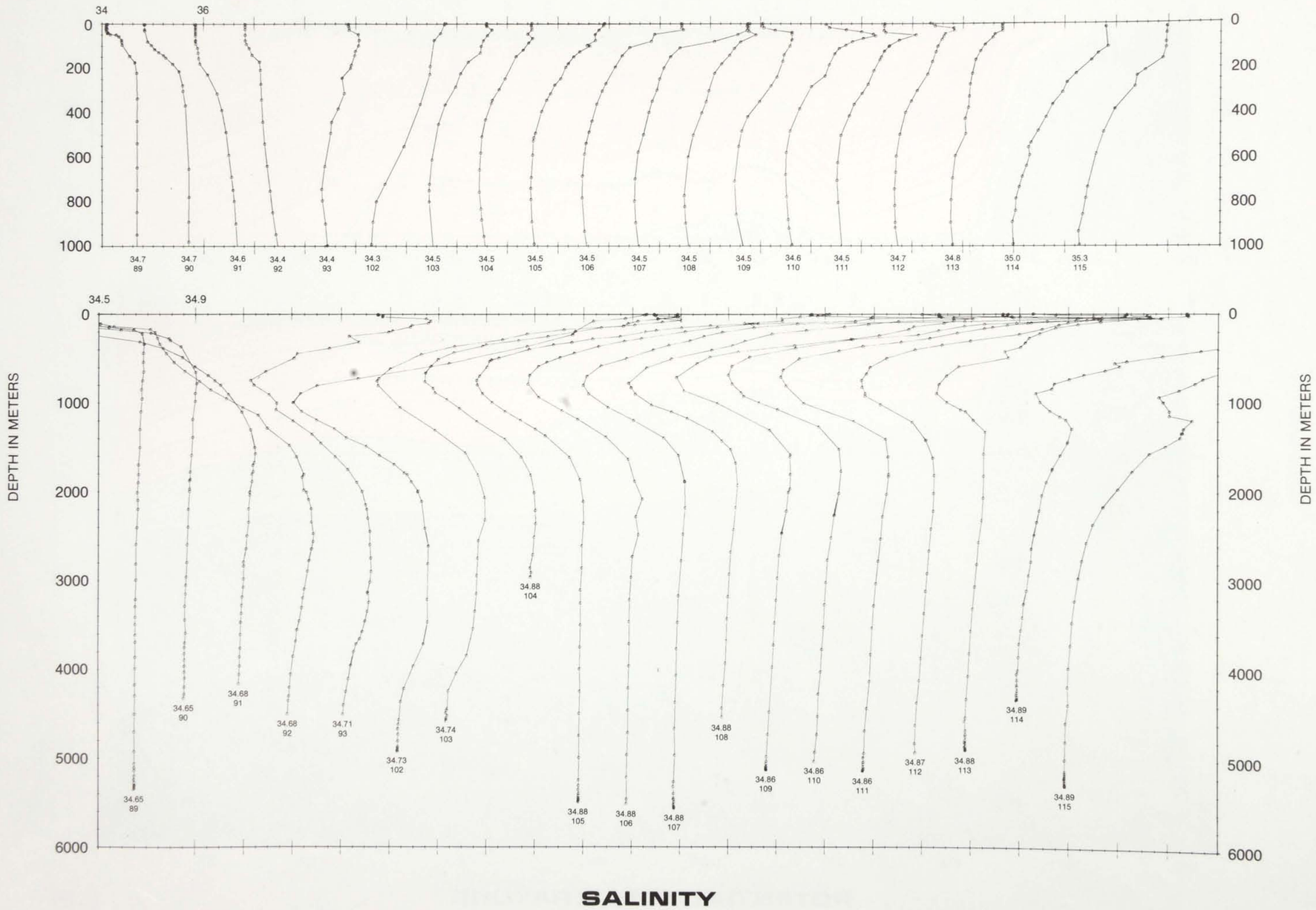


θ

PLATE 24

Vertical distribution of Salinity (‰) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC



EASTERN ATLANTIC

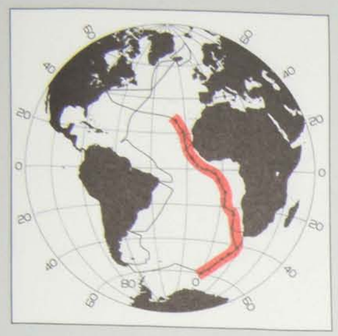


PLATE 25

Vertical distribution of Salinity (‰) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

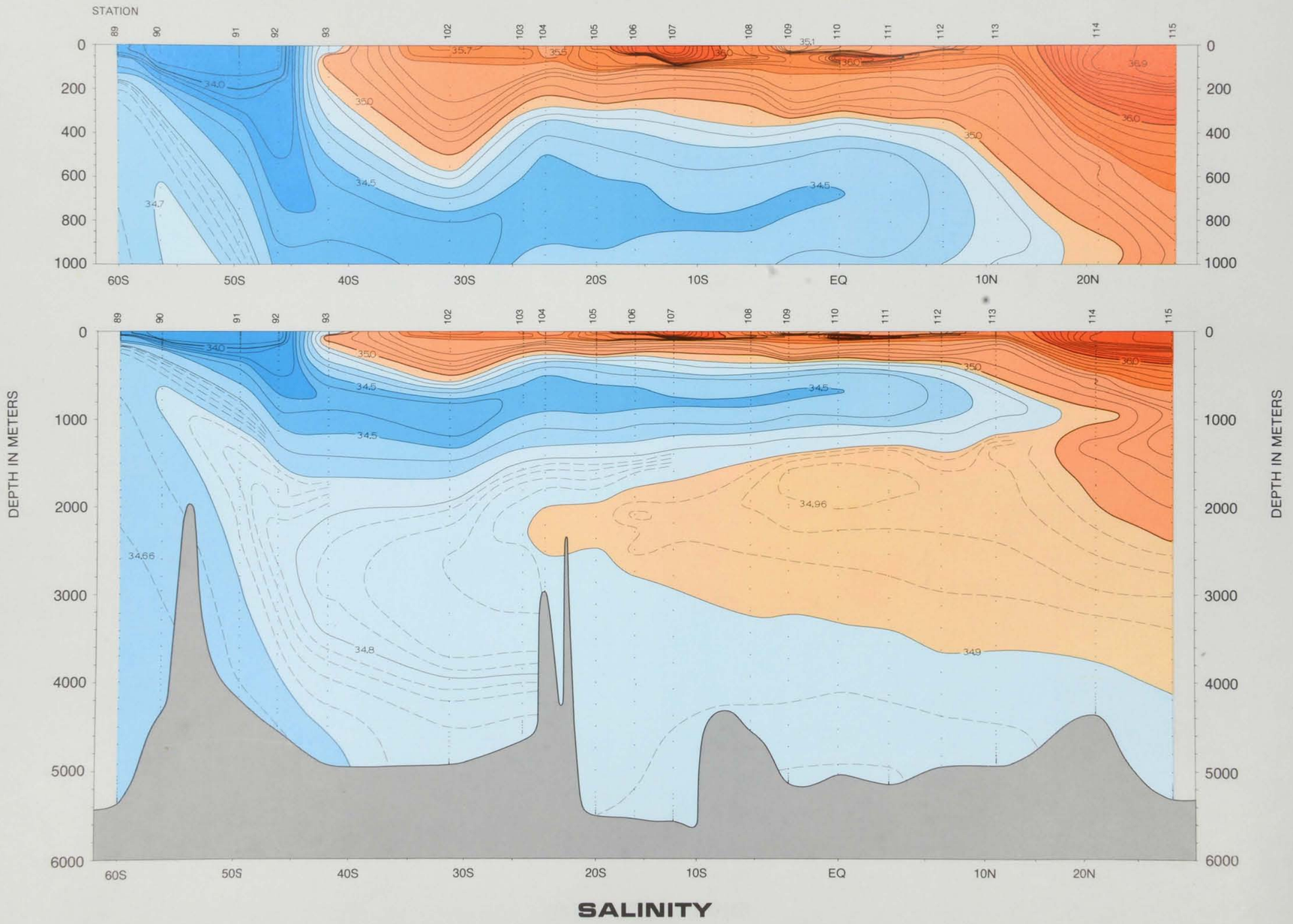
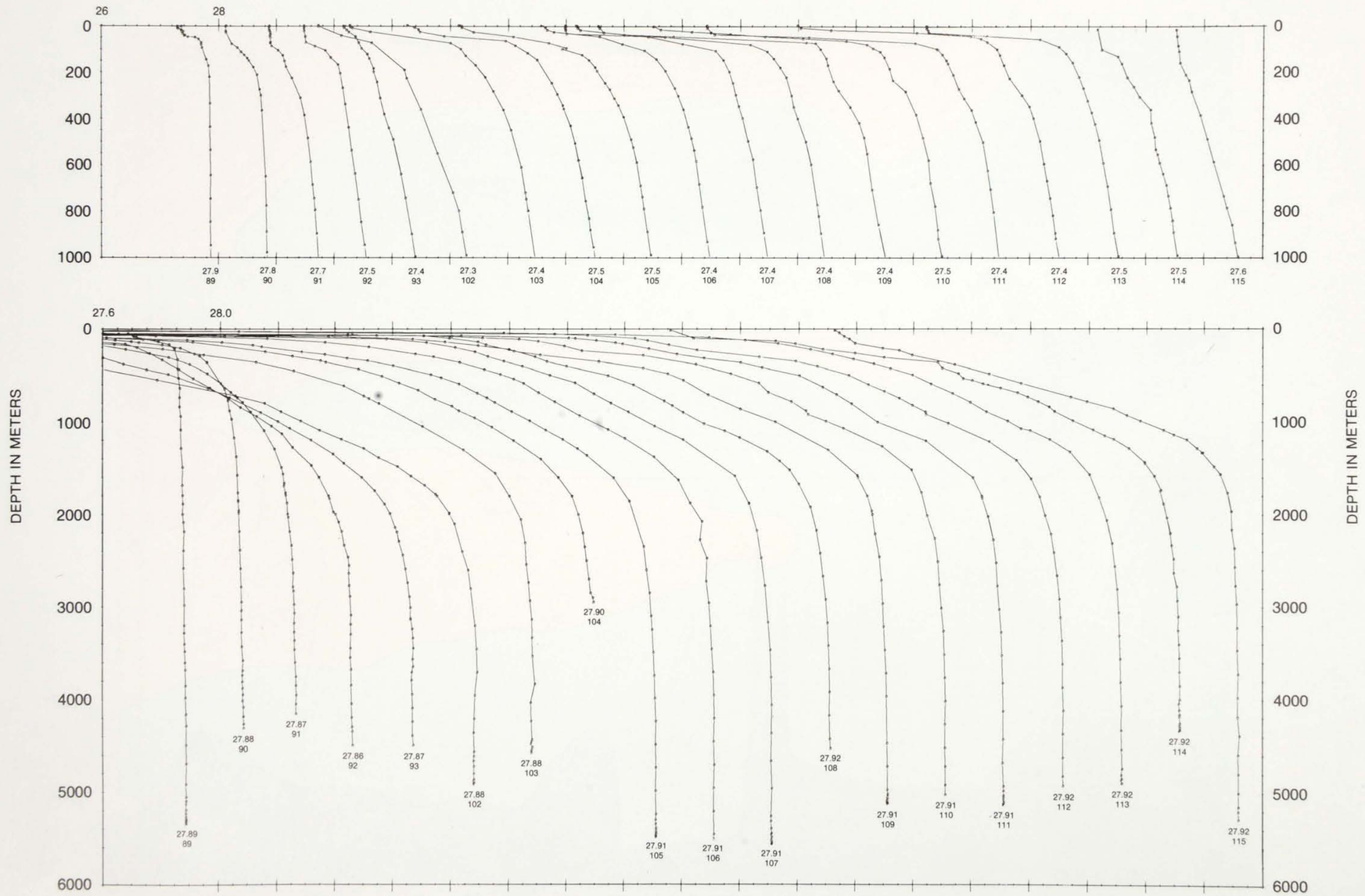


PLATE 26

Vertical distribution of Sigma Theta in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC

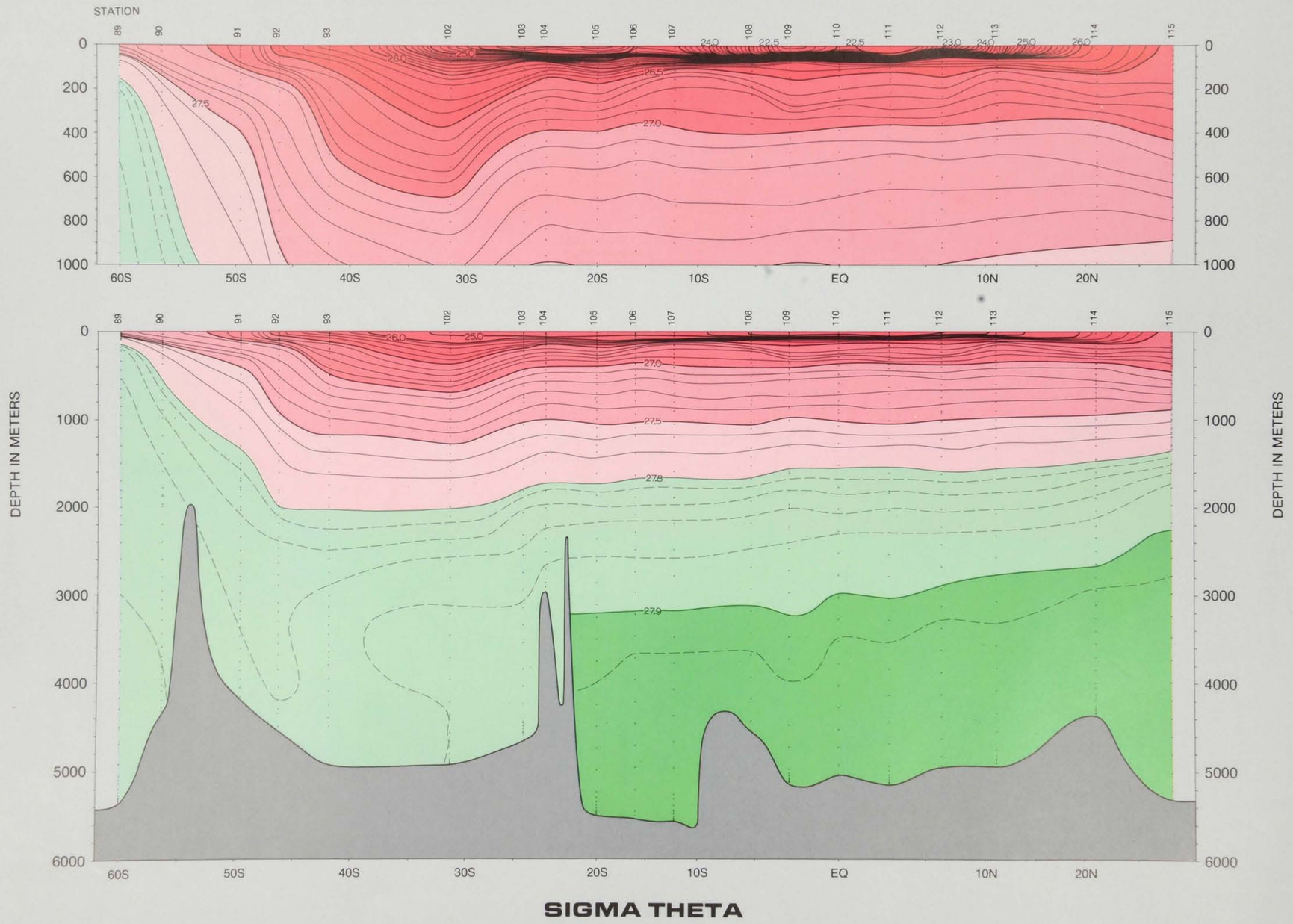


SIGMA THETA

EASTERN ATLANTIC

PLATE 27

Vertical distribution of Sigma Theta in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.



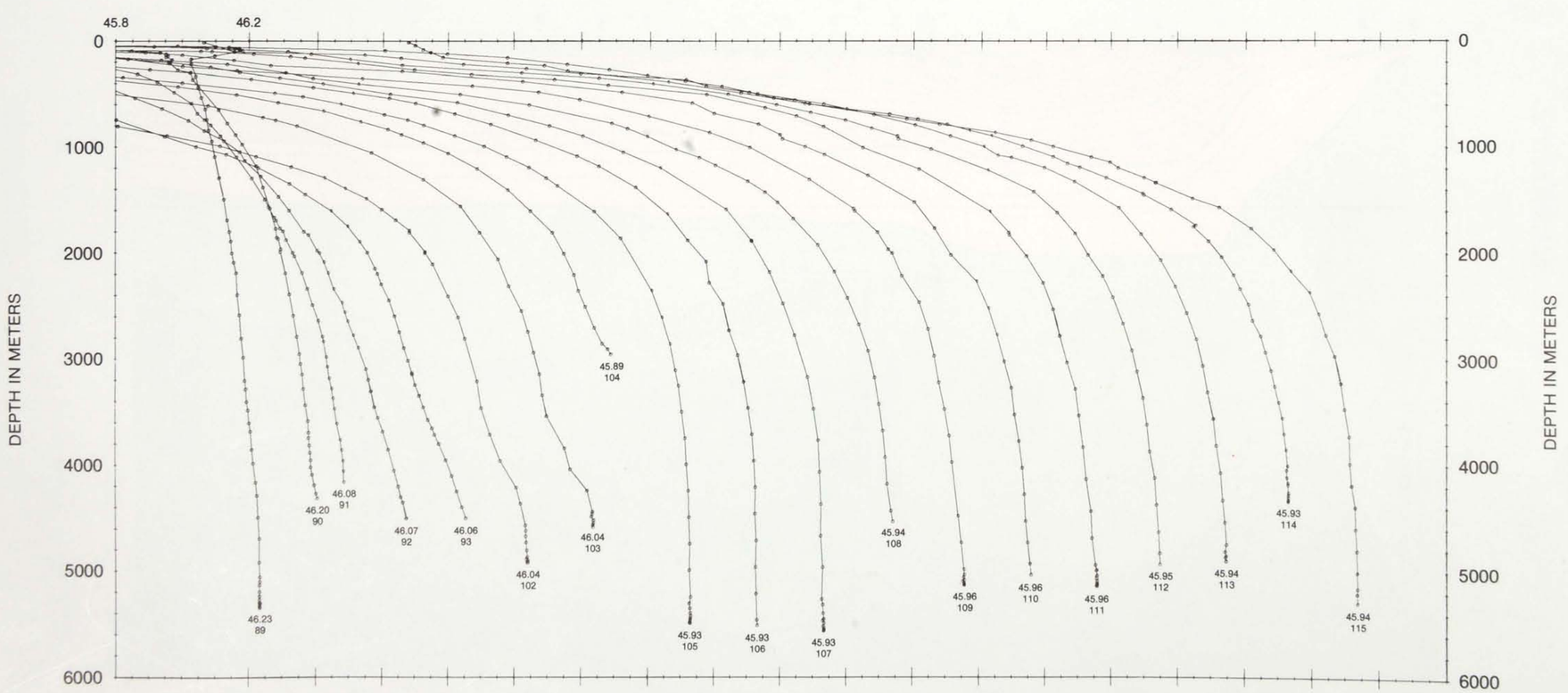
SIGMA THETA

σ_θ

PLATE 28

Vertical distribution of Sigma 4 in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC

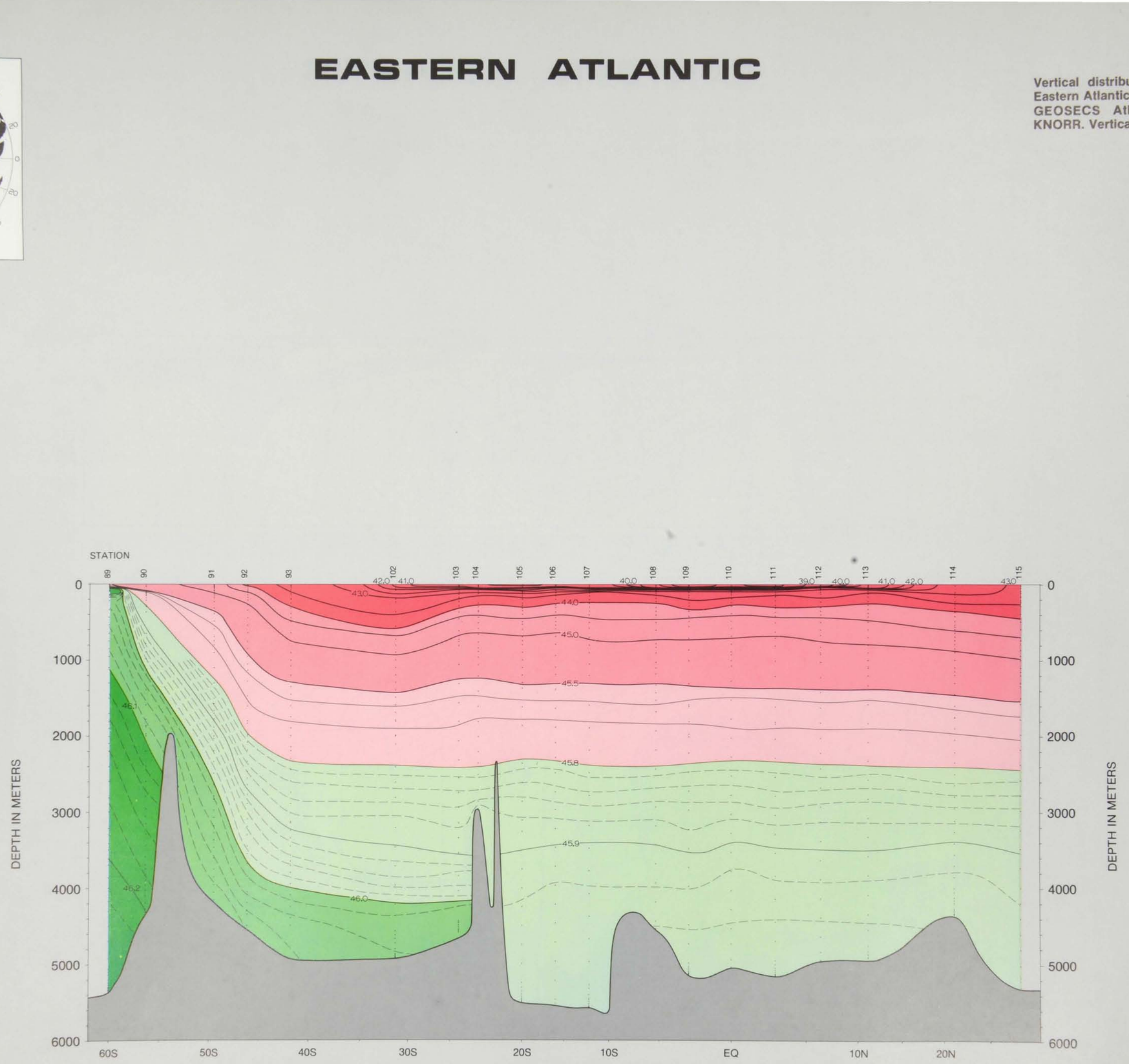


SIGMA 4

EASTERN ATLANTIC

PLATE 29

Vertical distribution of Sigma 4 in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.

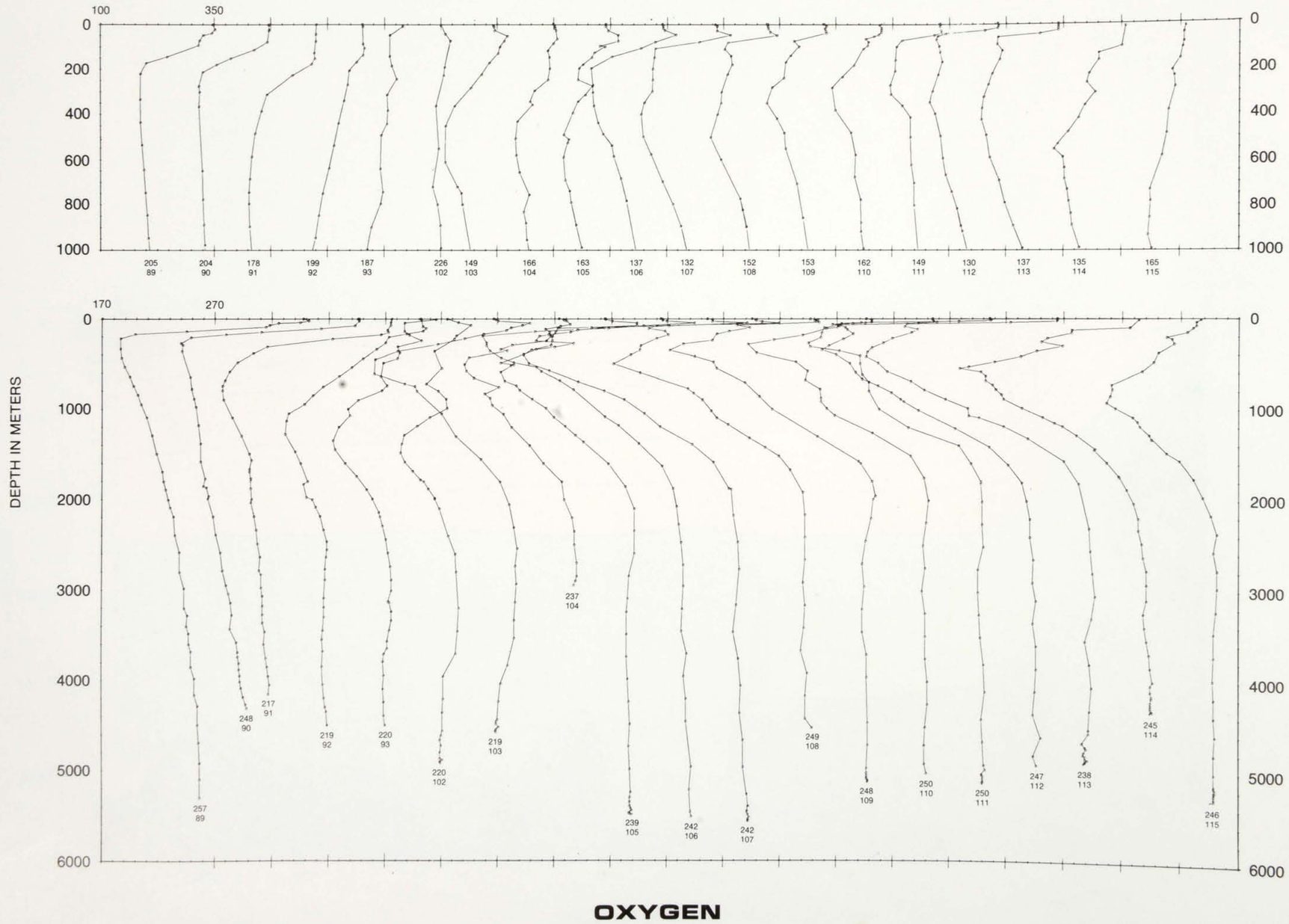


SIGMA 4

PLATE 30

Vertical distribution of Oxygen (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

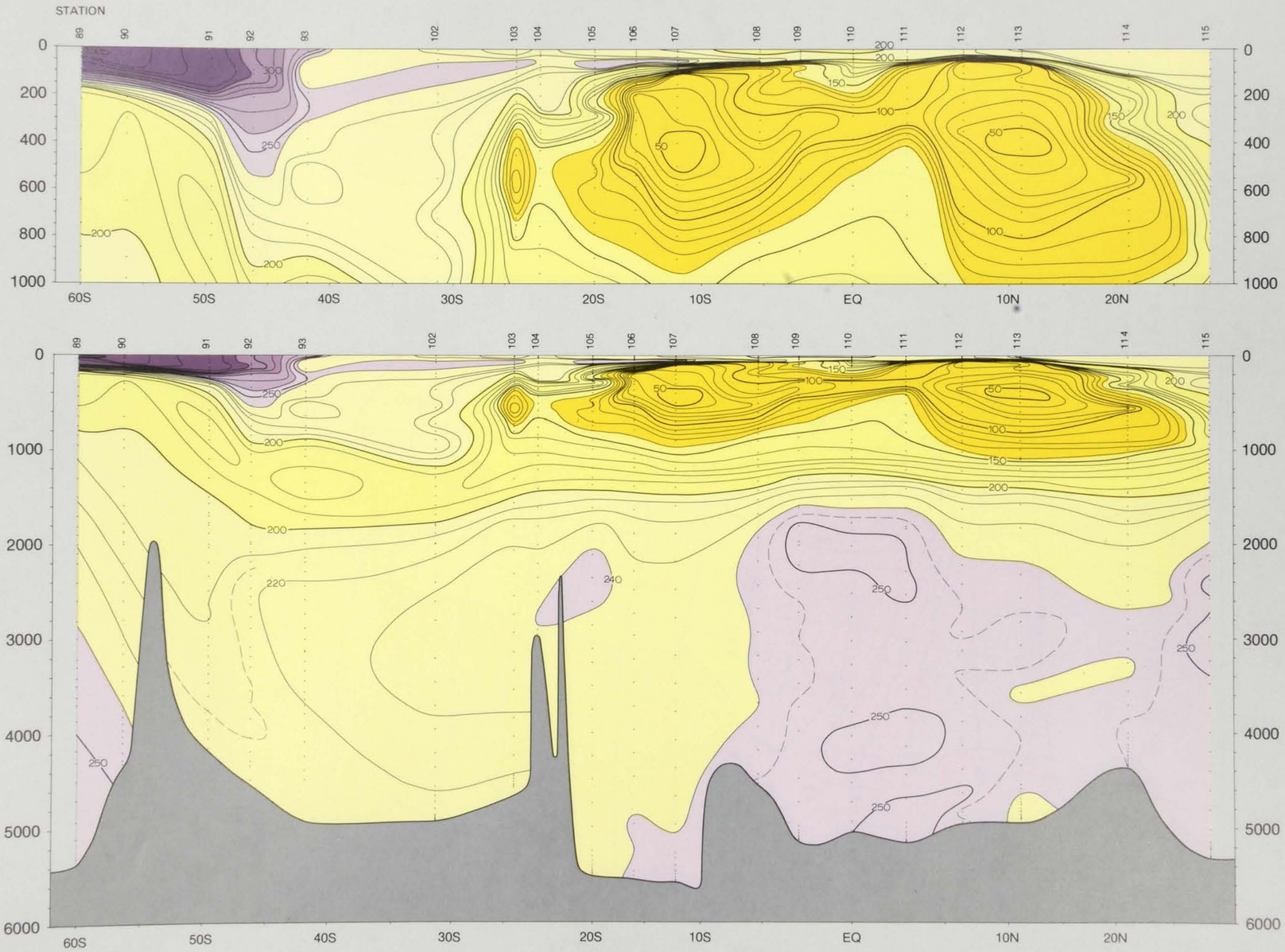
EASTERN ATLANTIC



EASTERN ATLANTIC

PLATE 31

Vertical distribution of Oxygen (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

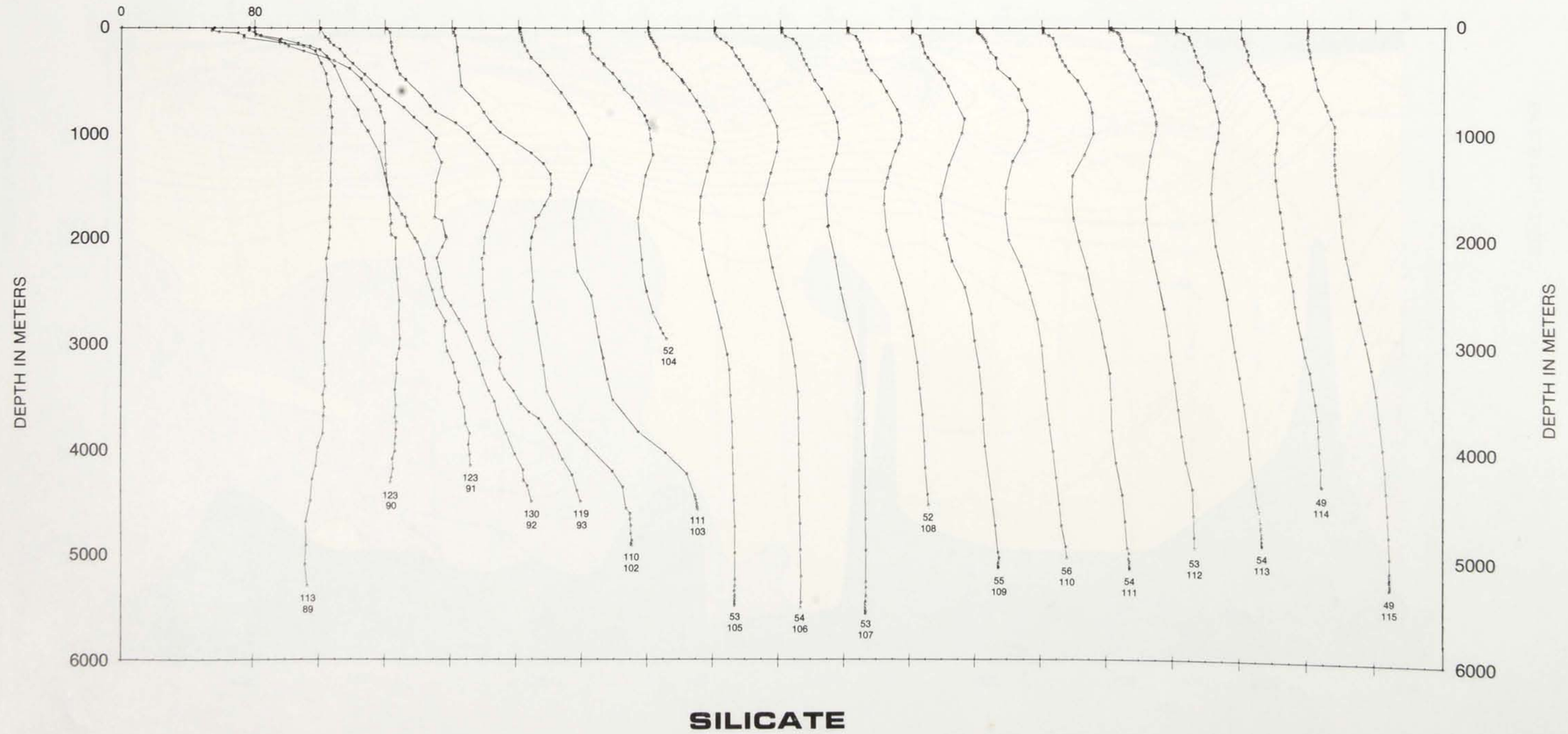


OXYGEN

PLATE 32

Vertical distribution of Silicate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC



SILICATE

EASTERN ATLANTIC

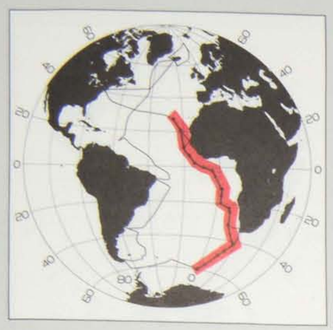


PLATE 33

Vertical distribution of Silicate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.

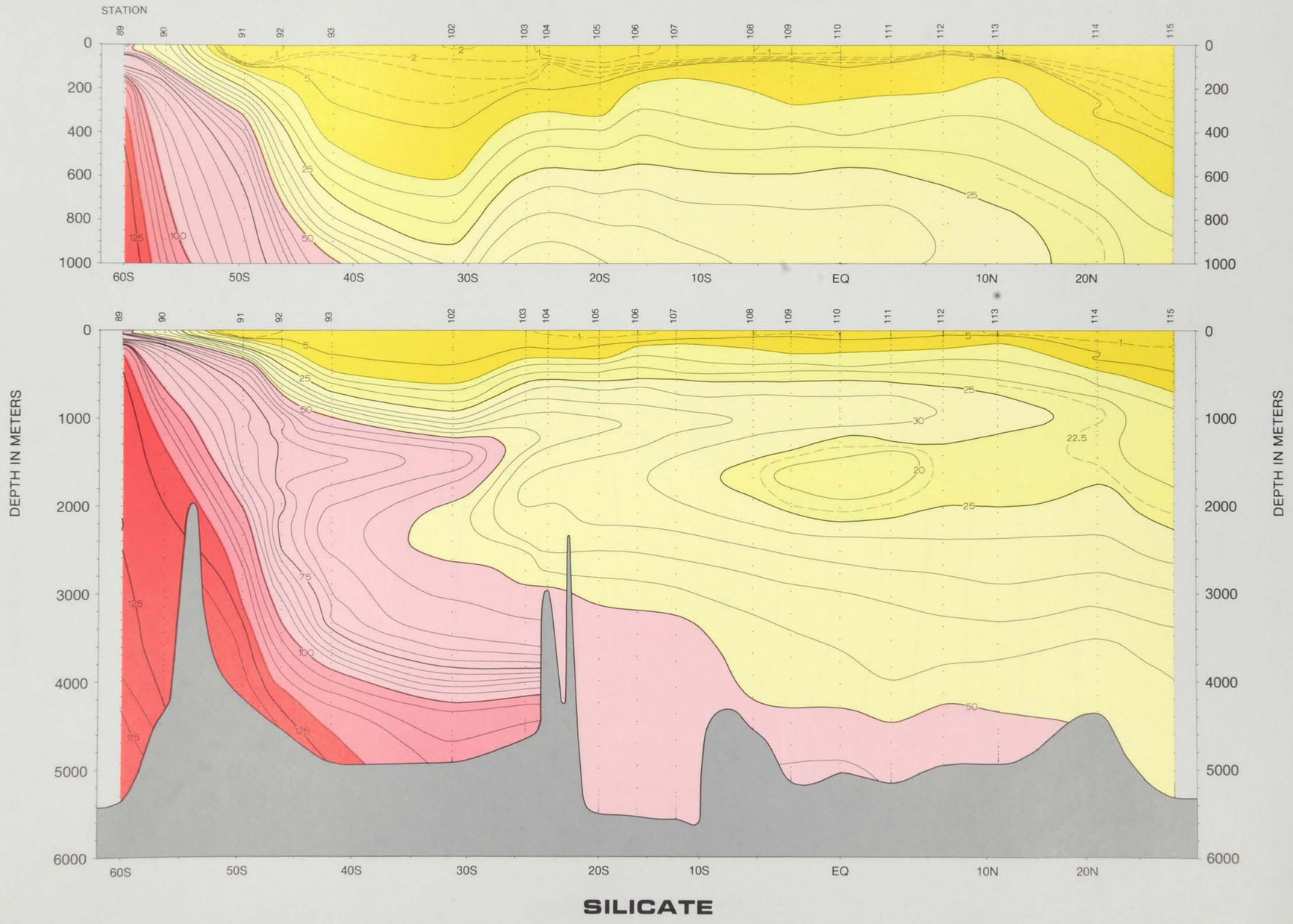


PLATE 34

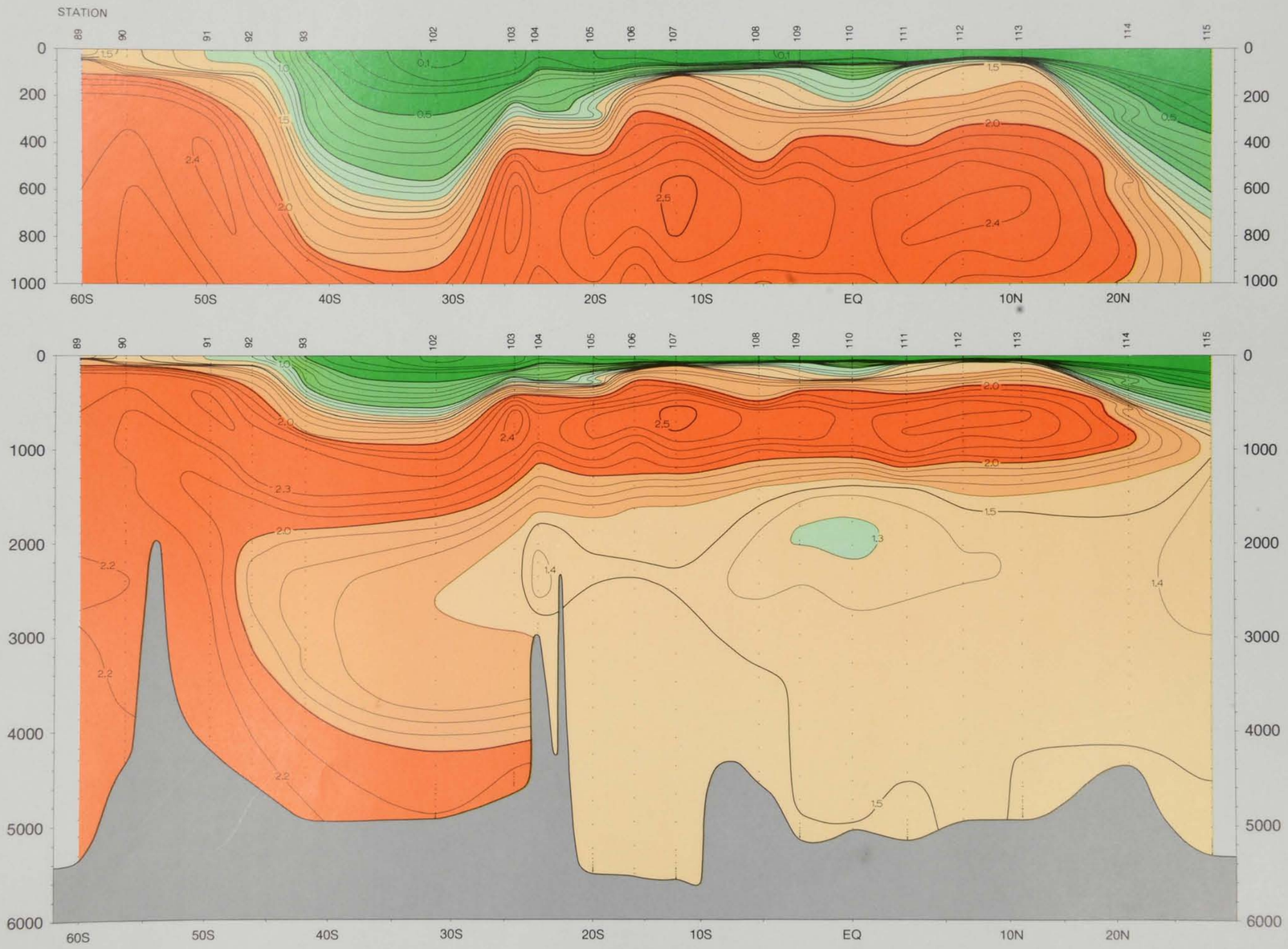
Vertical distribution of Phosphate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC

EASTERN ATLANTIC

PLATE 35

Vertical distribution of Phosphate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section and 1000:1 in the lower section.

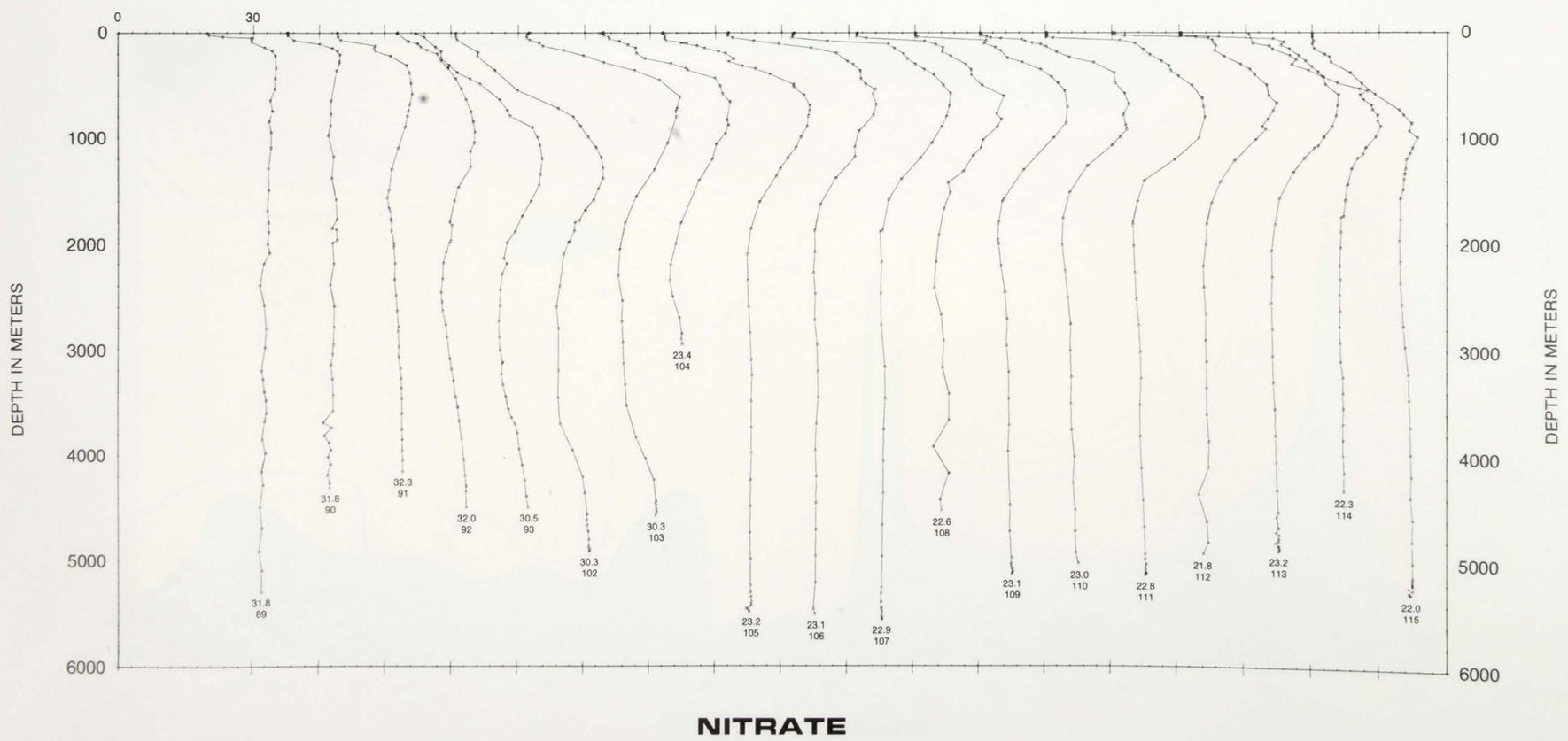


PHOSPHATE

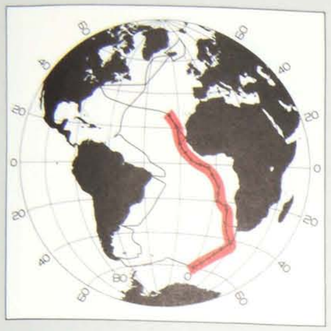
PLATE 36

Vertical distribution of Nitrate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC



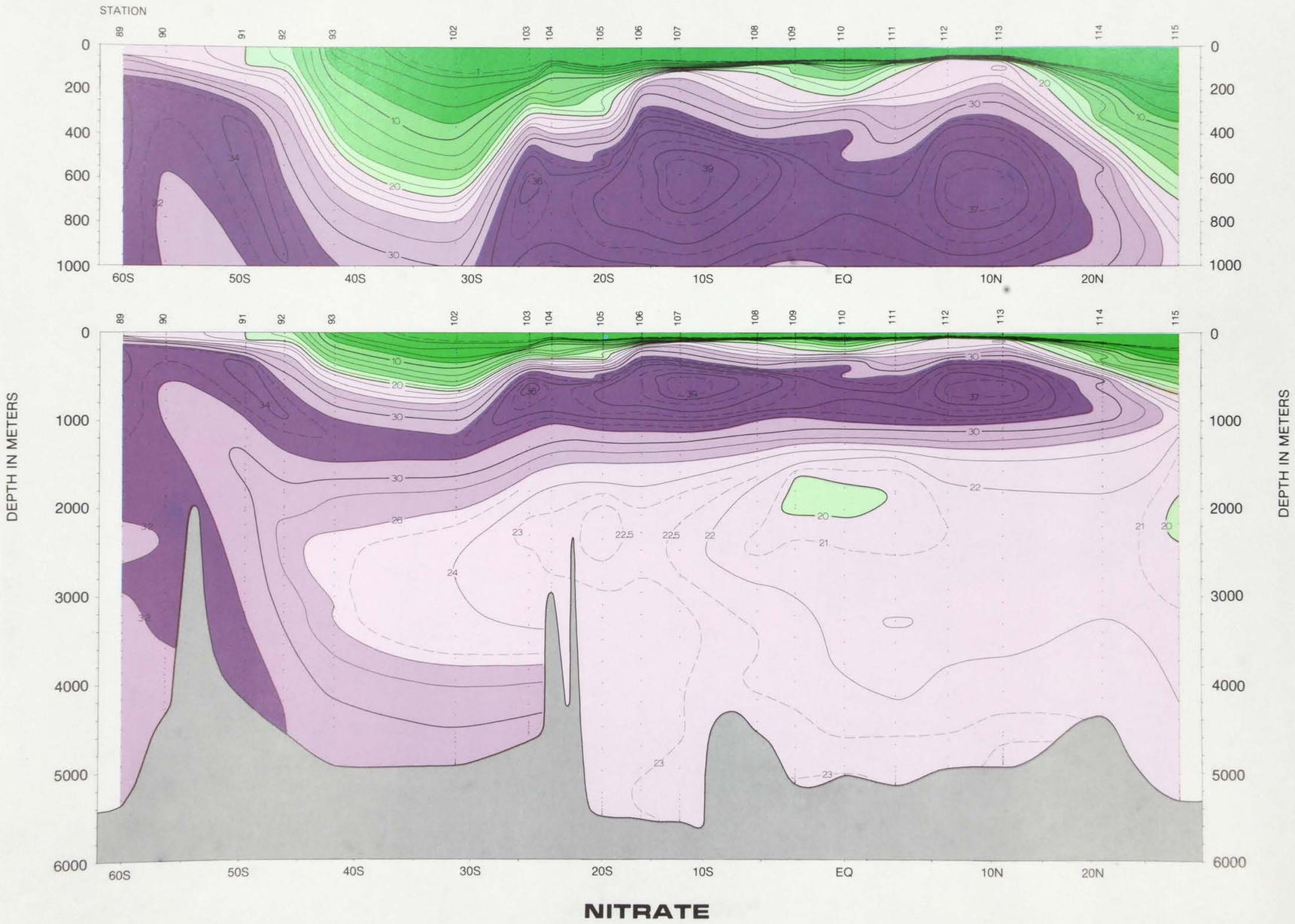
NITRATE



EASTERN ATLANTIC

PLATE 37

Vertical distribution of Nitrate (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower section.



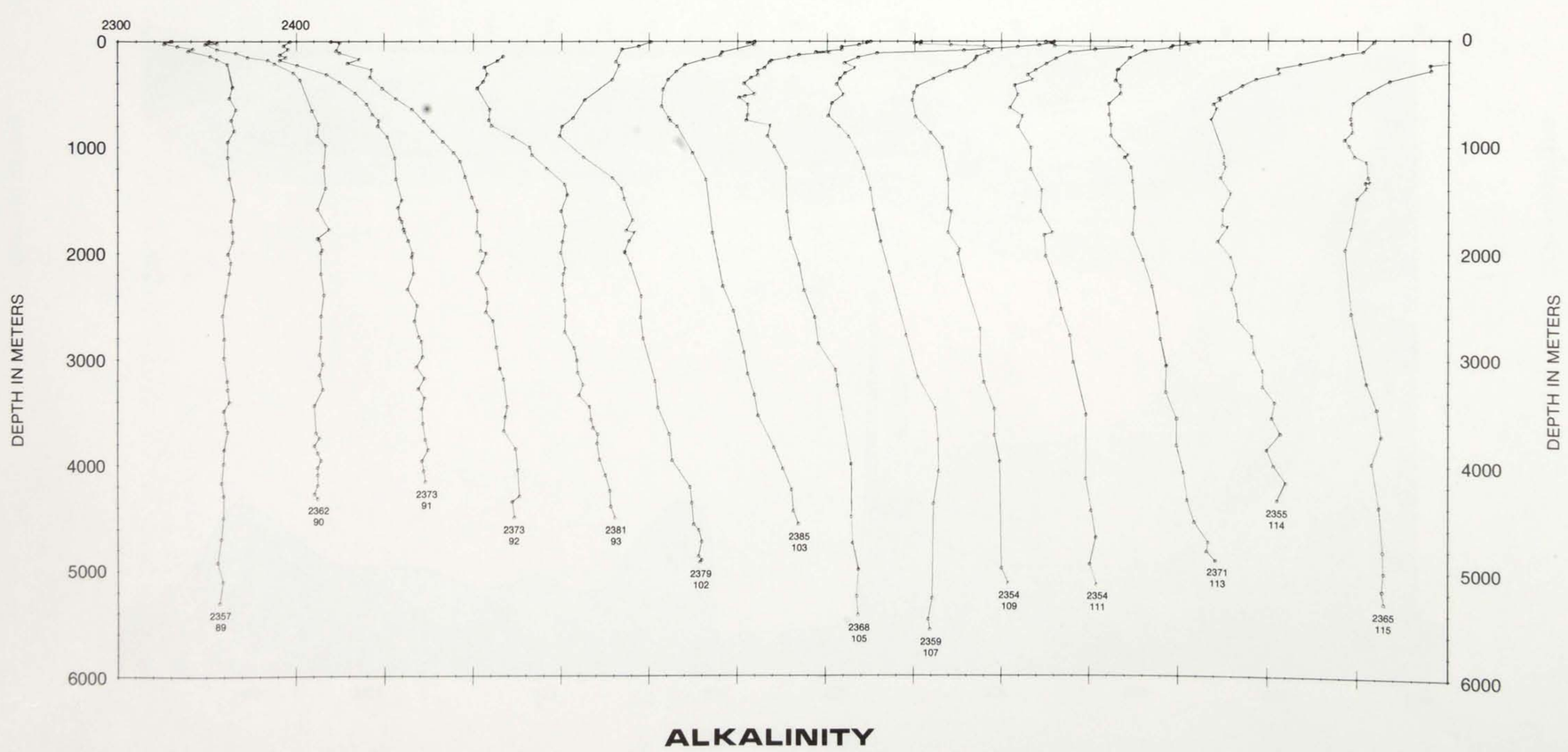
NITRATE

NO_3

PLATE 38

Vertical distribution of Alkalinity (μEq/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC



EASTERN ATLANTIC

PLATE 39

Vertical distribution of Alkalinity (μEq/kg) in the Eastern Atlantic, January to March, 1973, GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.

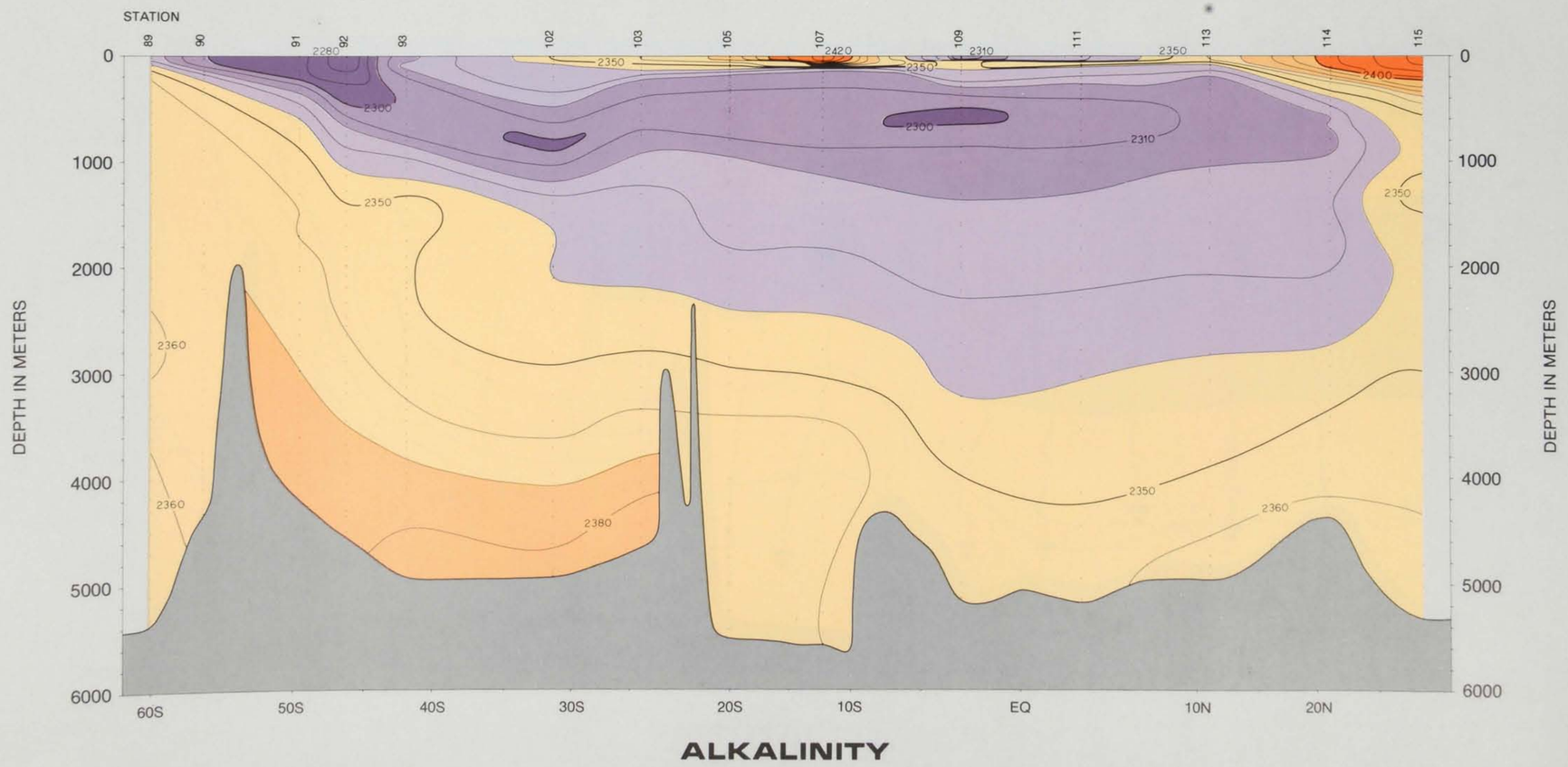
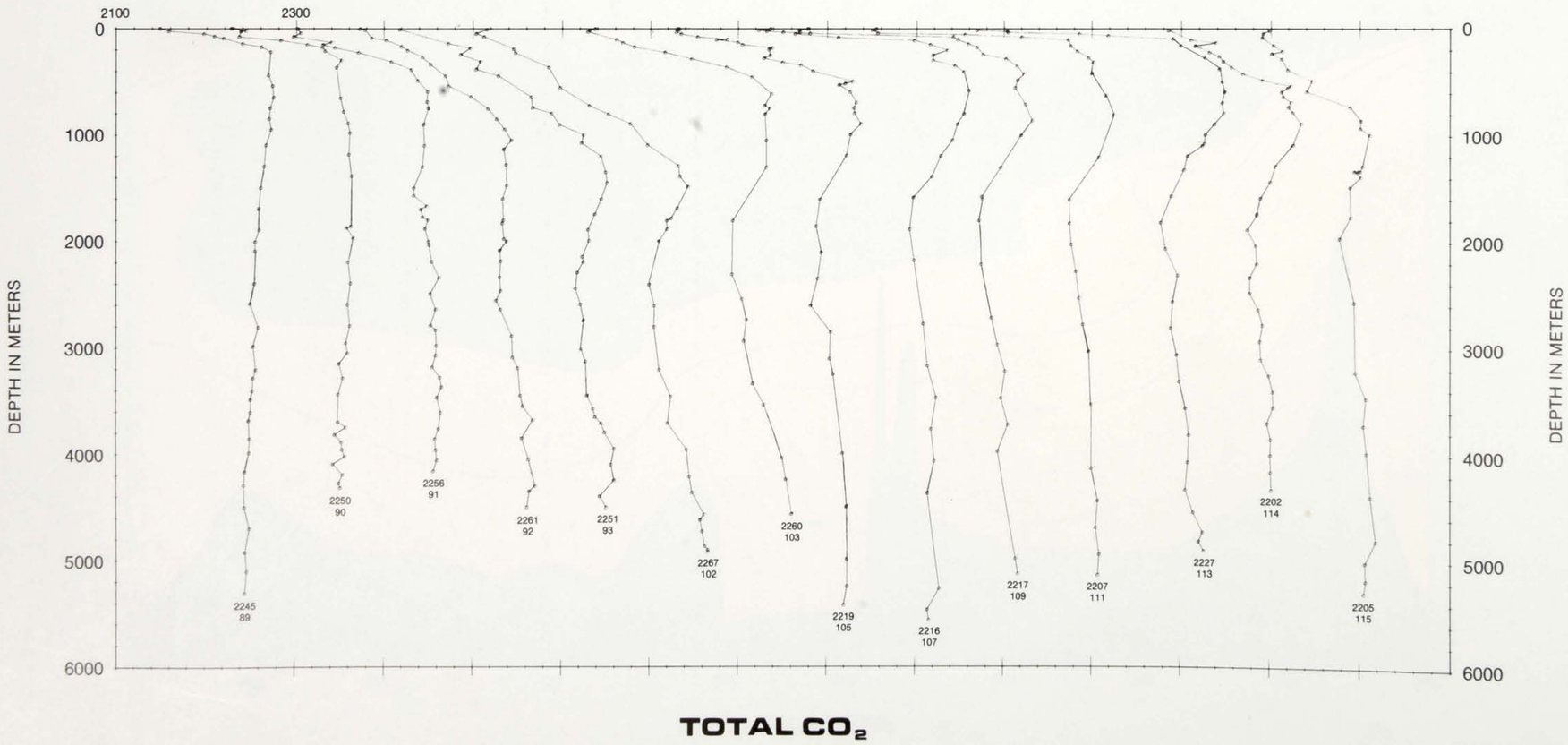
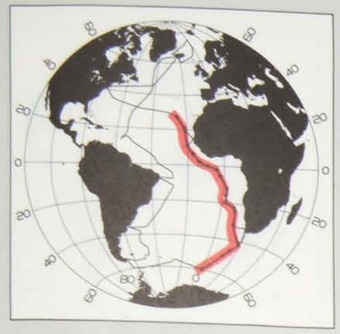


PLATE 40

Vertical distribution of Total CO_2 (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

EASTERN ATLANTIC





EASTERN ATLANTIC

PLATE 41

Vertical distribution of Total CO_2 (μM/kg) in the Eastern Atlantic, January to March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.

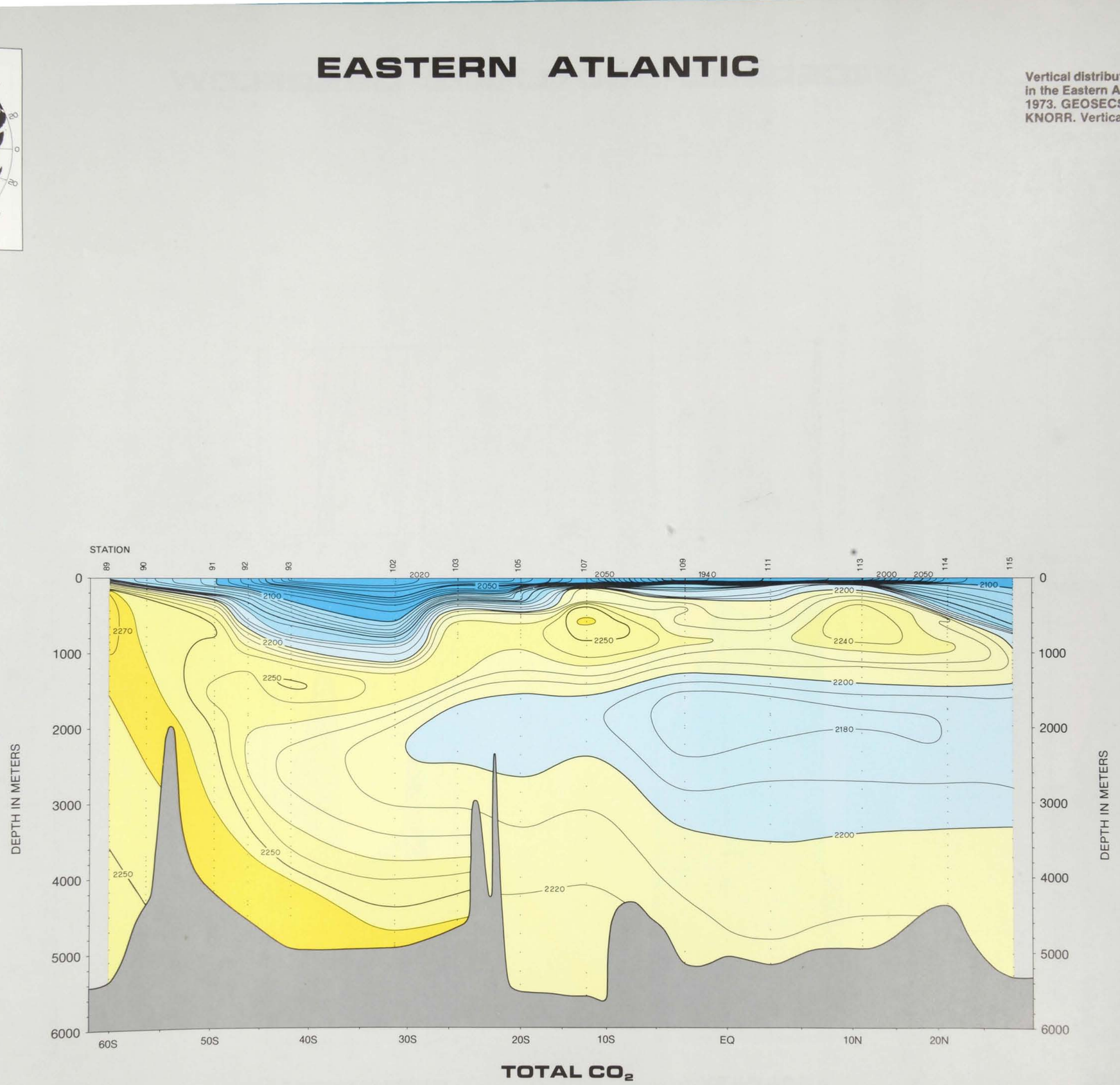
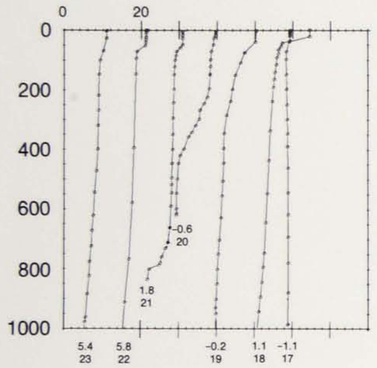
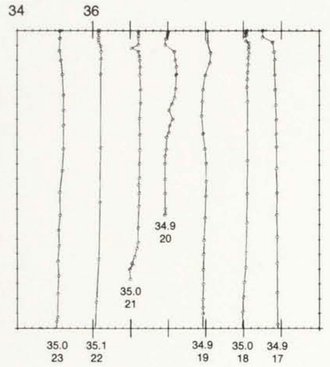


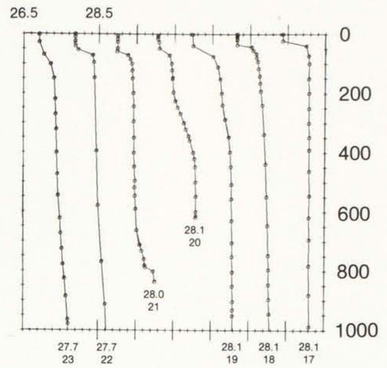
PLATE 42

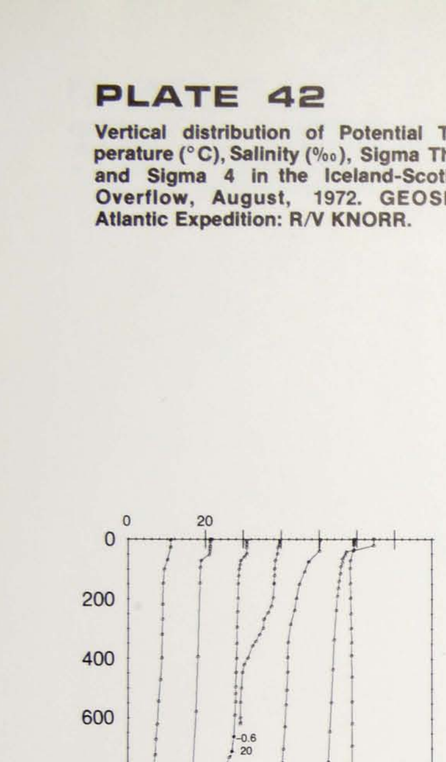
Vertical distribution of Potential Temperature (°C), Salinity (‰), Sigma Theta, and Sigma 4 in the Iceland-Scotland Overflow, August, 1972. GEOSECS Atlantic Expedition: R/V KNORR.

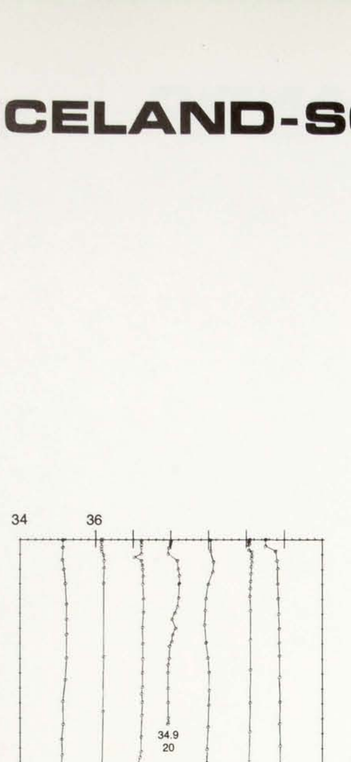
ICELAND-SCOTLAND OVERFLOW

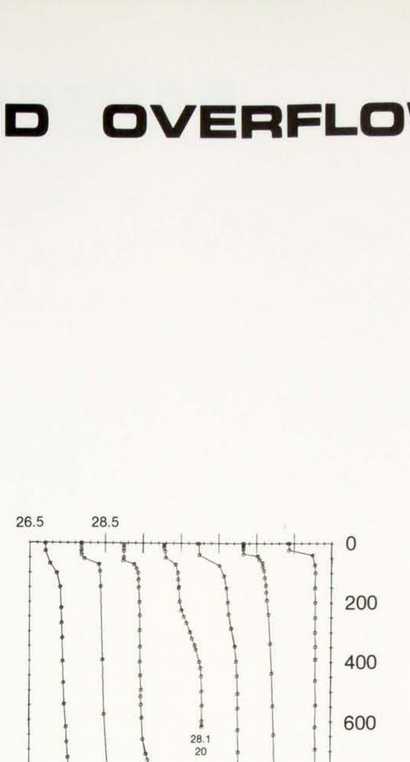












POTENTIAL TEMPERATURE

SALINITY

SIGMA THETA

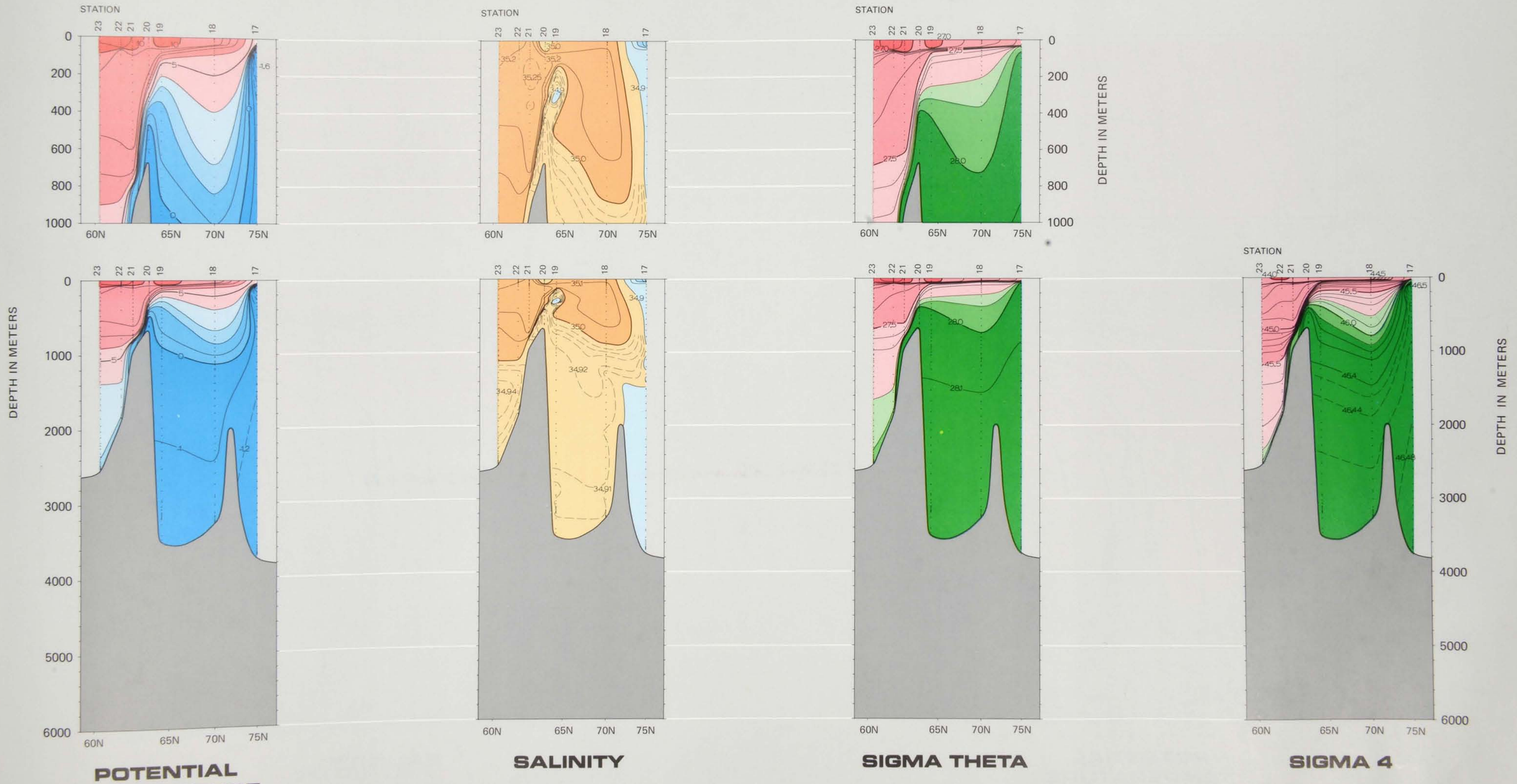
SIGMA 4

θ . S. σ_θ . σ_4

ICELAND-SCOTLAND OVERFLOW

PLATE 43

Vertical distribution of Potential Temperature (°C), Salinity (‰), Sigma Theta, and Sigma 4 in the Iceland-Scotland Overflow, August, 1972. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.

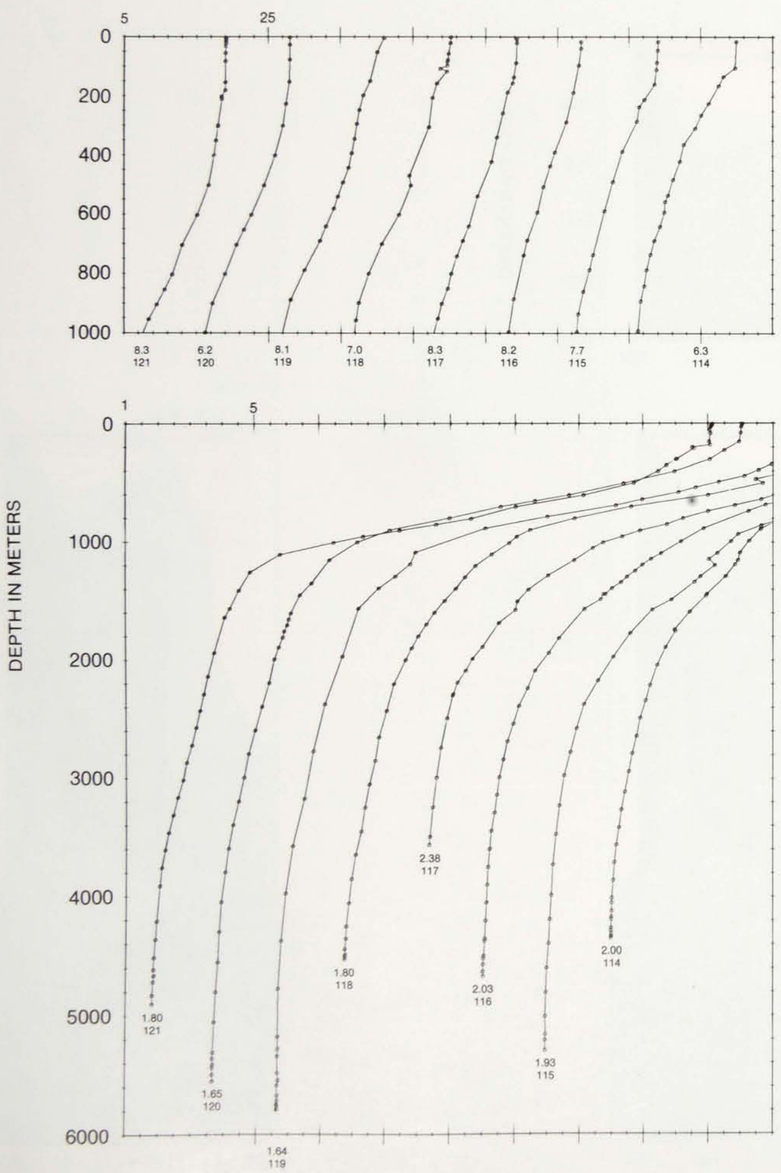


$\theta \cdot S \cdot \sigma_\theta \cdot \sigma_4$

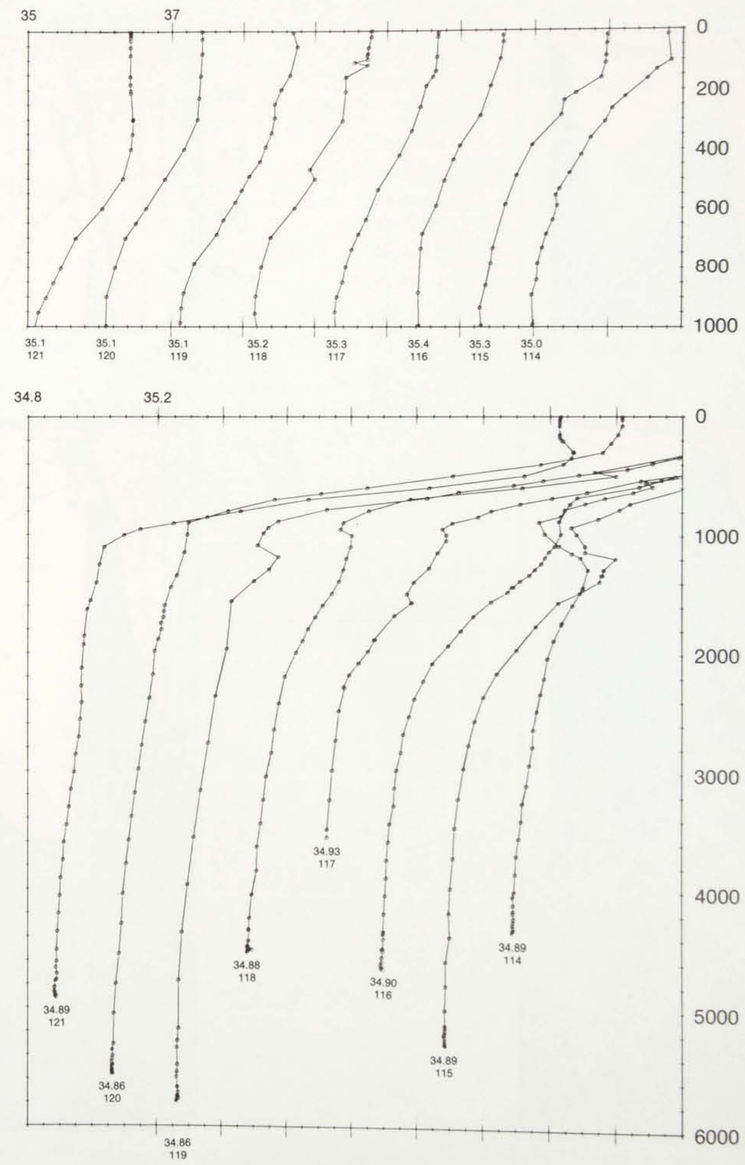
PLATE 44

Vertical distribution of Potential Temperature (°C) and Salinity (‰) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

NORTH ATLANTIC



POTENTIAL TEMPERATURE



SALINITY

NORTH ATLANTIC

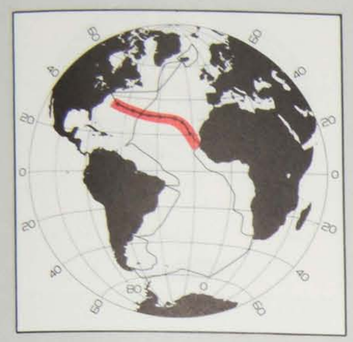
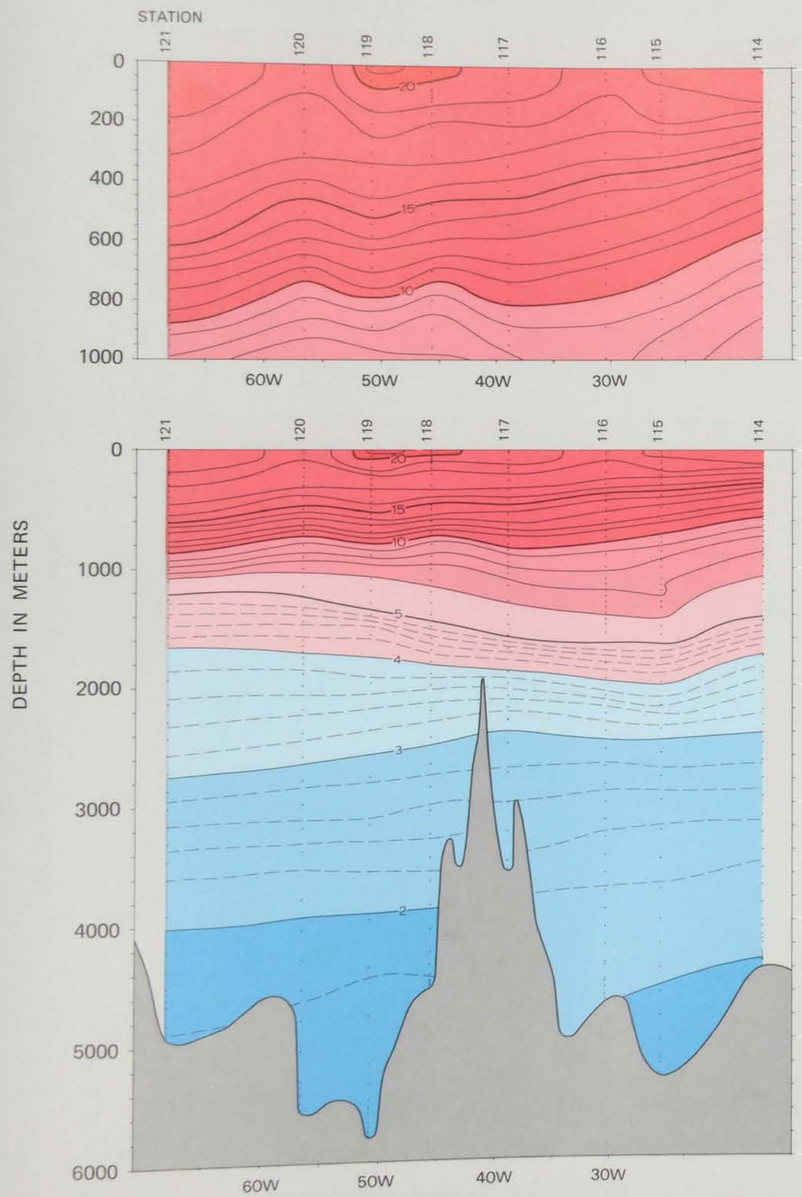
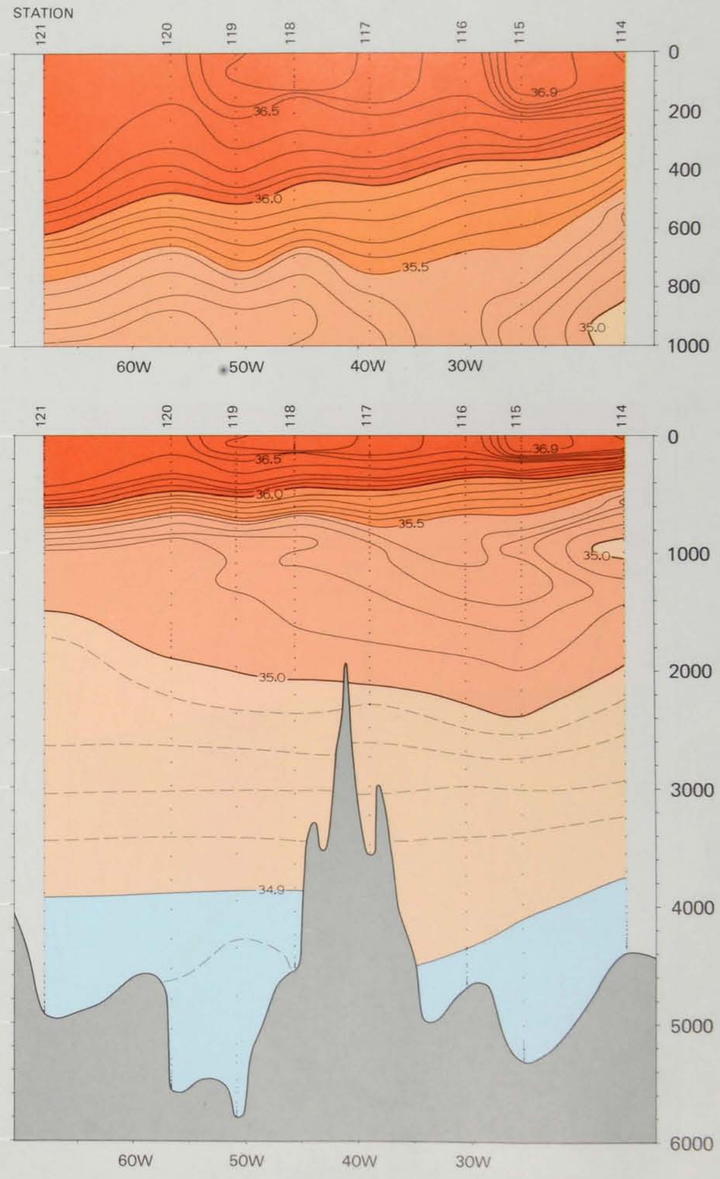


PLATE 45

Vertical distribution of Potential Temperature (°C) and Salinity (‰) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.



POTENTIAL TEMPERATURE

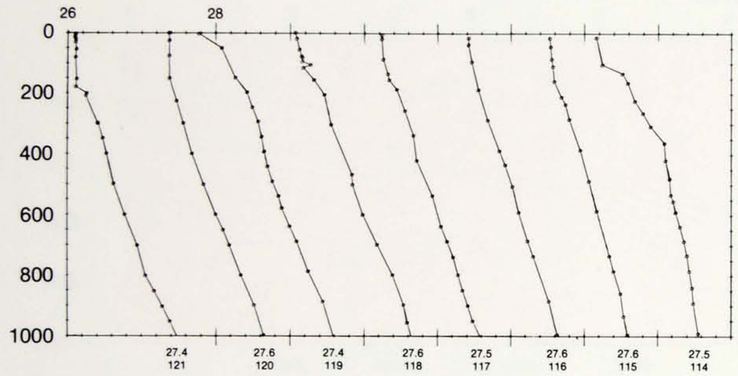


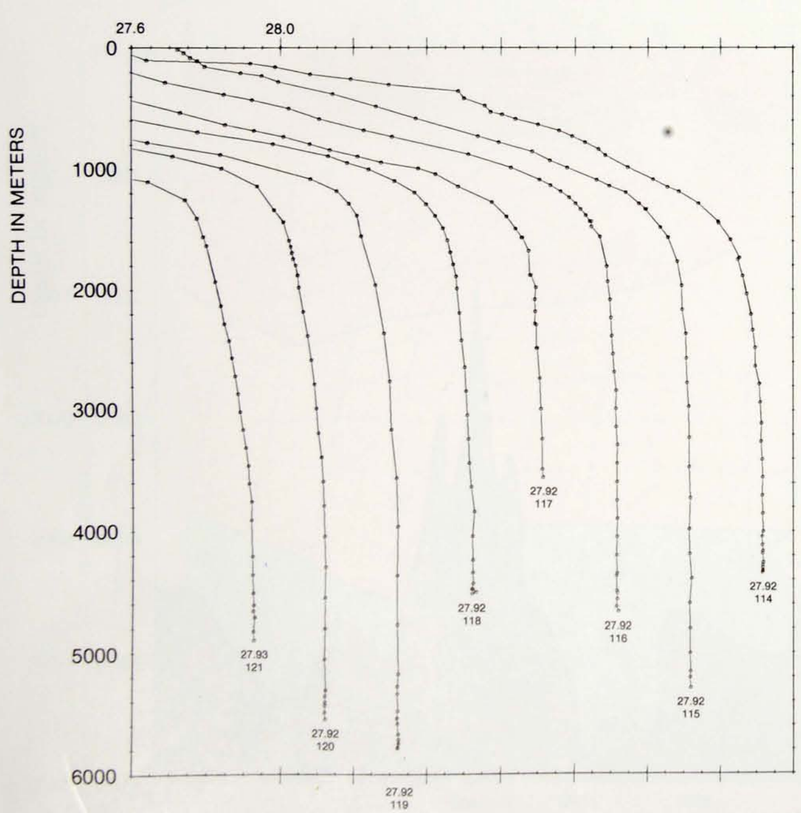
SALINITY

PLATE 46

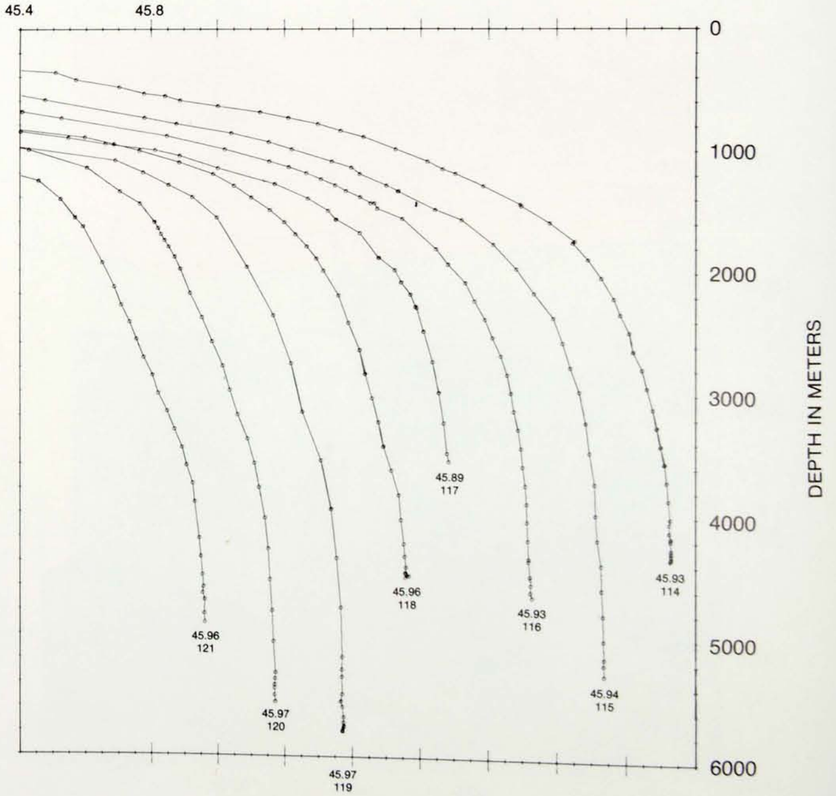
Vertical distribution of Sigma Theta and Sigma 4 in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

NORTH ATLANTIC





SIGMA THETA



SIGMA 4

NORTH ATLANTIC

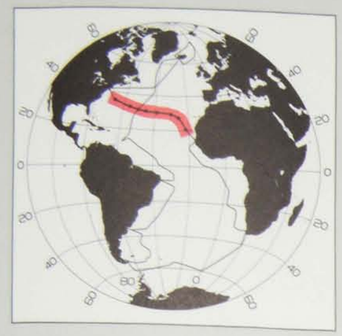
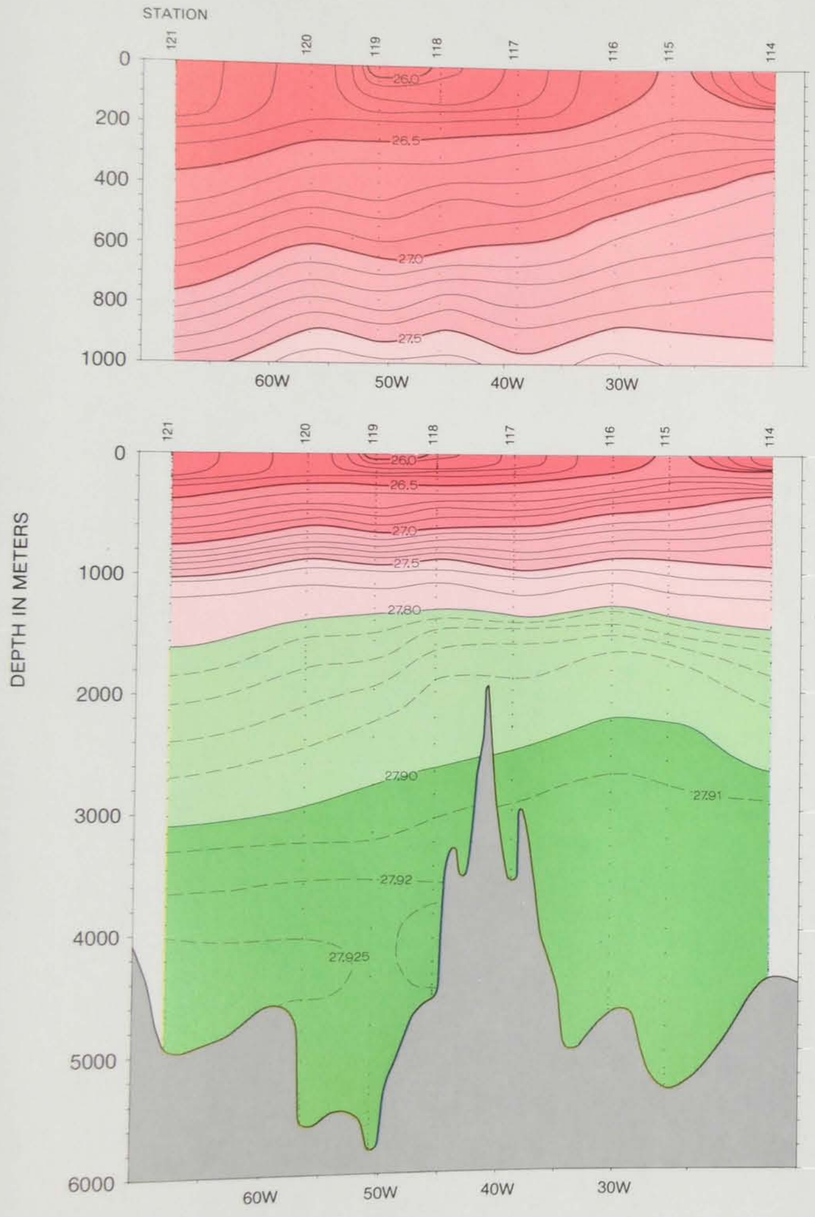


PLATE 47

Vertical distribution of Sigma Theta and Sigma 4 in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper section, and 1000:1 in the lower sections.



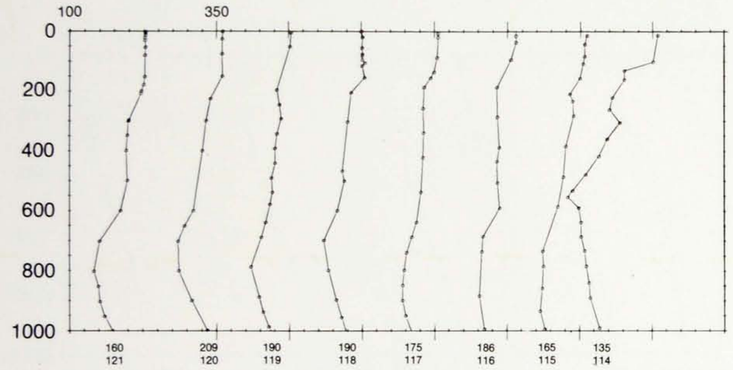
SIGMA THETA

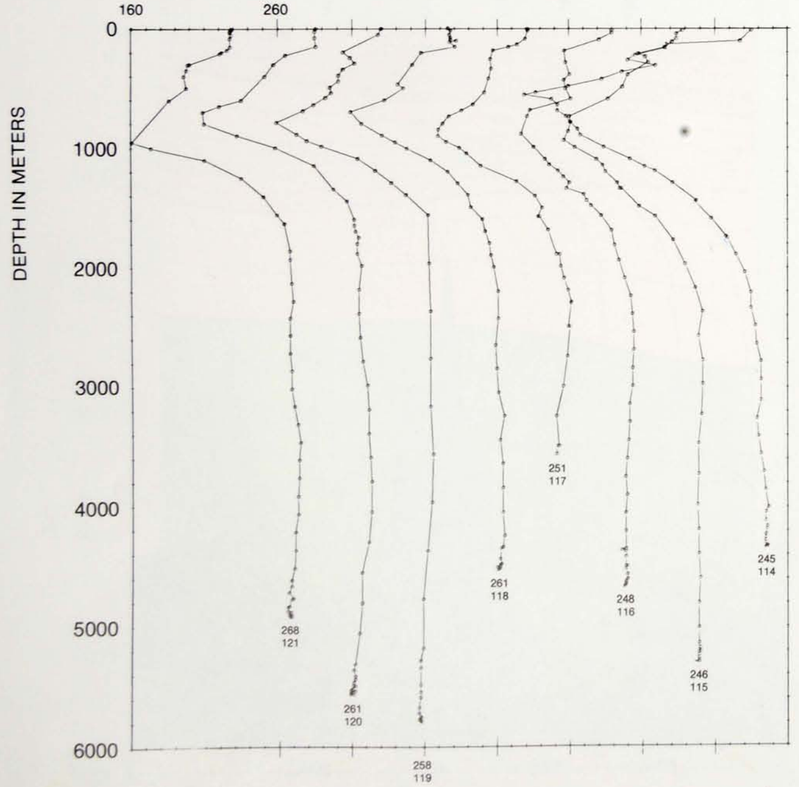
SIGMA 4

PLATE 48

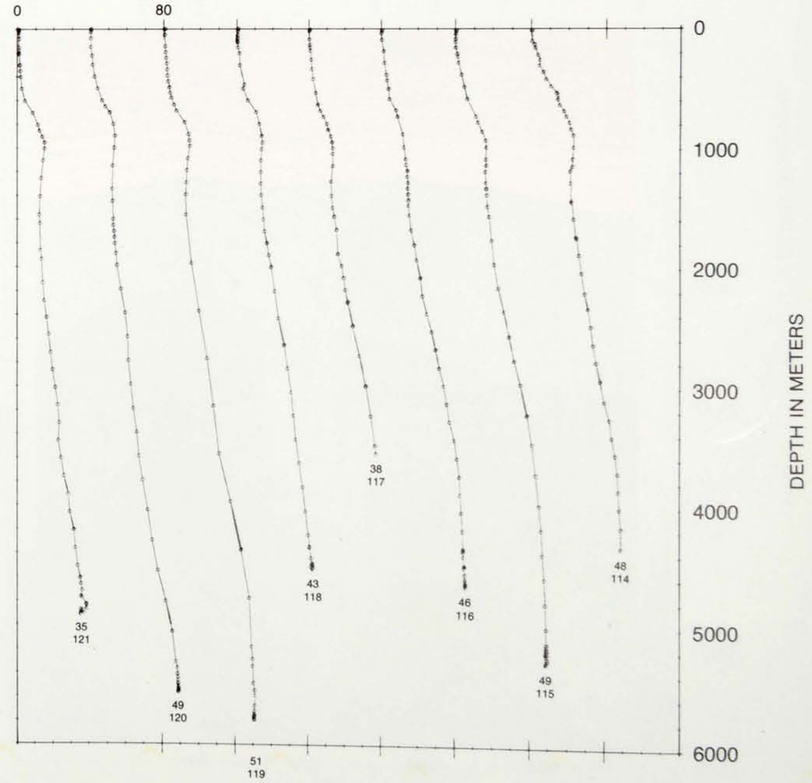
Vertical distribution of Oxygen (μM/kg) and Silicate (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

NORTH ATLANTIC





OXYGEN



SILICATE

NORTH ATLANTIC

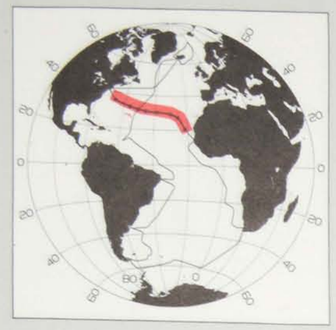
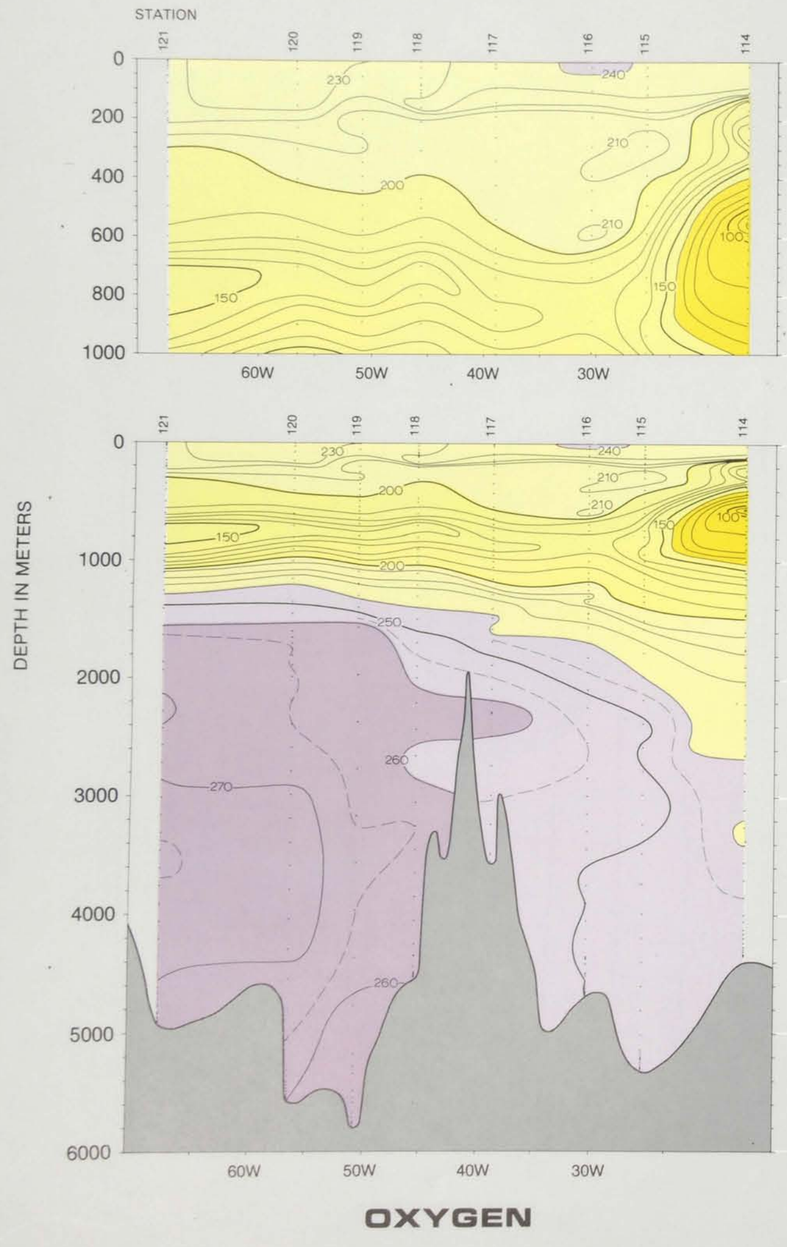


PLATE 49

Vertical distribution of Oxygen (μM/kg) and Silicate (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.



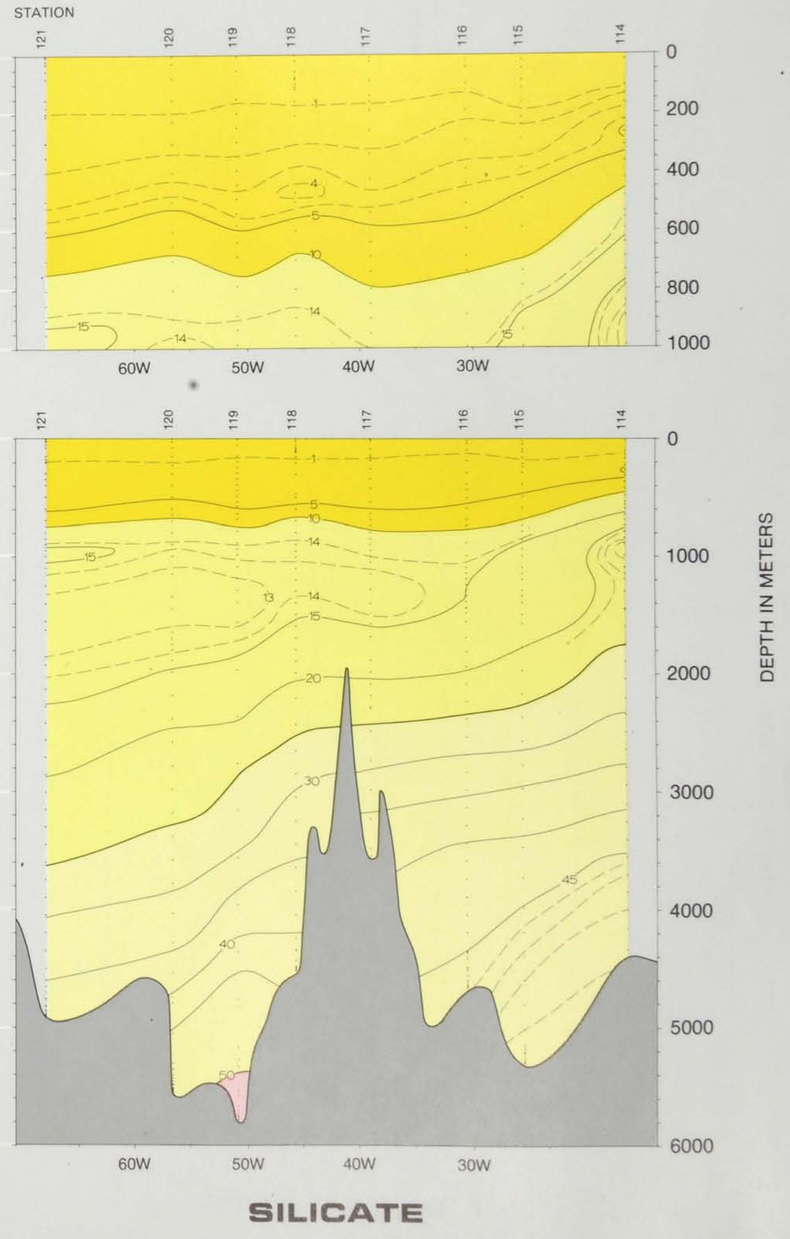
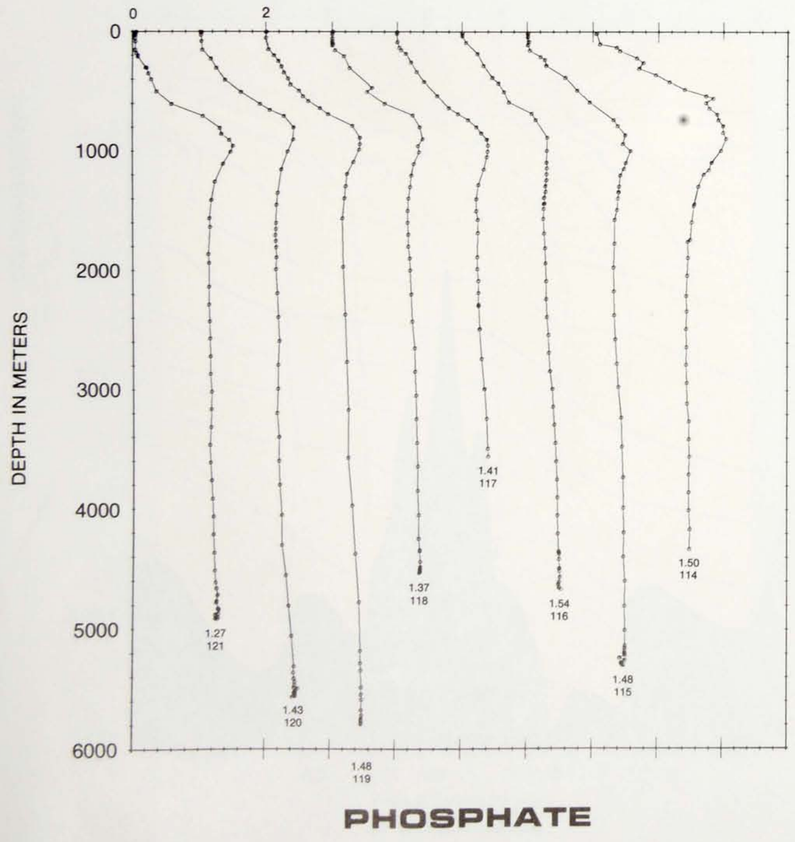


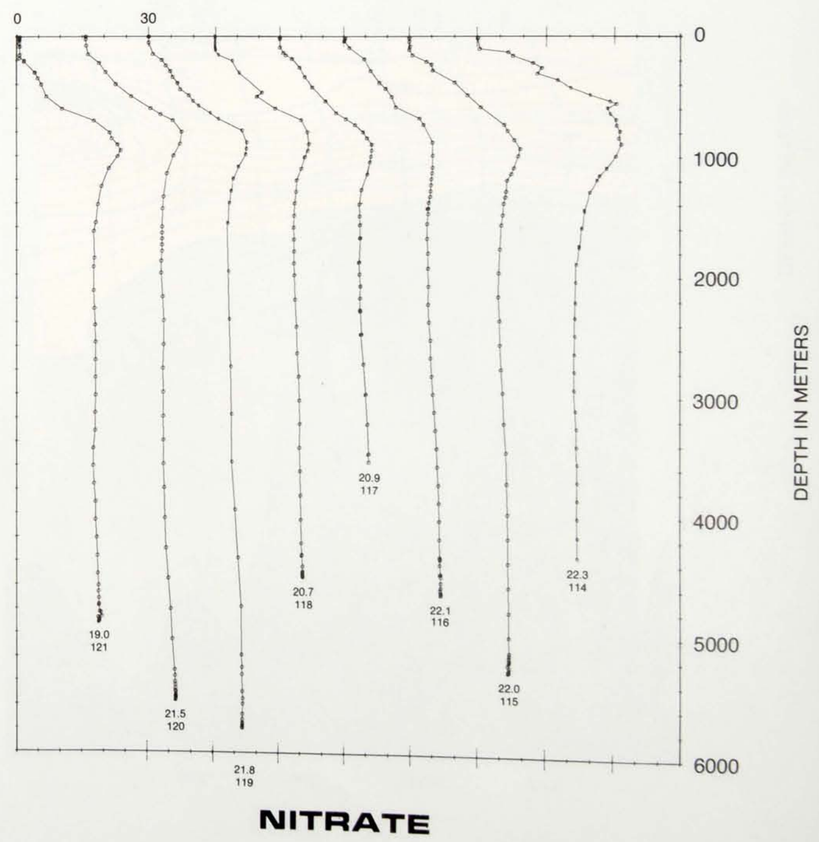
PLATE 50

Vertical distribution of Phosphate (μM/kg) and Nitrate (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

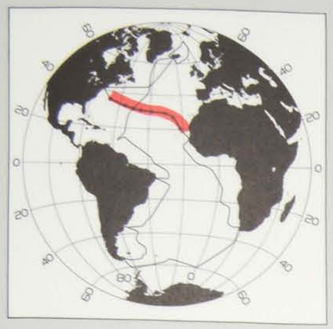
NORTH ATLANTIC



PHOSPHATE



NITRATE



NORTH ATLANTIC

PLATE 51

Vertical distribution of Phosphate (μM/kg) and Nitrate (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.

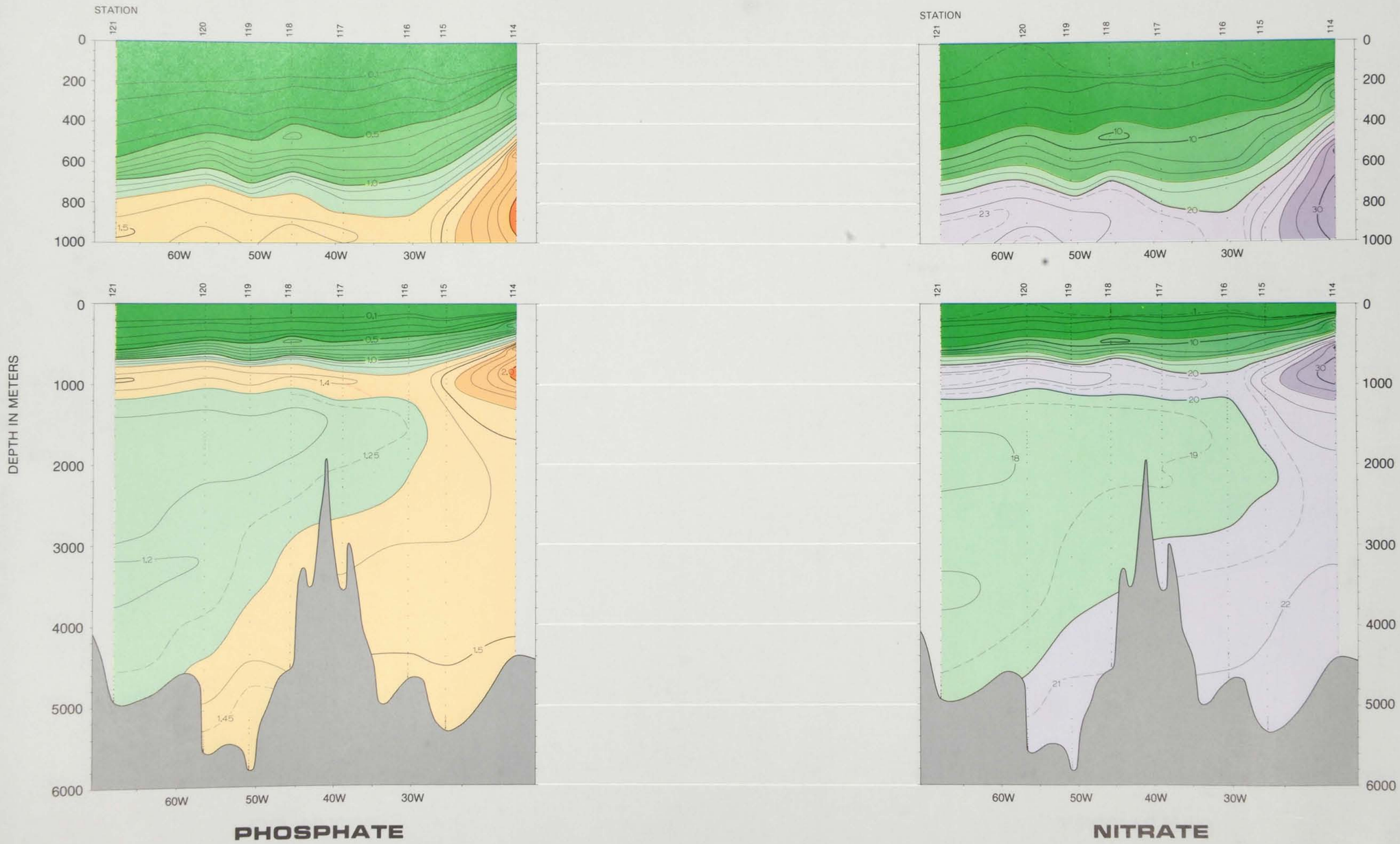
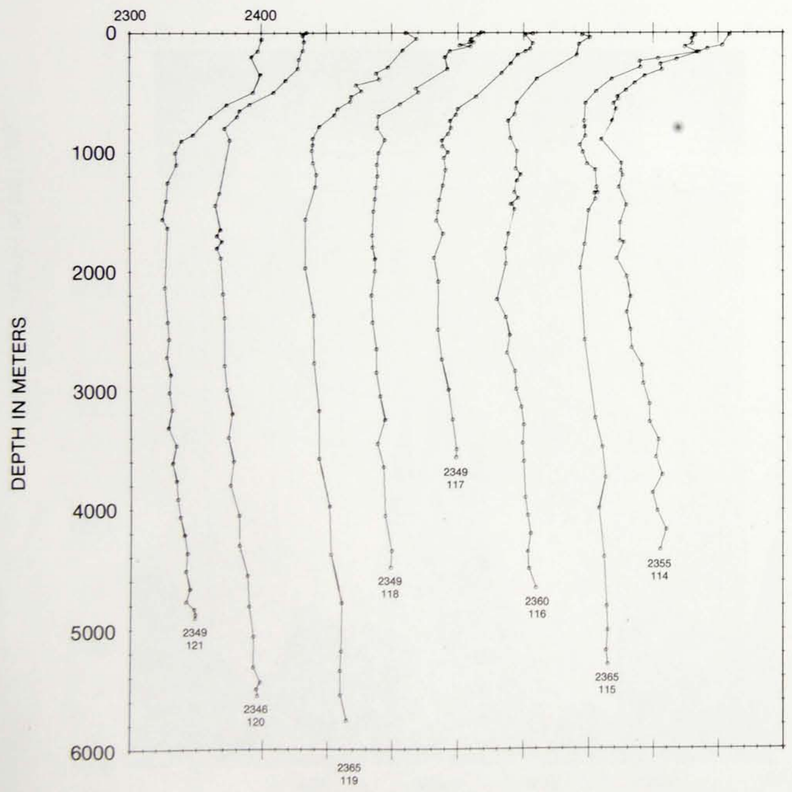


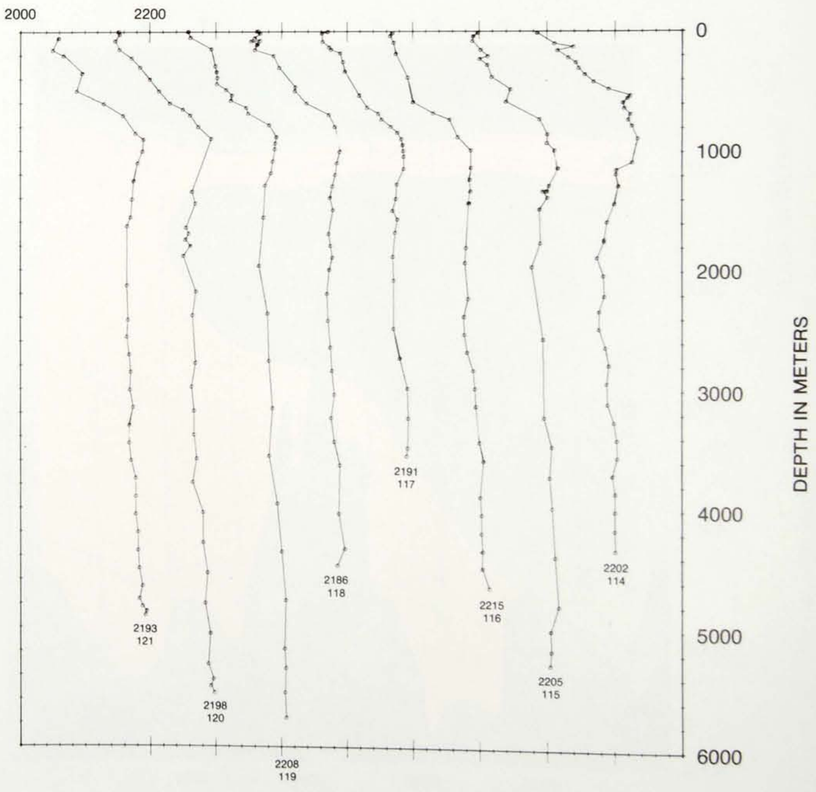
PLATE 52

Vertical distribution of Alkalinity (μEq/kg) and Total CO_2 (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

NORTH ATLANTIC



ALKALINITY



TOTAL CO_2

NORTH ATLANTIC

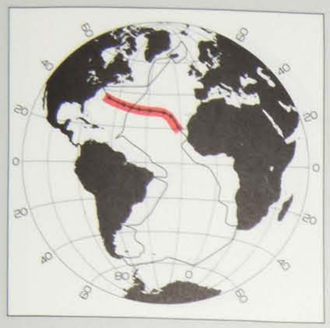
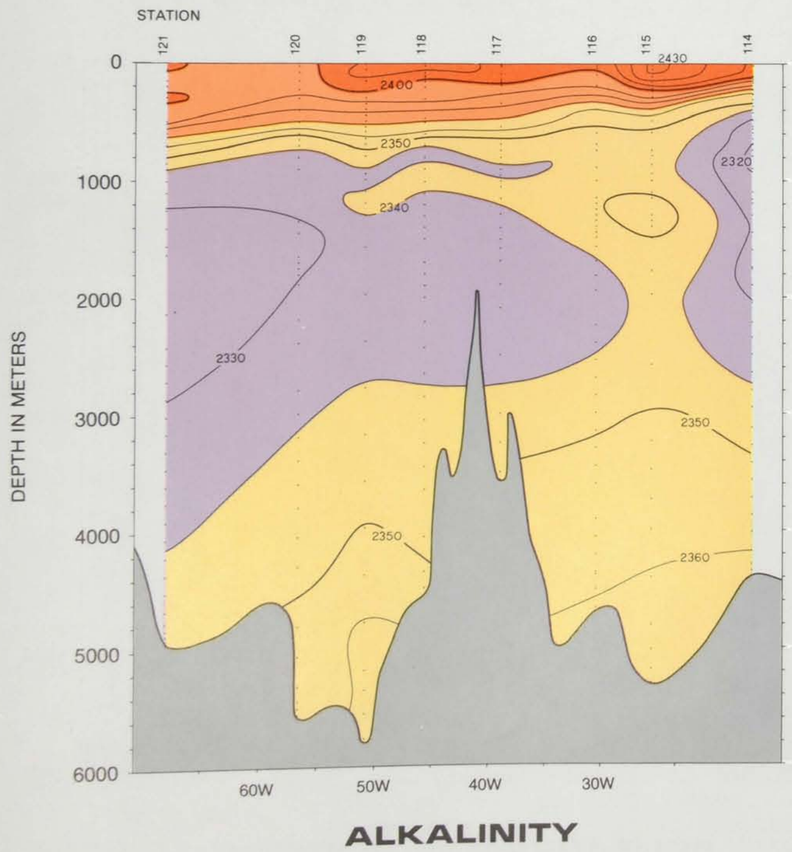
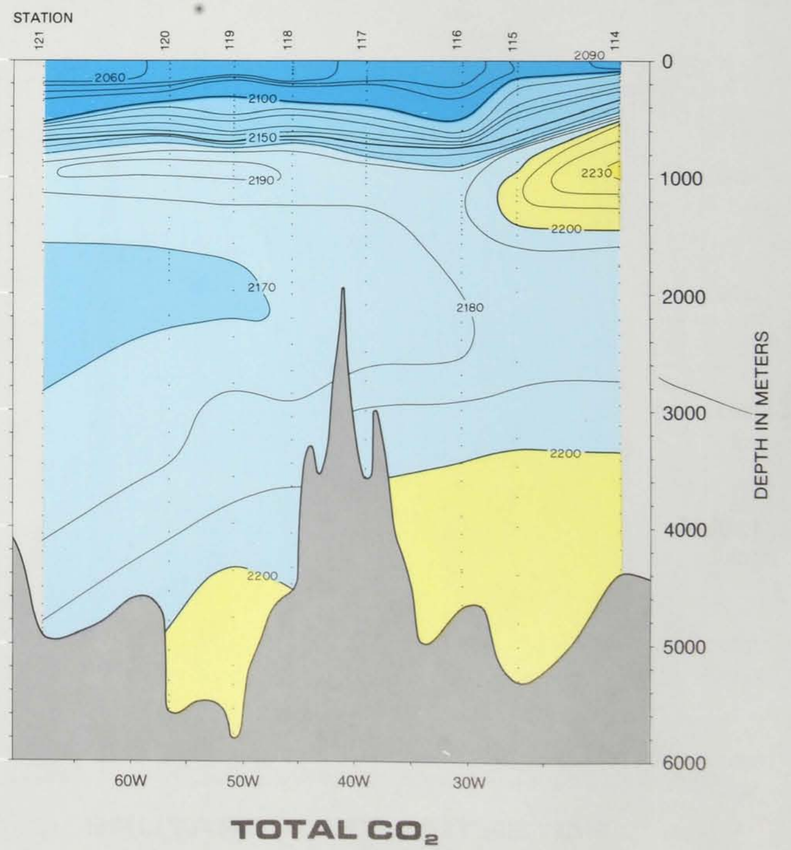


PLATE 53

Vertical Distribution of Alkalinity (μ Eq/kg) and Total CO_2 (μM/kg) in the North Atlantic, March, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.



ALKALINITY

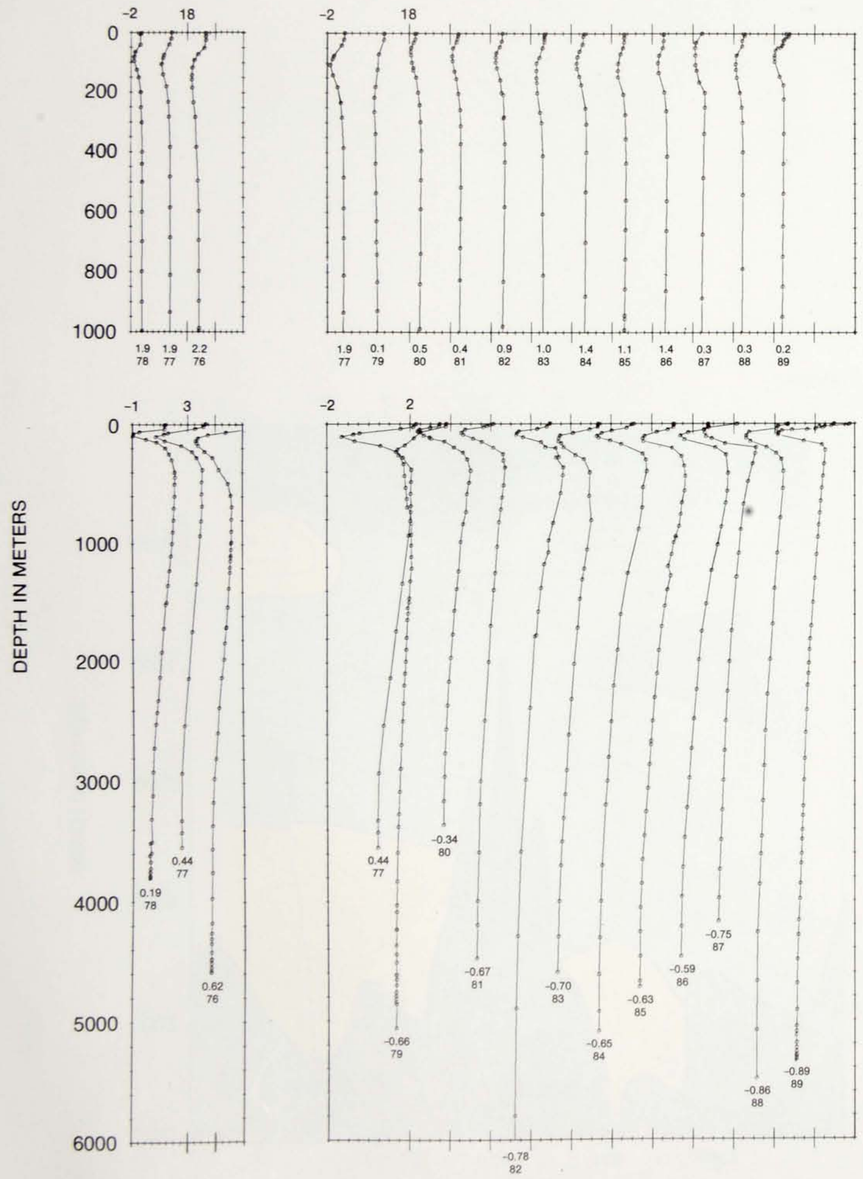


TOTAL CO_2

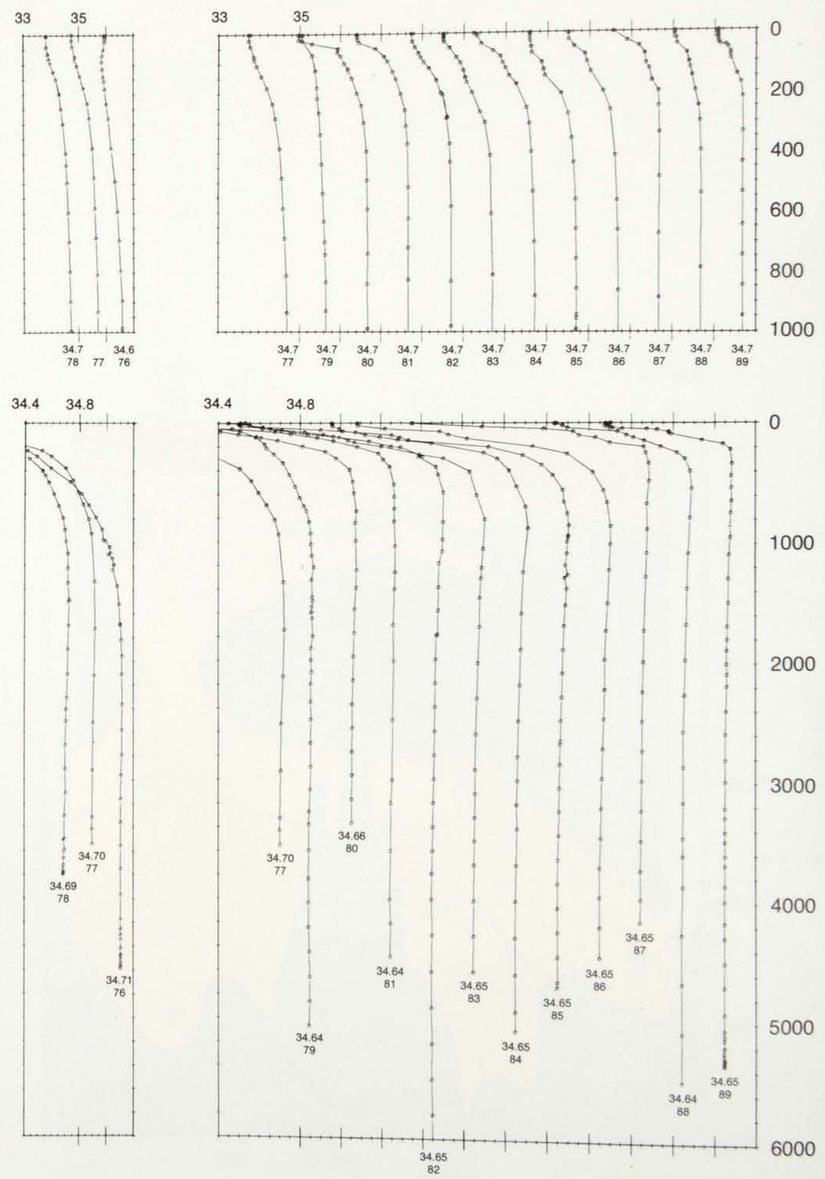
PLATE 54

Vertical distribution of Potential Temperature (°C) and Salinity (‰) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

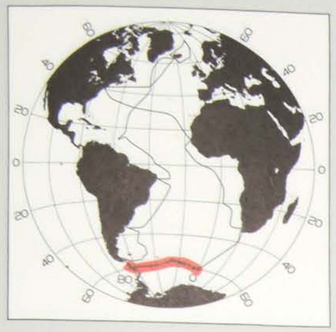
DRAKE PASSAGE AND CIRCUMPOLAR CURRENT



POTENTIAL TEMPERATURE



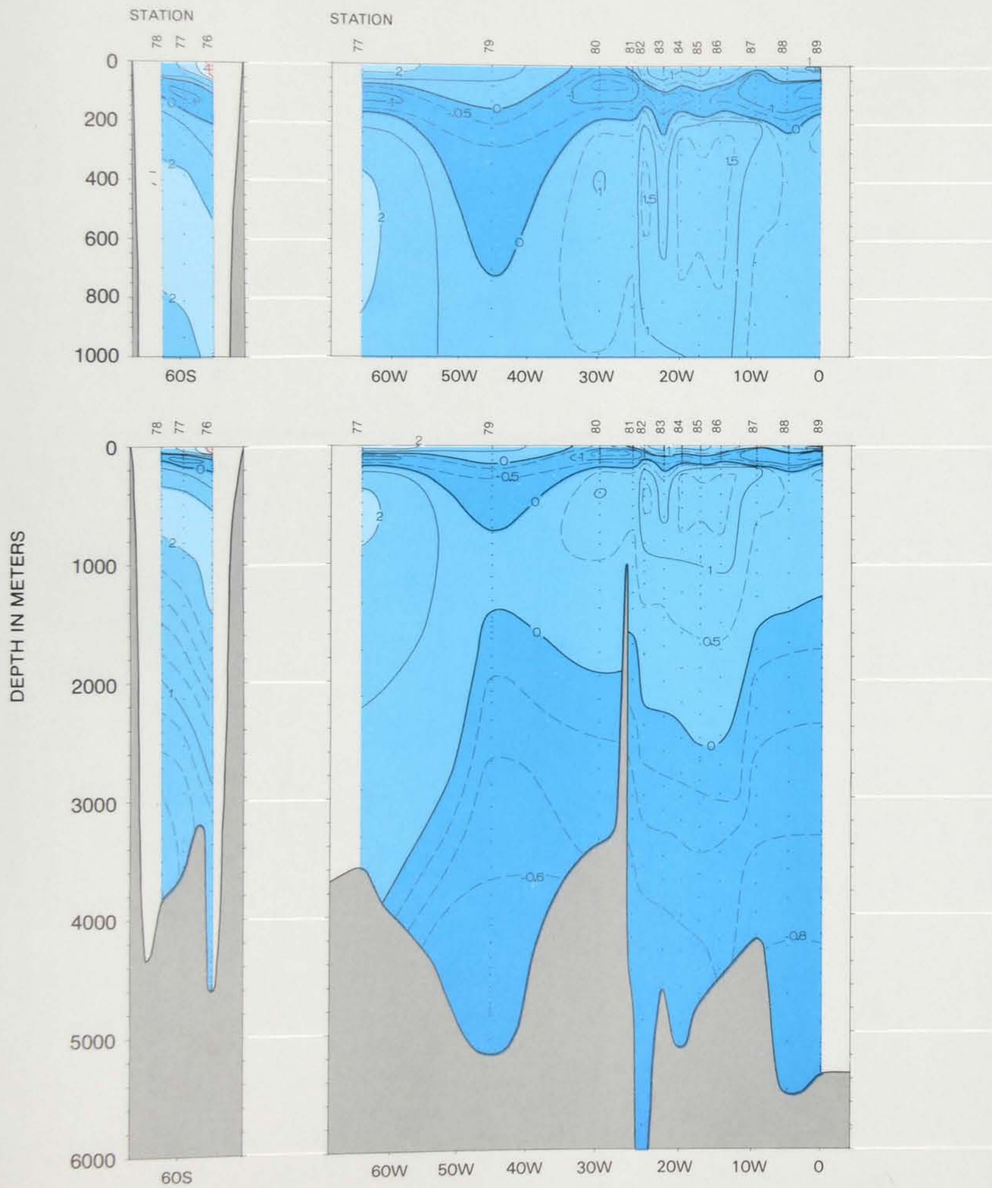
SALINITY



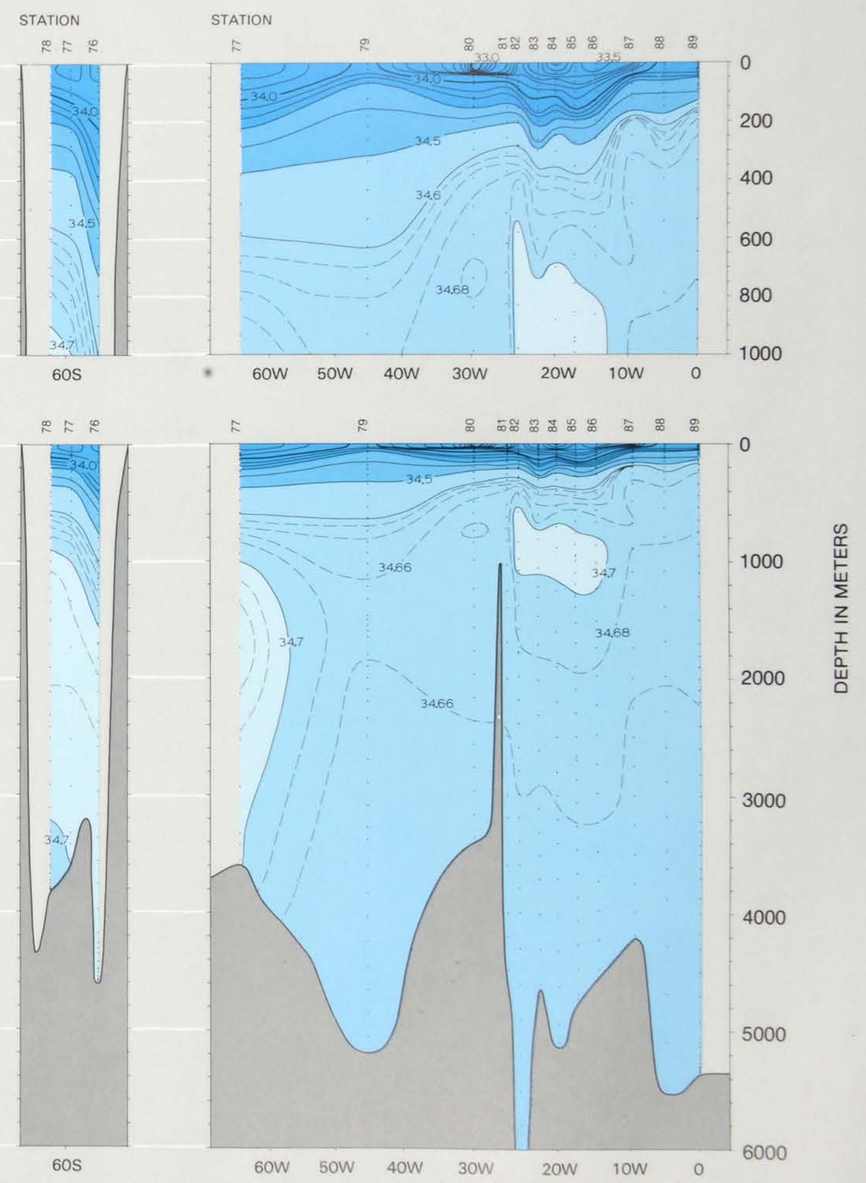
DRAKE PASSAGE AND CIRCUMPOLAR CURRENT

PLATE 55

Vertical distribution of Potential Temperature (° C) and Salinity (‰) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973, GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.



POTENTIAL TEMPERATURE

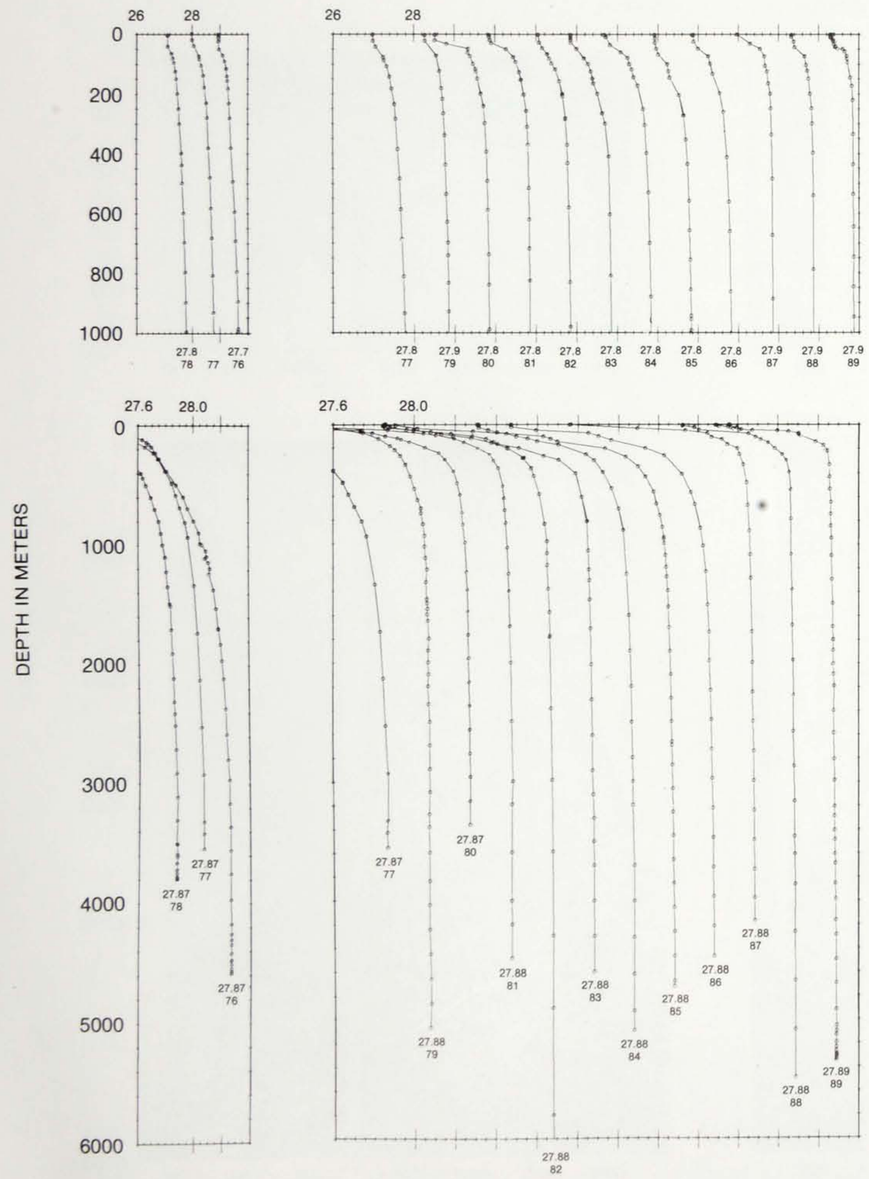


SALINITY

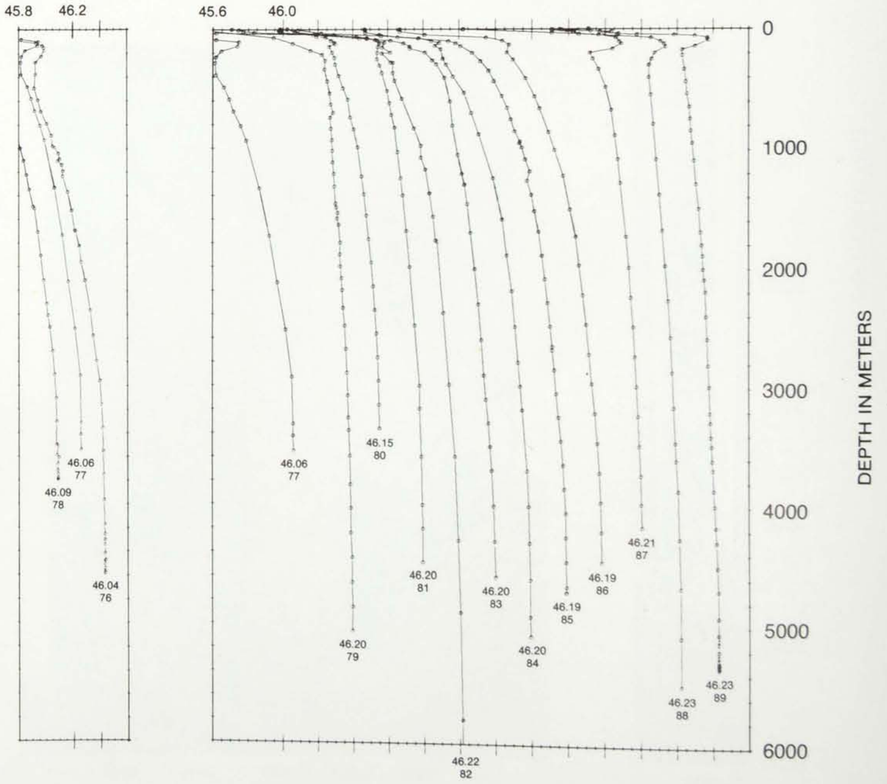
PLATE 56

Vertical distribution of Sigma Theta and Sigma 4 in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

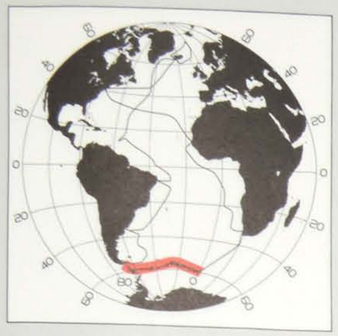
DRAKE PASSAGE AND CIRCUMPOLAR CURRENT



SIGMA THETA



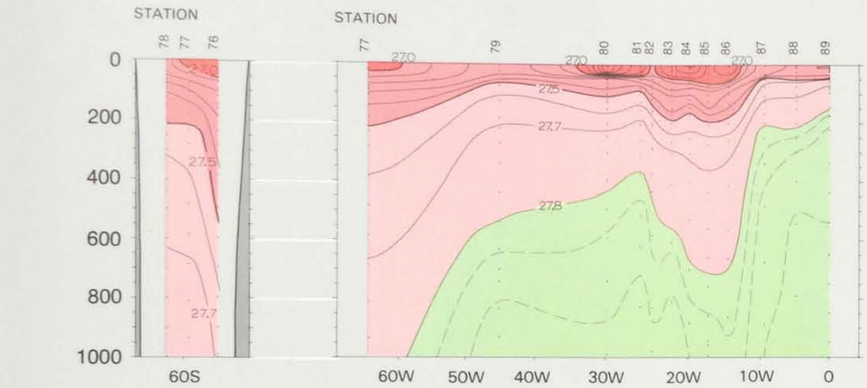
SIGMA 4

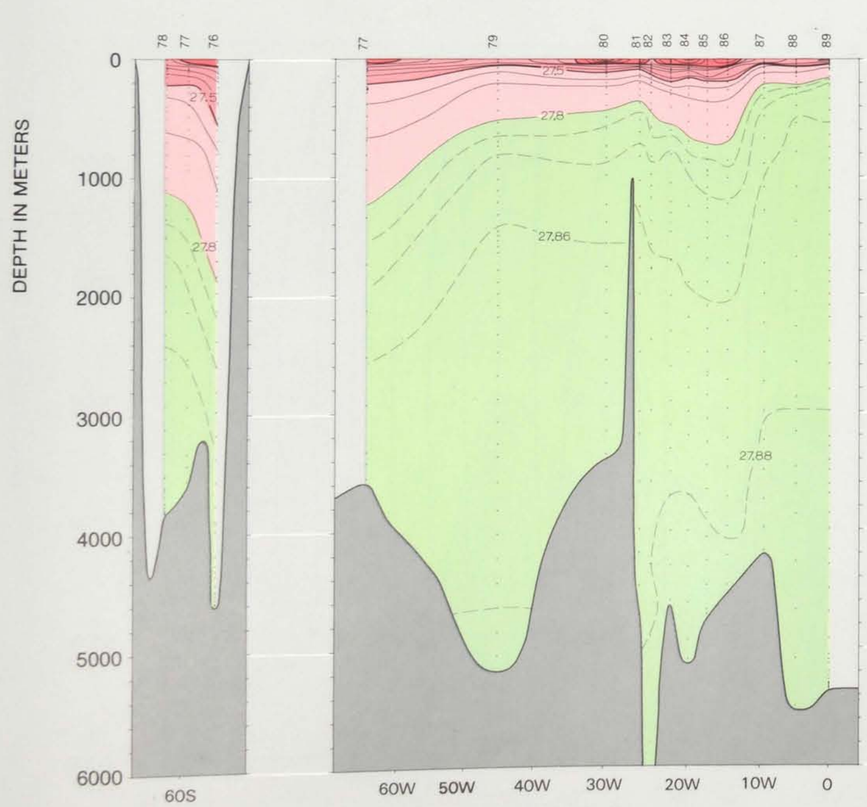


DRAKE PASSAGE AND CIRCUMPOLAR CURRENT

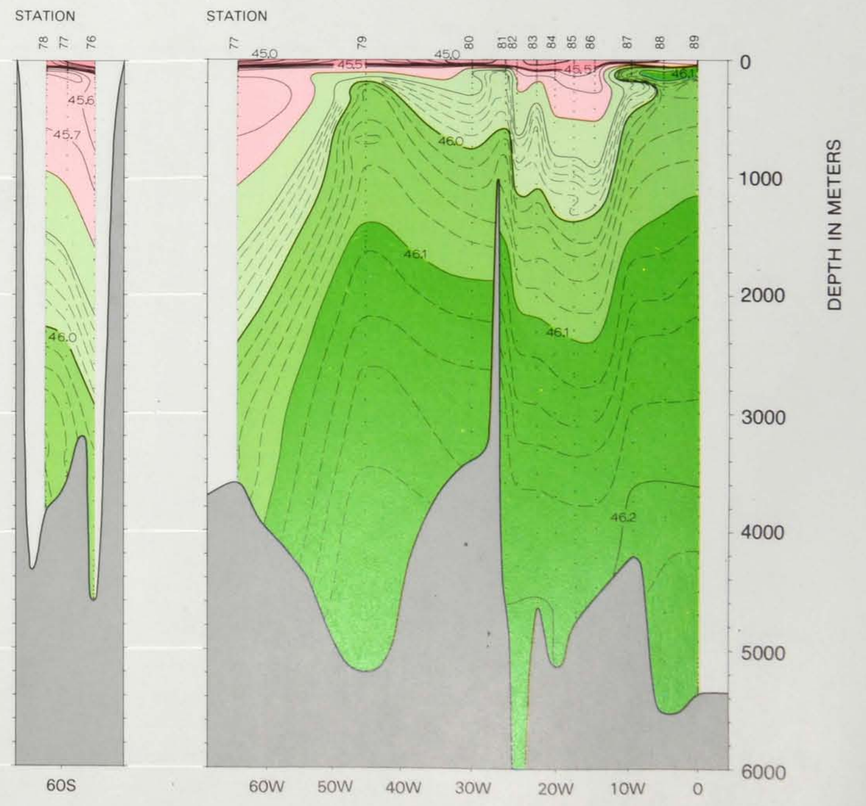
PLATE 57

Vertical distribution of Sigma Theta and Sigma 4 in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.





SIGMA THETA

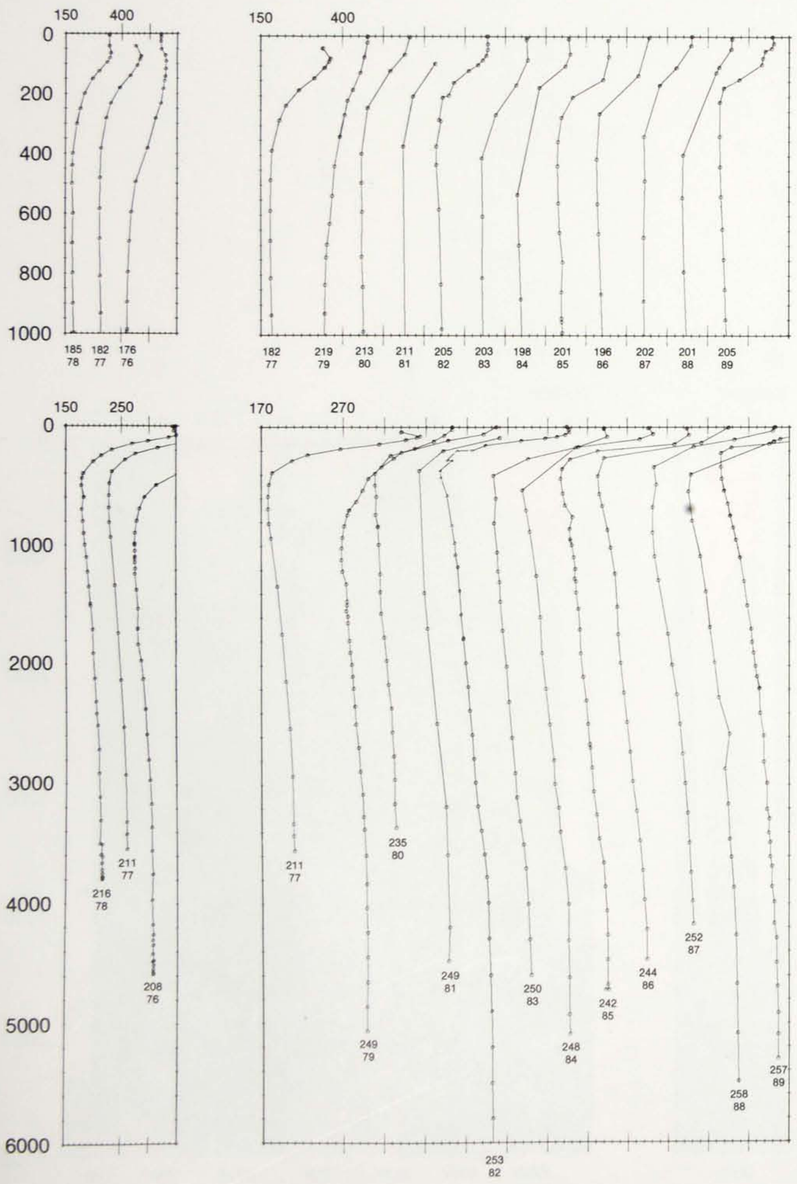


SIGMA 4

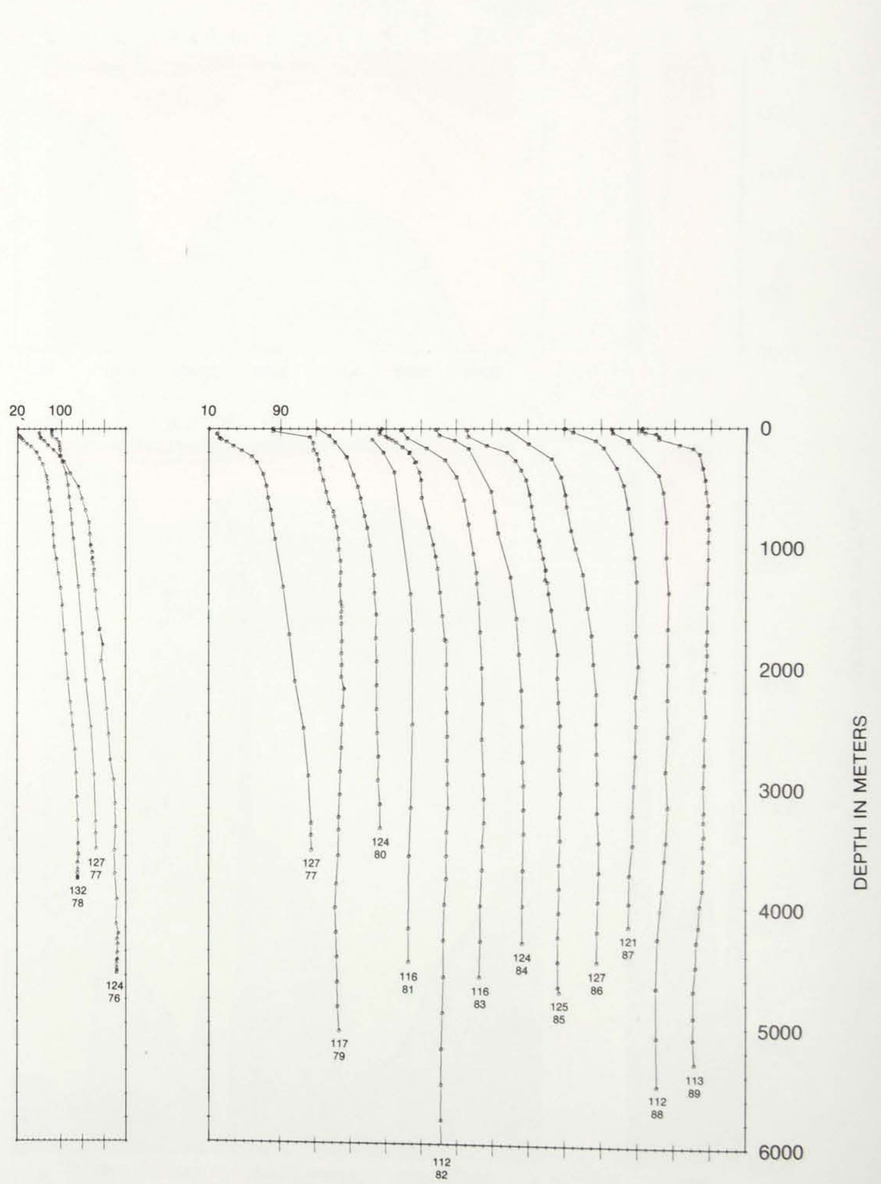
PLATE 58

Vertical distribution of Oxygen (μM/kg) and Silicate (μM/kg) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

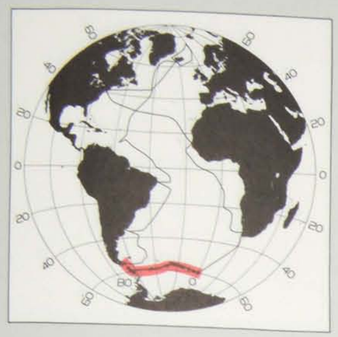
DRAKE PASSAGE AND CIRCUMPOLAR CURRENT



OXYGEN



SILICATE



DRAKE PASSAGE AND CIRCUMPOLAR CURRENT

PLATE 59

Vertical distribution of Oxygen (μM/kg) and Silicate(μM/kg) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.

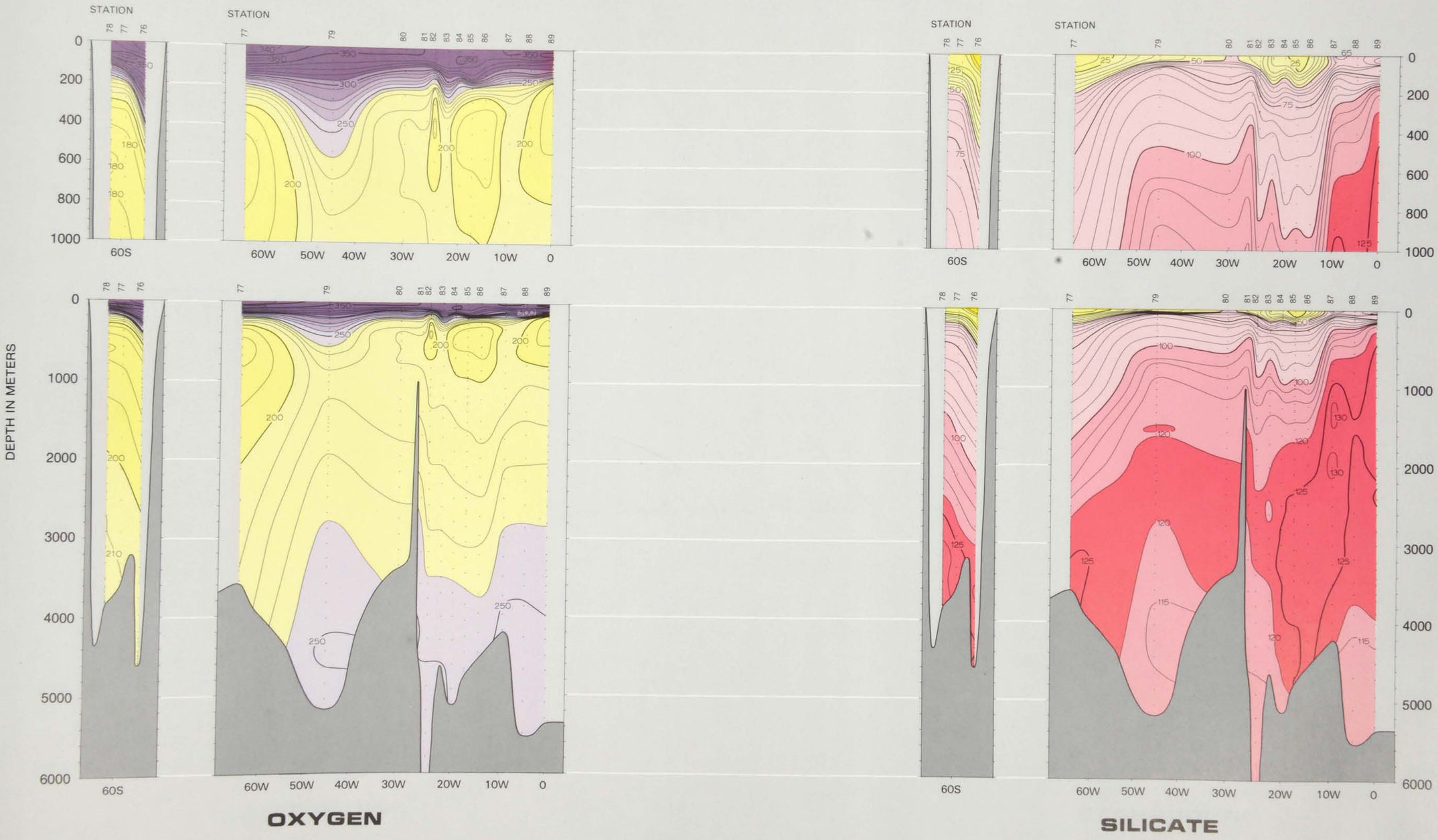
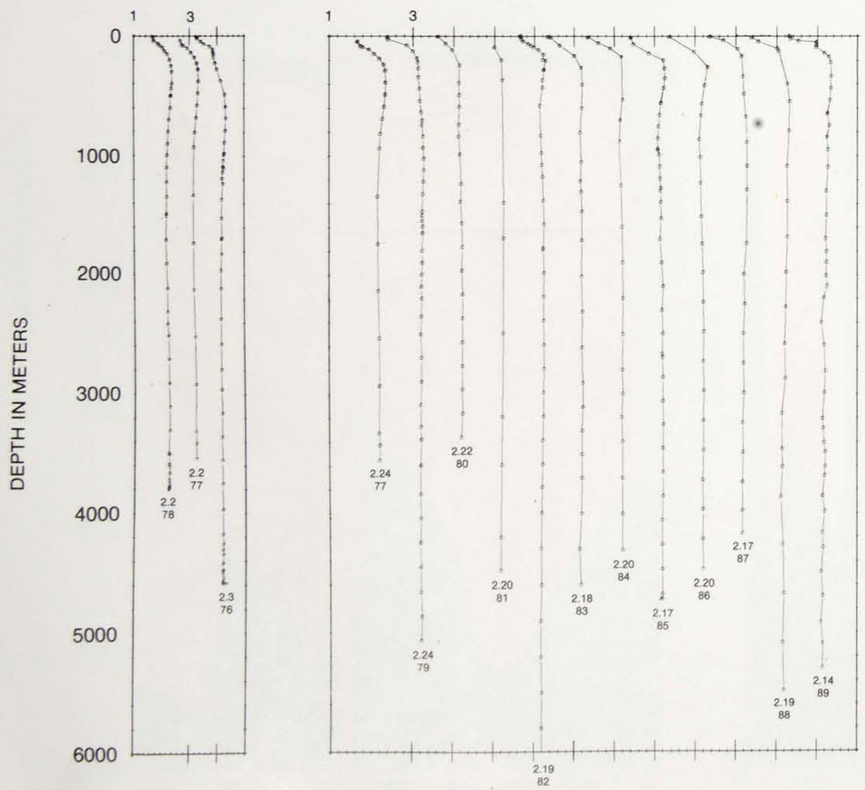


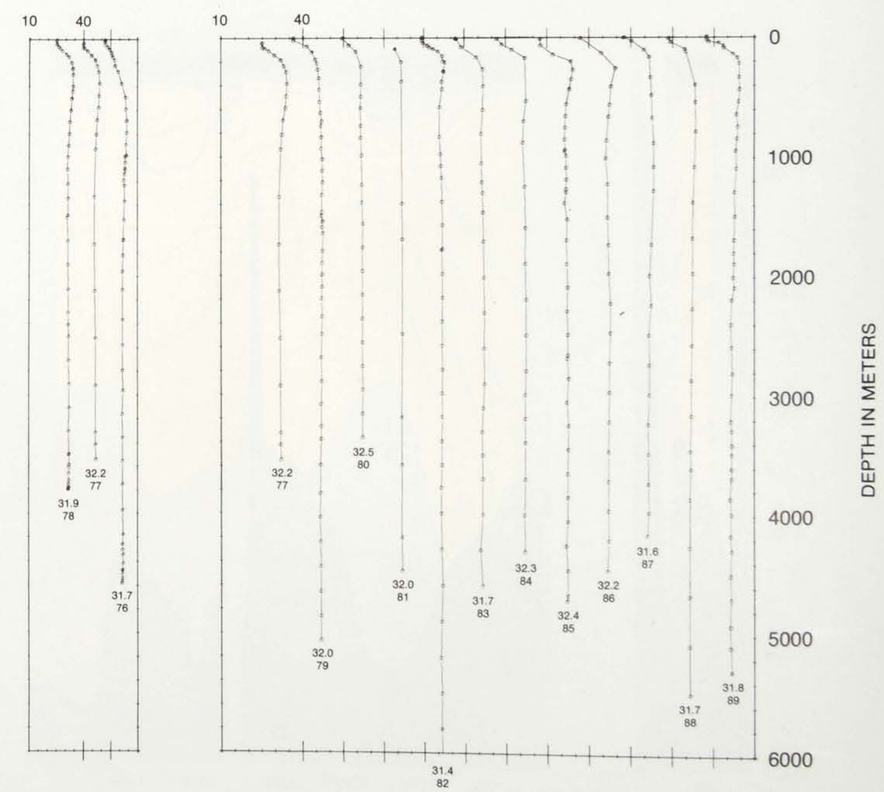
PLATE 60

Vertical distribution of Phosphate (μM/kg) and Nitrate (μM/kg) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

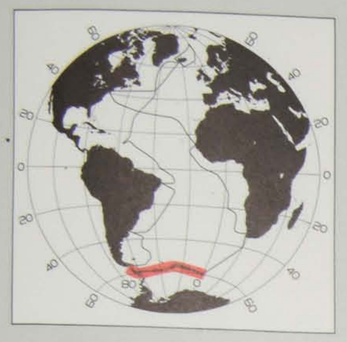
DRAKE PASSAGE AND CIRCUMPOLAR CURRENT



PHOSPHATE



NITRATE



DRAKE PASSAGE AND CIRCUMPOLAR CURRENT

PLATE 61

Vertical Distribution of Phosphate (μM/kg) and Nitrate (μM/kg) in the Drake Passage and Circumpolar Current, December, 1972 to January, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 2500:1 in the upper sections, and 1000:1 in the lower sections.

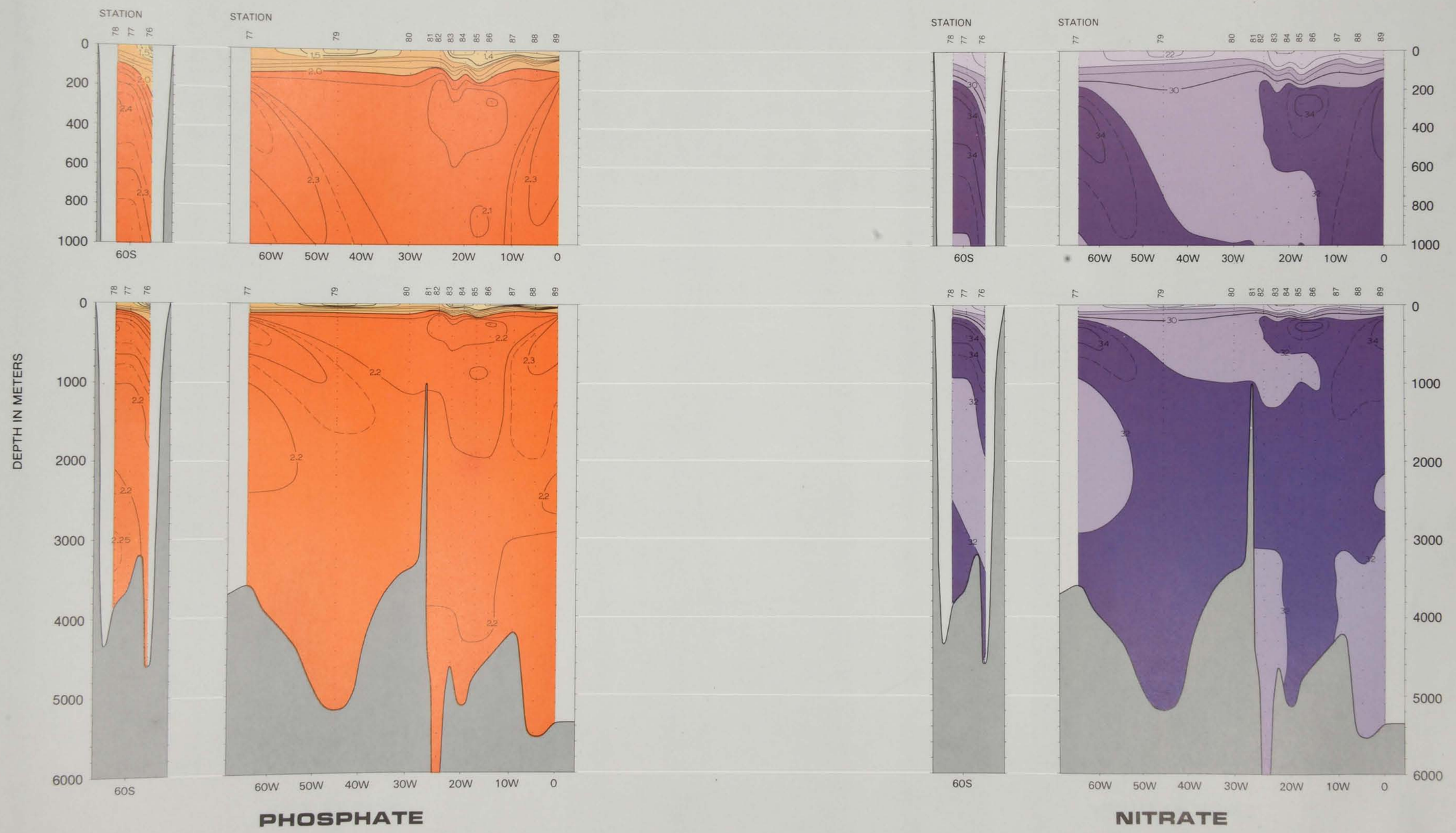
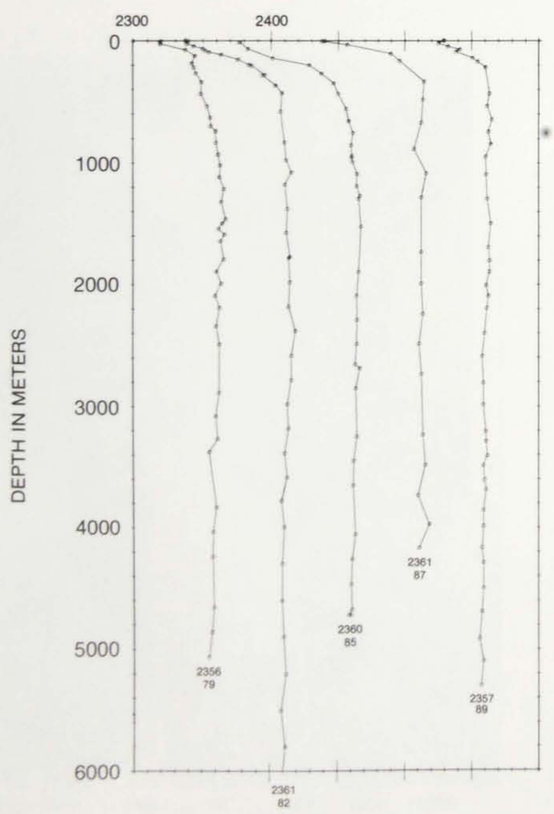


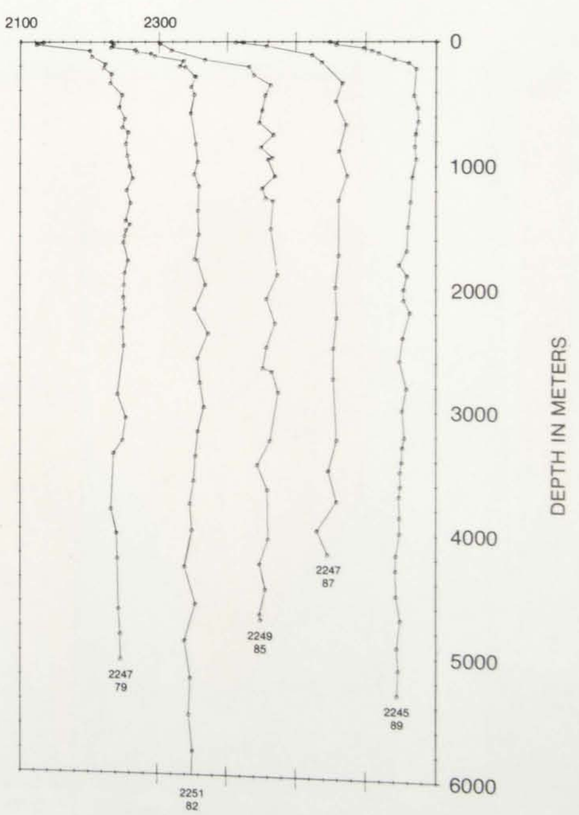
PLATE 62

Vertical distribution of Alkalinity (μEq/kg) and Total CO_2 (μM/kg) in the Circumpolar Current, January, 1973. GEOSECS Atlantic Expedition: R/V KNORR.

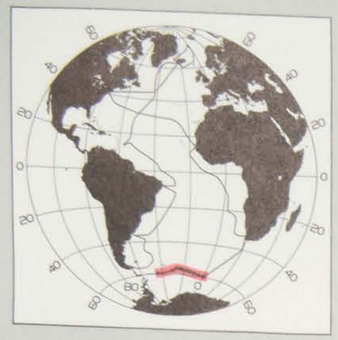
CIRCUMPOLAR CURRENT



ALKALINITY



TOTAL CO_2



CIRCUMPOLAR CURRENT

PLATE 63

Vertical distribution of Alkalinity (μEq/kg) and Total CO_2 (μM/kg) in the Circumpolar Current, January, 1973. GEOSECS Atlantic Expedition: R/V KNORR. Vertical exaggeration is 1000:1.

CHAPTER 2

Property-Property Plots

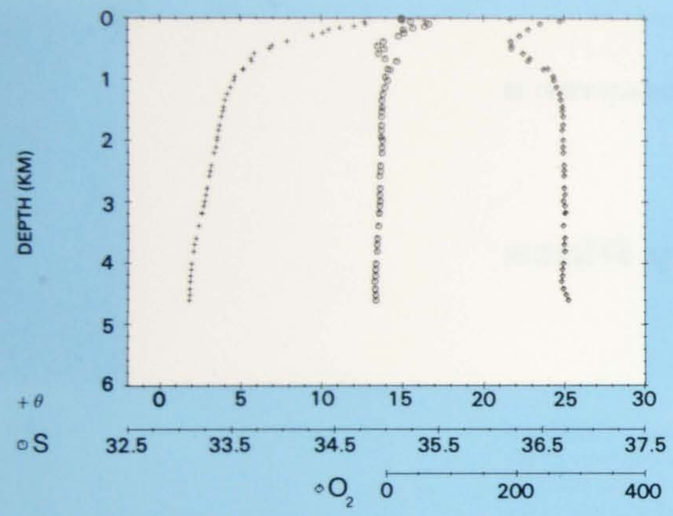
A set of data plots was prepared for each of 113 Atlantic GEOSECS stations. These plots were designed to offer a visual comparison of the different hydrographic properties at any station, as well as a comparison of the same properties at different stations. The arrangement of plots is the same on each page. The horizontal and vertical scales are unchanged for all stations on seven of the nine plots per station, and in all cases the scale factors (units of the property per unit length on the plot) are constant. The plots of Sigma 4 vs. depth in the center of the page, and salinity vs. Sigma 4 at lower right-hand corner, are the only two plots for which it was necessary to shift the plotting scales. For Stations 14 through 20 the Sigma 4 scale was increased from 45.3 - 46.3 to 45.5 - 46.5 on both plots. The salinity scale on the lower right-hand plot is 34.6 - 35.1 °/oo for Stations 14 to 20, and 31 to 113. For Stations 1 through 13, 21 through 30, and 114 through 121, the salinity scale is 34.8 - 35.3 °/oo.

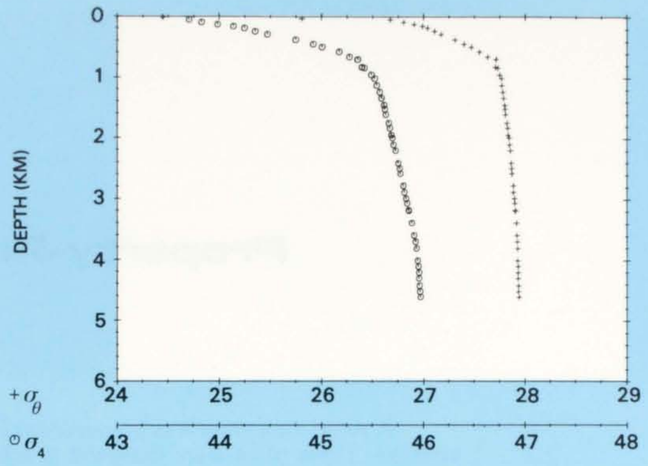
In the bottom row of property-property plots, points whose numerical values fall outside the limits given beneath the plots will still be shown, as long as the points appear within the overall plot boundary. Plots designed for properties which were not measured on a station are omitted for that station. The number of plots per station will therefore vary from six to nine.

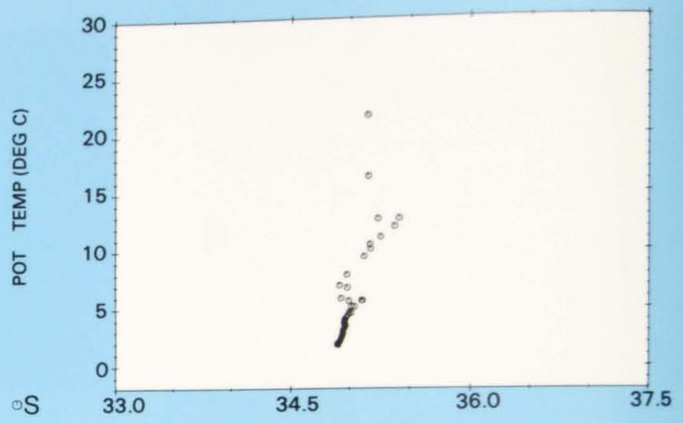
PLATE 64

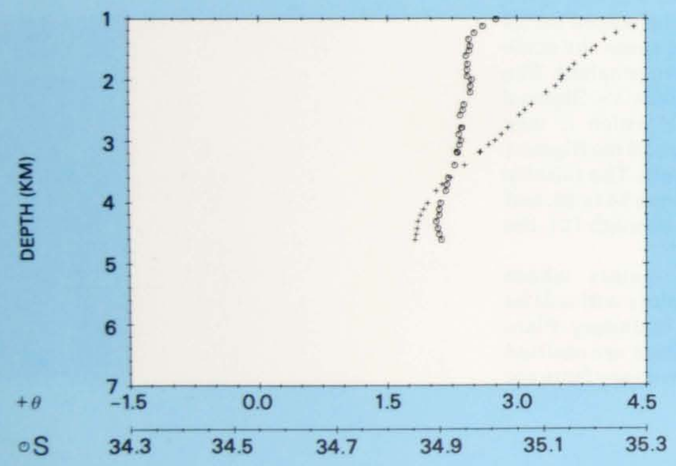
Station 1.
Latitude 44° 57' N,
Longitude 42° 00' W.
24 July 1972.

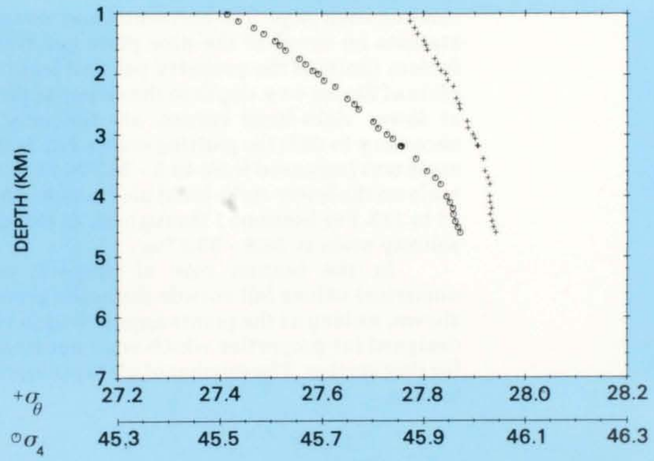
PROPERTY–PROPERTY PLOTS
STATION 1

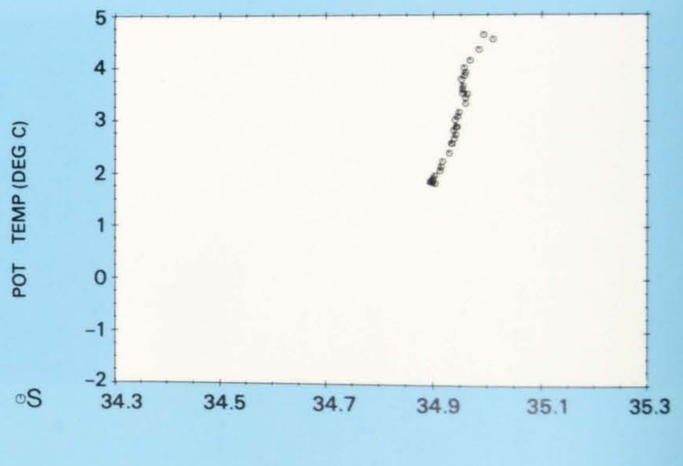


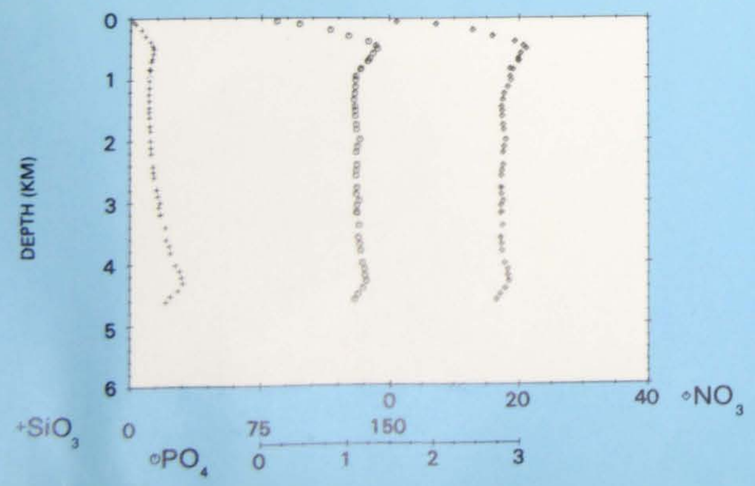


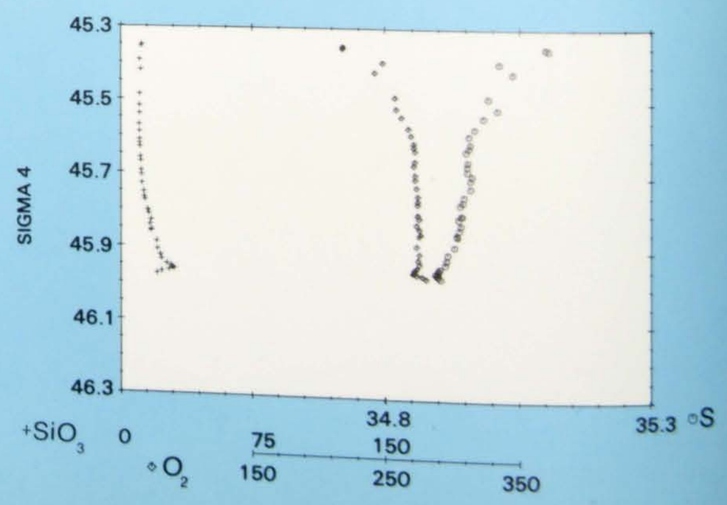


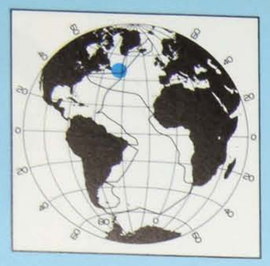








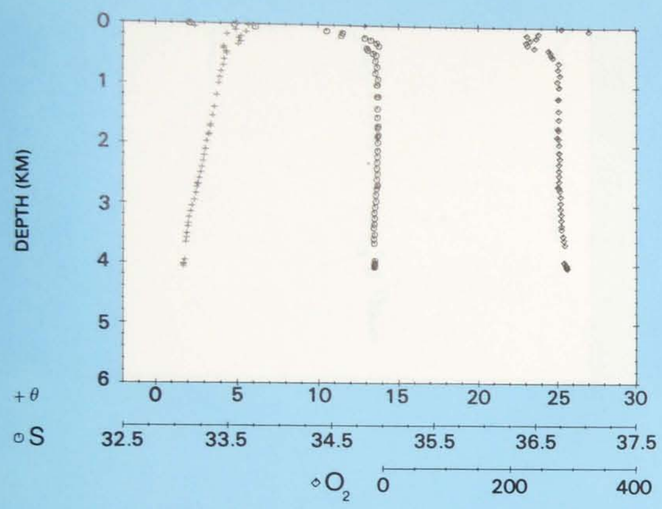


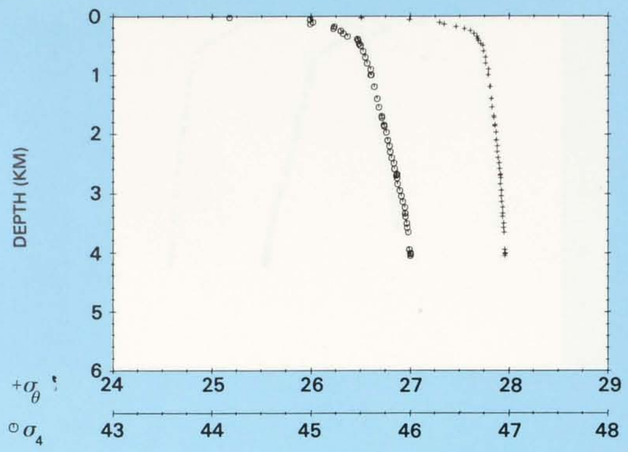


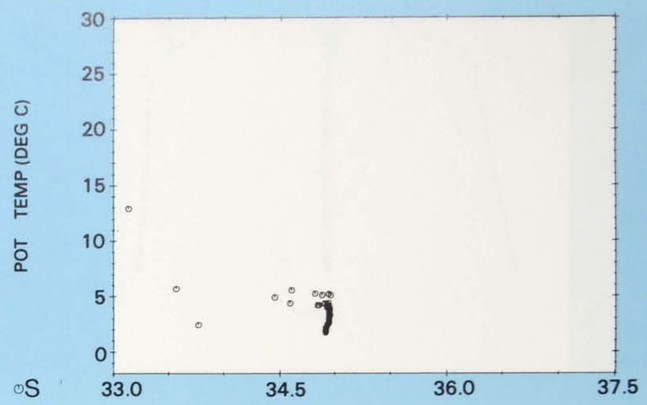
PROPERTY–PROPERTY PLOTS
STATION 2

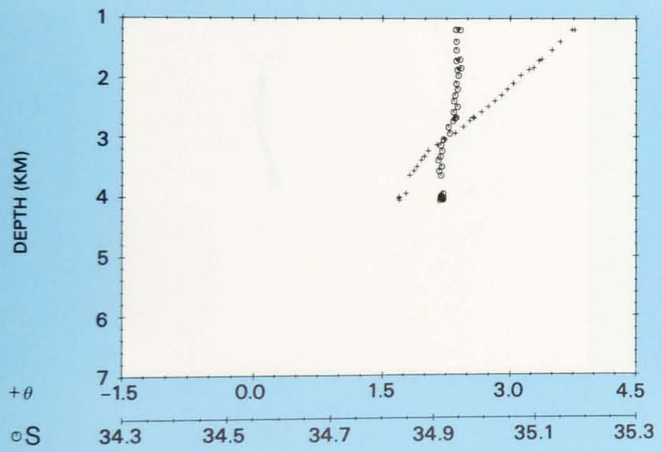
PLATE 65

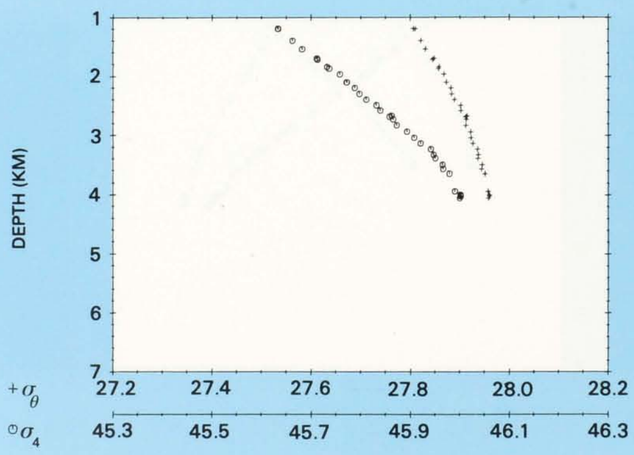
Station 2
Latitude 47° 58′ N,
Longitude 42° 32′ W.
26 July 1972.

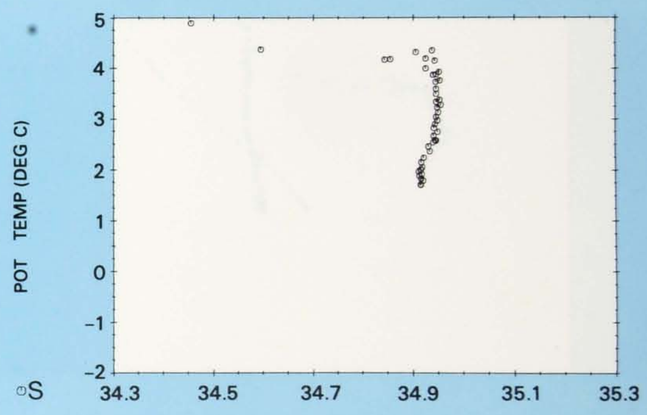


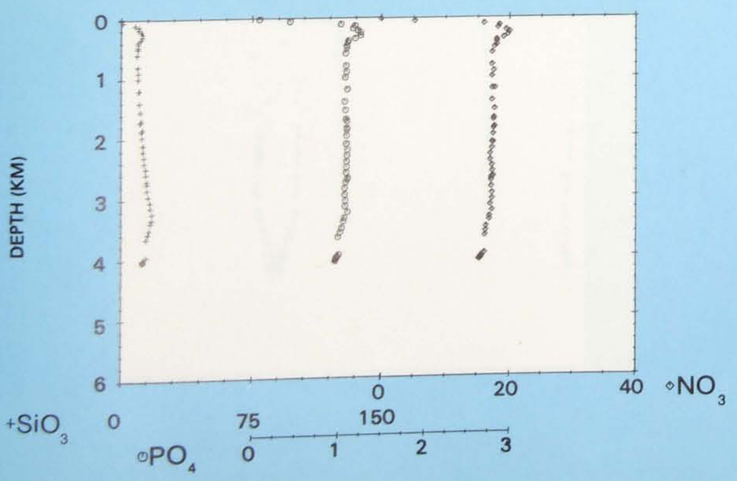












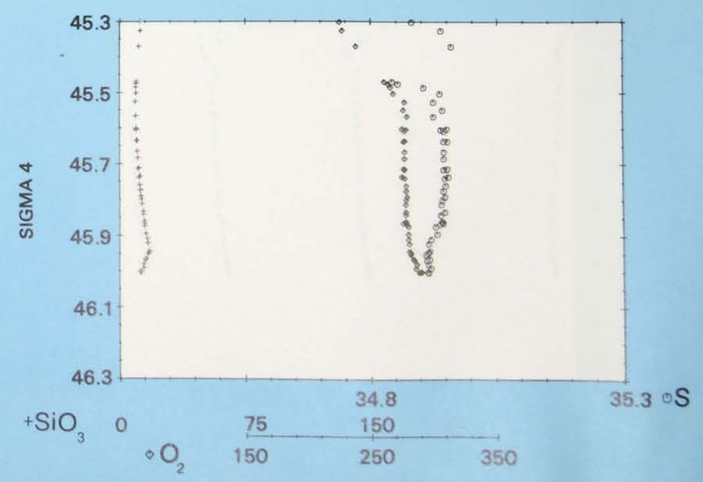
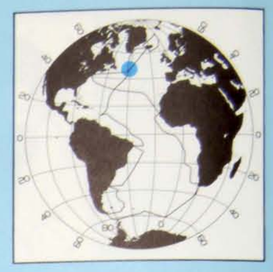
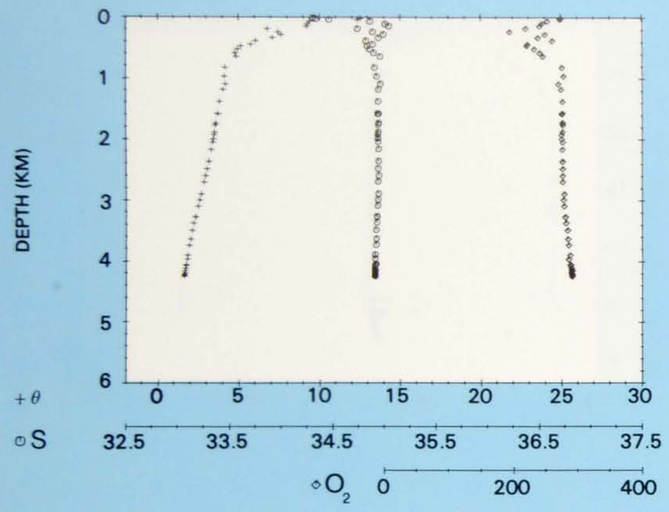


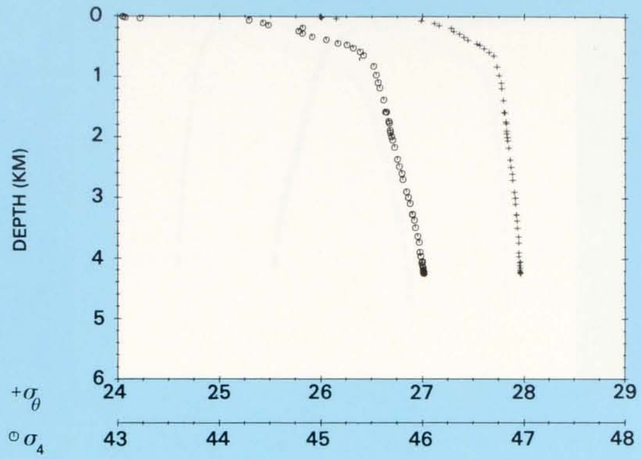
PLATE 66

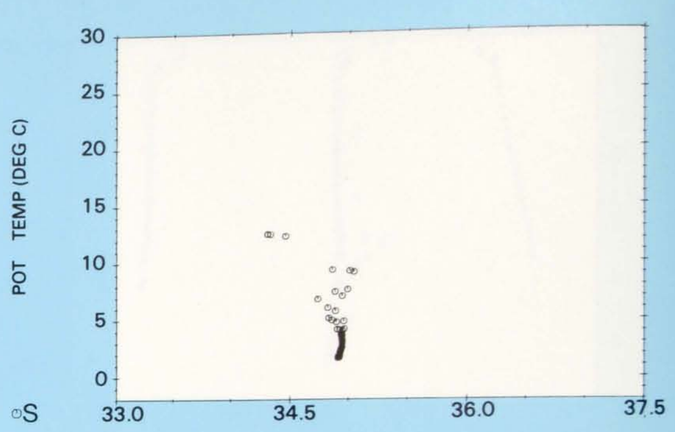
Station 3.
Latitude 51° 01′ N,
Longitude 43° 07′ W.
28 July 1972.

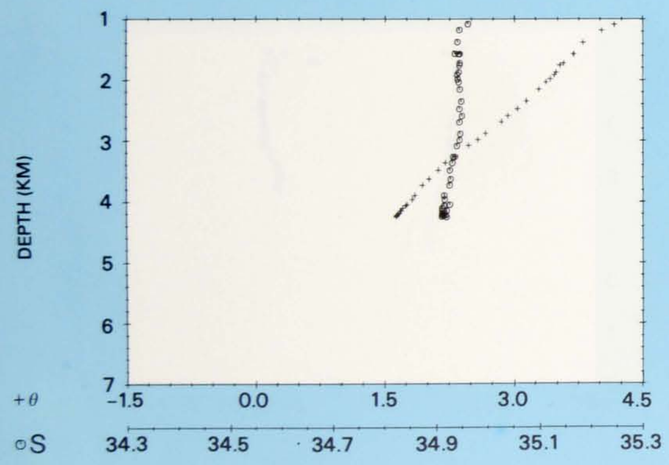
PROPERTY–PROPERTY PLOTS
STATION 3

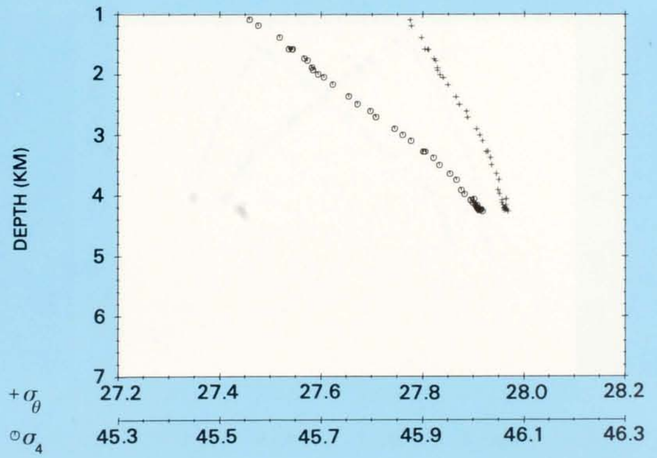


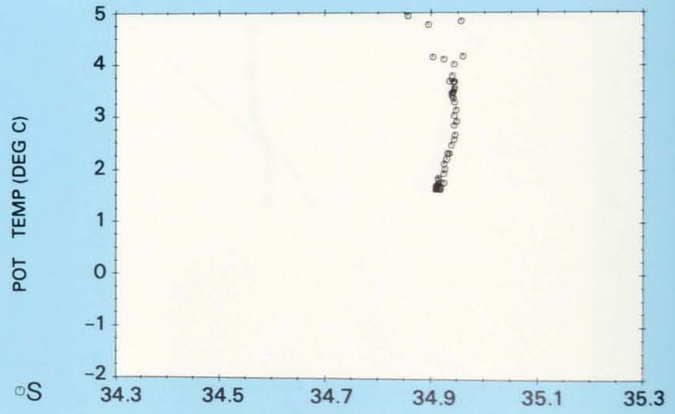


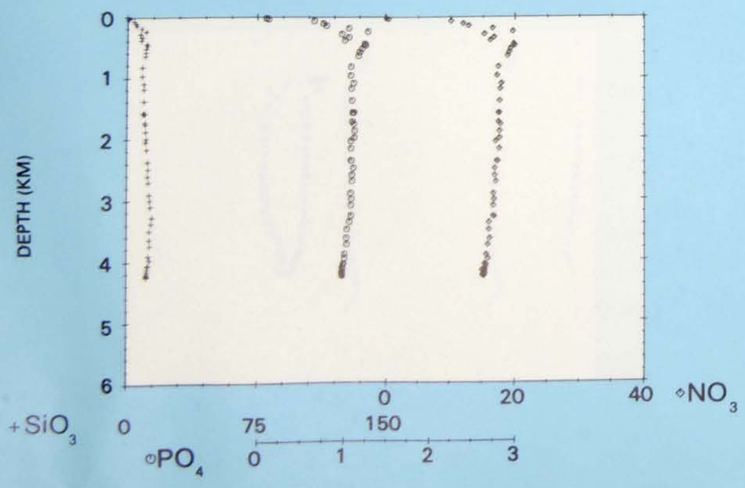


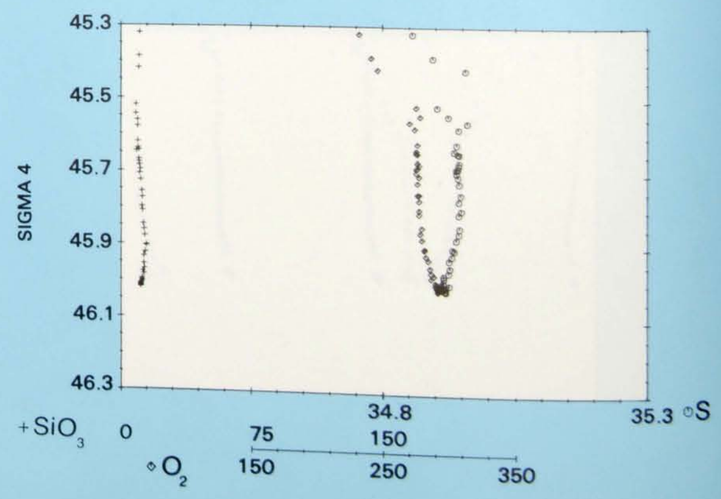


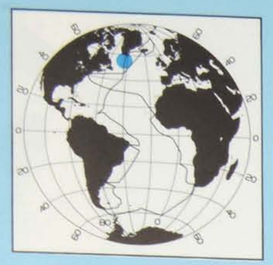








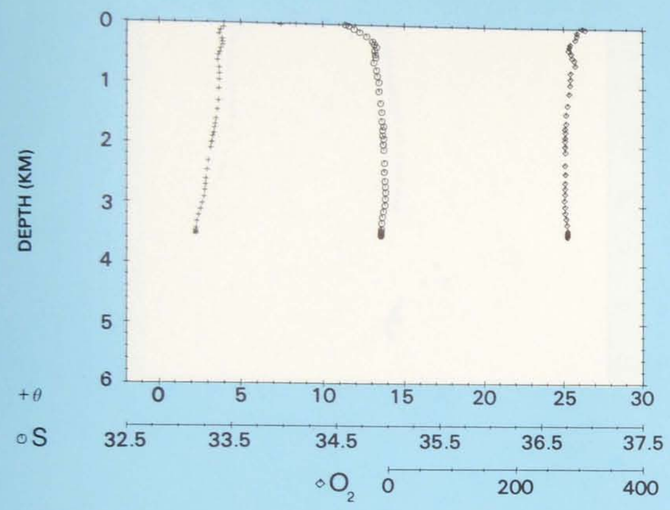


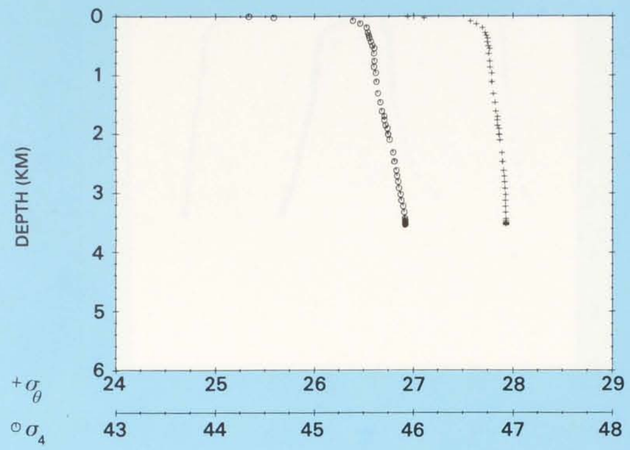


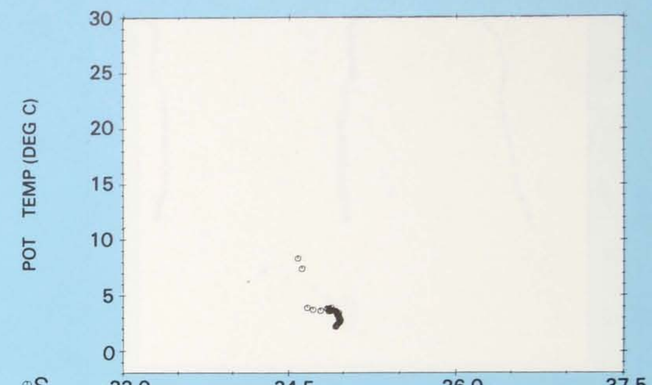
PROPERTY–PROPERTY PLOTS
STATION 4

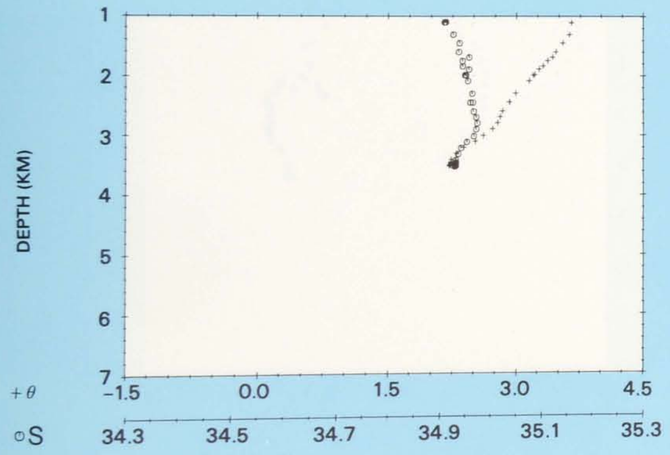
PLATE 67

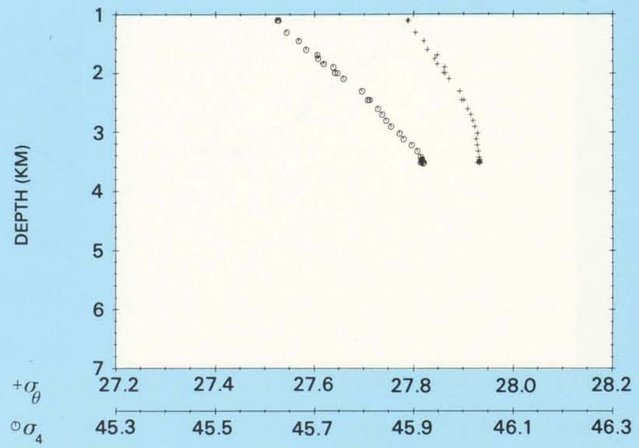
Station 4.
Latitude 54° 05′ N,
Longitude 42° 57′ W.
30 July 1972.

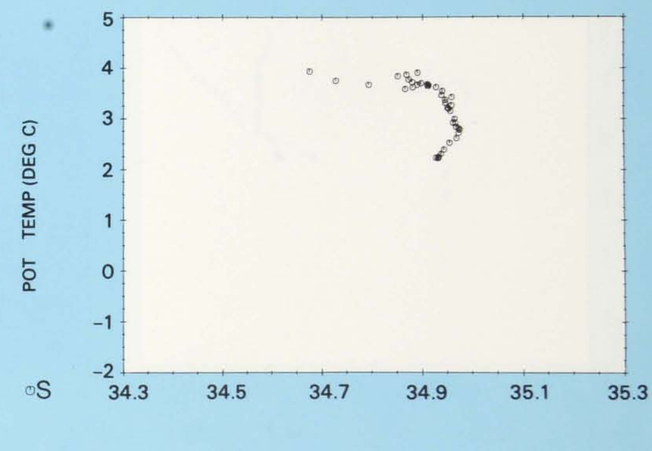


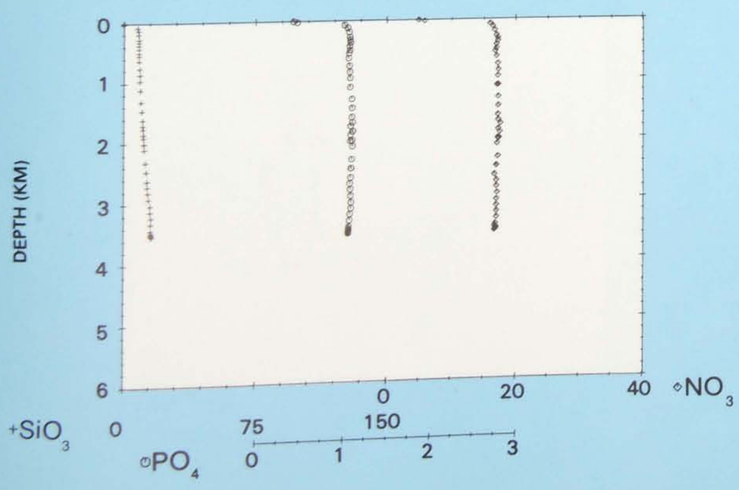












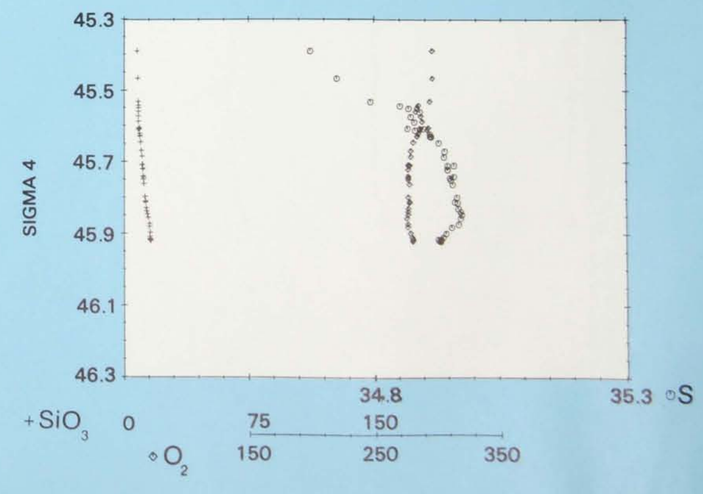
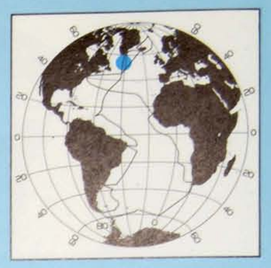
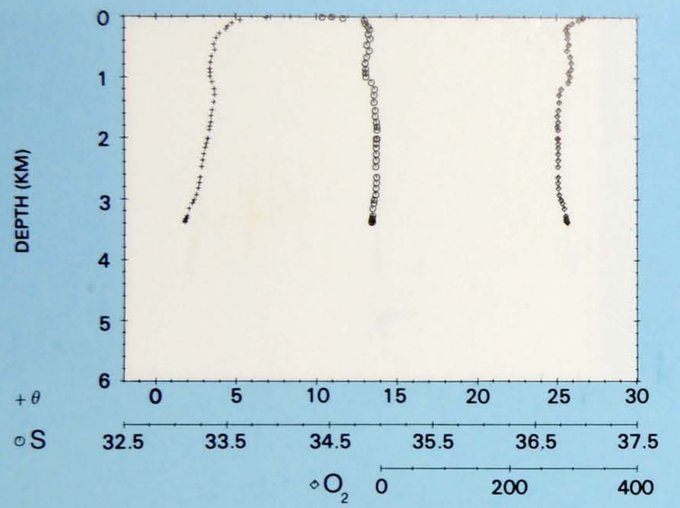


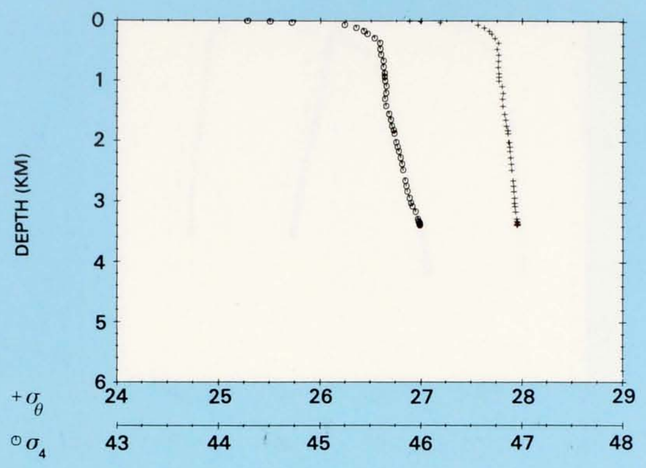
PLATE 68

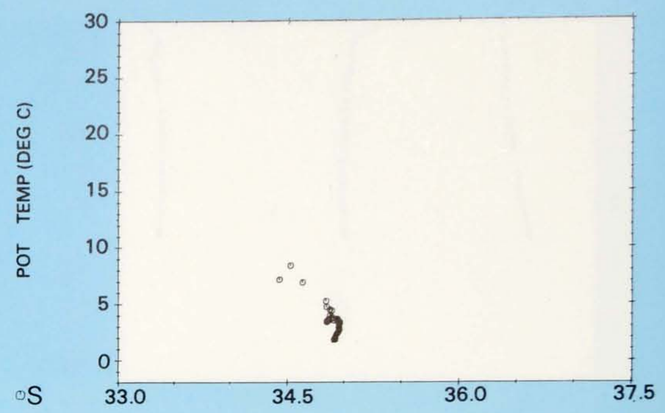
Station 5.
Latitude 56° 56′ N,
Longitude 42° 33′ W.
31 July 1972.

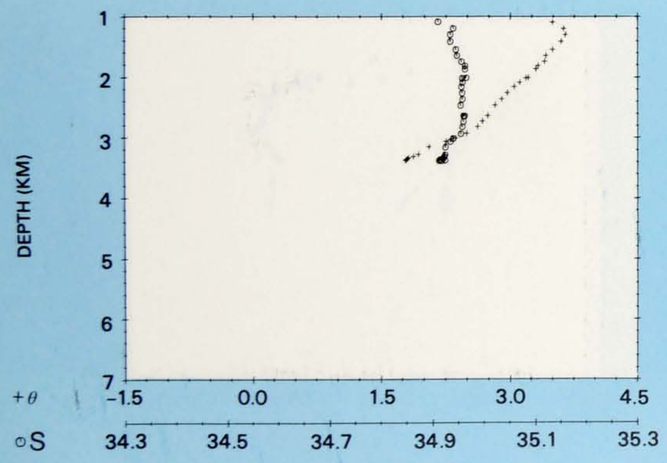
PROPERTY–PROPERTY PLOTS
STATION 5

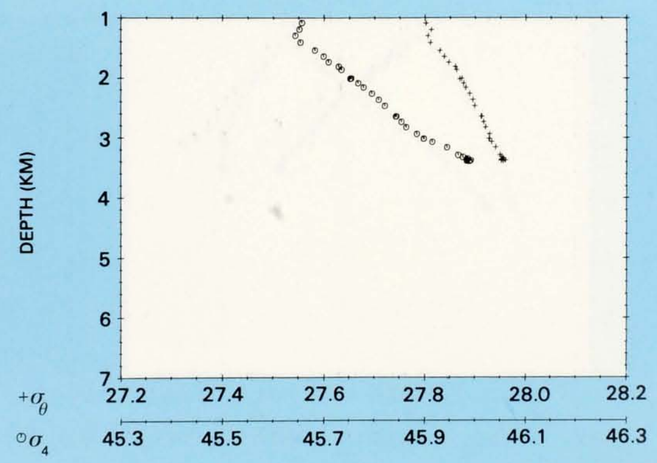


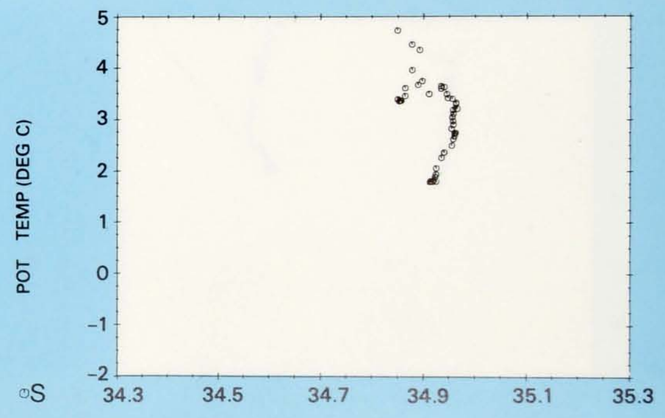


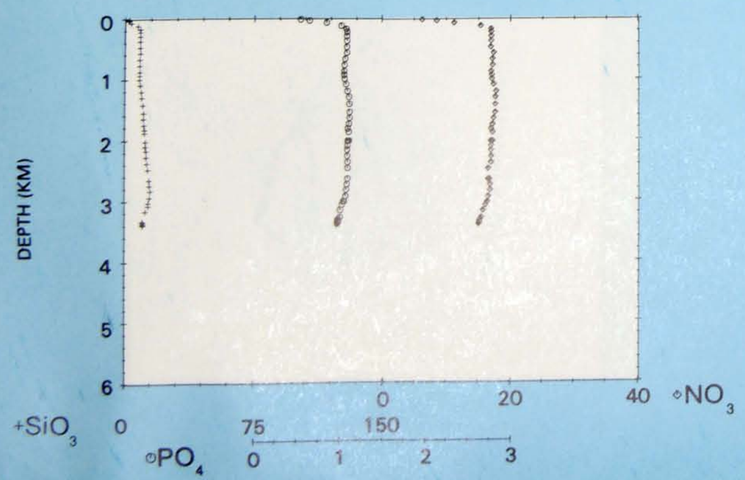


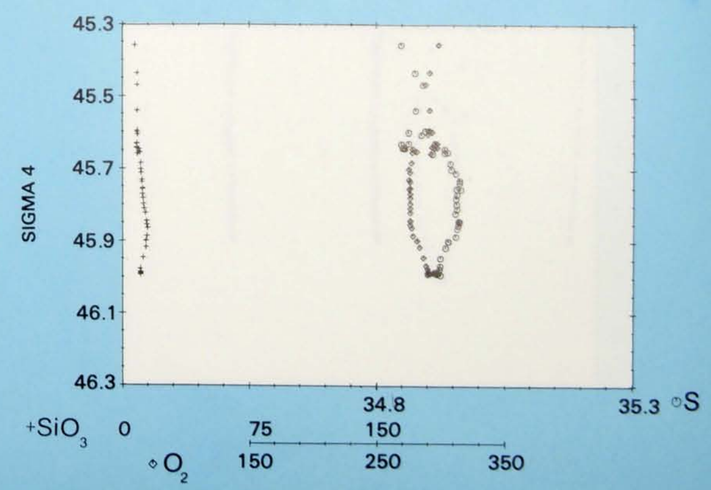








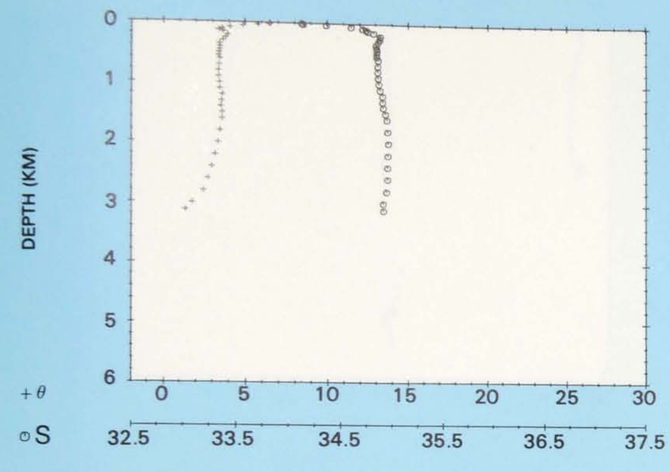


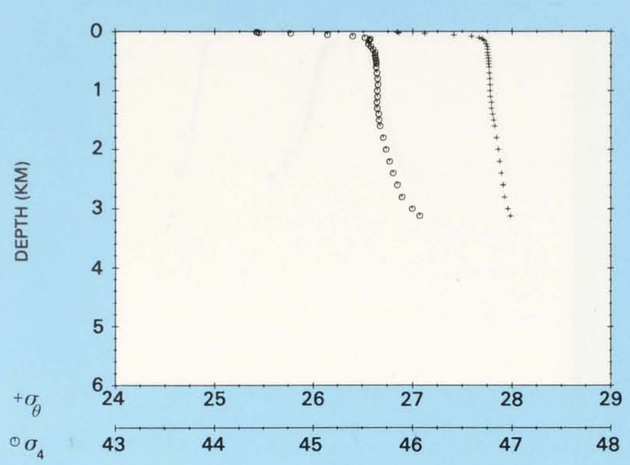


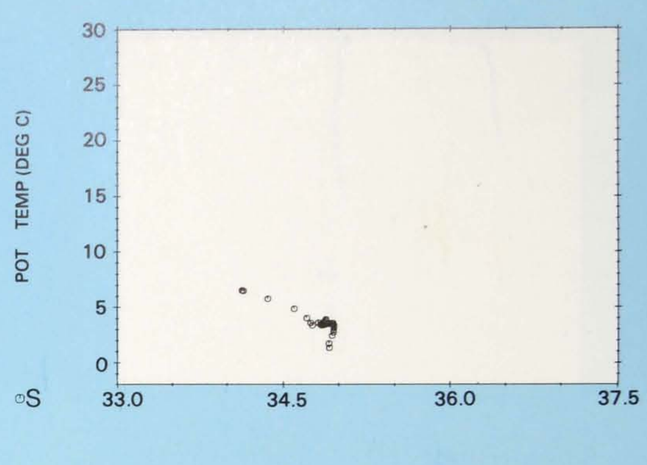
PROPERTY–PROPERTY PLOTS
STATION 6

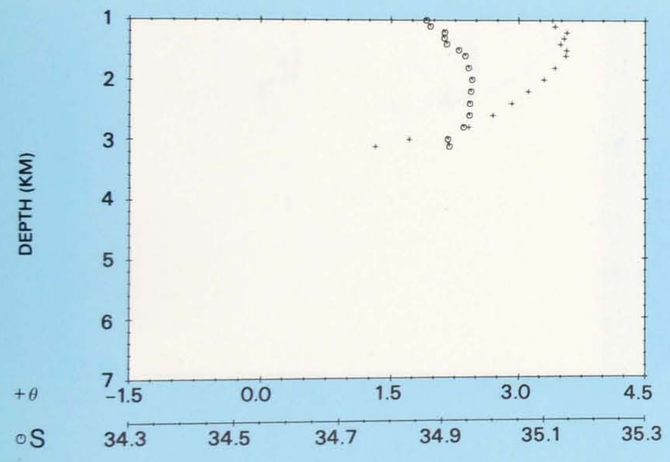
PLATE 69

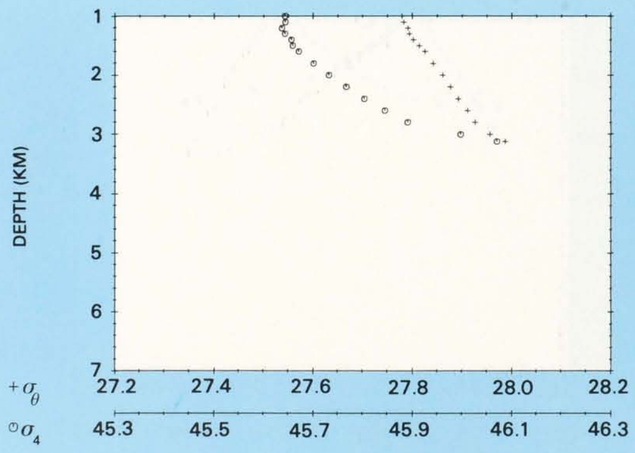
Station 6.
Latitude 58° 00′ N,
Longitude 41° 58′ W.
2 August 1972.











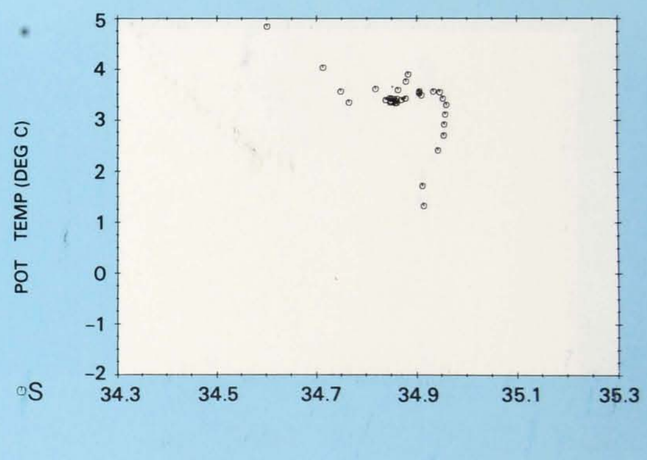
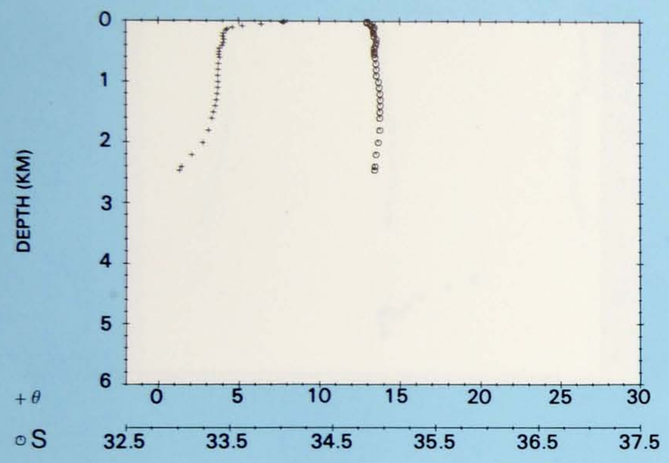
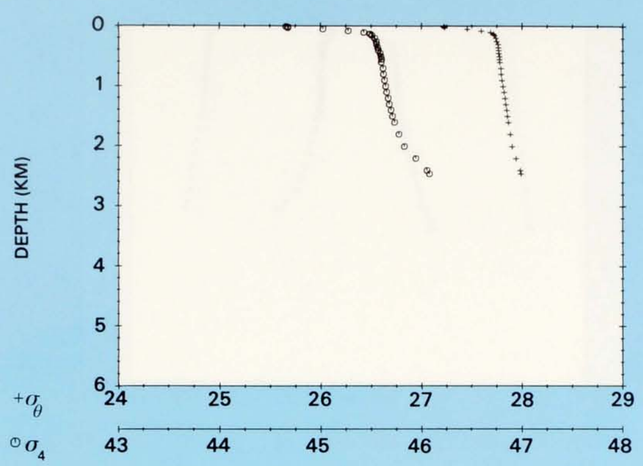


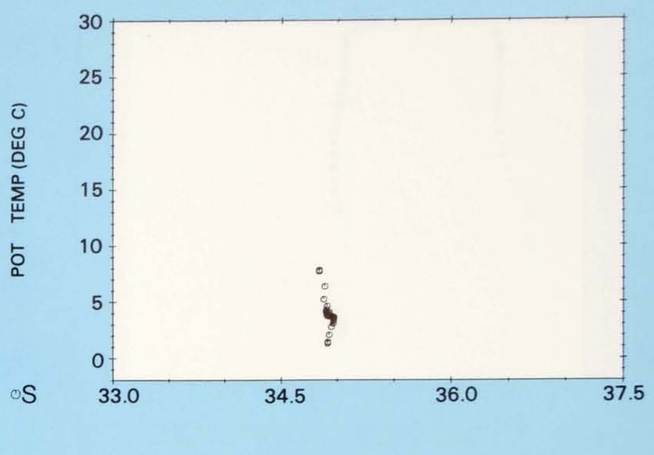
PLATE 70

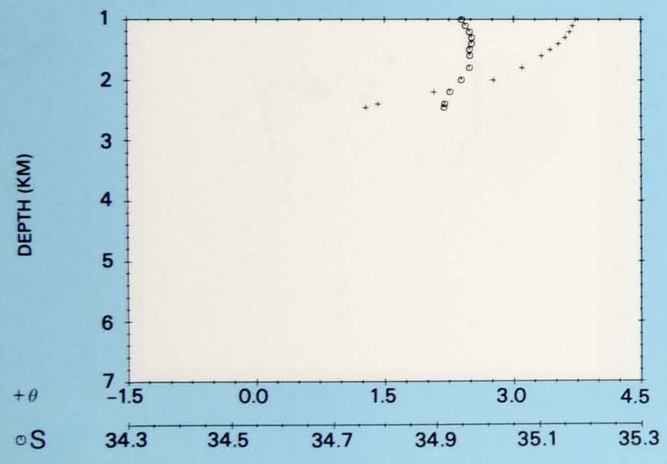
Station 7.
Latitude 59° 30′ N,
Longitude 40° 56′ W.
2 August 1972.

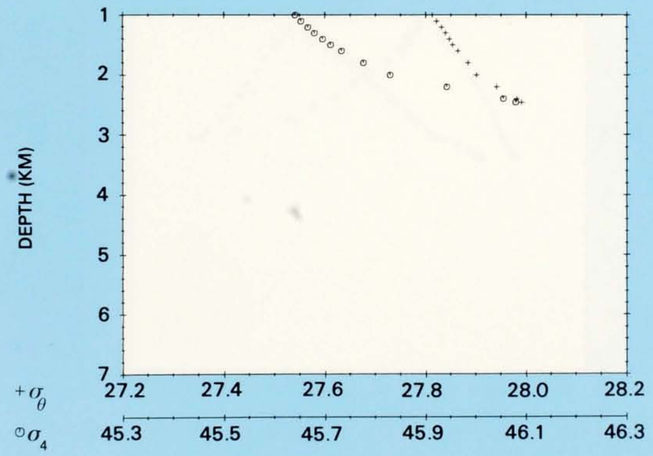
PROPERTY–PROPERTY PLOTS
STATION 7

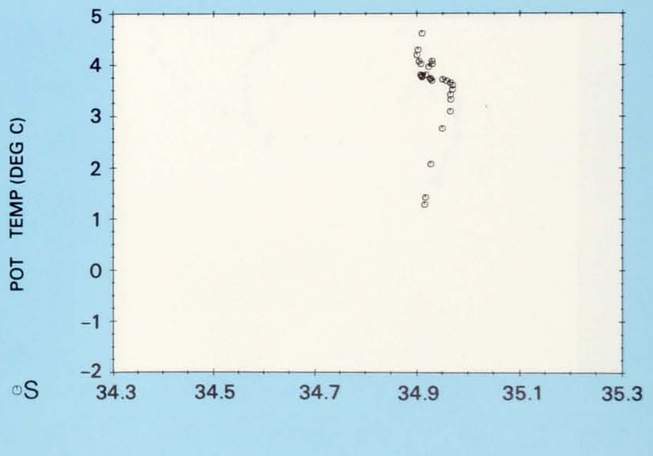


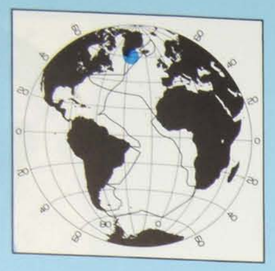








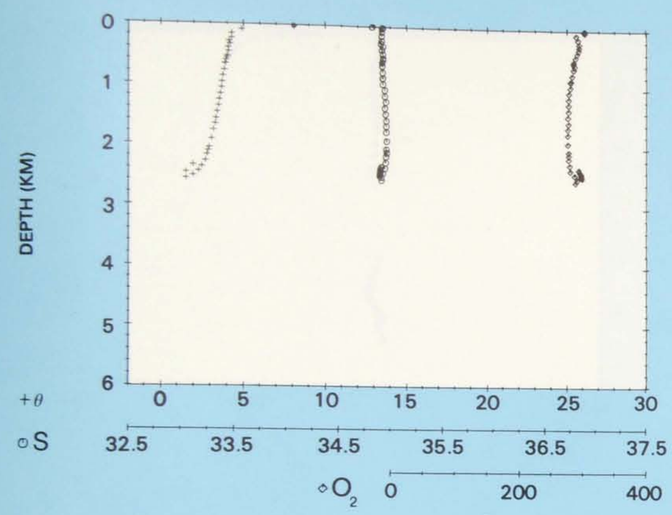


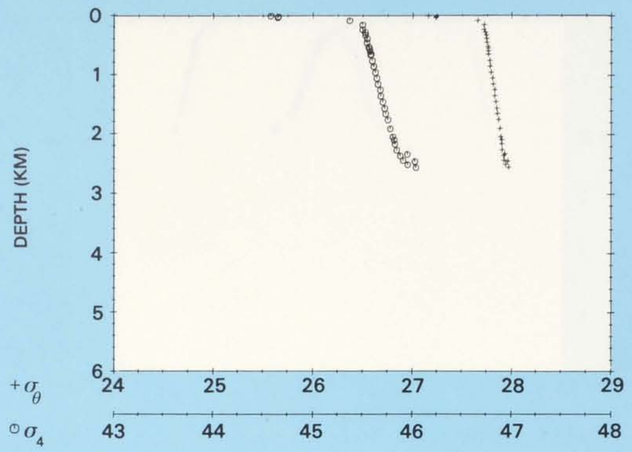


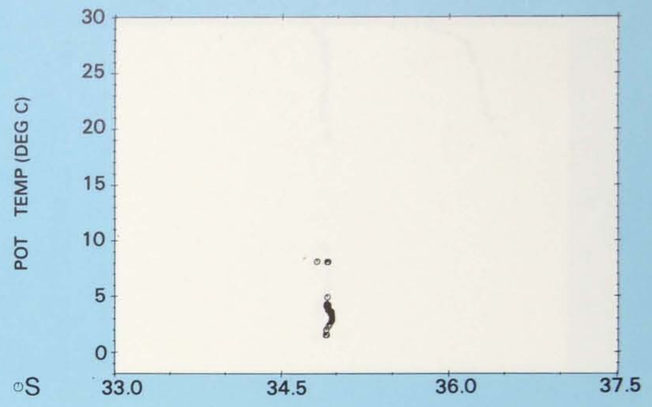
PROPERTY–PROPERTY PLOTS
STATION 8

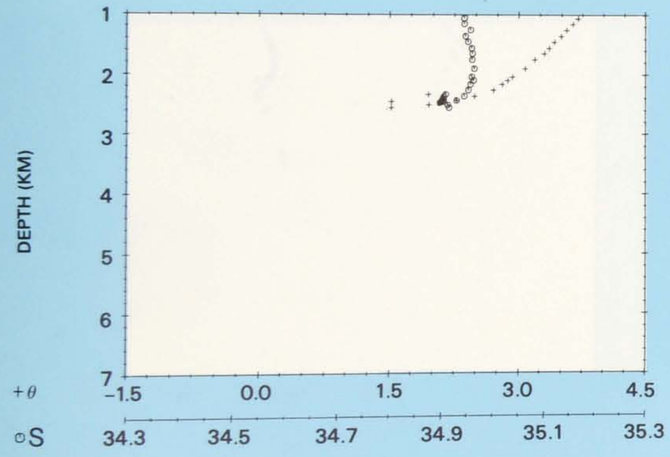
PLATE 71

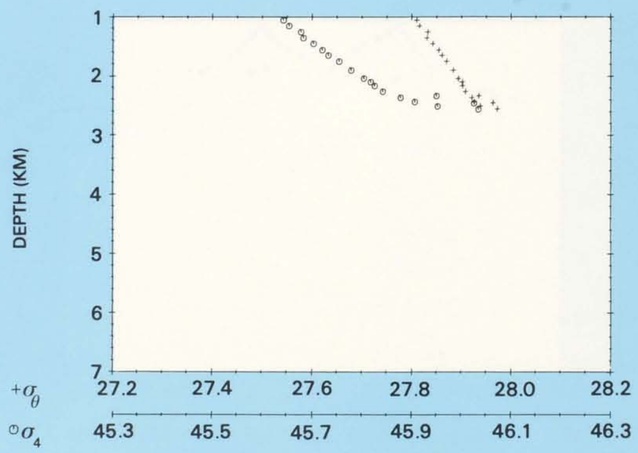
Station 8.
Latitude 60° 30′ N,
Longitude 40° 01′ W.
3 August 1972.

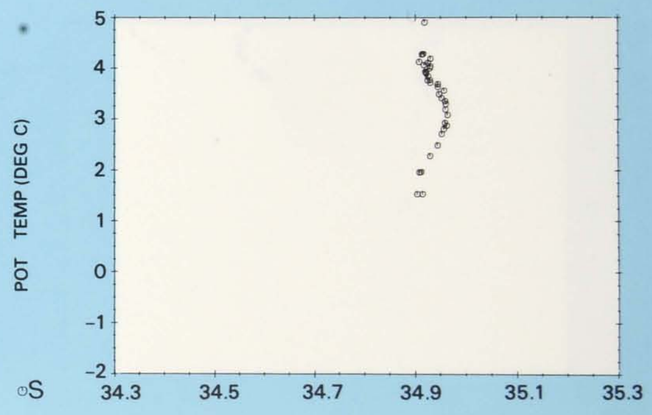


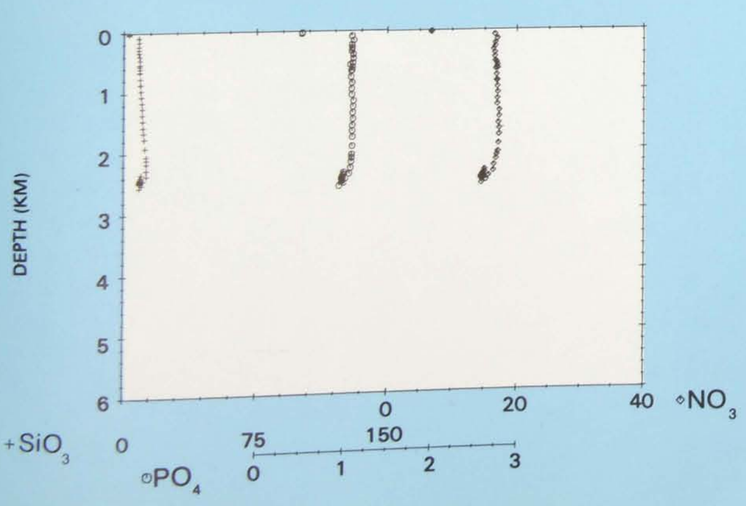












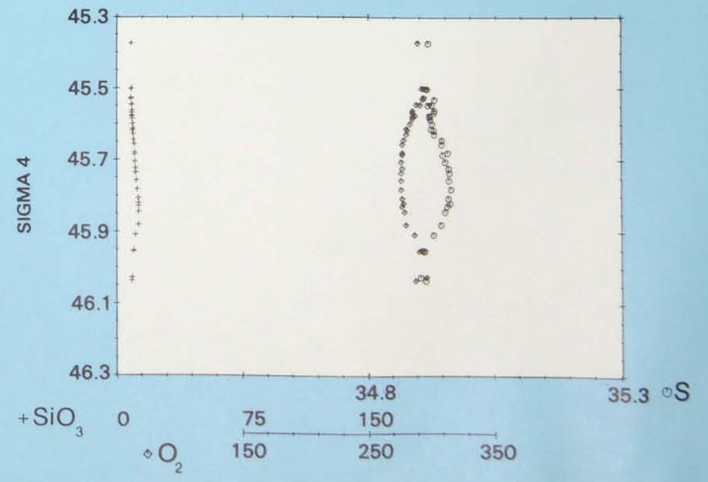
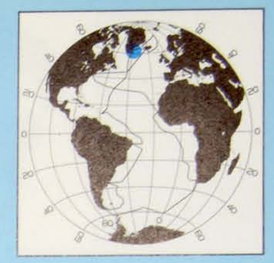
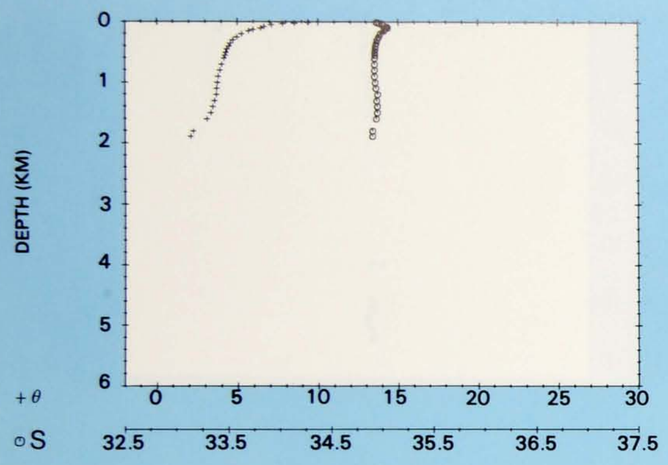


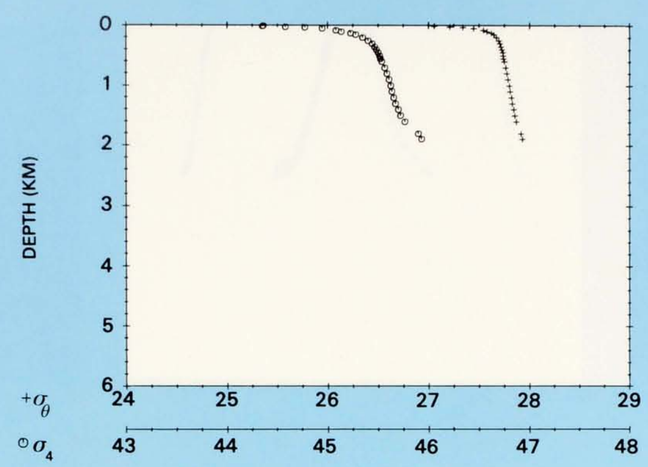
PLATE 72

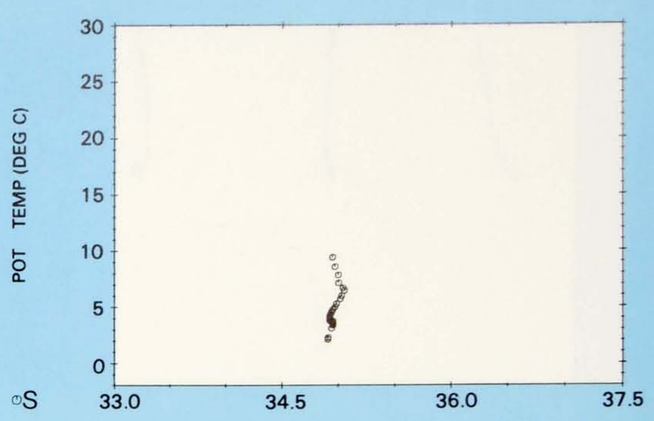
Station 9.
Latitude 62° 25′ N,
Longitude 39° 04′ W.
4 August 1972.

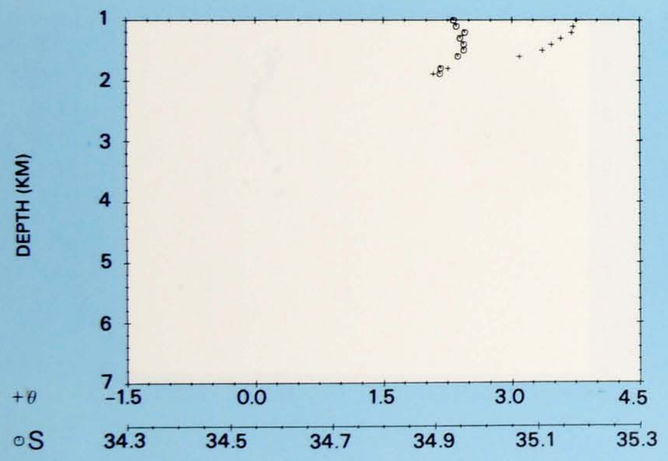
PROPERTY–PROPERTY PLOTS
STATION 9

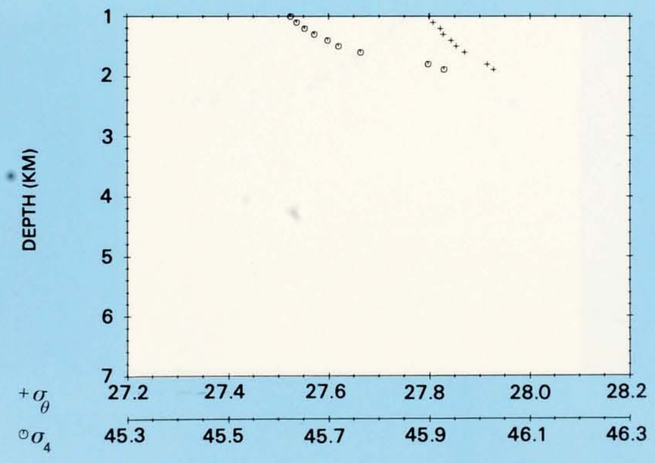


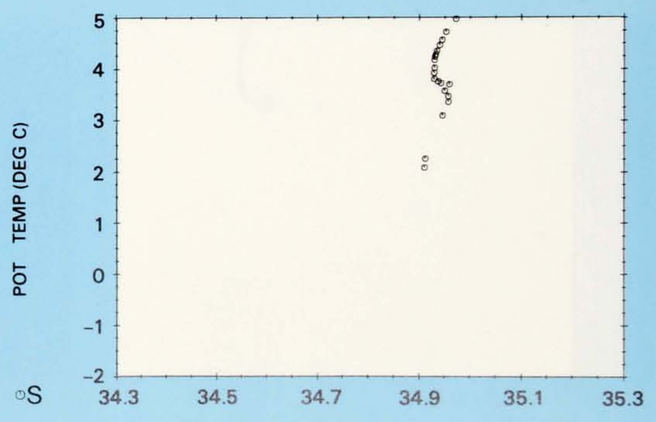


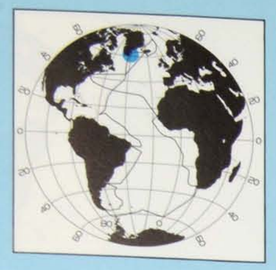








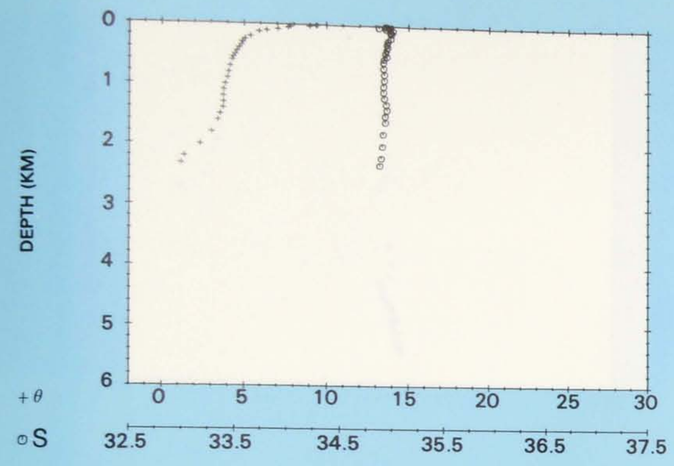


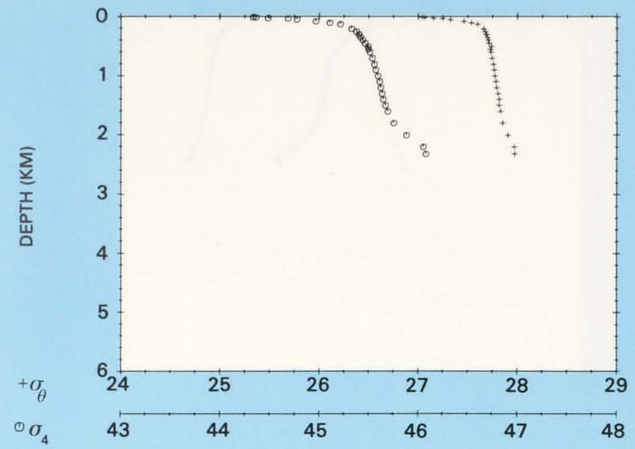


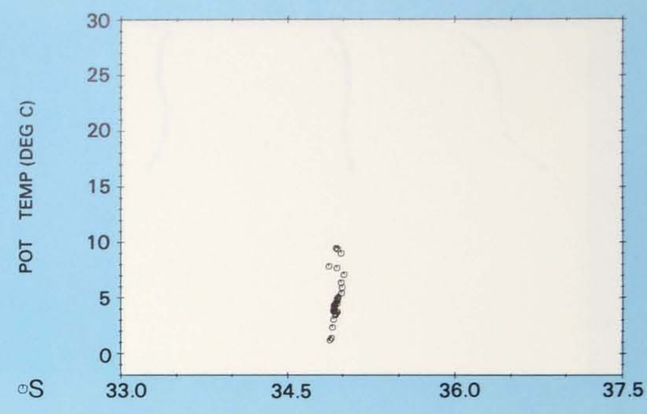
PROPERTY–PROPERTY PLOTS
STATION 10

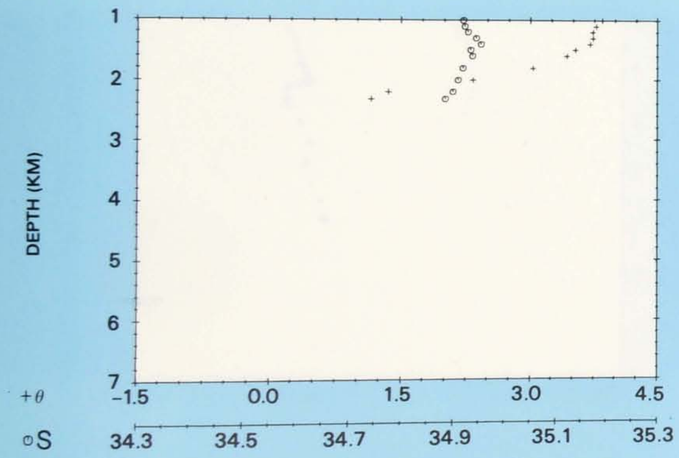
PLATE 73

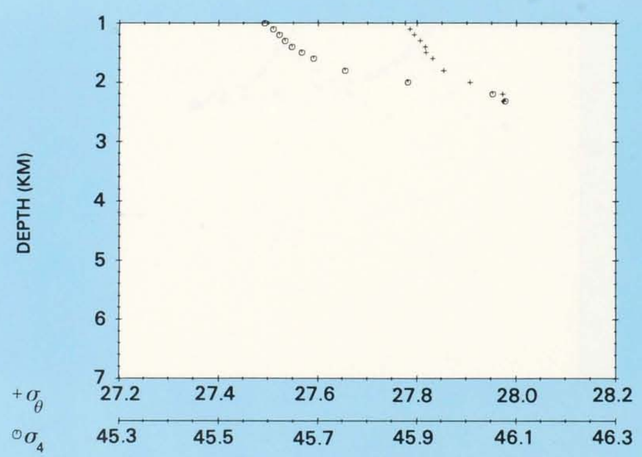
Station 10.
Latitude 63° 00′ N,
Longitude 36° 50′ W.
5 August 1972.











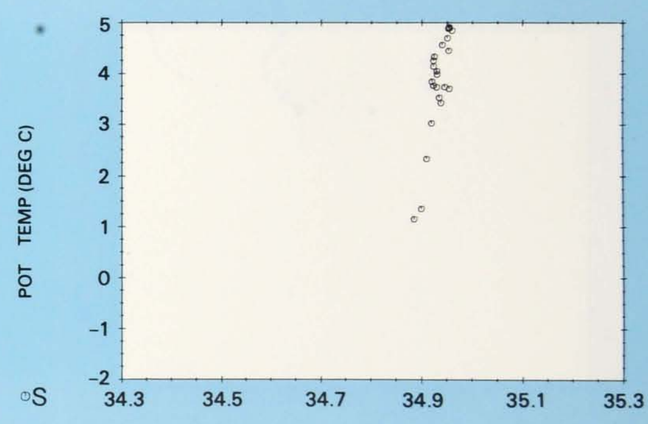
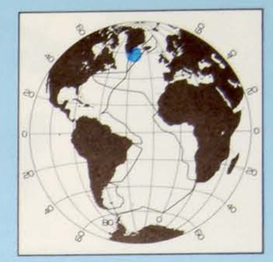
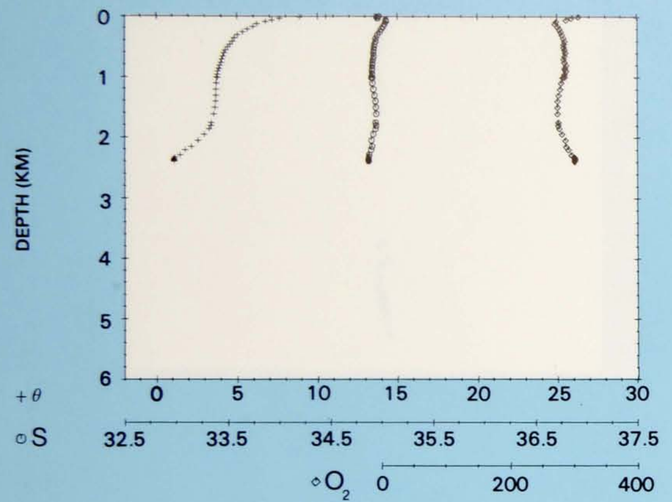


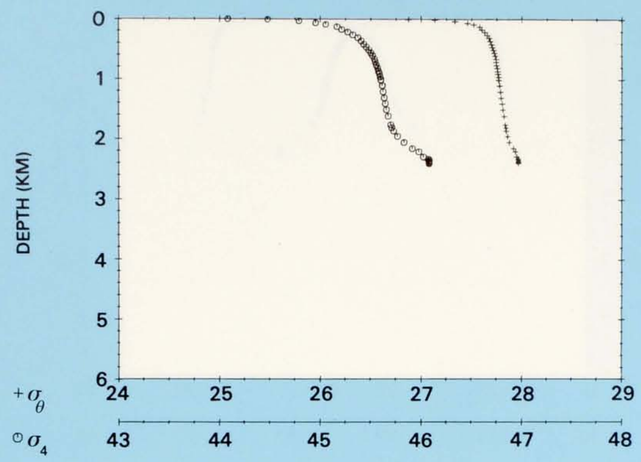
PLATE 74

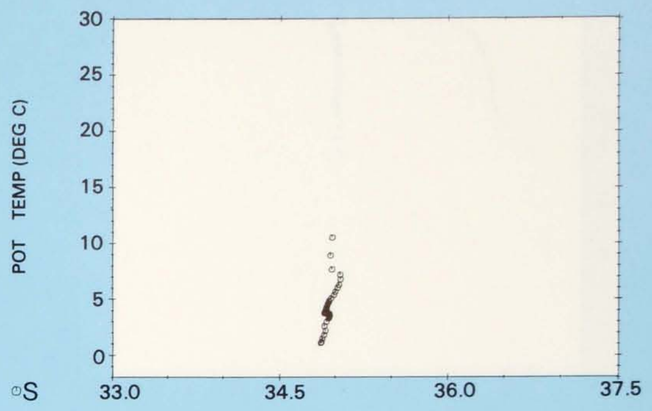
Station 11.
Latitude 63° 31′ N,
Longitude 35° 13′ W.
5 August 1972.

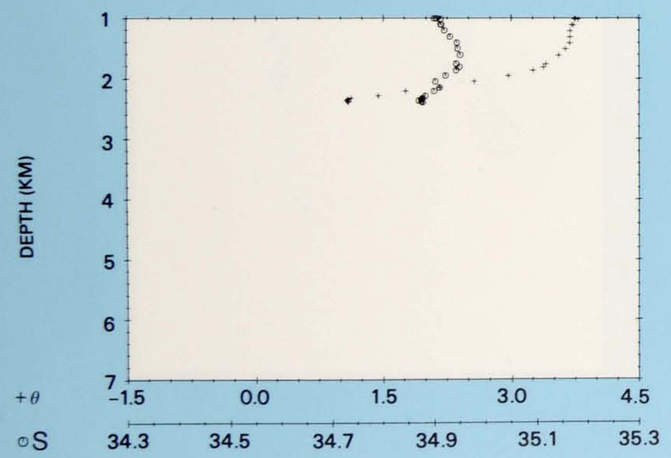
PROPERTY–PROPERTY PLOTS
STATION 11

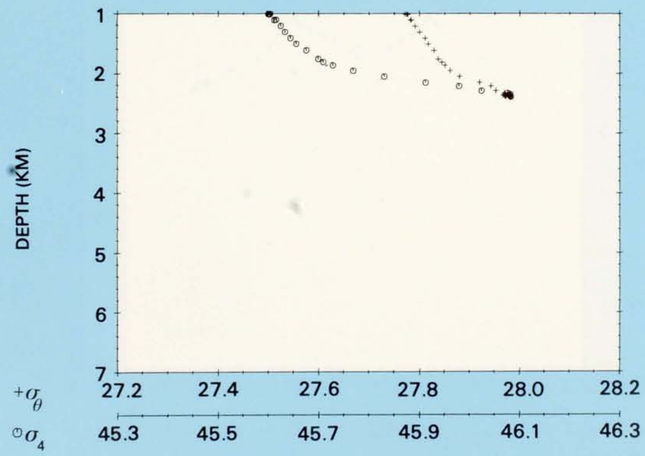


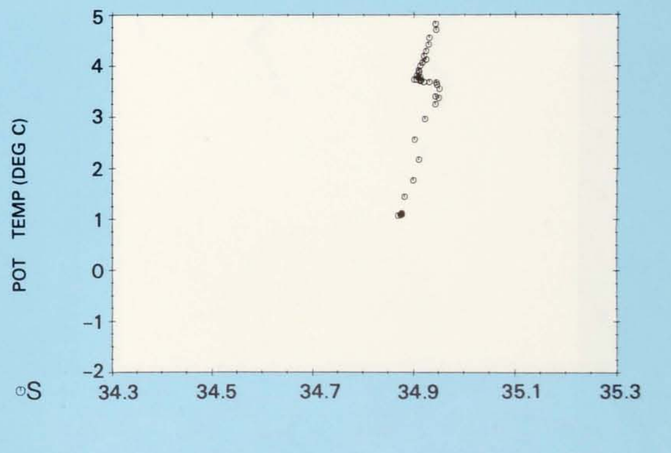


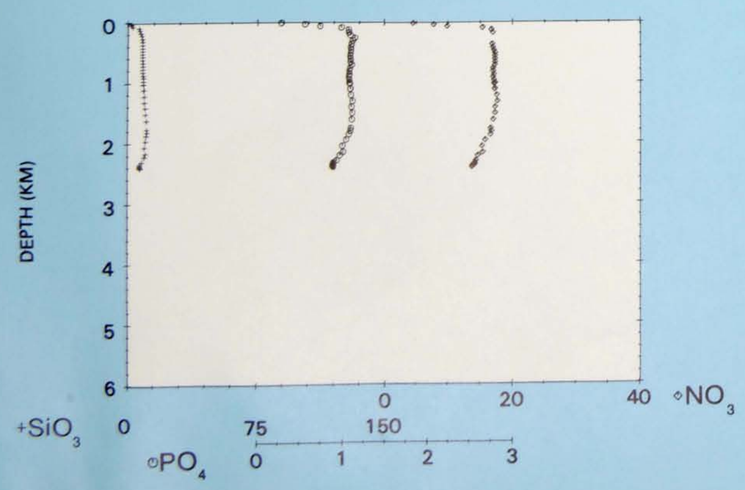


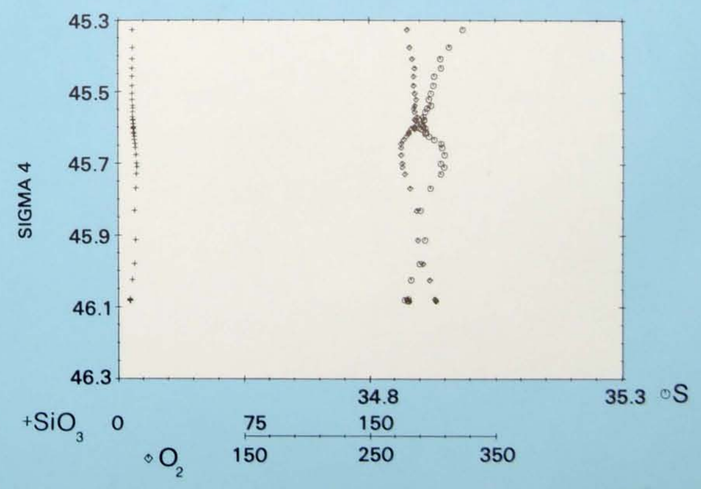


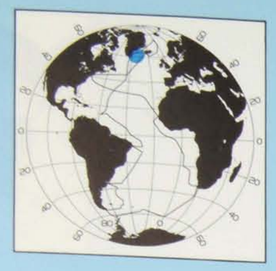








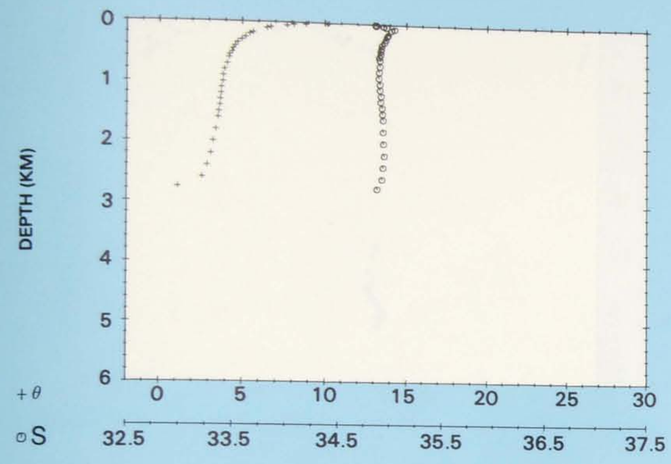


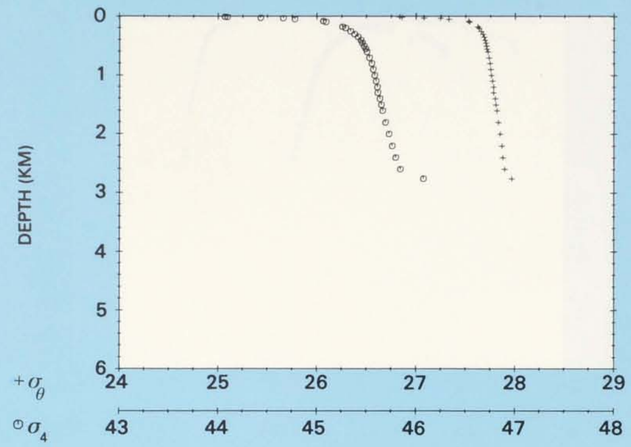


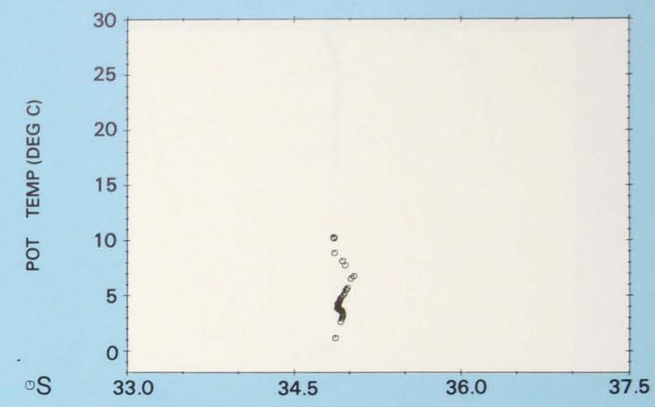
PROPERTY–PROPERTY PLOTS
STATION 12

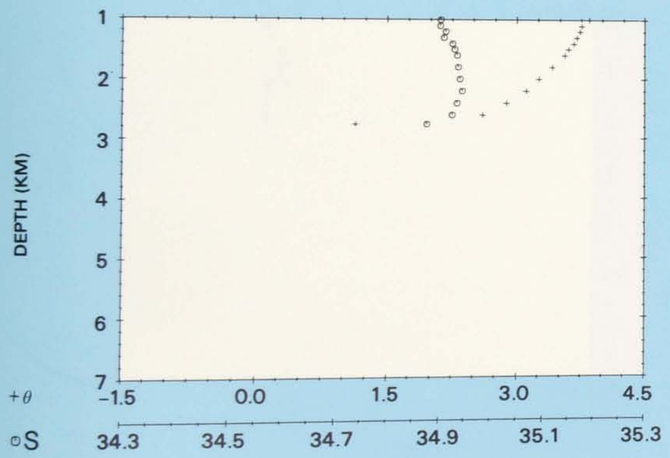
PLATE 75

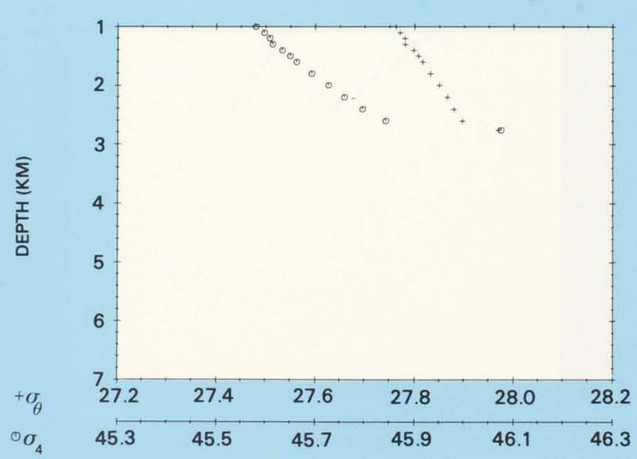
Station 12.
Latitude 63° 37′ N,
Longitude 32° 52′ W.
6 August 1972.











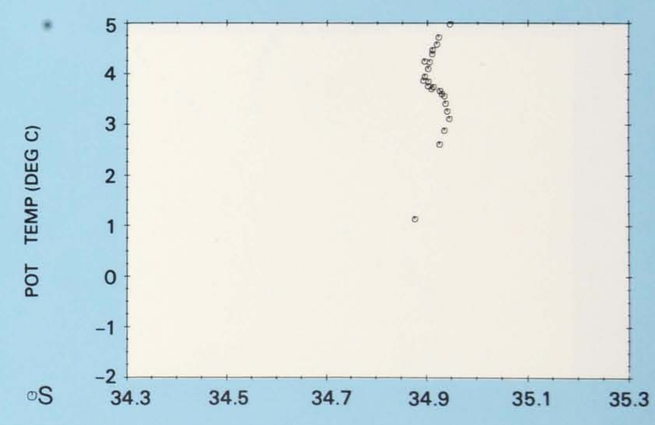
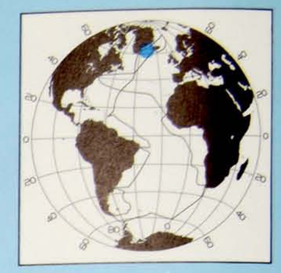
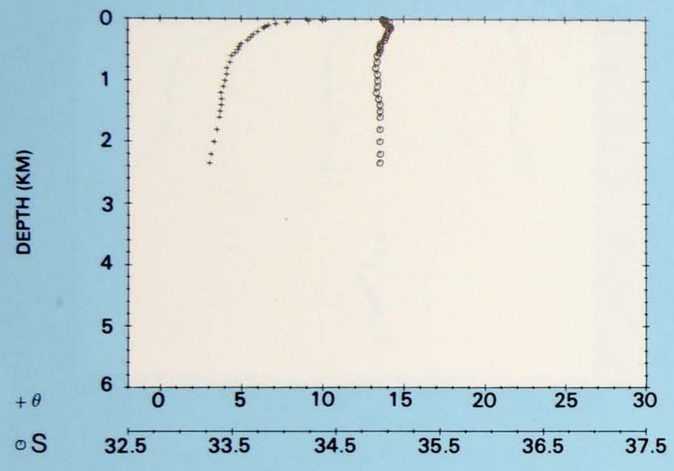


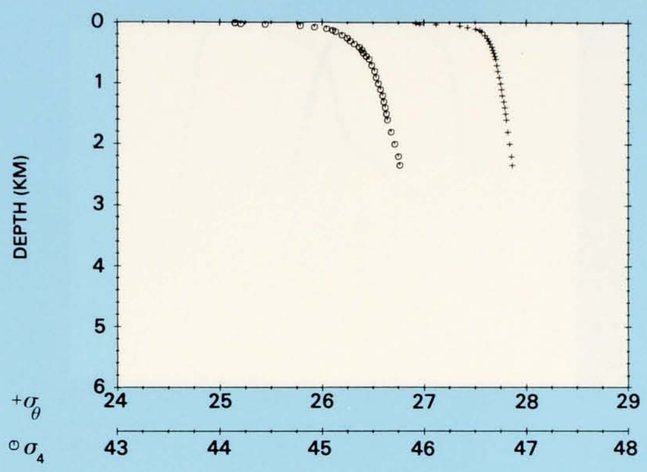
PLATE 76

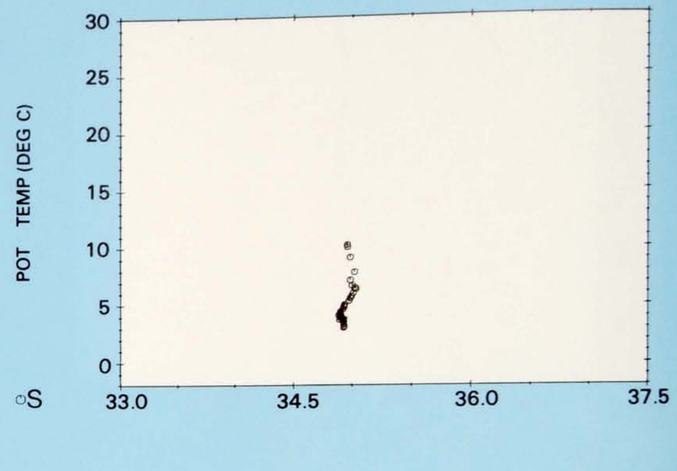
Station 13.
Latitude 63° 43′ N,
Longitude 30° 31′ W.
6 August 1972.

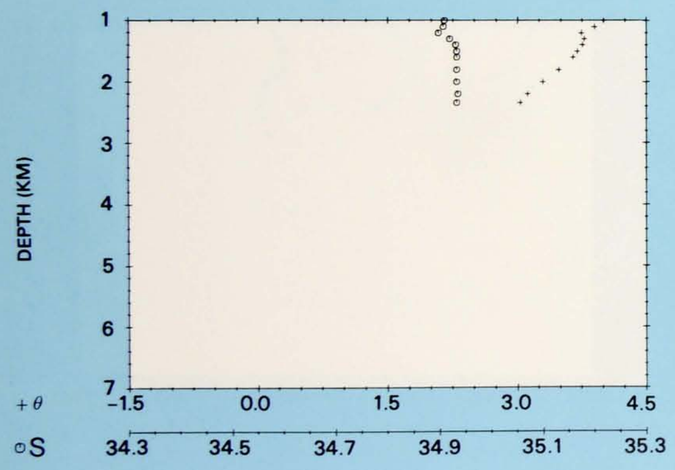
PROPERTY–PROPERTY PLOTS
STATION 13

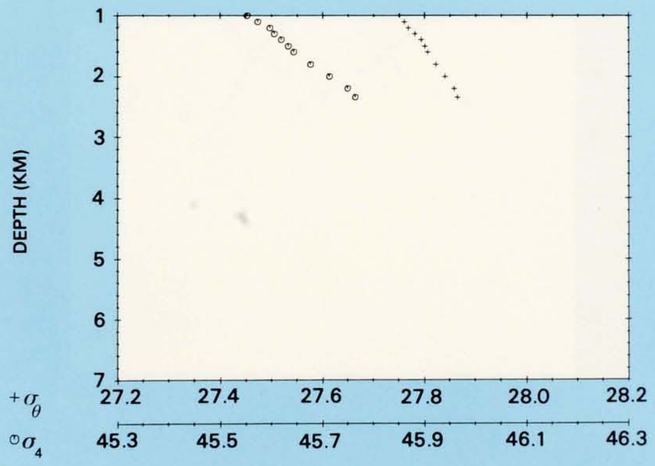


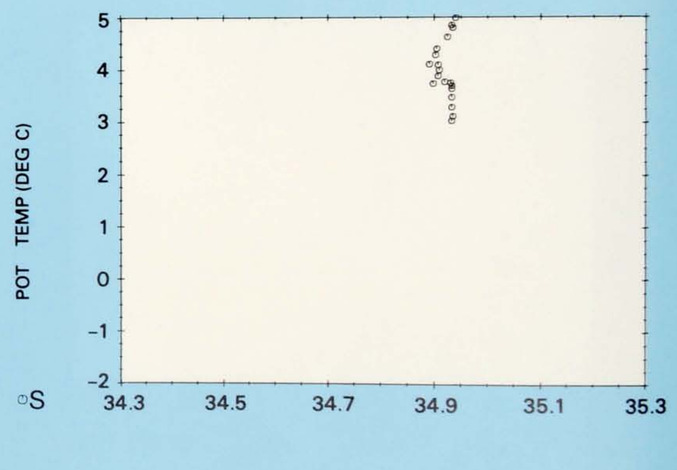


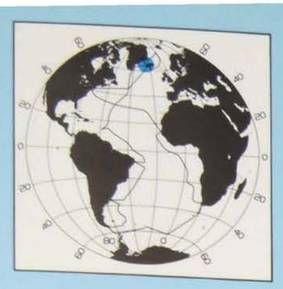








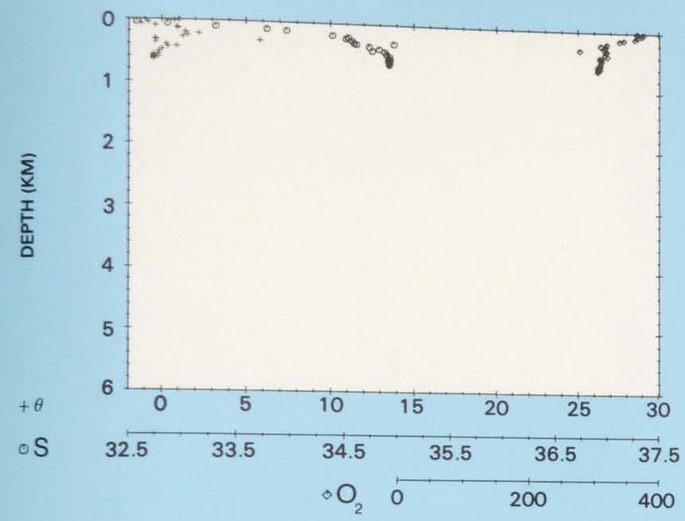


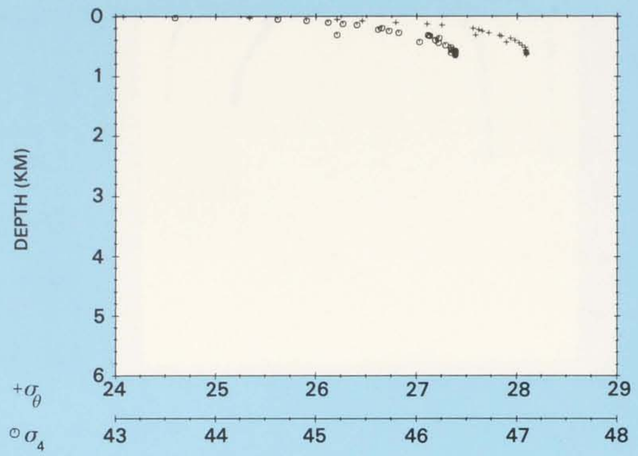


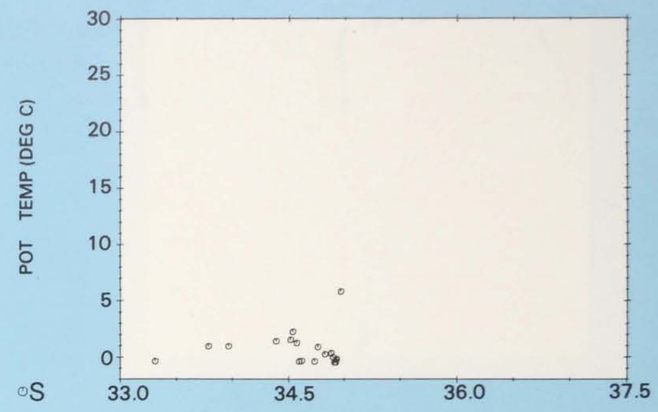
PROPERTY–PROPERTY PLOTS
STATION 14

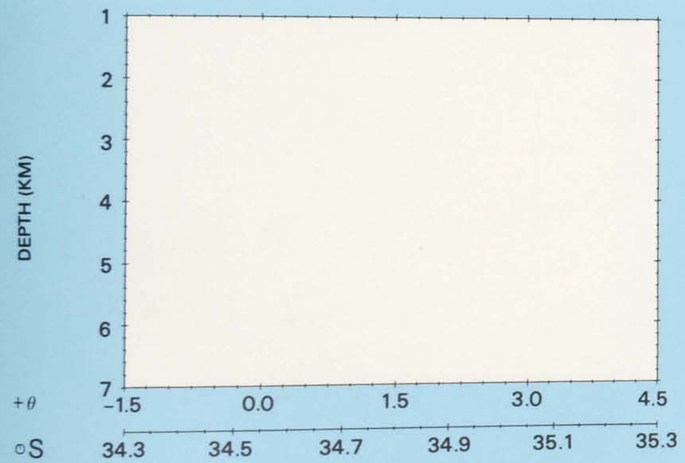
PLATE 77

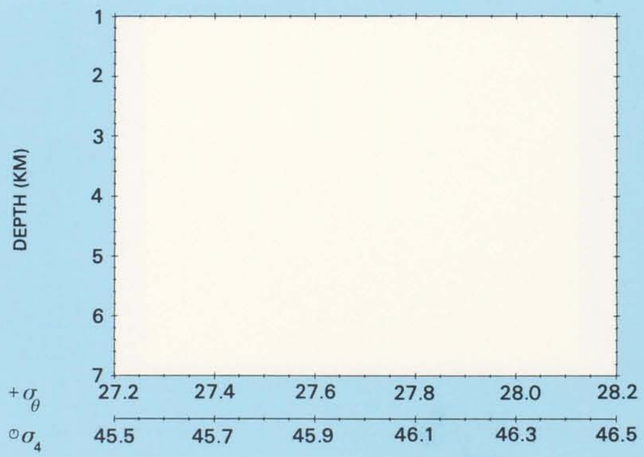
Station 14.
Latitude 65° 55′ N,
Longitude 27° 27′ W.
13 August 1972.

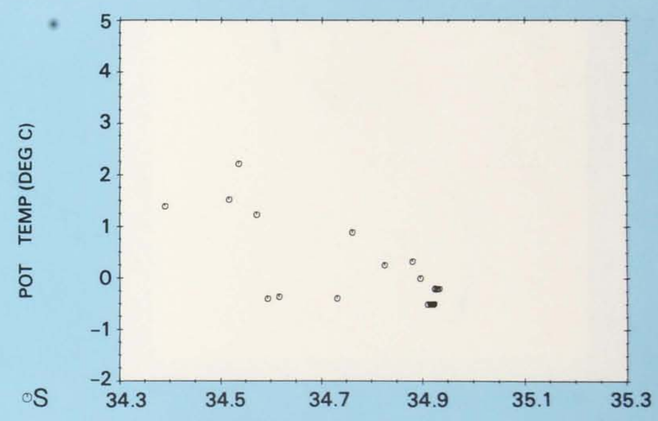


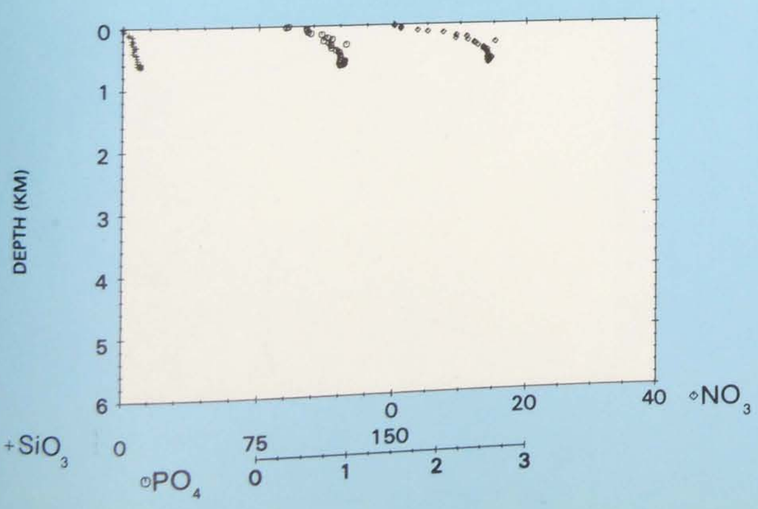












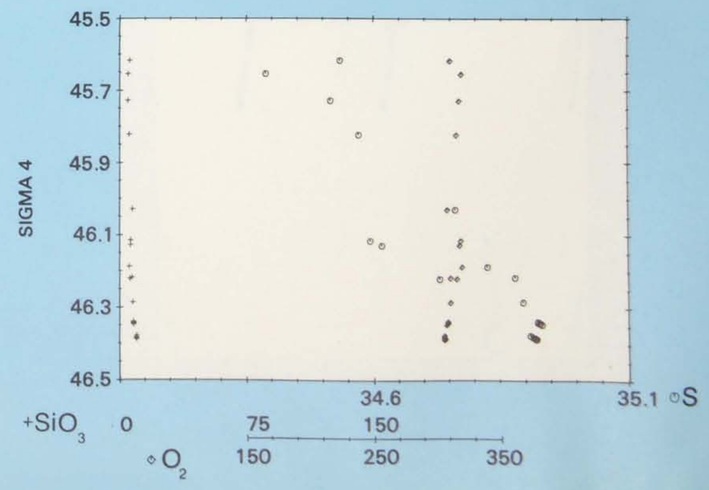
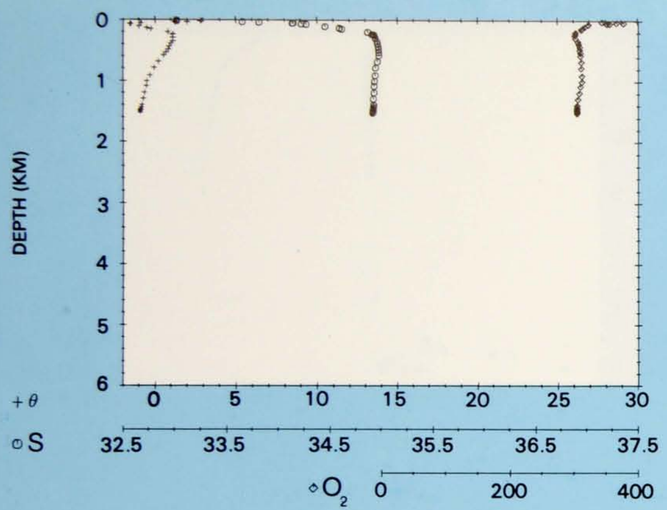
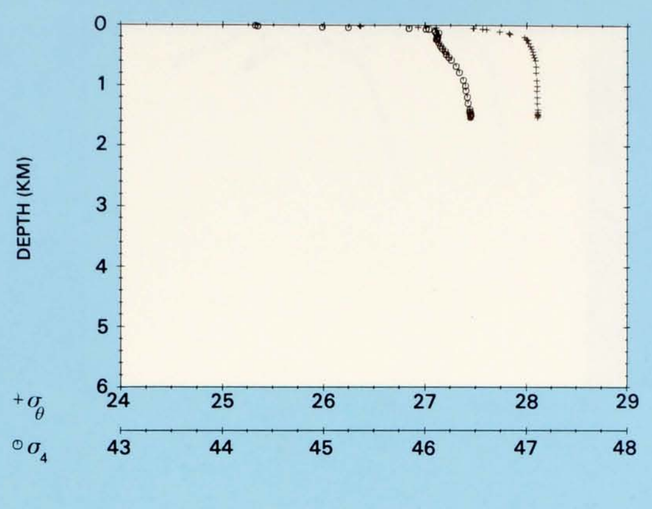


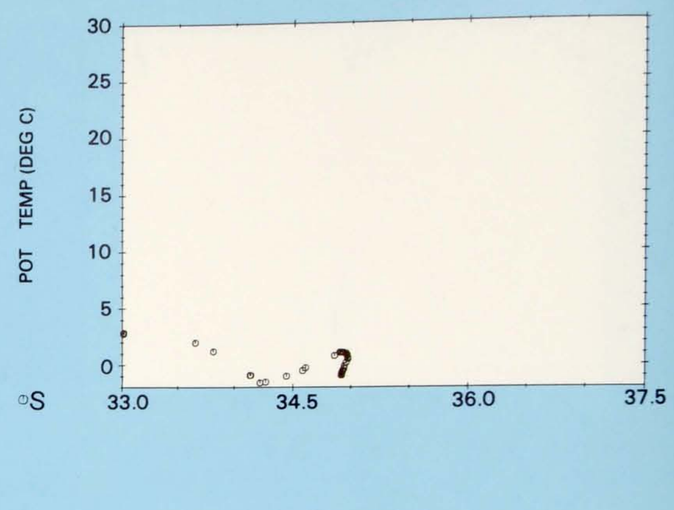
PLATE 78

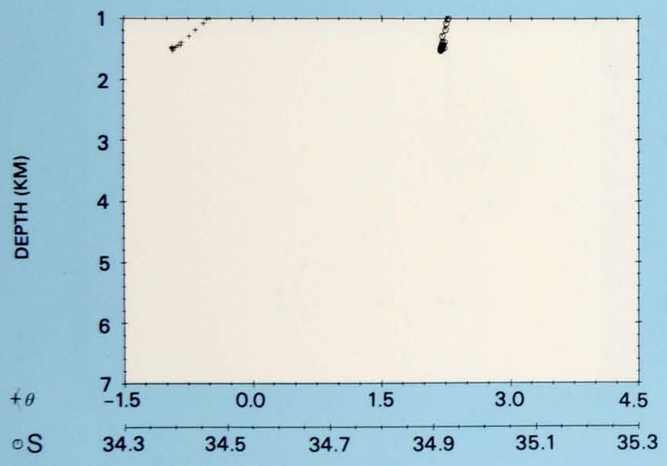
Station 15.
Latitude 69° 00′ N,
Longitude 20° 01′ W.
15 August 1972.

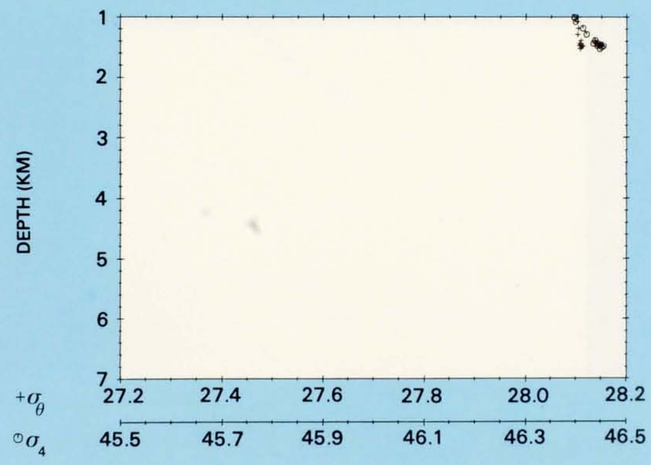
PROPERTY–PROPERTY PLOTS
STATION 15

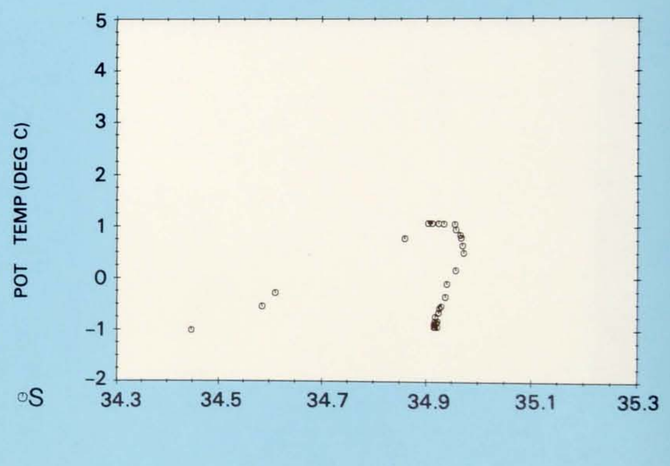


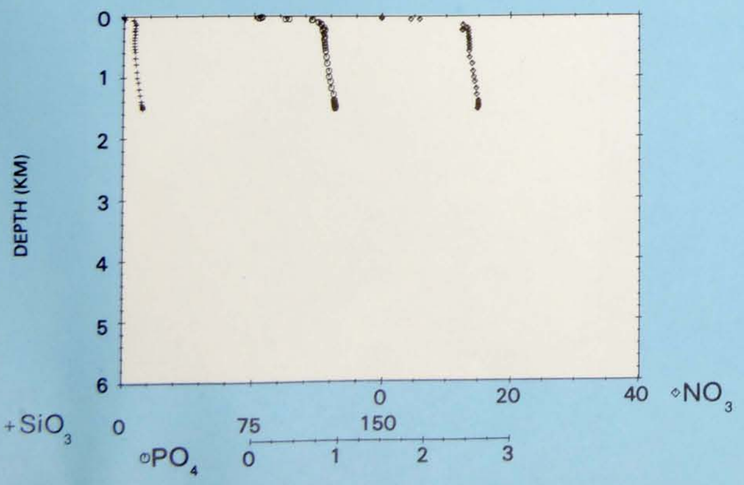


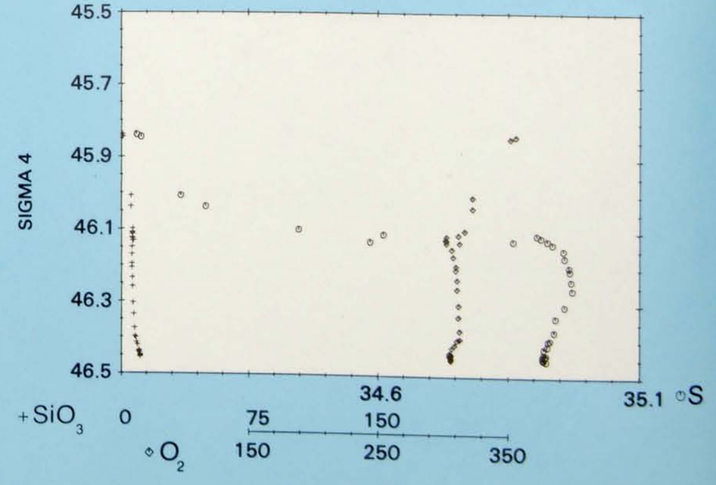


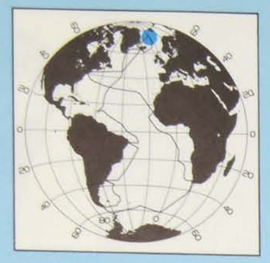








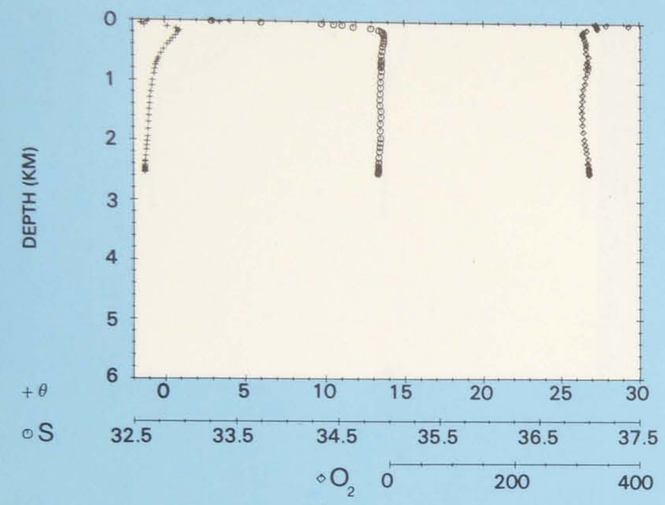


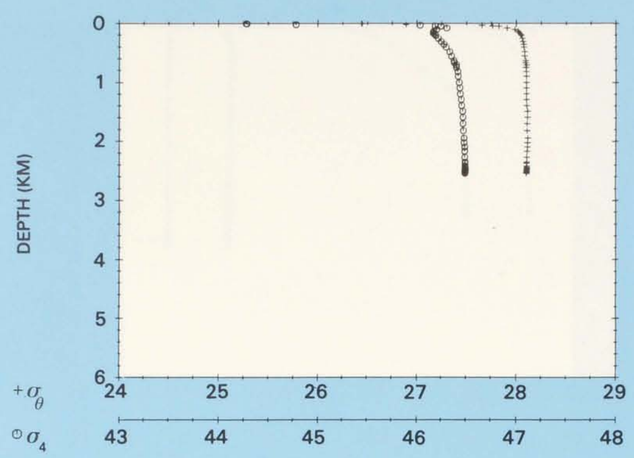


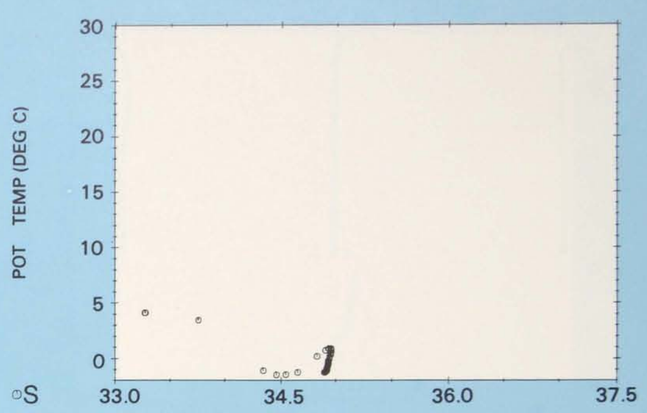
PROPERTY–PROPERTY PLOTS
STATION 16

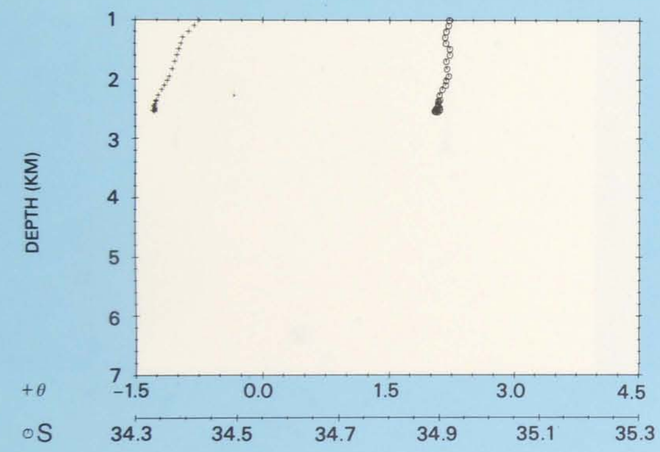
PLATE 79

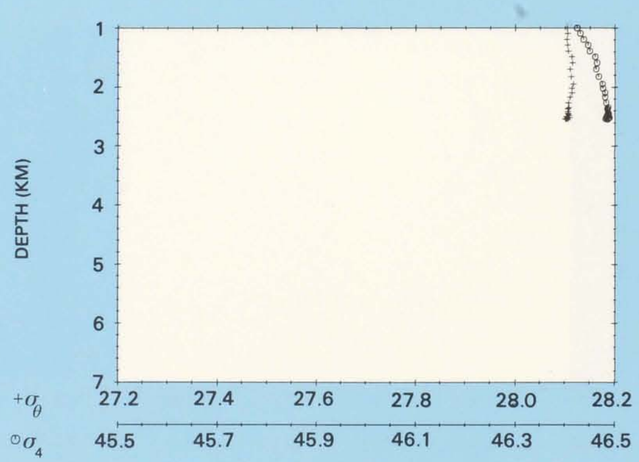
Station 16.
Latitude 72° 02′ N,
Longitude 8° 26′ W.
16 August 1972.

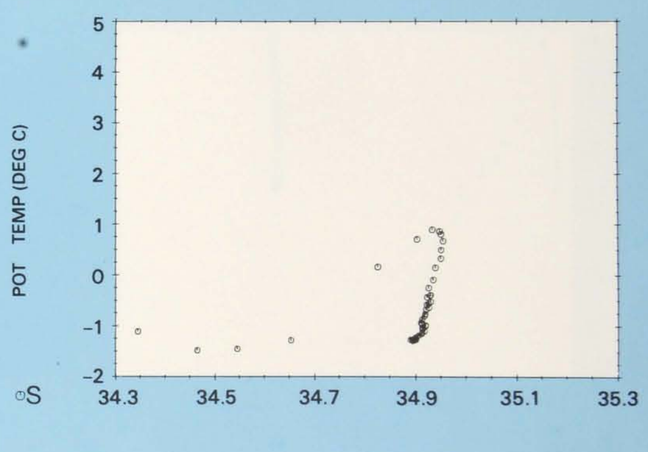


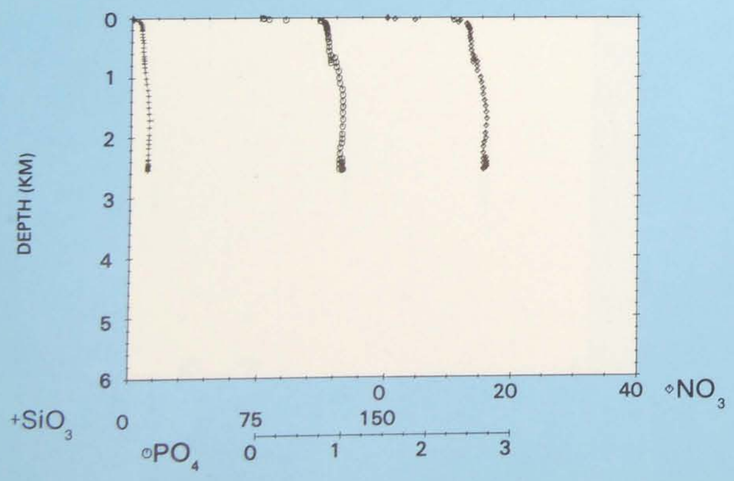












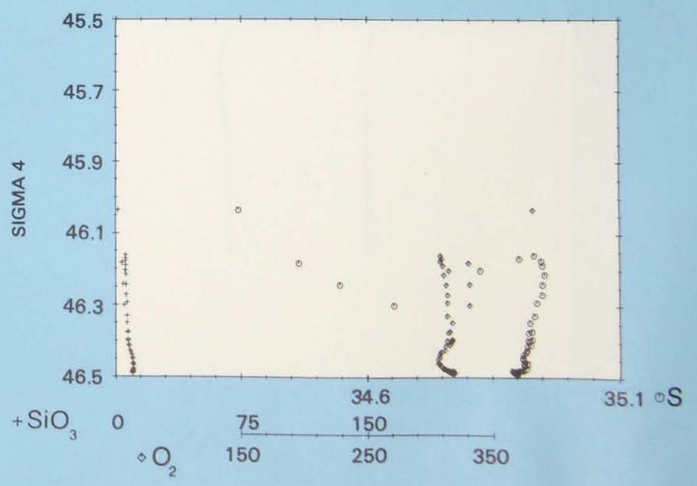
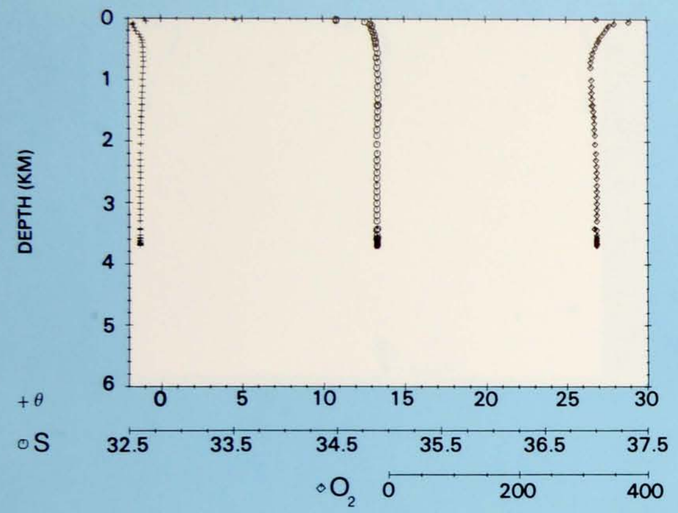
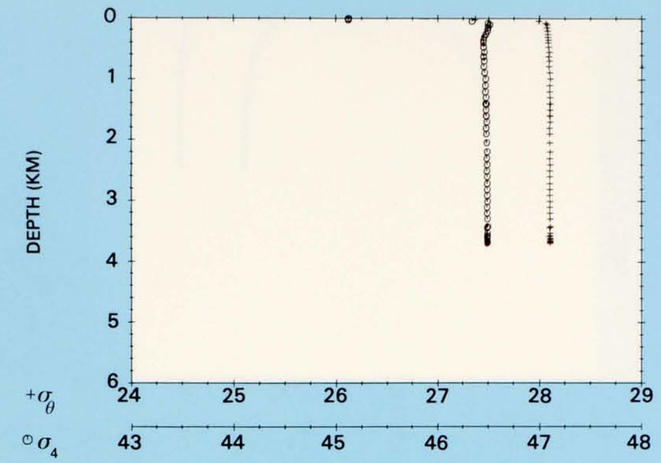


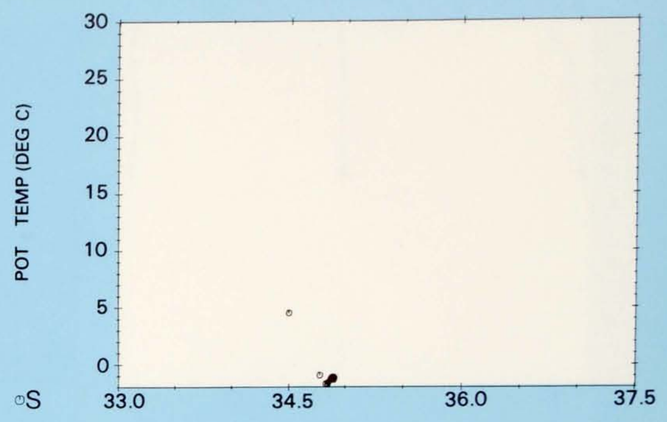
PLATE 80

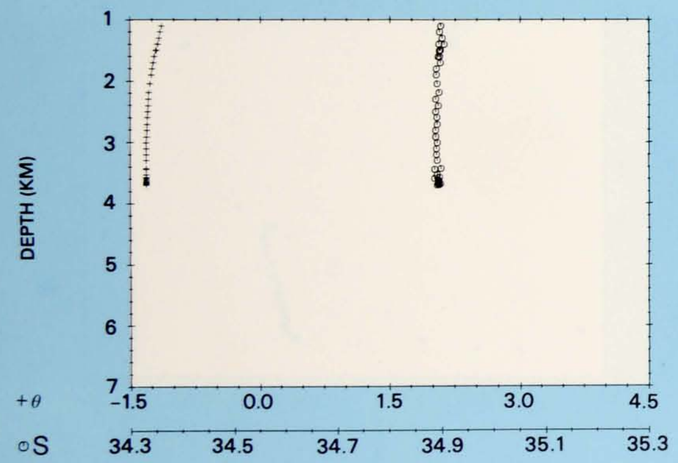
Station 17.
Latitude 74° 56′ N,
Longitude 1° 07′ W.
18 August 1972.

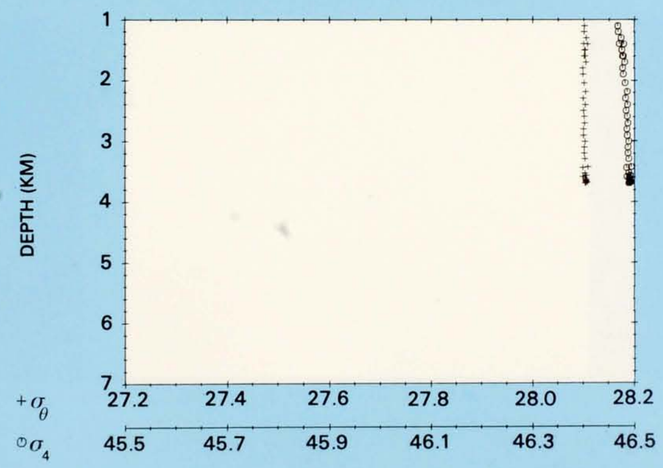
PROPERTY–PROPERTY PLOTS
STATION 17

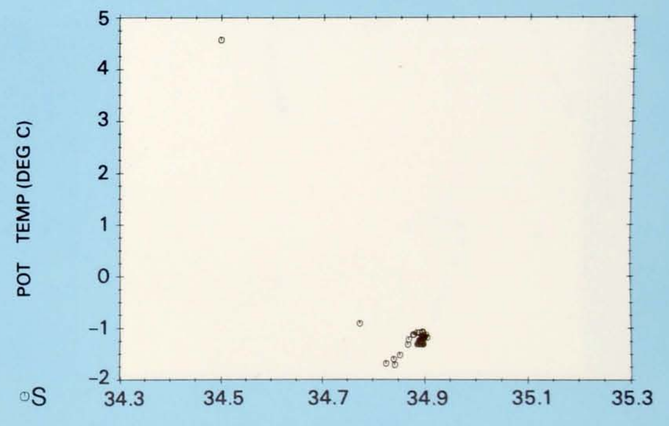


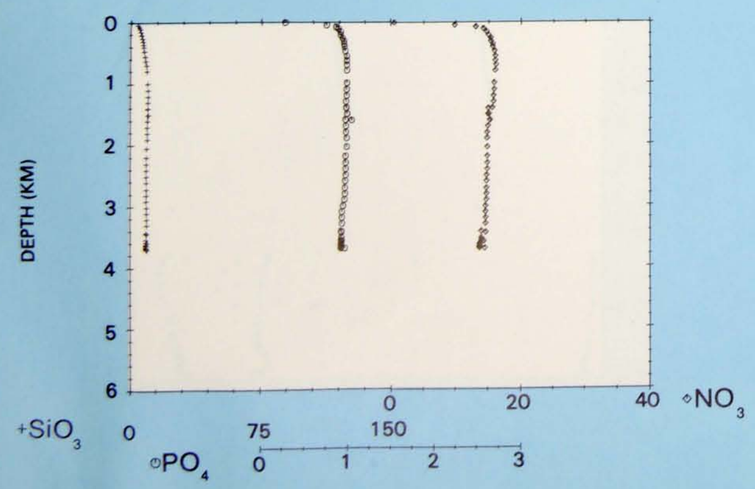


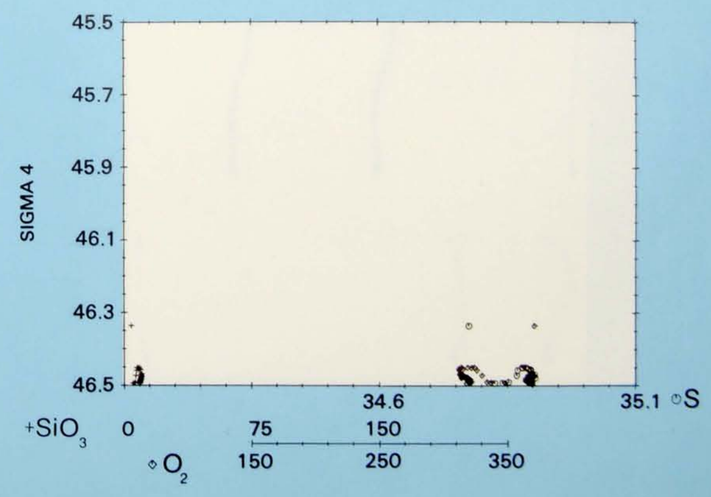


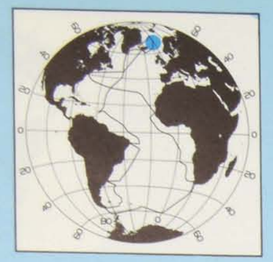








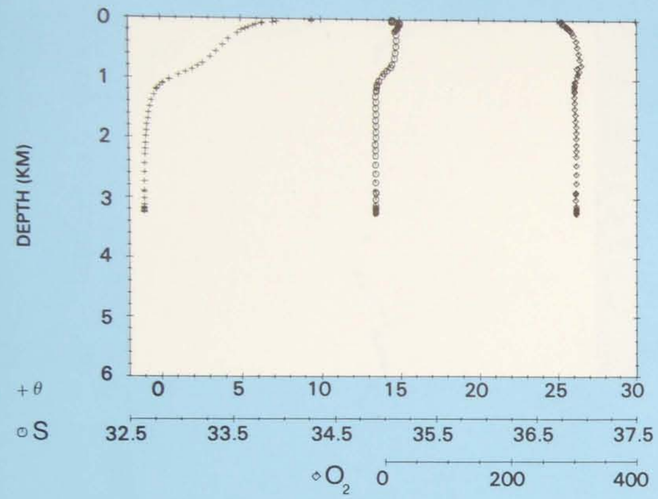


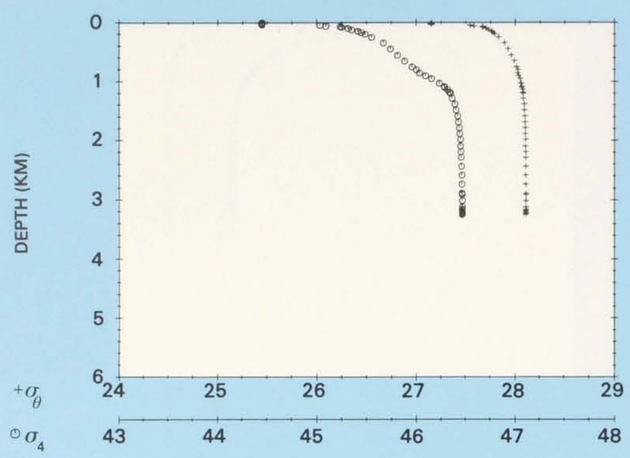


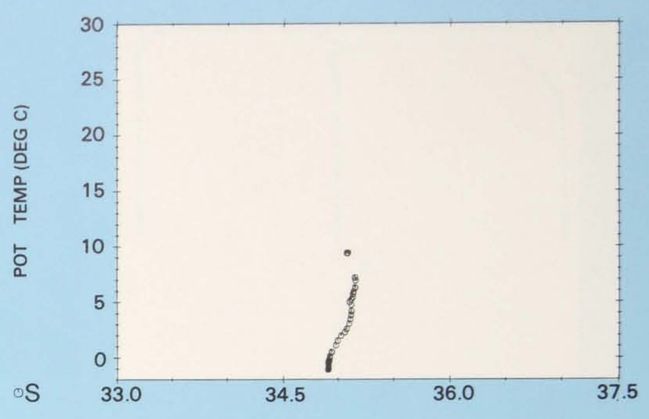
PROPERTY–PROPERTY PLOTS
STATION 18

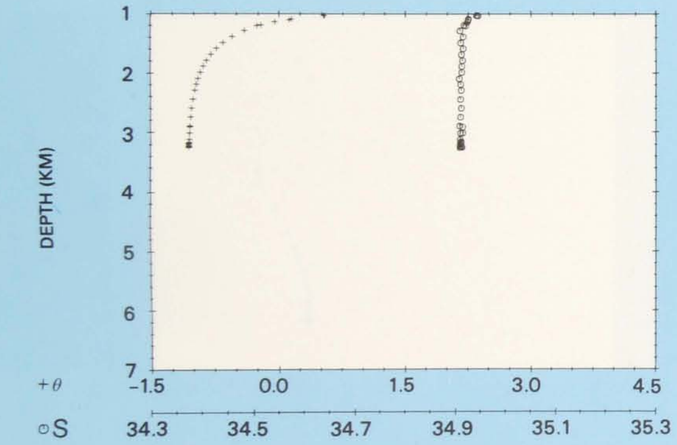
PLATE 81

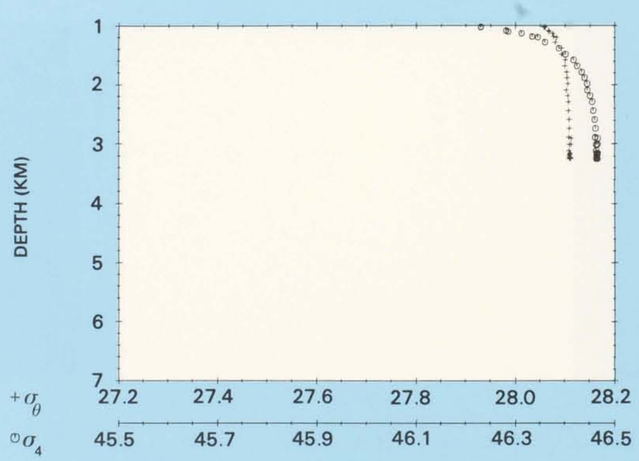
Station 18.
Latitude 70° 00′ N,
Longitude 0° 00′ W.
22 August 1972.

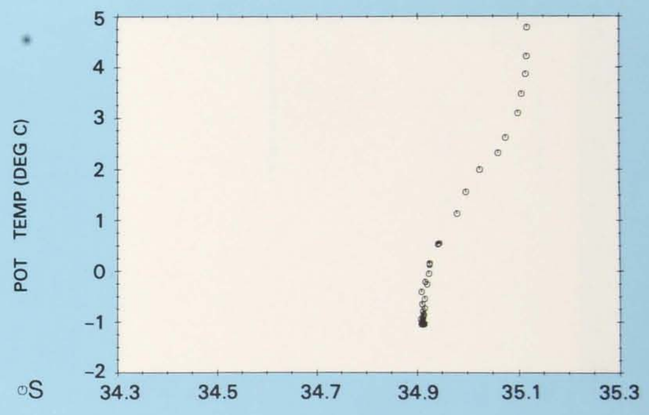


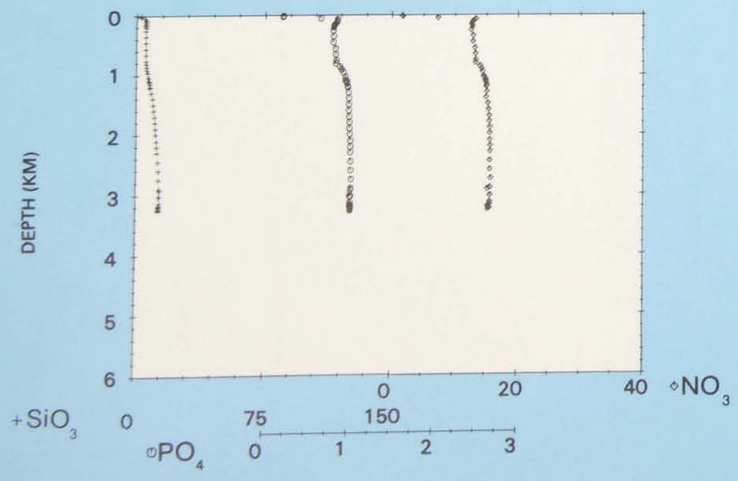












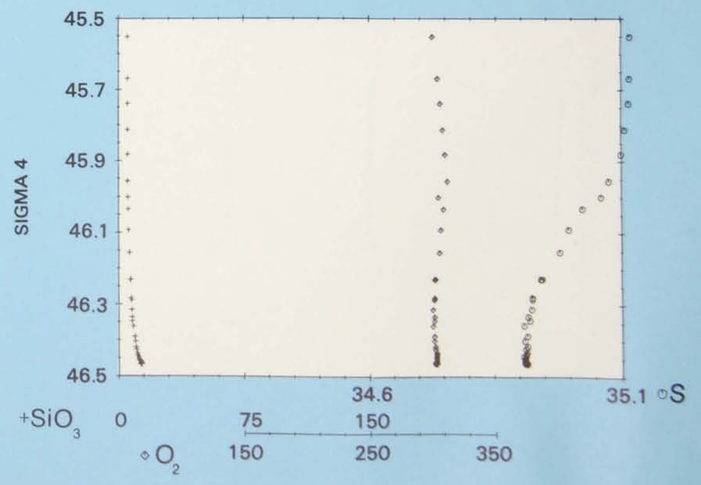
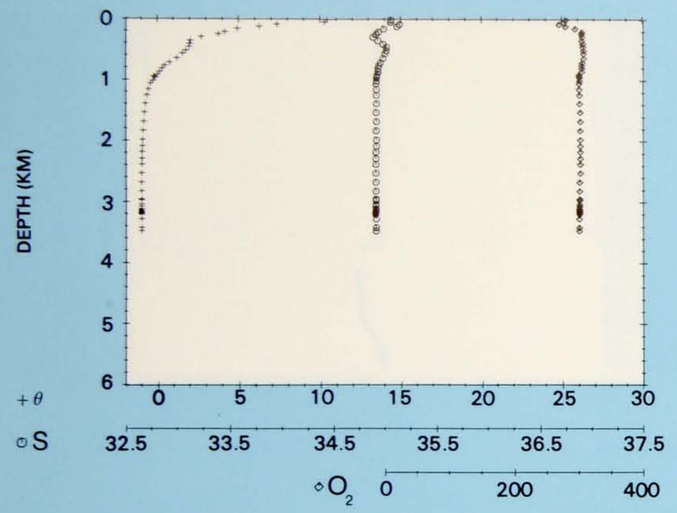
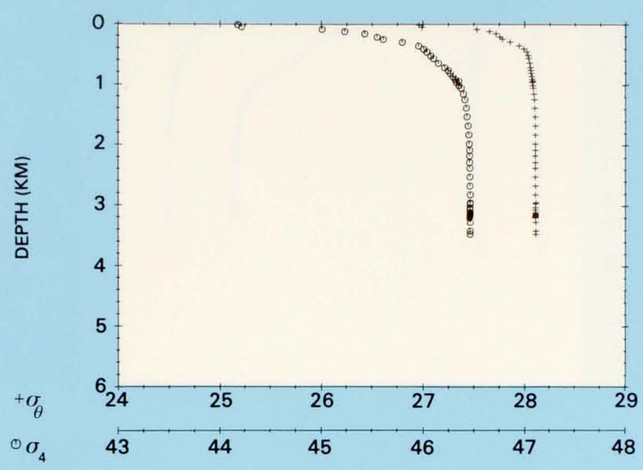


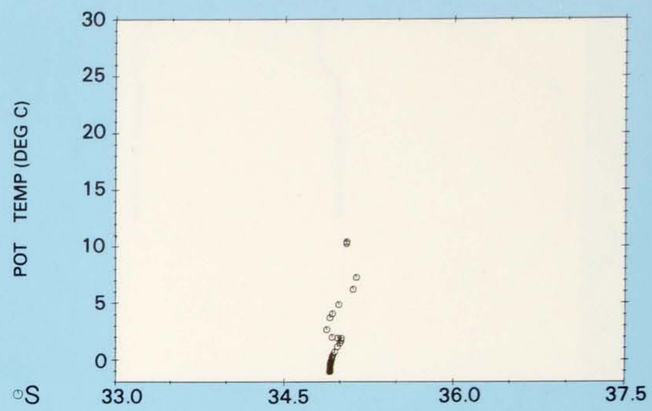
PLATE 82

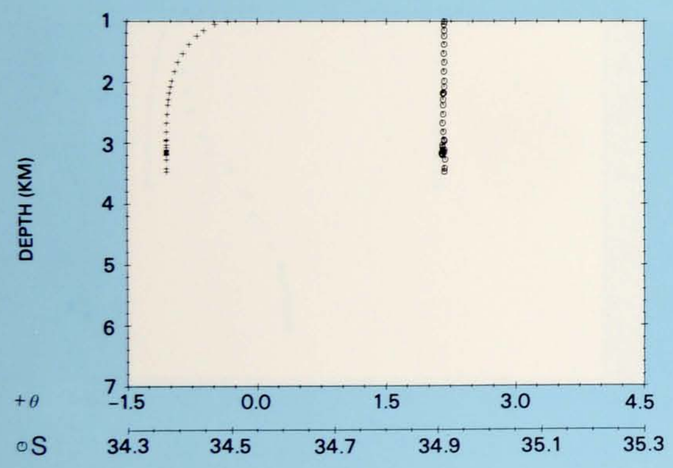
Station 19.
Latitude 64° 12′ N,
Longitude 5° 34′ W.
24 August 1972.

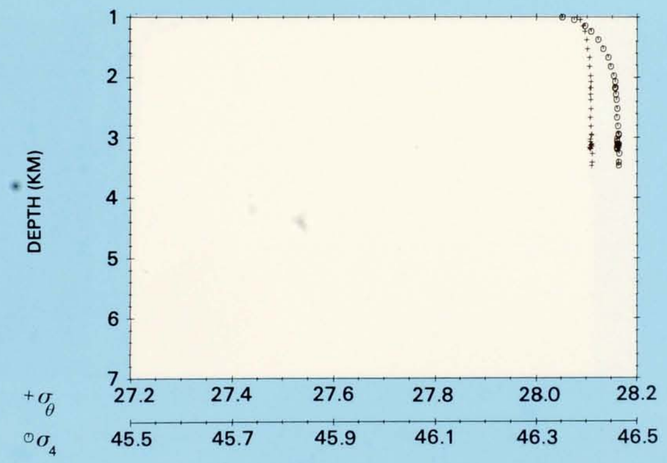
PROPERTY–PROPERTY PLOTS
STATION 19

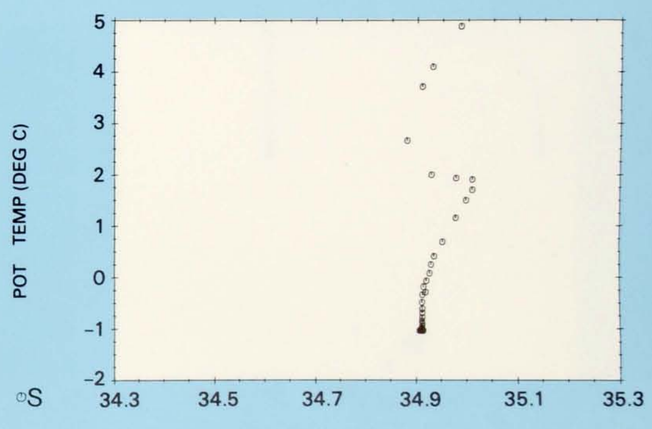


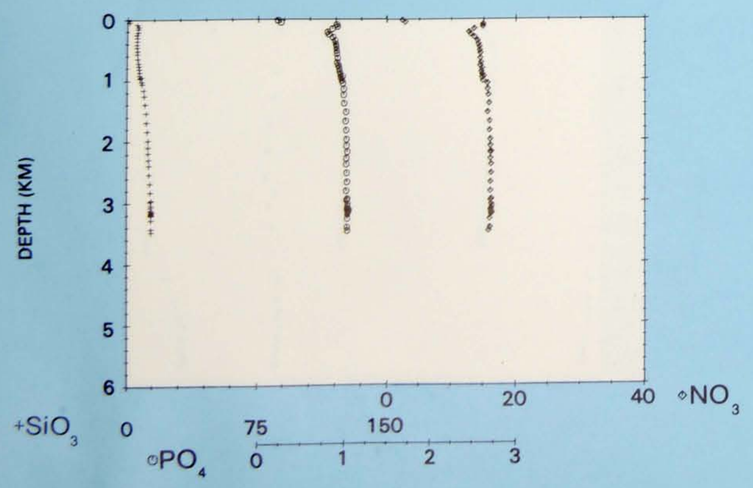


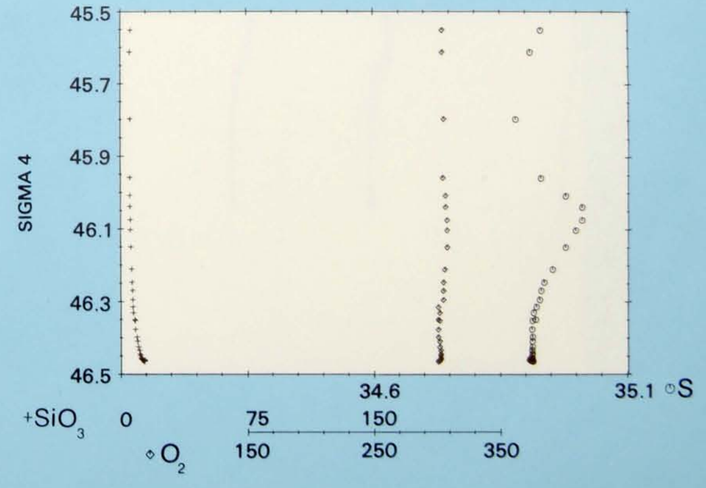


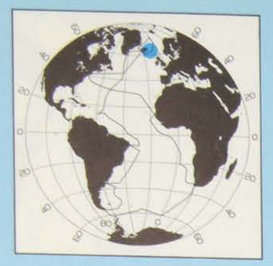








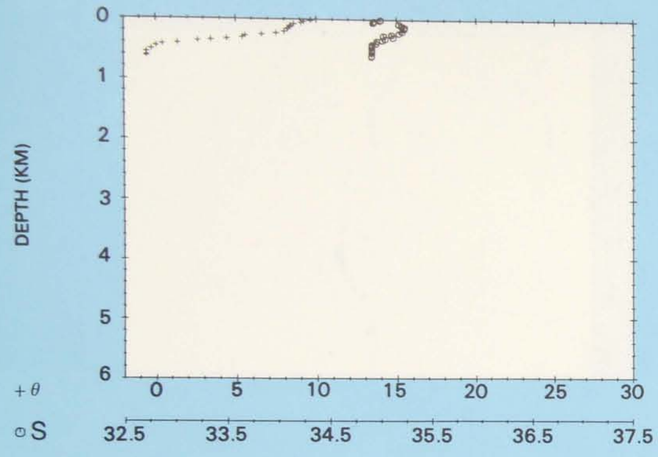


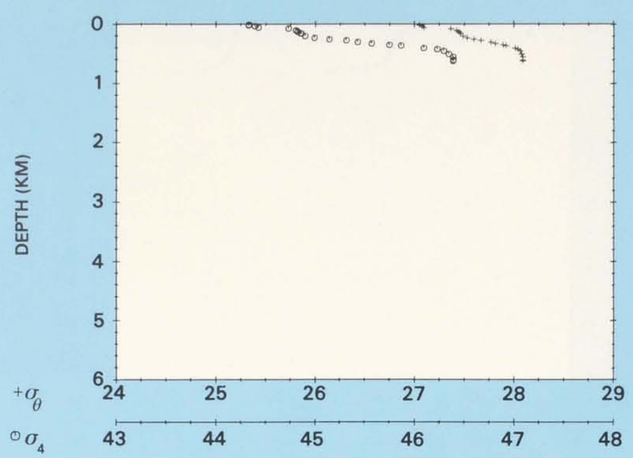


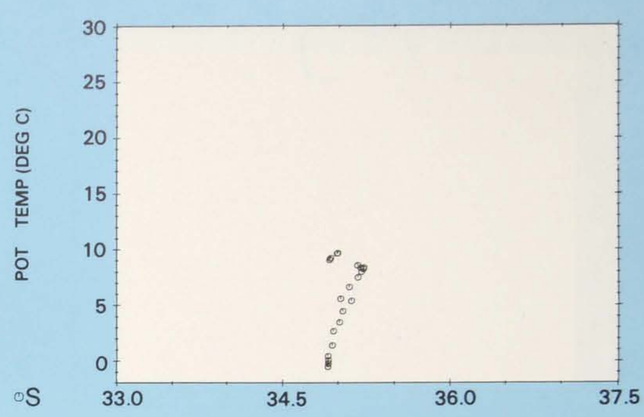
PROPERTY–PROPERTY PLOTS
STATION 20

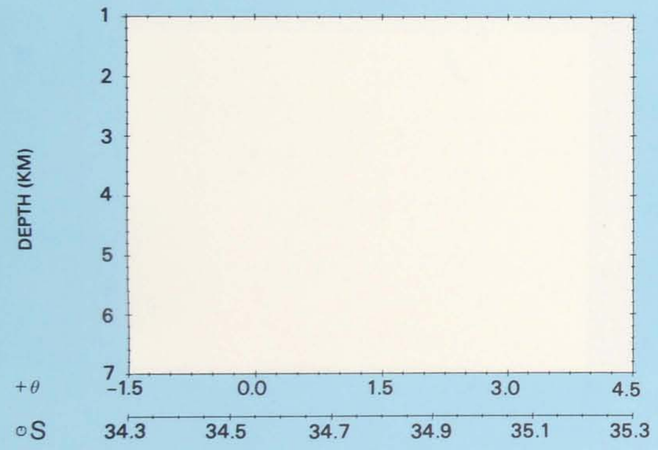
PLATE 83

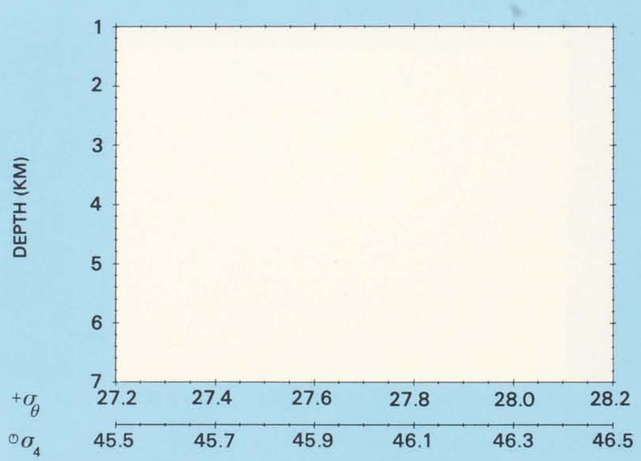
Station 20.
Latitude 63° 24′ N,
Longitude 8° 23′ W.
26 August 1972.











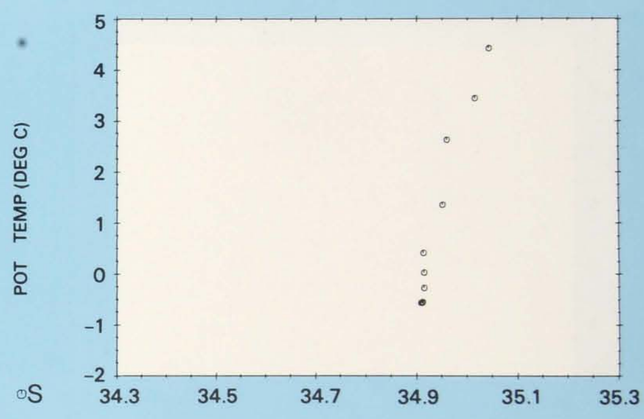
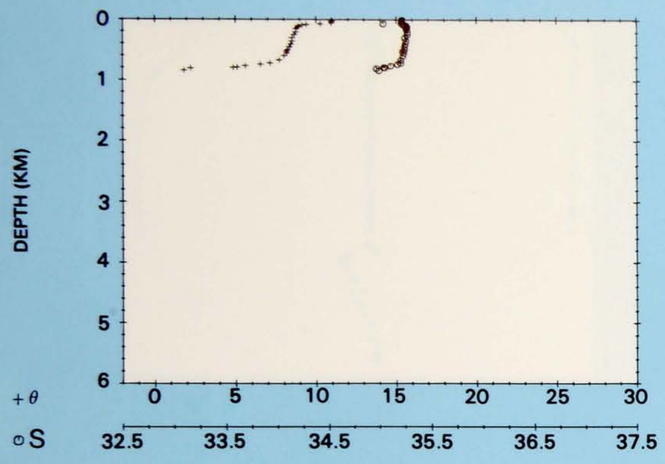
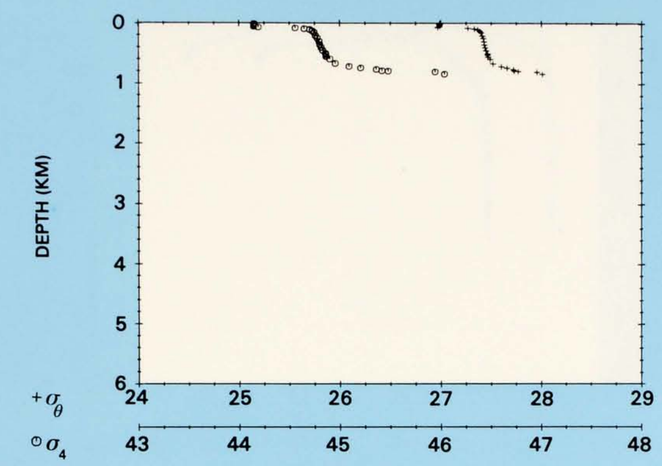


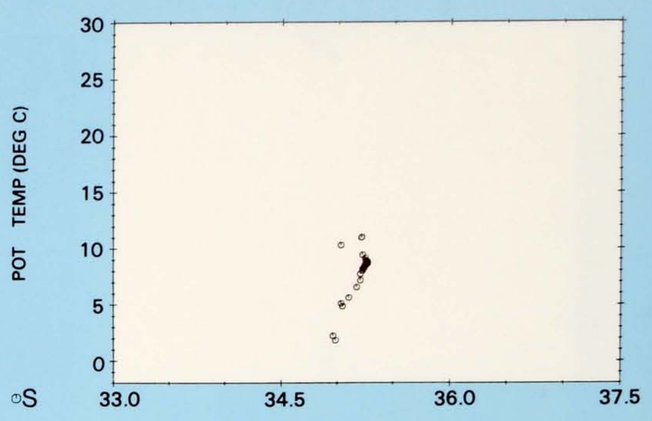
PLATE 84

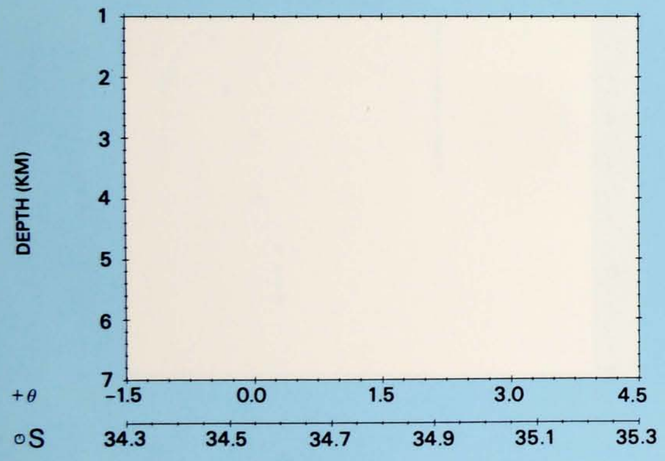
Station 21.
Latitude 62° 24′ N,
Longitude 11° 53′ W.
27 August 1972.

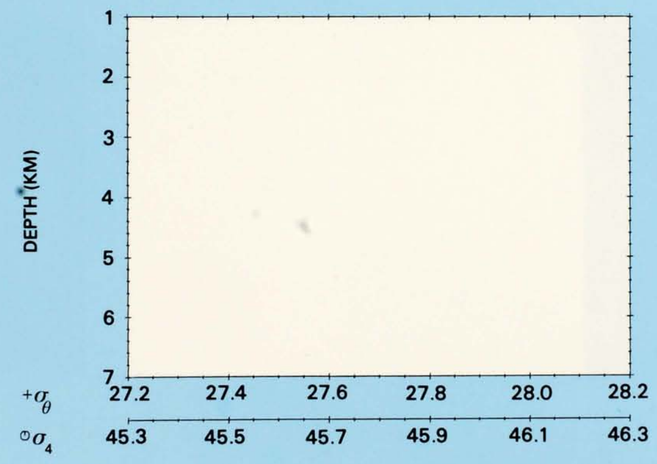
PROPERTY–PROPERTY PLOTS
STATION 21

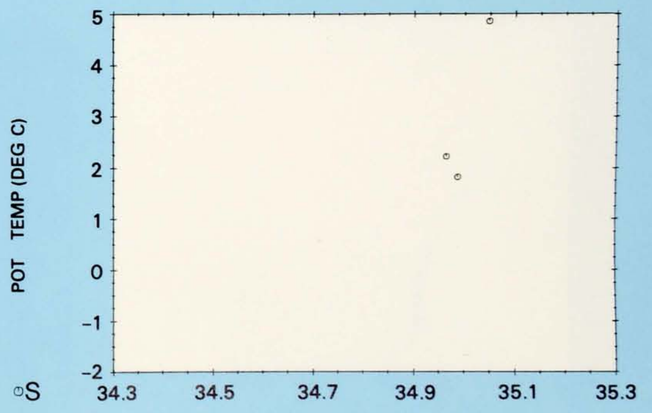








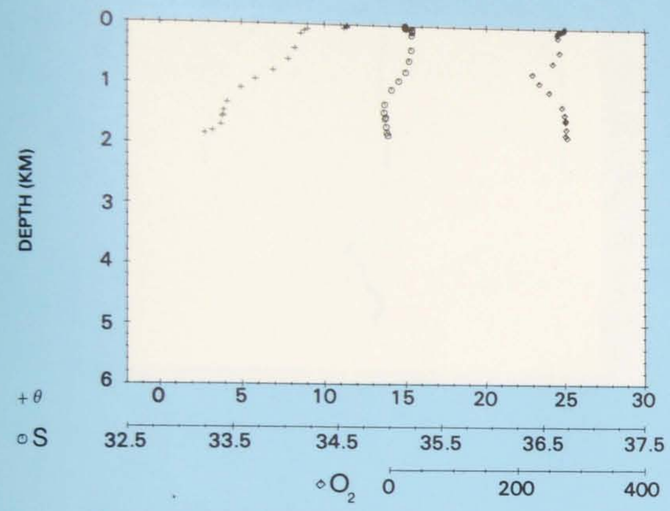


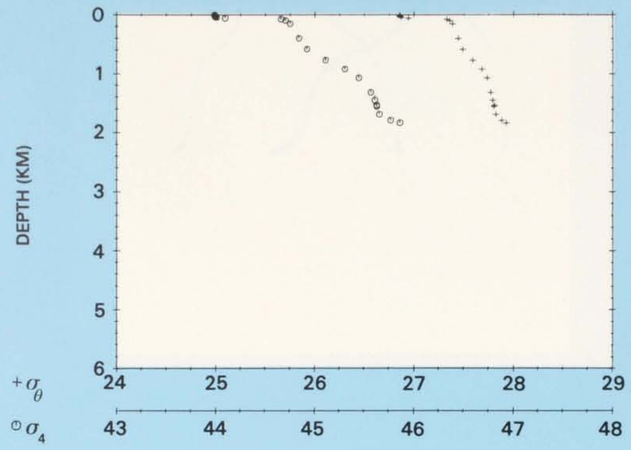


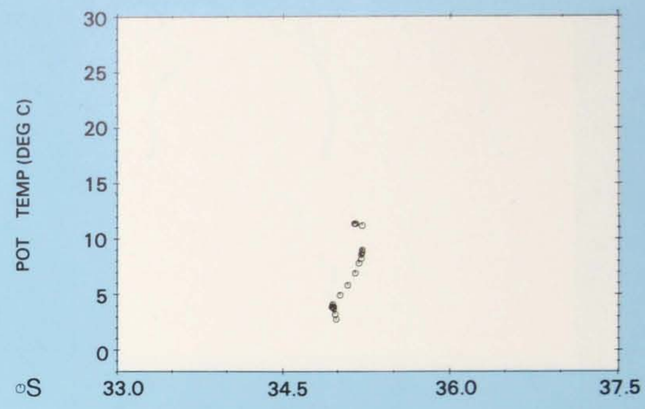
PROPERTY–PROPERTY PLOTS
STATION 22

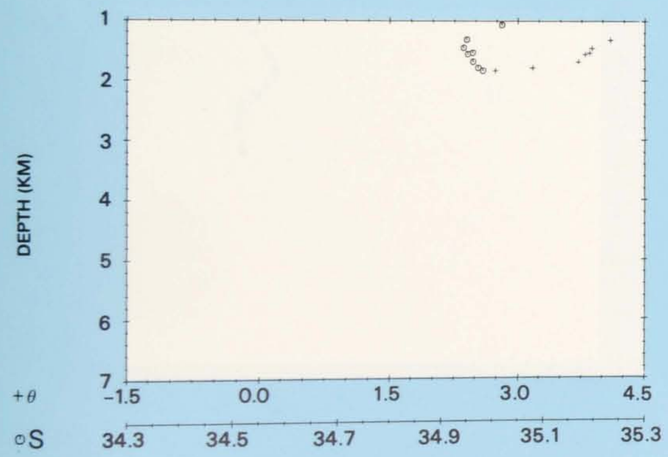
PLATE 85

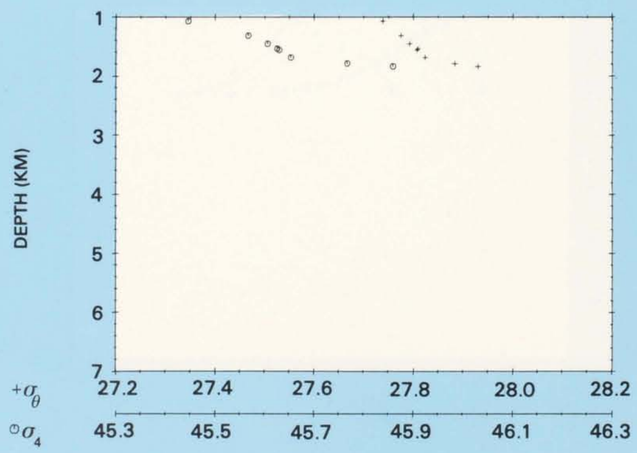
Station 22.
Latitude 61° 39′ N,
Longitude 14° 17′ W.
27 August 1972.

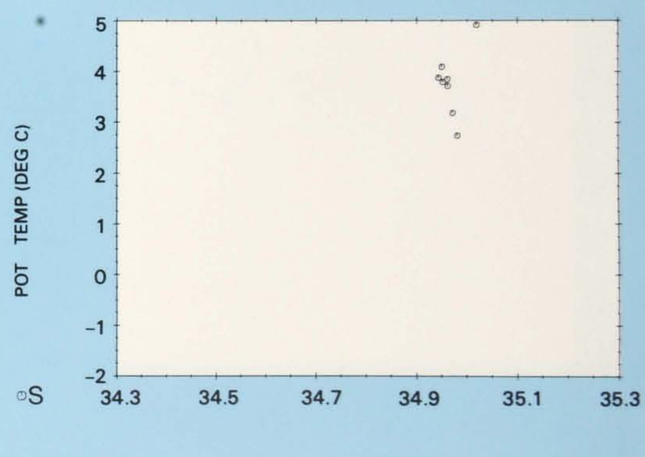


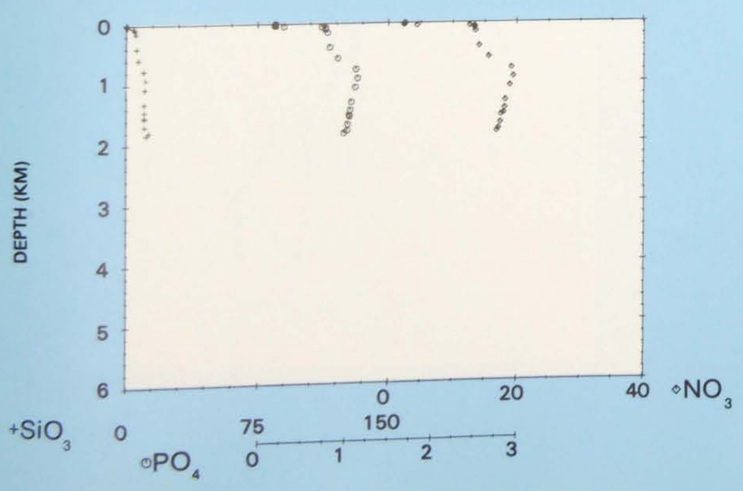












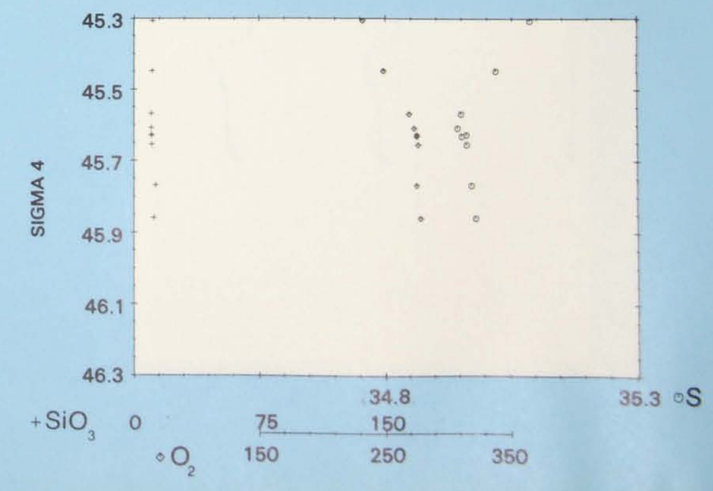
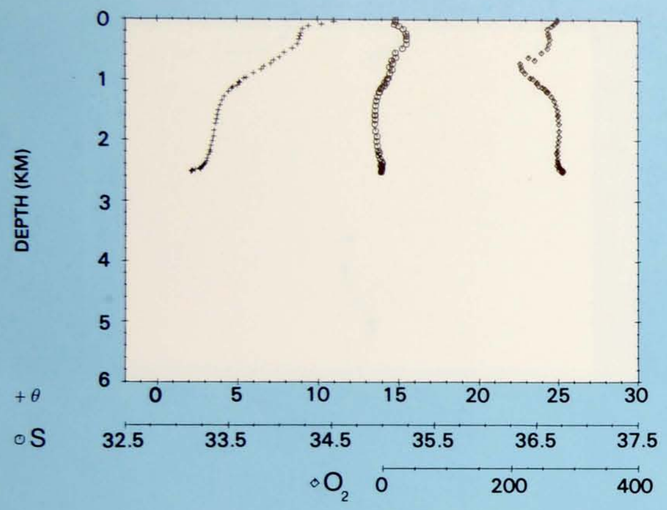
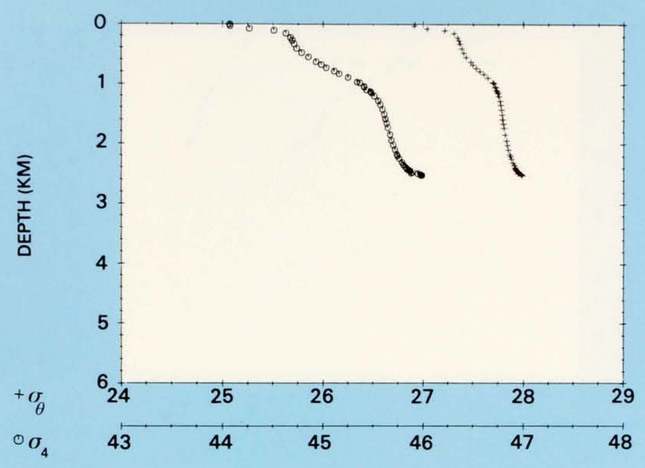


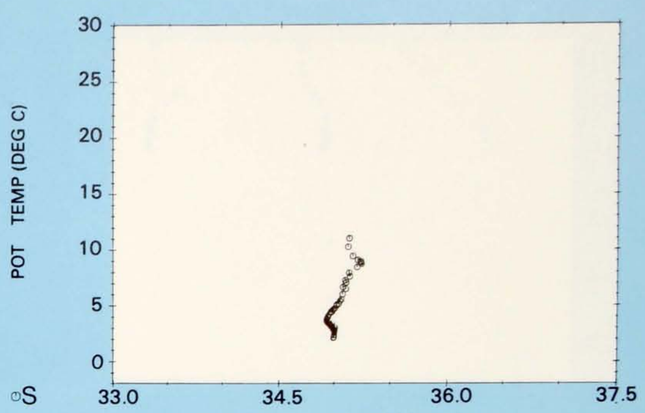
PLATE 86

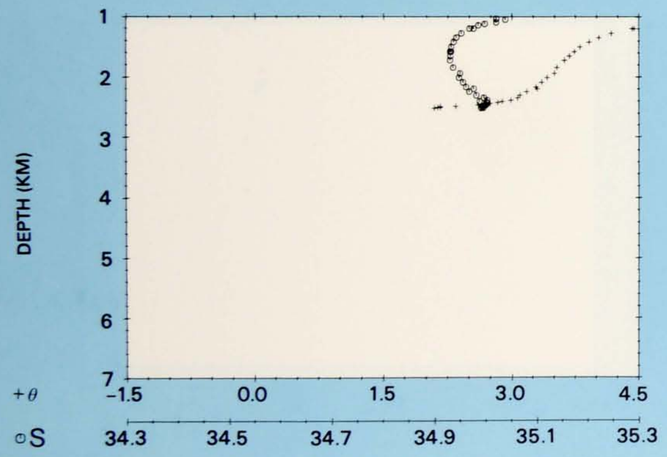
Station 23.
Latitude 60° 24′ N,
Longitude 18° 37′ W.
28 August 1972.

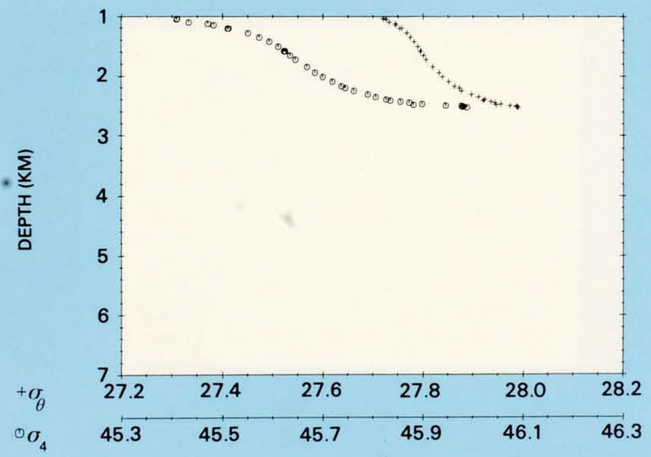
PROPERTY–PROPERTY PLOTS
STATION 23

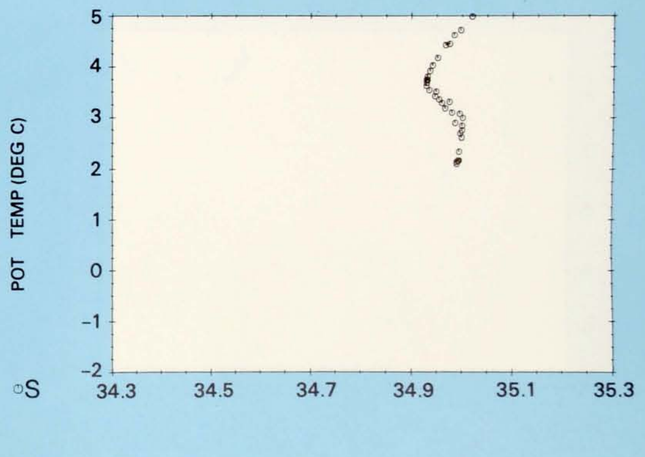


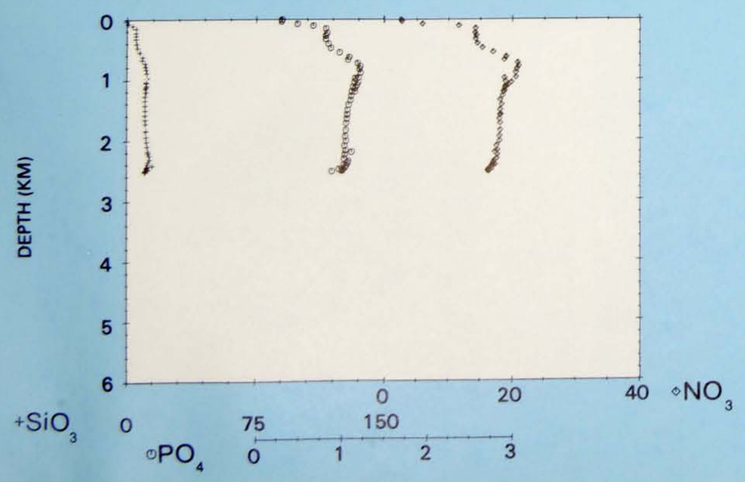


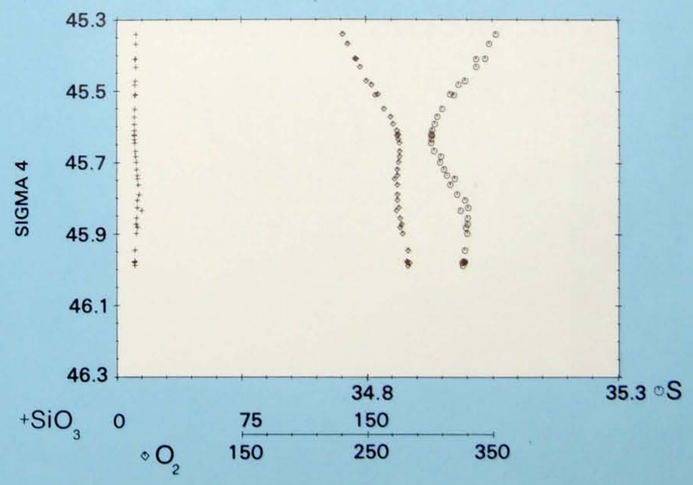








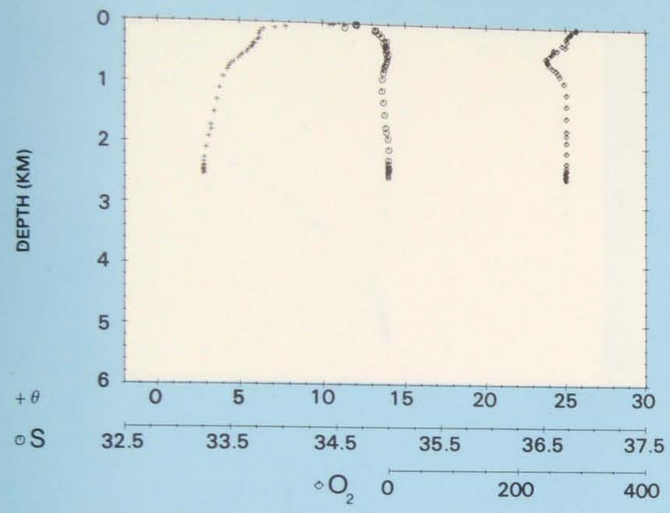


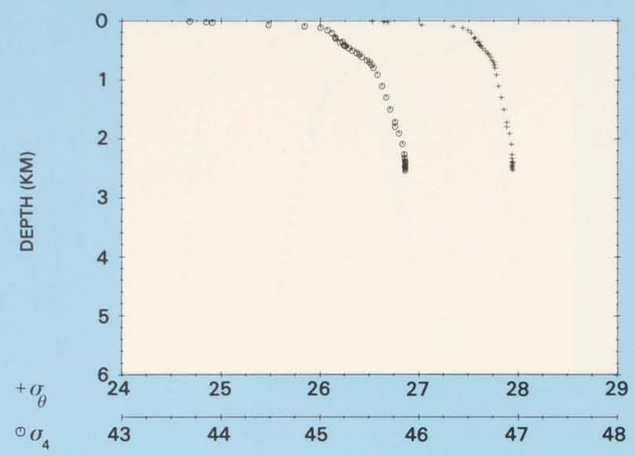


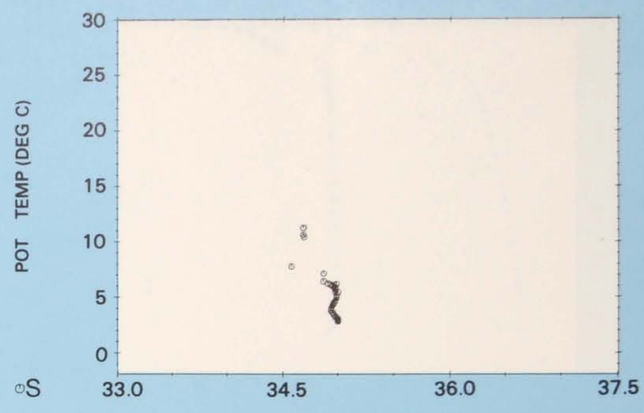
PROPERTY–PROPERTY PLOTS
STATION 24

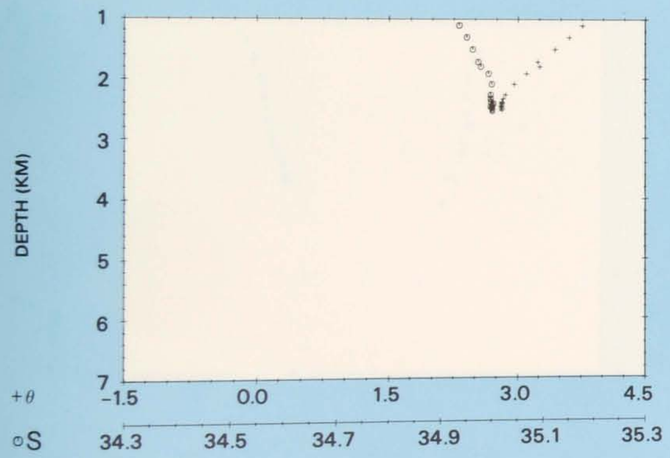
PLATE 87

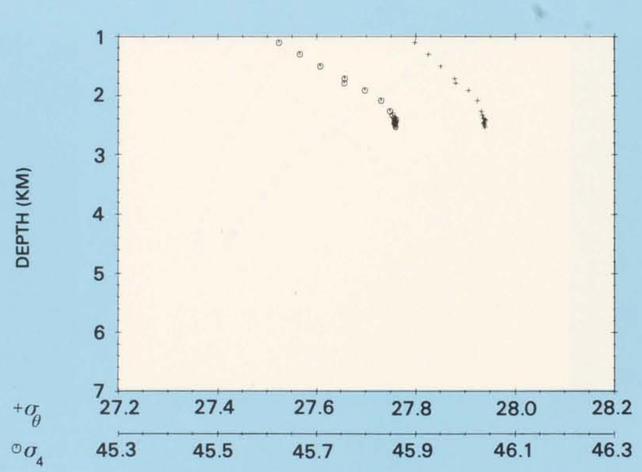
Station 24.
Latitude 53° 45′ N,
Longitude 33° 37′ W.
7 September 1972.

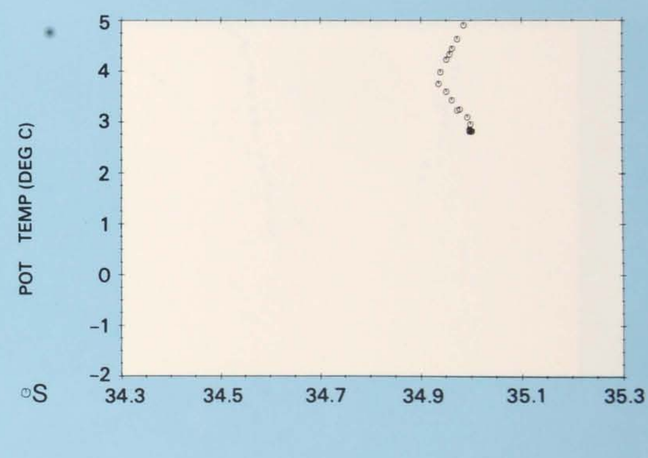


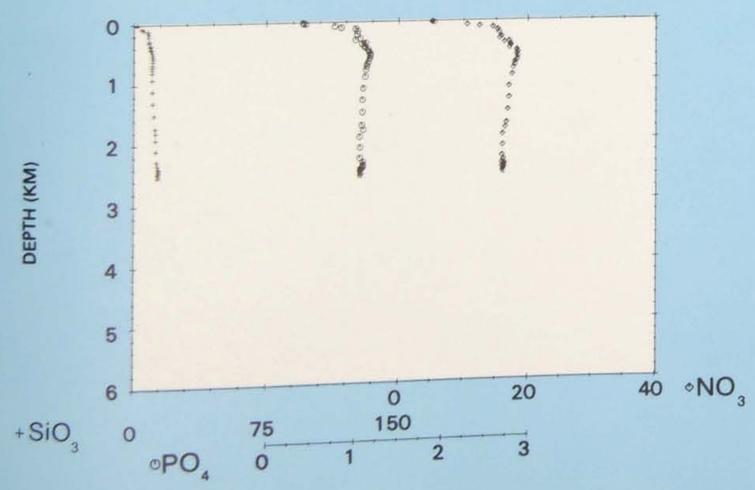


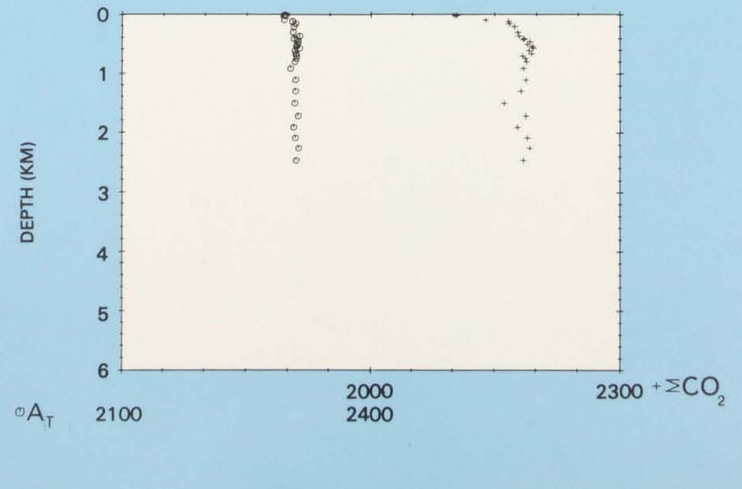












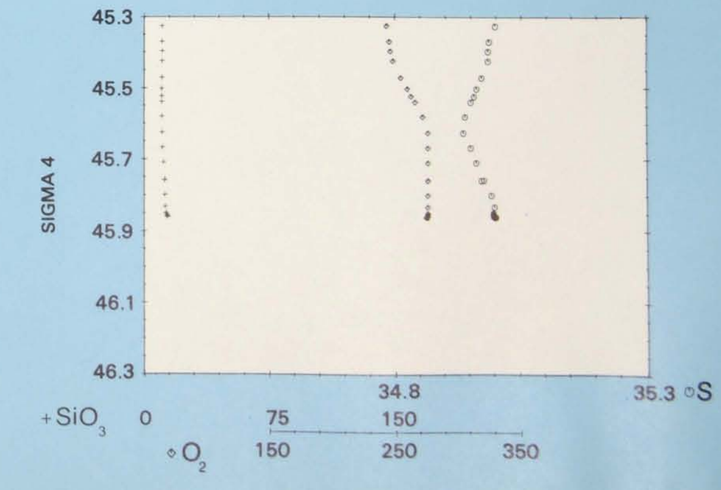
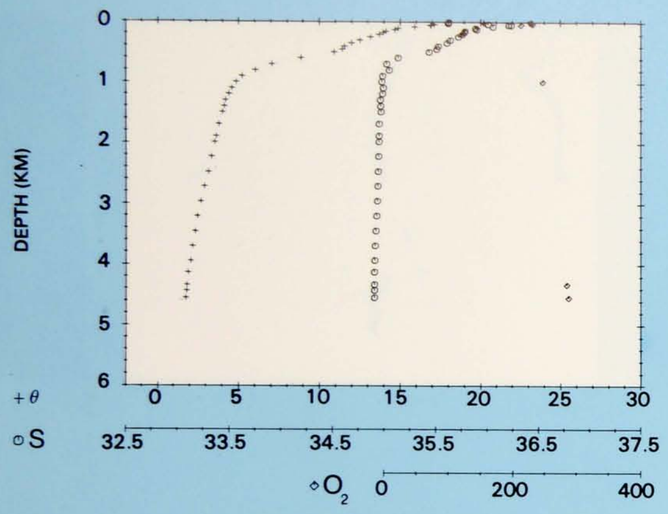
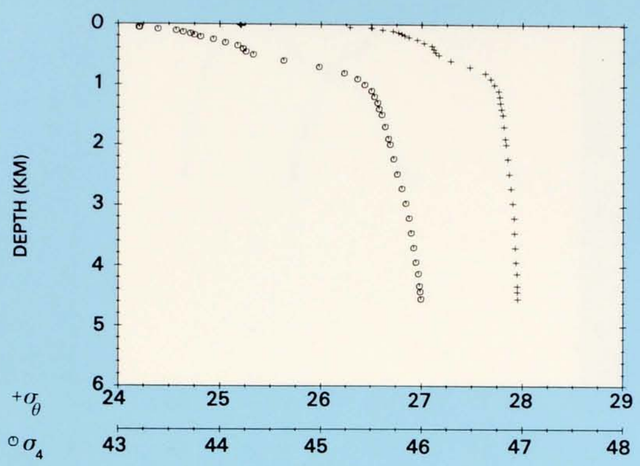


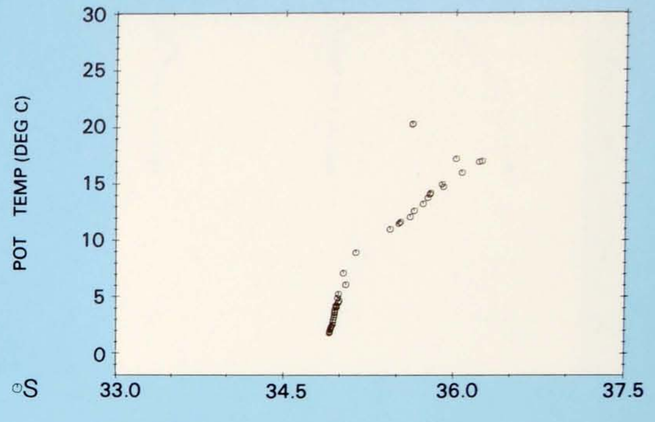
PLATE 88

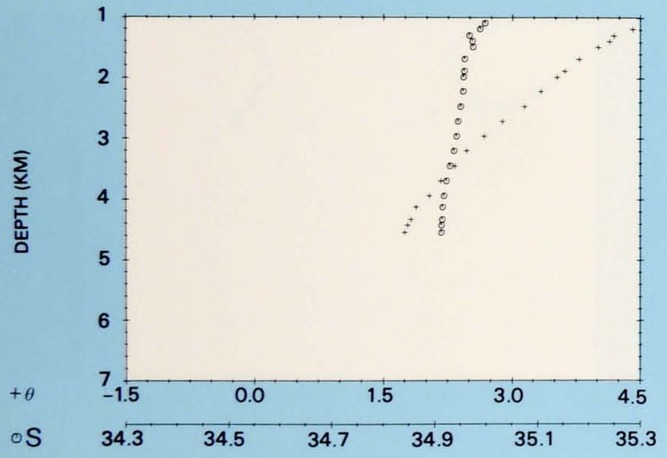
Station 25.
Latitude 47° 36′ N,
Longitude 39° 53′ W.
10 September 1972.

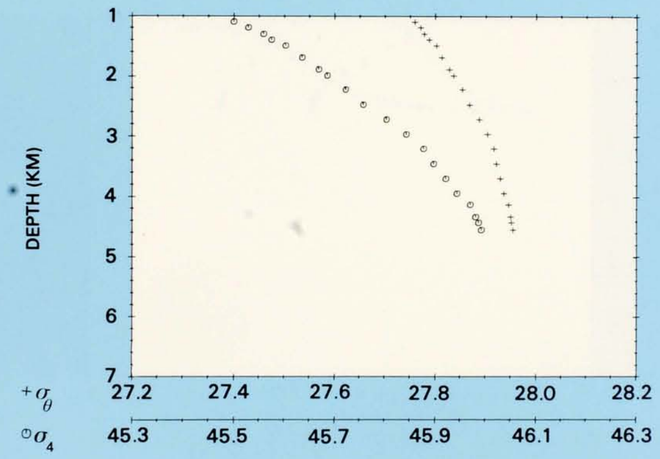
PROPERTY–PROPERTY PLOTS
STATION 25

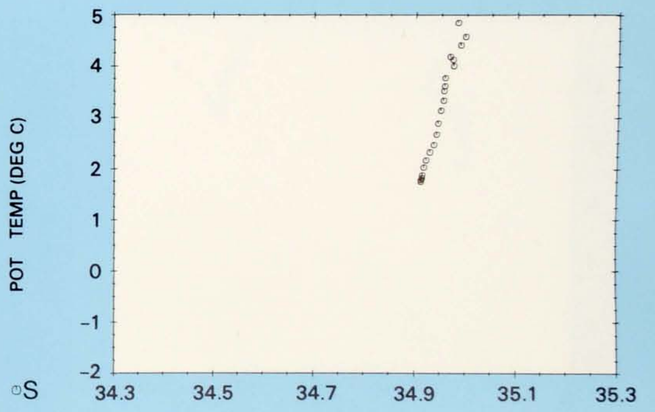








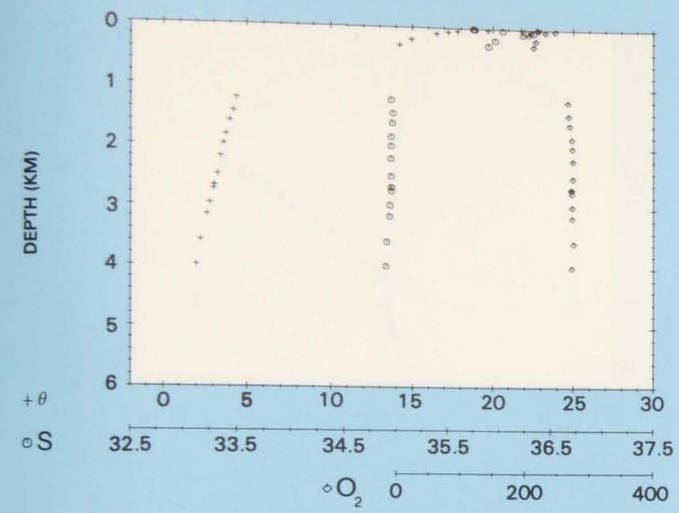


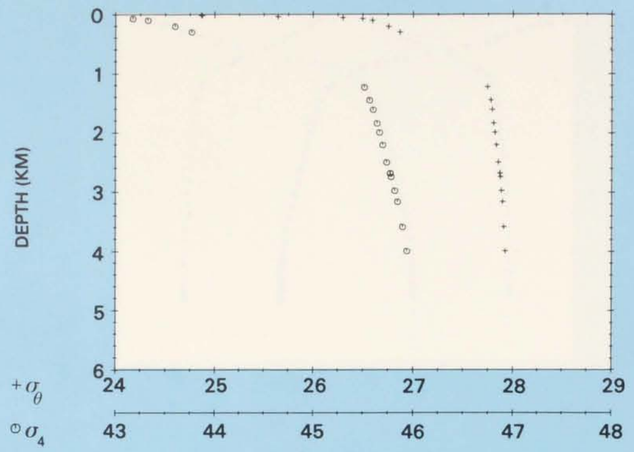


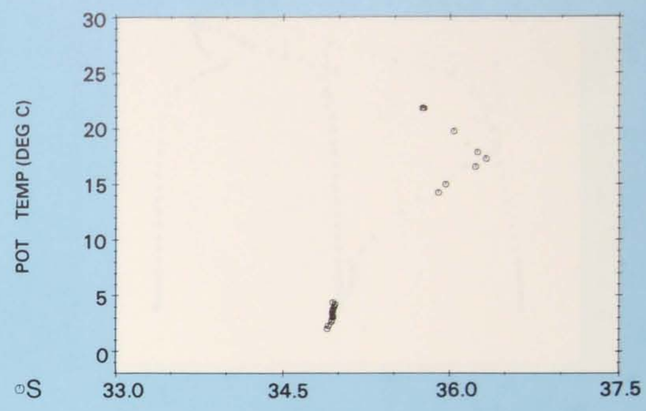
PROPERTY–PROPERTY PLOTS
STATION 26

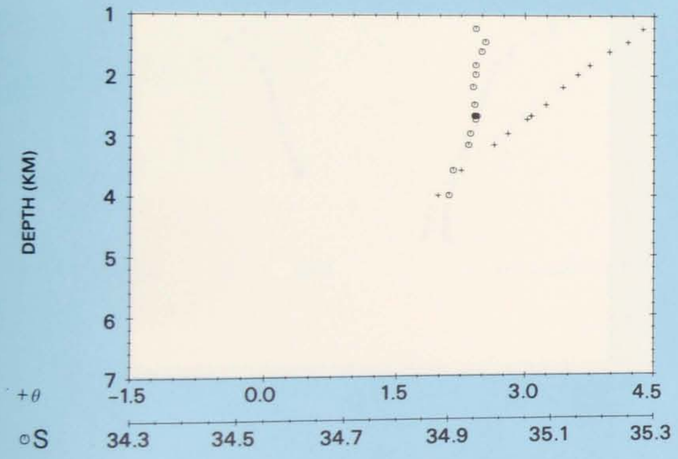
PLATE 89

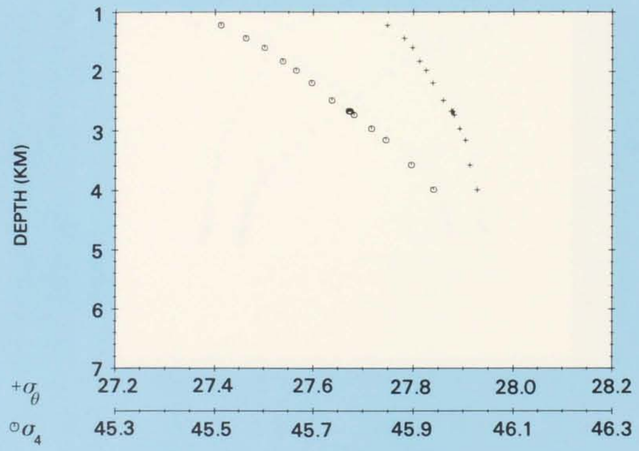
Station 26.
Latitude 44° 57′ N,
Longitude 42° 04′ W.
11 September 1972.

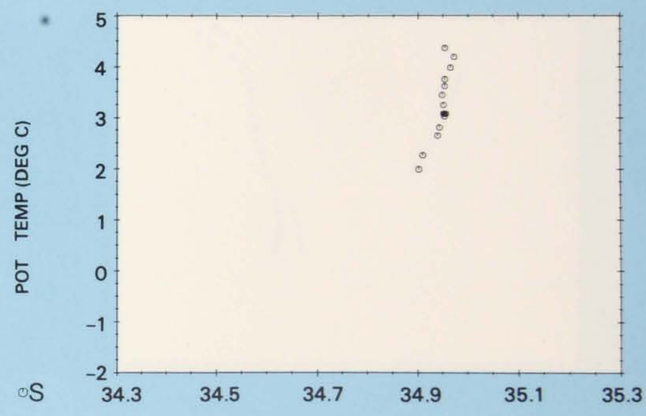


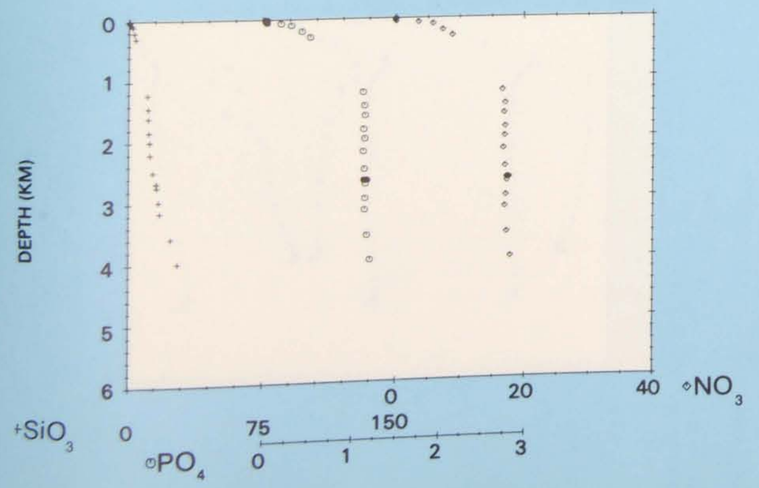


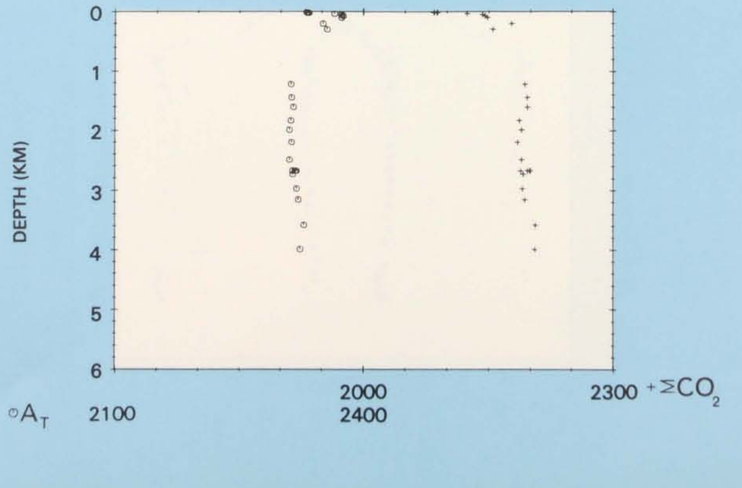












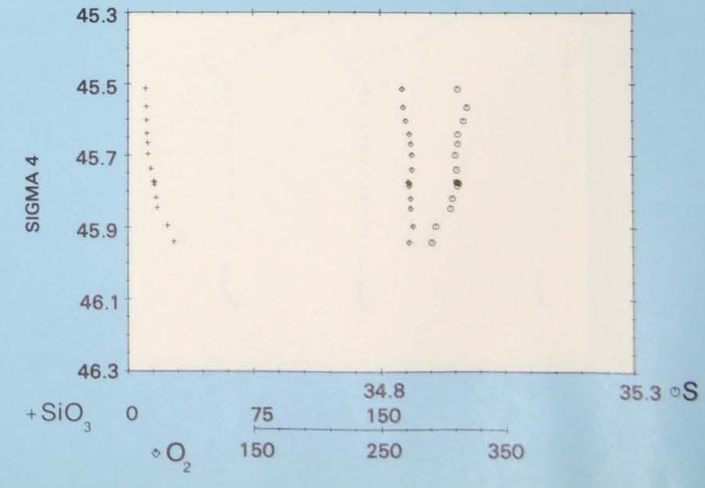
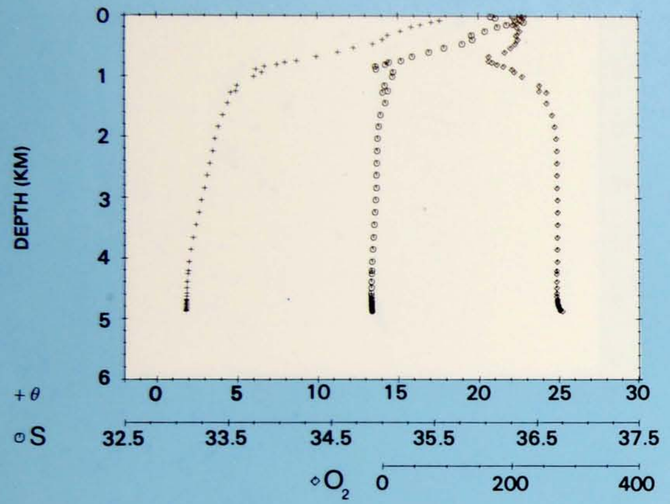
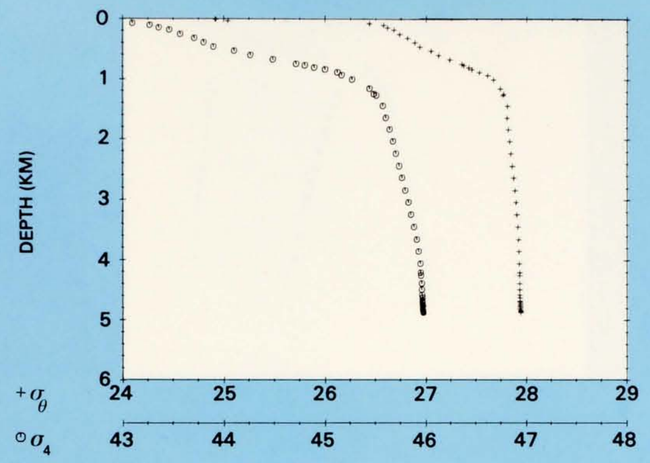


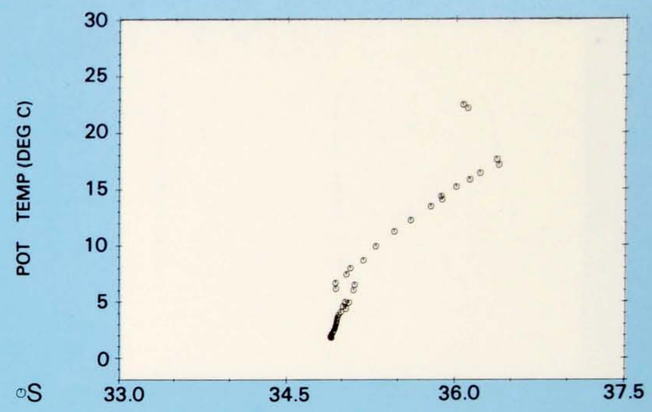
PLATE 90

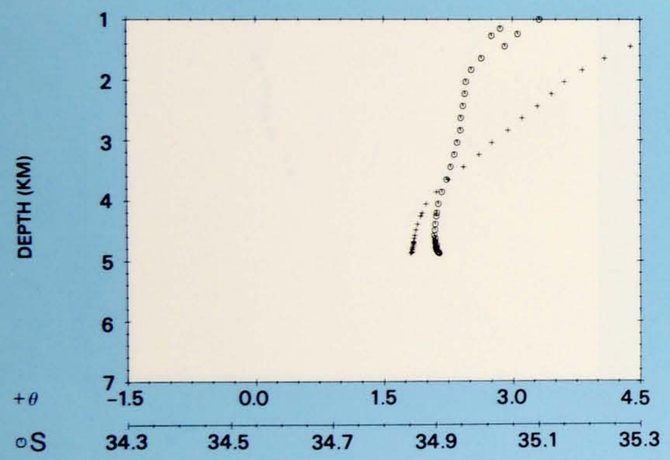
Station 27.
Latitude 42° 00′ N,
Longitude 42° 02′ W.
12 September 1972.

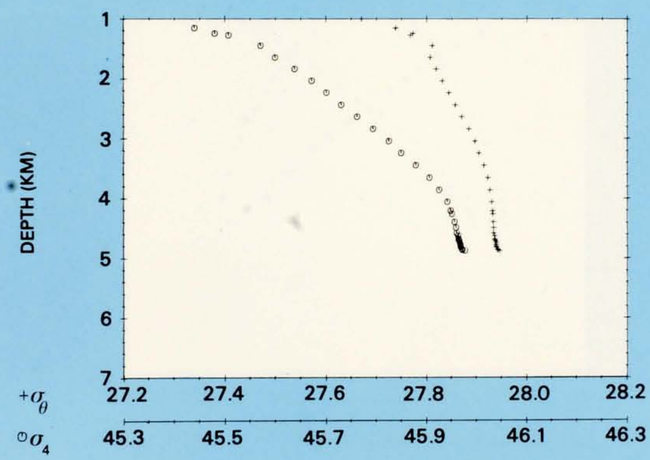
PROPERTY–PROPERTY PLOTS
STATION 27

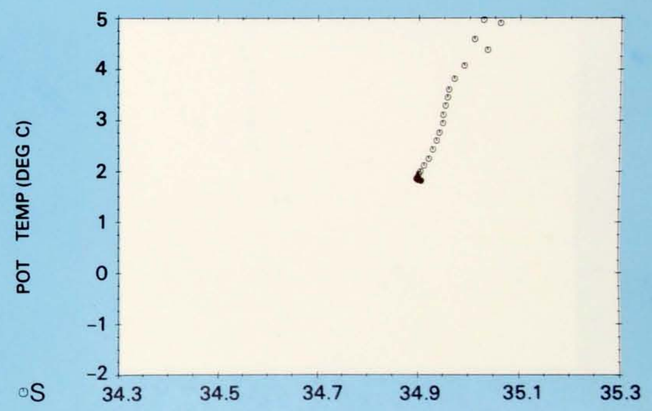


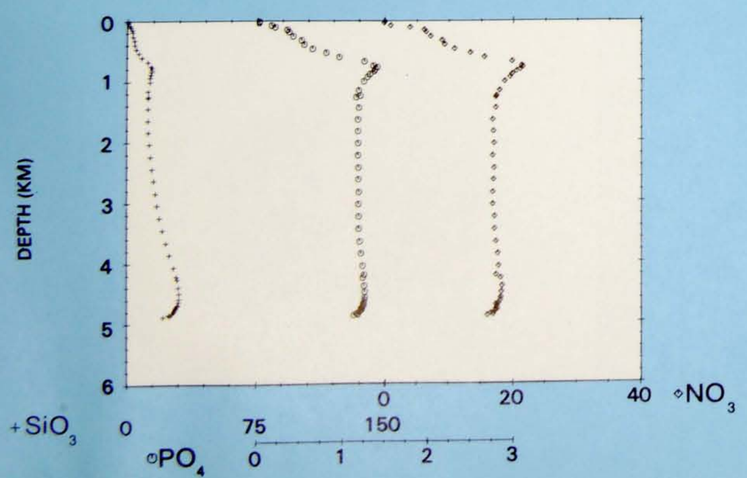


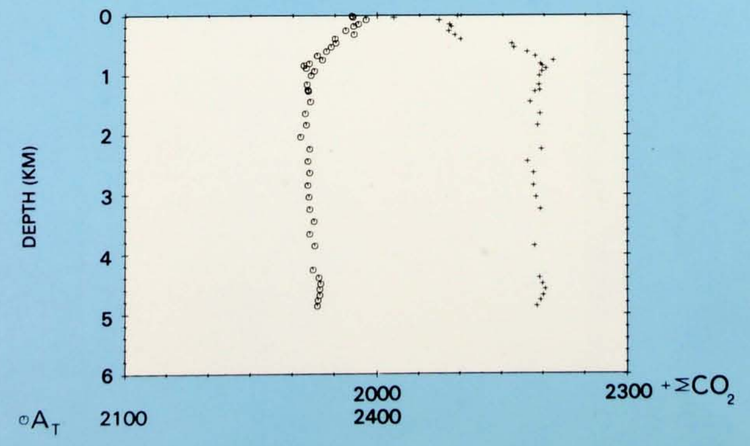


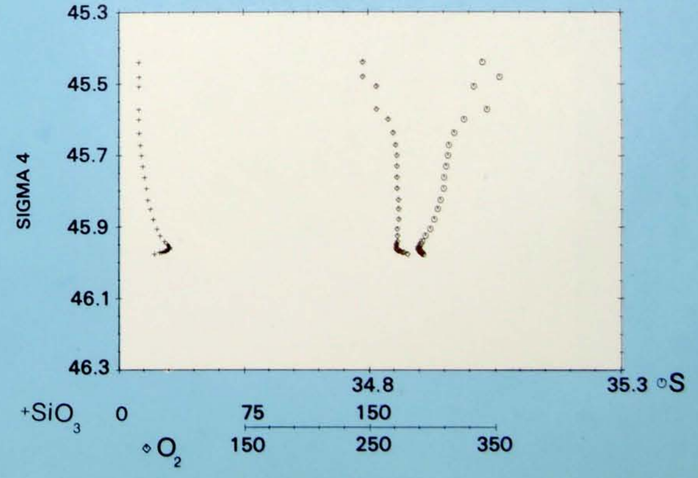








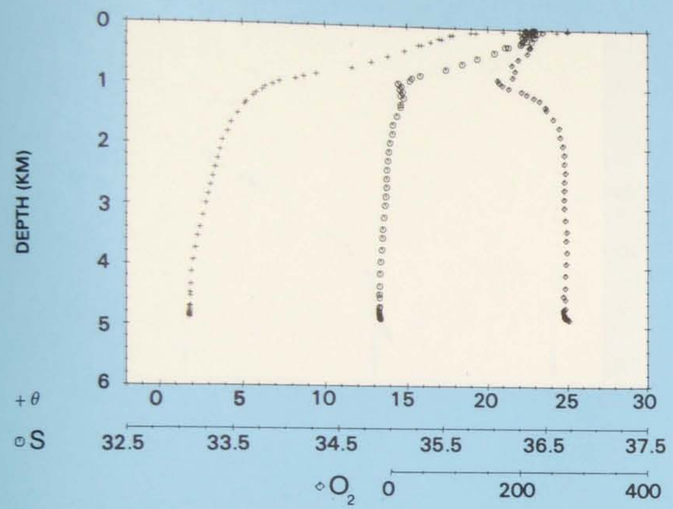


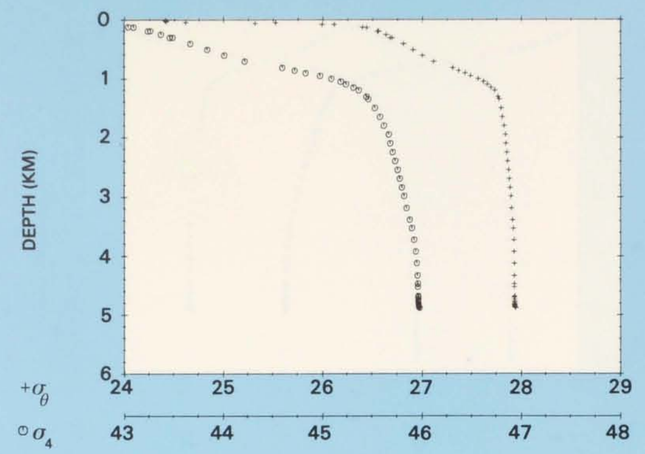


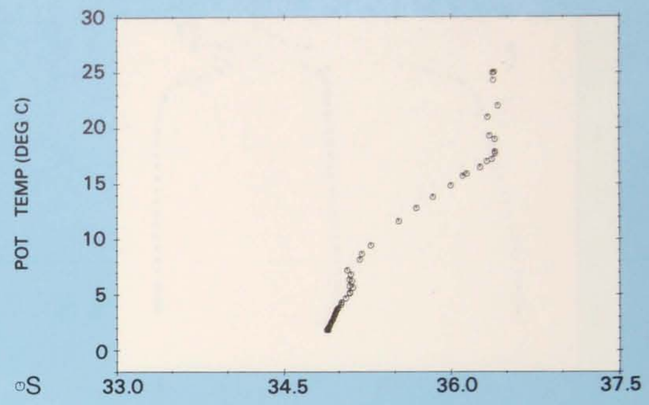
PROPERTY–PROPERTY PLOTS
STATION 28

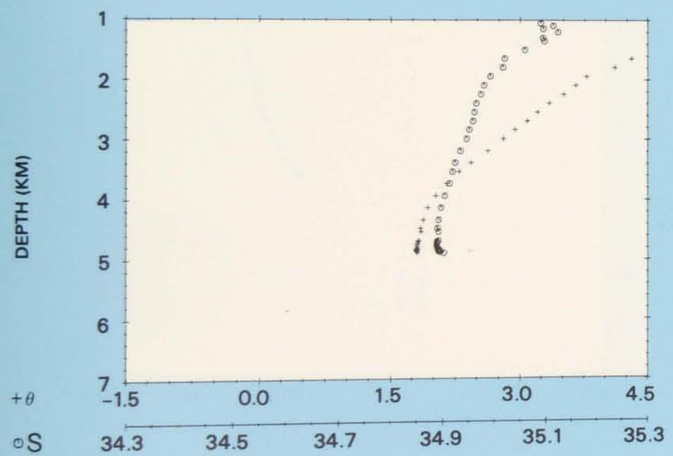
PLATE 91

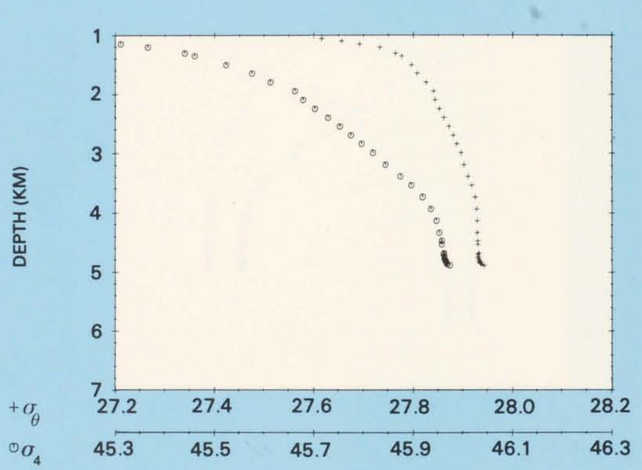
Station 28.
Latitude 39° 00′ N,
Longitude 43° 59′ W.
15 September 1972.

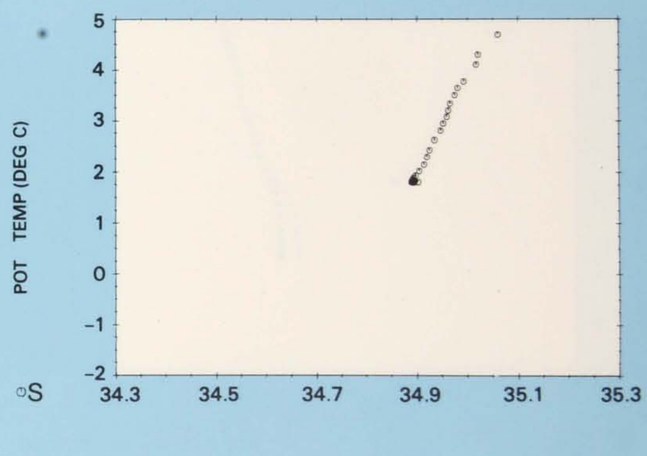


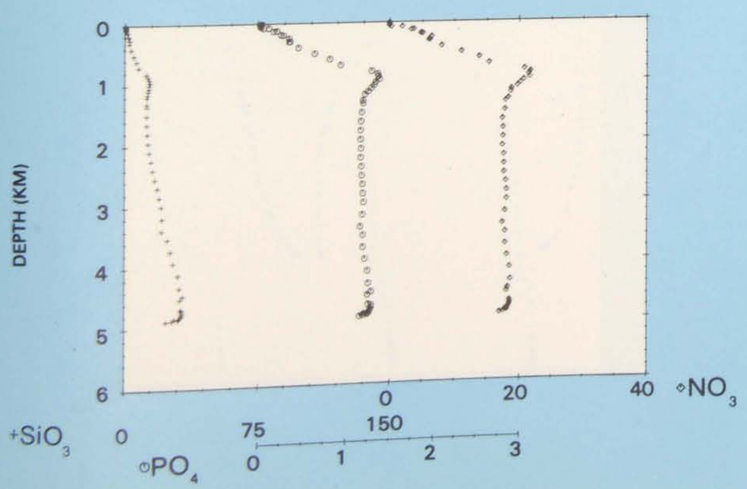


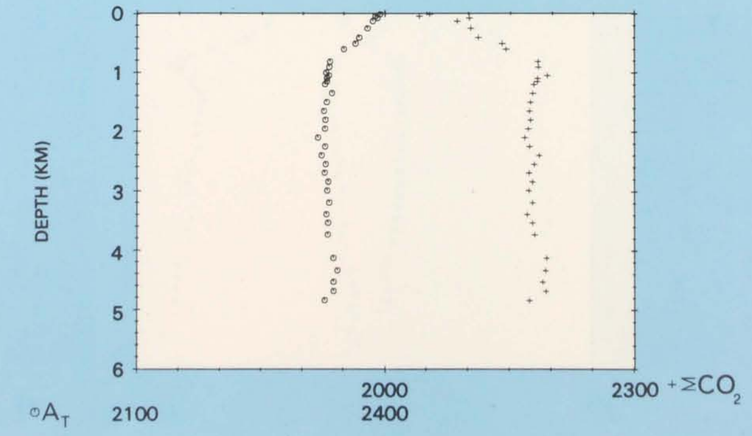












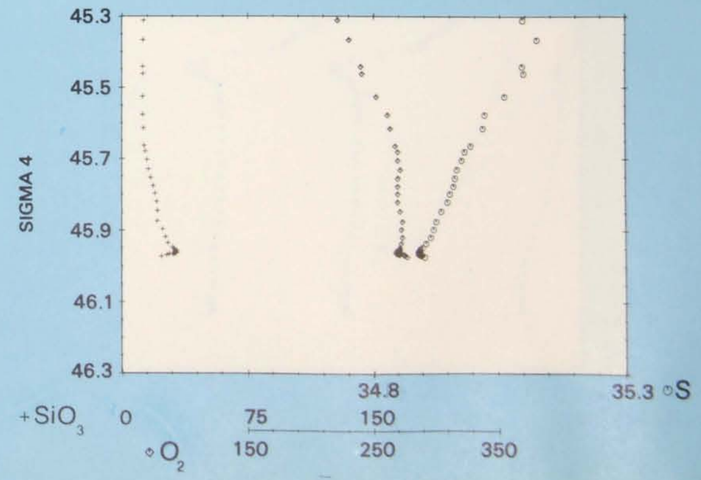
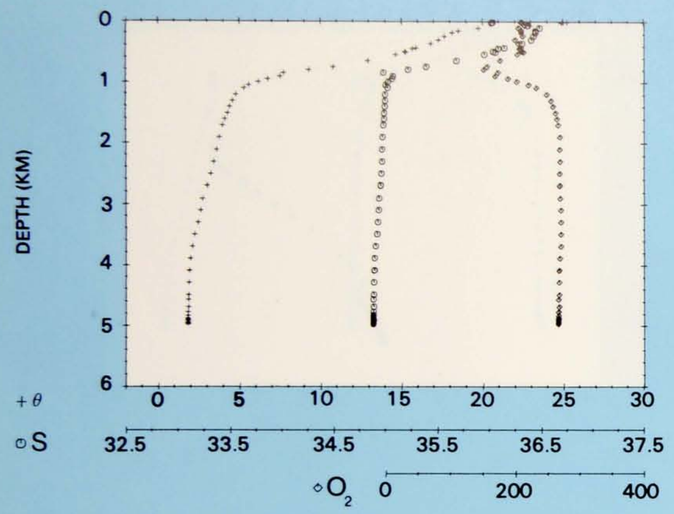
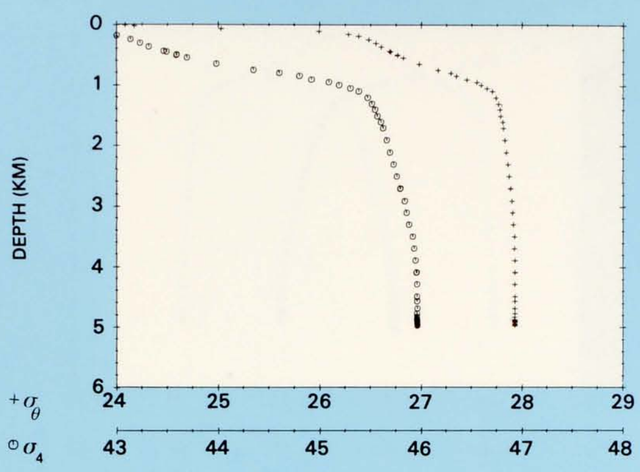


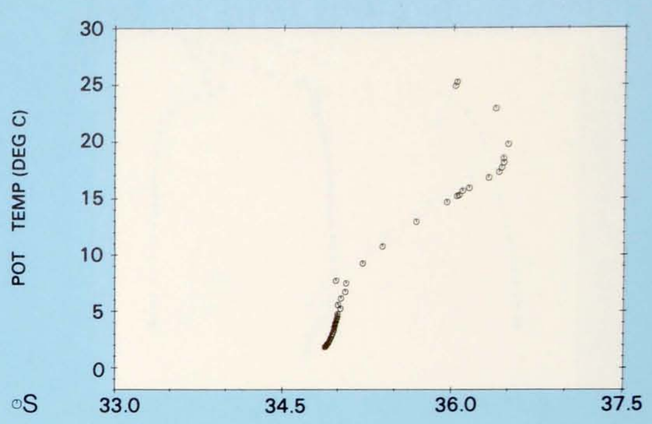
PLATE 92

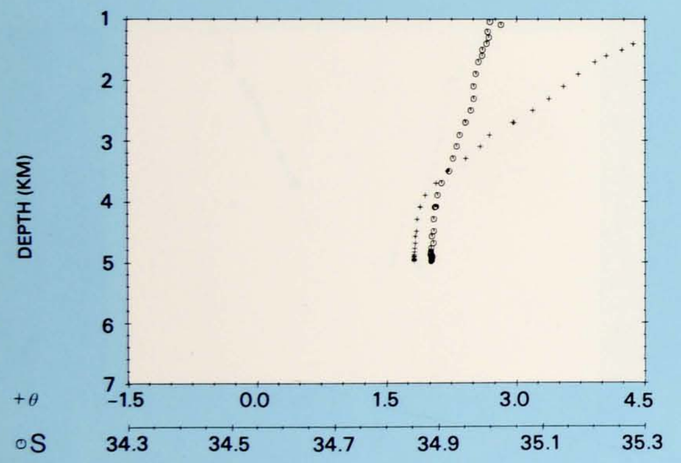
Station 29.
Latitude 35° 58′ N,
Longitude 47° 00′ W.
17 September 1972.

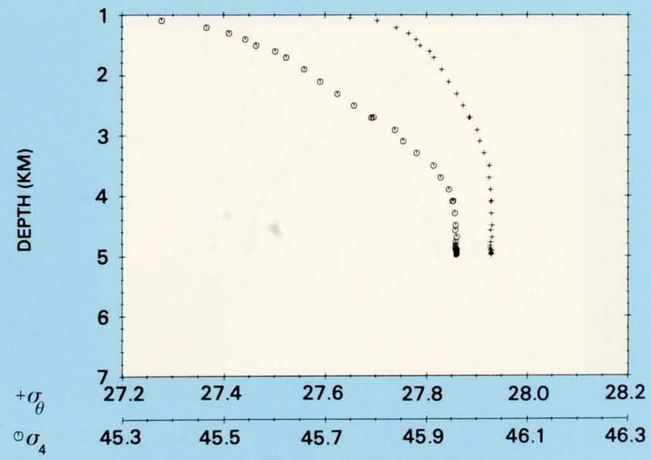
PROPERTY–PROPERTY PLOTS
STATION 29

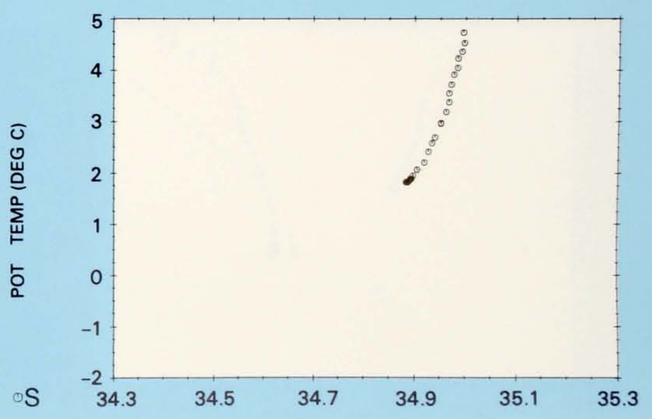


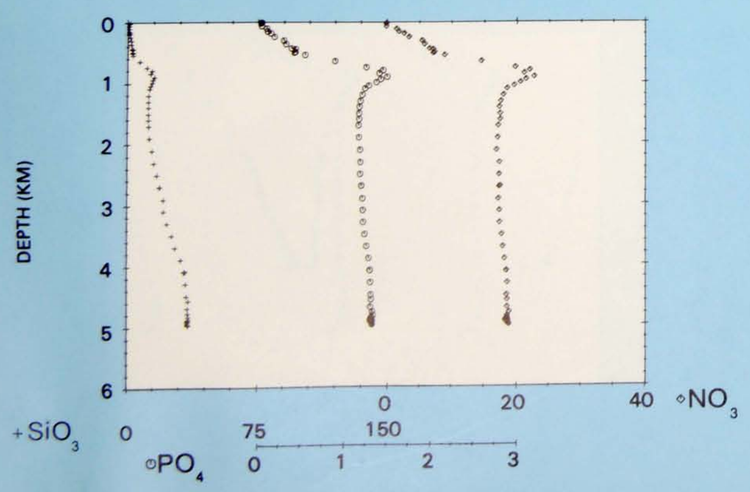


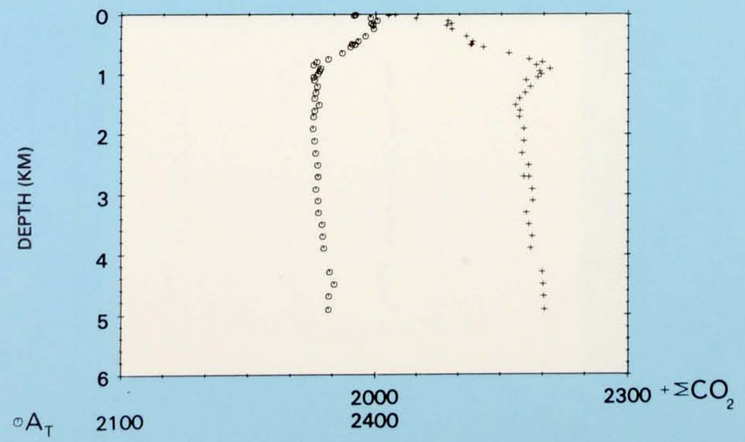


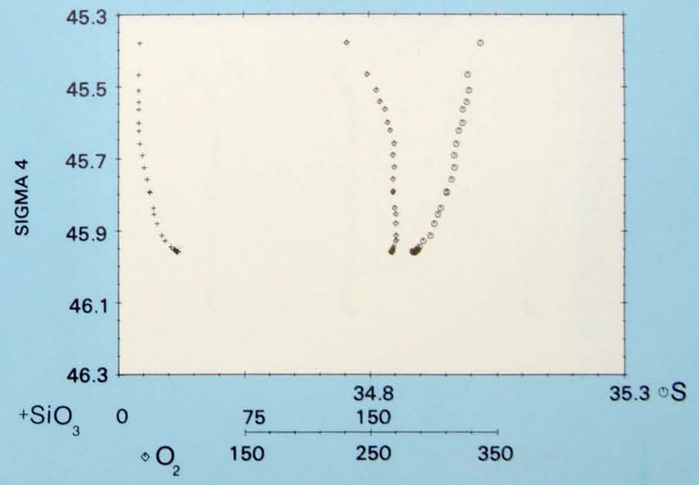








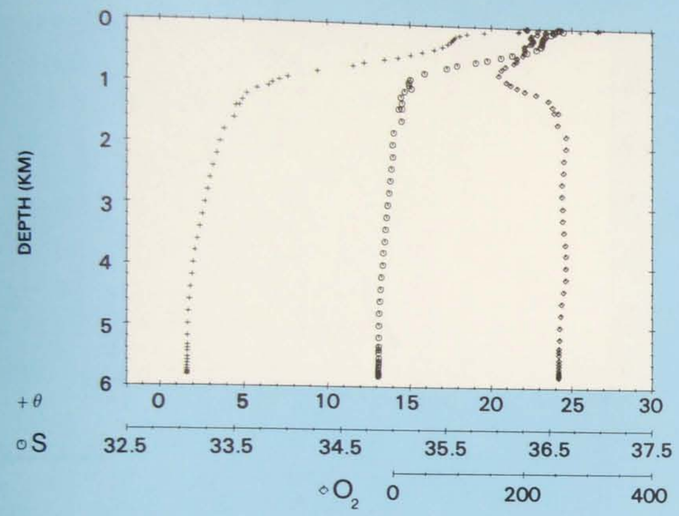


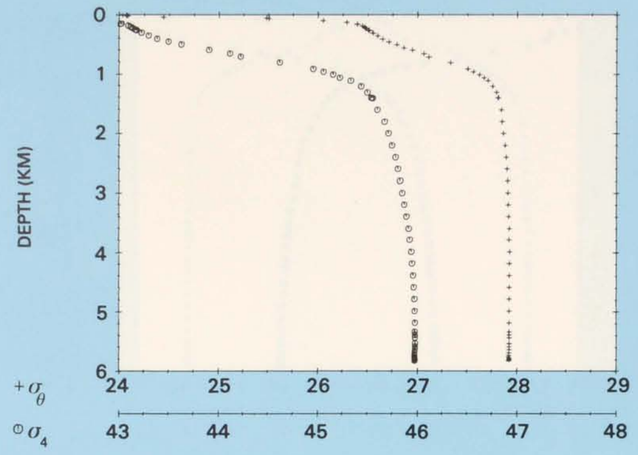


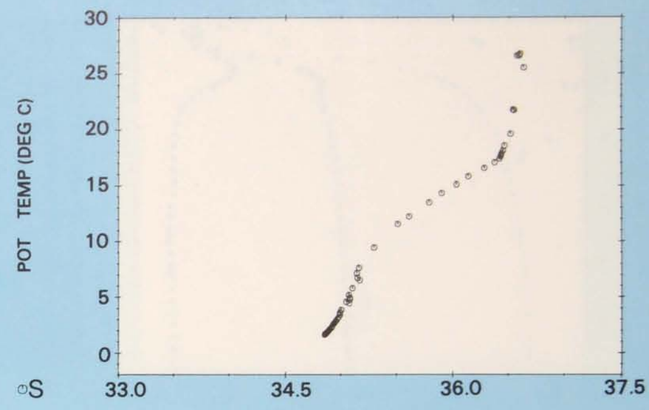
PROPERTY–PROPERTY PLOTS
STATION 30

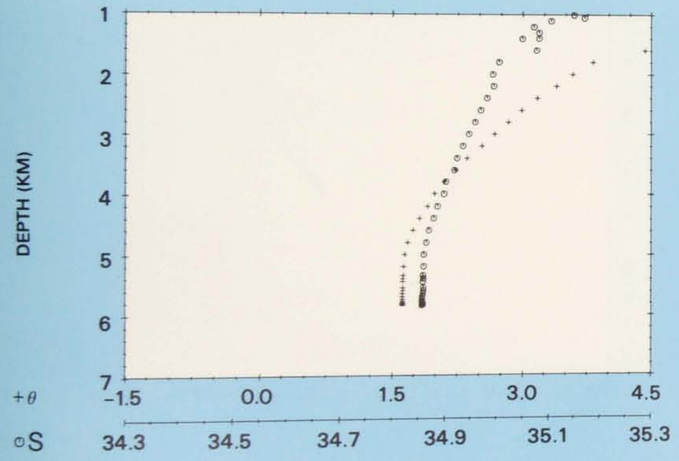
PLATE 93

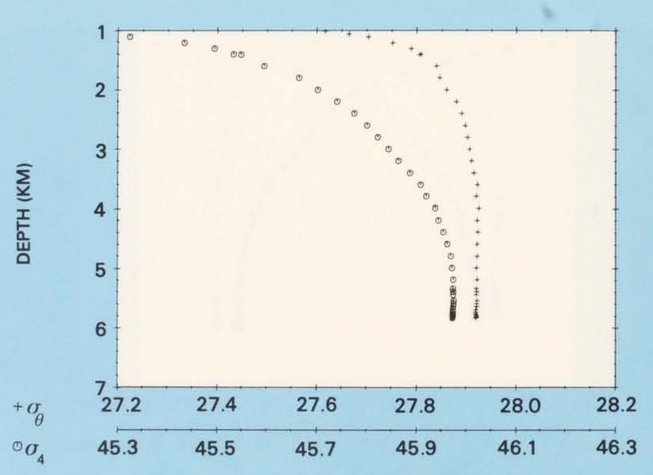
Station 30.
Latitude 31° 48′ N,
Longitude 50° 46′ W.
20 September 1972.

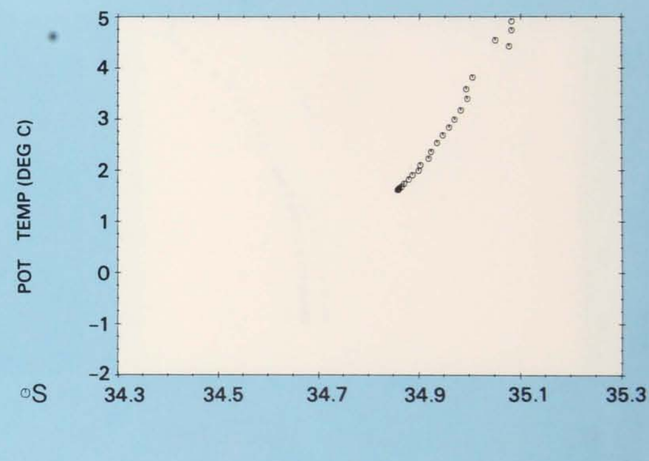


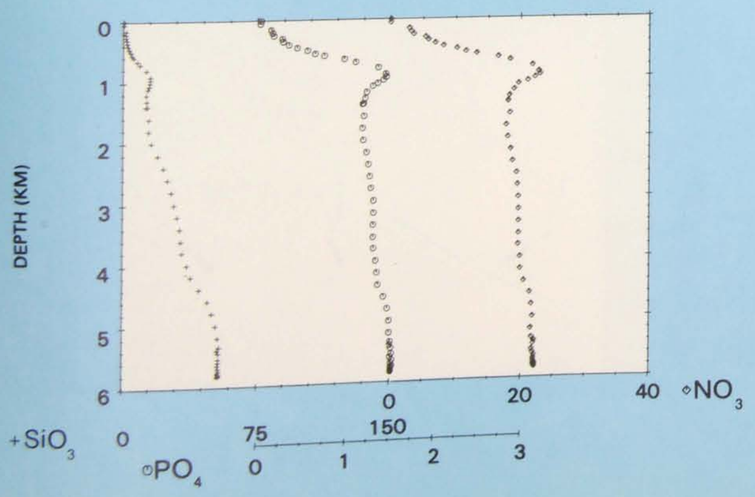


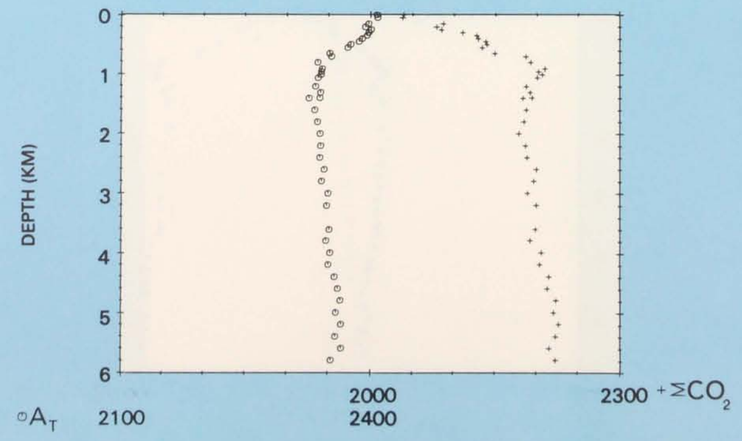












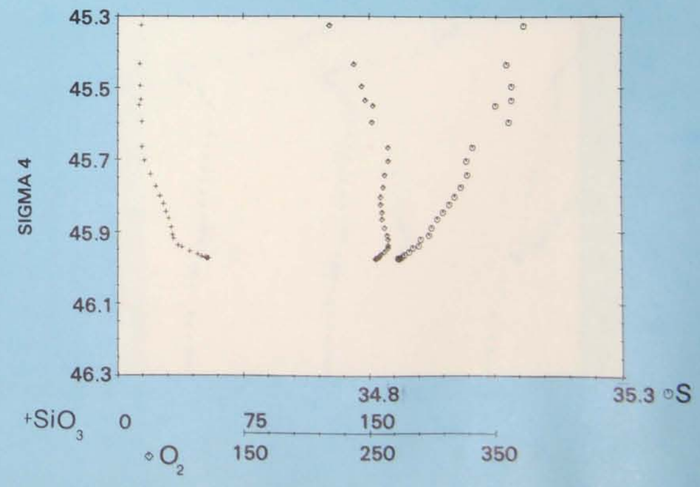
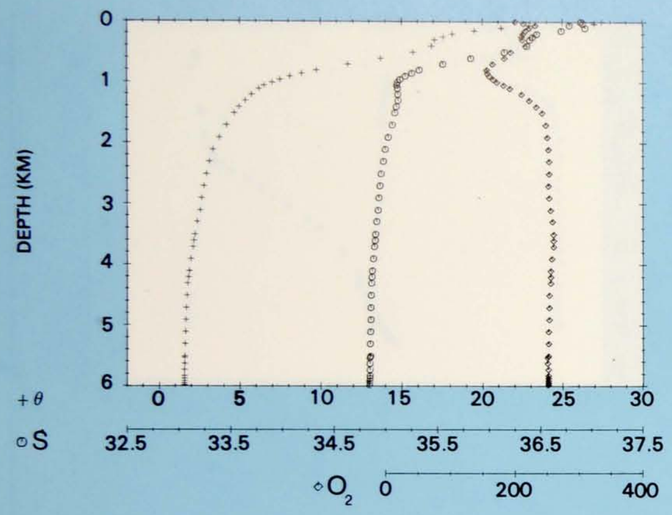
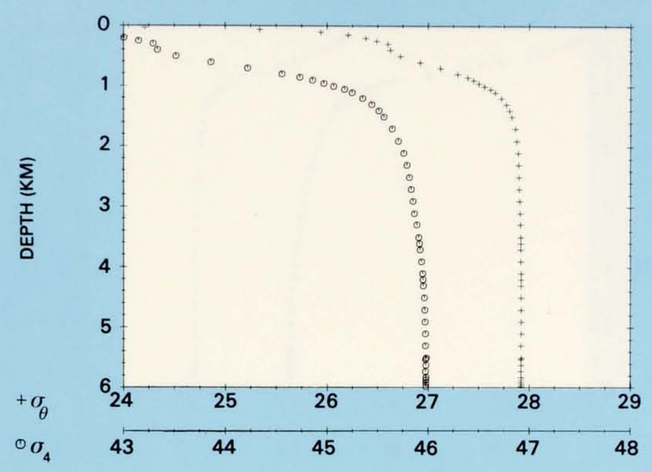


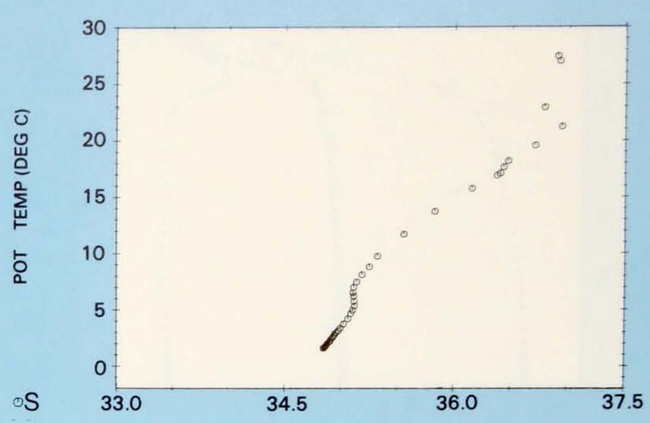
PLATE 94

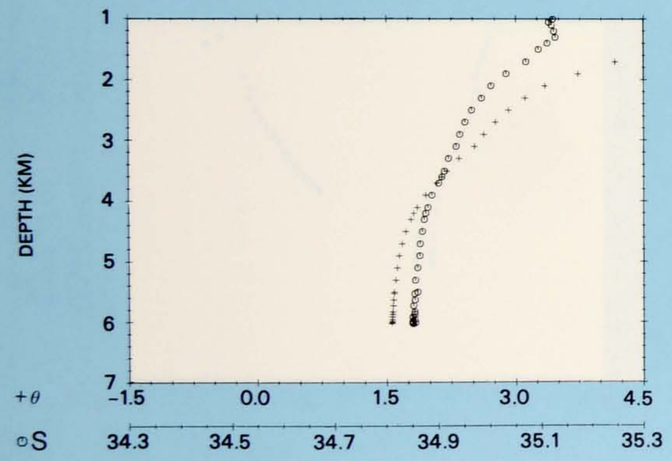
Station 31.
Latitude 27° 00′ N,
Longitude 53° 32′ W.
22 September 1972.

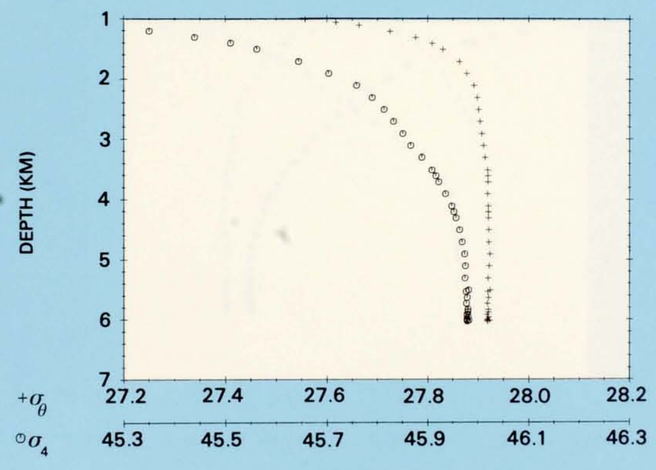
PROPERTY–PROPERTY PLOTS
STATION 31

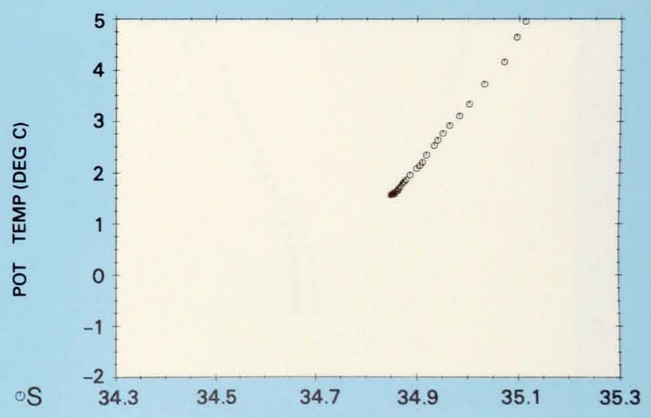


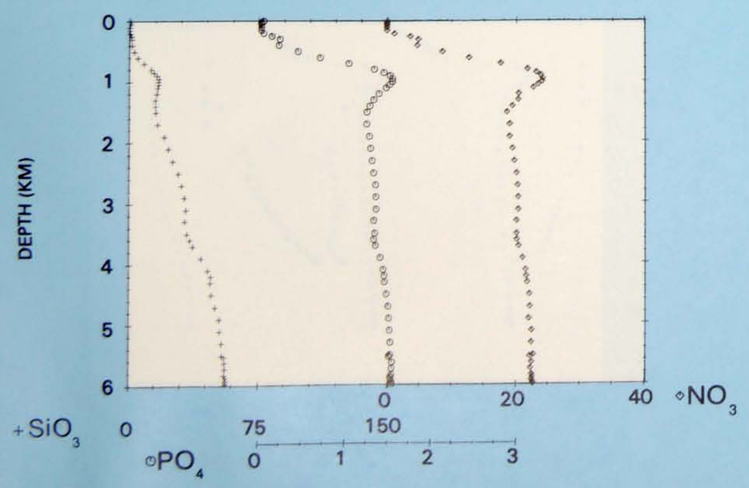


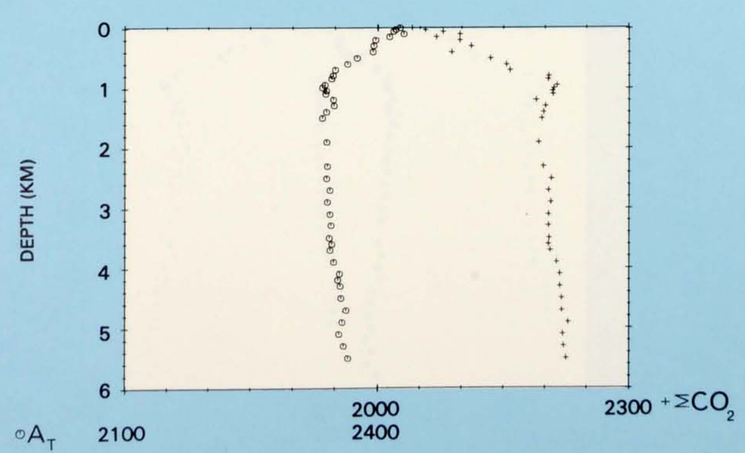


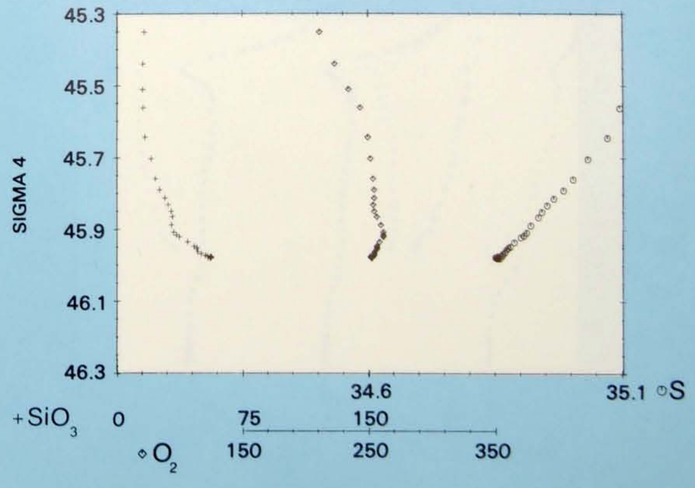








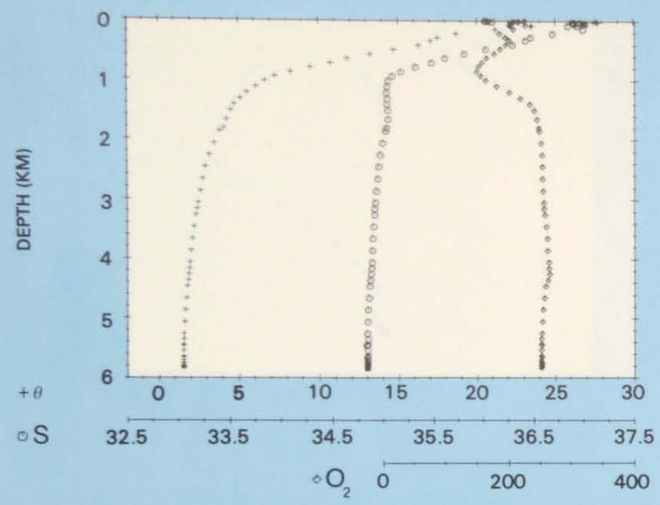


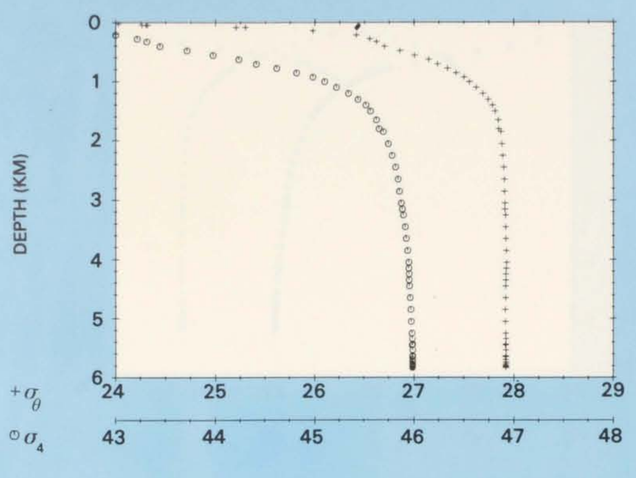


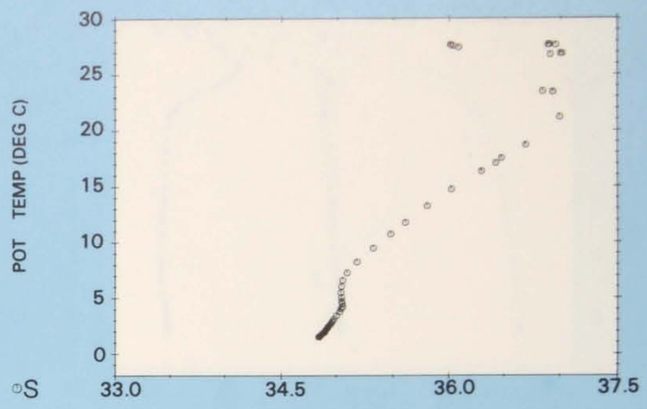
PROPERTY–PROPERTY PLOTS
STATION 32

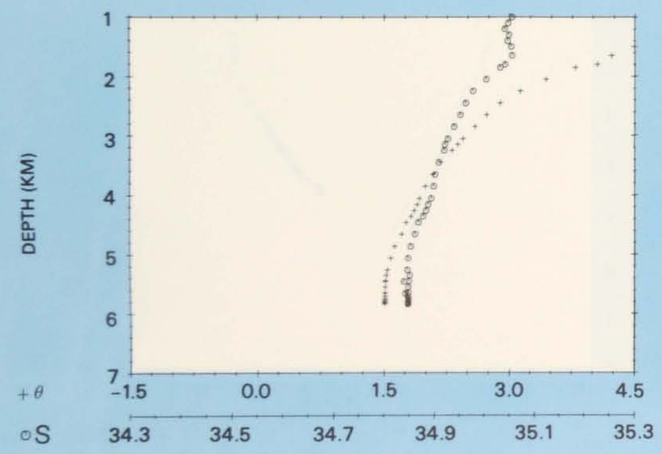
PLATE 95

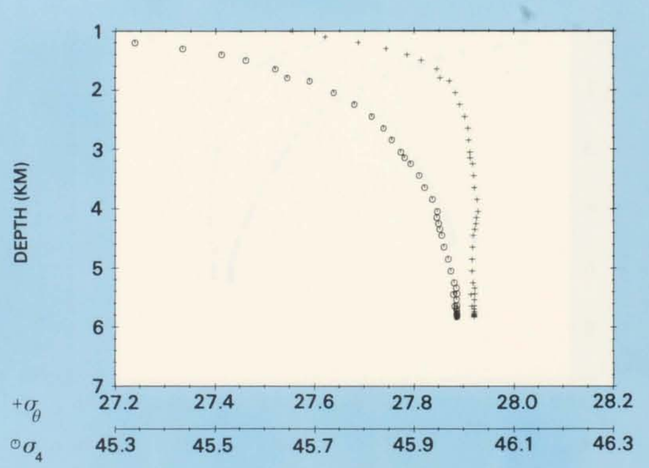
Station 32.
Latitude 23° 50′ N,
Longitude 53° 59′ W.
24 September 1972.

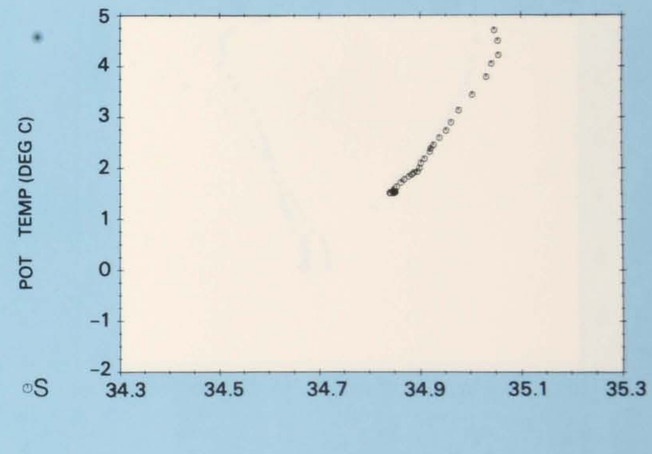


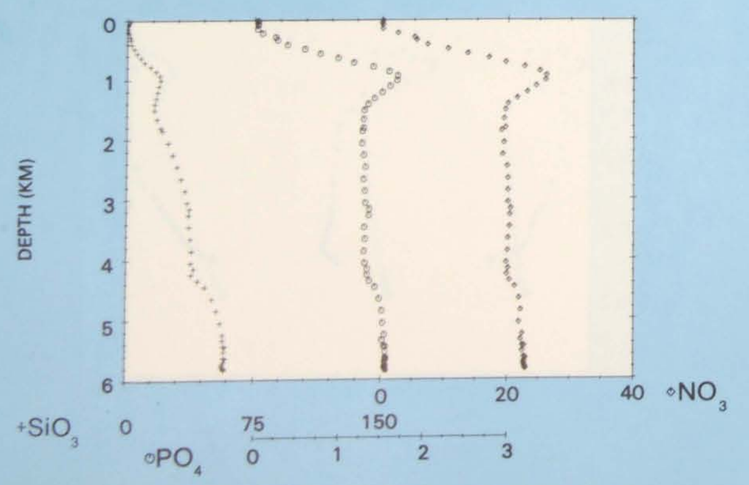


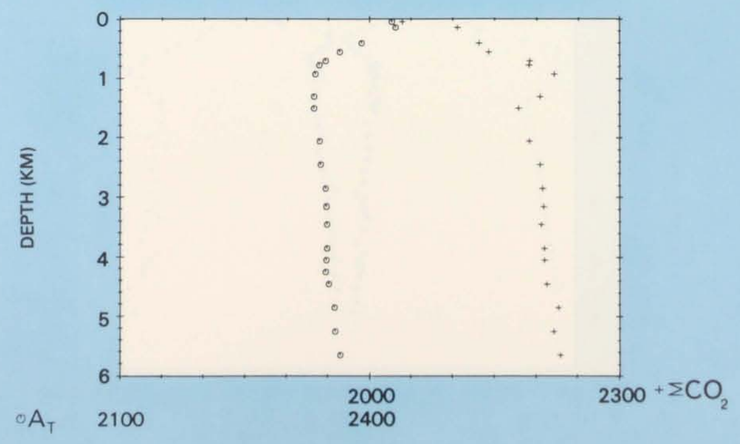












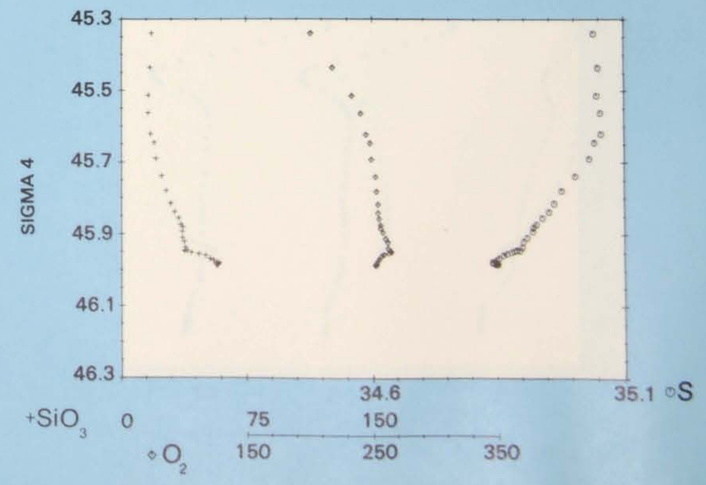
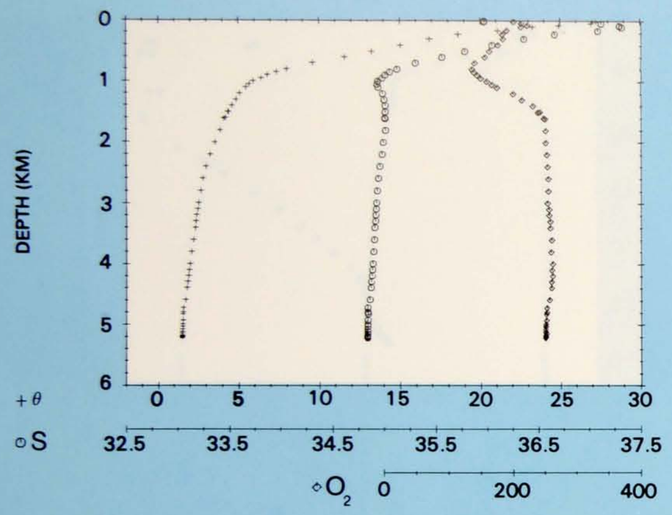
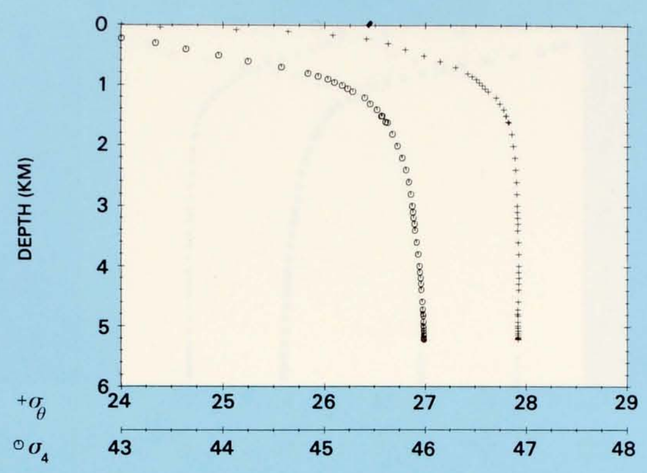


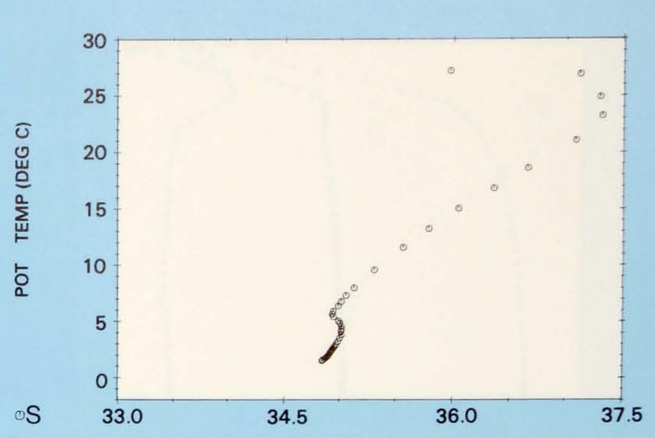
PLATE 96

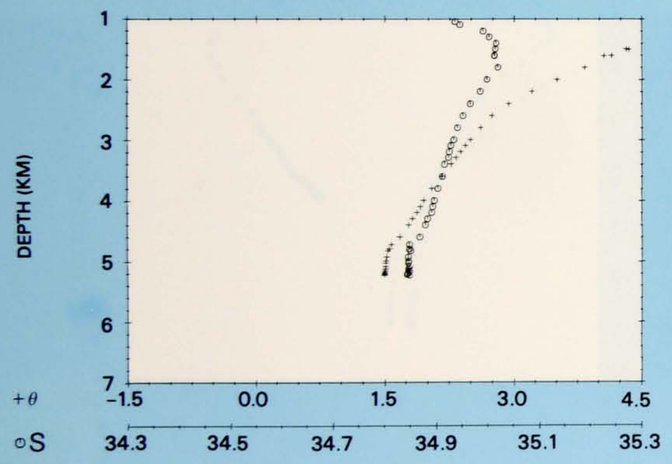
Station 33.
Latitude 21° 00'N,
Longitude 54° 00' W.
26 September 1972.

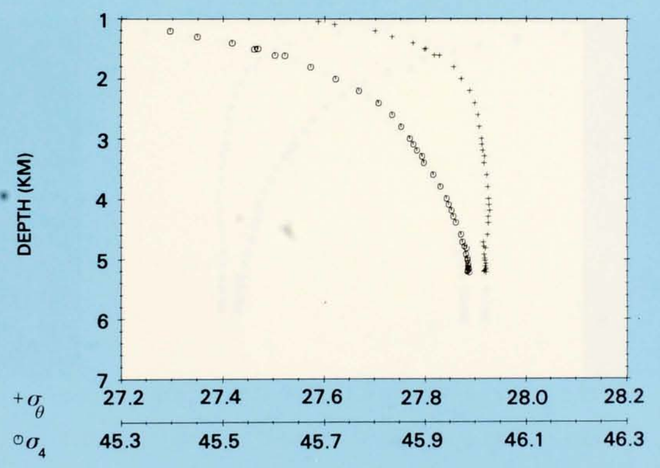
PROPERTY–PROPERTY PLOTS
STATION 33

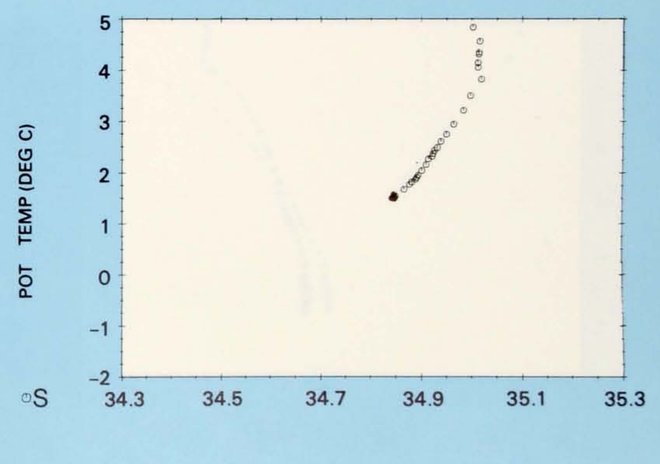


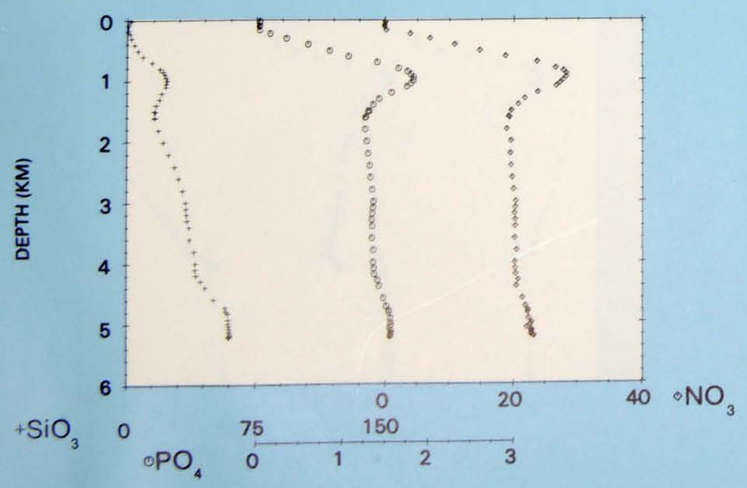


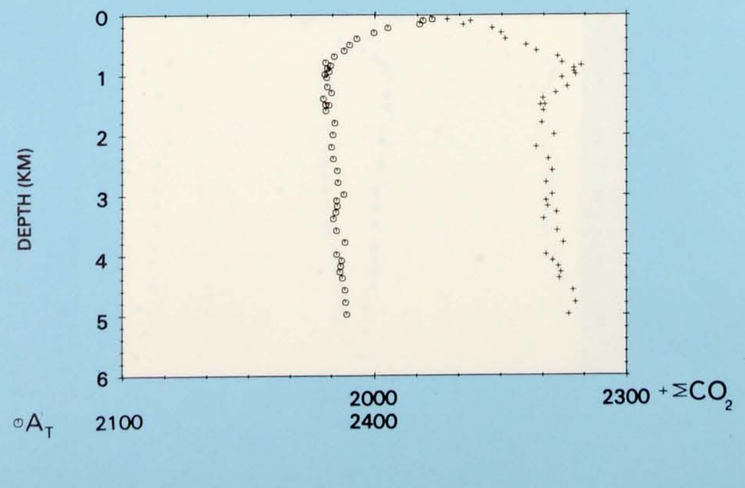


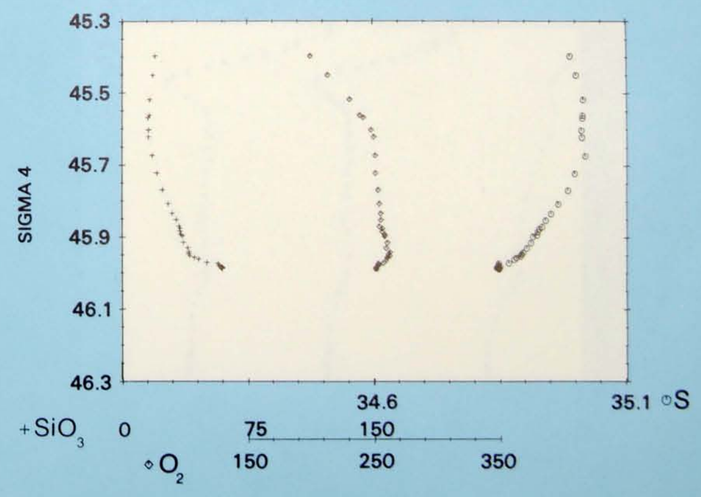


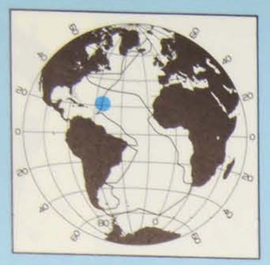








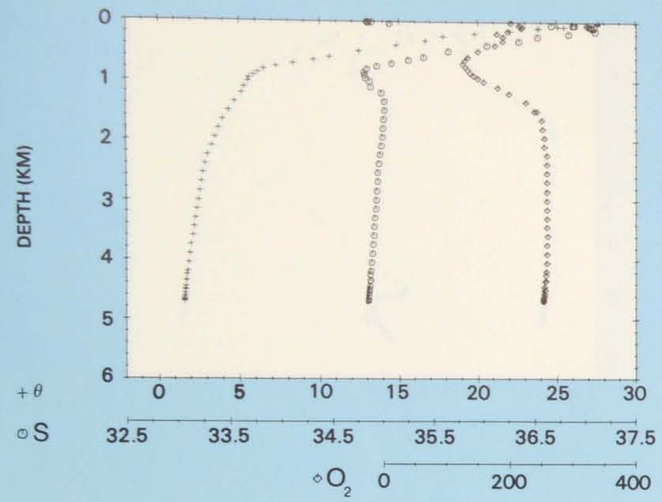


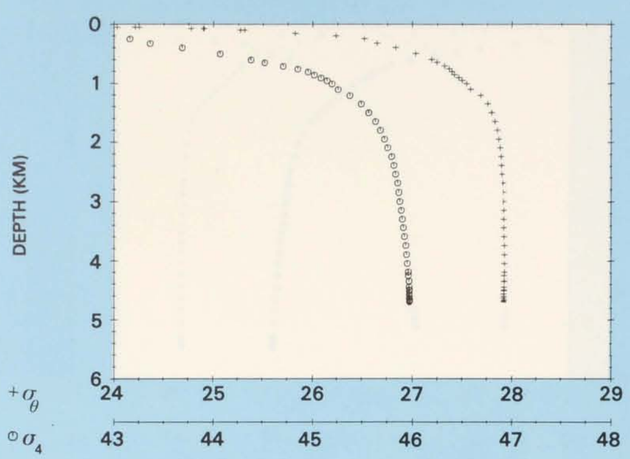


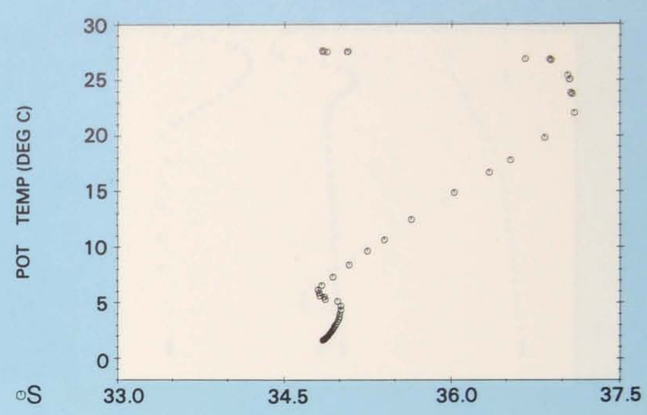
PROPERTY–PROPERTY PLOTS
STATION 34

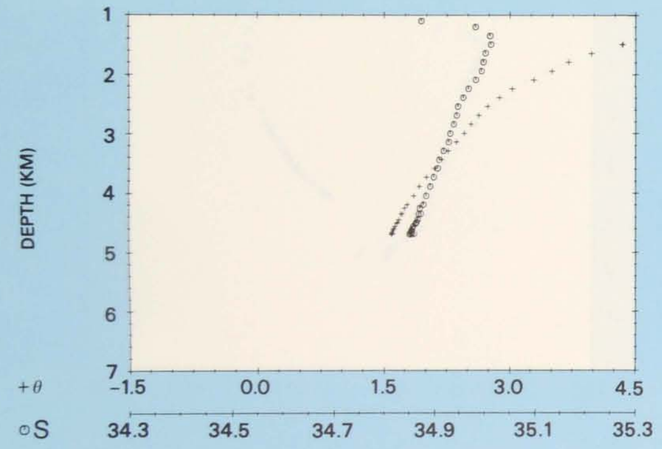
PLATE 97

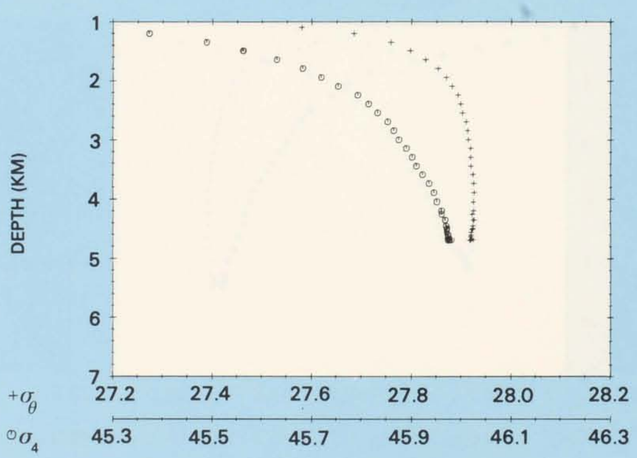
Station 34.
Latitude 18°01′ N,
Longitude 53°59′ W.
28 September 1972.

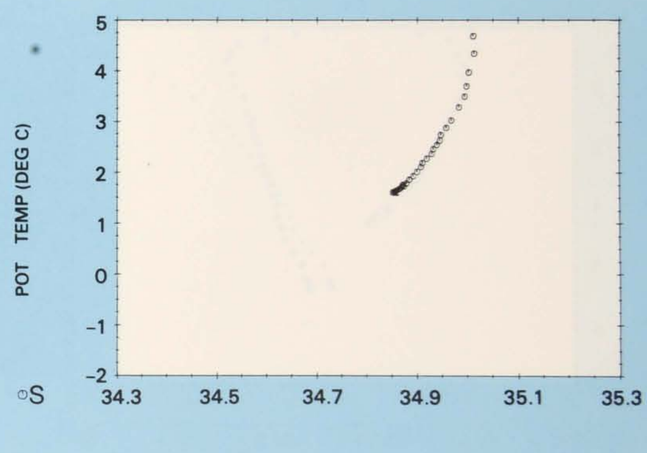


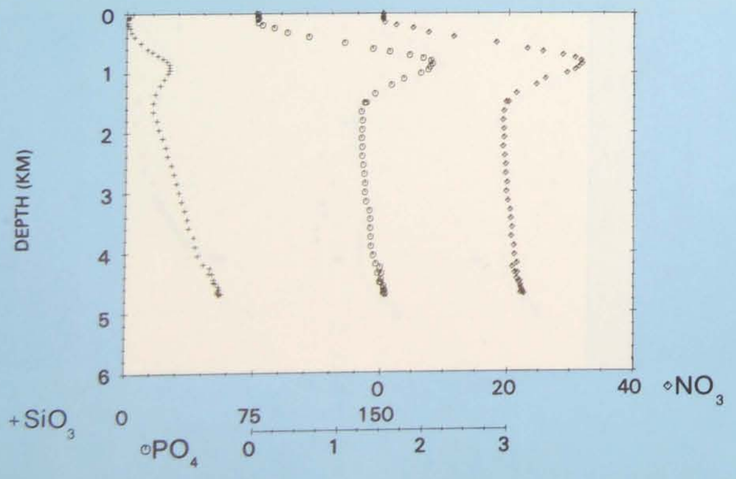


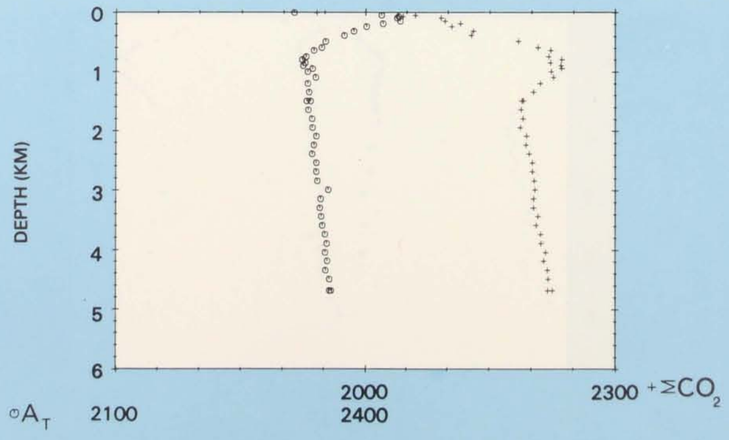












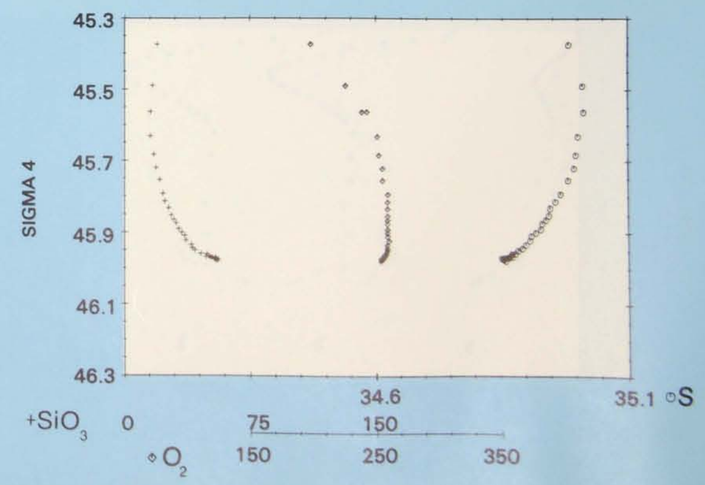
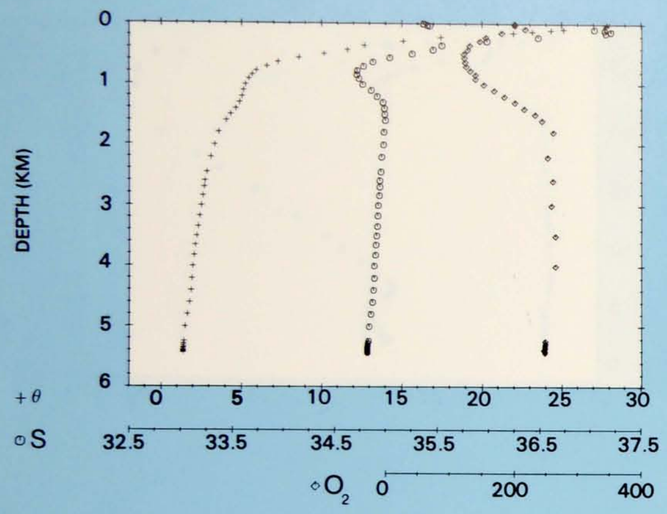
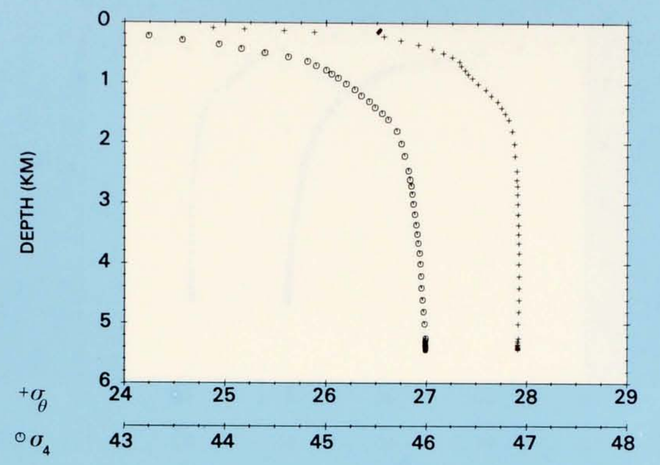


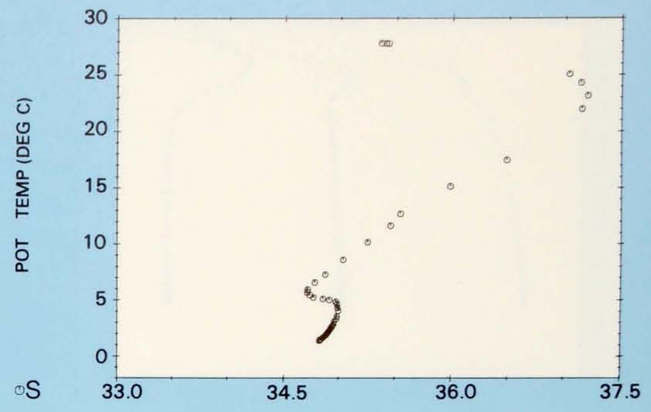
PLATE 98

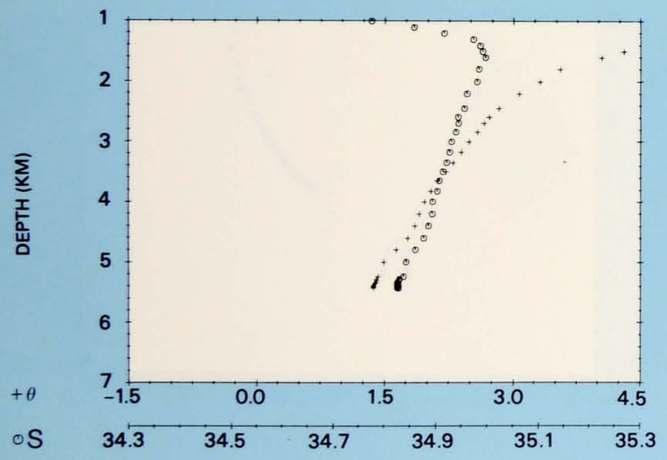
Station 36.
Latitude 15° 00′ N,
Longitude 53° 56′ W.
11 October 1972.

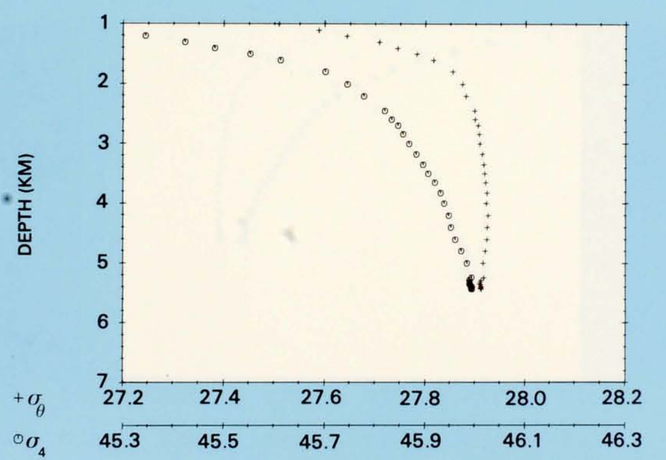
PROPERTY–PROPERTY PLOTS
STATION 36

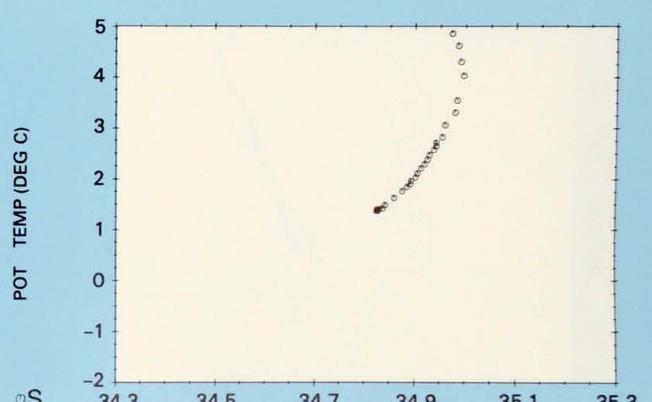


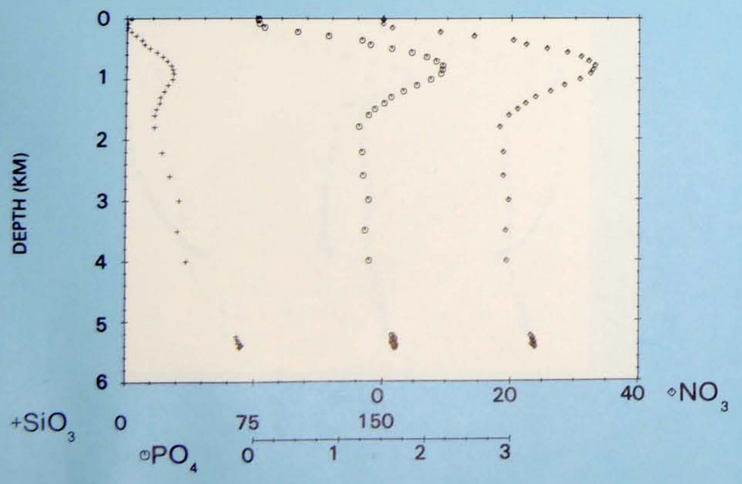


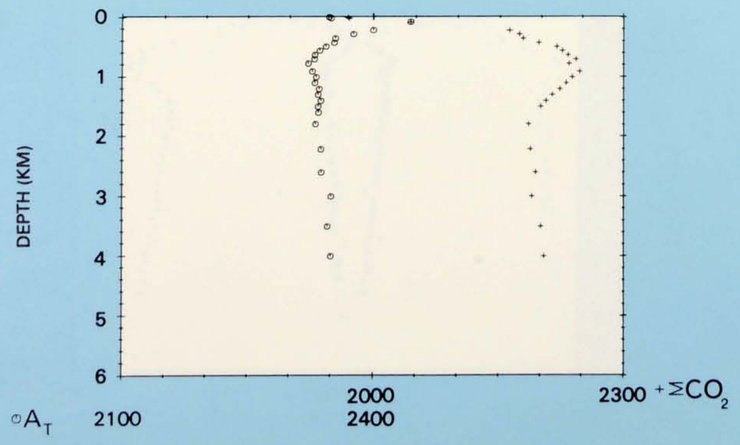


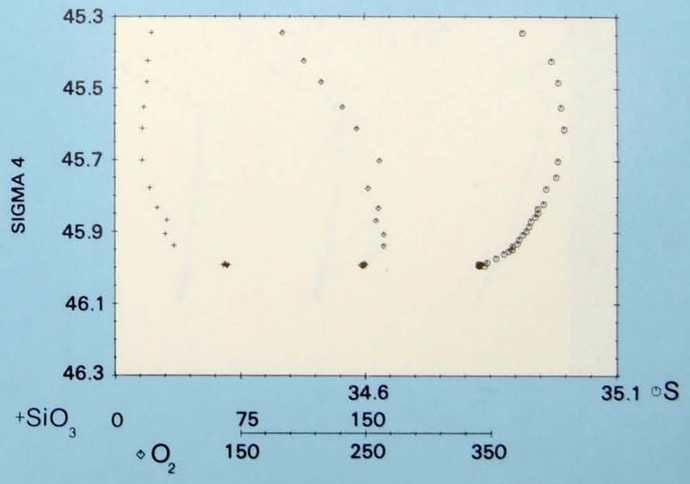


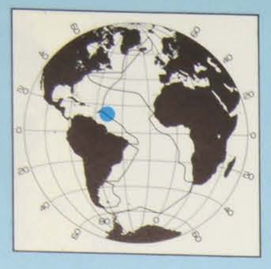








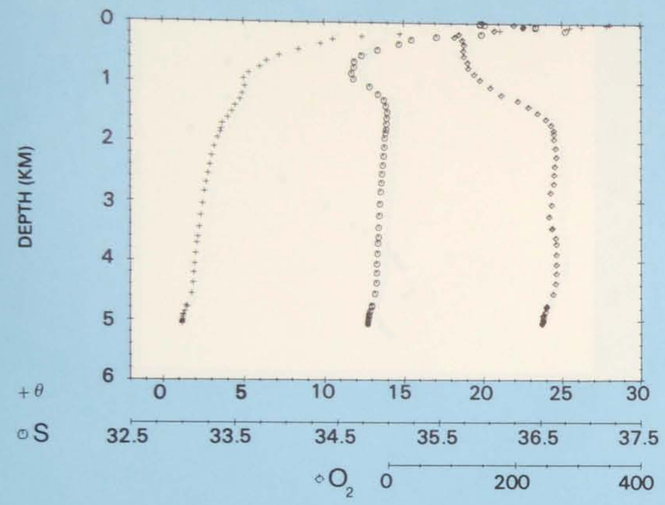


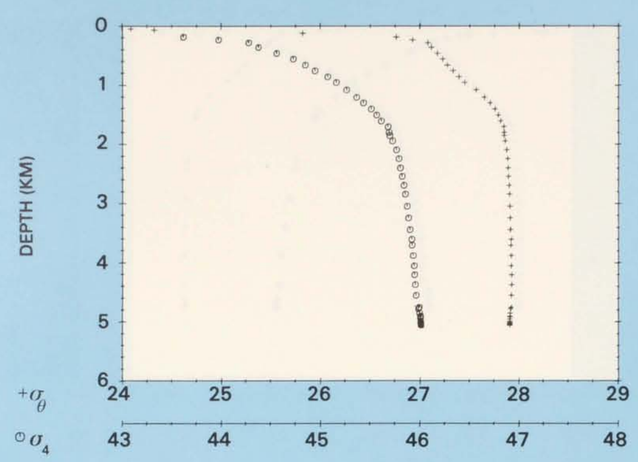


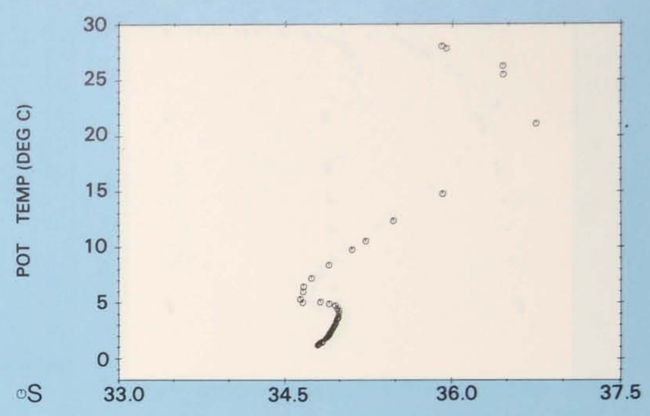
PROPERTY–PROPERTY PLOTS
STATION 37

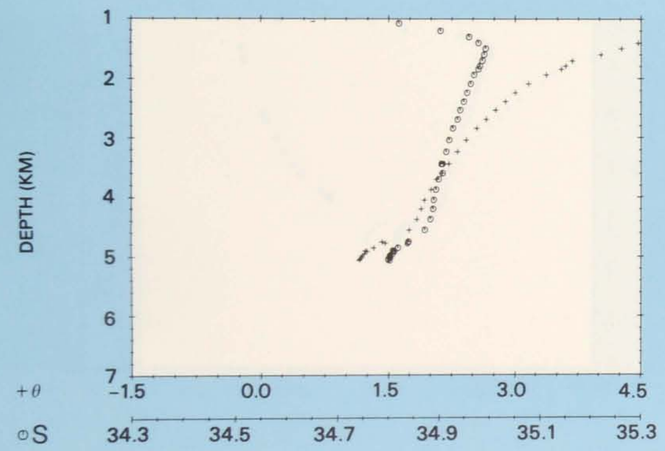
PLATE 99

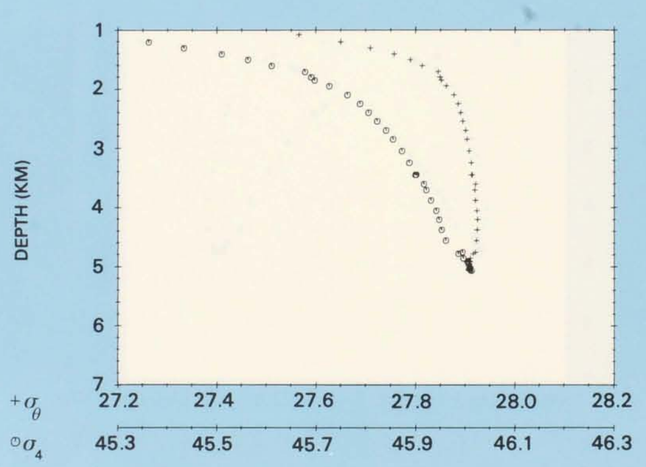
Station 37.
Latitude 12° 01′ N,
Longitude 50° 59′ W.
13 October 1972.

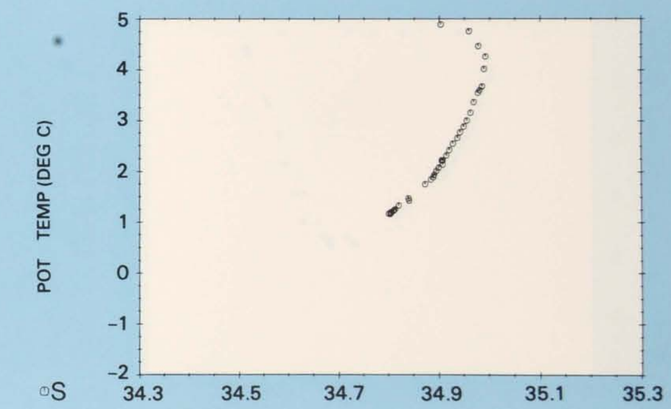


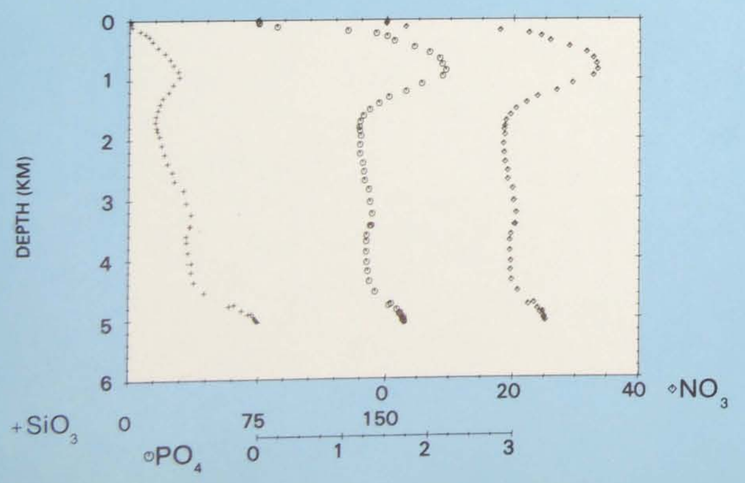


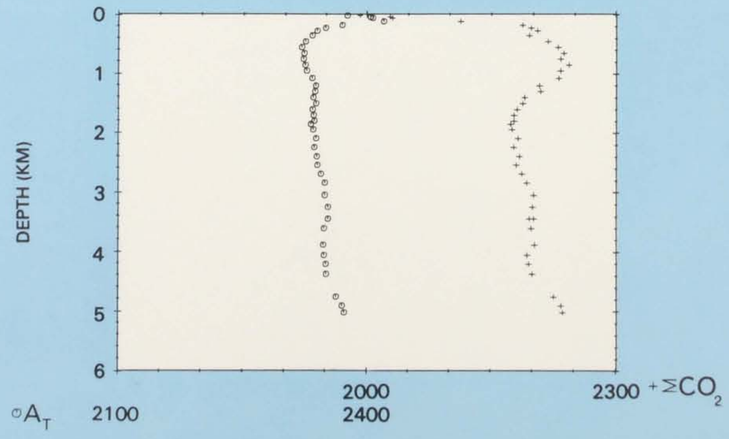












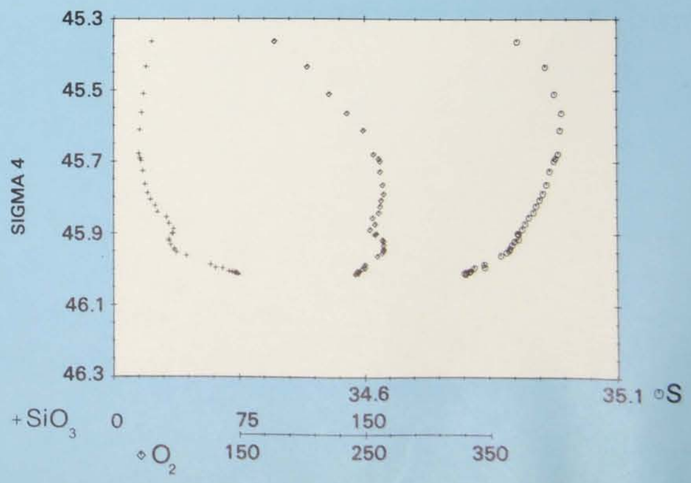
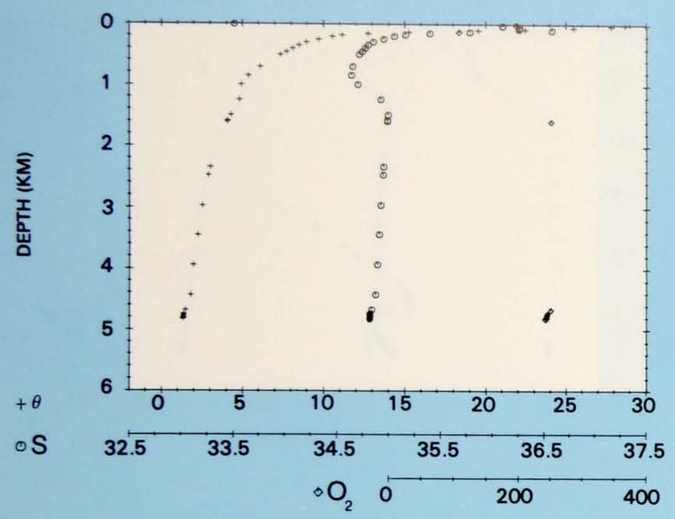
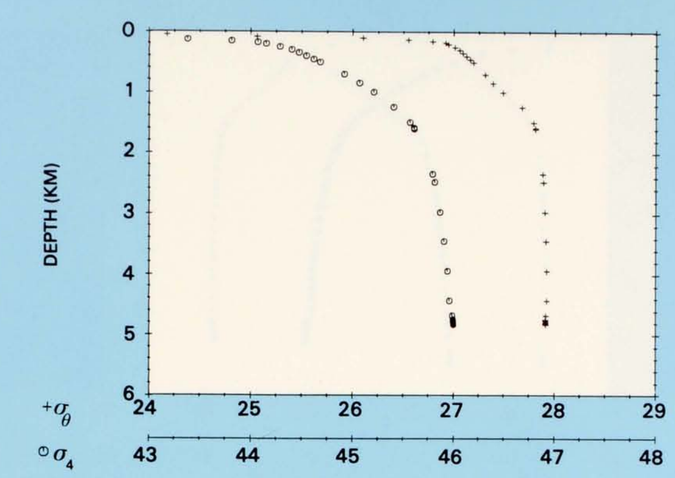


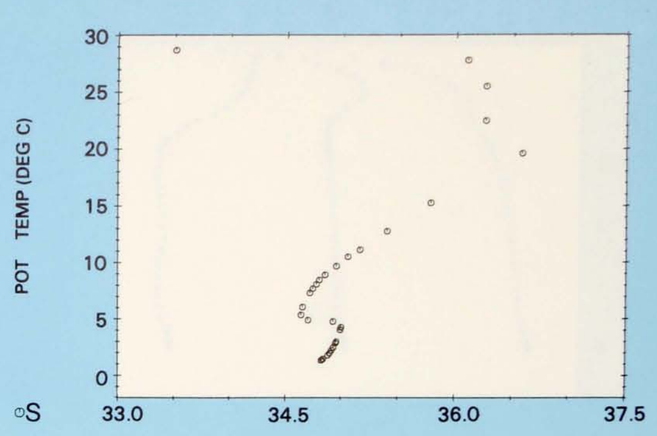
PLATE 100

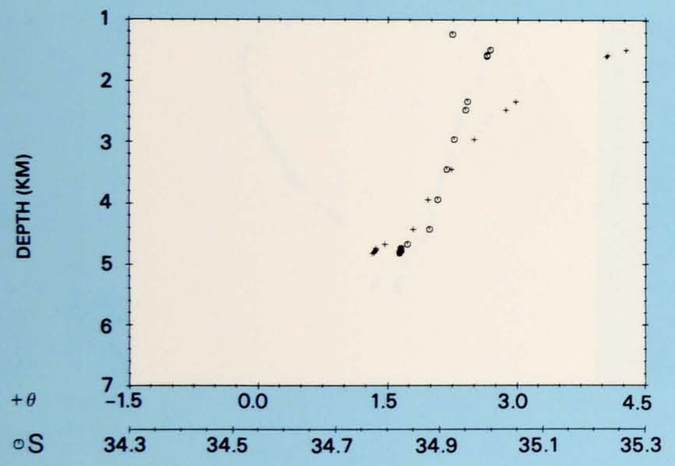
Station 38.
Latitude 9° 45′ N,
Longitude 47° 10′ W.
15 October 1972.

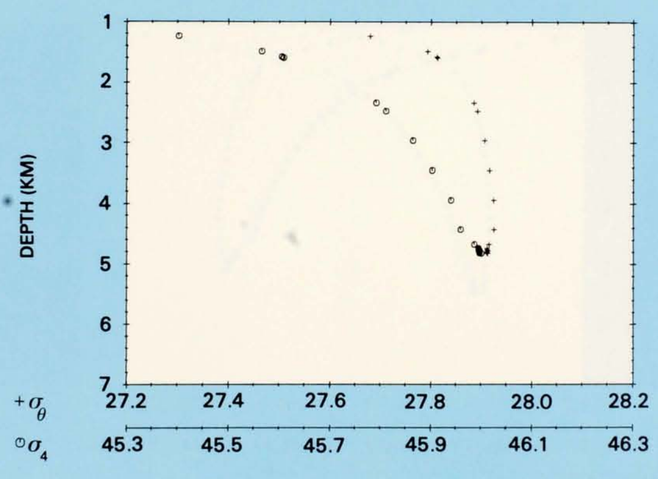
PROPERTY–PROPERTY PLOTS
STATION 38

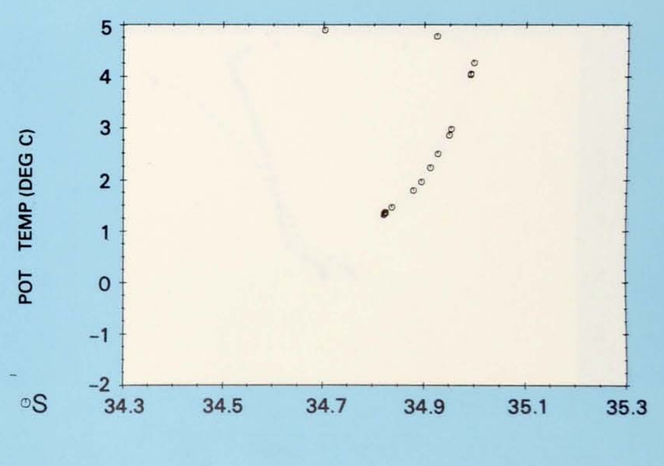








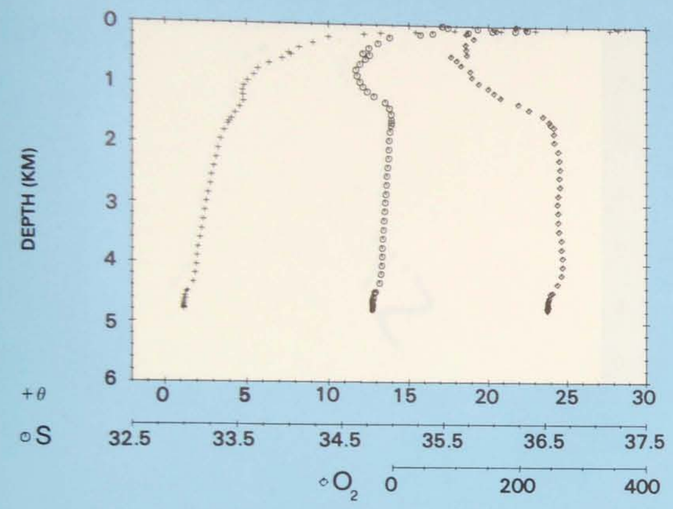


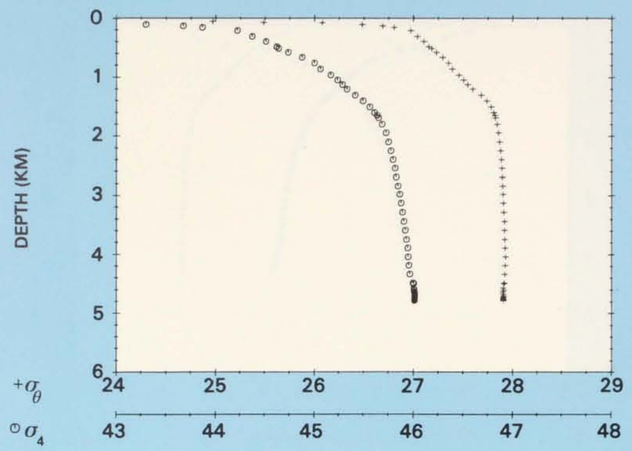


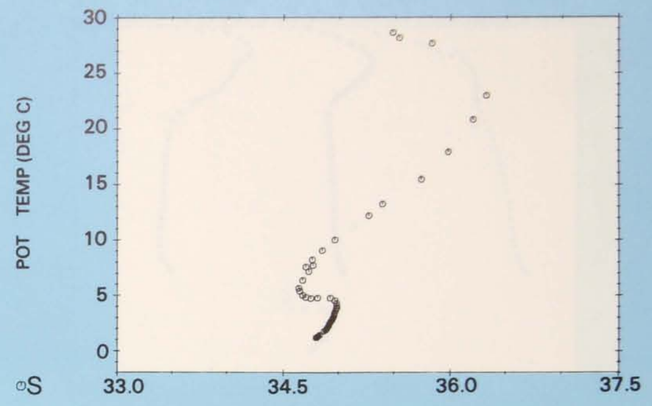
PROPERTY–PROPERTY PLOTS
STATION 39

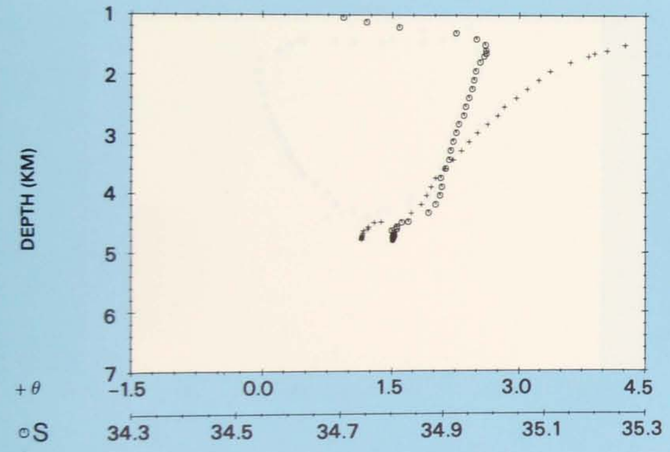
PLATE 101

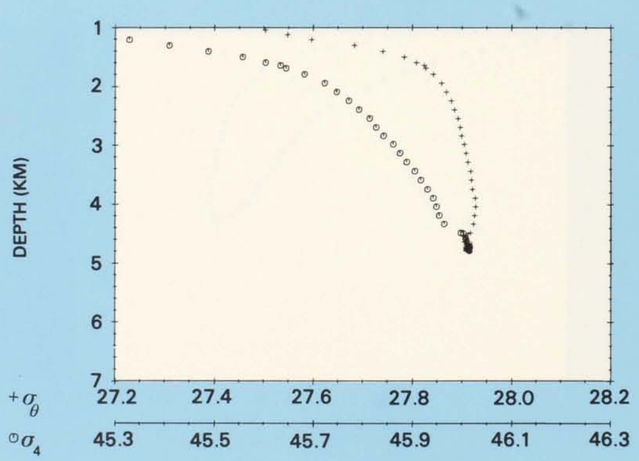
Station 39.
Latitude 7°57′ N,
Longitude 43°51′ W.
17 October 1972.

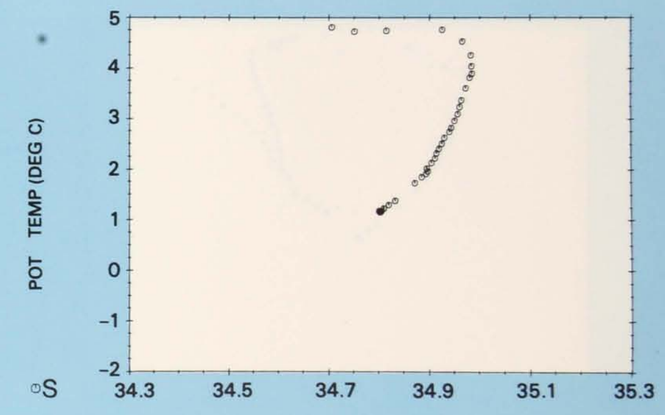


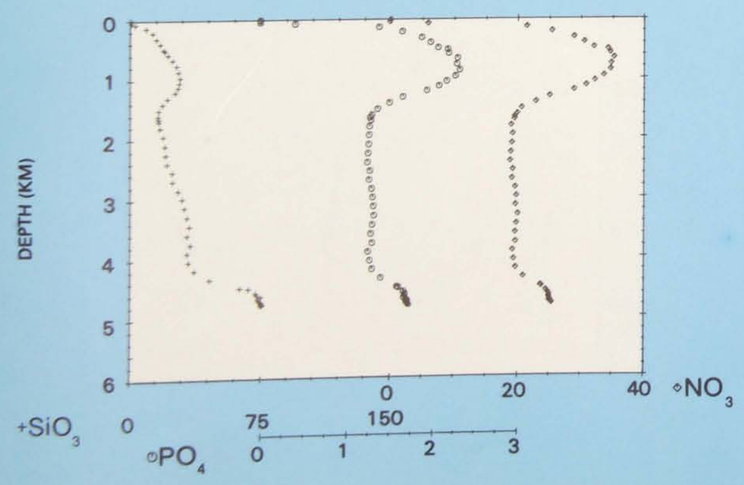


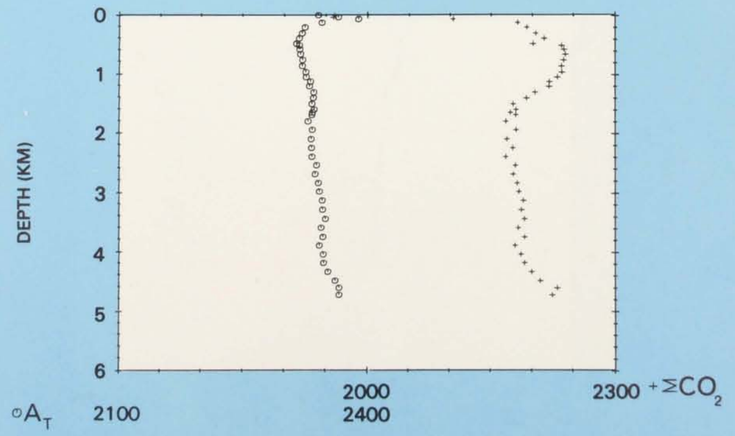












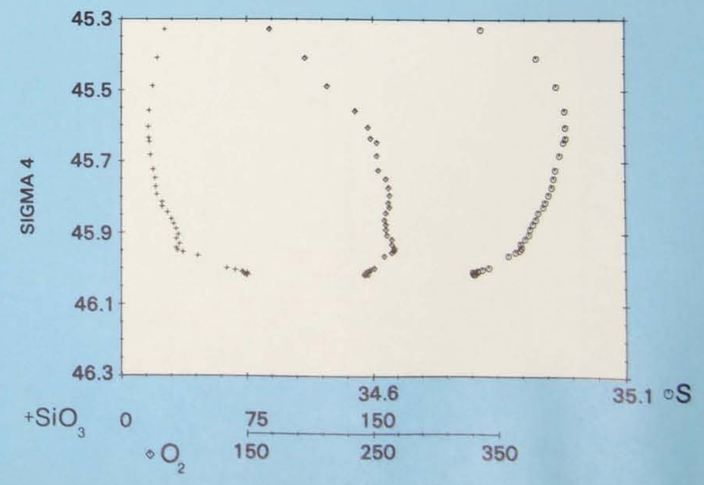
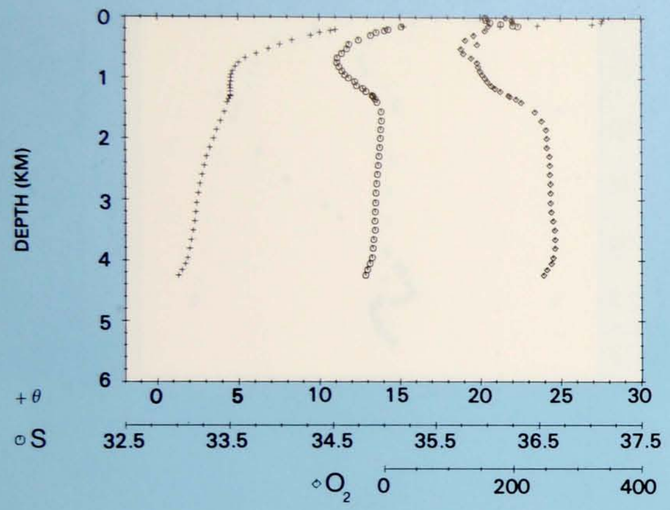
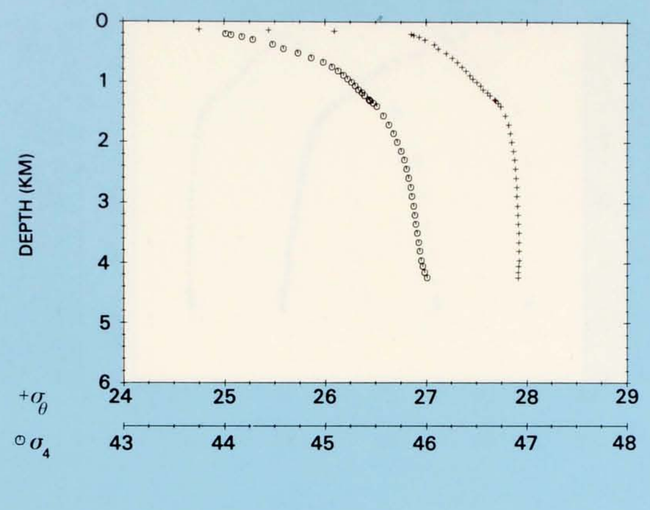


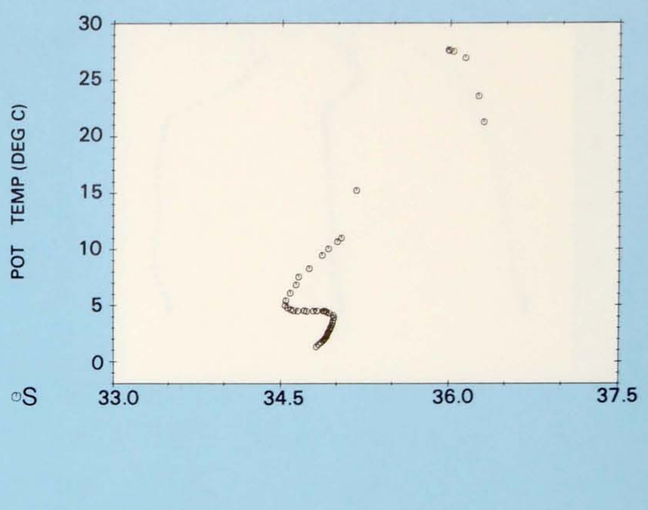
PLATE 102

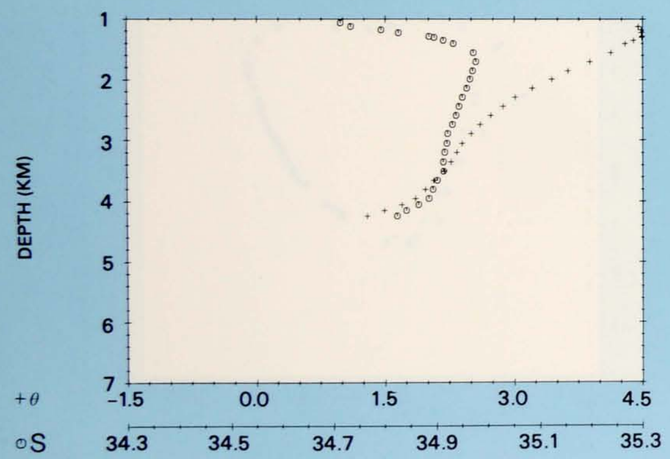
Station 40.
Latitude 3° 56′ N,
Longitude 38° 31′ W.
19 October 1972.

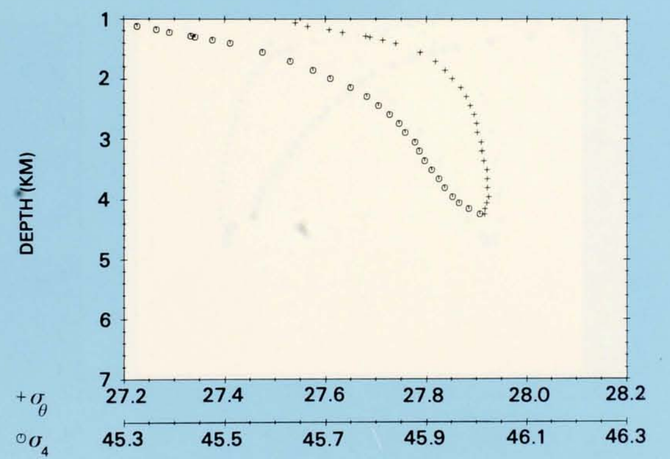
PROPERTY–PROPERTY PLOTS
STATION 40

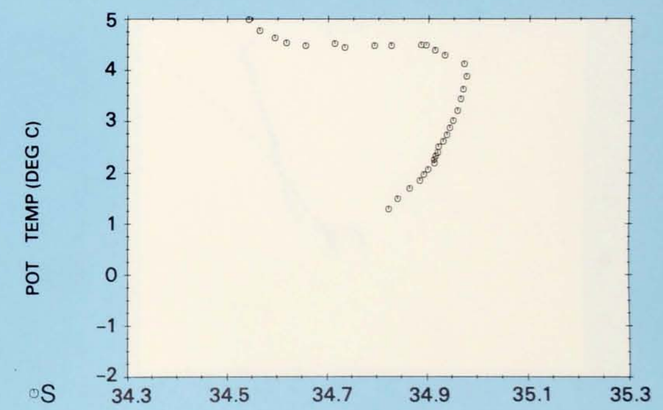


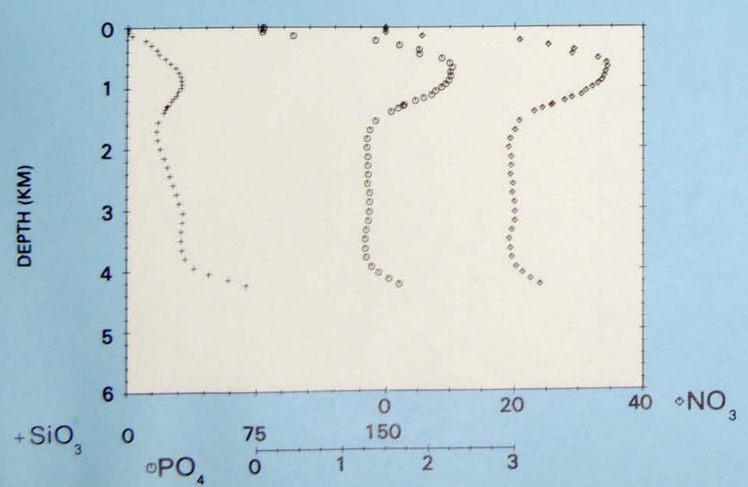


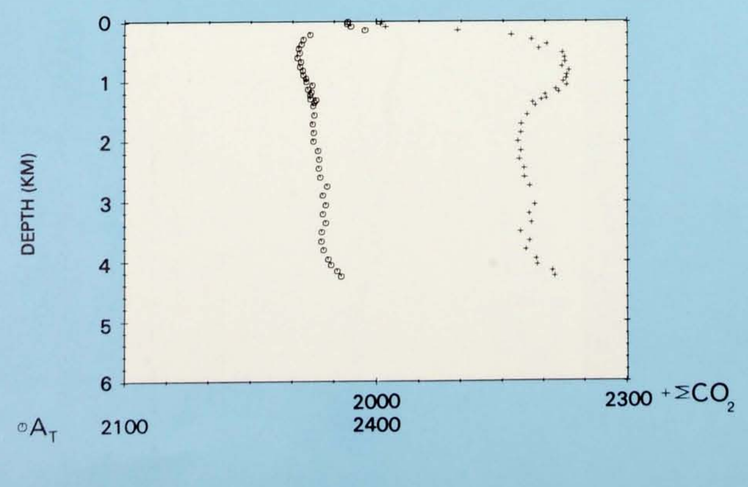


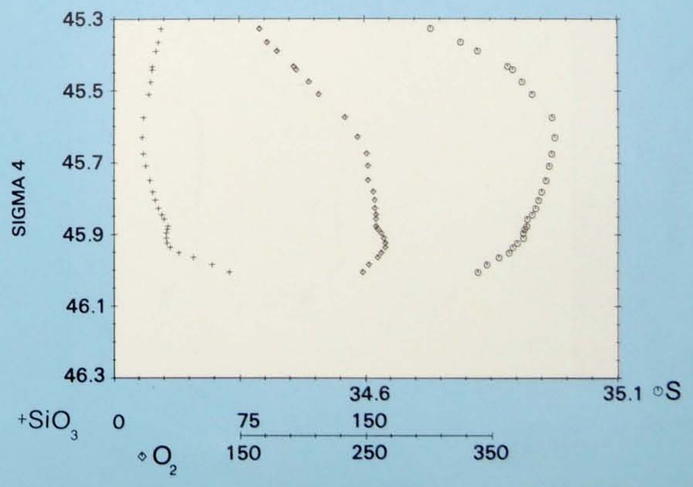


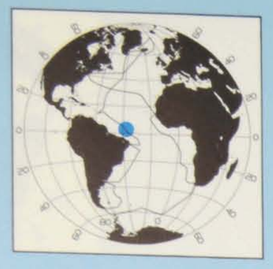








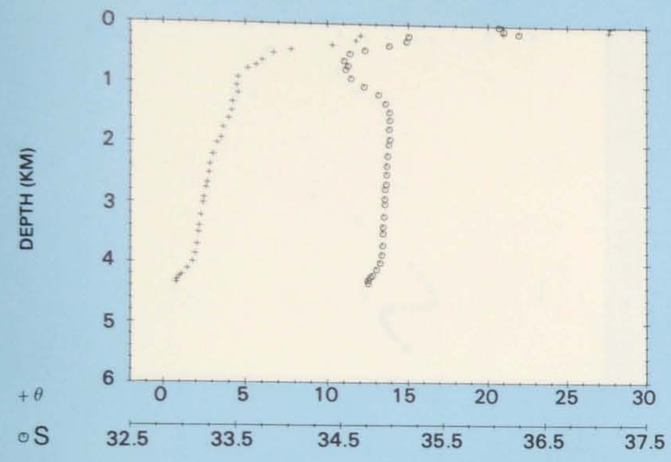


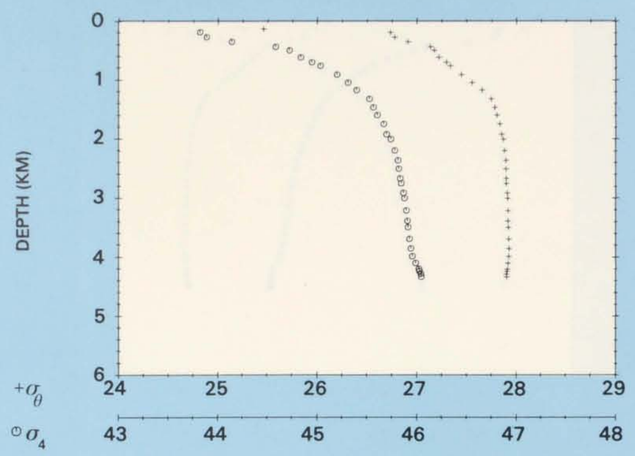


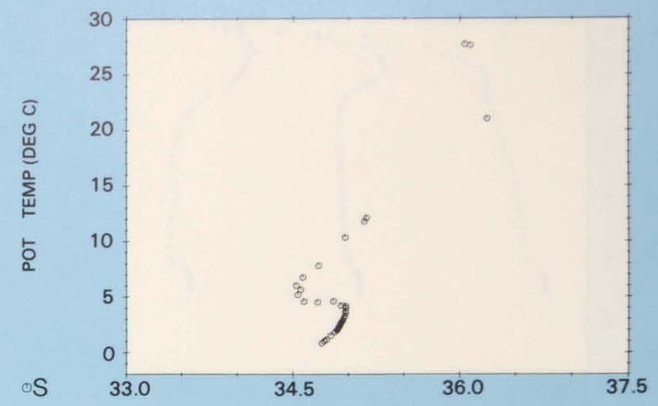
PROPERTY–PROPERTY PLOTS
STATION 41

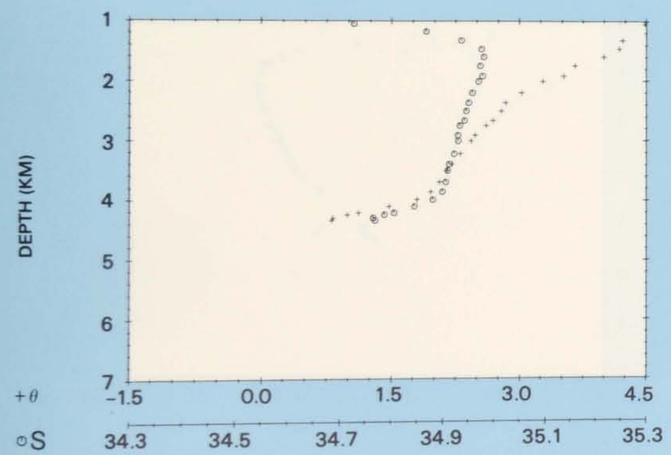
PLATE 103

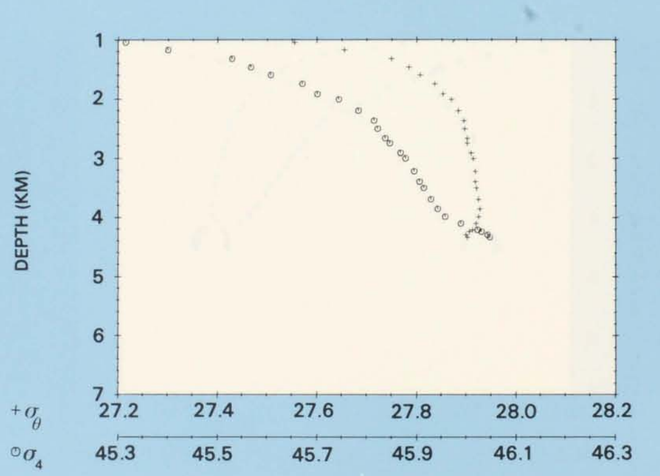
Station 41.
Latitude 2° 00′ N,
Longitude 37° 21′ W.
21 October 1972.











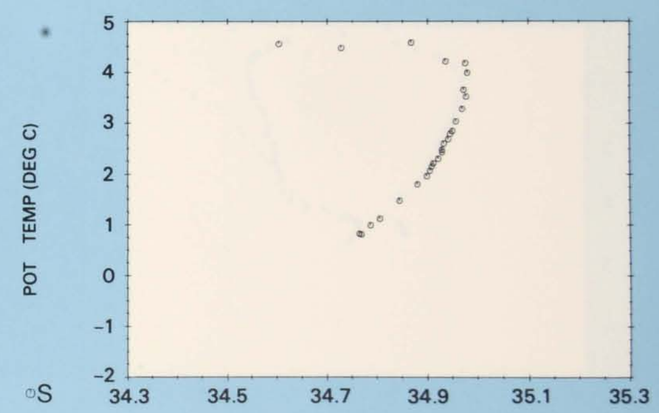
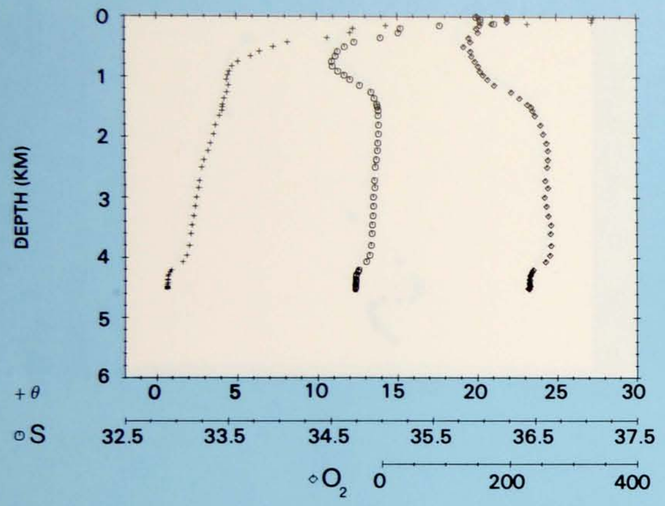
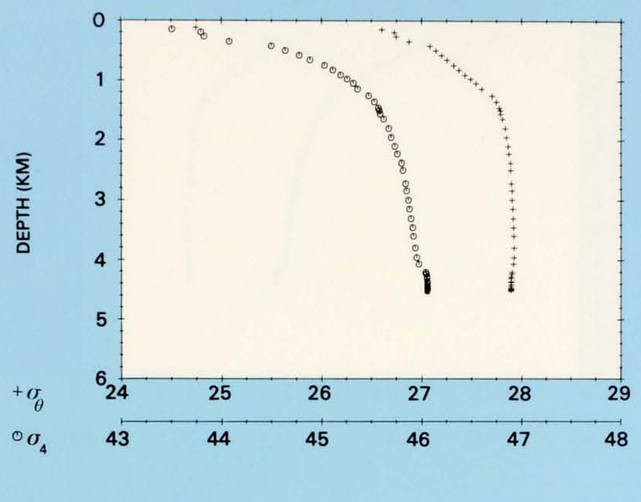


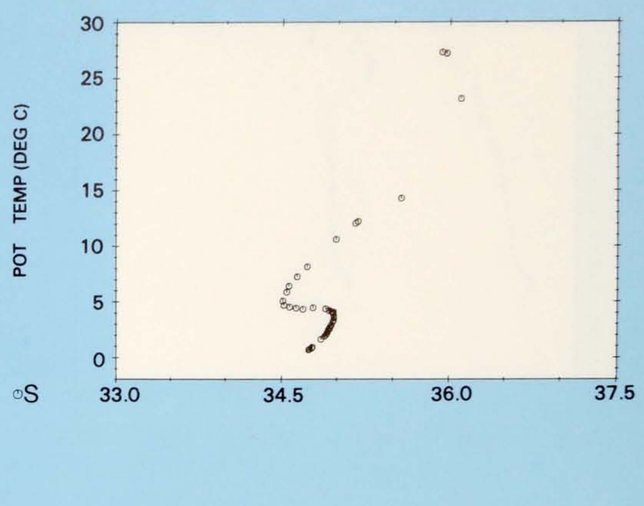
PLATE 104

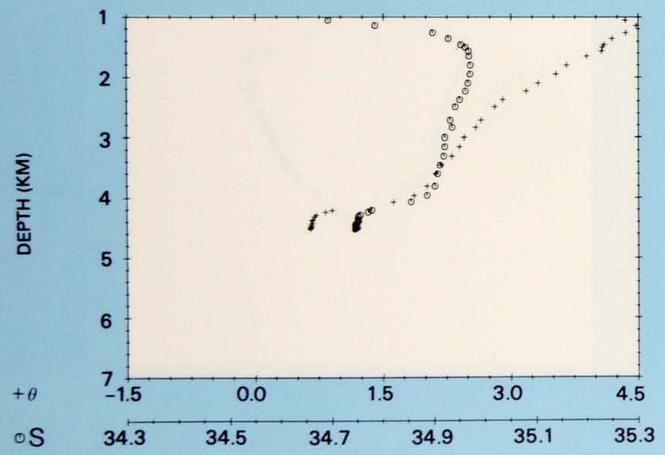
Station 42.
Latitude 0° 58′ N,
Longitude 37° 04′ W.
21 October 1972.

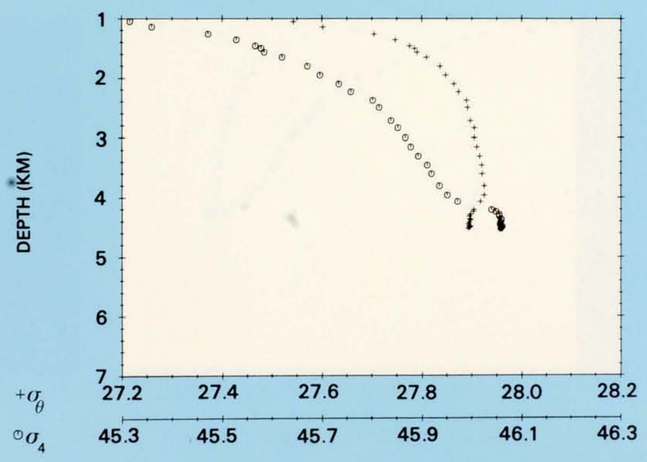
PROPERTY–PROPERTY PLOTS
STATION 42

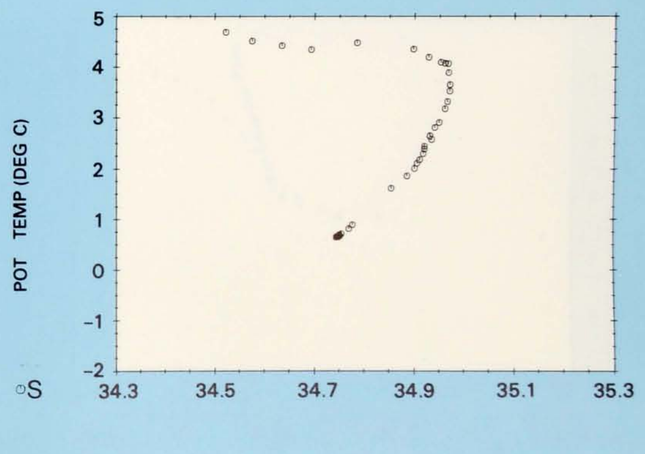


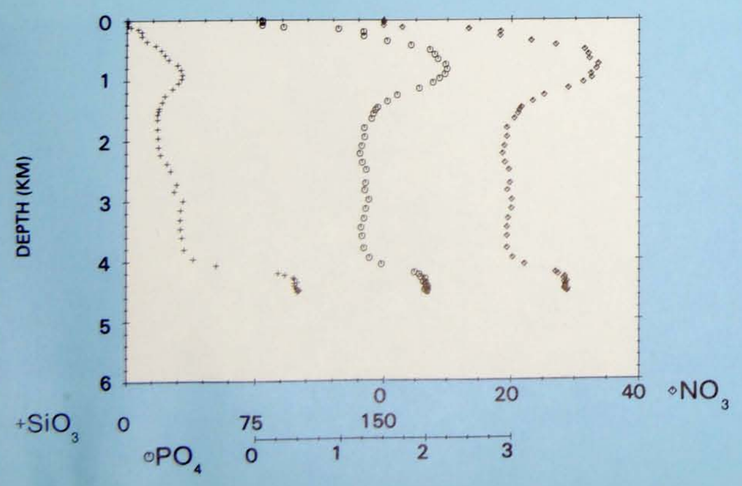


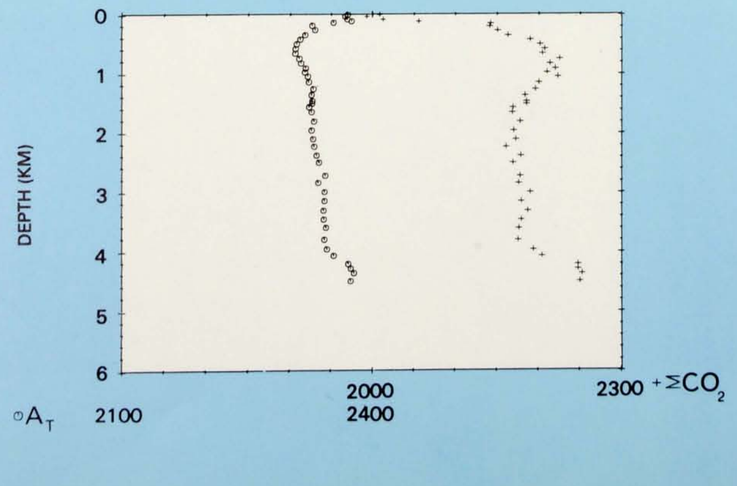


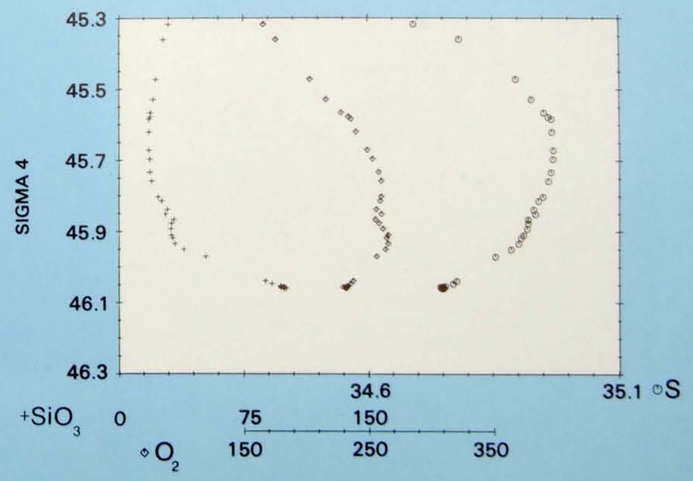








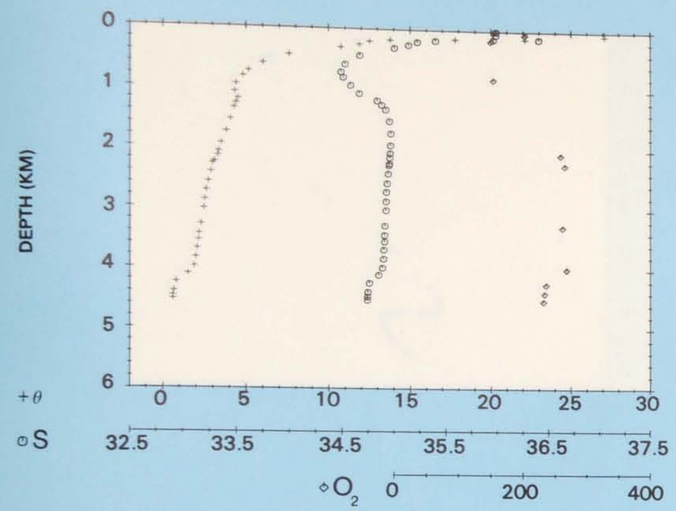


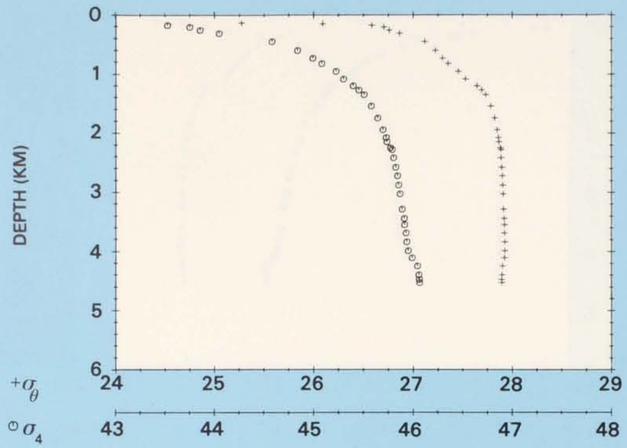


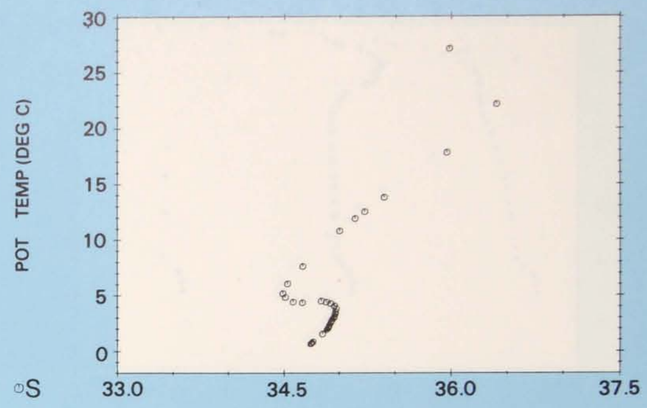
PROPERTY–PROPERTY PLOTS
STATION 43

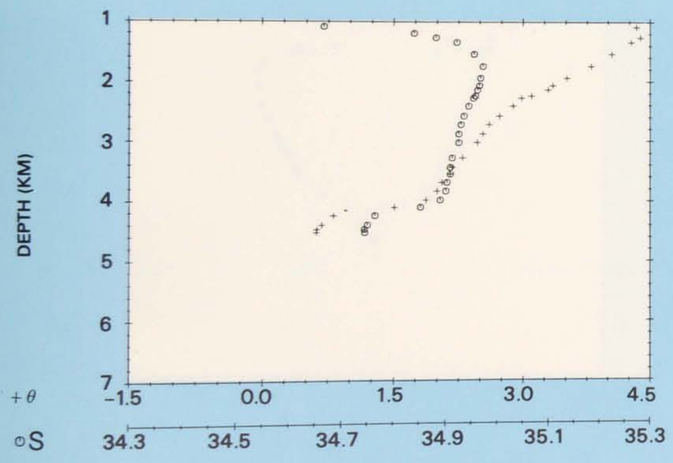
PLATE 105

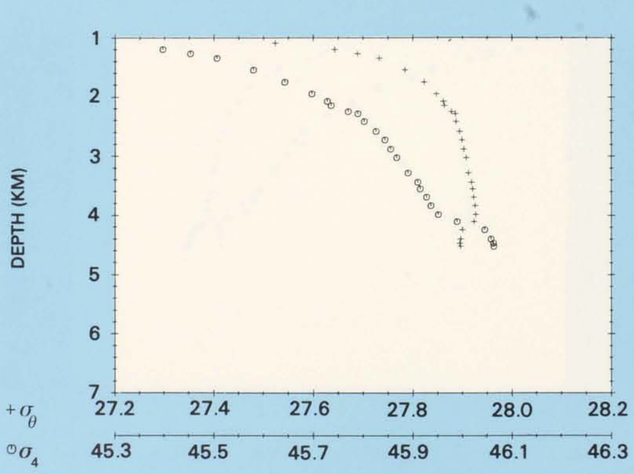
Station 43.
Latitude 0°31′ N,
Longitude 36°31′ W.
22 October 1972.











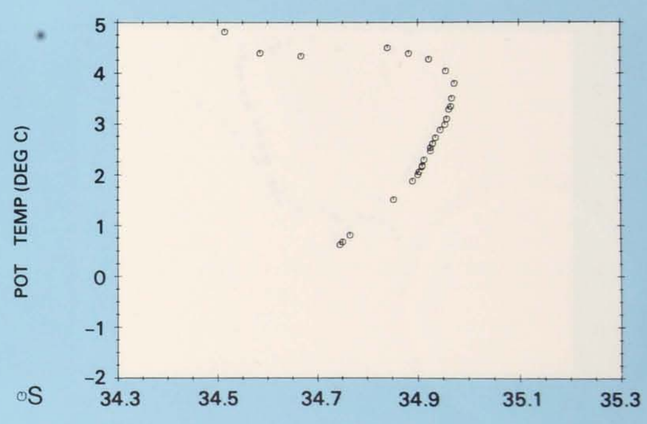
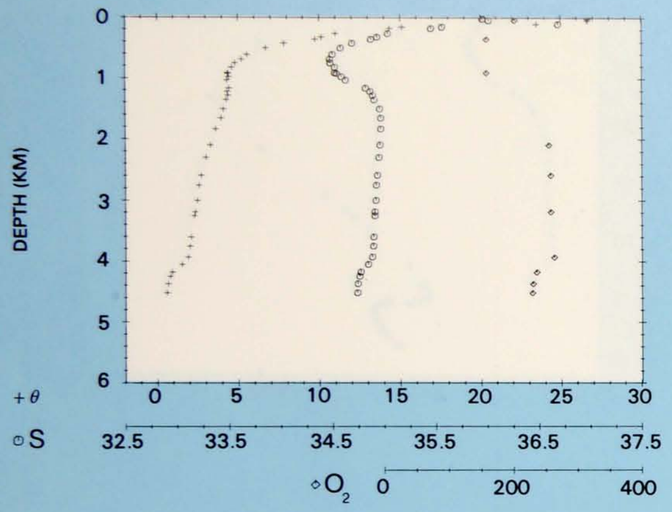
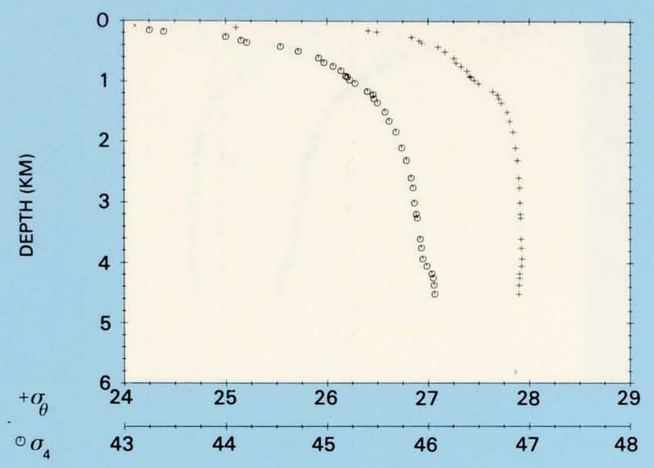


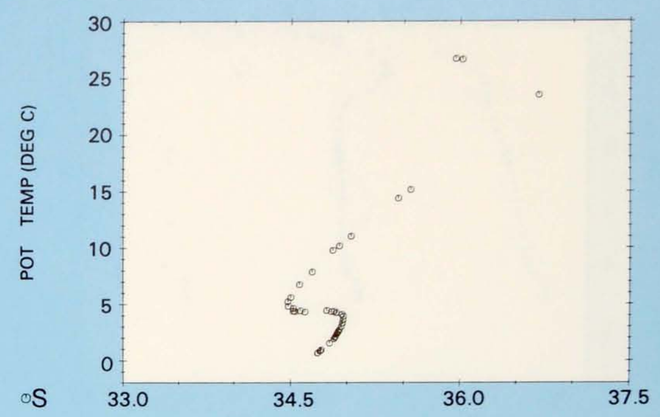
PLATE 106

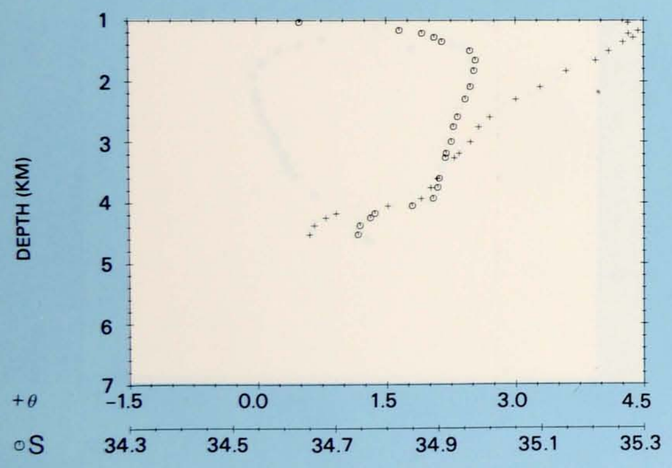
Station 44.
Latitude 0°01′ N,
Longitude 35°58′ W.
22 October 1972.

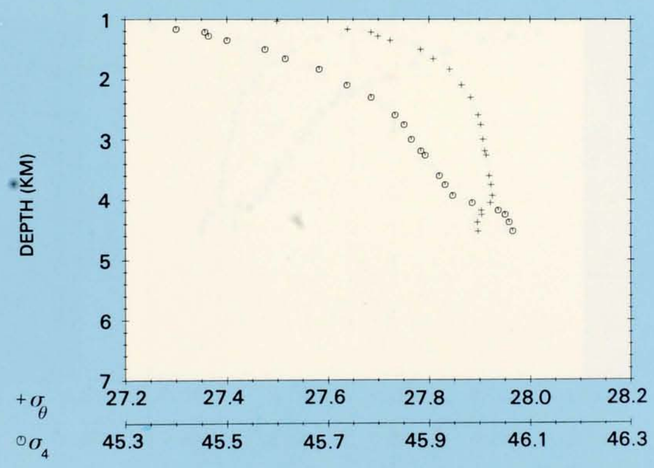
PROPERTY–PROPERTY PLOTS
STATION 44

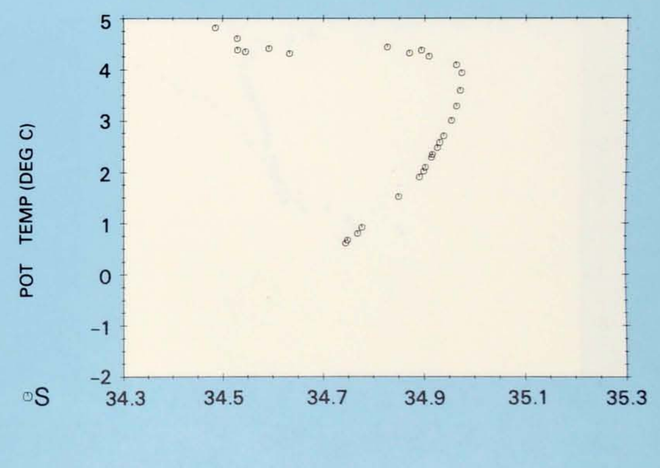








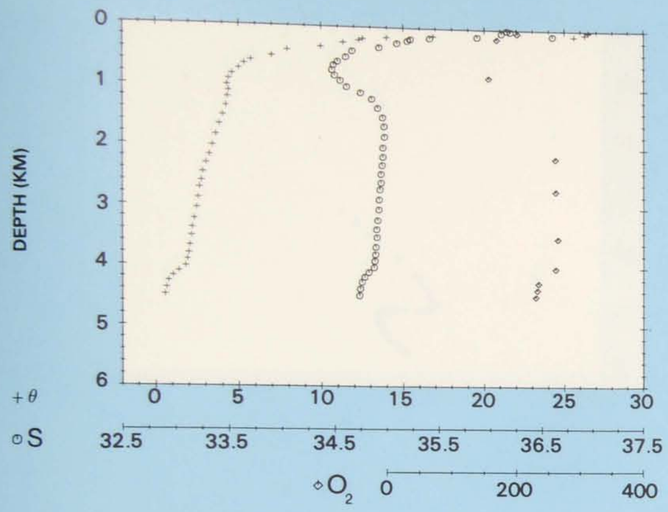


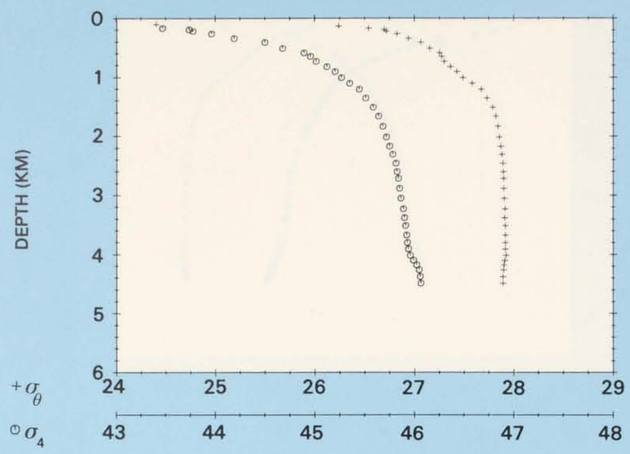


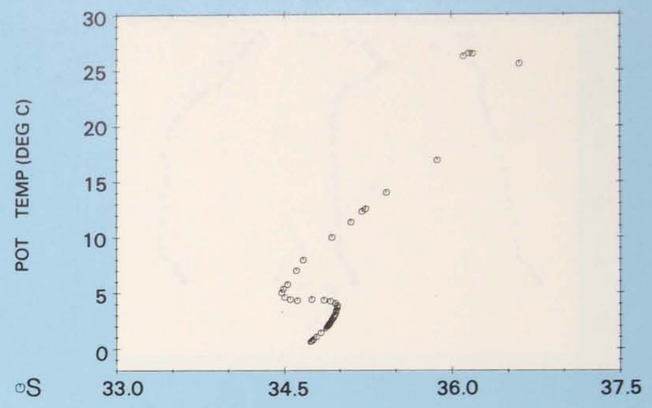
PROPERTY–PROPERTY PLOTS
STATION 45

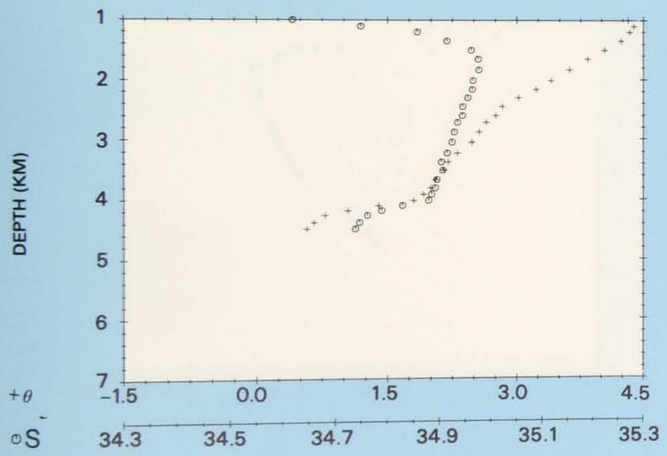
PLATE 107

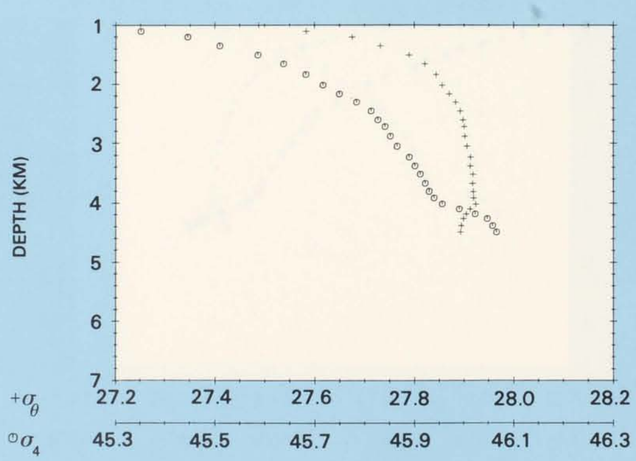
Station 45.
Latitude 0° 30′ S,
Longitude 34° 59′ W.
23 October 1972.











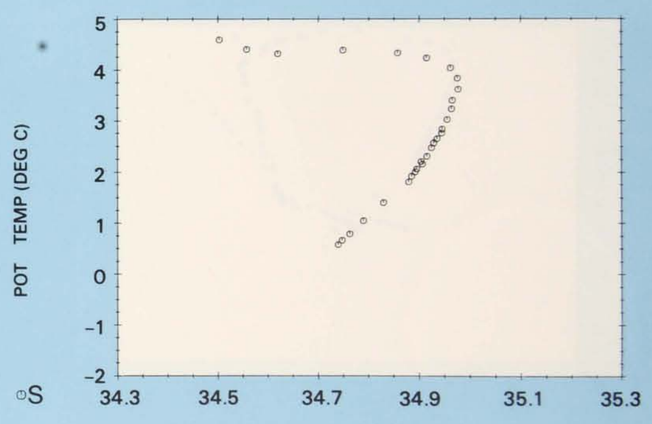
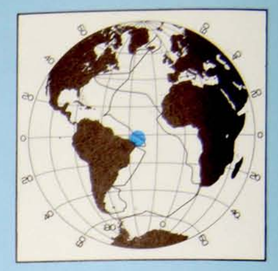
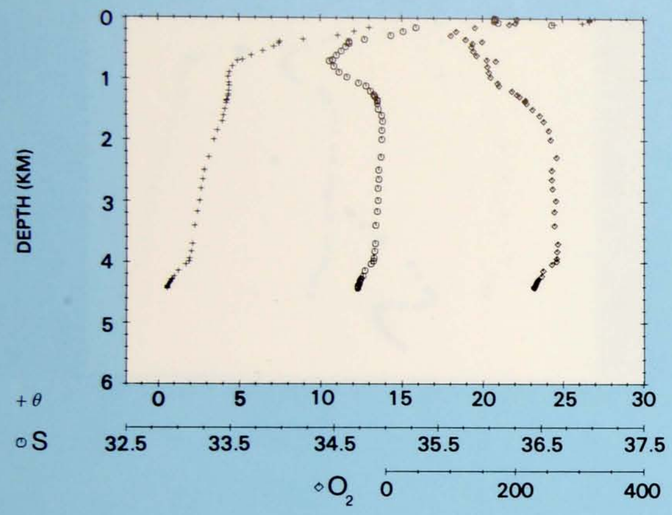


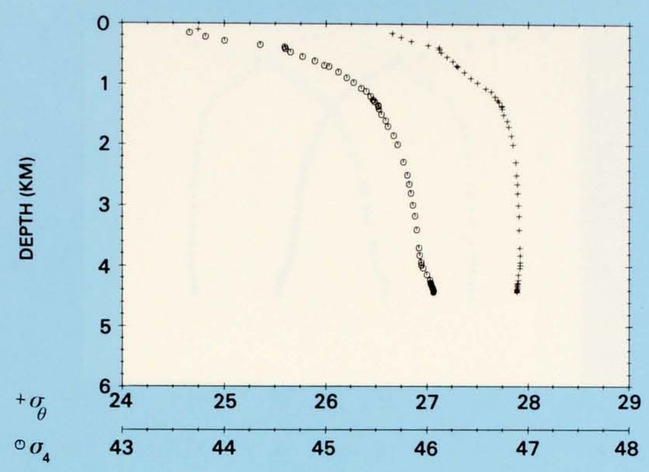
PLATE 108

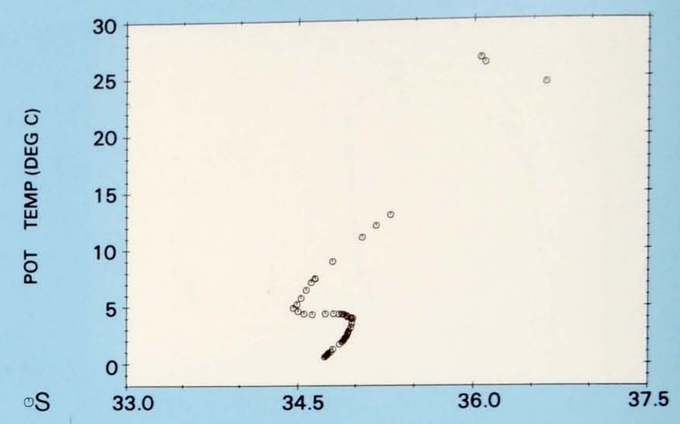
Station 46.
Latitude 0°59′ S,
Longitude 34°02′ W.
23 October 1972.

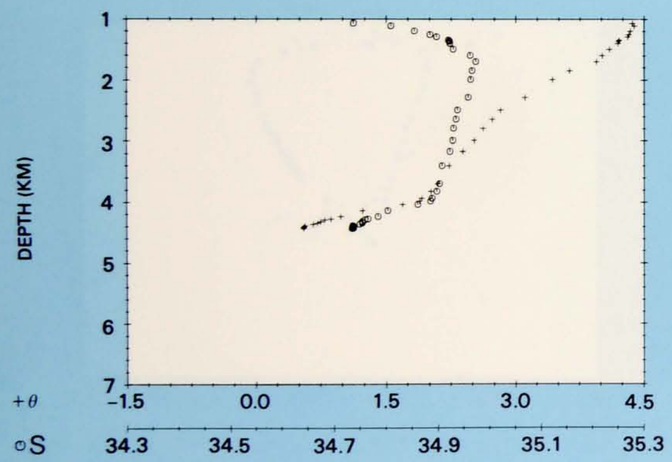
PROPERTY–PROPERTY PLOTS
STATION 46

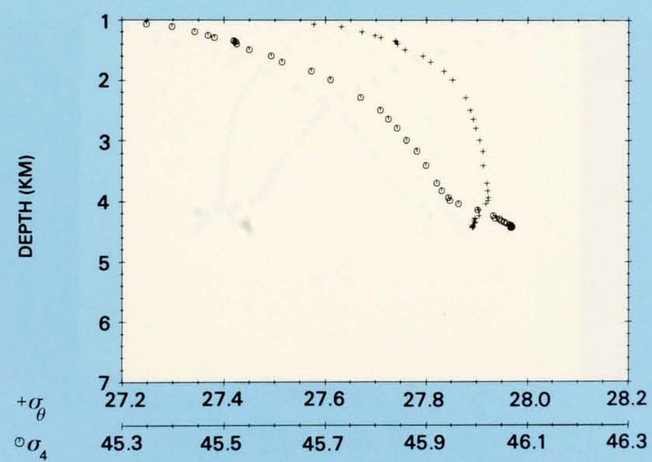


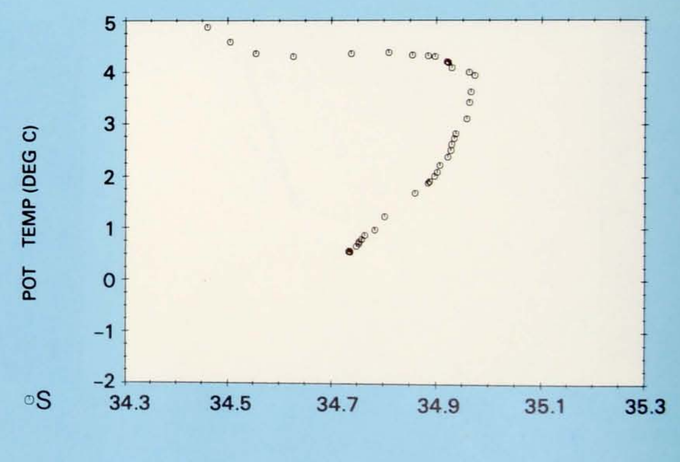


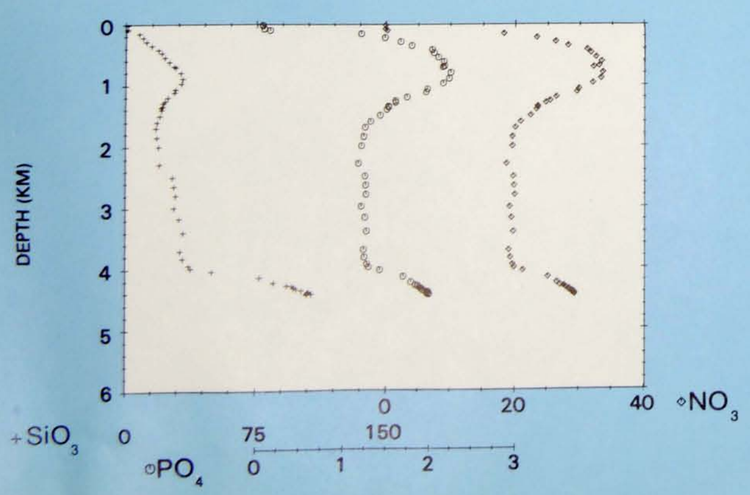


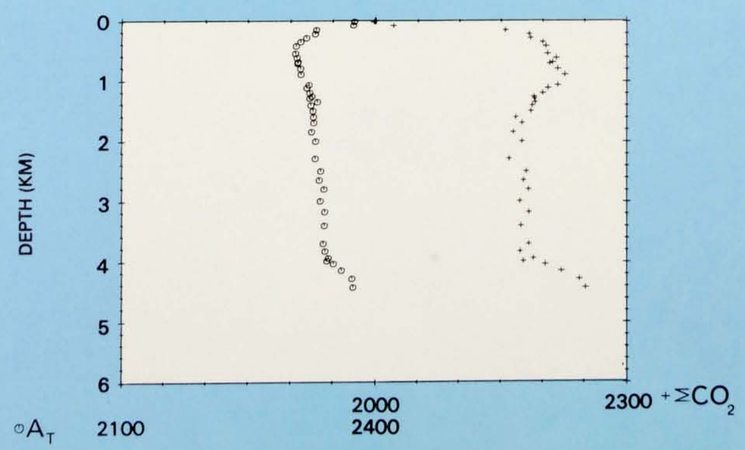


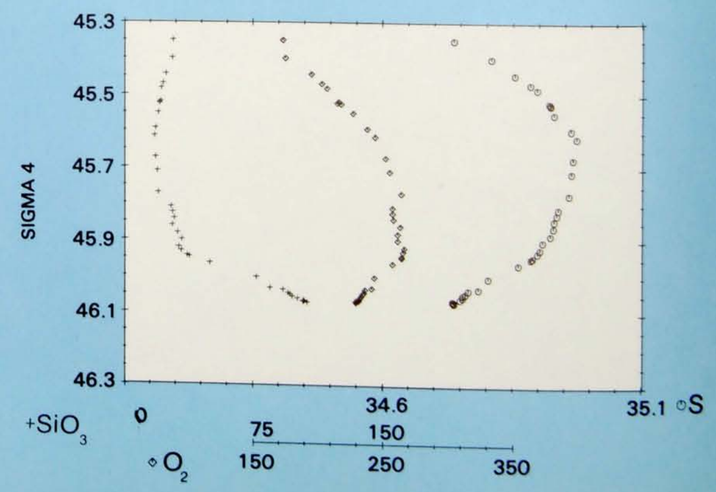


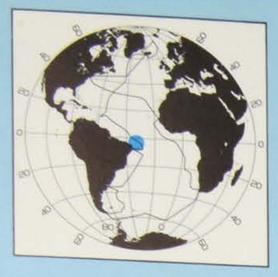








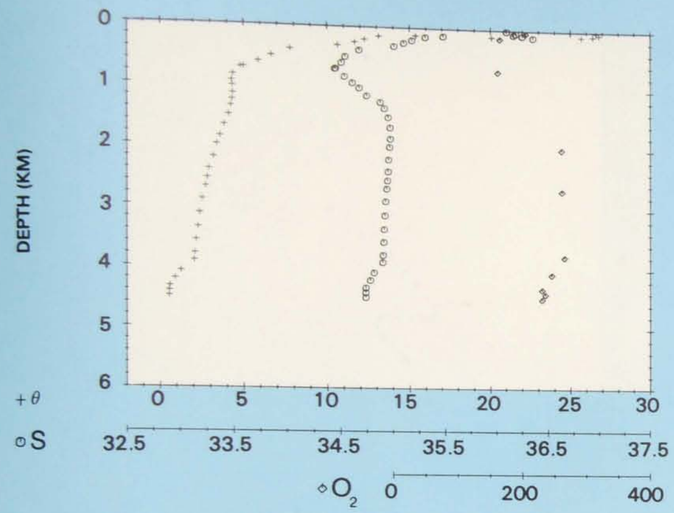


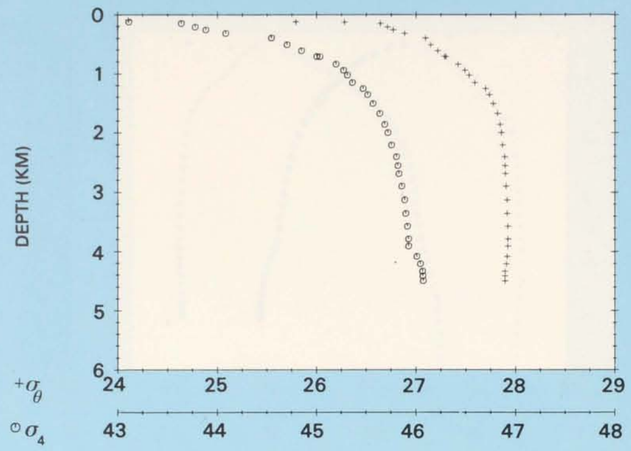


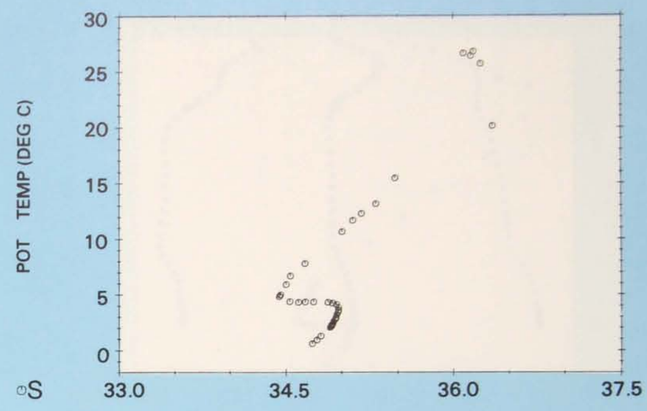
PROPERTY–PROPERTY PLOTS
STATION 47

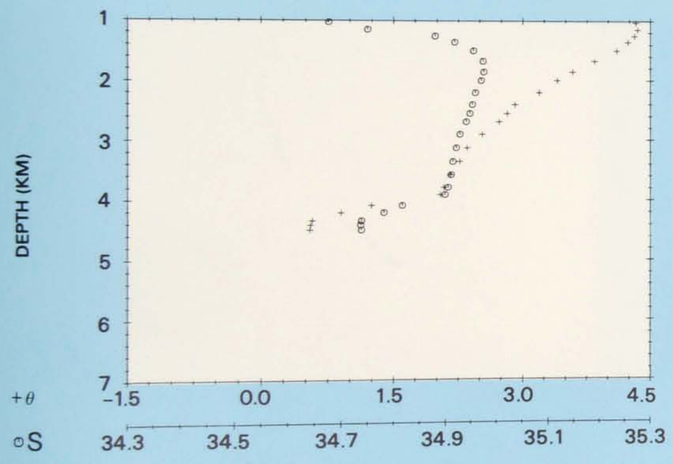
PLATE 109

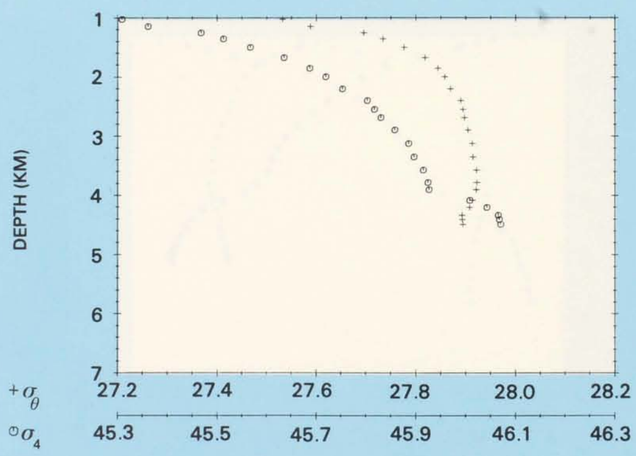
Station 47.
Latitude 1° 58′ S,
Longitude 32° 31′ W.
24 October 1972.











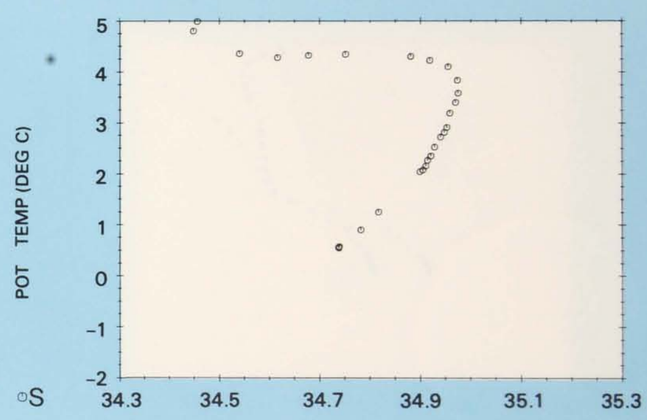
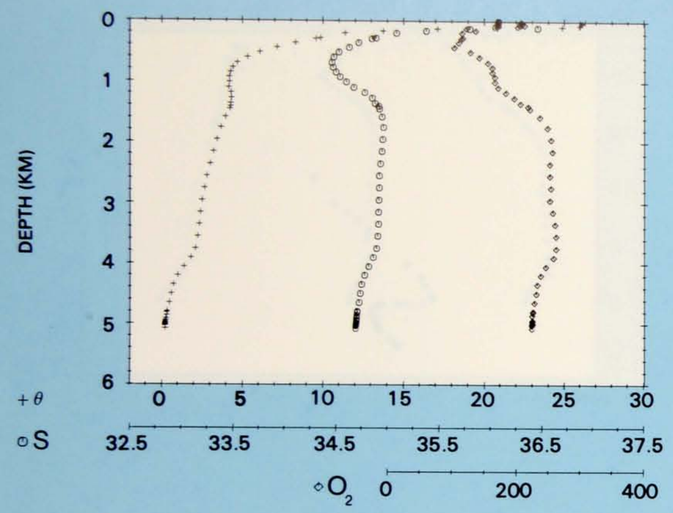
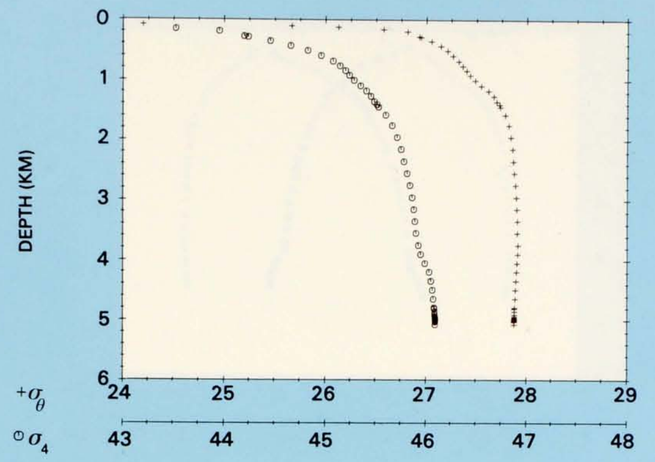


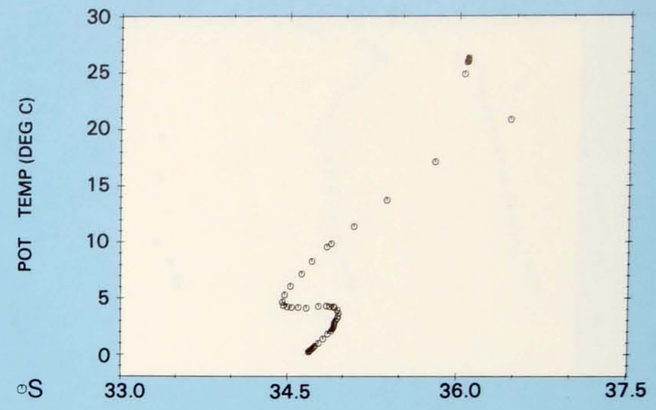
PLATE 110

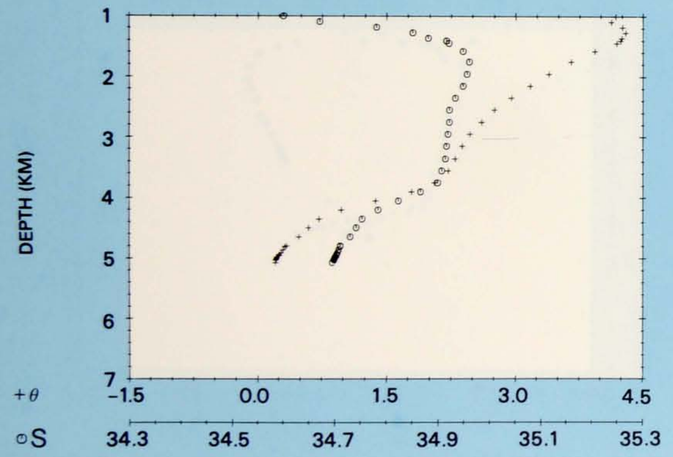
Station 48.
Latitude 4° 00′ S,
Longitude 29° 00′ W.
25 October 1972.

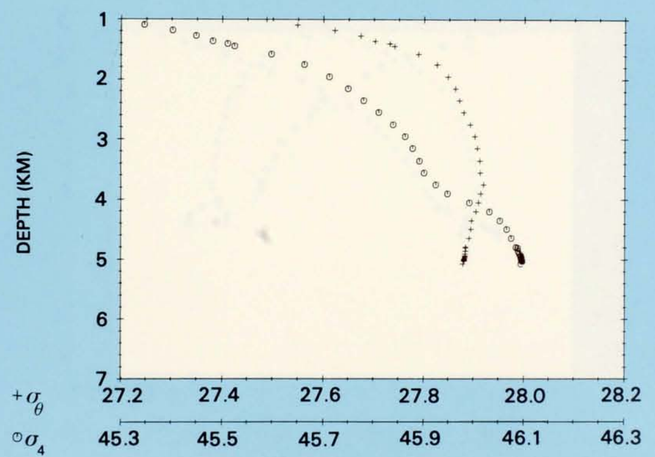
PROPERTY–PROPERTY PLOTS
STATION 48

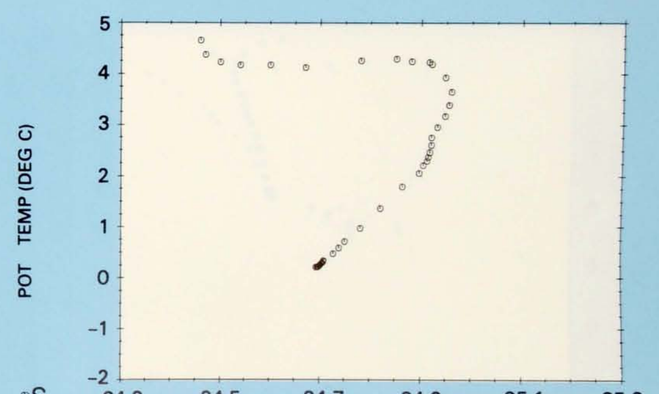


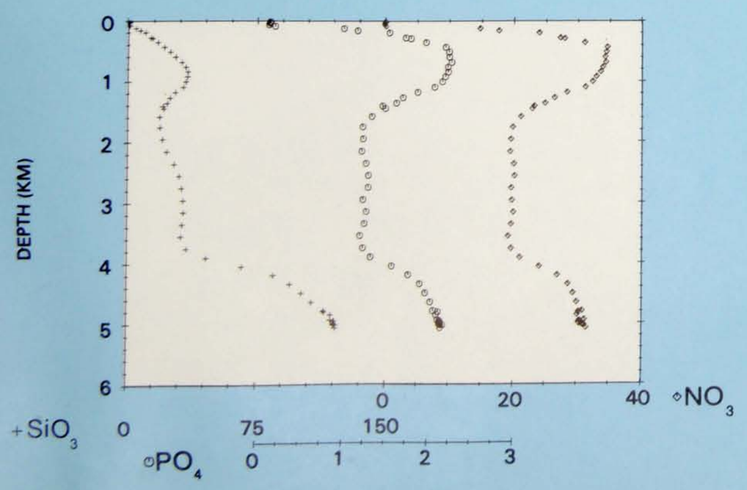


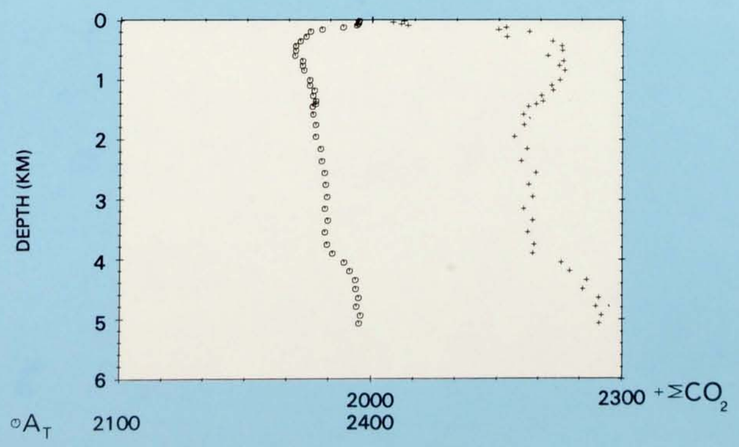


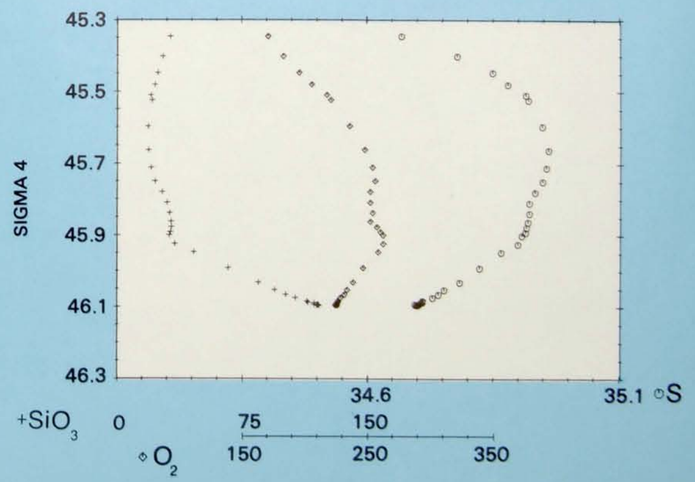


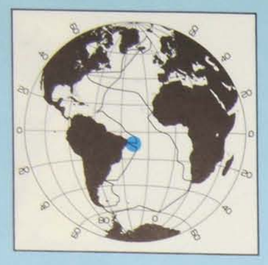








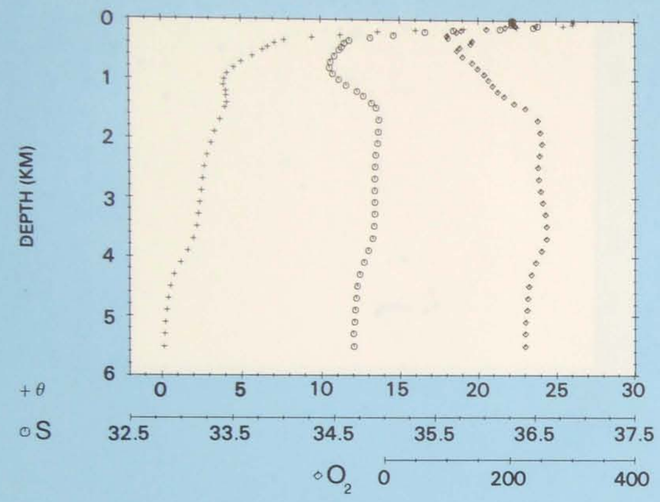


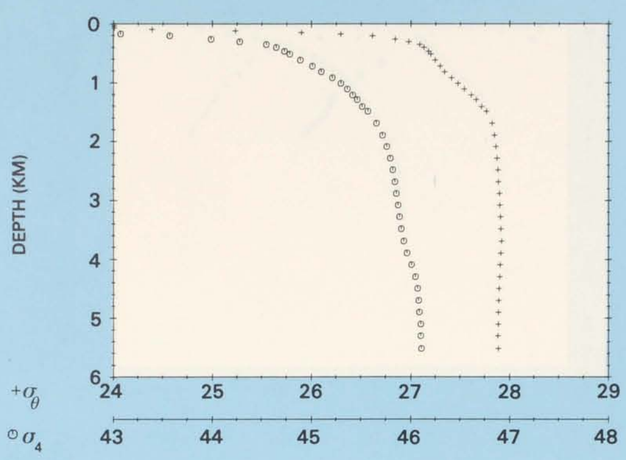


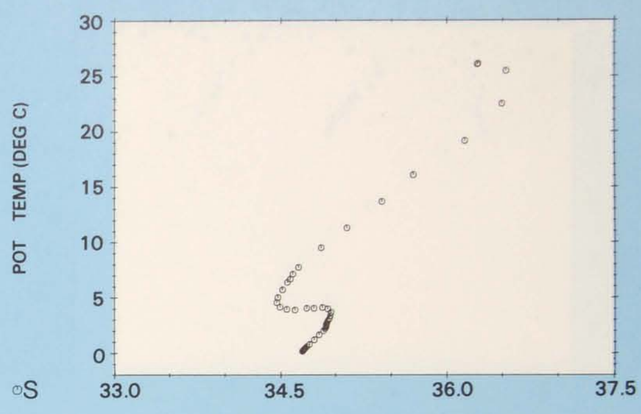
PROPERTY–PROPERTY PLOTS
STATION 49

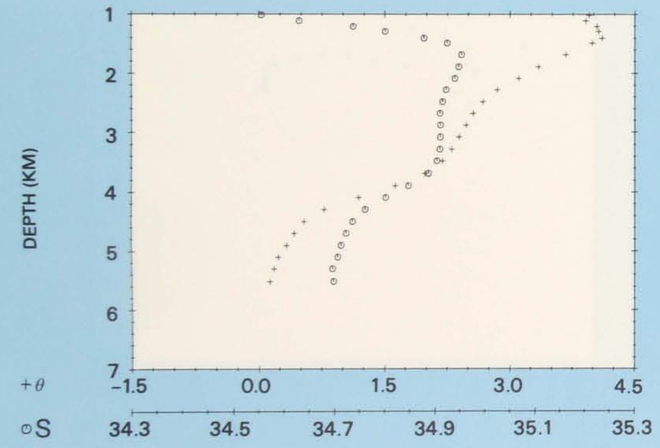
PLATE 111

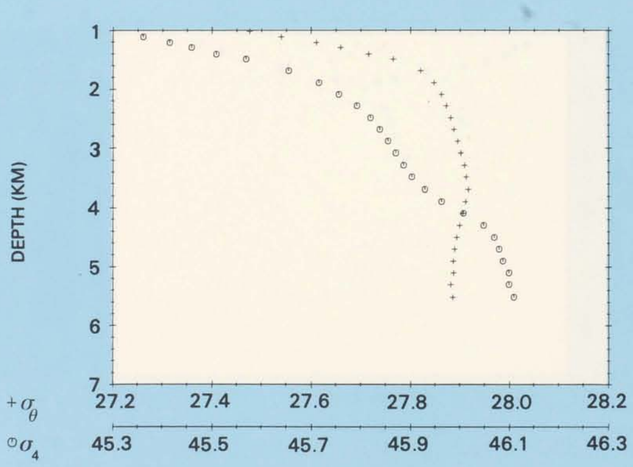
Station 49.
Latitude 7° 56′ S,
Longitude 28° 12′ W.
29 October 1972.

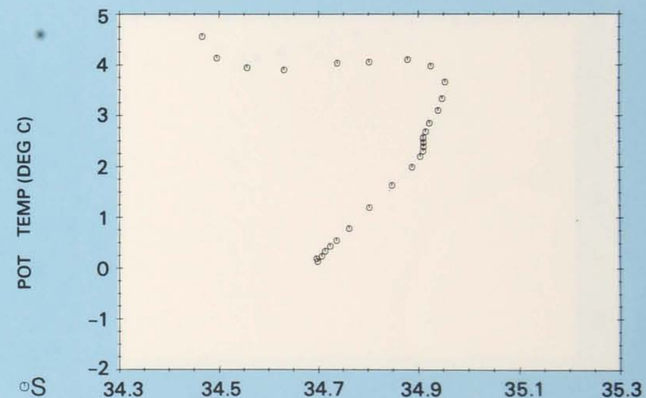


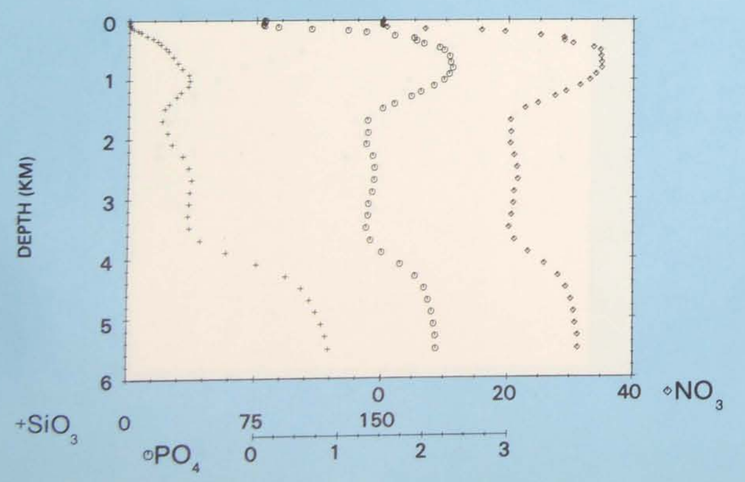


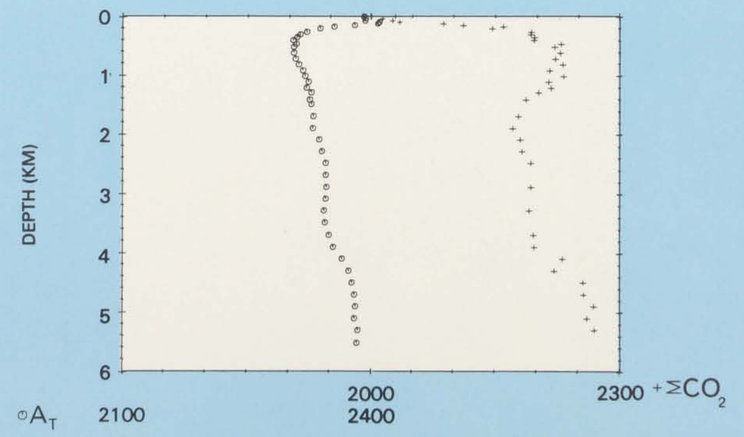












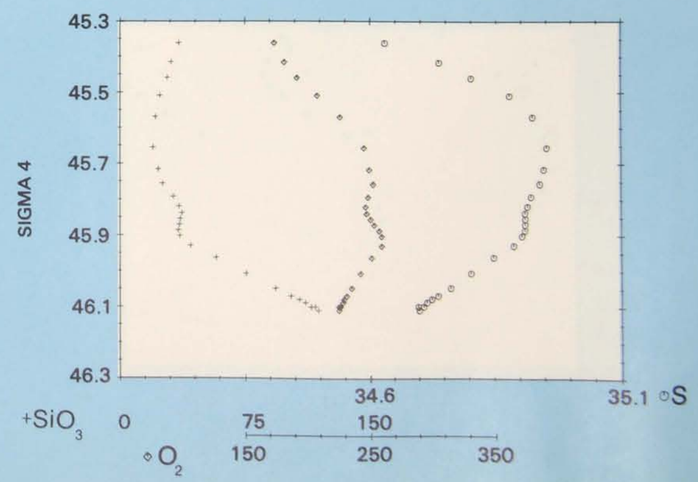
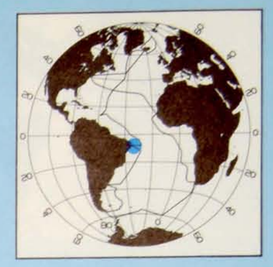
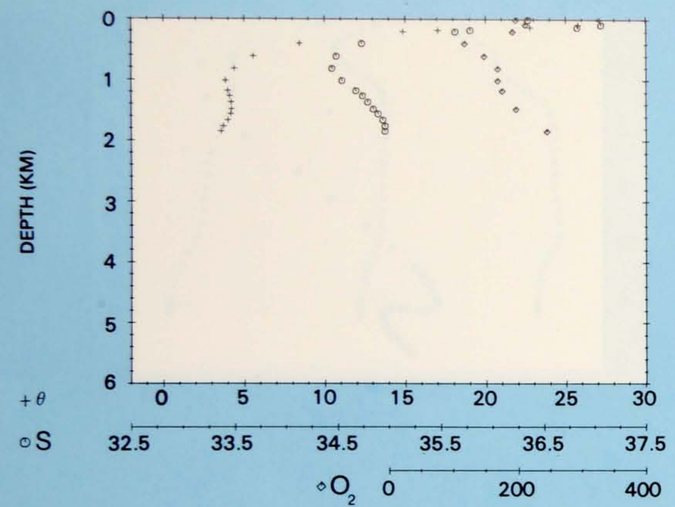


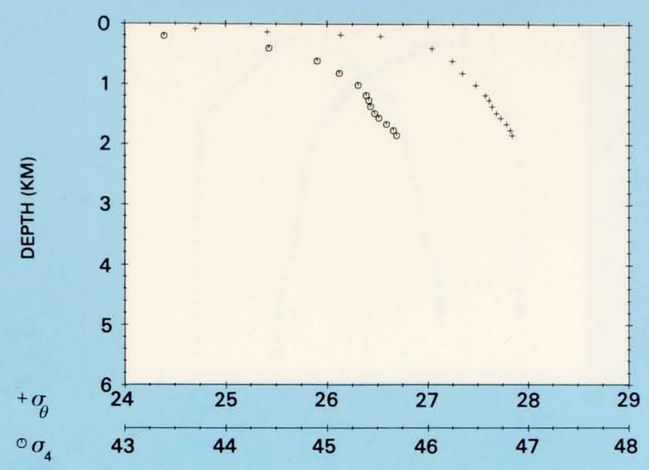
PLATE 112

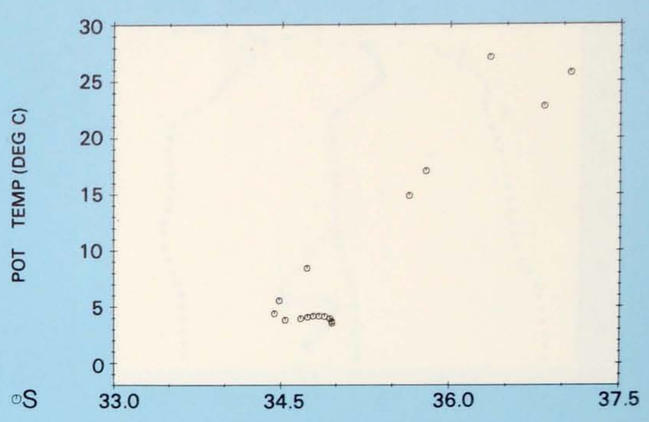
Station 50.
Latitude 8° 26′ S,
Longitude 34° 11′ W.
5 November 1972.

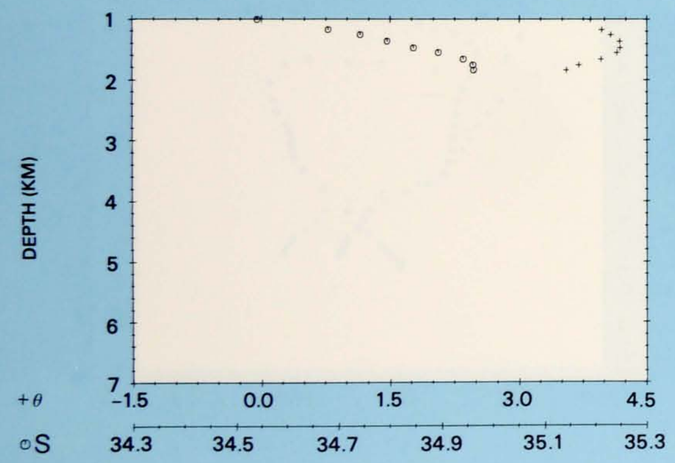
PROPERTY–PROPERTY PLOTS
STATION 50

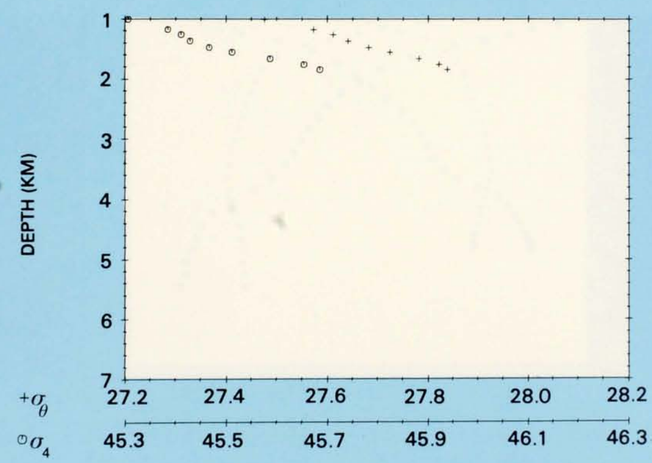


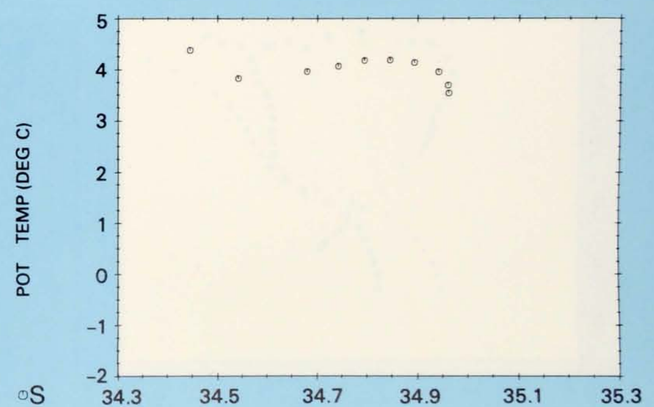


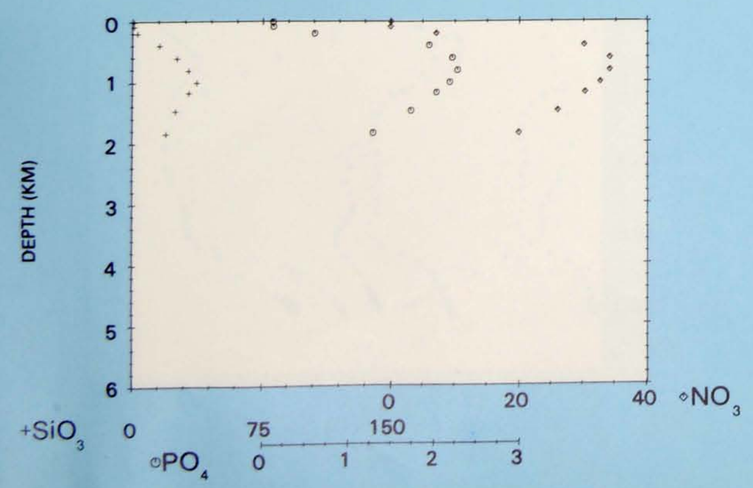


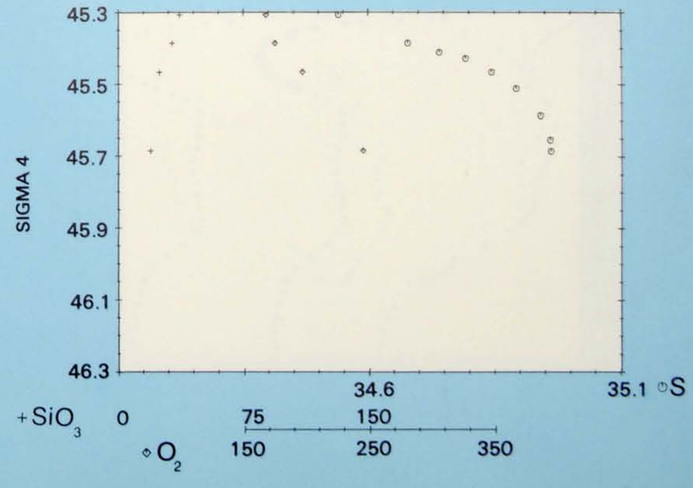








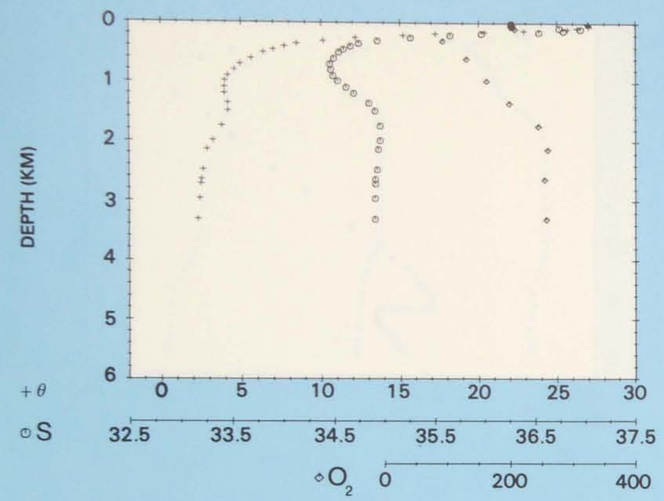


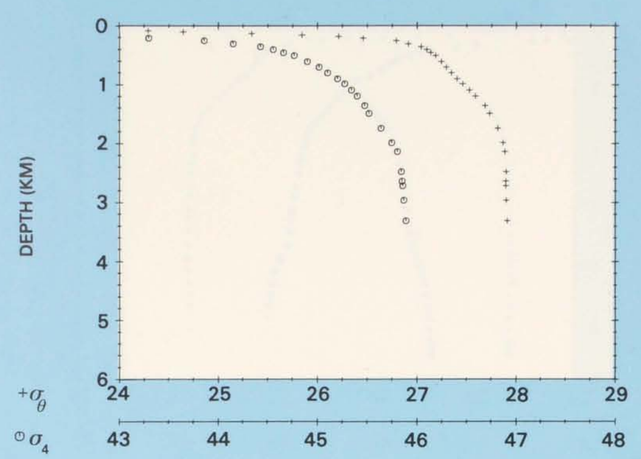


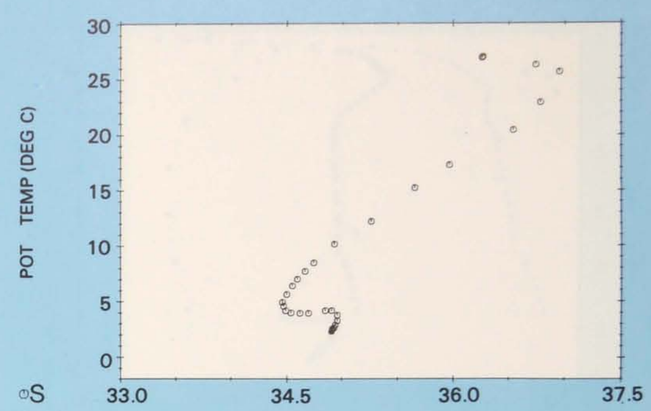
PROPERTY–PROPERTY PLOTS
STATION 51

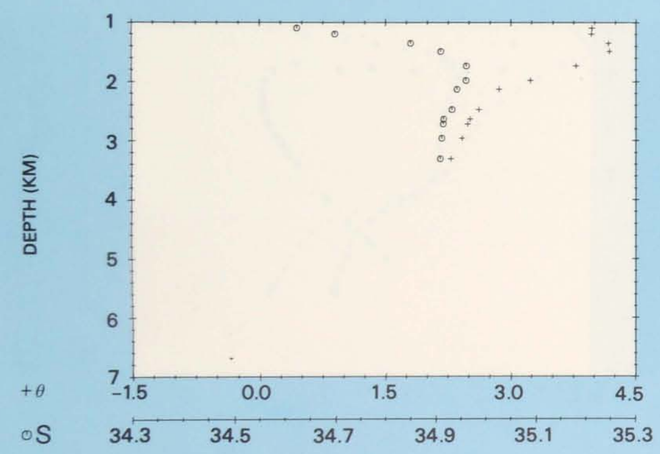
PLATE 113

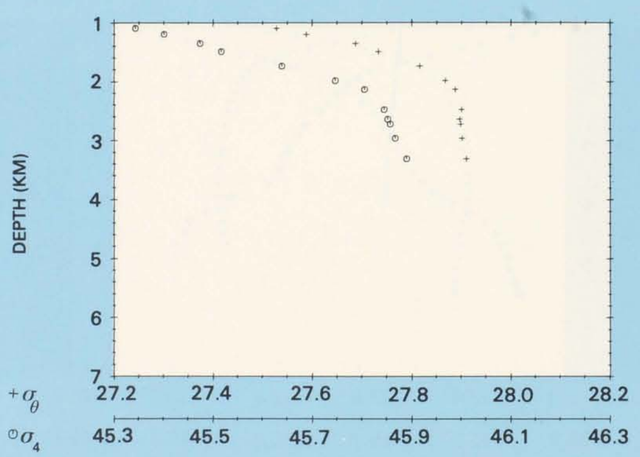
Station 51.
Latitude 8° 38′ S,
Longitude 33° 47′ W.
5 November 1972.

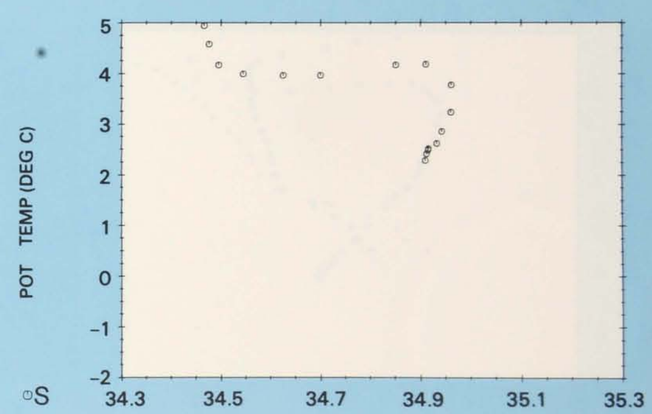


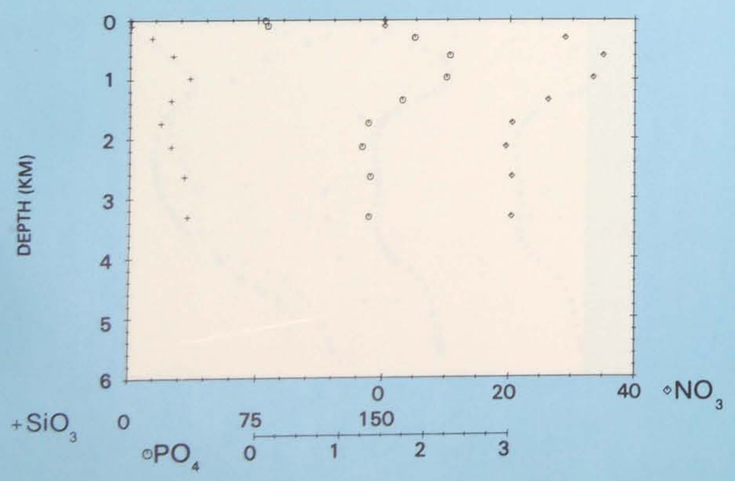












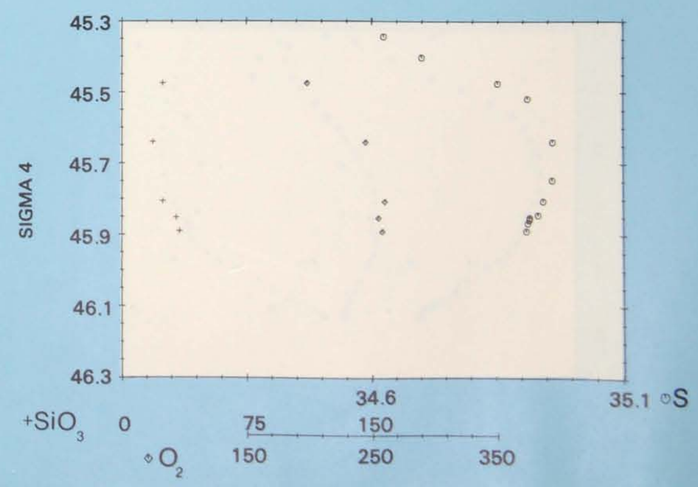
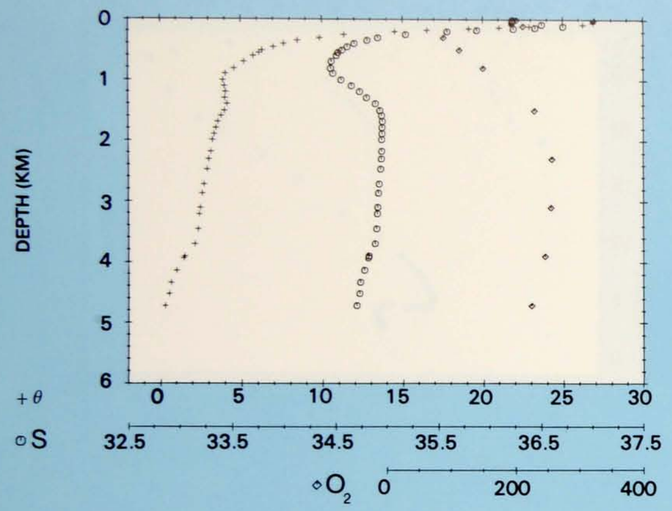
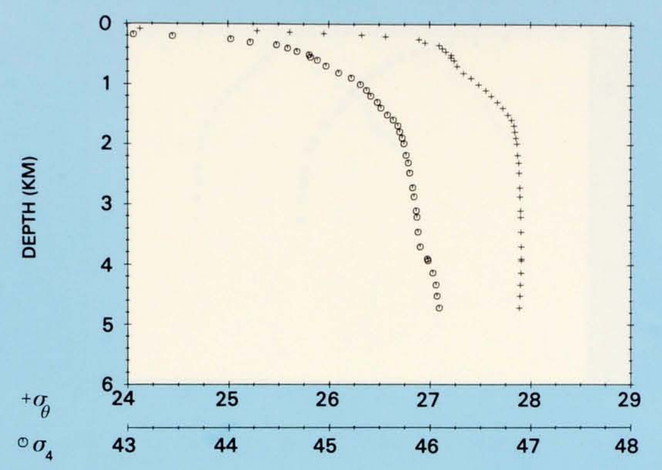


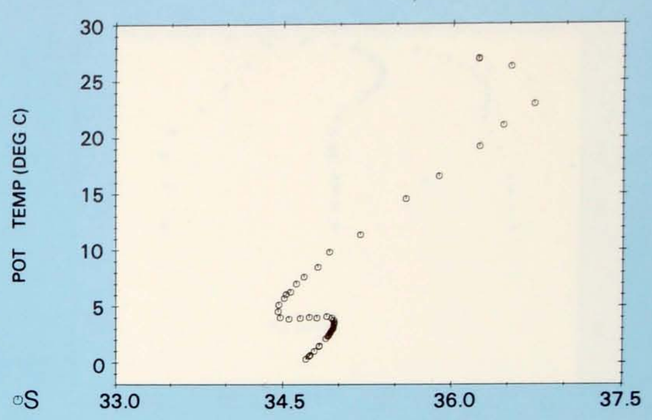
PLATE 114

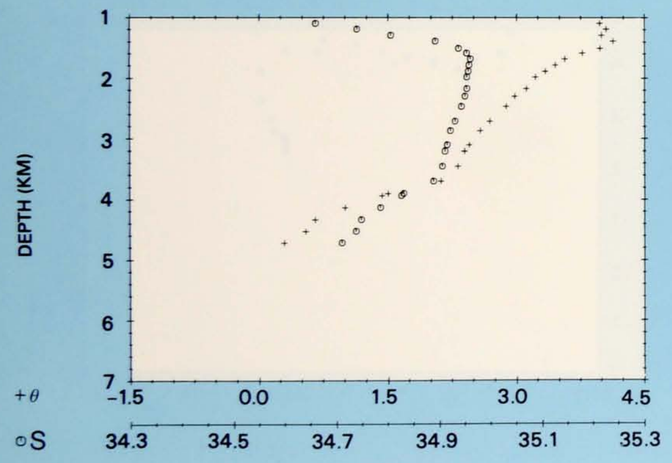
Station 52.
Latitude 8° 54′ S,
Longitude 33° 17′ W.
5 November 1972.

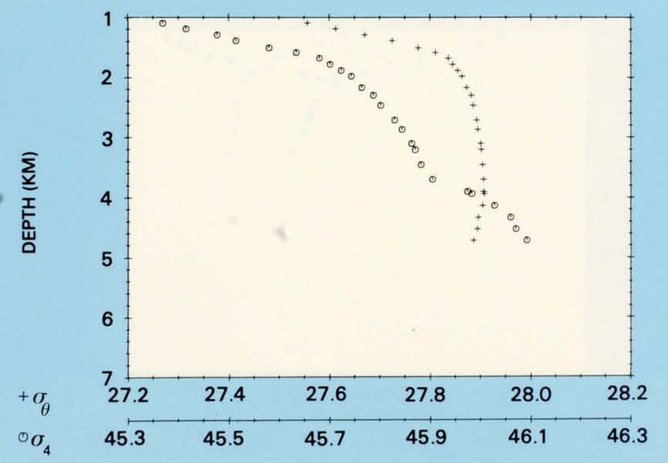
PROPERTY–PROPERTY PLOTS
STATION 52

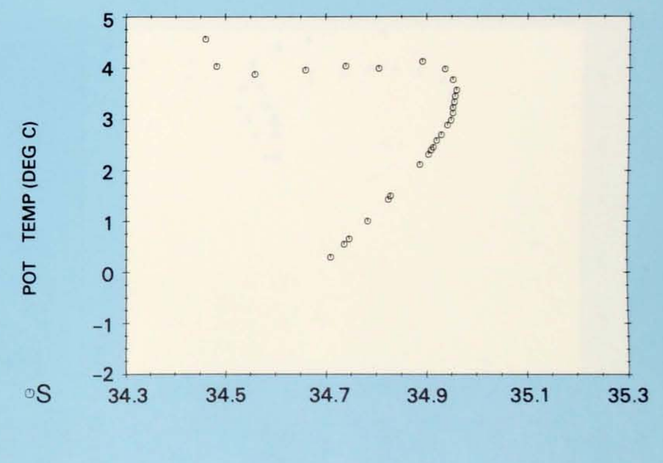


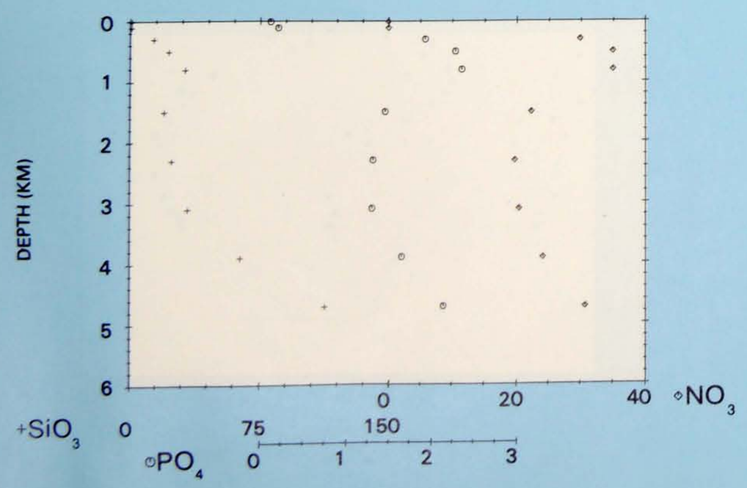


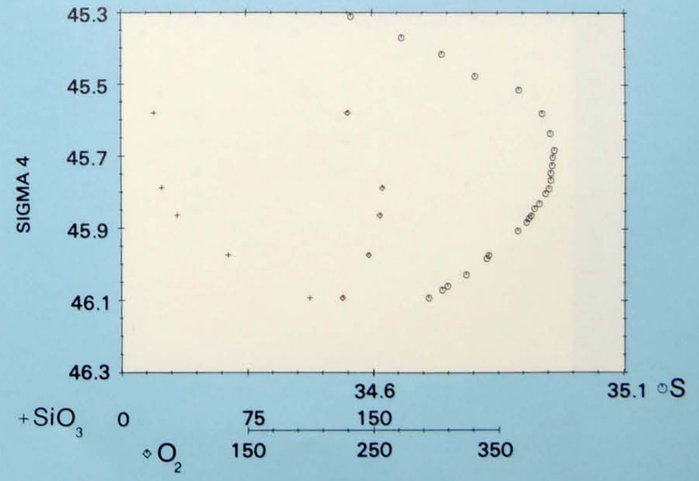


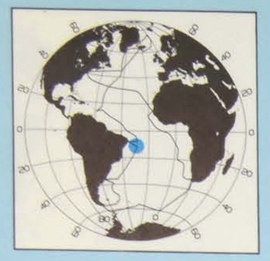








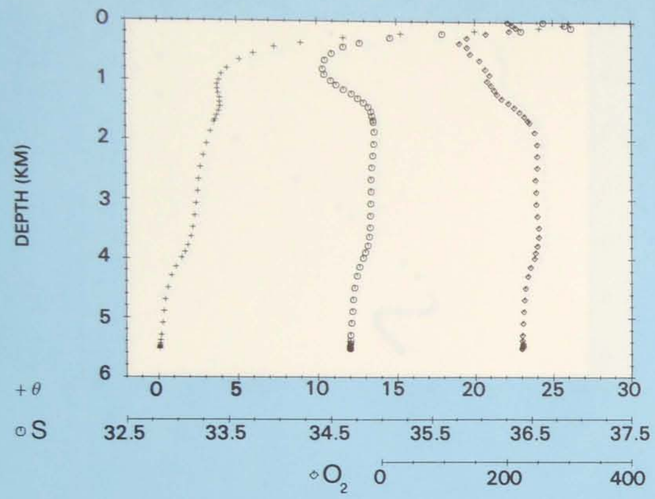


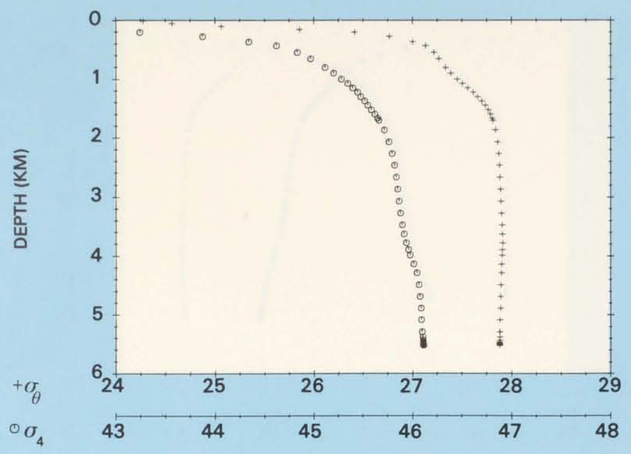


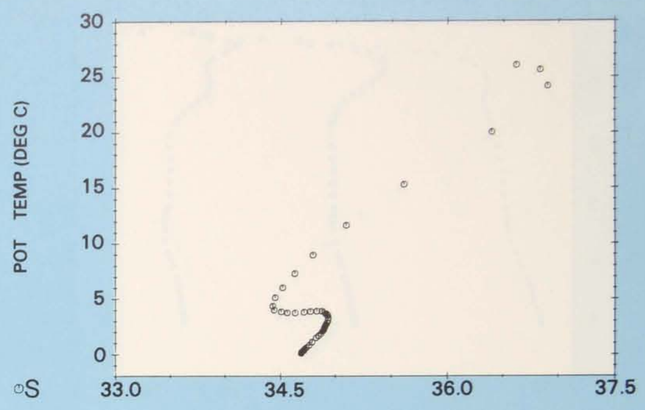
PROPERTY–PROPERTY PLOTS
STATION 53

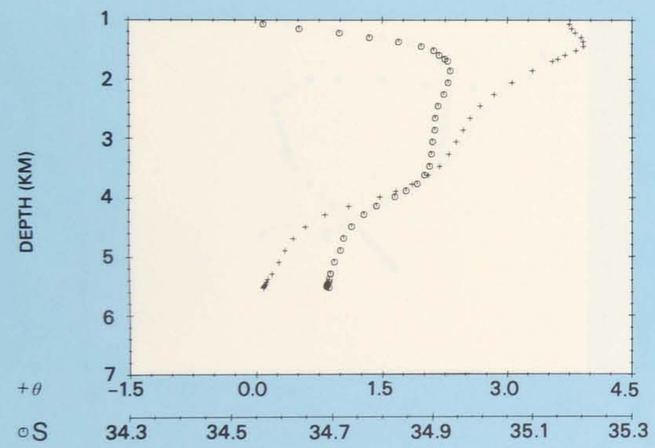
PLATE 115

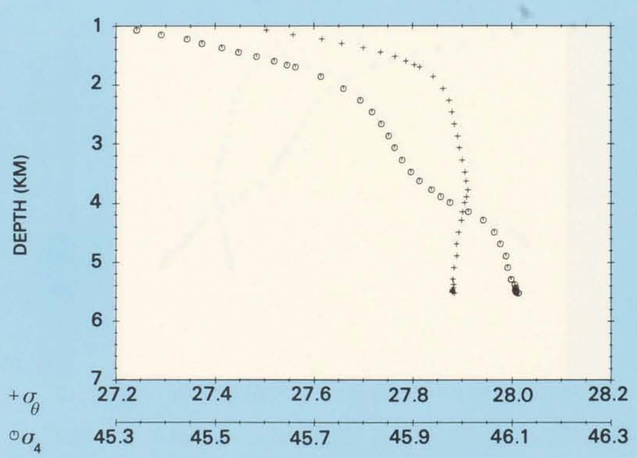
Station 53.
Latitude 11° 59′ S.
Longitude 27° 59′ W.
7 November 1972.

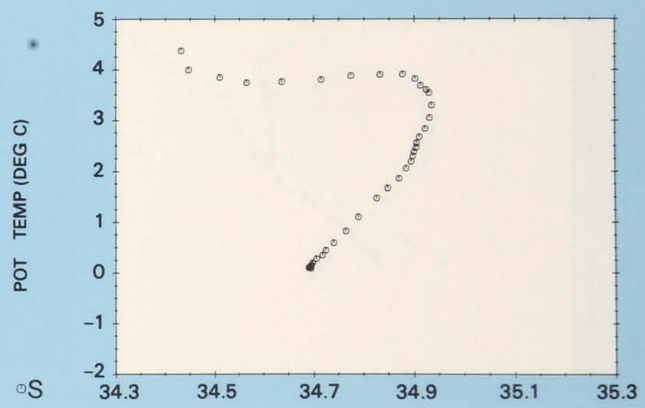


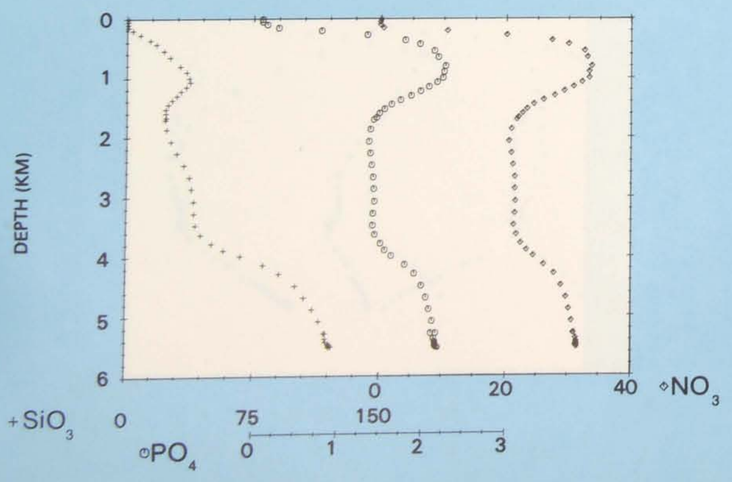


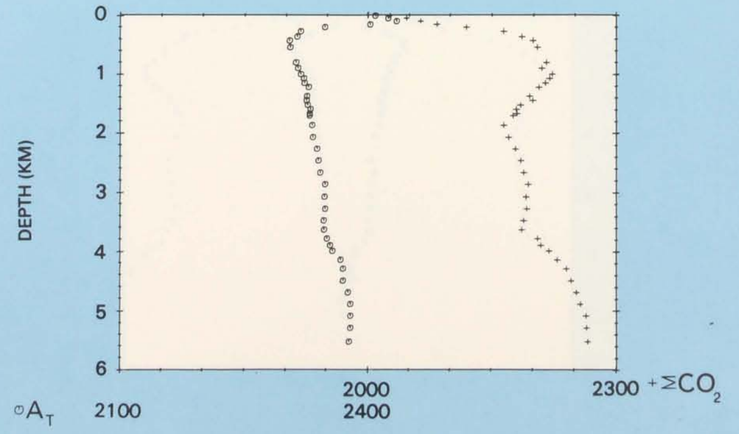












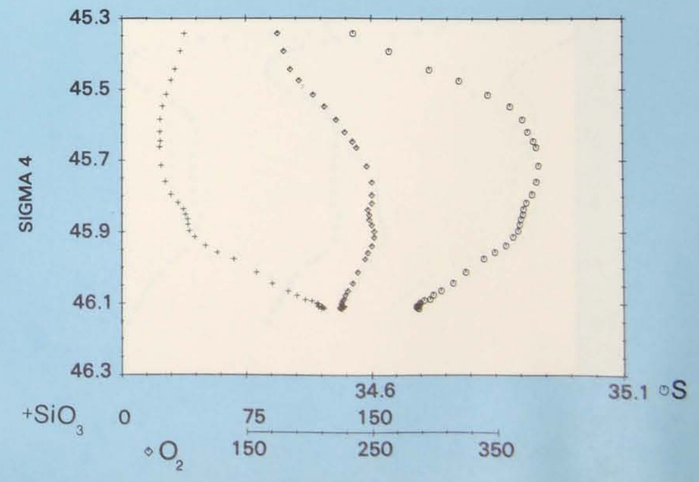
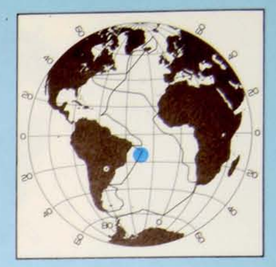
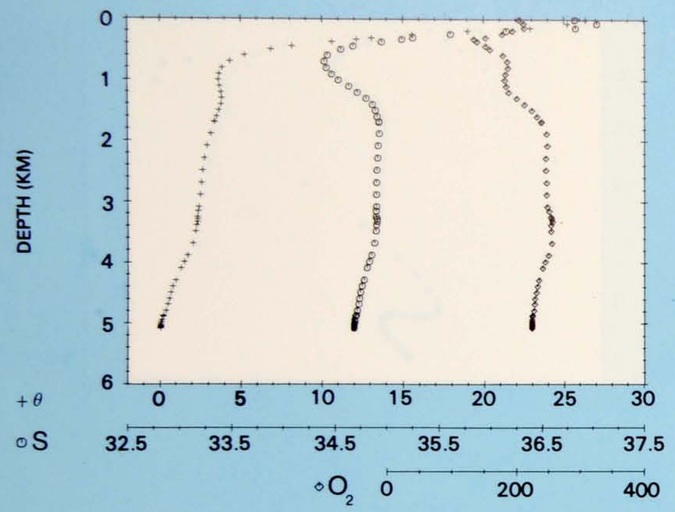


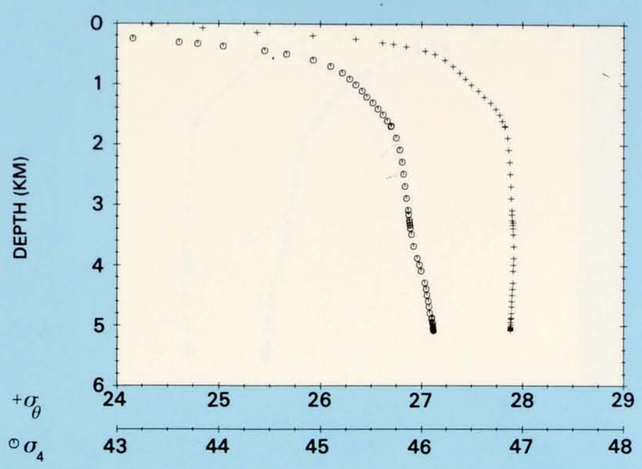
PLATE 116

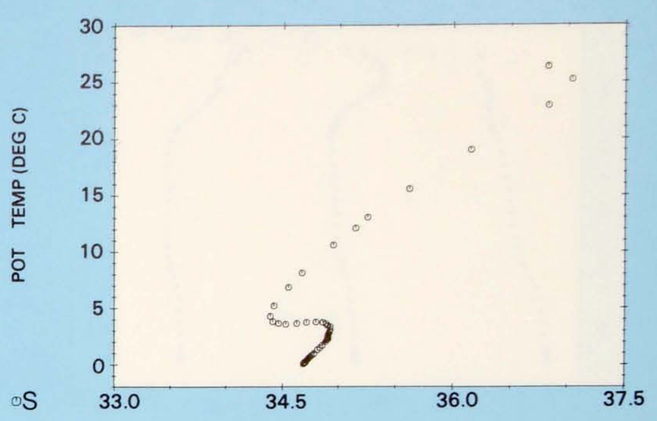
Station 54.
Latitude 15° 02′ S,
Longitude 29° 32′ W.
8 November 1972.

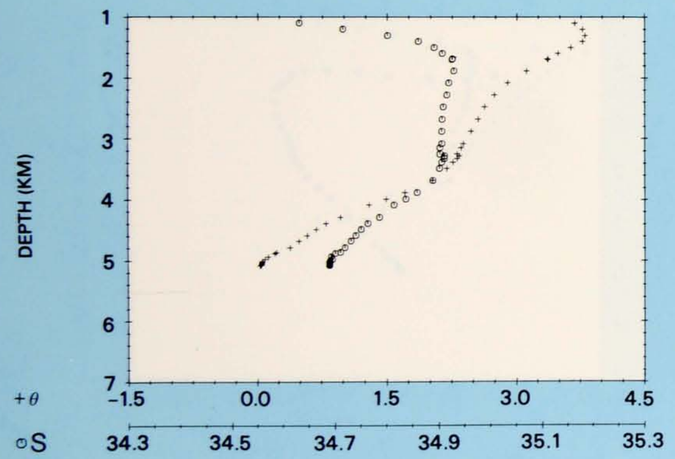
PROPERTY–PROPERTY PLOTS
STATION 54

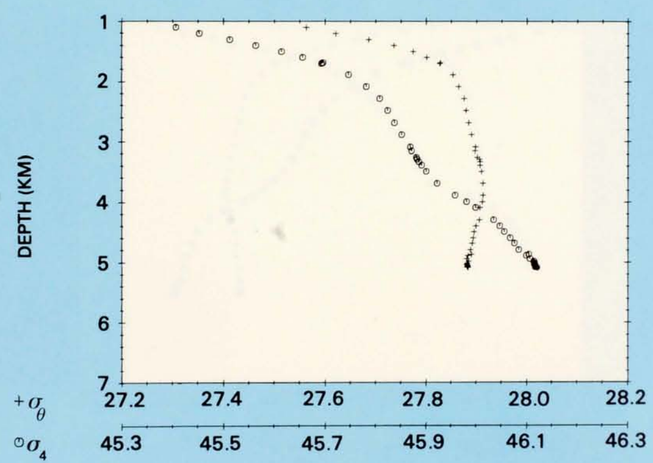


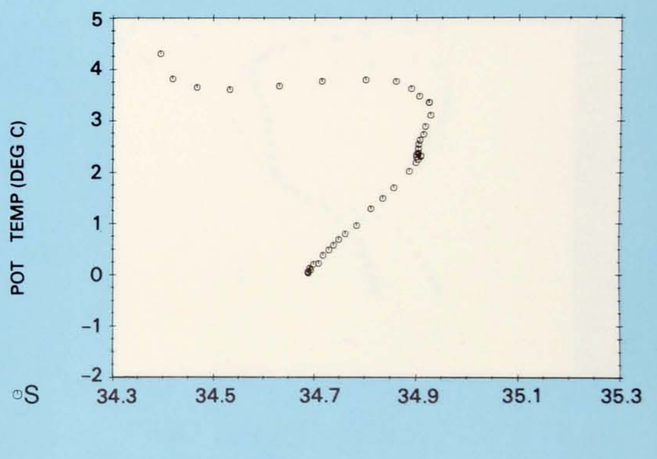


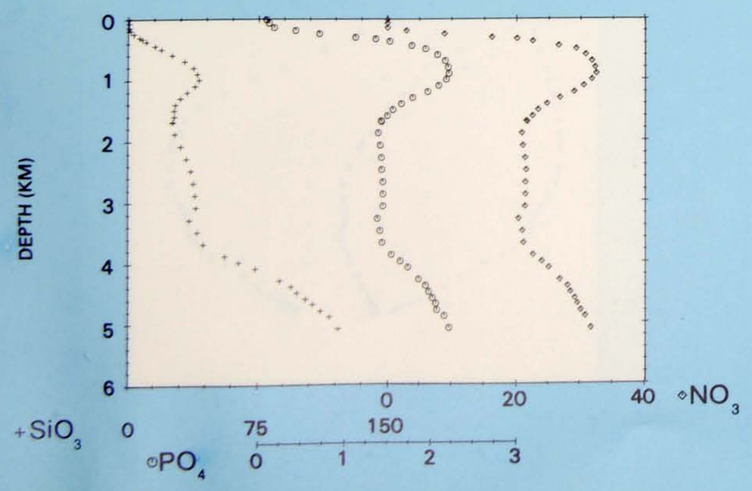


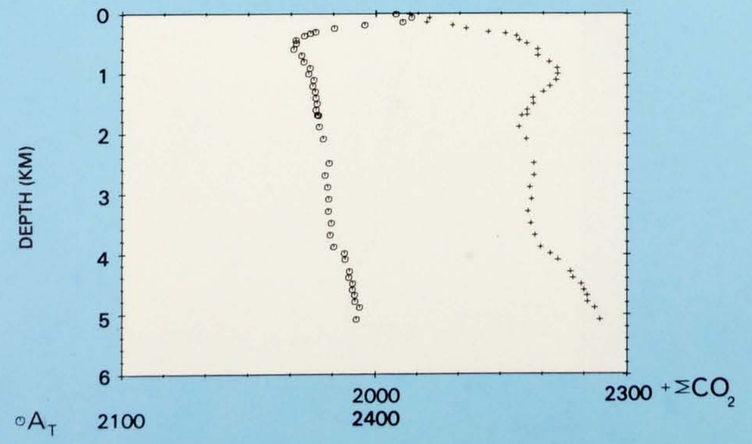


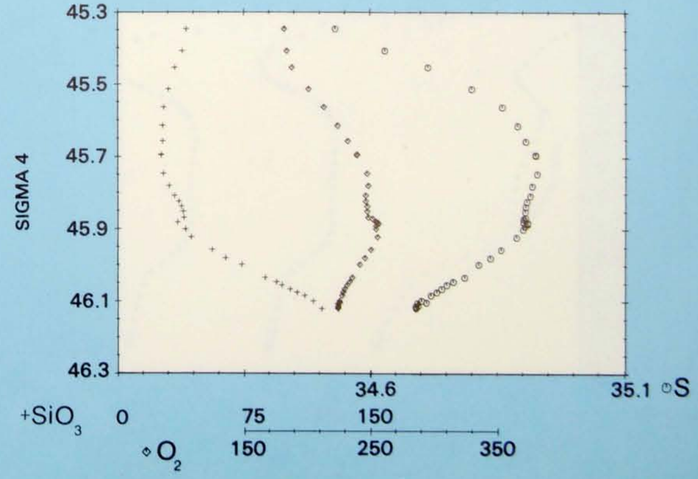


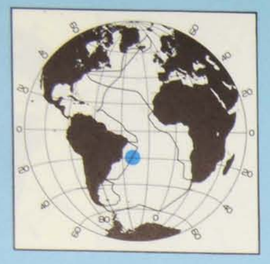








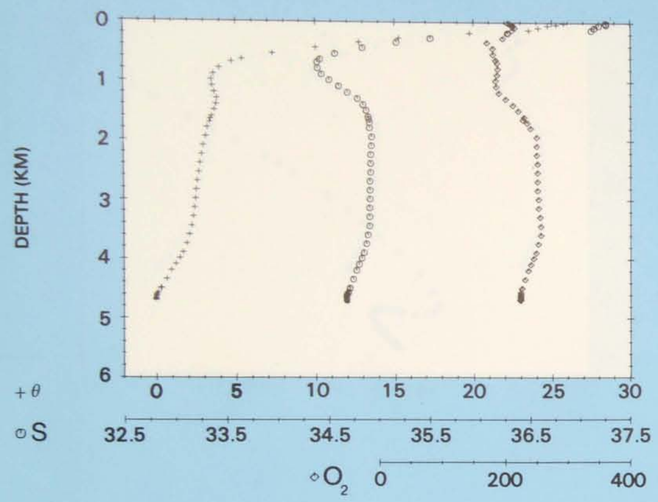


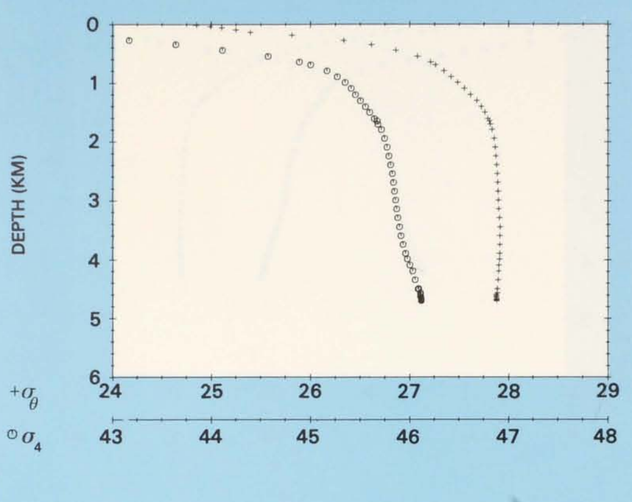


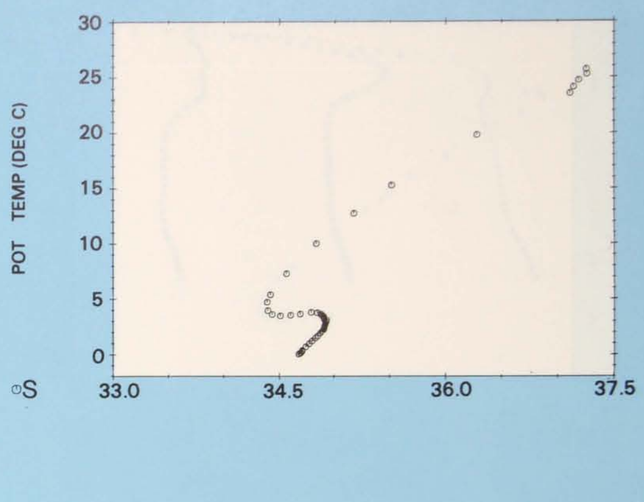
PROPERTY–PROPERTY PLOTS
STATION 55

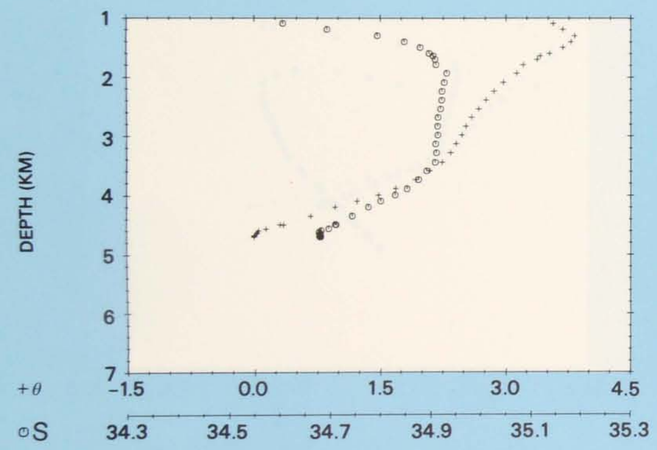
PLATE 117

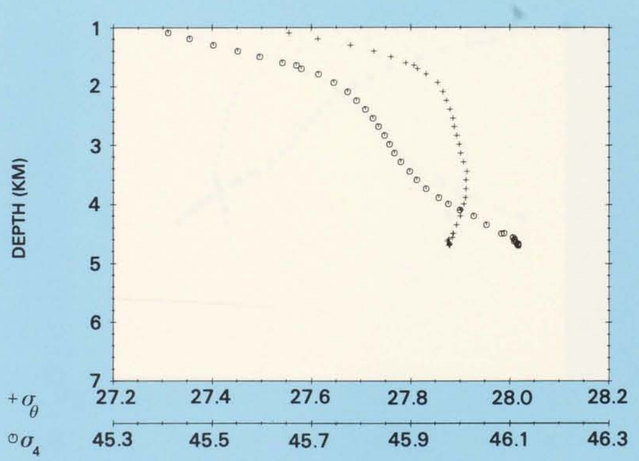
Station 55.
Latitude 18° 00′ S,
Longitude 31° 00′ W.
11 November 1972.

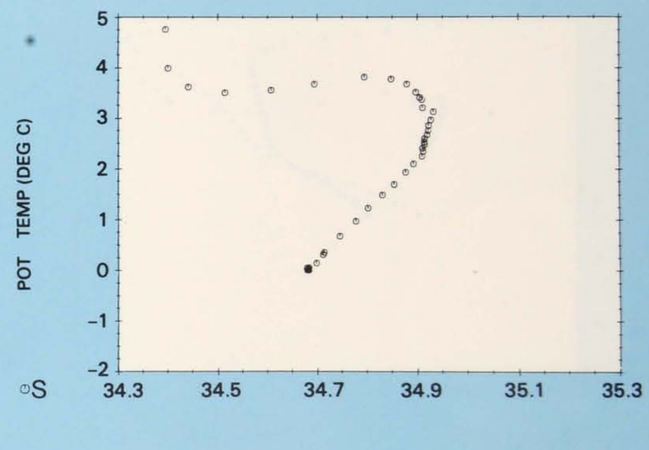


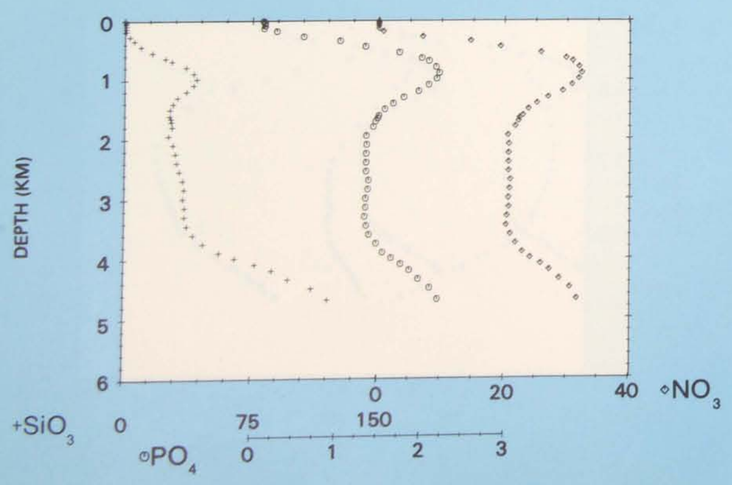


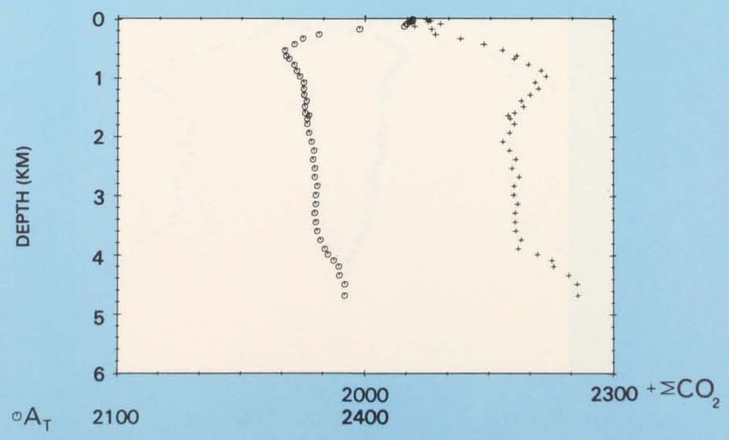












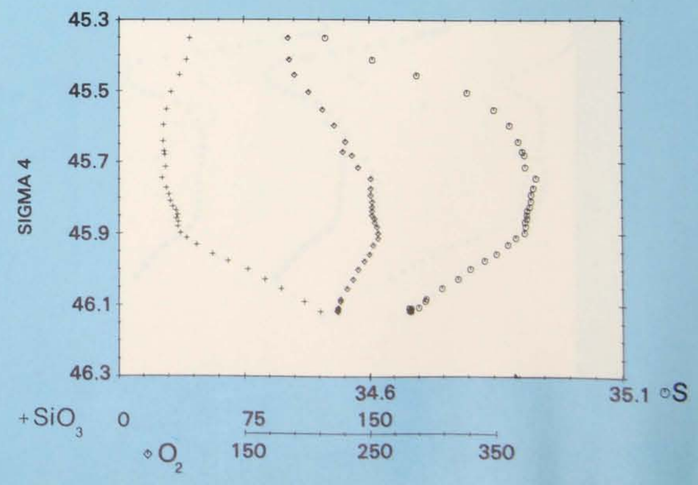
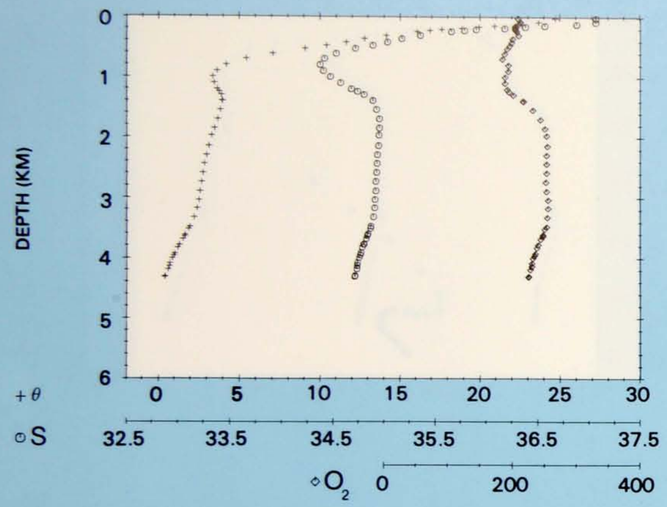
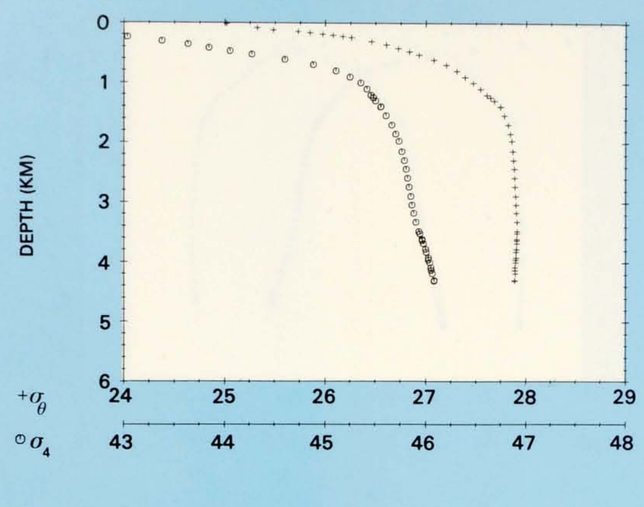


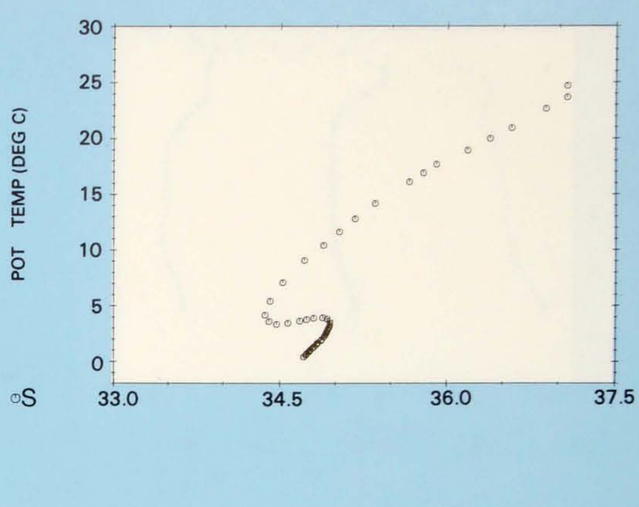
PLATE 118

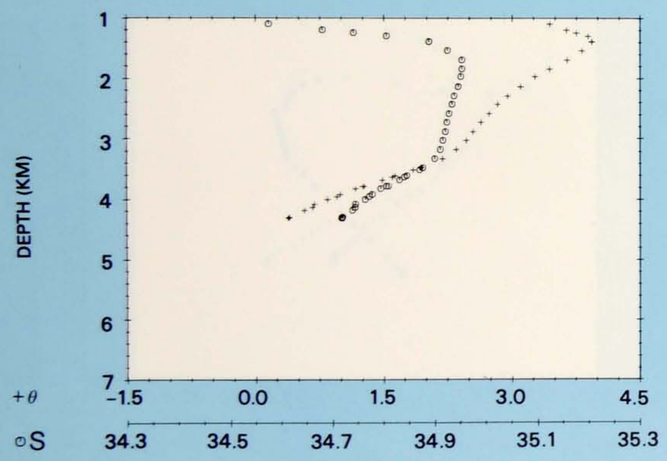
Station 56.
Latitude 21° 00′ S,
Longitude 33° 00′ W.
12 November 1972.

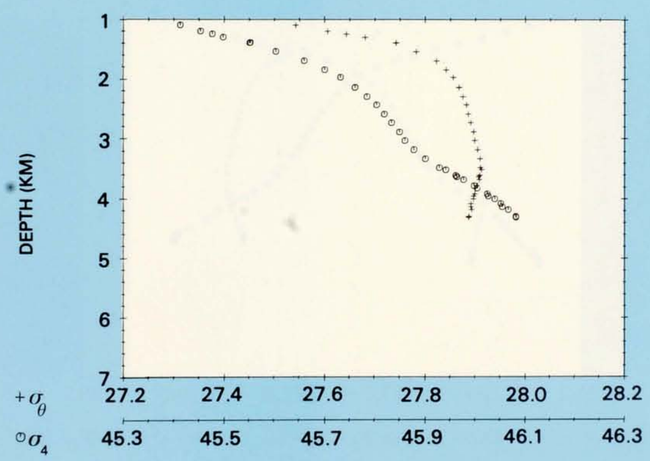
PROPERTY–PROPERTY PLOTS
STATION 56

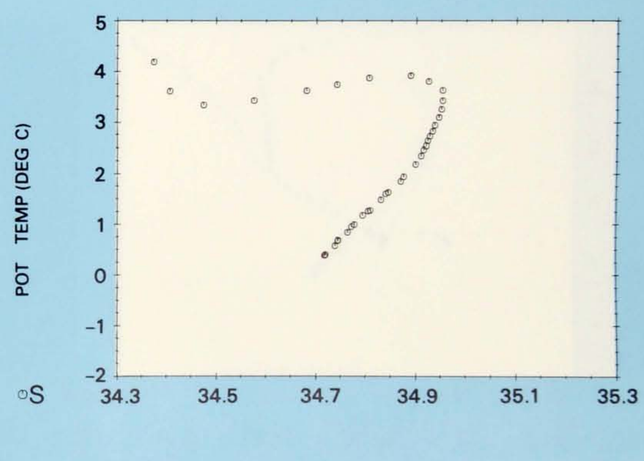


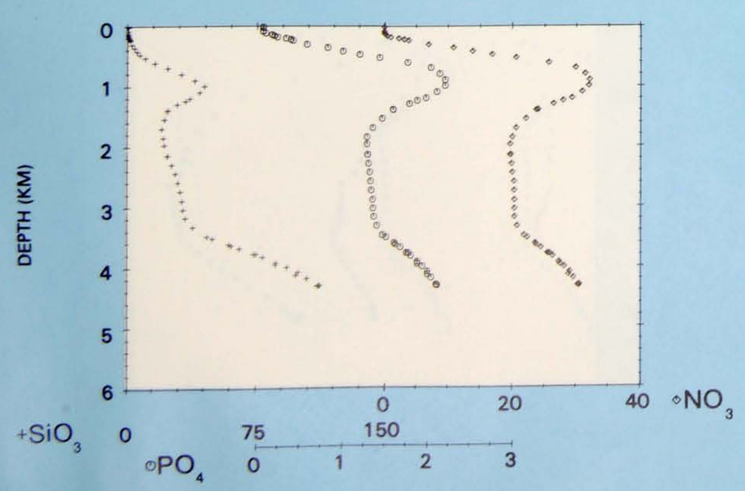


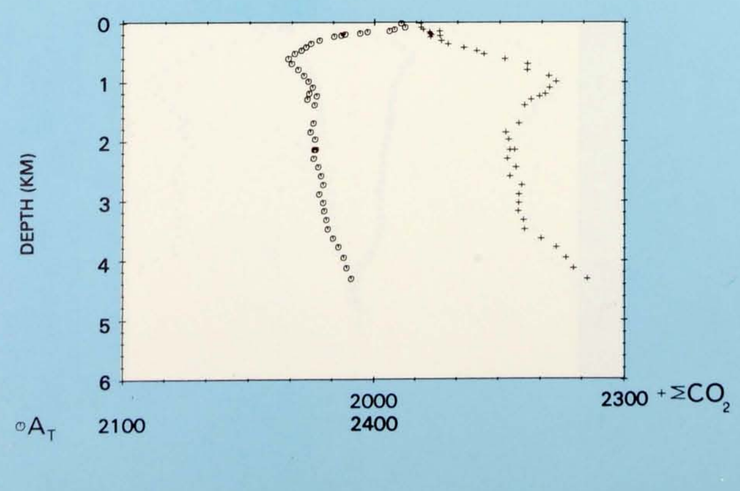


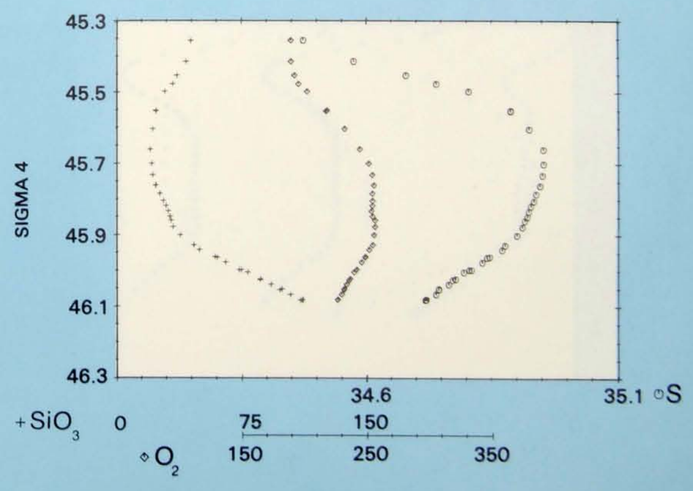


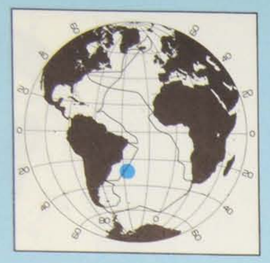








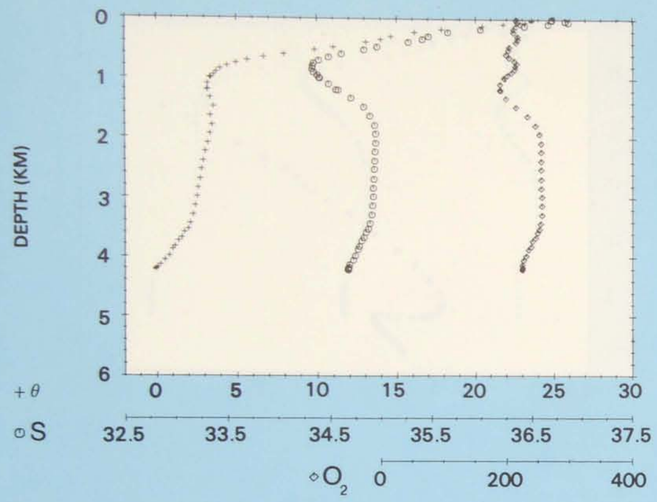


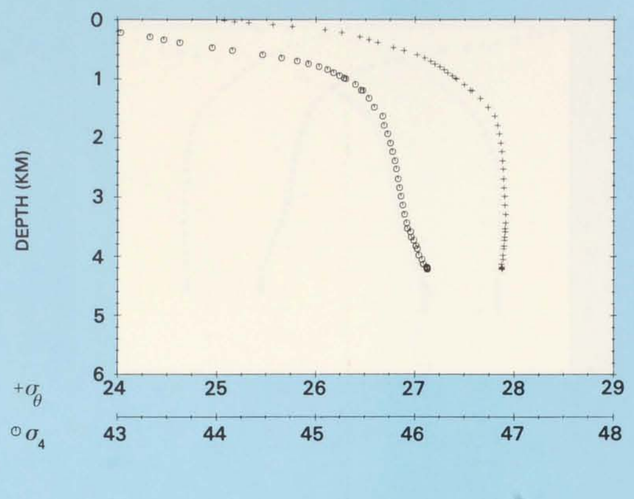


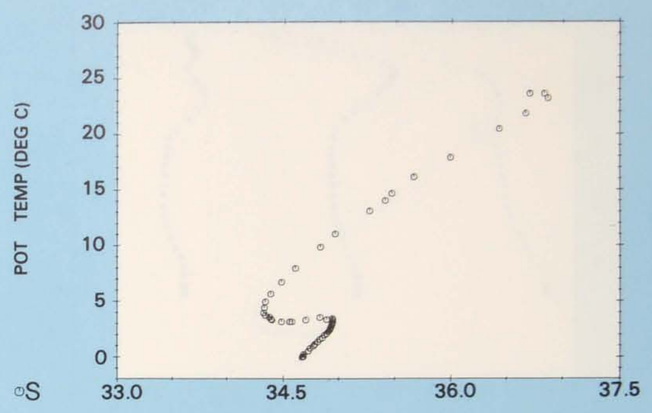
PROPERTY–PROPERTY PLOTS
STATION 57

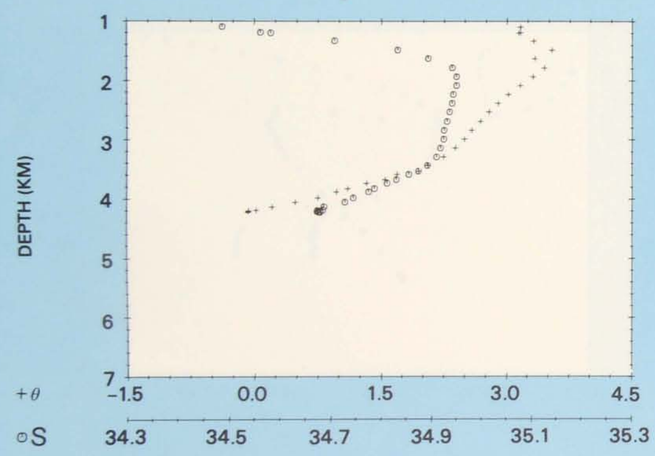
PLATE 119

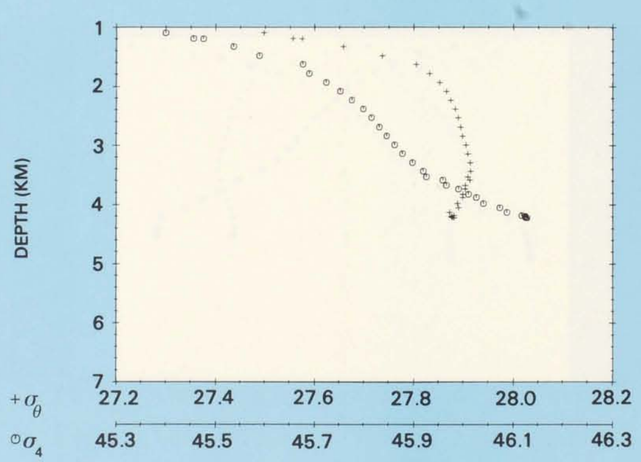
Station 57.
Latitude 23° 59′ S,
Longitude 35° 00′ W.
15 November 1972.

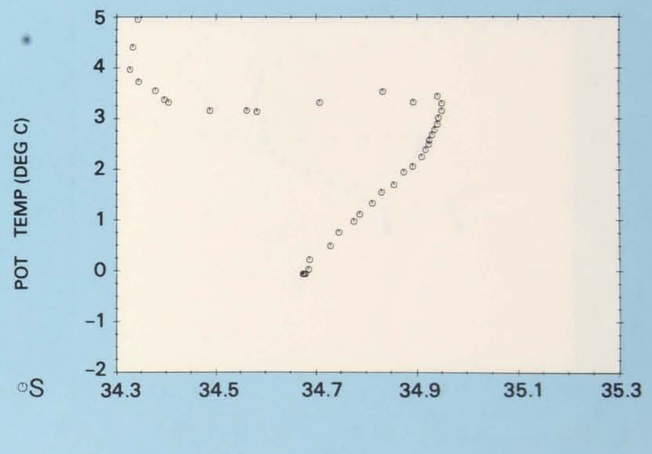


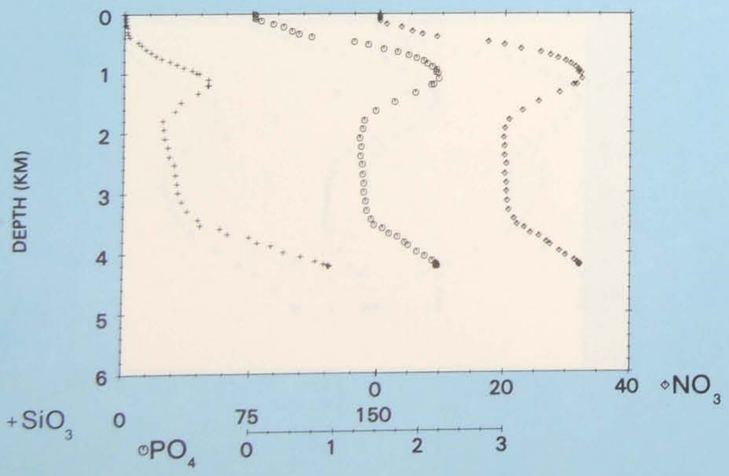


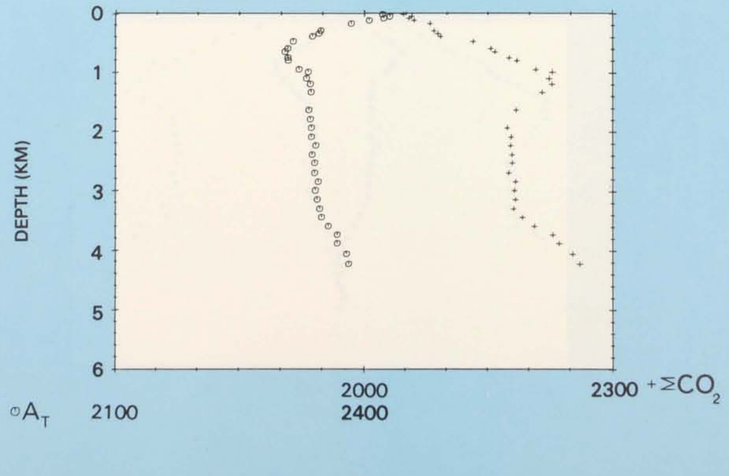












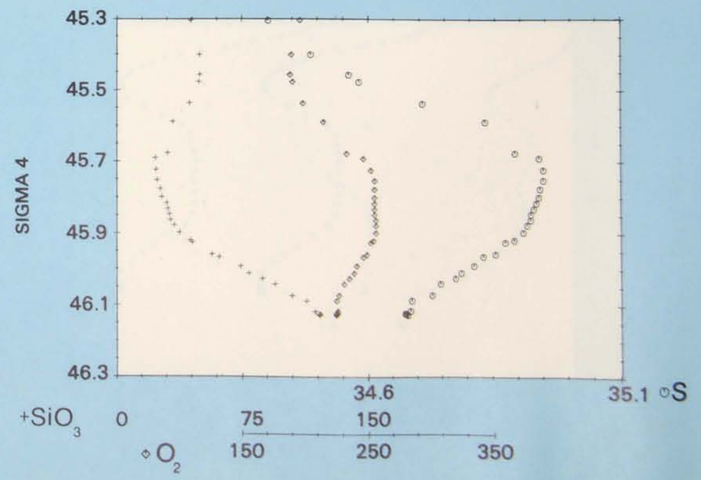
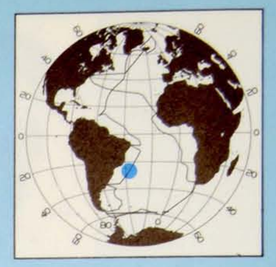
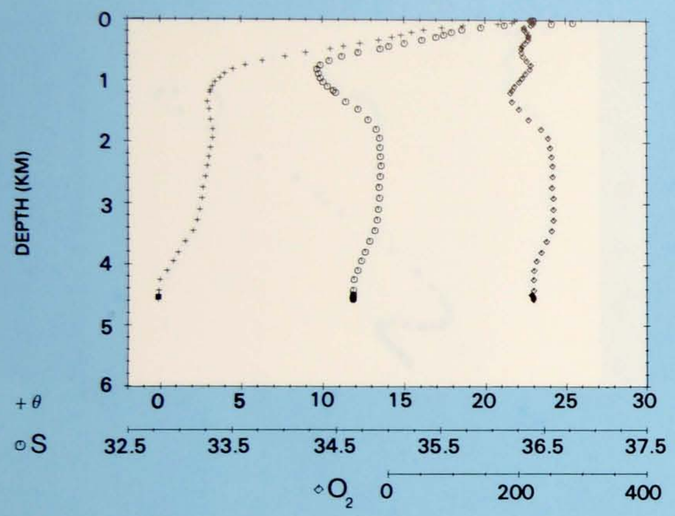


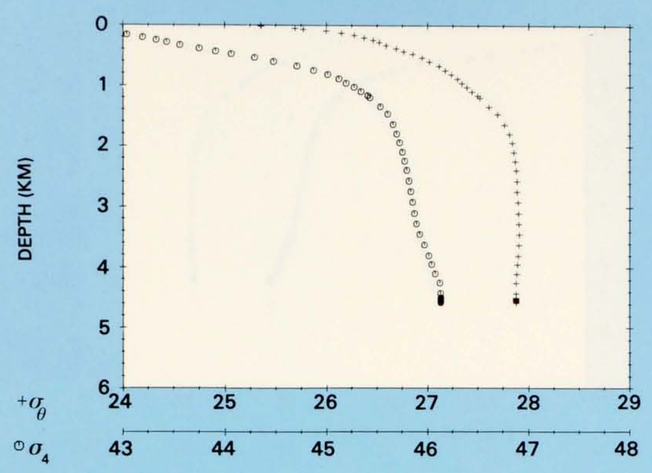
PLATE 120

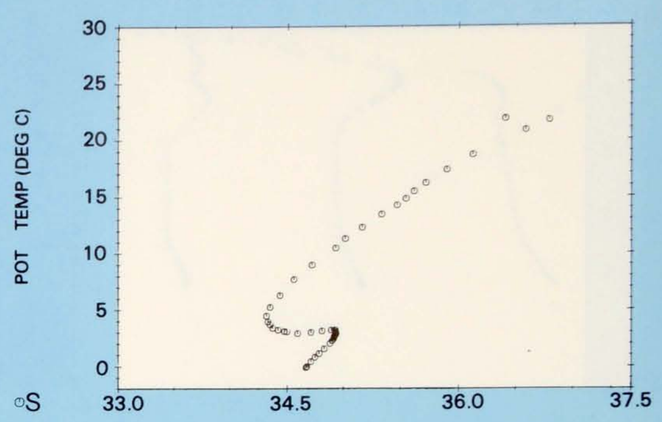
Station 58.
Latitude 27° 00' S,
Longitude 37° 01' W.
16 November 1972.

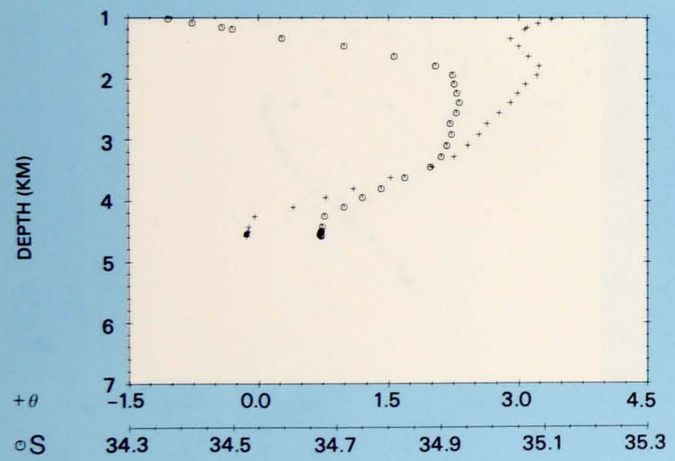
PROPERTY–PROPERTY PLOTS
STATION 58

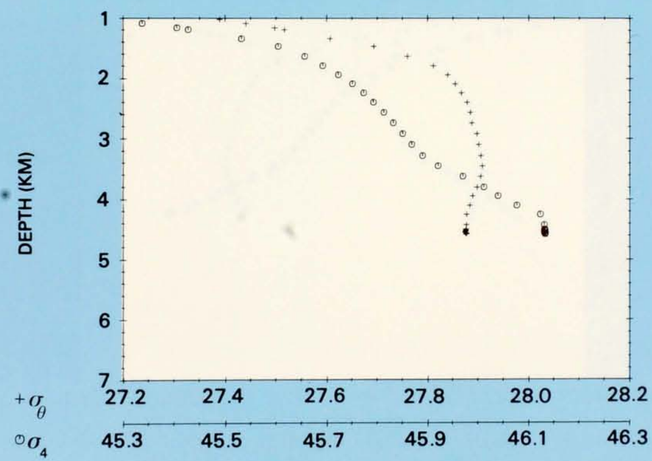


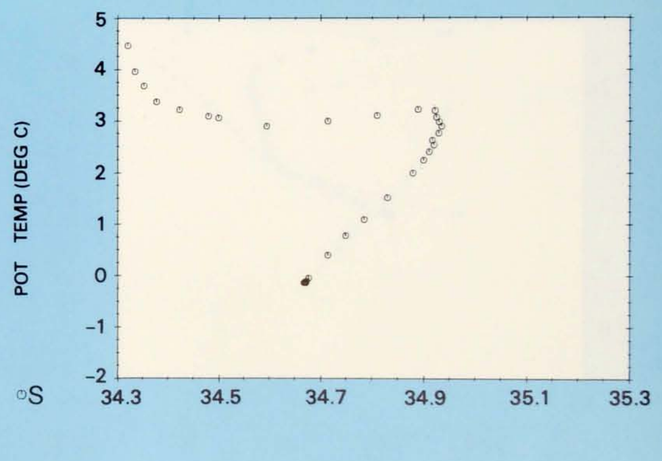


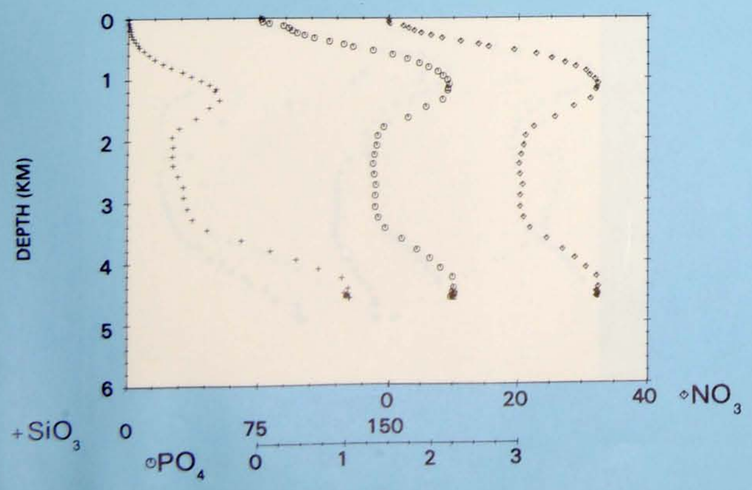


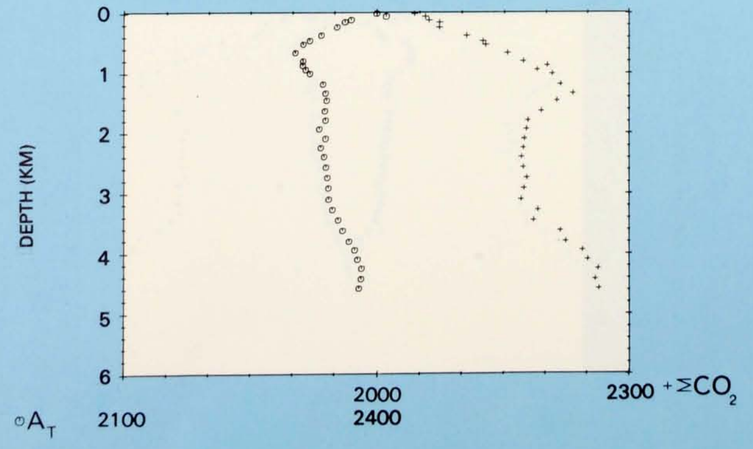


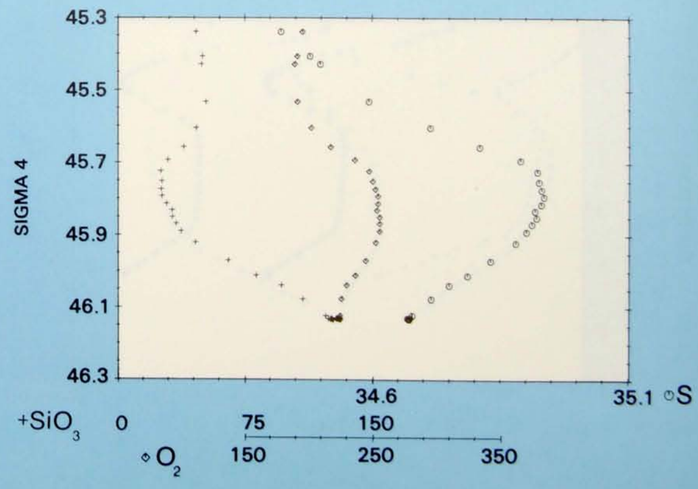








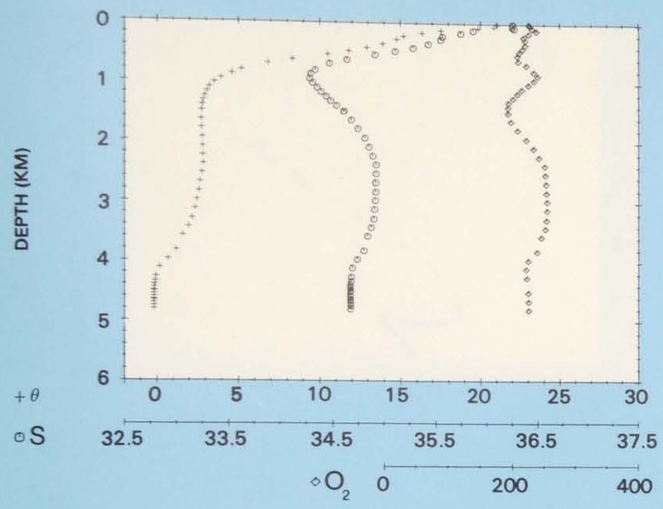


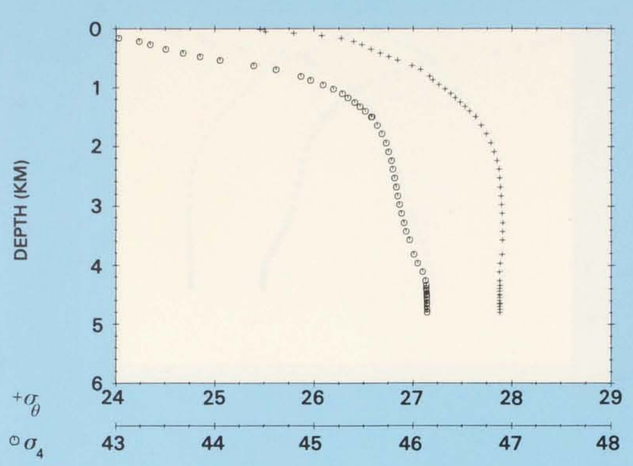


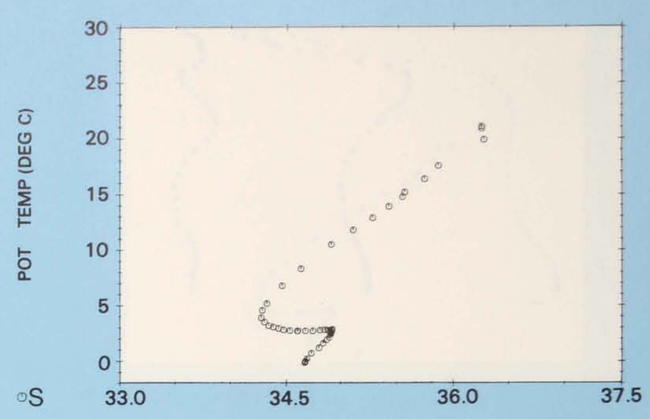
PROPERTY–PROPERTY PLOTS
STATION 59

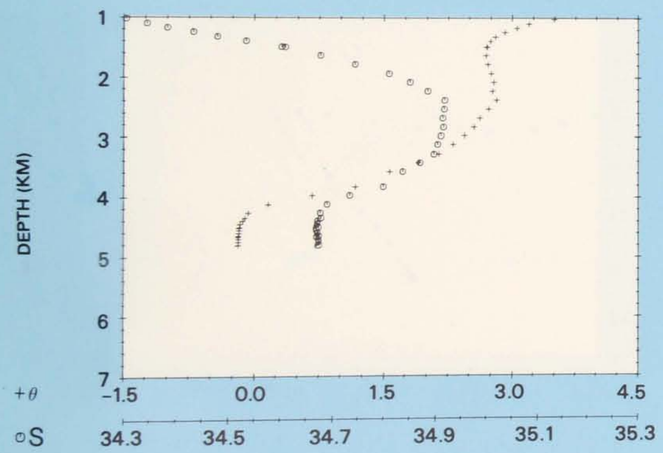
PLATE 121

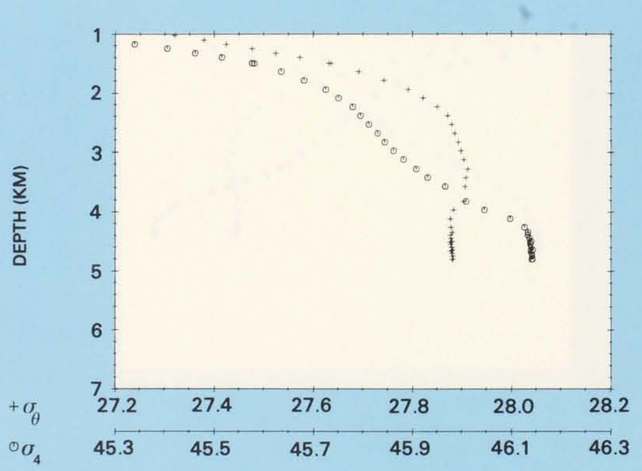
Station 59.
Latitude 30° 12′ S,
Longitude 39° 18′ W.
20 November 1972.

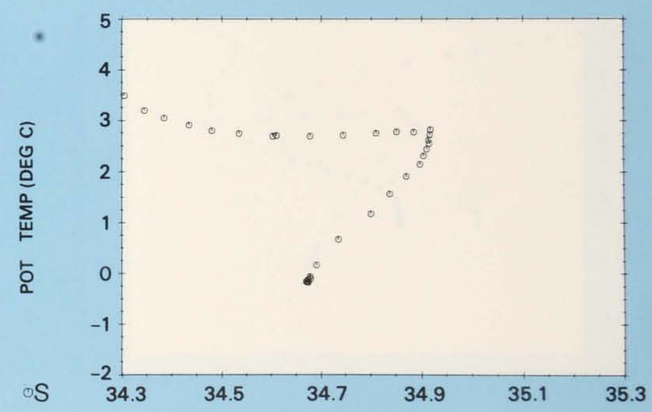


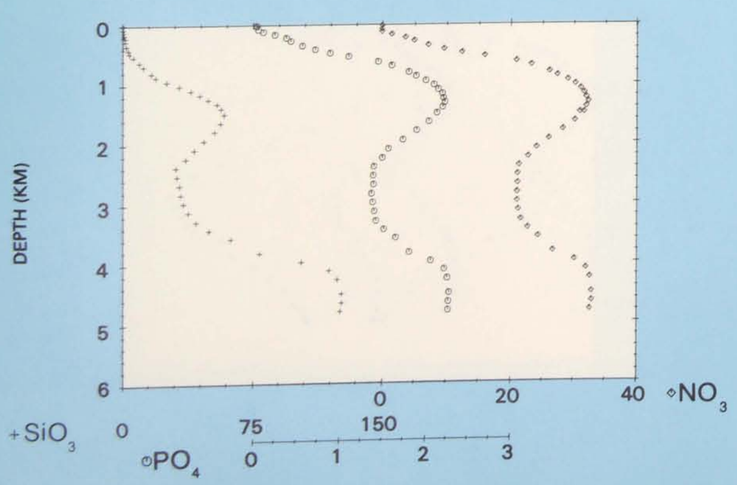


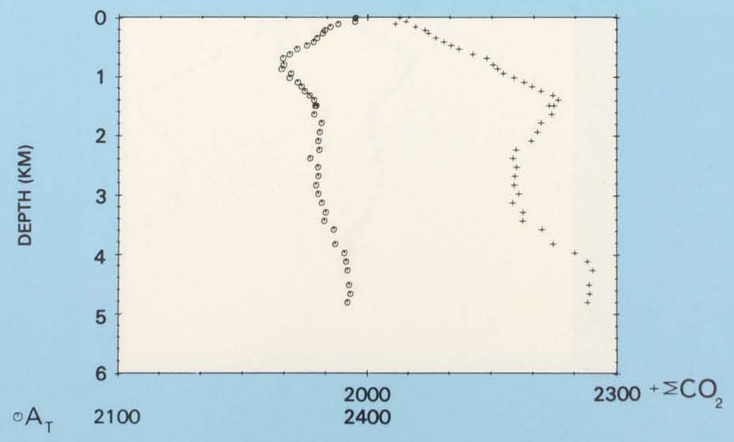












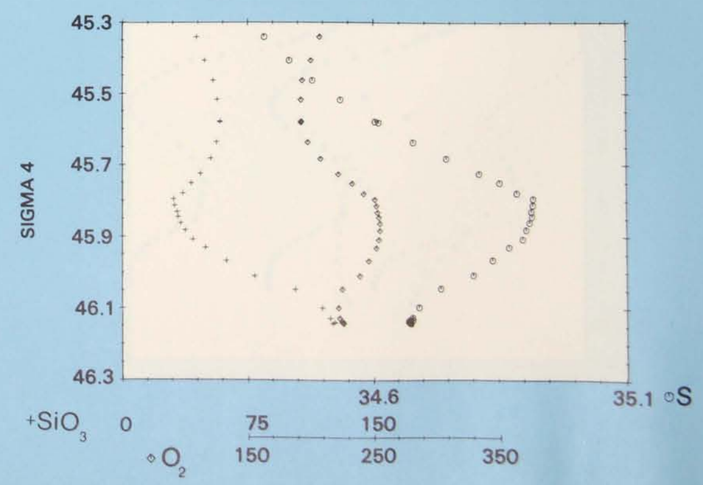
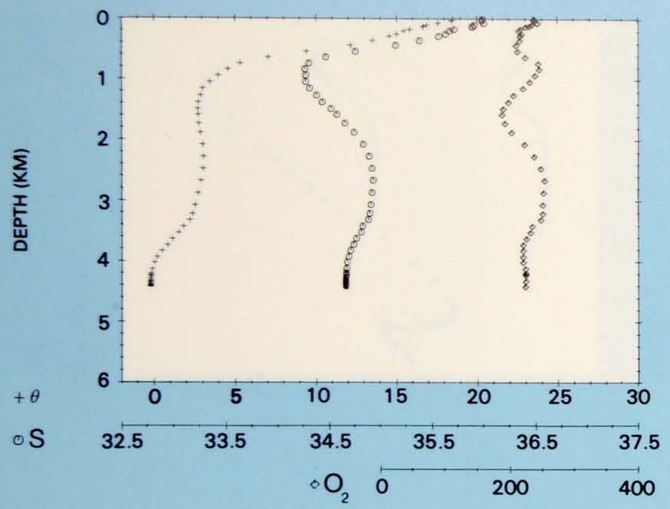
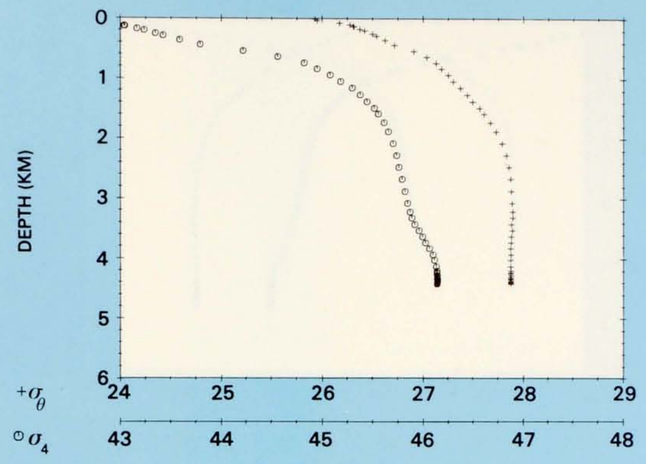


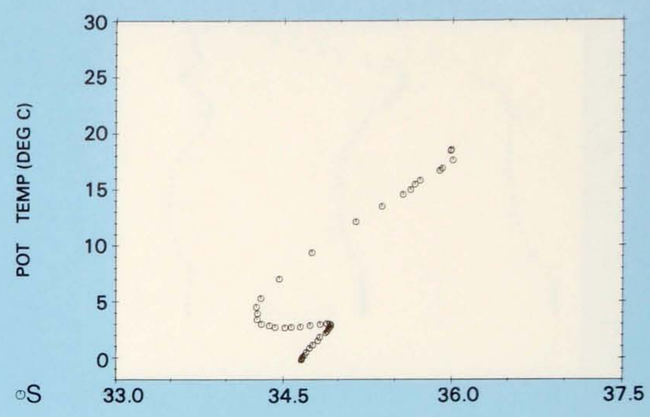
PLATE 122

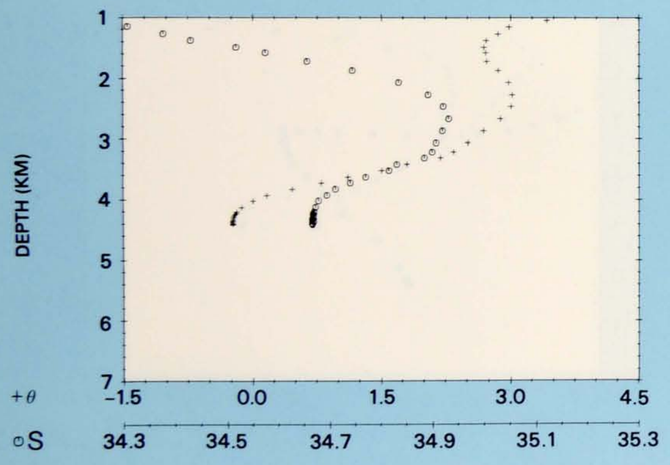
Station 60.
Latitude 32° 58′ S,
Longitude 42° 30′ W.
22 November 1972.

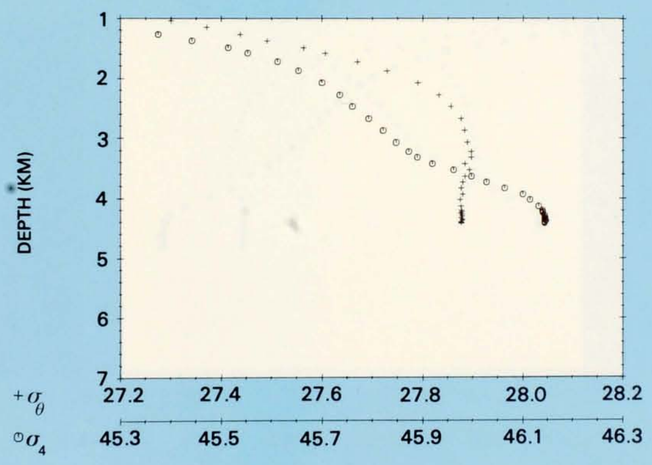
PROPERTY–PROPERTY PLOTS
STATION 60

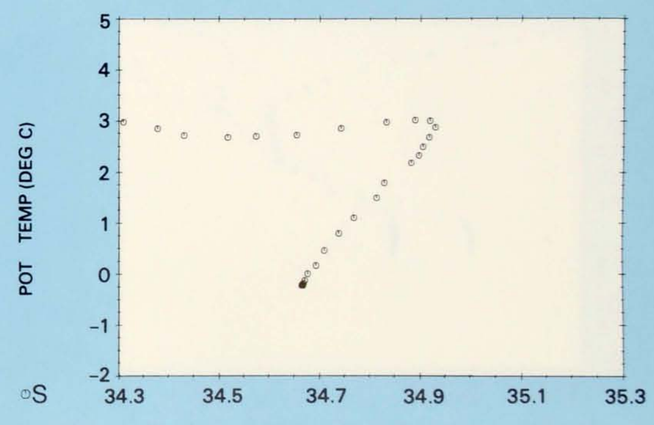


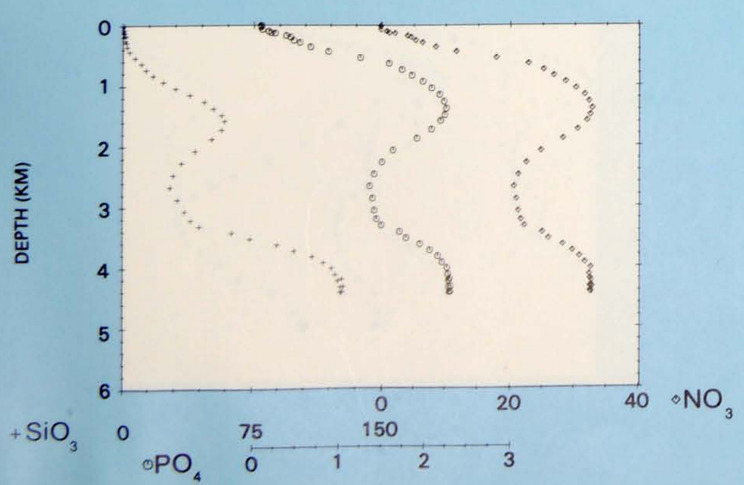


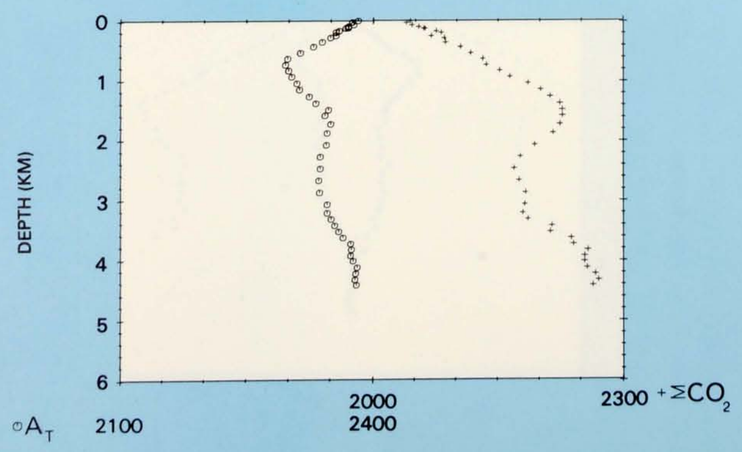


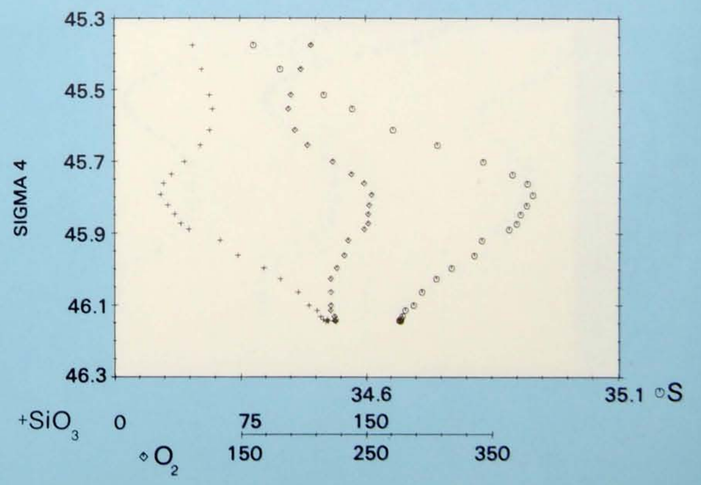








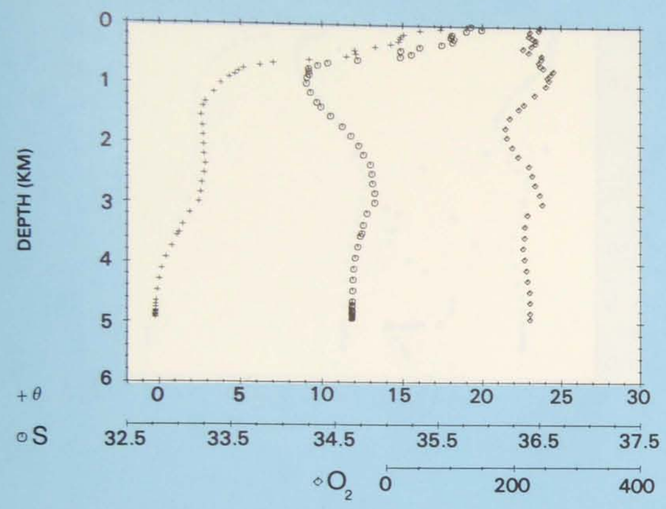


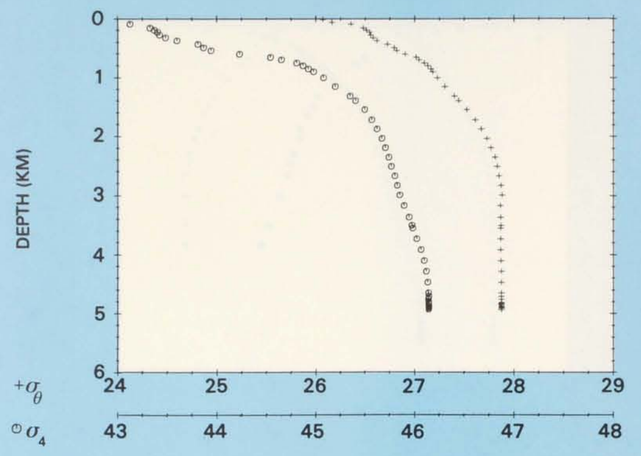


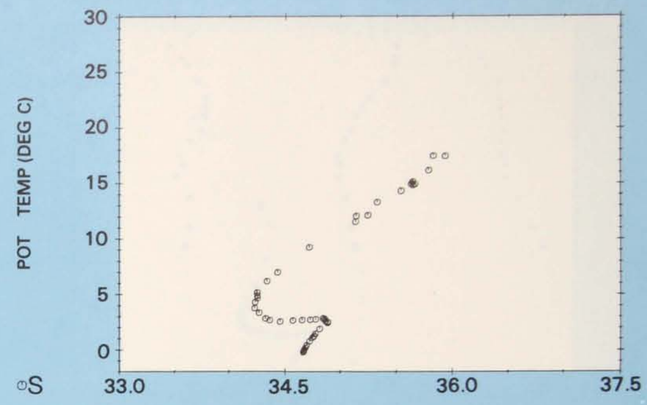
PROPERTY–PROPERTY PLOTS
STATION 61

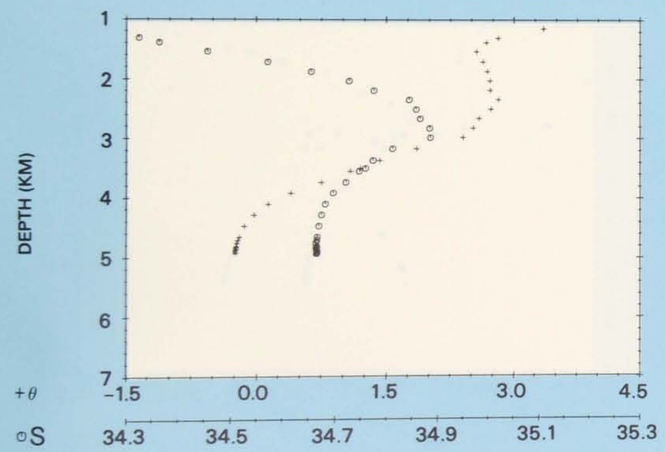
PLATE 123

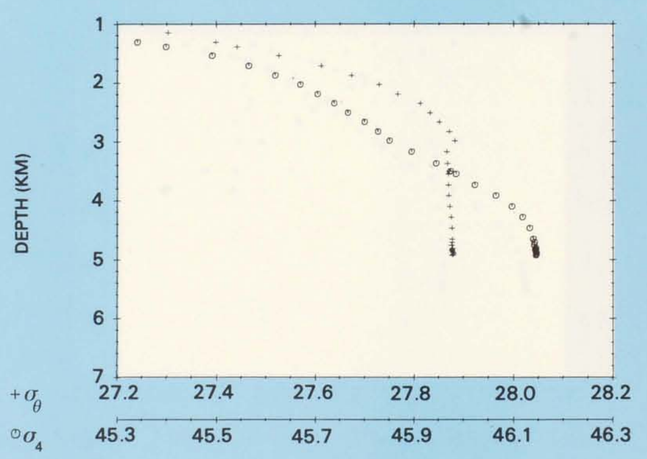
Station 61.
Latitude 36° 00′ S,
Longitude 45° 00′ W.
24 November 1972.

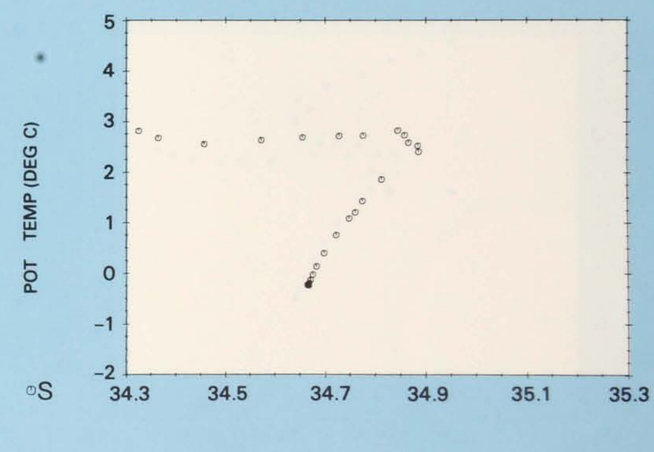


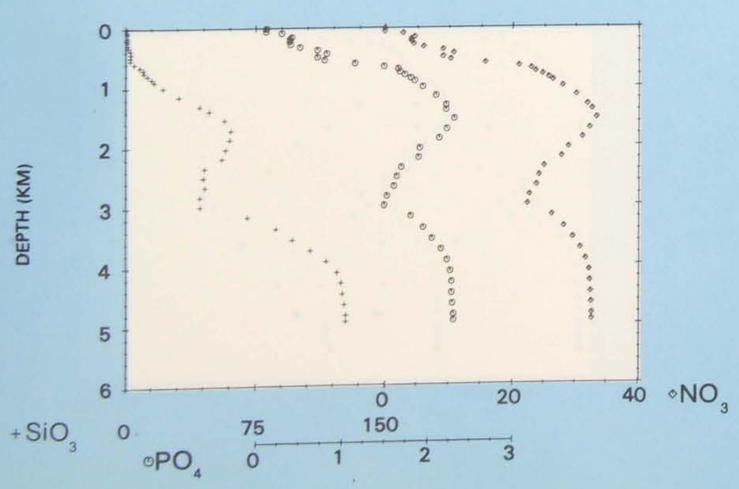


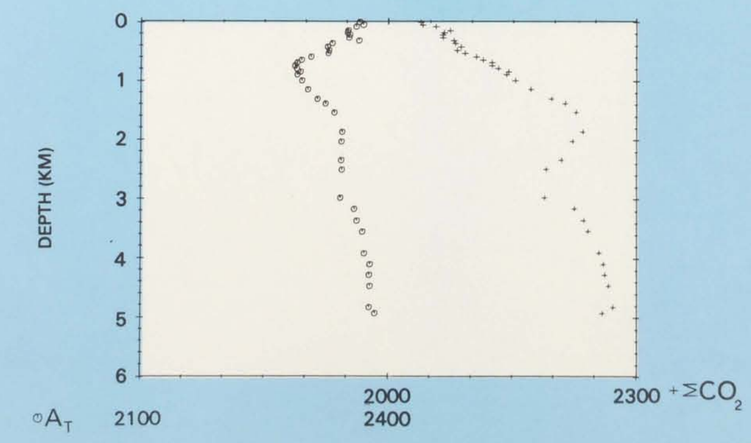












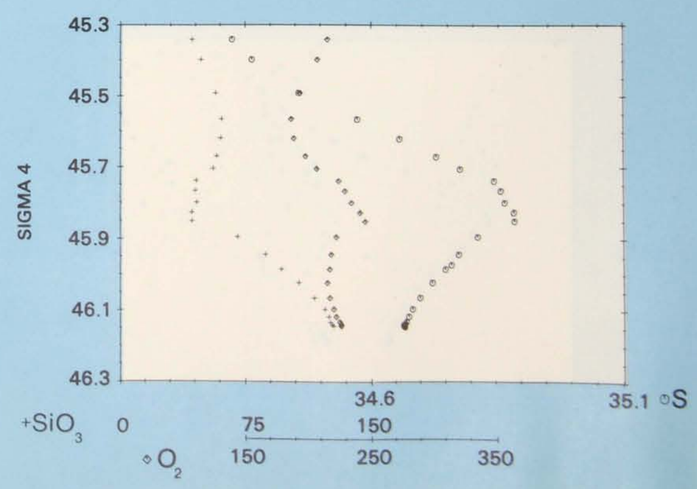
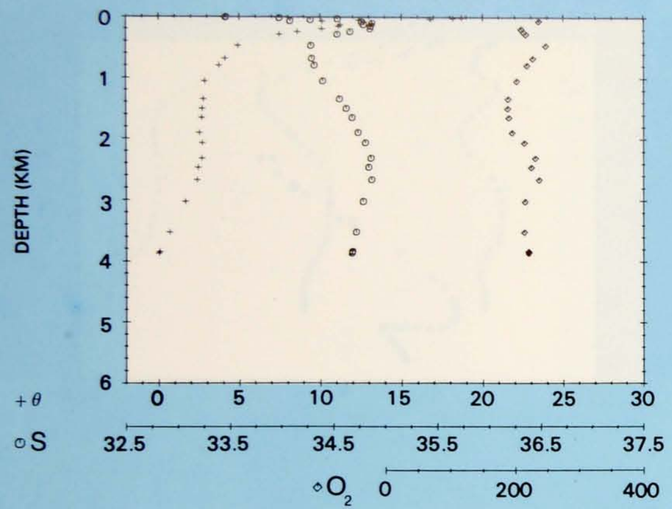
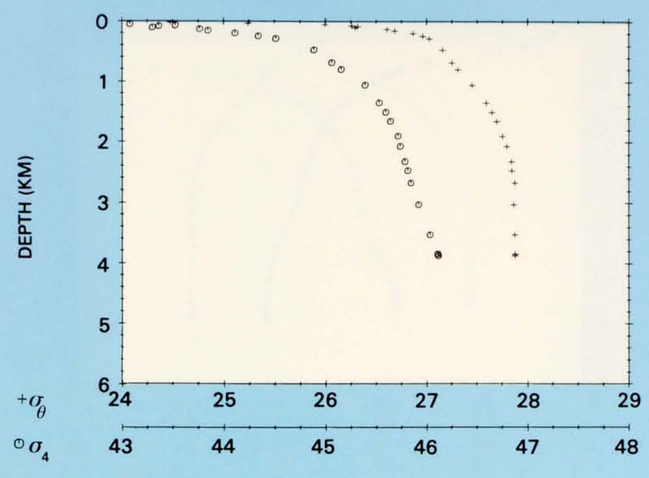


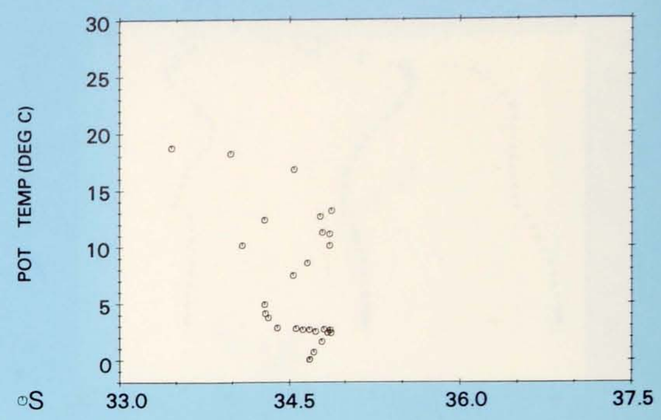
PLATE 124

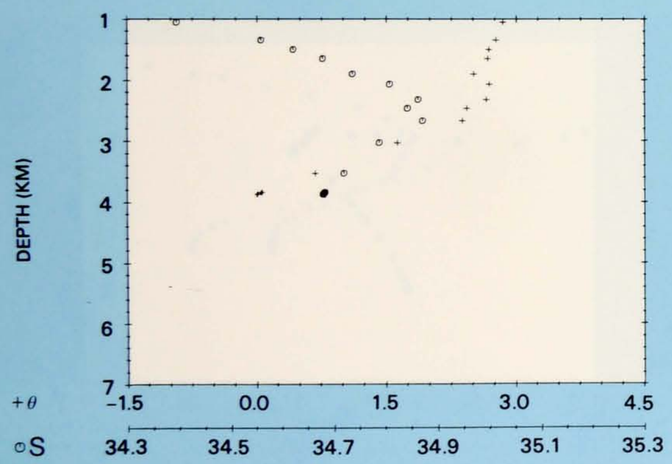
Station 63.
Latitude 37° 14′ S,
Longitude 52° 00′ W.
4 December 1972.

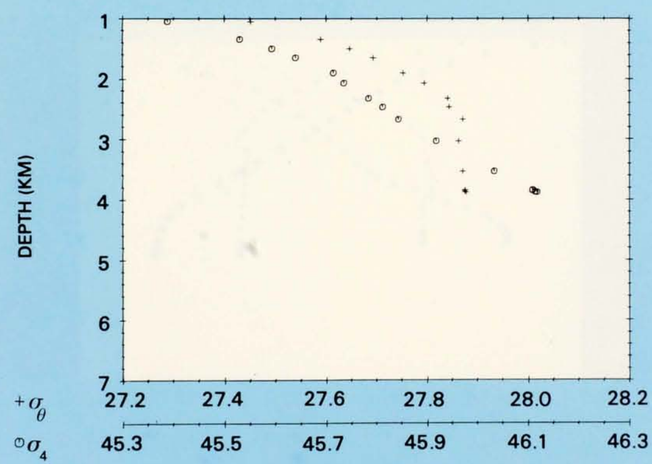
PROPERTY–PROPERTY PLOTS
STATION 63

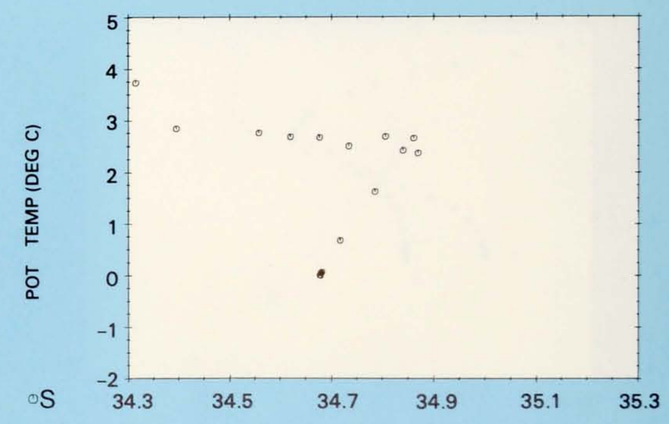


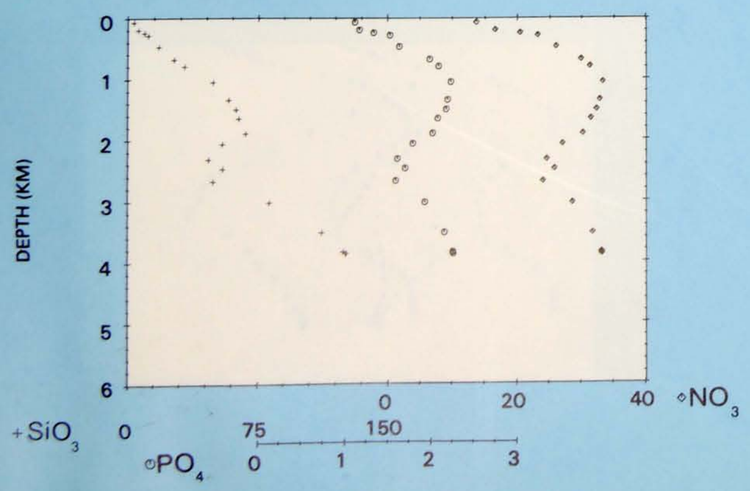


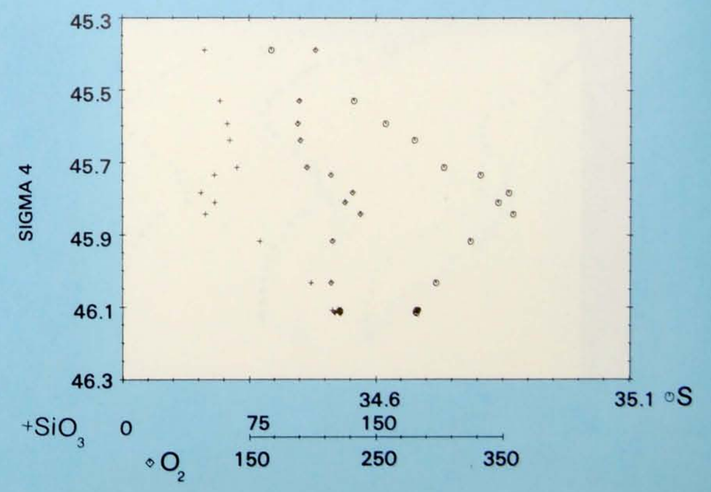








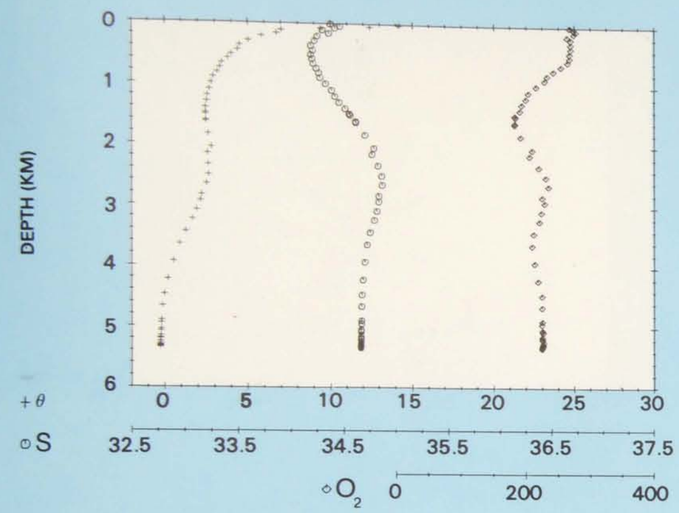


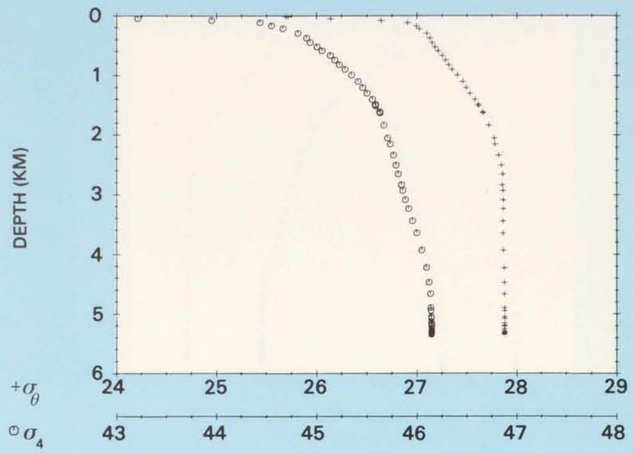


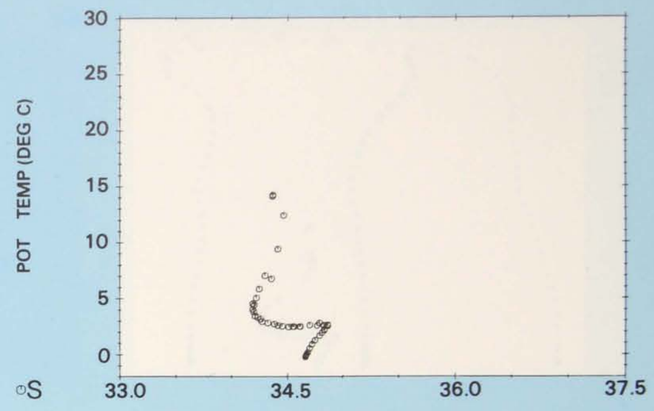
PROPERTY–PROPERTY PLOTS
STATION 64

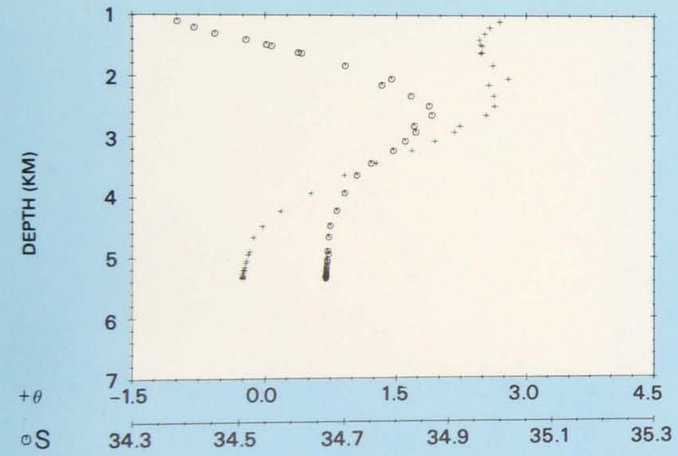
PLATE 125

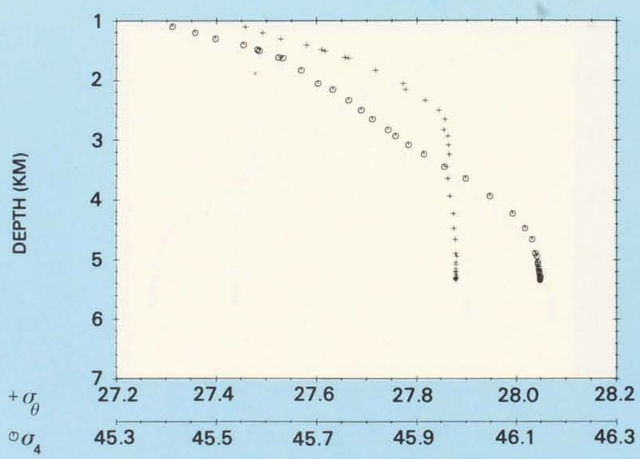
Station 64.
Latitude 39° 05′ S,
Longitude 48° 33′ W.
6 December 1972.

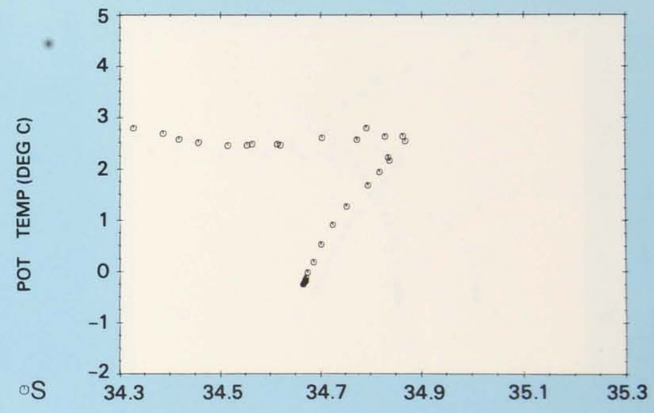


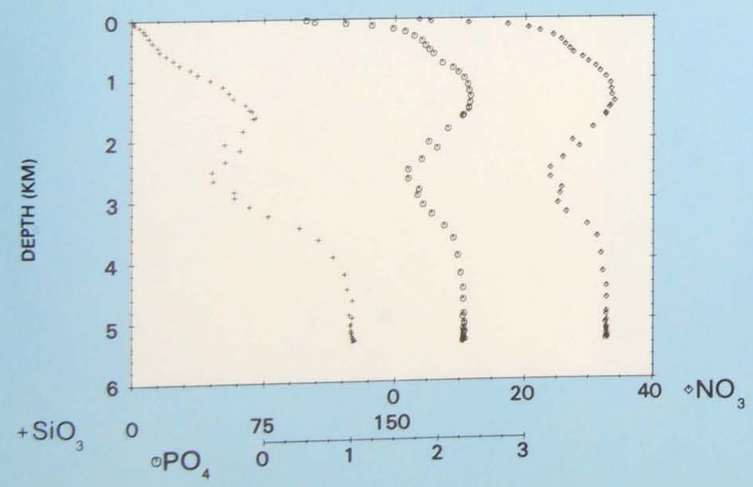


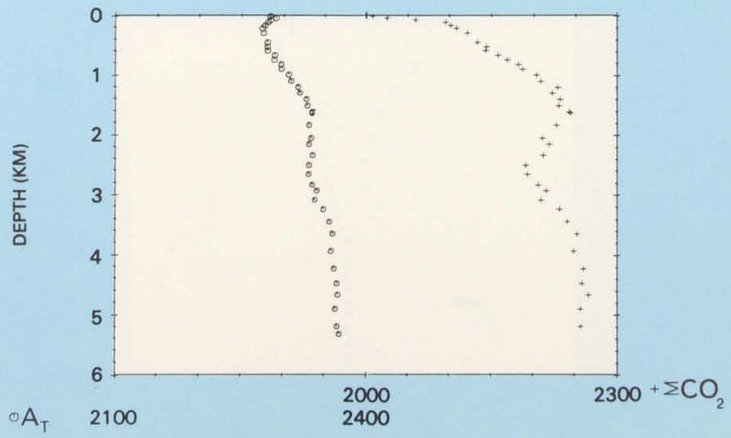












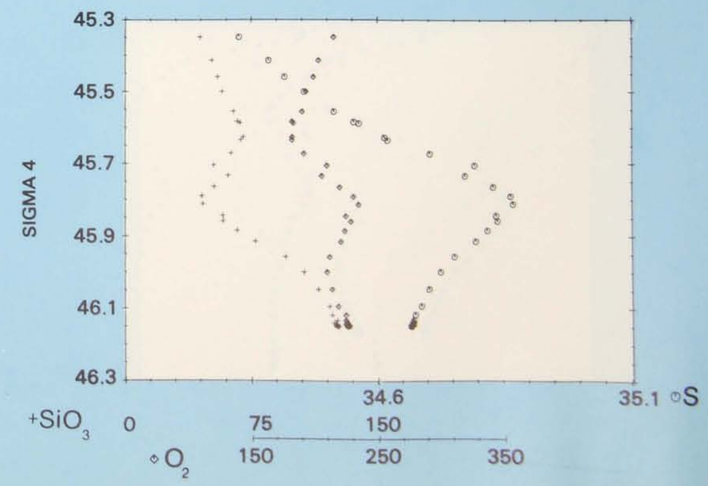
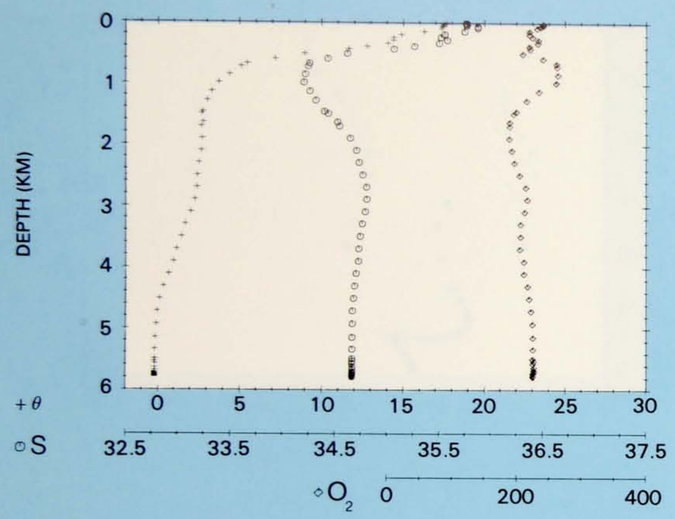
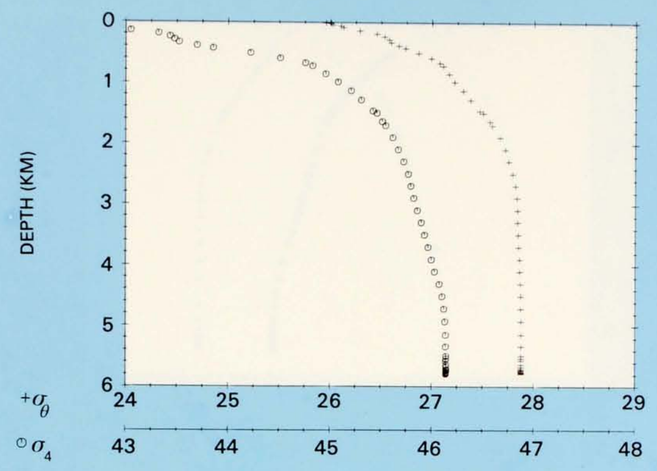


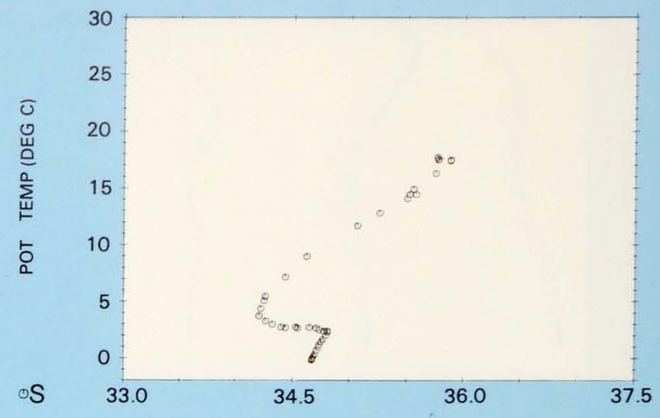
PLATE 126

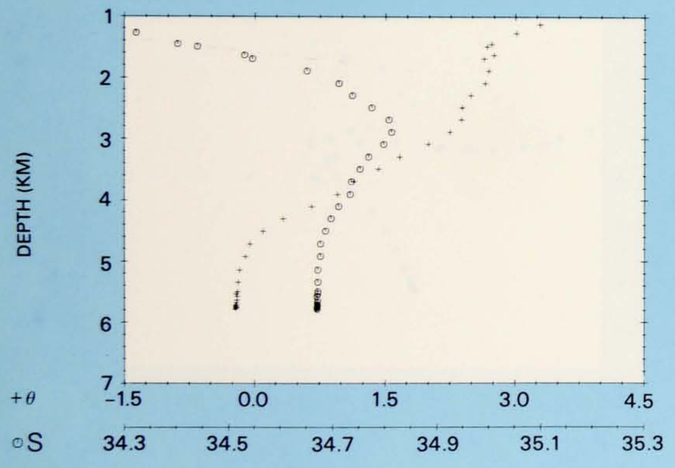
Station 66.
Latitude 41° 32′ S,
Longitude 50° 57′ W.
8 December 1972.

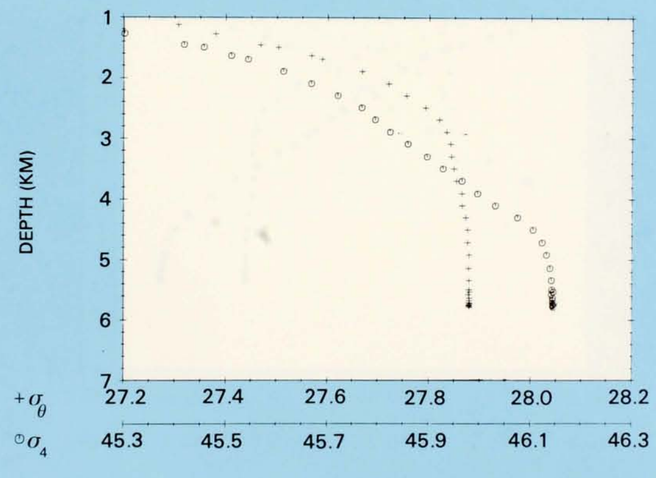
PROPERTY–PROPERTY PLOTS
STATION 66

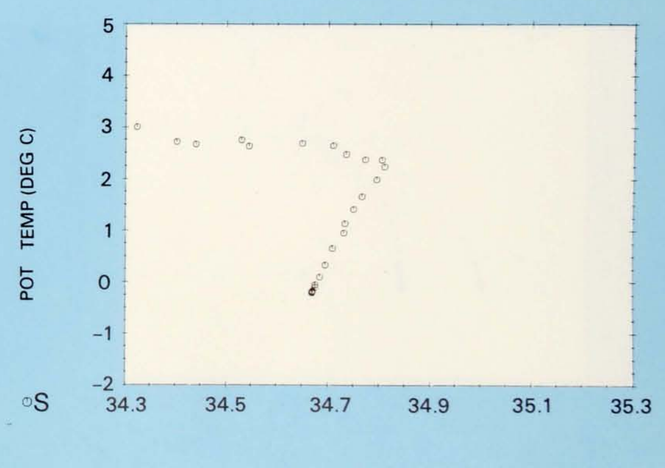


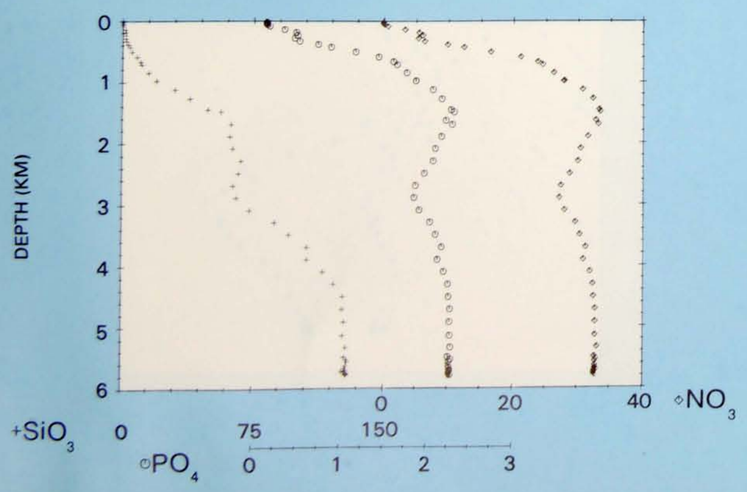


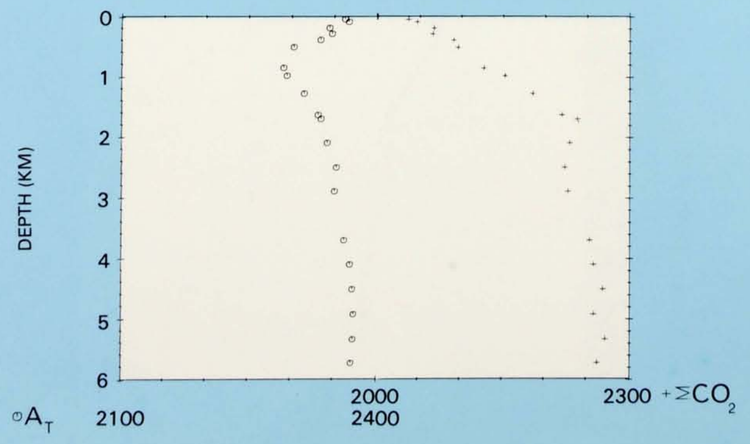


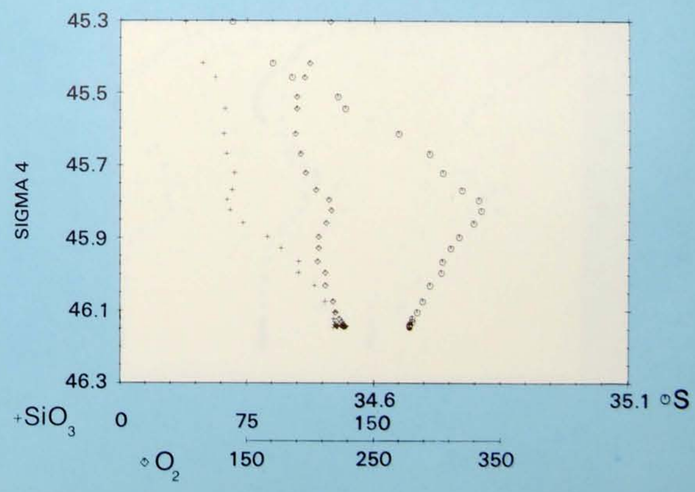








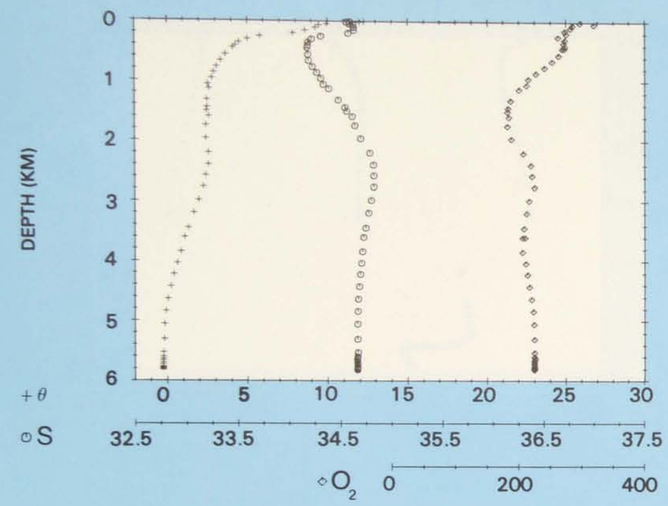


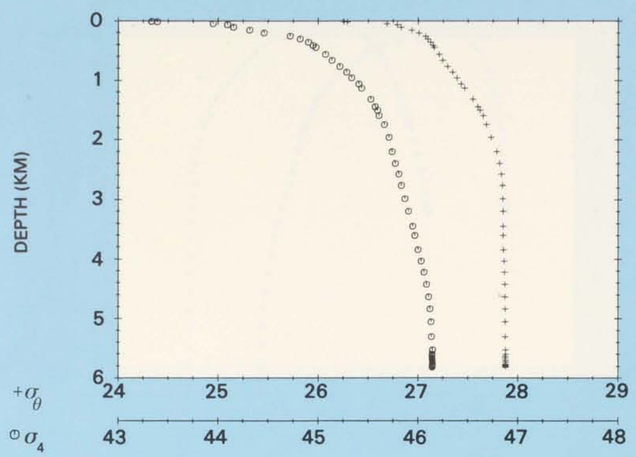


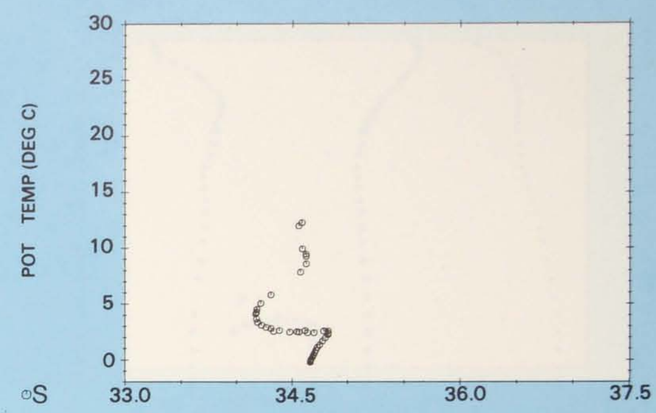
PROPERTY–PROPERTY PLOTS
STATION 67

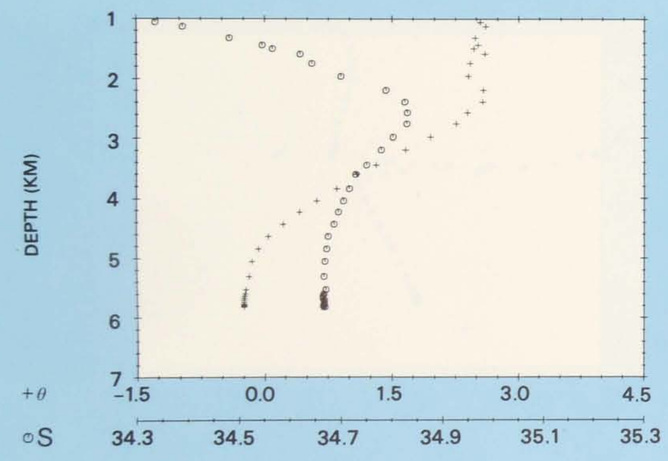
PLATE 127

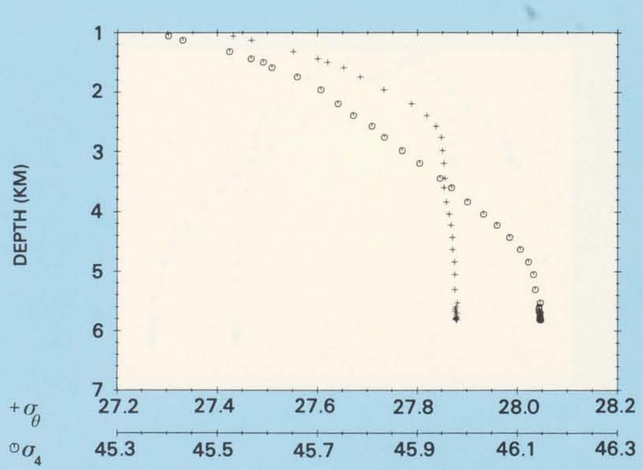
Station 67.
Latitude 44° 58′ S,
Longitude 51° 03′ W.
9 December 1972.

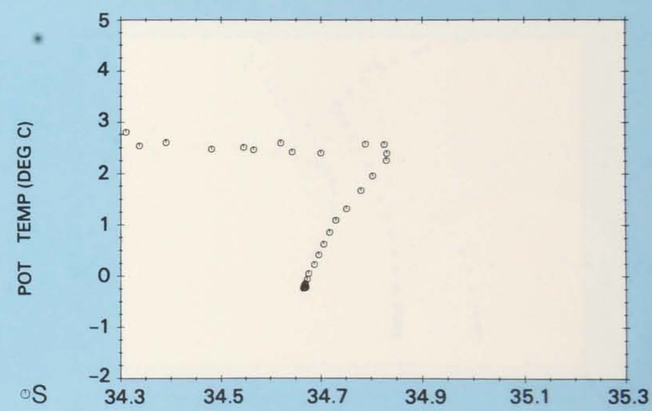


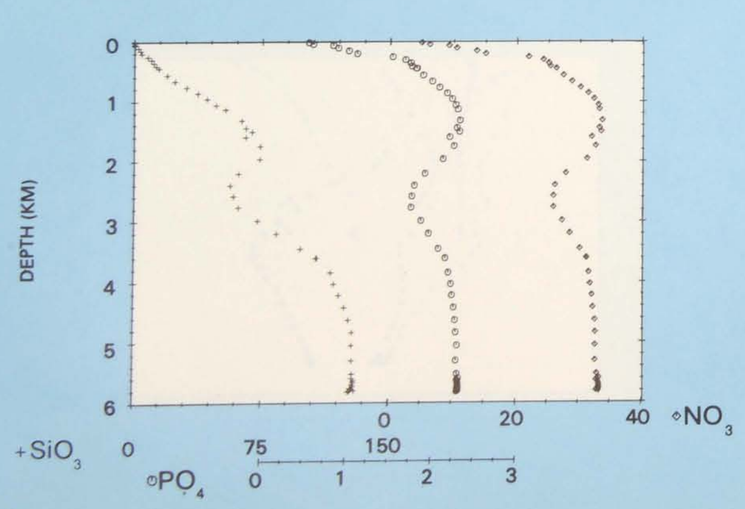


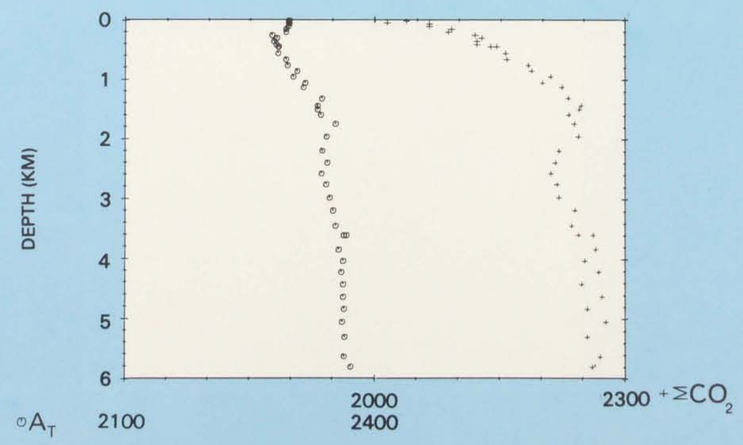












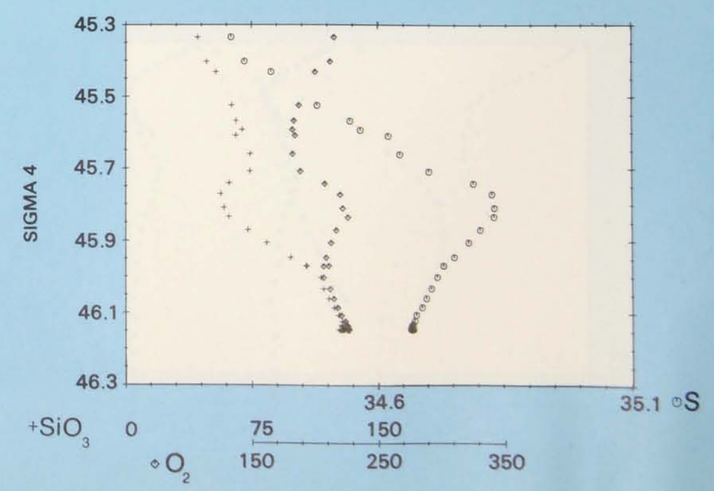
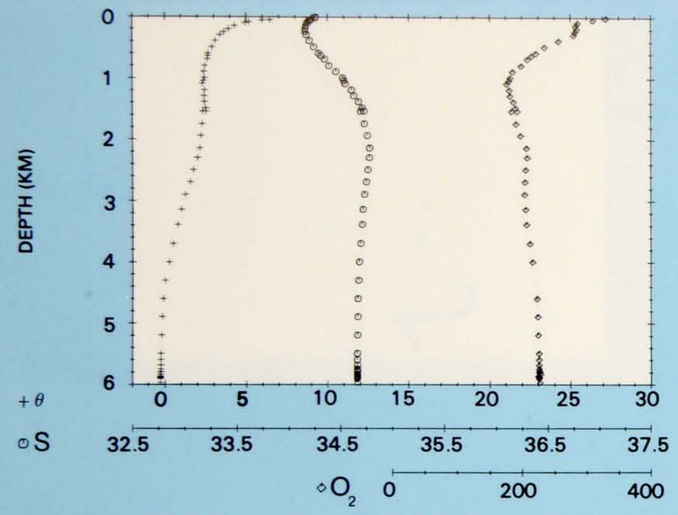
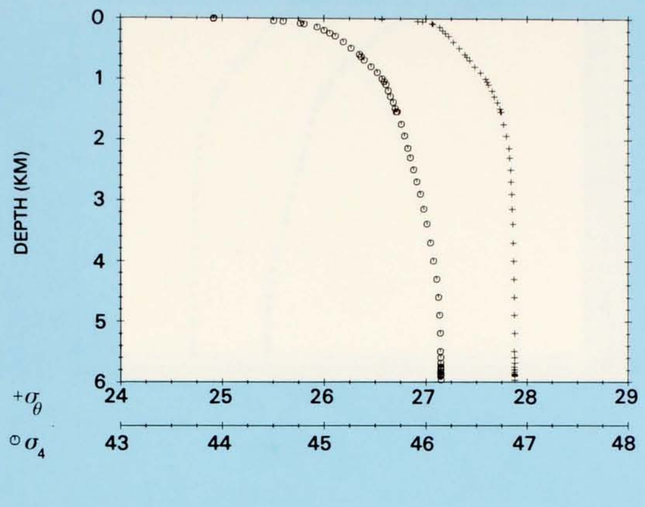


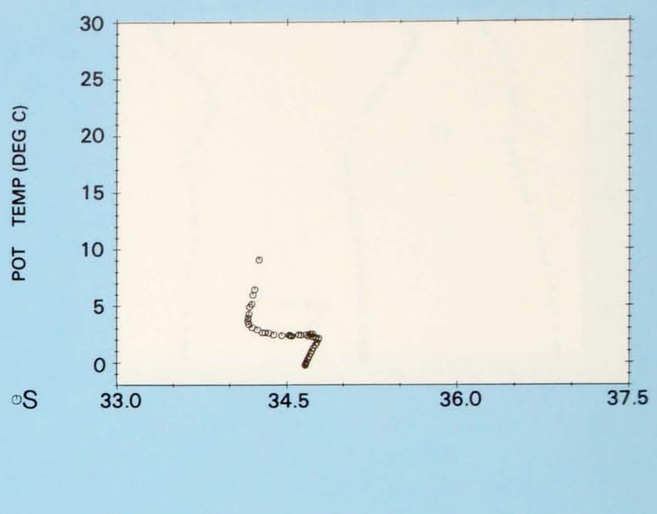
PLATE 128

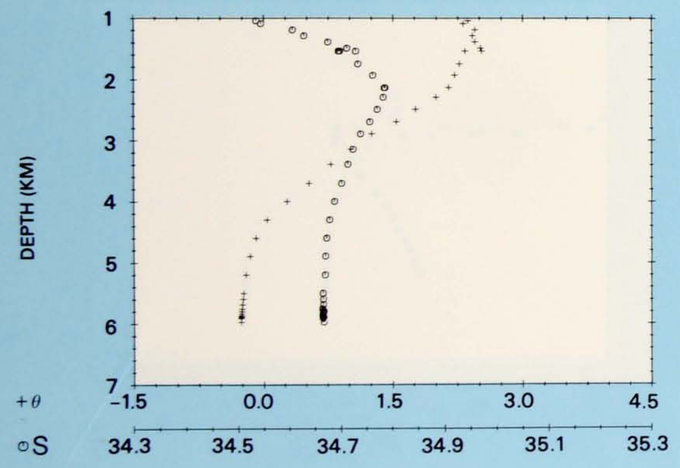
Station 68.
Latitude 48° 39′ S,
Longitude 45° 59′ W.
13 December 1972.

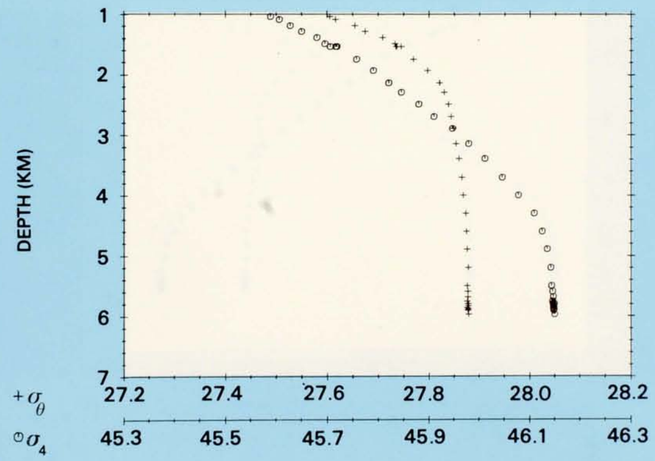
PROPERTY–PROPERTY PLOTS
STATION 68

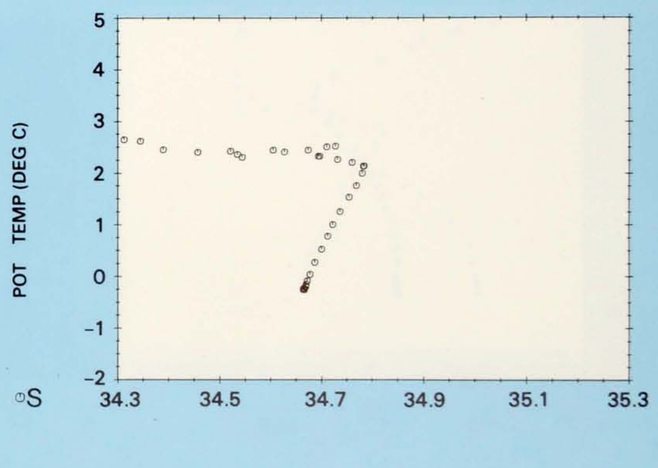


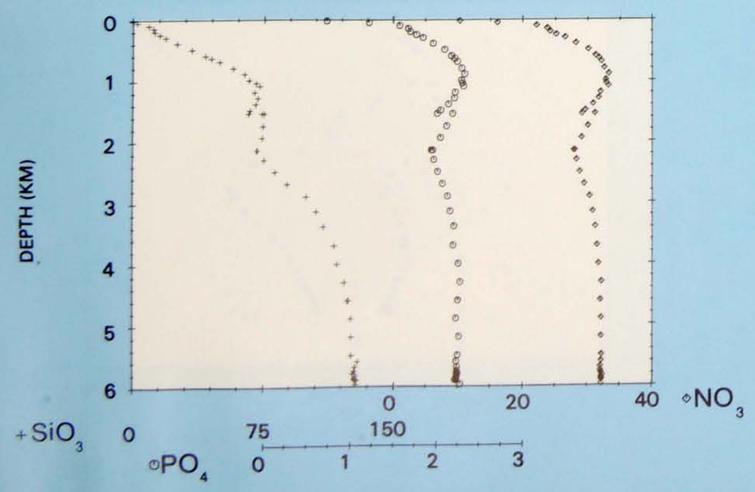


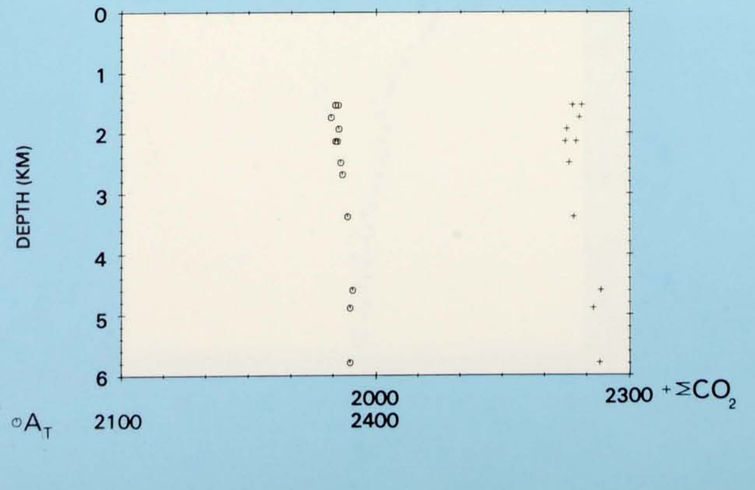


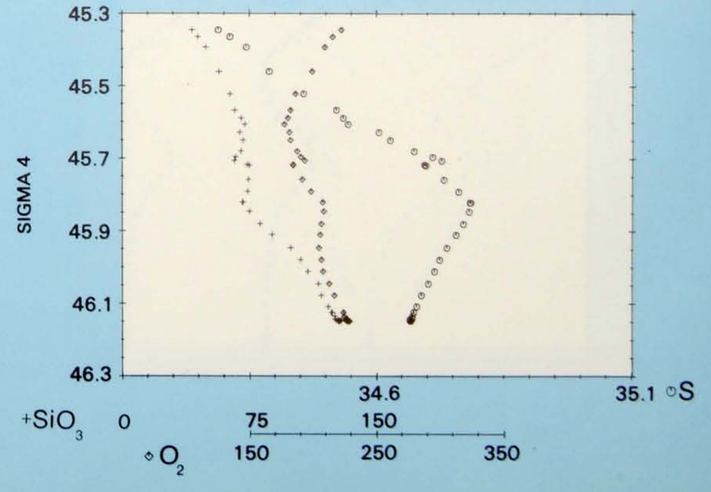








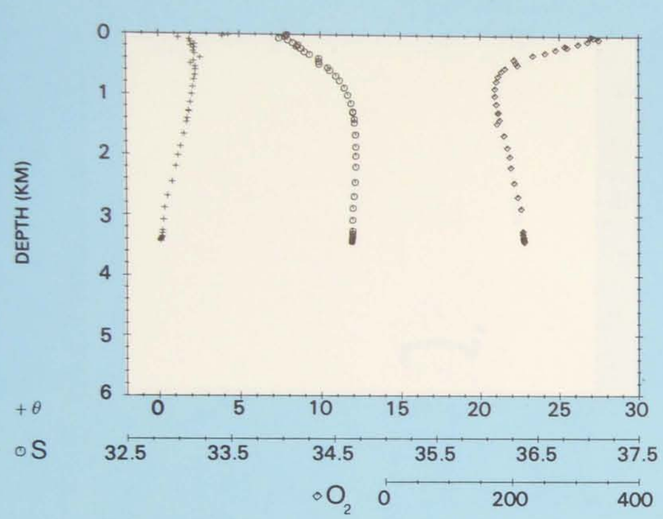


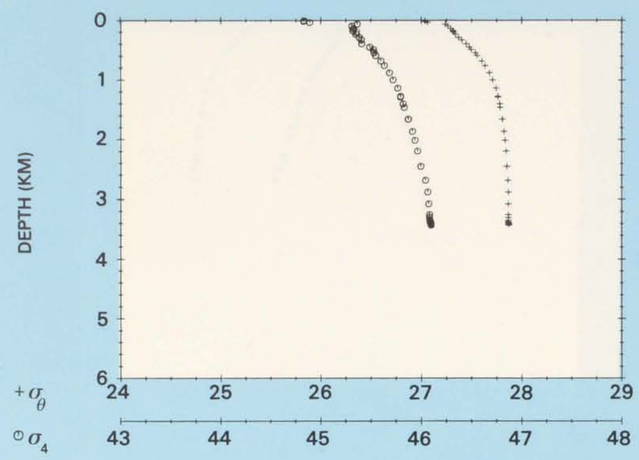


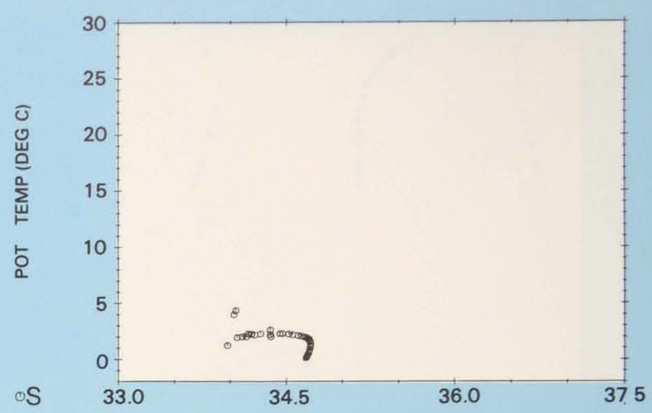
PROPERTY–PROPERTY PLOTS
STATION 69

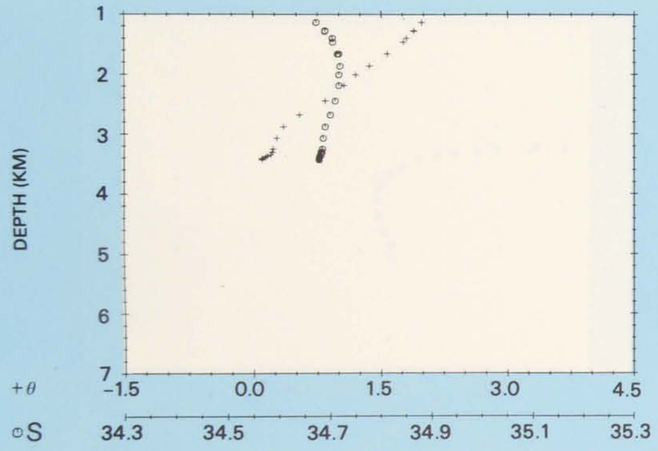
PLATE 129

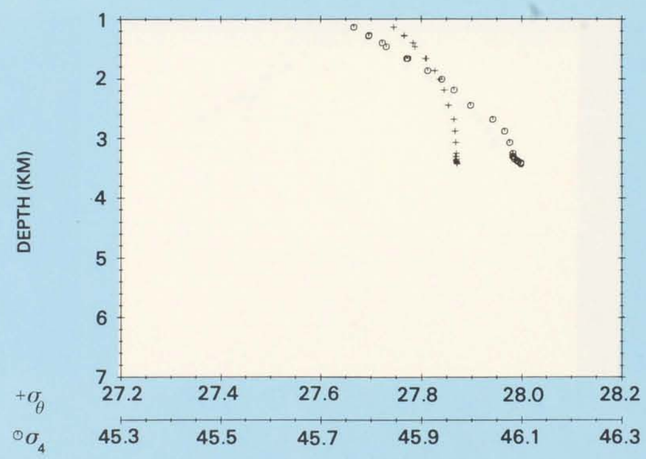
Station 69.
Latitude 52° 31′ S,
Longitude 46° 22′ W.
15 December 1972.

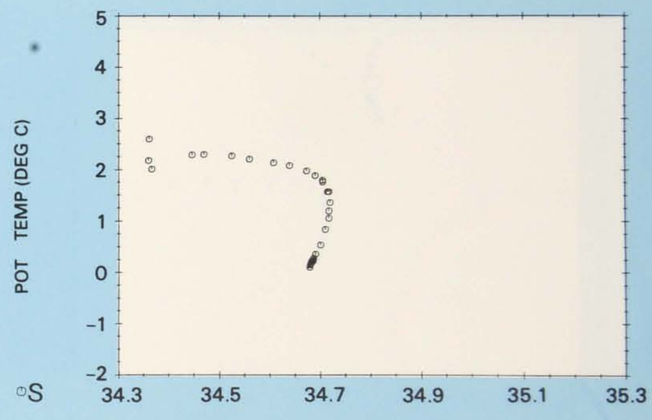


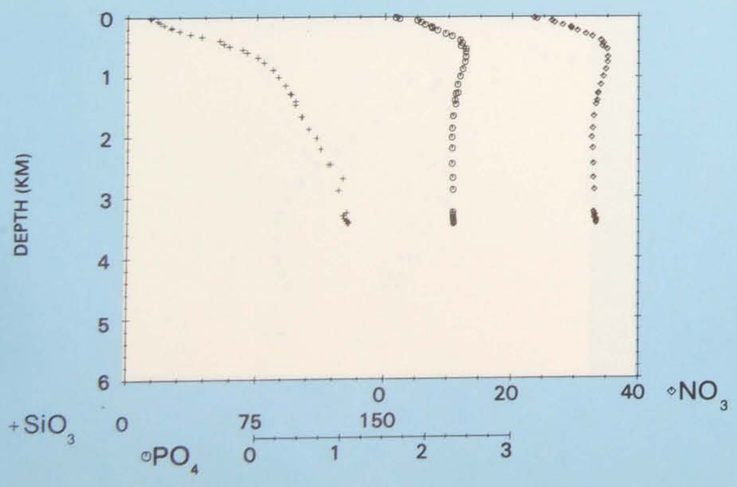












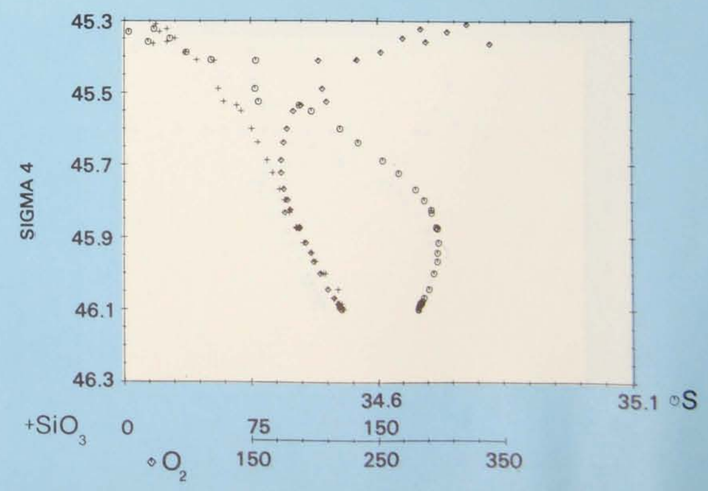
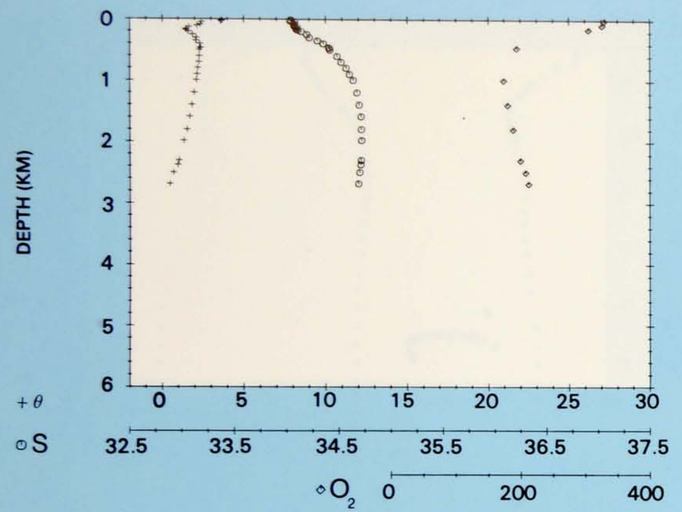
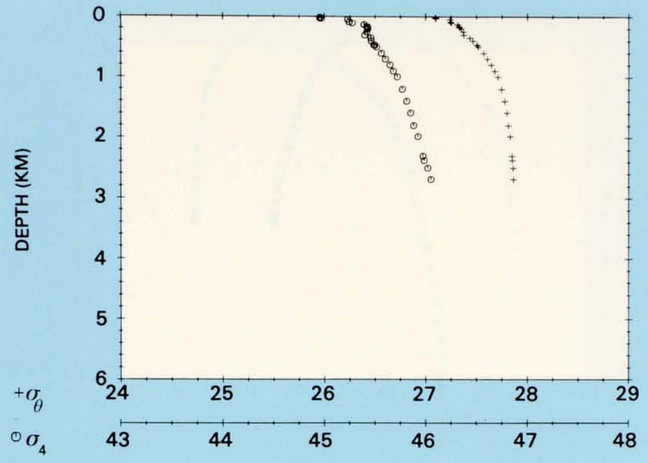


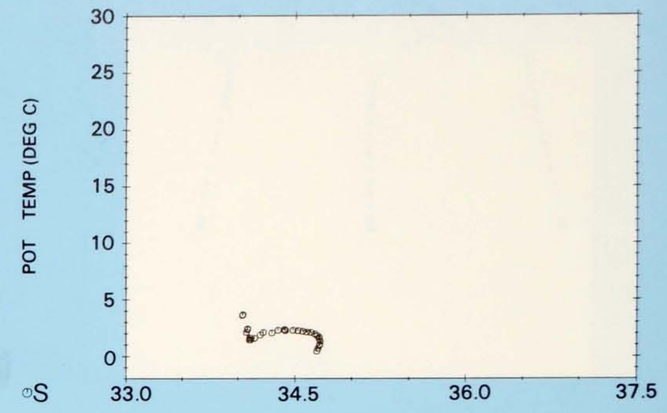
PLATE 130

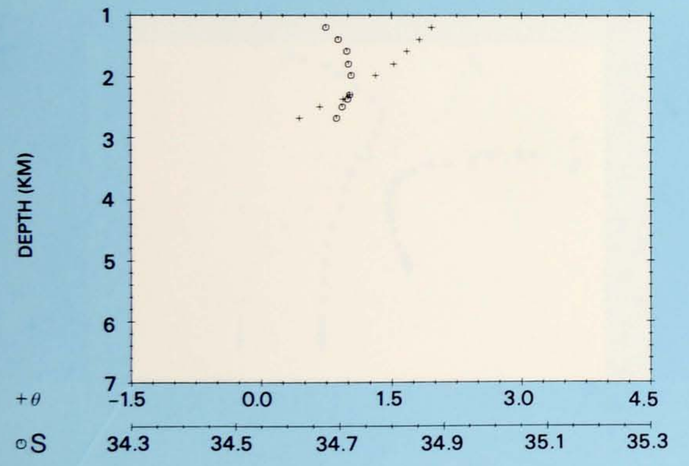
Station 70.
Latitude 53° 03′ S,
Longitude 47° 43′ W.
16 December 1972.

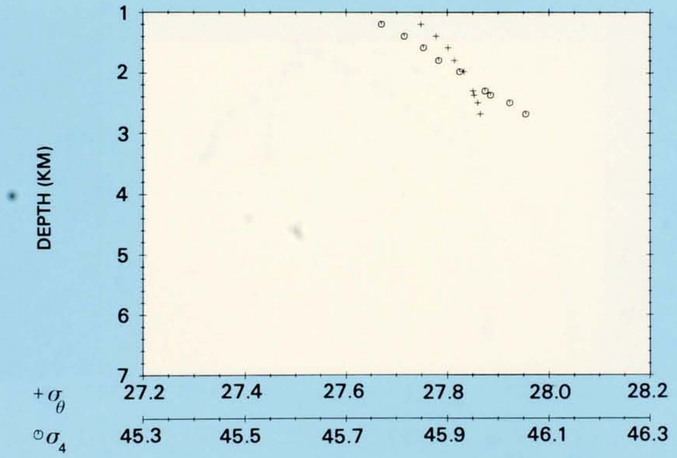
PROPERTY–PROPERTY PLOTS
STATION 70

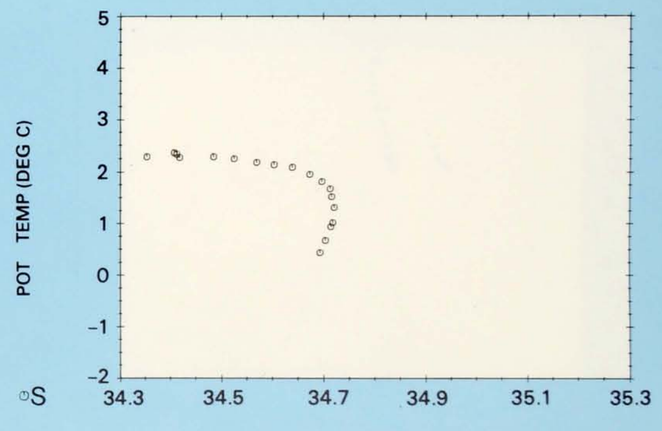


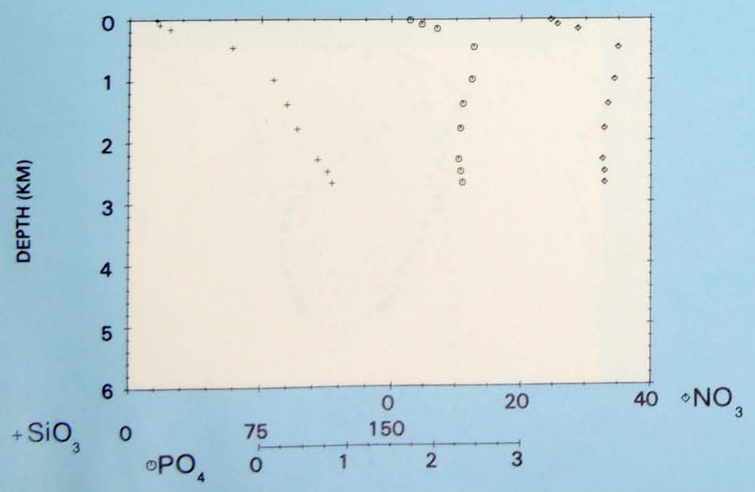


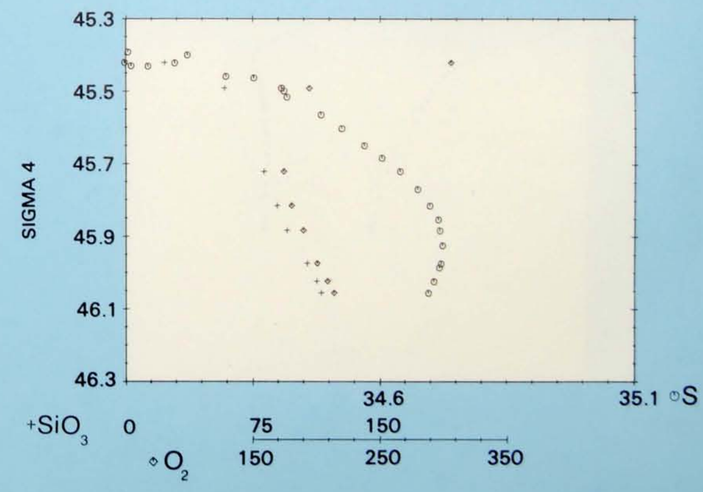








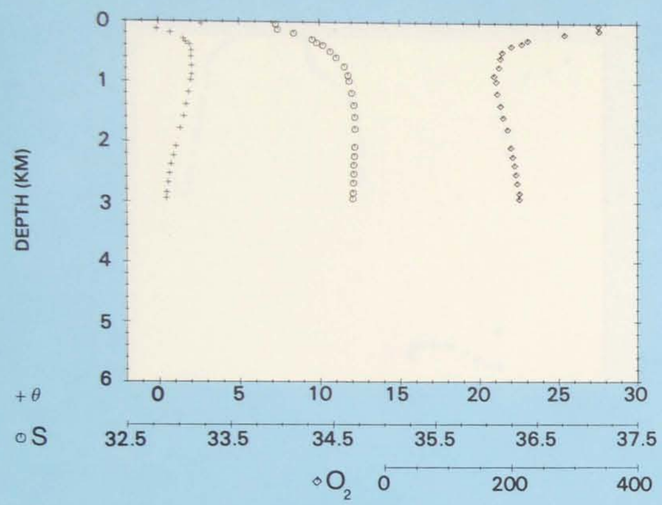


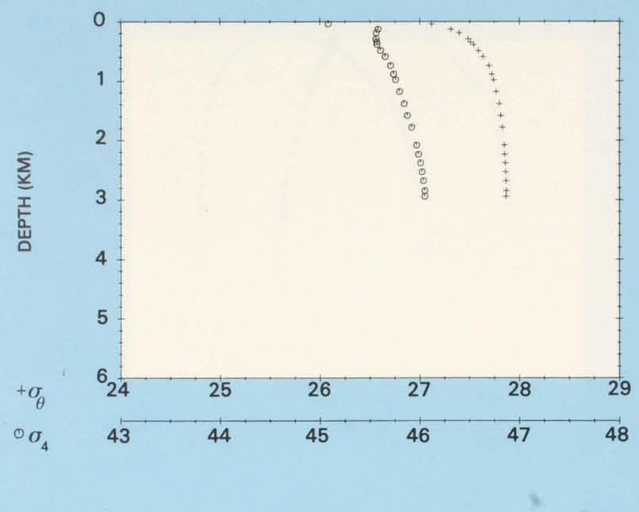


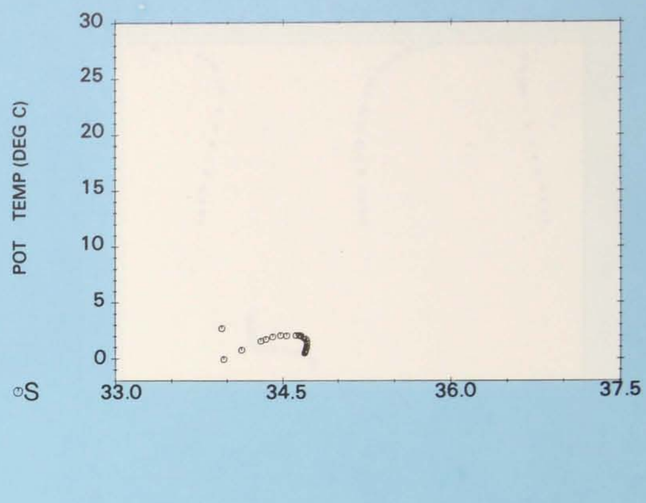
PROPERTY–PROPERTY PLOTS
STATION 71

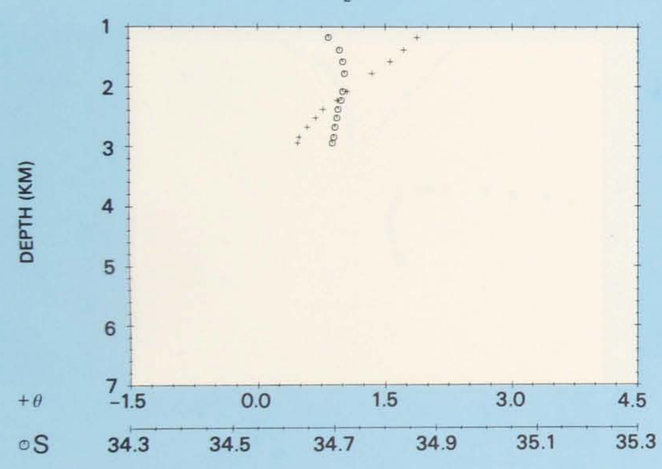
PLATE 131

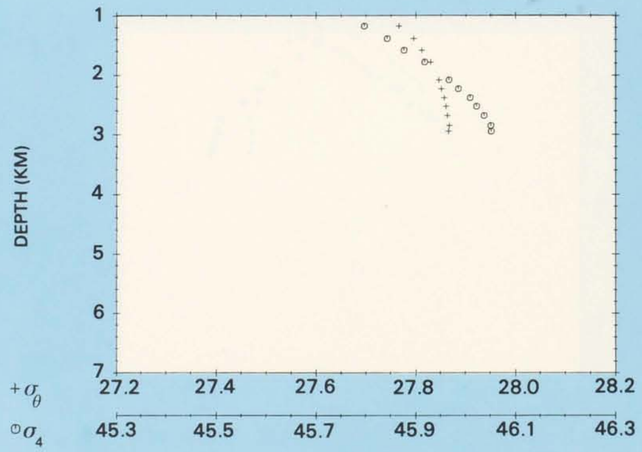
Station 71.
Latitude 53° 07′ S,
Longitude 48° 24′ W.
16 December 1972.

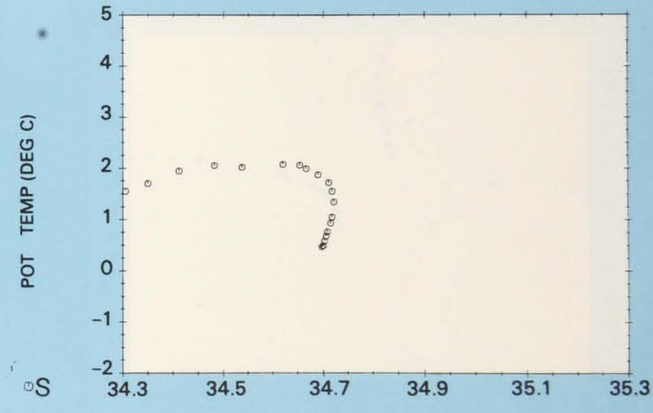


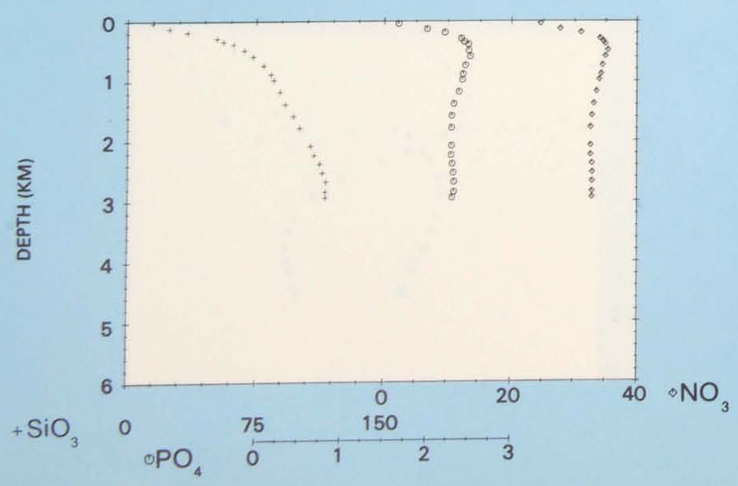












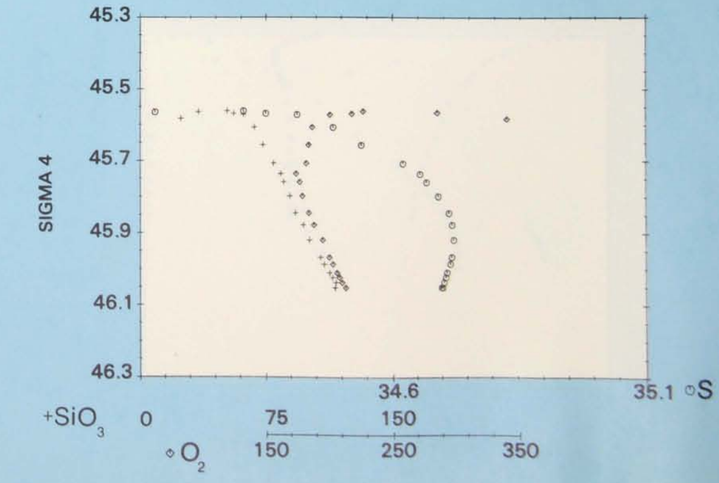
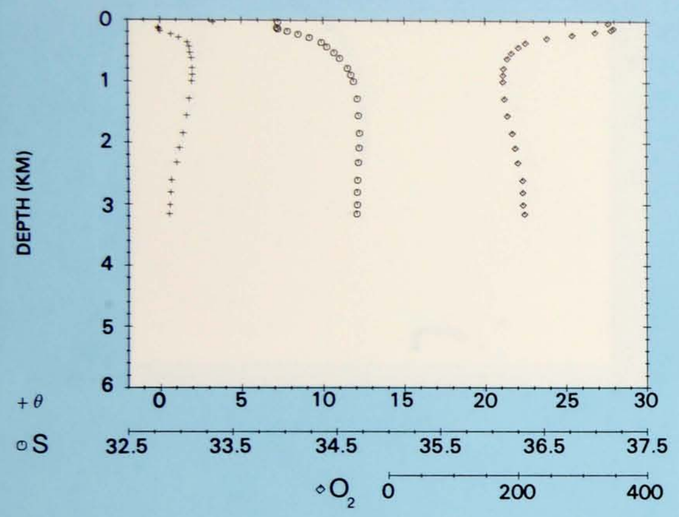
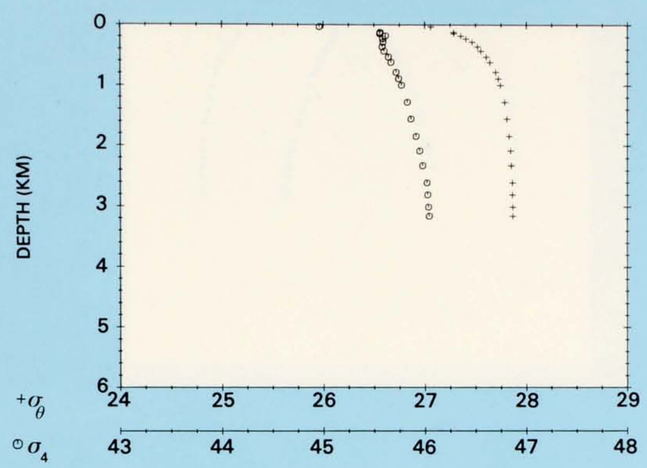


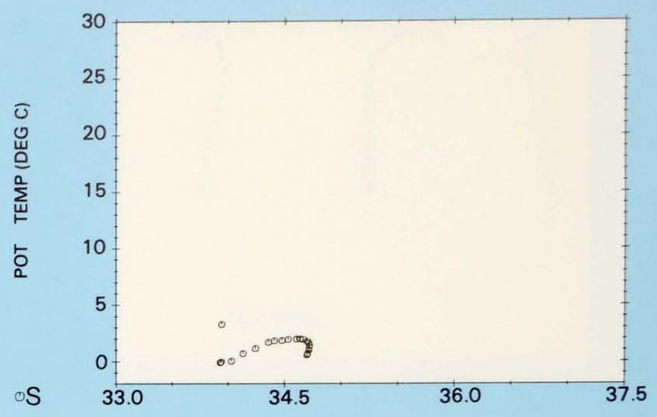
PLATE 132

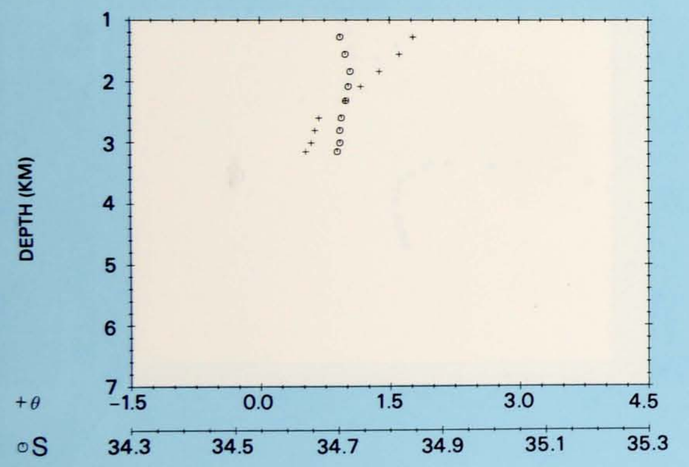
Station 72.
Latitude 53° 04′ S,
Longitude 48° 50′ W.
16 December 1972.

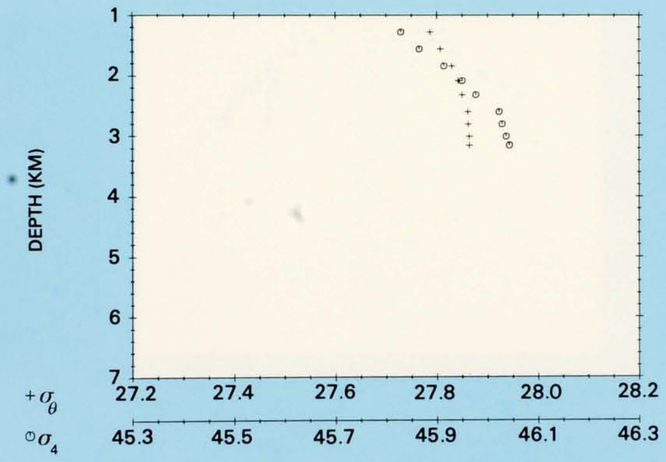
PROPERTY–PROPERTY PLOTS
STATION 72

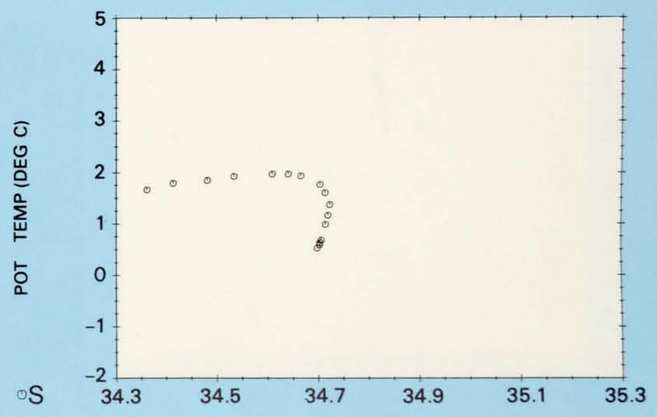


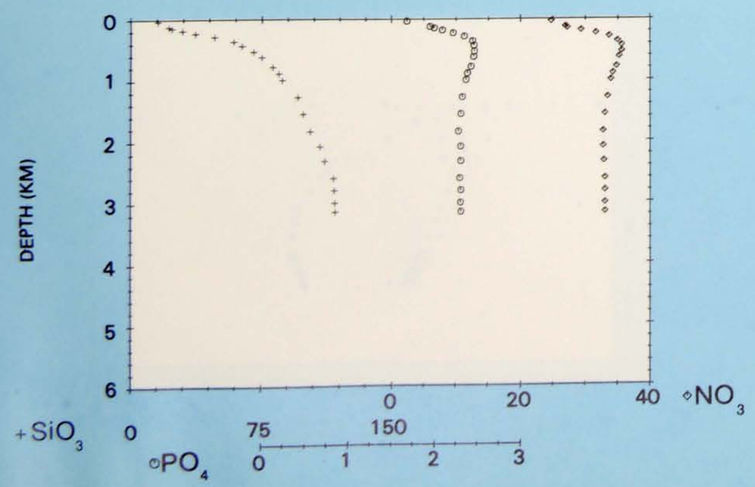


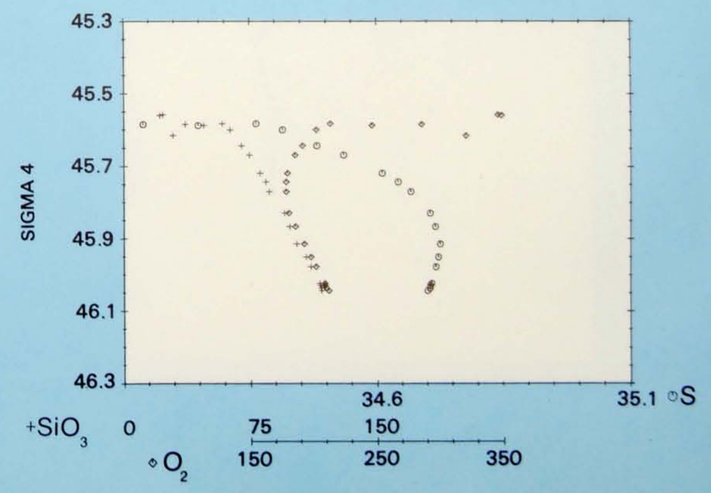








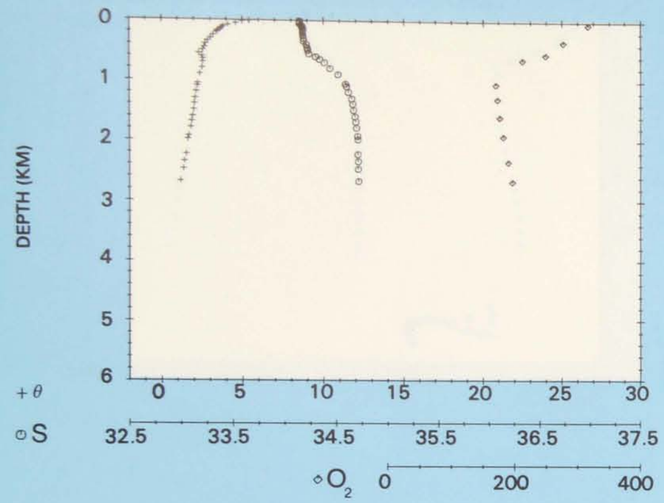


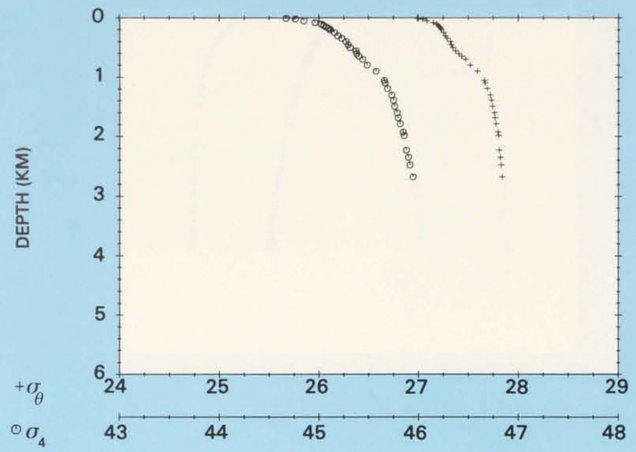


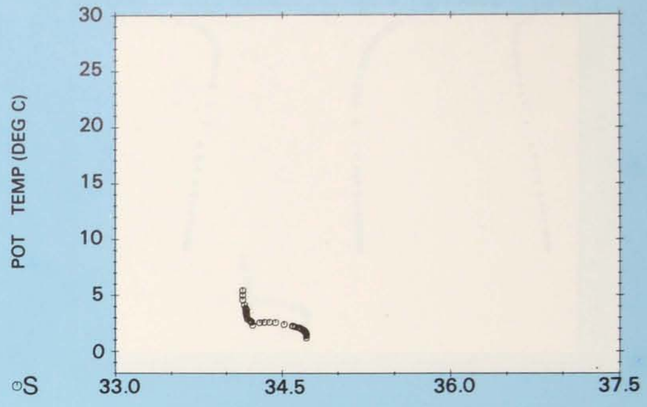
PROPERTY–PROPERTY PLOTS
STATION 73

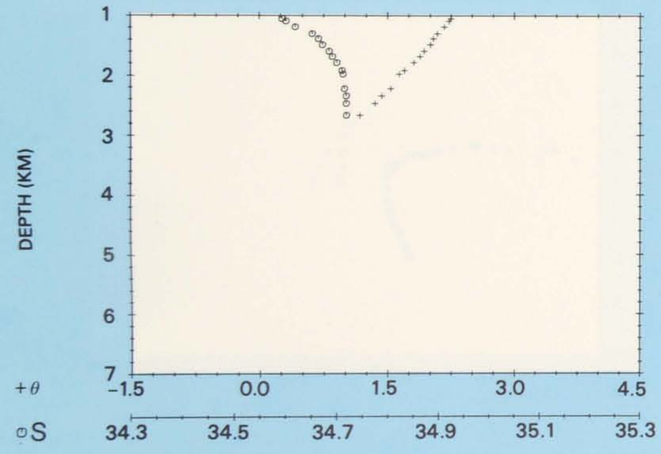
PLATE 133

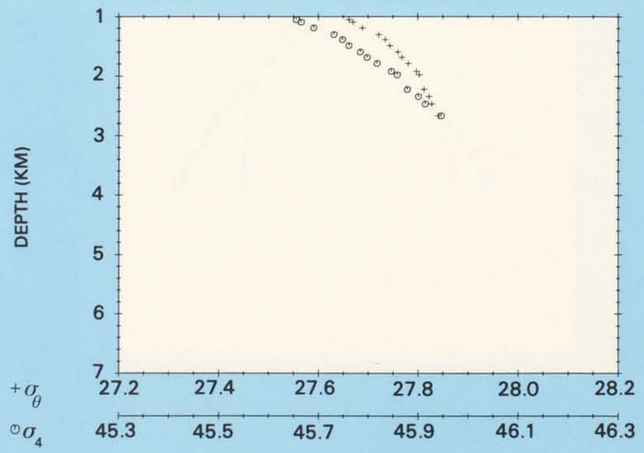
Station 73.
Latitude 53° 02′ S,
Longitude 49° 31′ W.
17 December 1972.

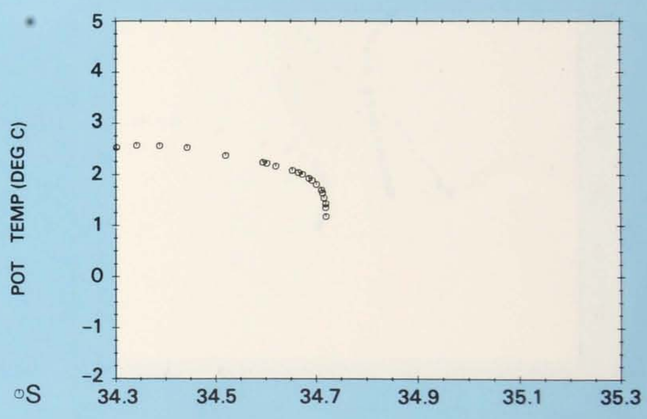


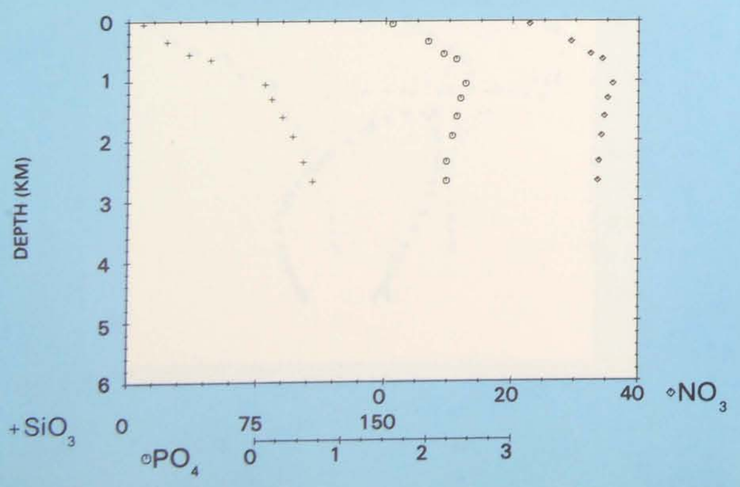












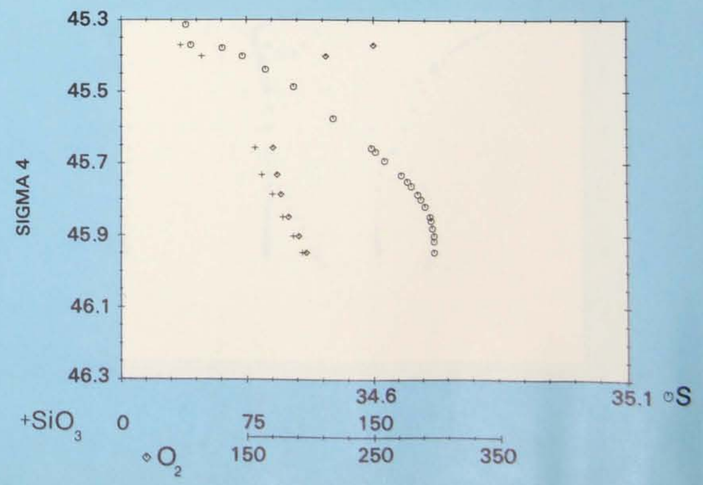
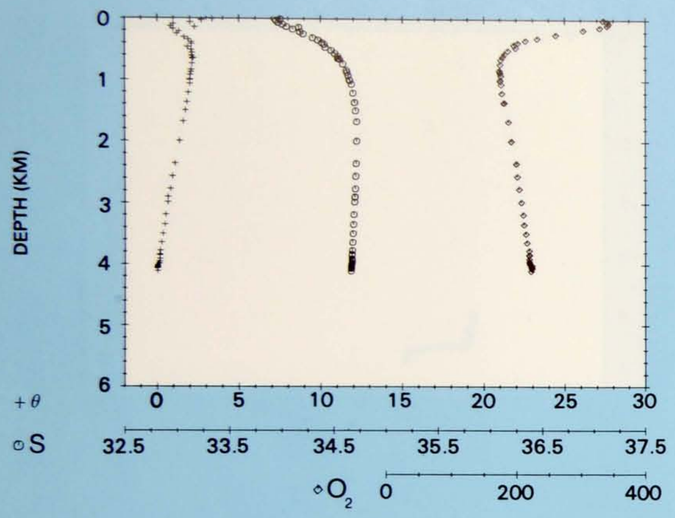
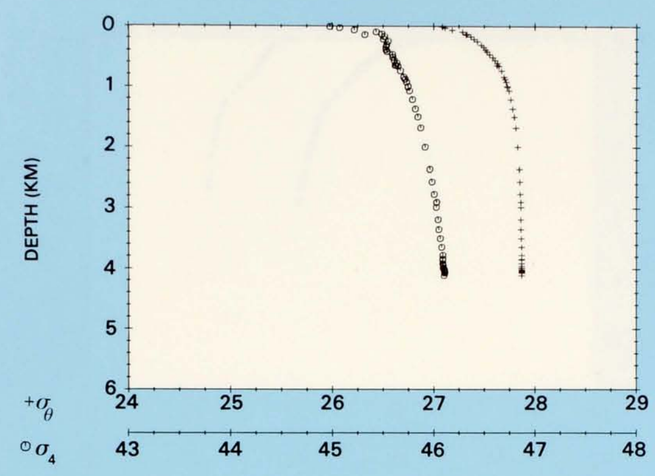


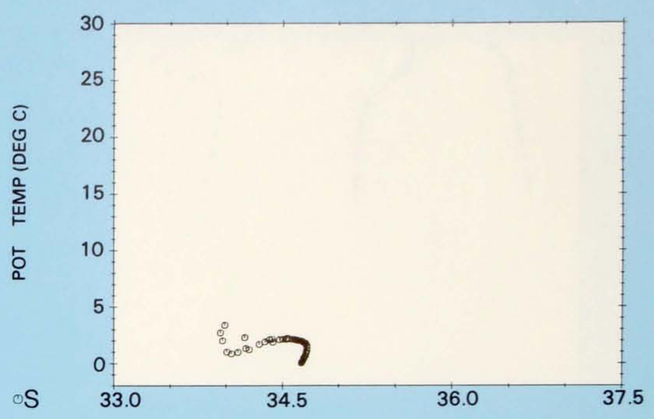
PLATE 134

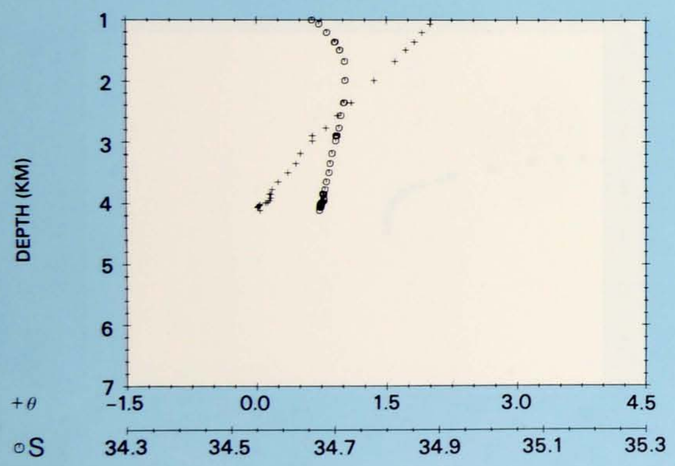
Station 74.
Latitude 55° 00′ S,
Longitude 50° 04′ W.
17 December 1972.

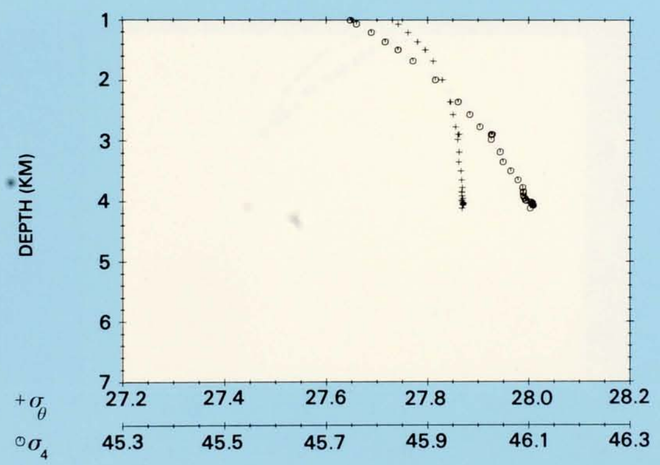
PROPERTY–PROPERTY PLOTS
STATION 74

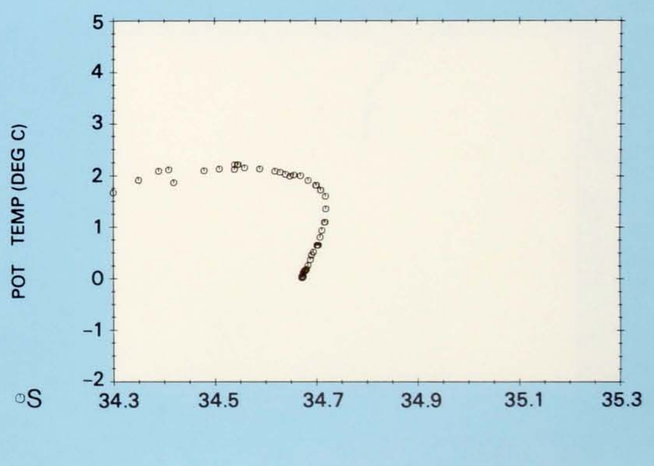


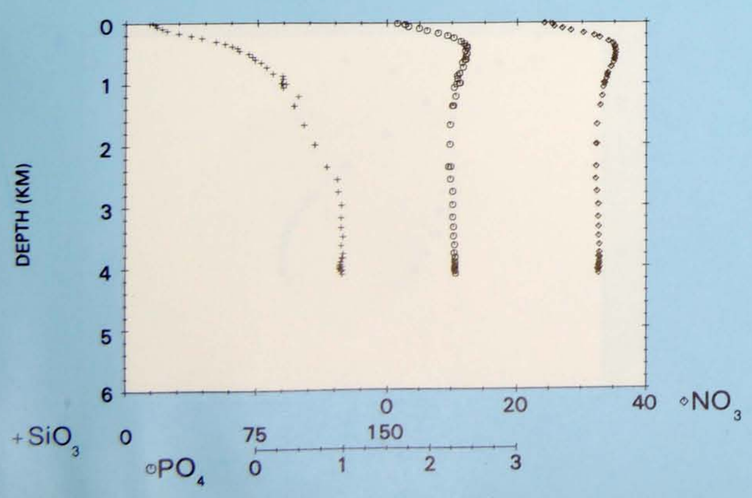


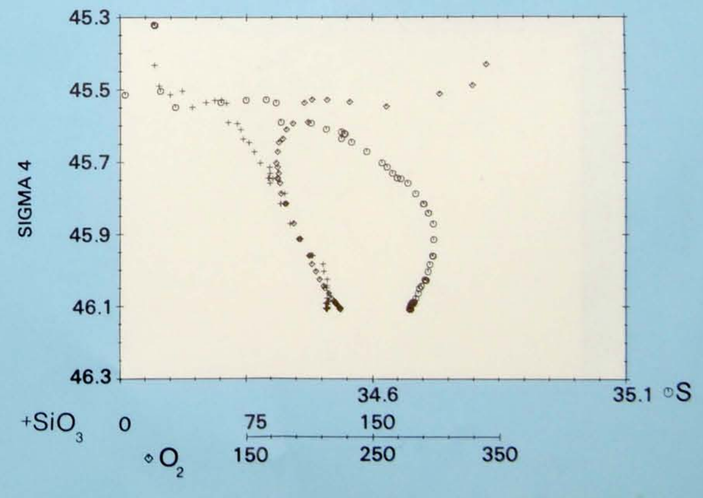








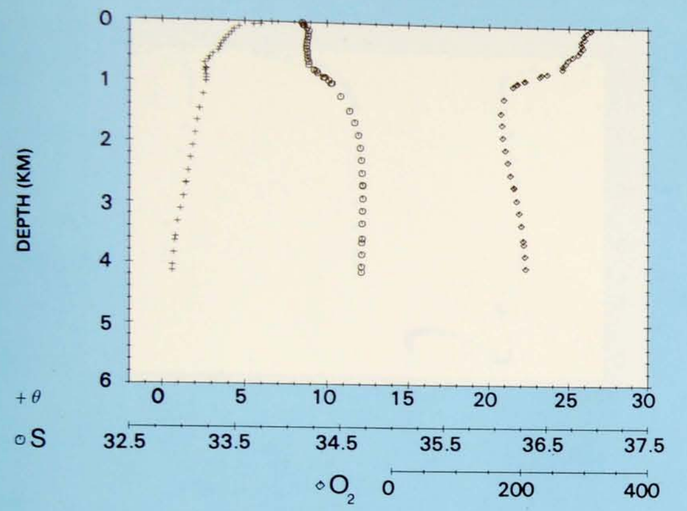


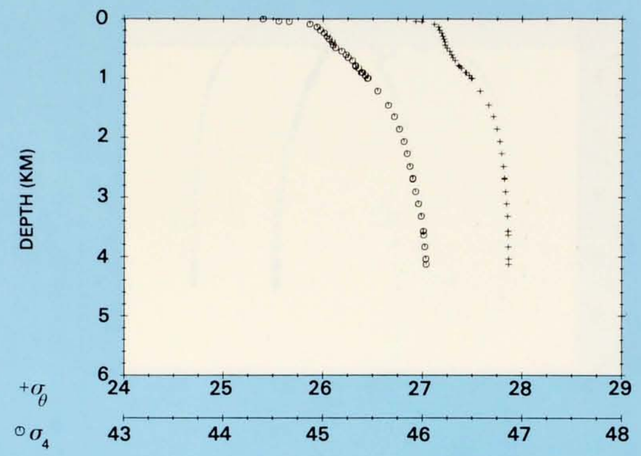


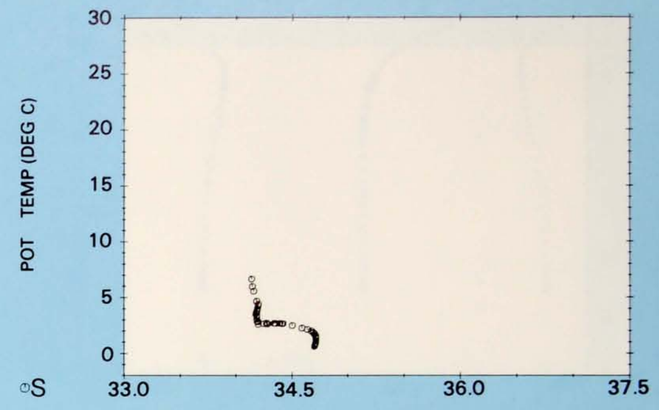
PROPERTY–PROPERTY PLOTS
STATION 75

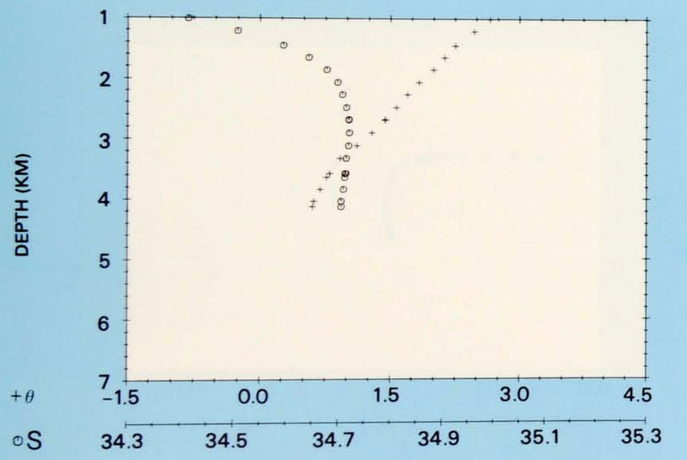
PLATE 135

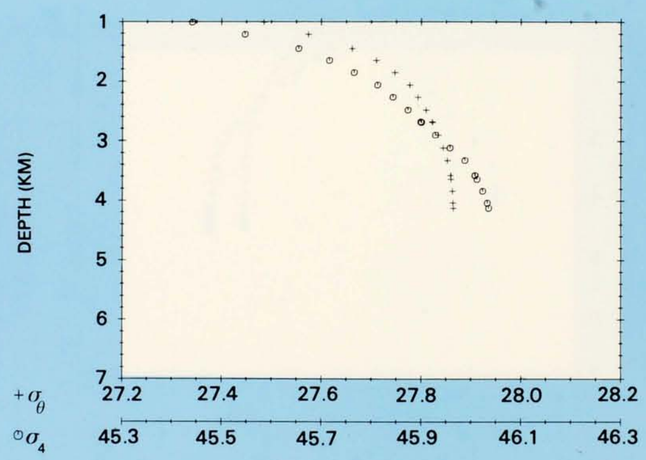
Station 75.
Latitude 56° 02′ S,
Longitude 61° 02′ W.
20 December 1972.

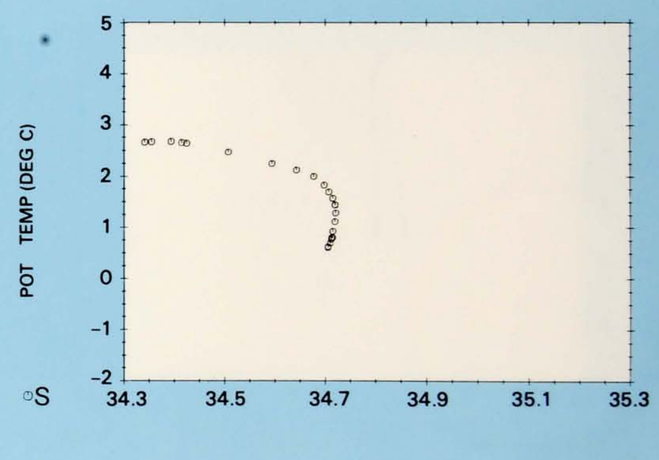


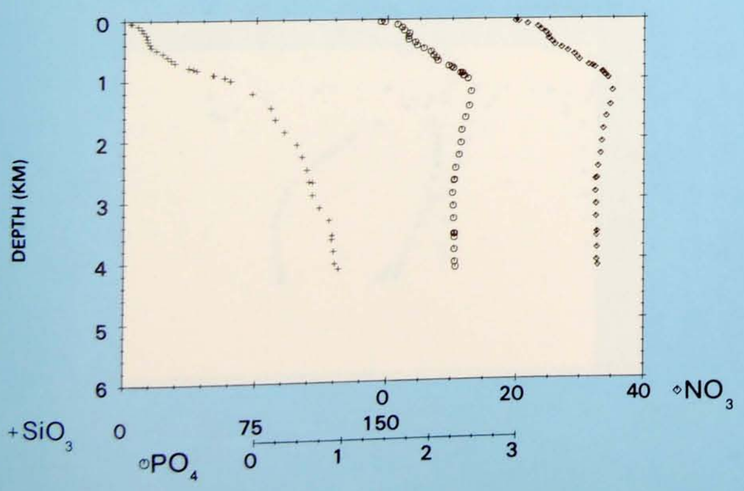












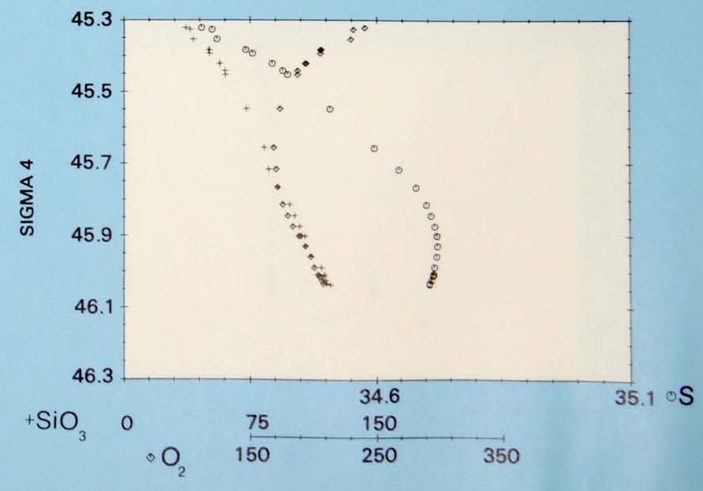
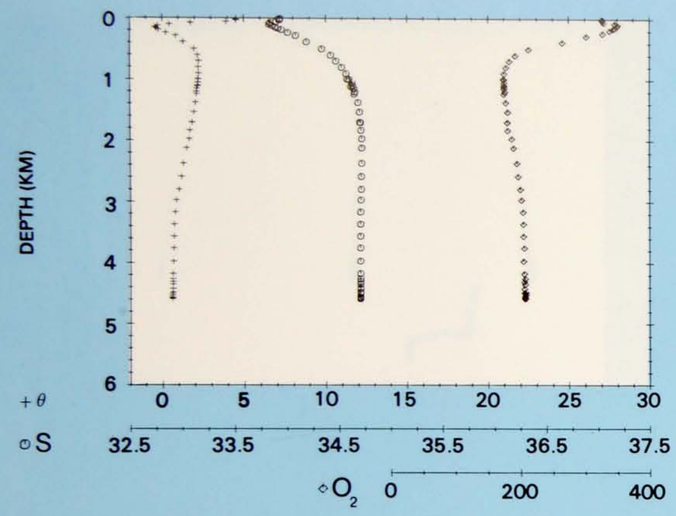
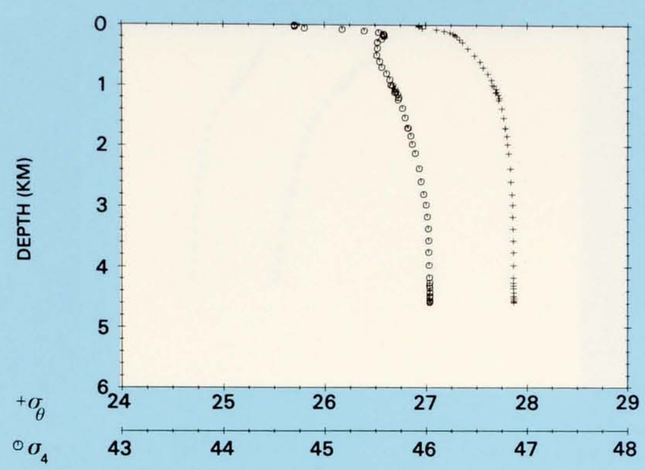


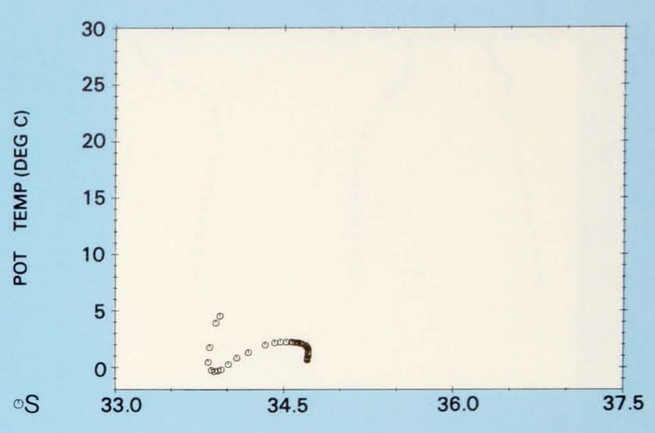
PLATE 136

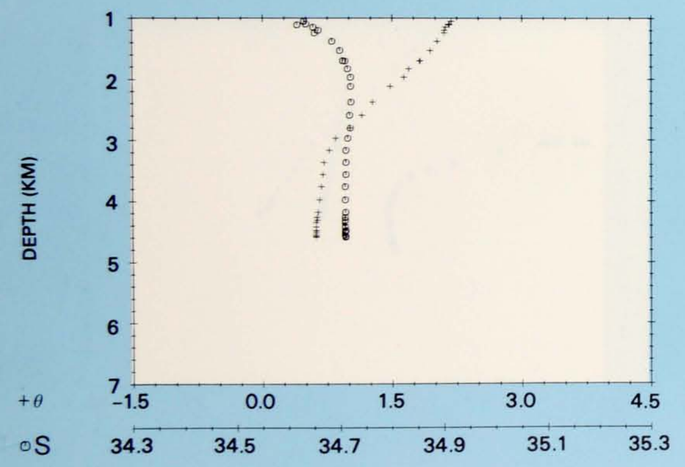
Station 76.
Latitude 57° 44′ S,
Longitude 66° 08′ W.
31 December 1972.

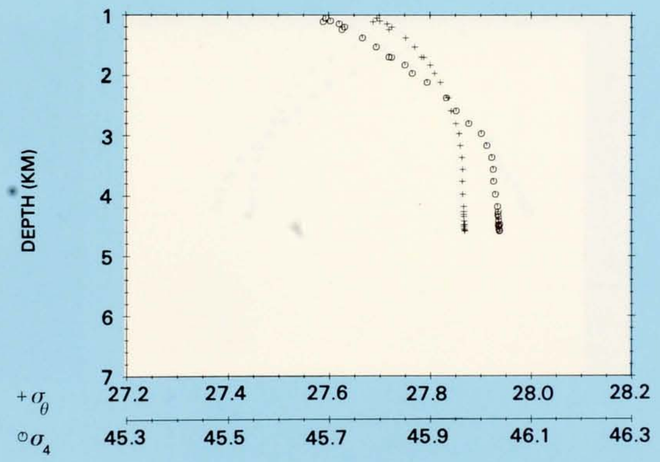
PROPERTY–PROPERTY PLOTS
STATION 76

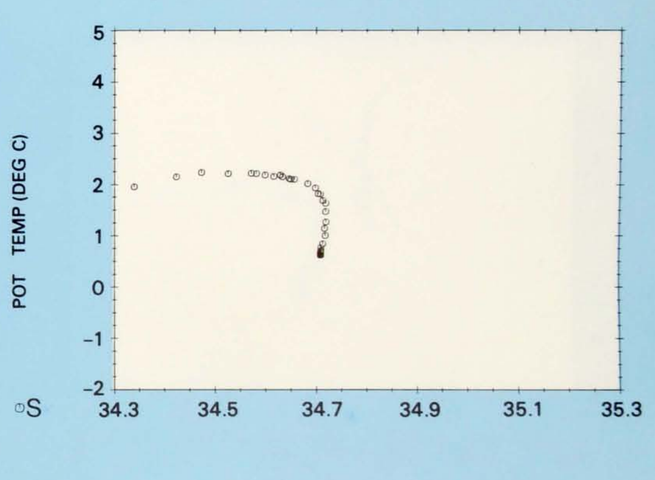


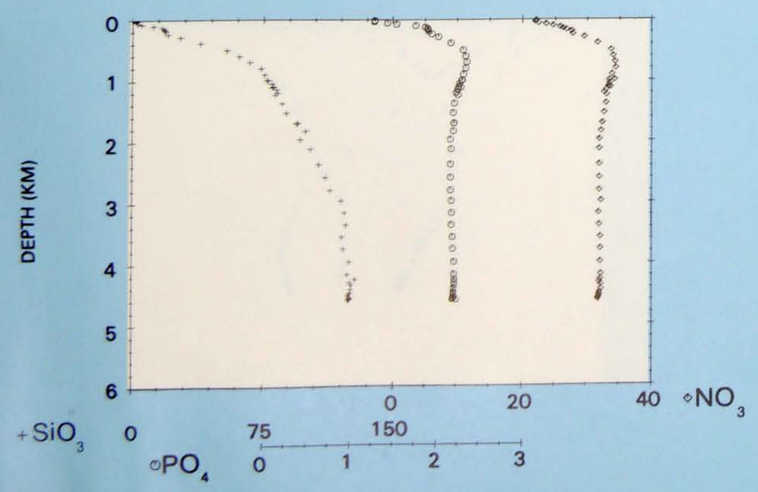


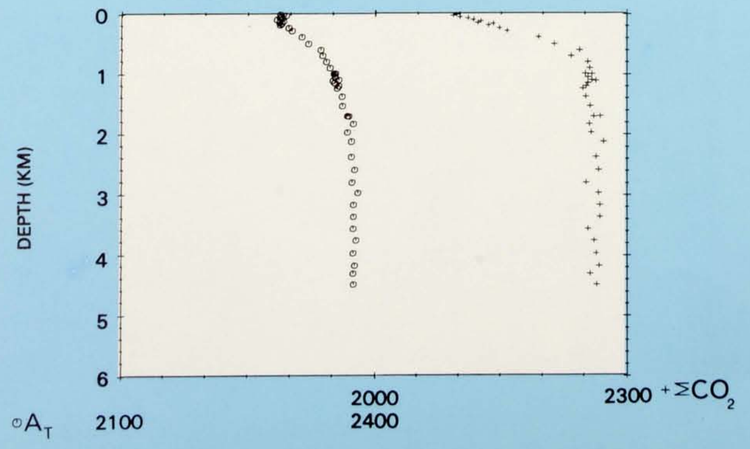


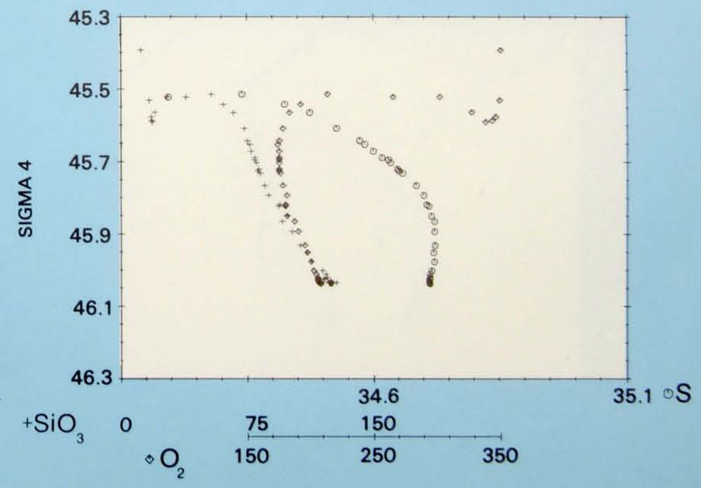








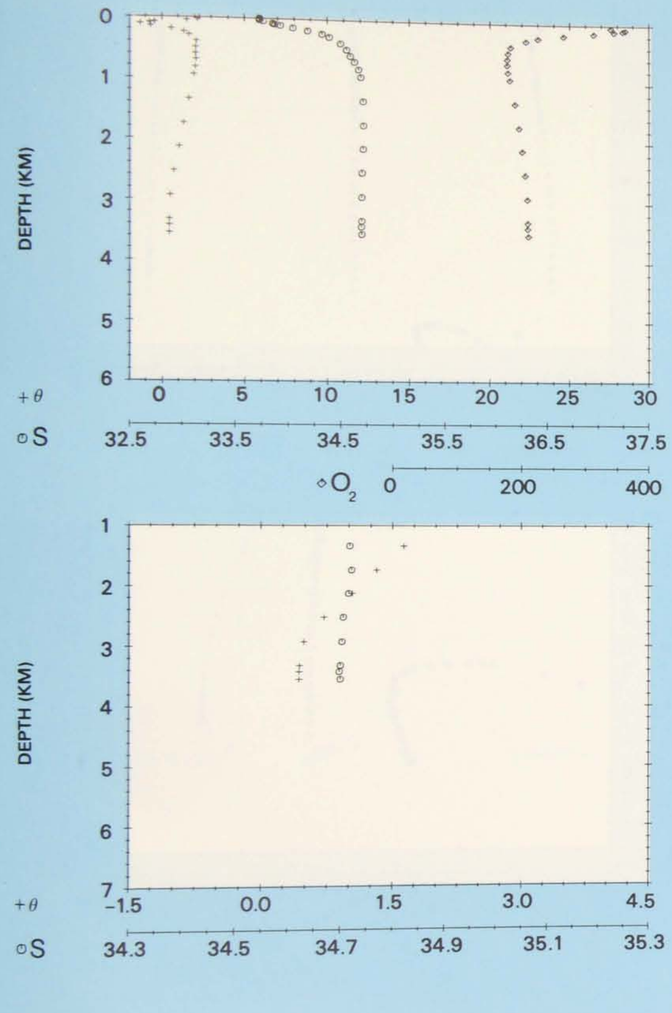


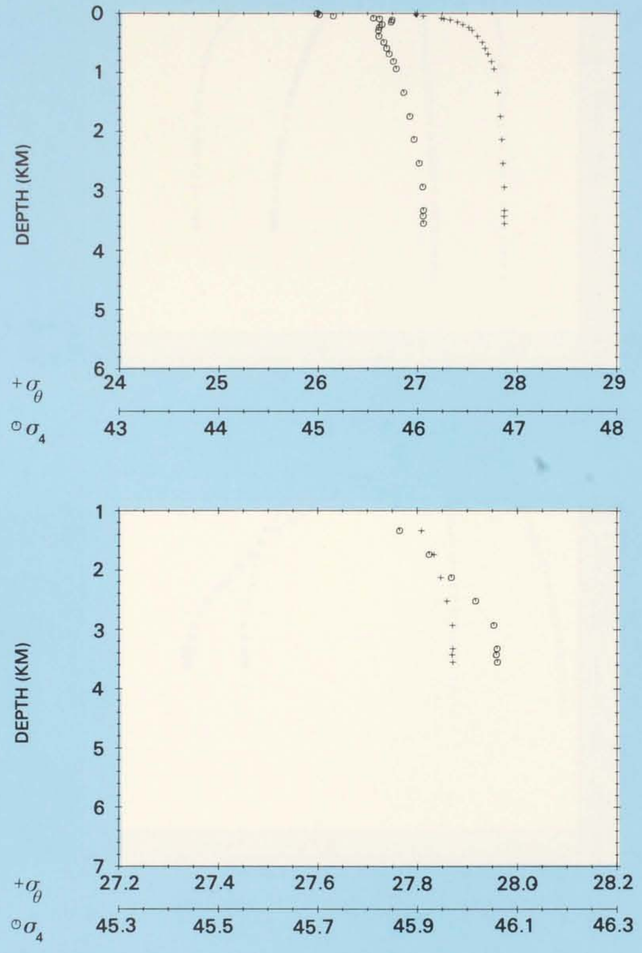


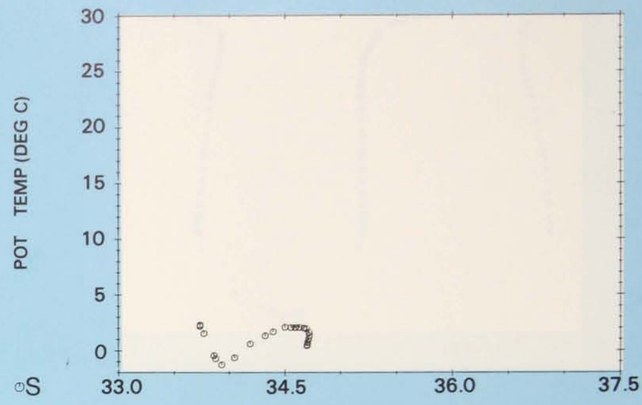
PROPERTY–PROPERTY PLOTS
STATION 77

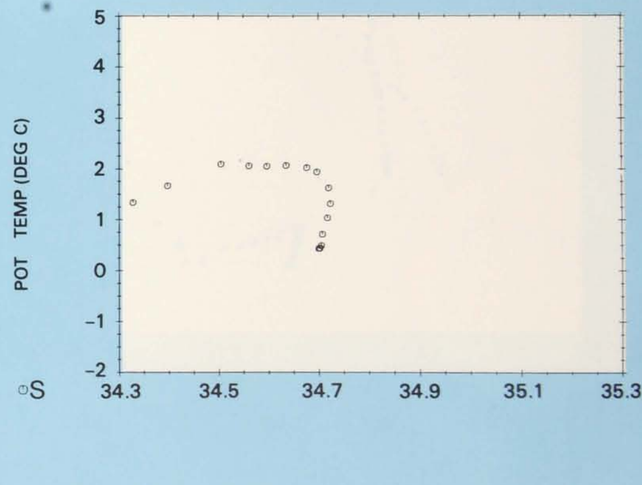
PLATE 137

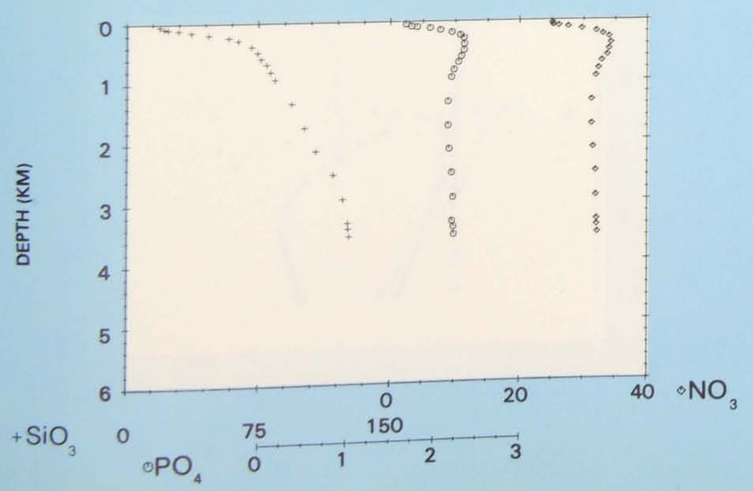
Station 77.
Latitude 59° 39′ S,
Longitude 64° 30′ W.
2 January 1973.











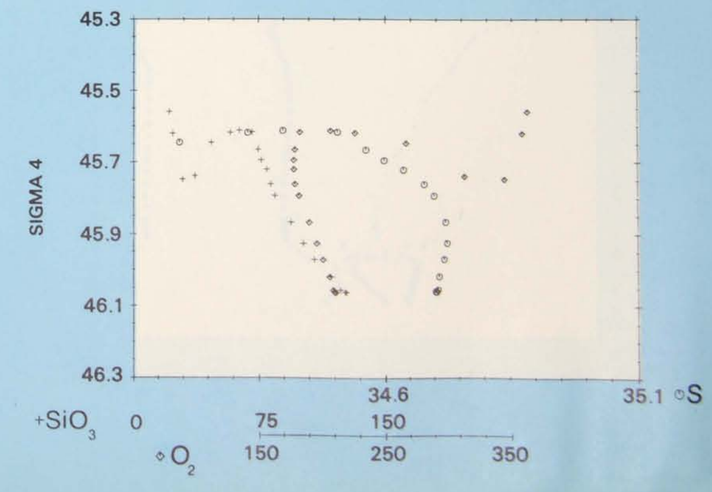
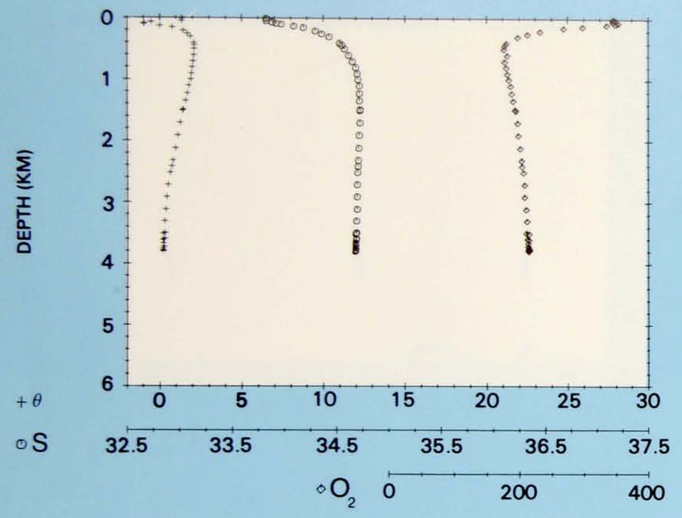
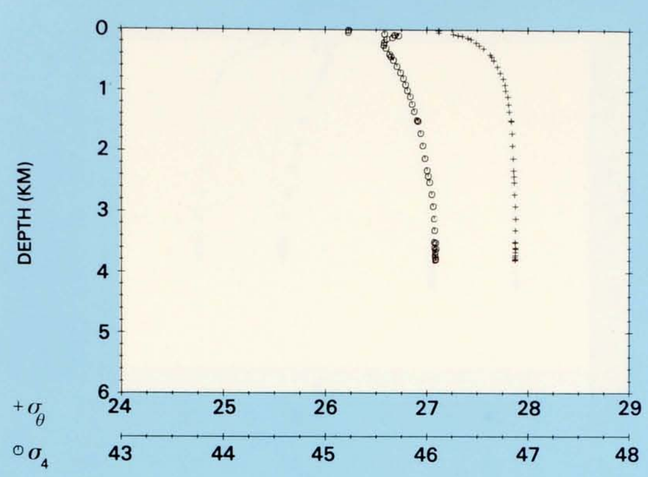


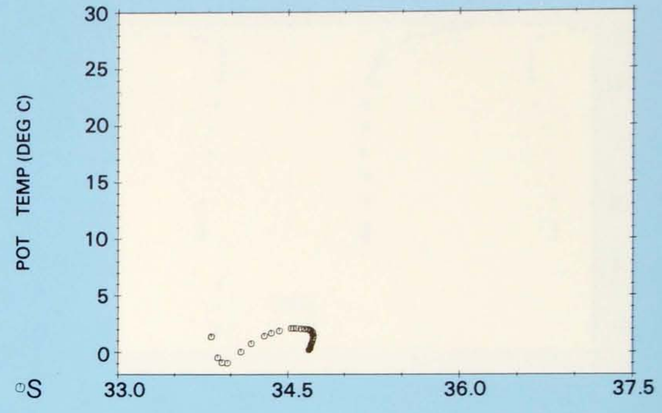
PLATE 138

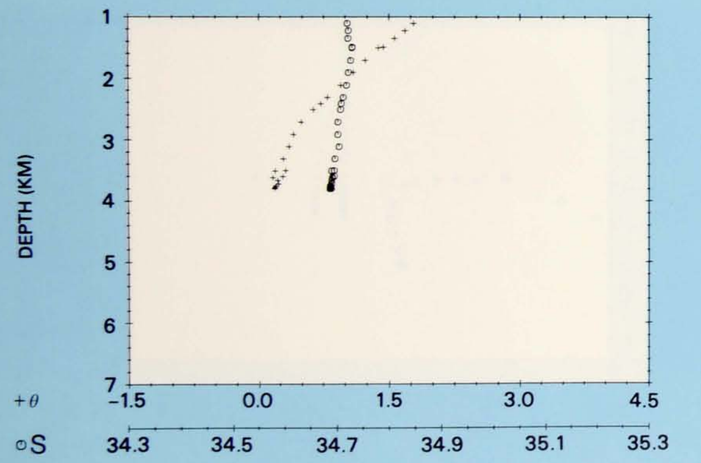
Station 78.
Latitude 61° 03′ S,
Longitude 62° 58′ W.
3 January 1973.

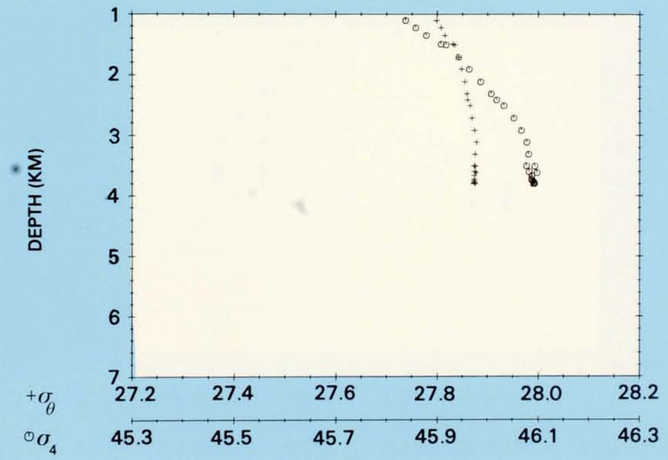
PROPERTY–PROPERTY PLOTS STATION 78

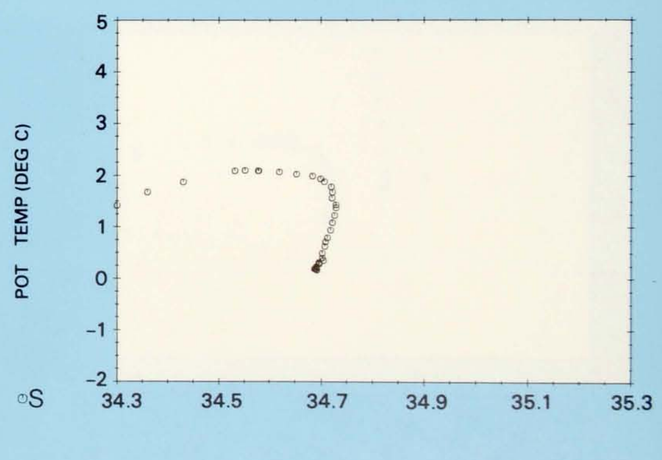


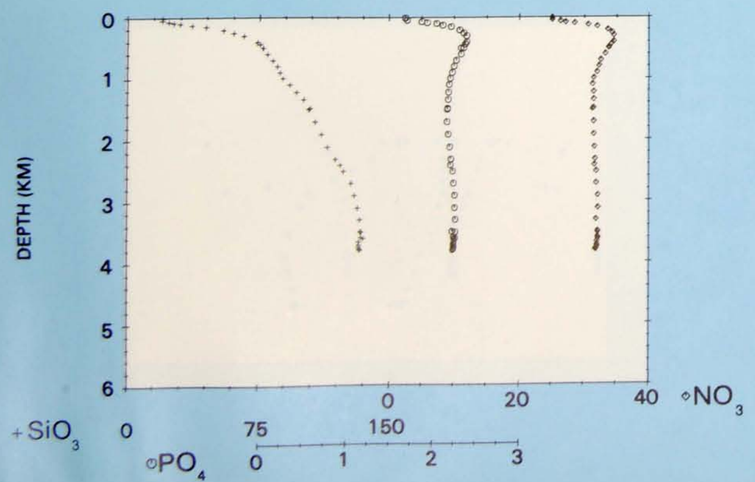


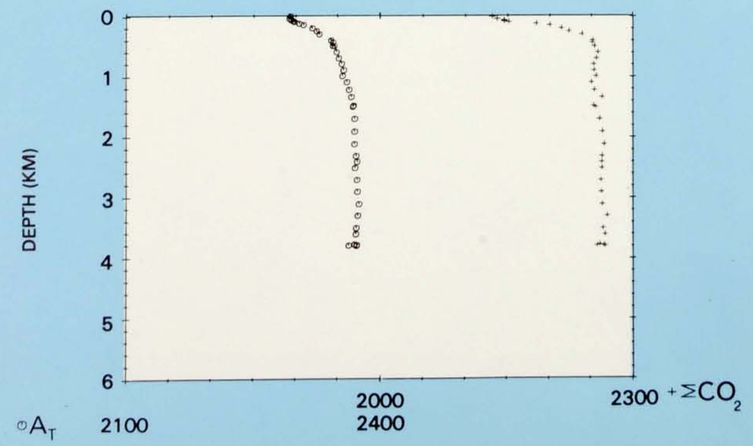


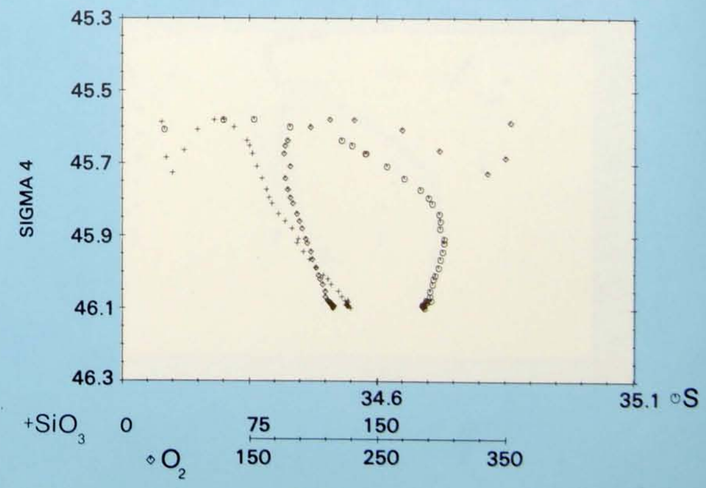


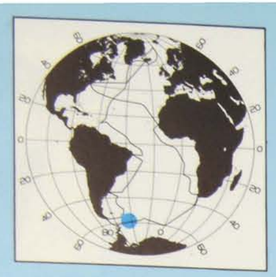








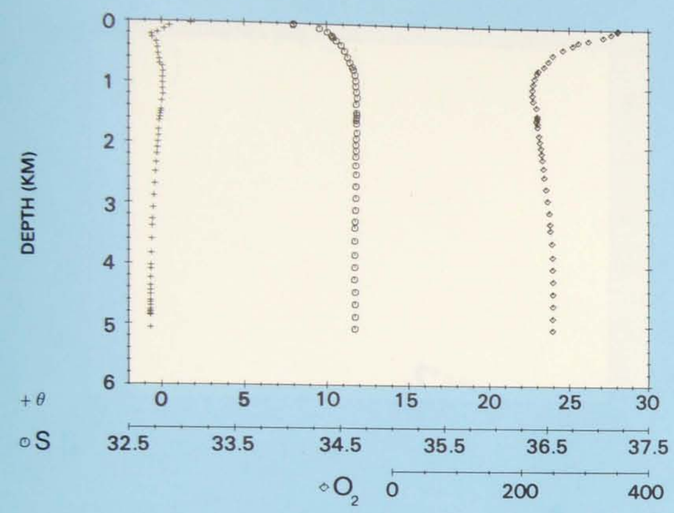


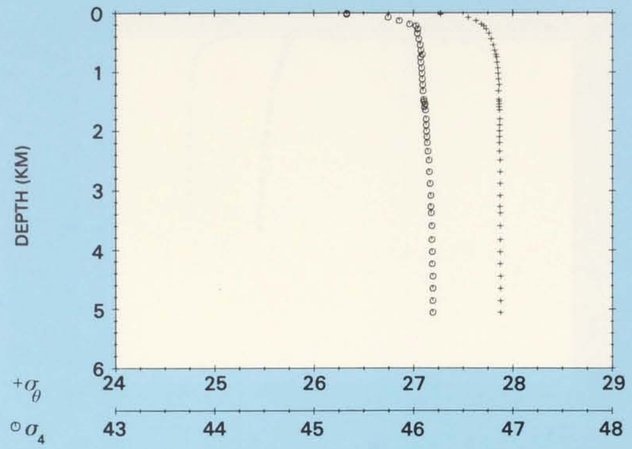


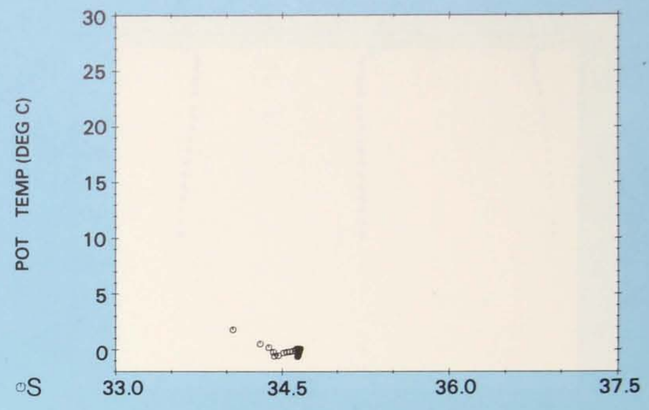
PROPERTY–PROPERTY PLOTS
STATION 79

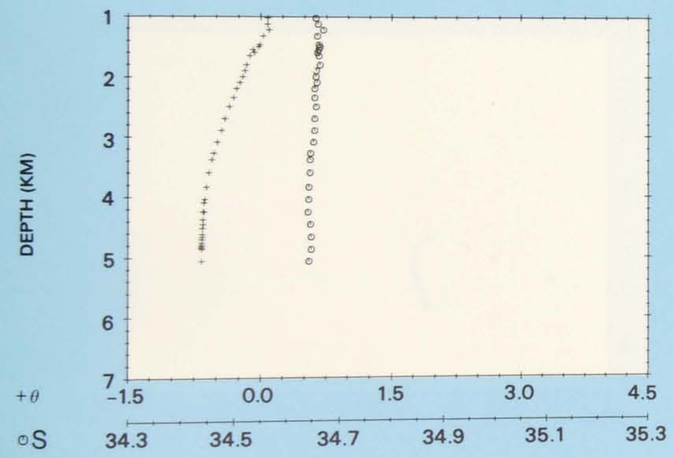
PLATE 139

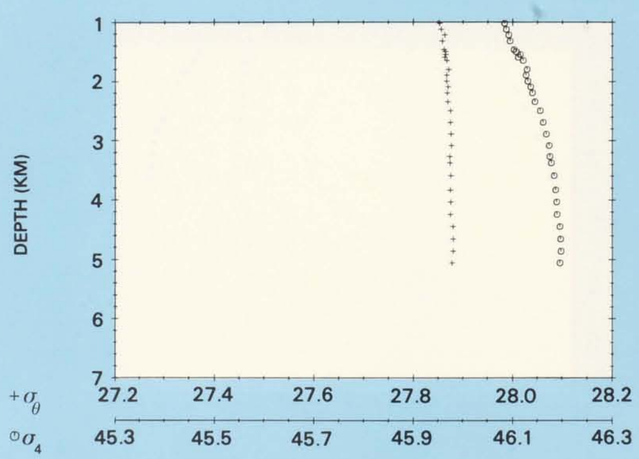
Station 79.
Latitude 59° 56′ S,
Longitude 45° 02′ W.
6 January 1973.

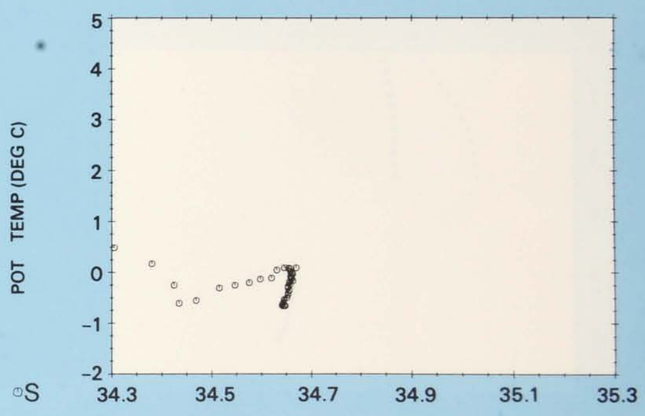


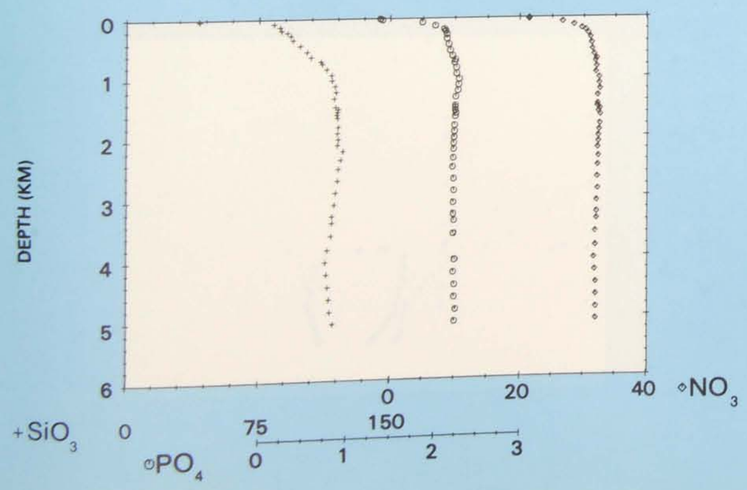


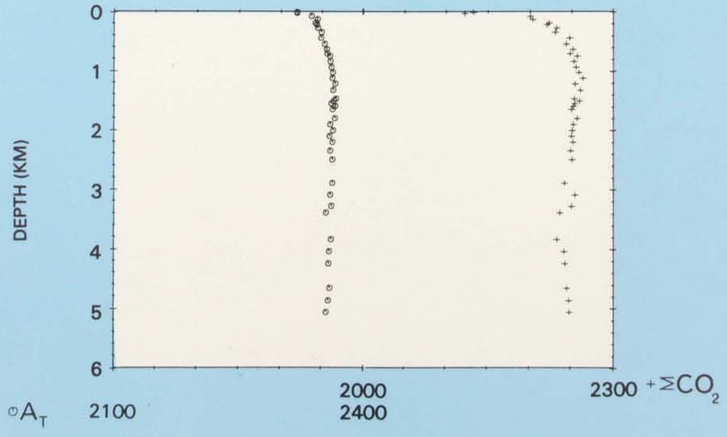












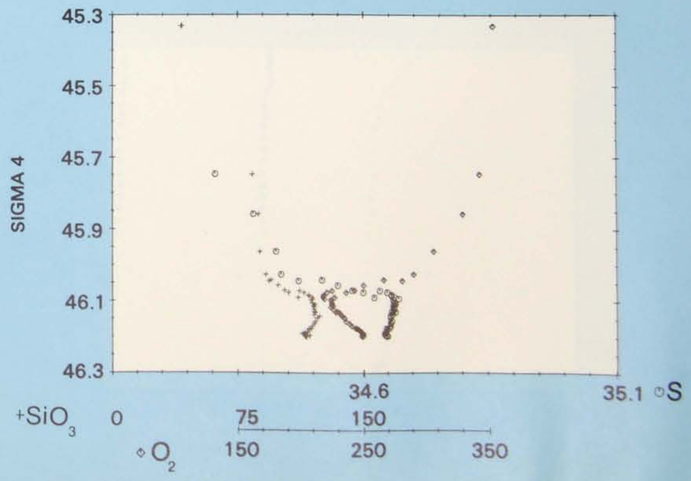
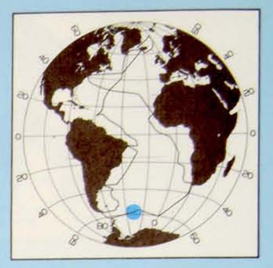
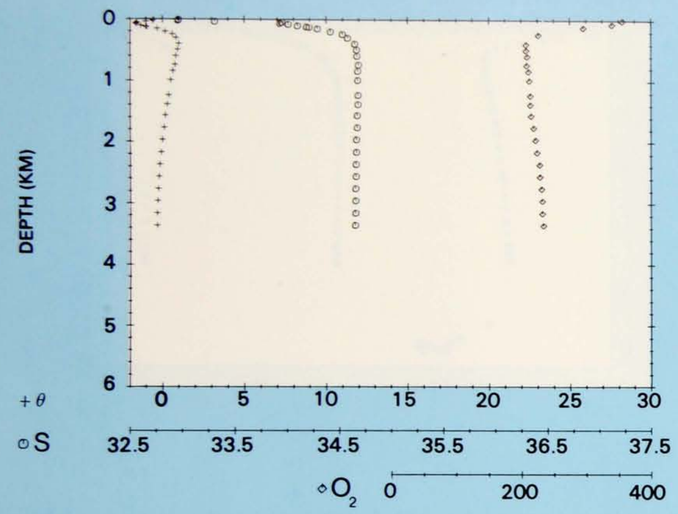


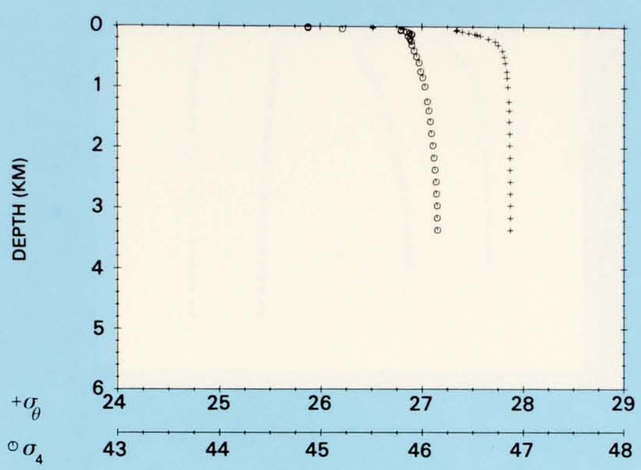
PLATE 140

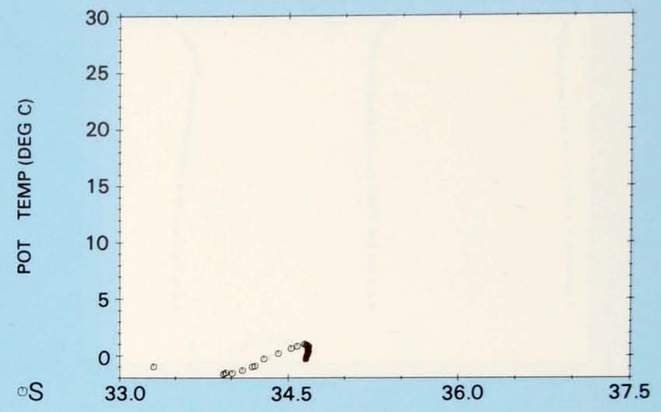
Station 80.
Latitude 57° 47′ S,
Longitude 29° 44′ W.
10 January 1973.

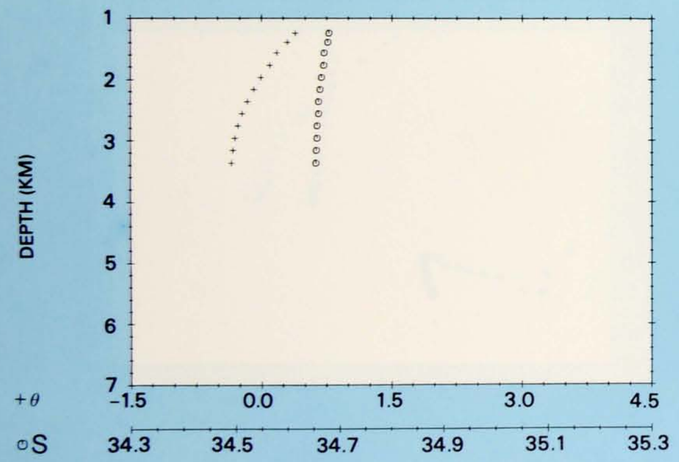
PROPERTY–PROPERTY PLOTS
STATION 80

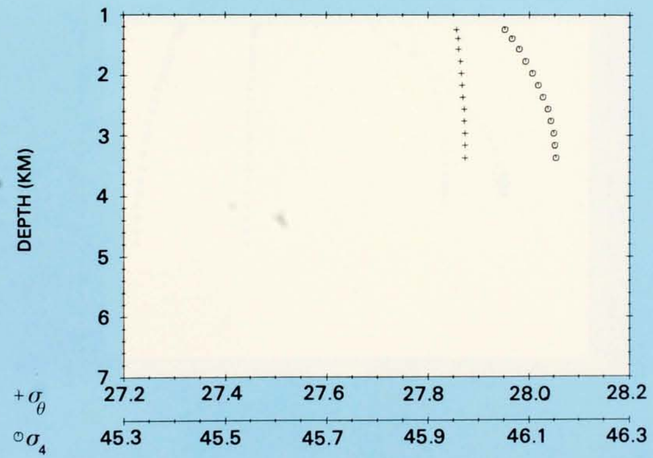


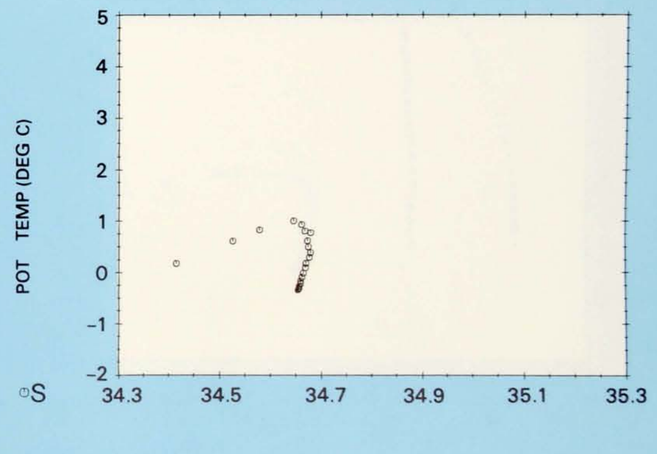


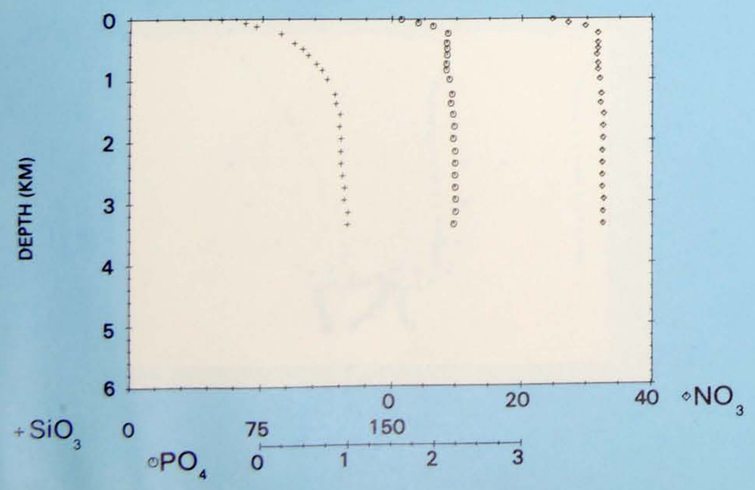


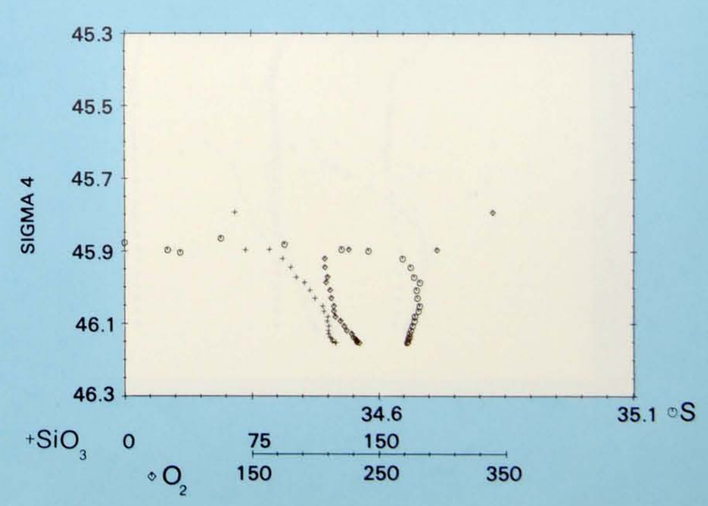


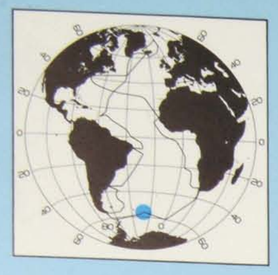








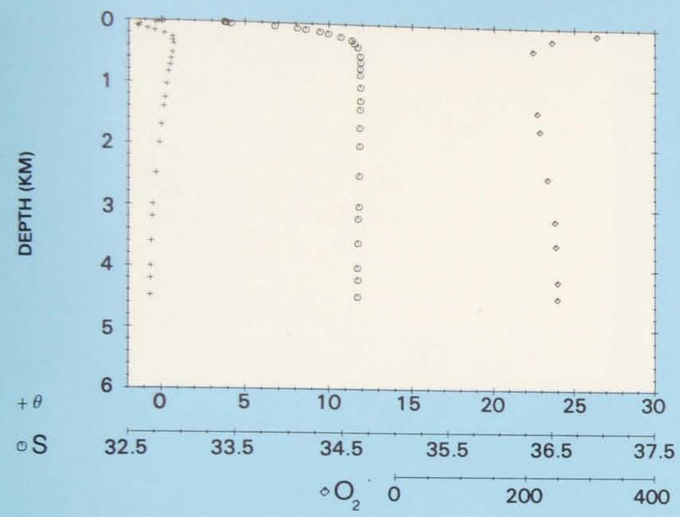


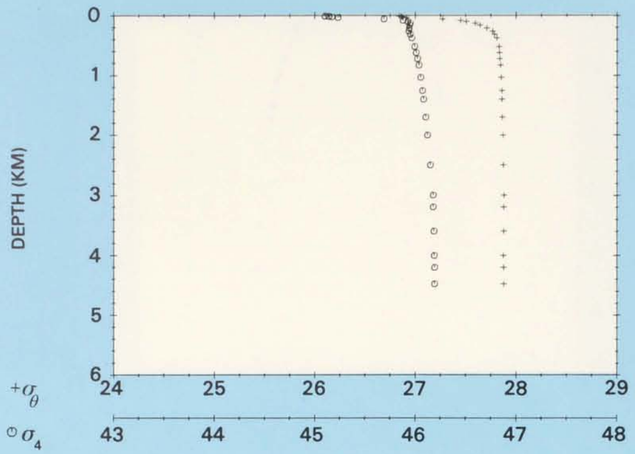


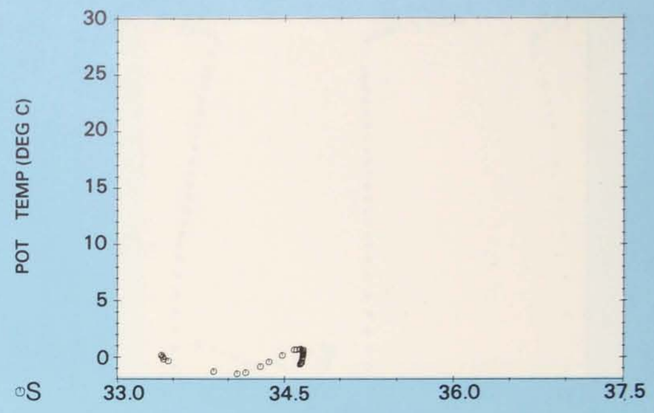
PROPERTY–PROPERTY PLOTS
STATION 81

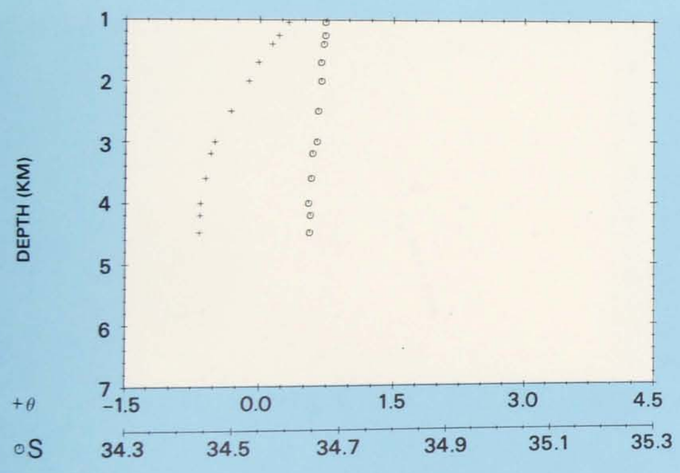
PLATE 141

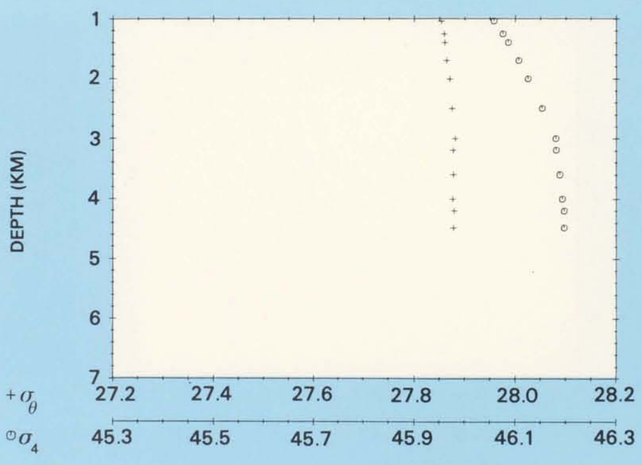
Station 81.
Latitude 55° 58′ S,
Longitude 26° 26′ W.
11 January 1973.

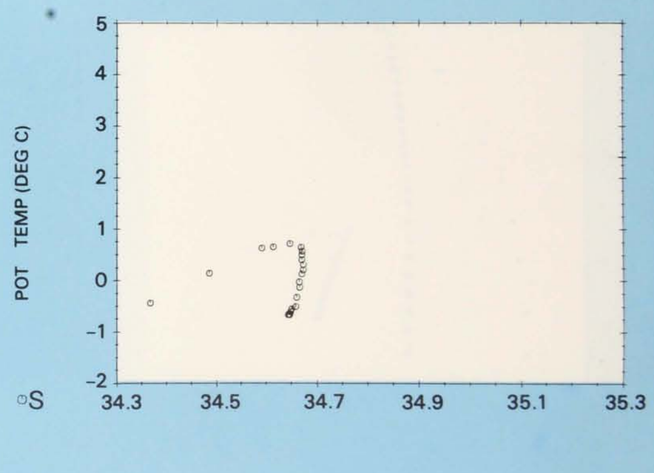


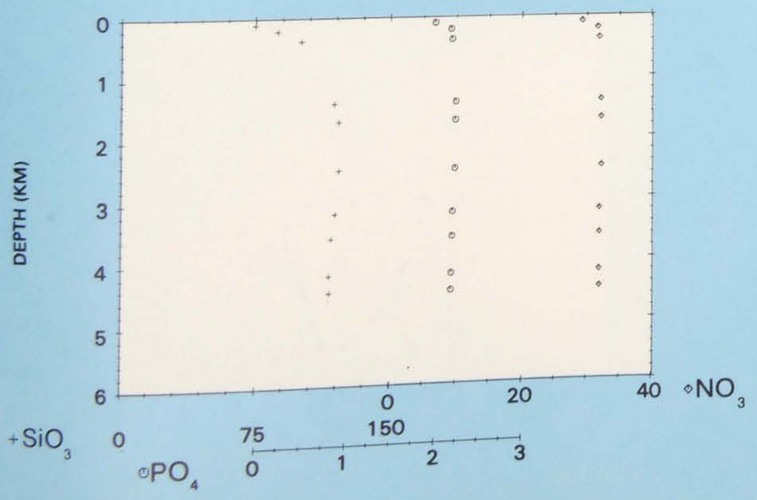












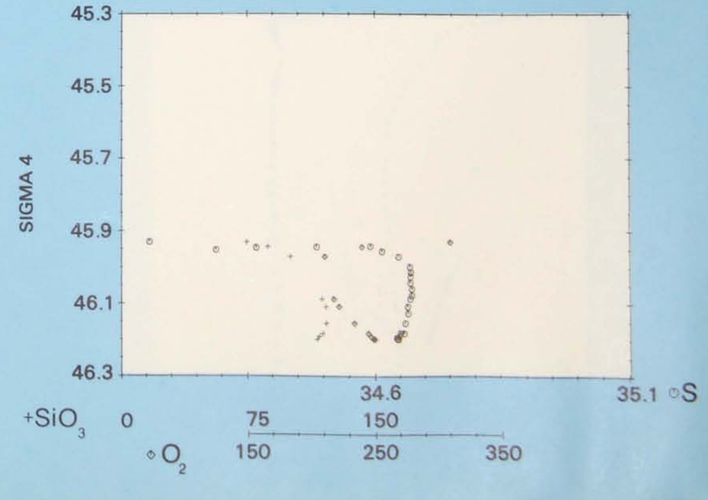
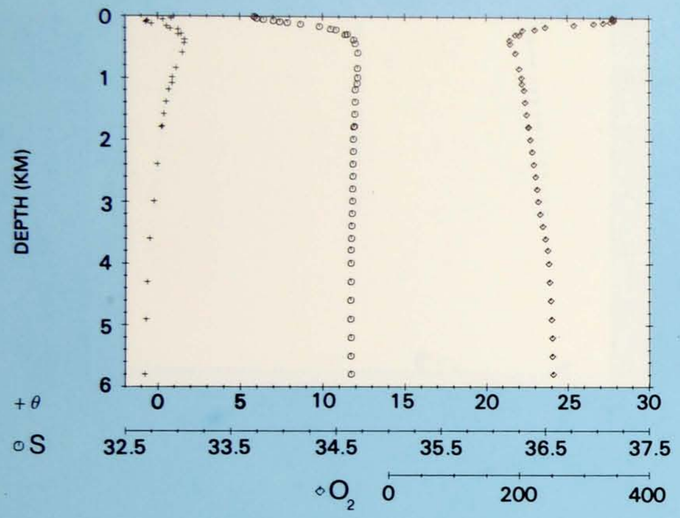
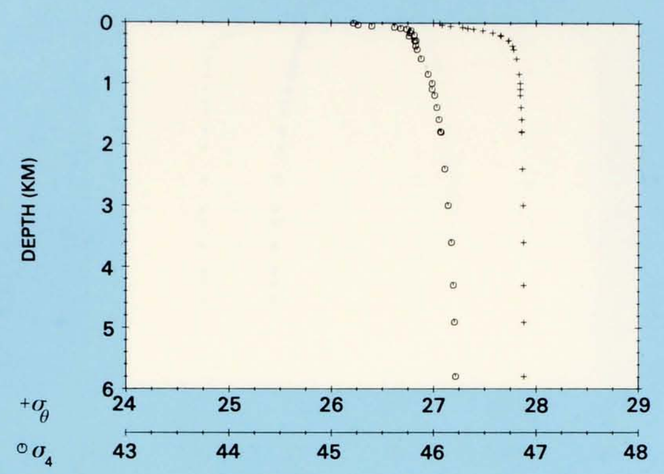


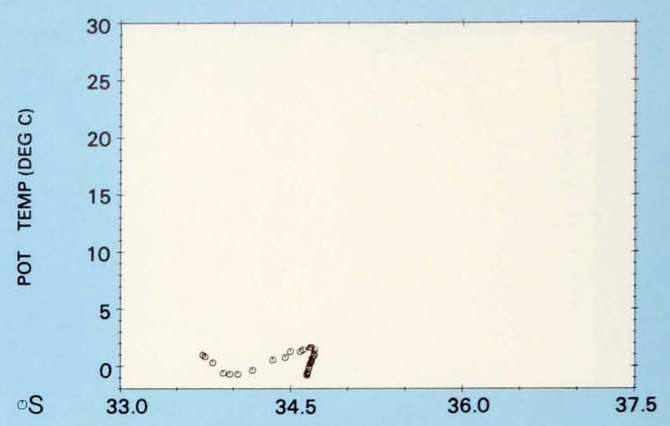
PLATE 142

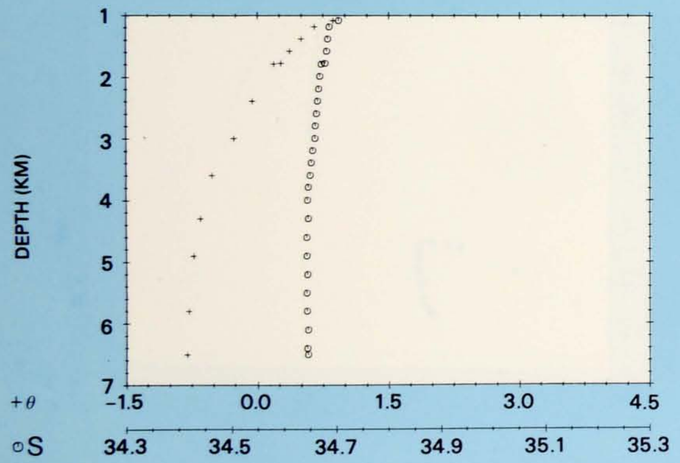
Station 82.
Latitude 56° 15′ S,
Longitude 24° 55′ W.
11 January 1973.

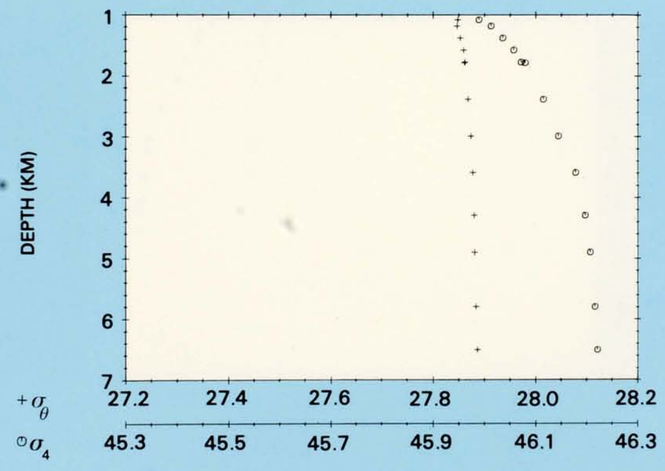
PROPERTY–PROPERTY PLOTS
STATION 82

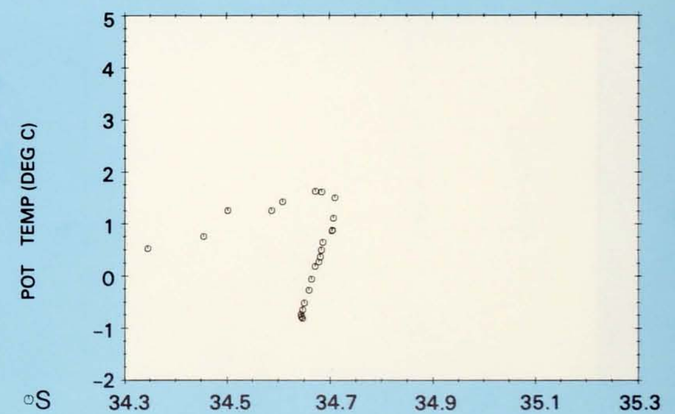


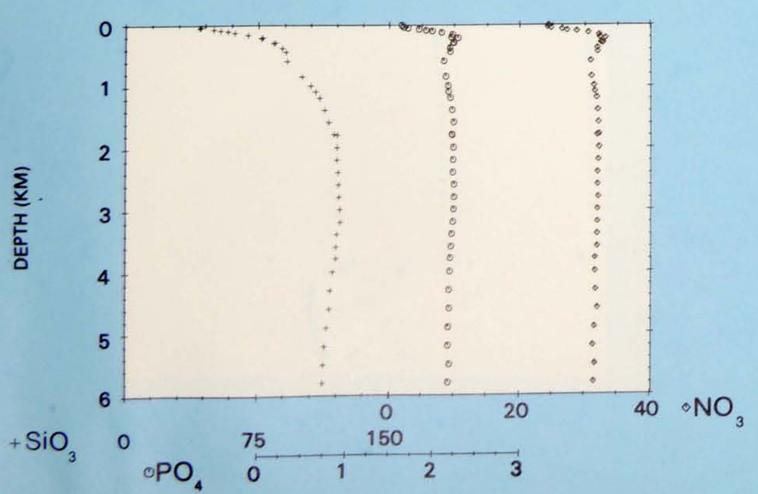


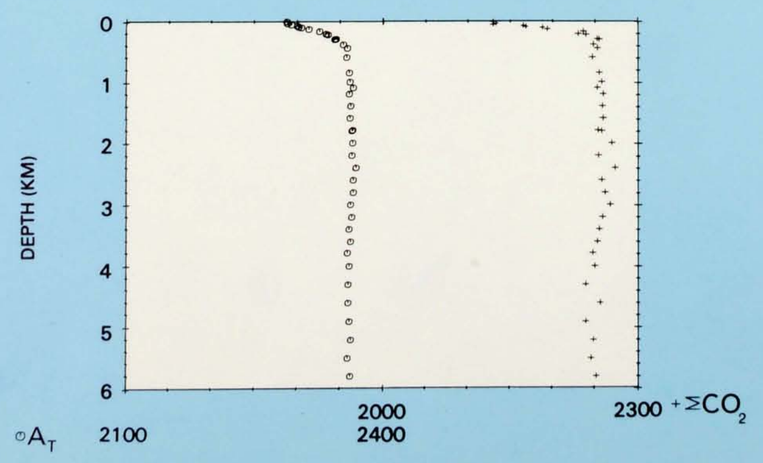


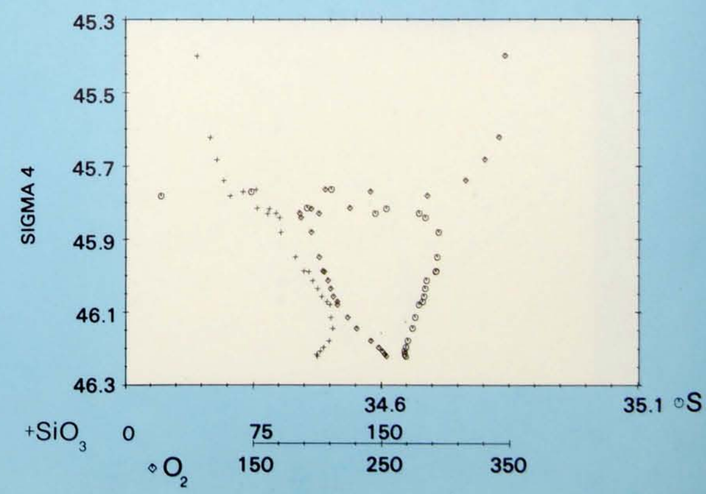


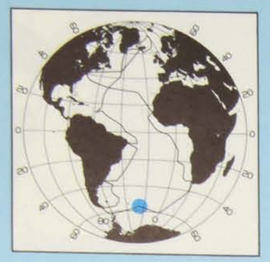








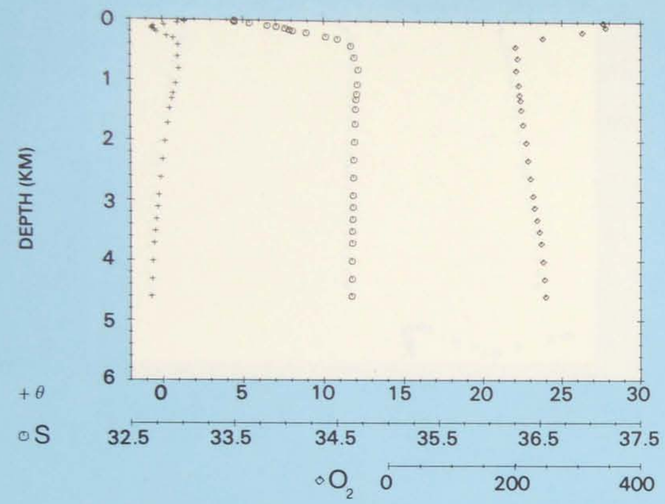


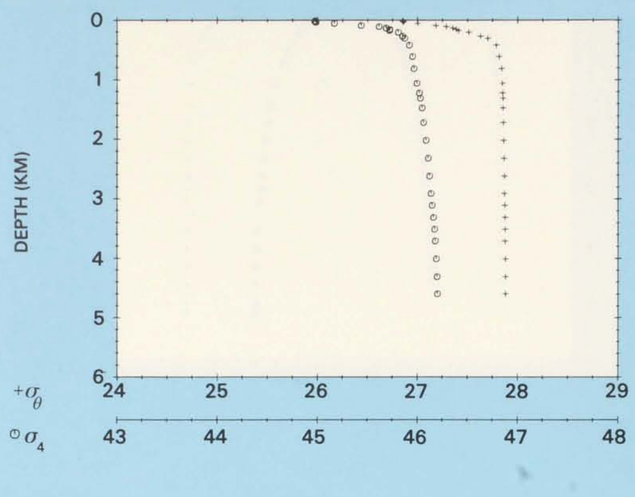


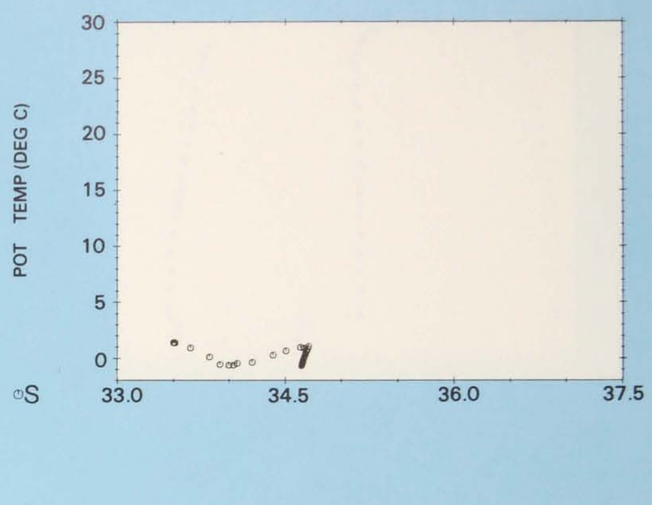
PROPERTY–PROPERTY PLOTS
STATION 83

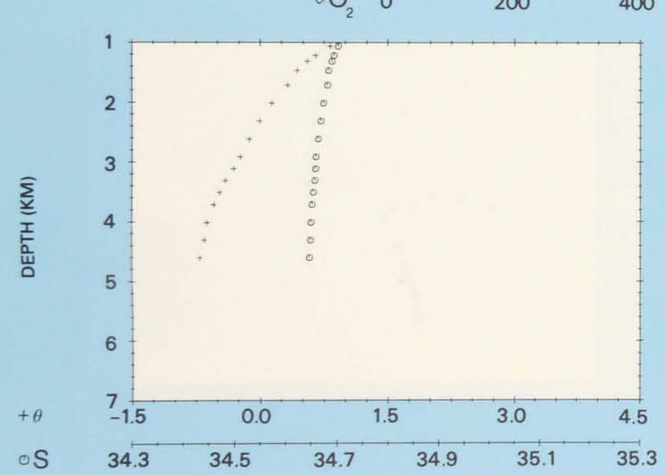
PLATE 143

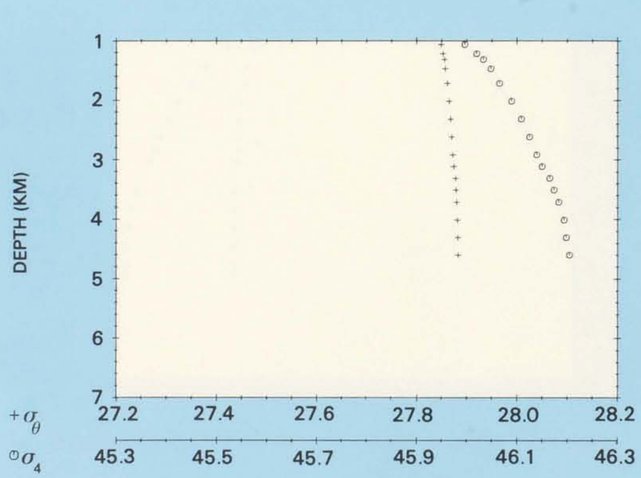
Station 83.
Latitude 56° 48′ S,
Longitude 22° 22′ W.
17 January 1973.

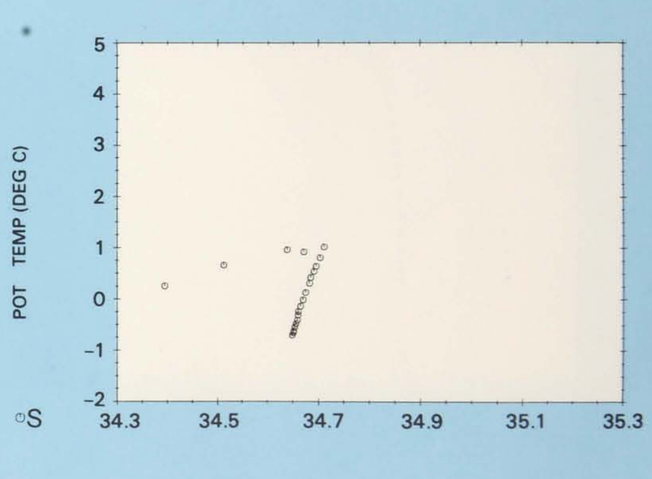


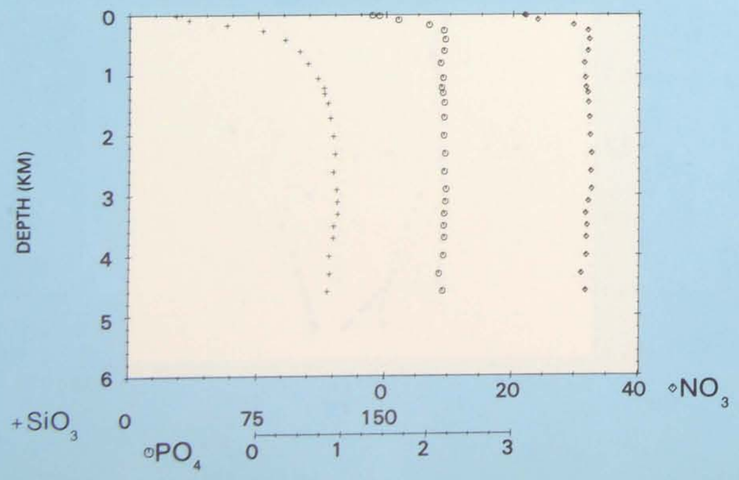












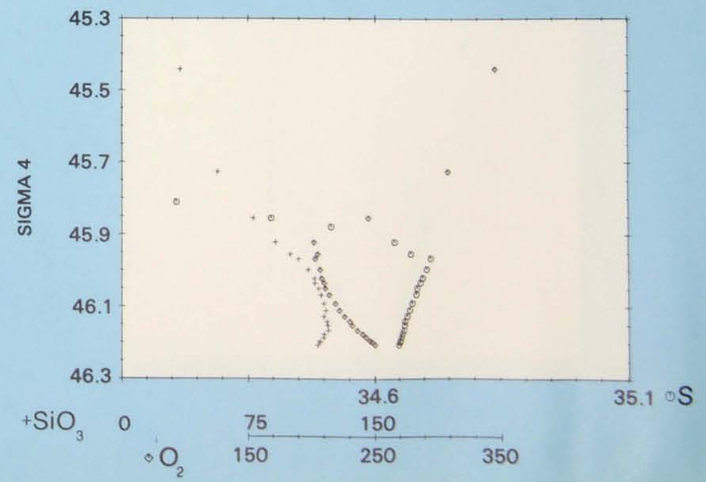
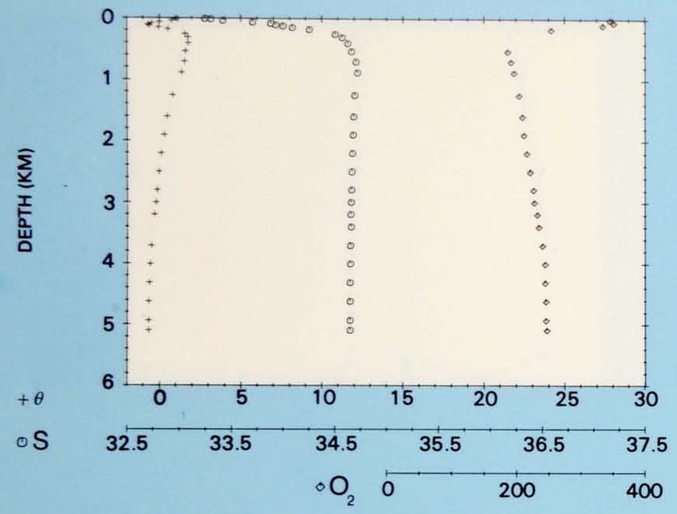
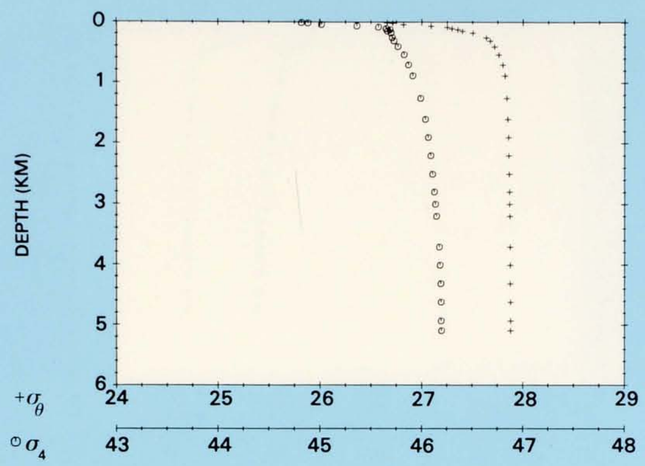


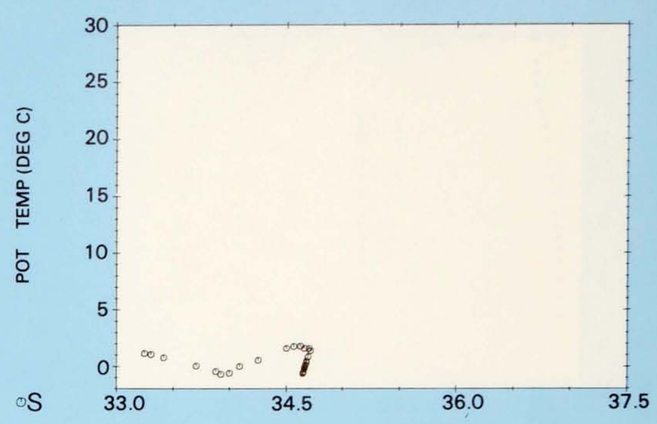
PLATE 144

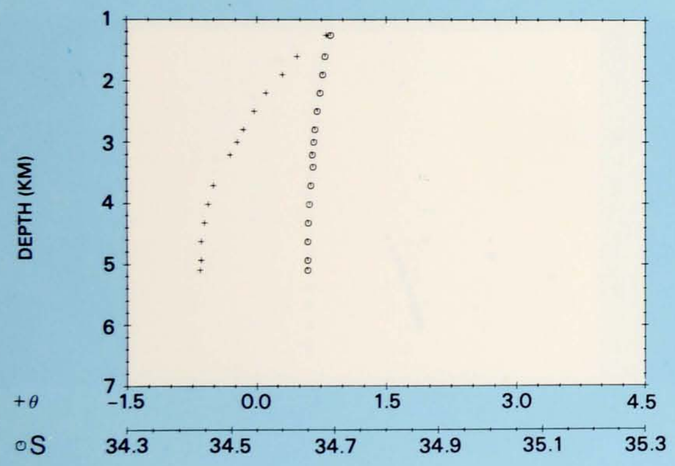
Station 84.
Latitude 56° 55′ S,
Longitude 19° 49′ W.
18 January 1973.

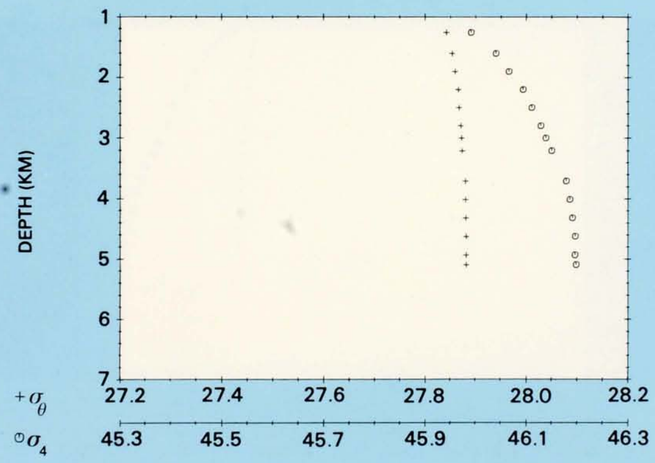
PROPERTY–PROPERTY PLOTS
STATION 84

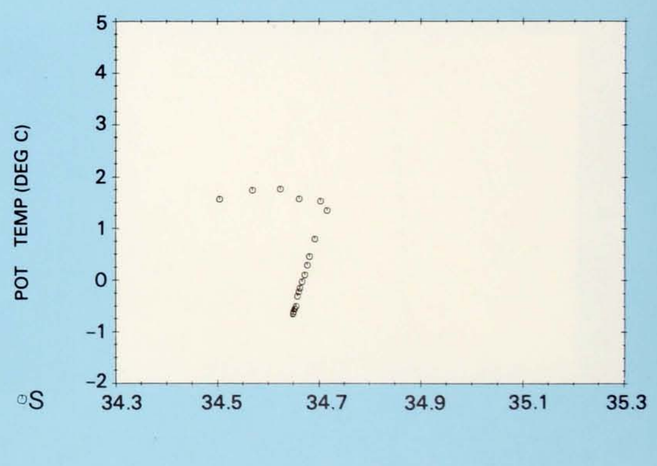


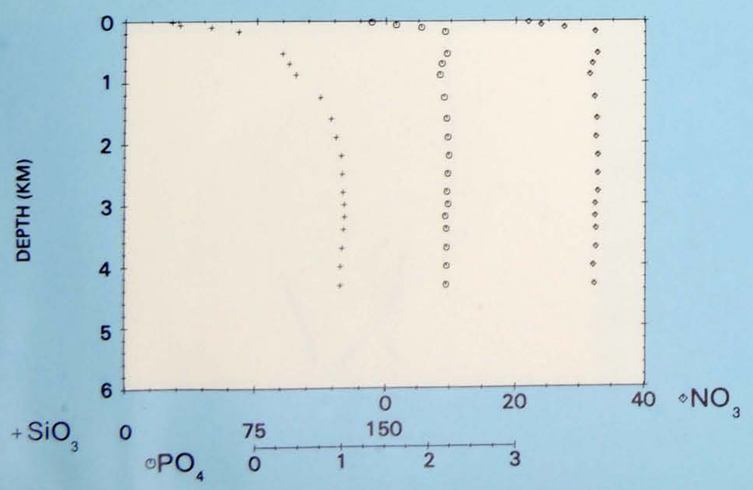


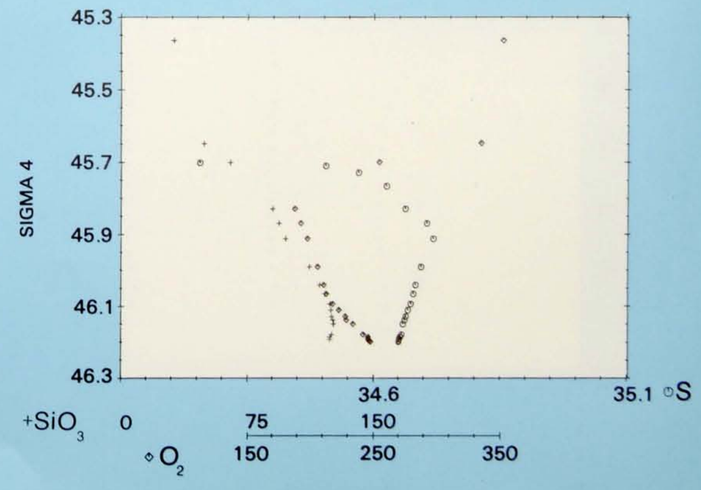


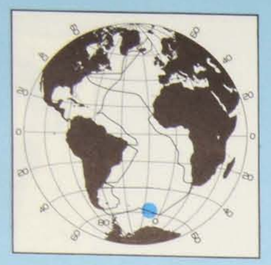








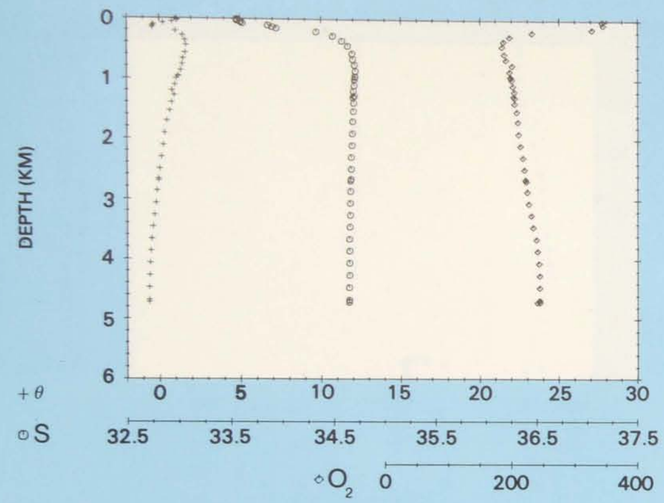


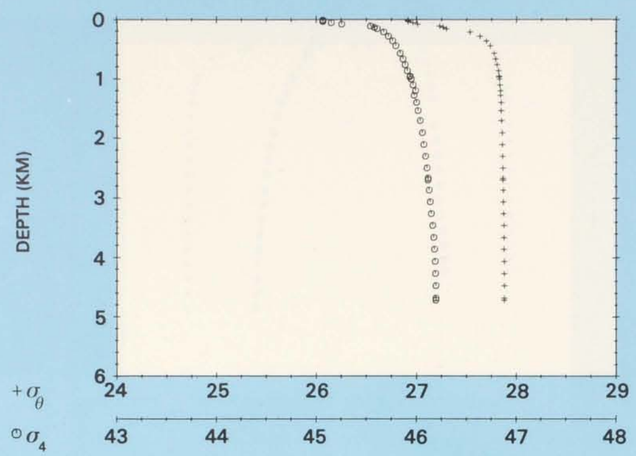


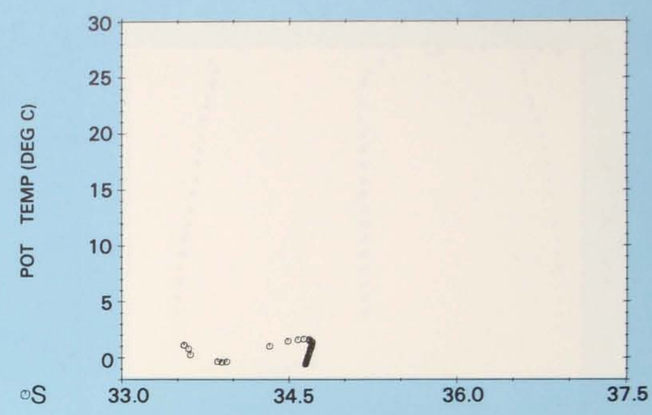
PROPERTY–PROPERTY PLOTS
STATION 85

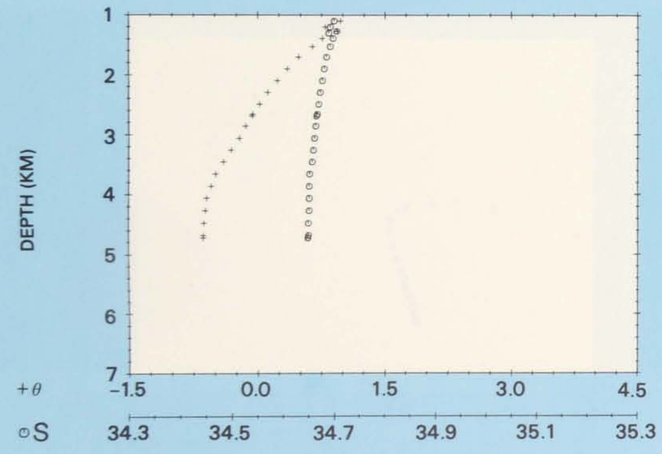
PLATE 145

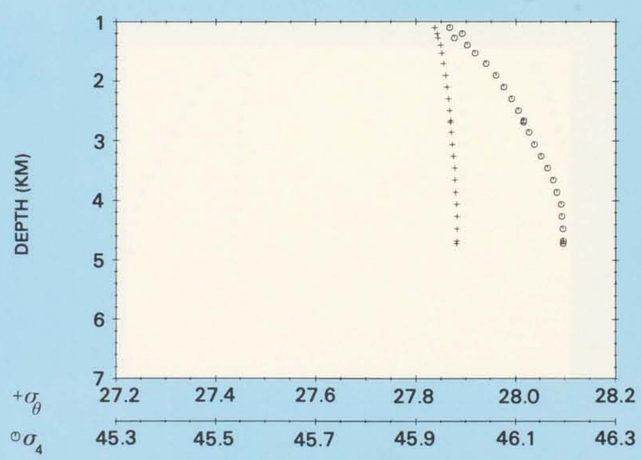
Station 85.
Latitude 57° 30′ S,
Longitude 17° 23′ W.
18 January 1973.

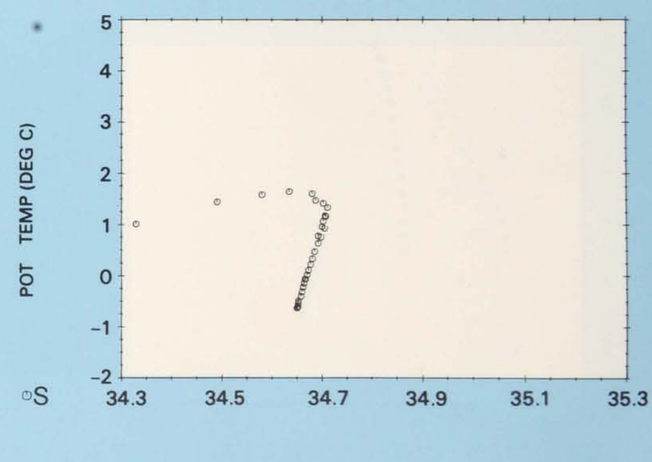


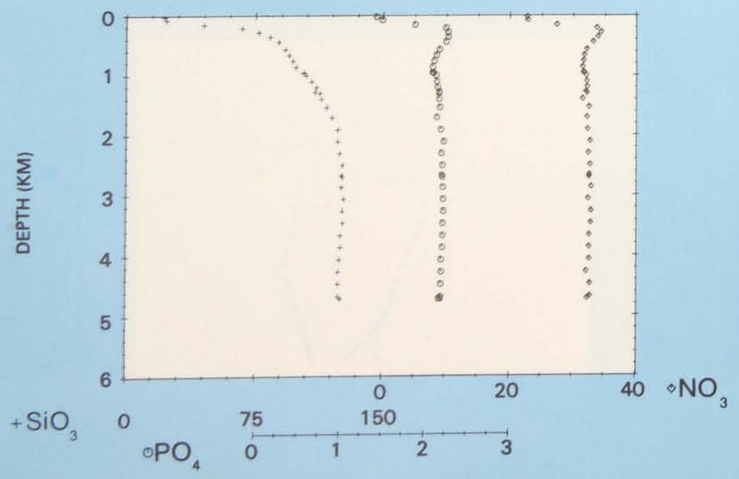


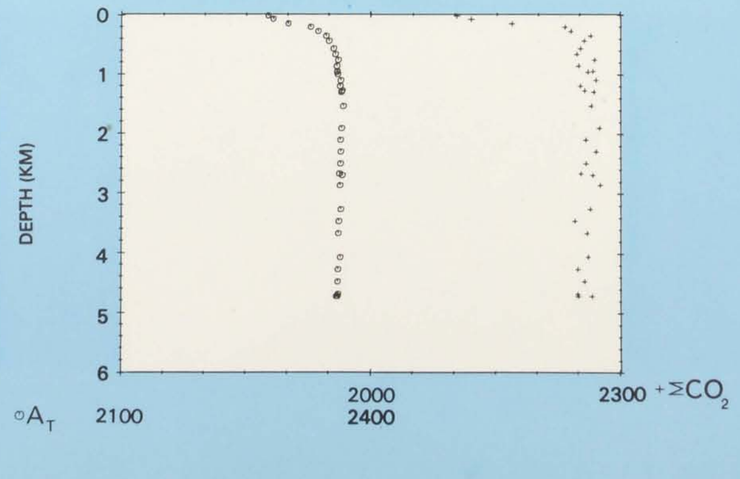












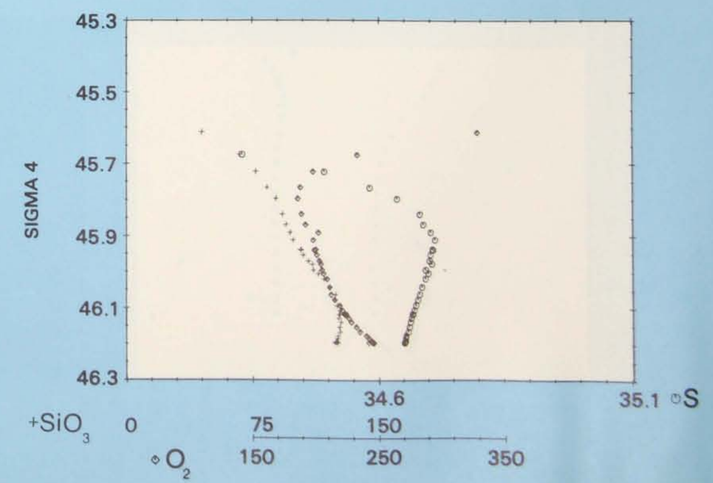
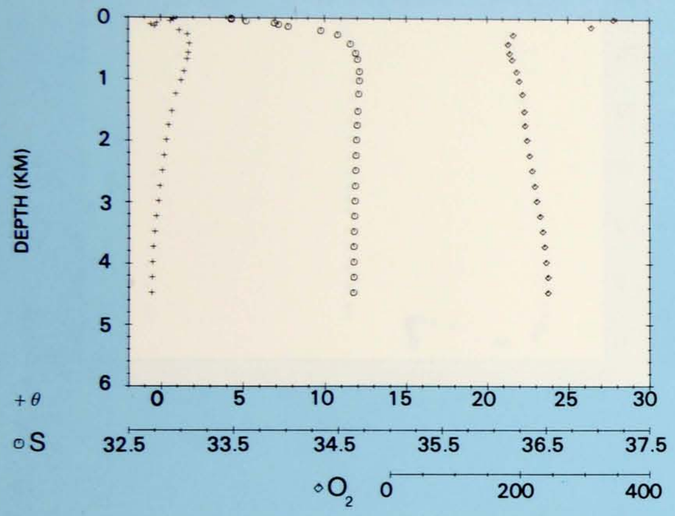
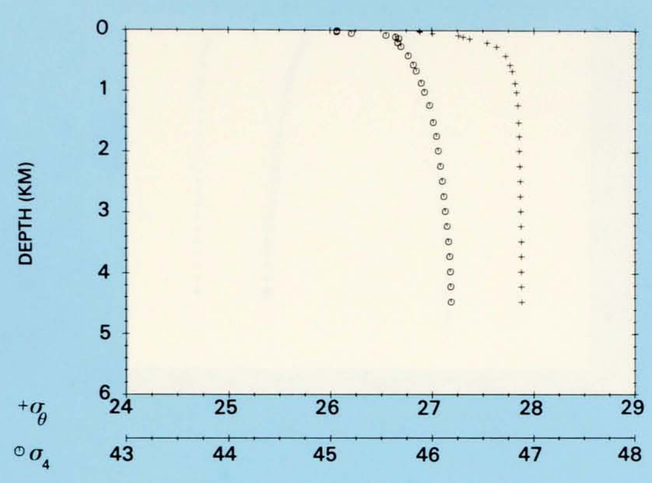


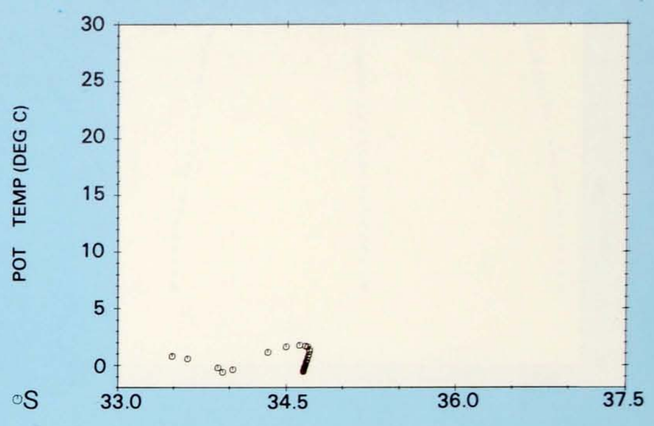
PLATE 146

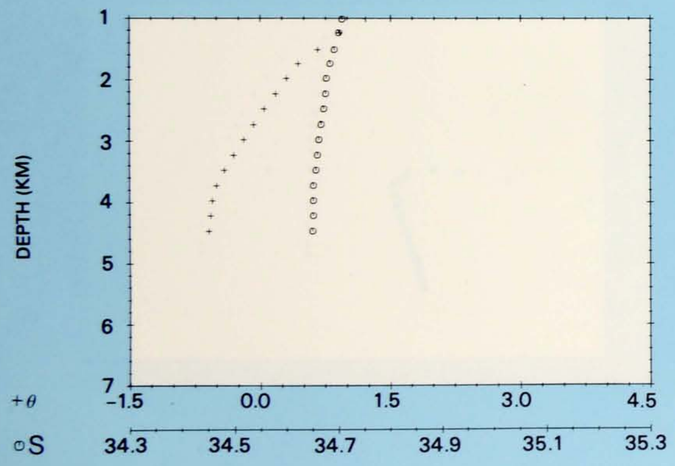
Station 86.
Latitude 57° 52′ S,
Longitude 14° 32′ W.
19 January 1973.

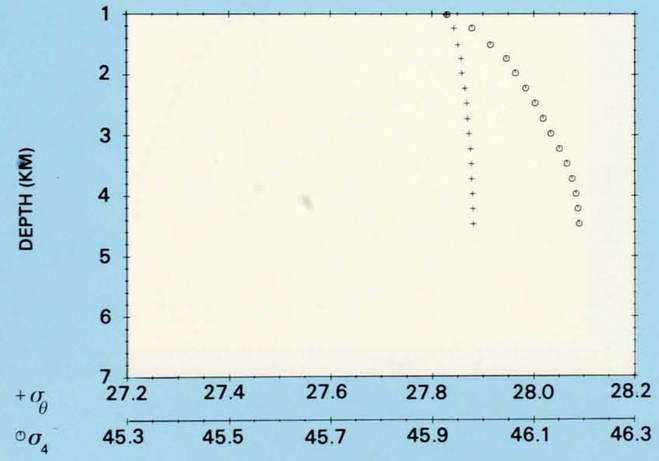
PROPERTY–PROPERTY PLOTS
STATION 86

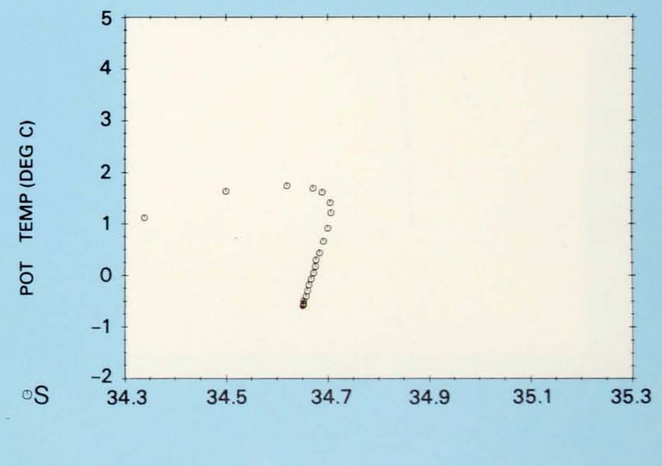


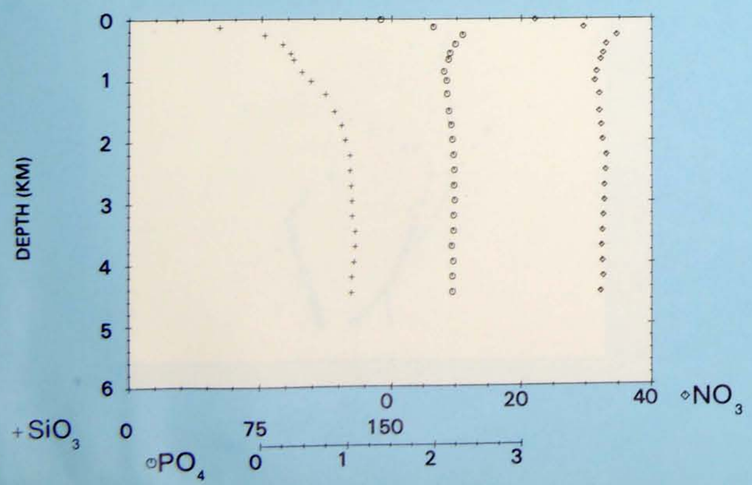


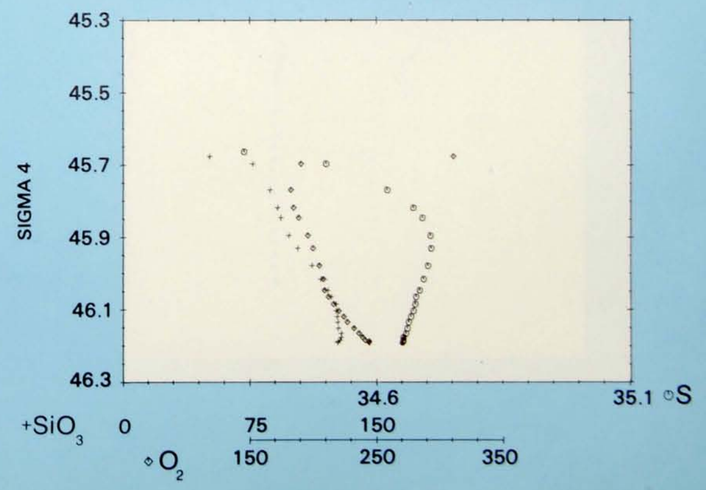








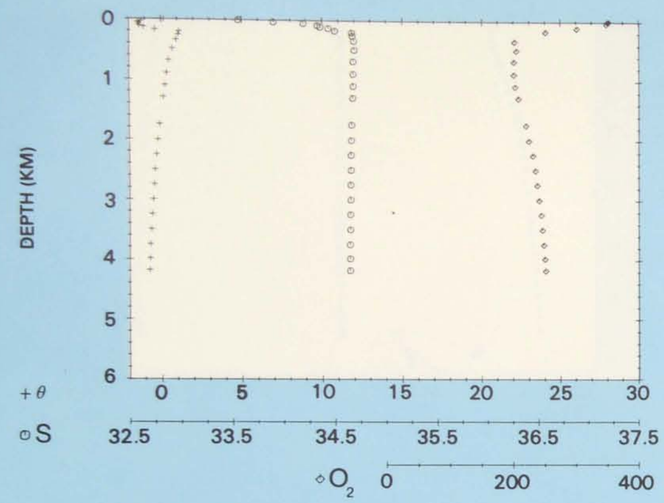


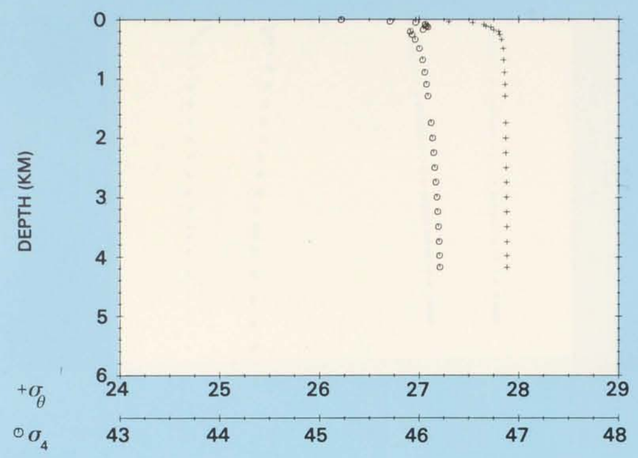


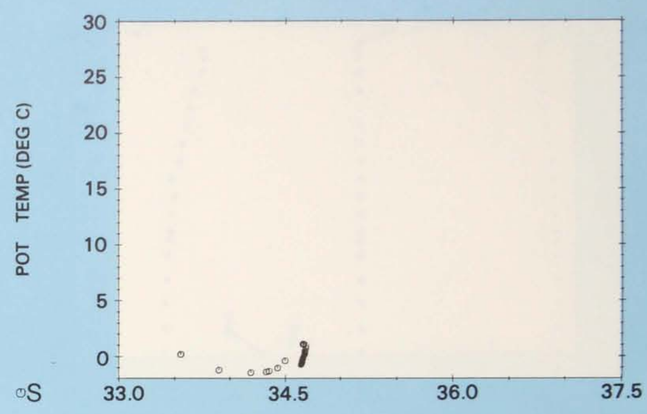
PROPERTY–PROPERTY PLOTS
STATION 87

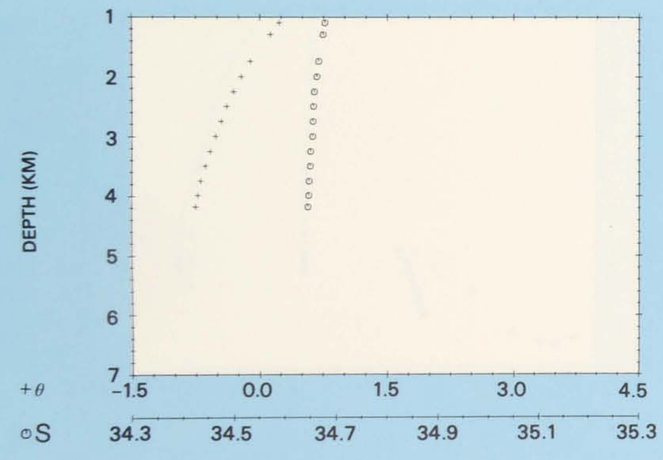
PLATE 147

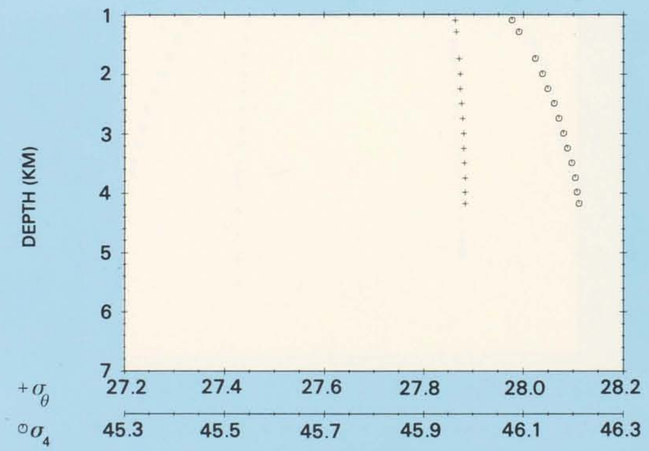
Station 87.
Latitude 58° 38′ S,
Longitude 9° 26′ W.
20 January 1973.

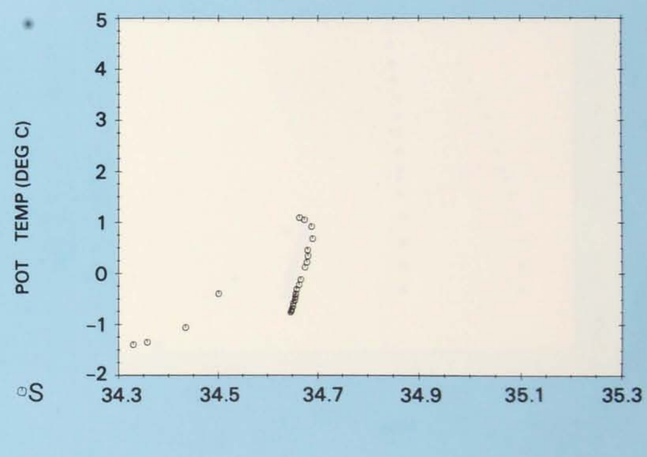


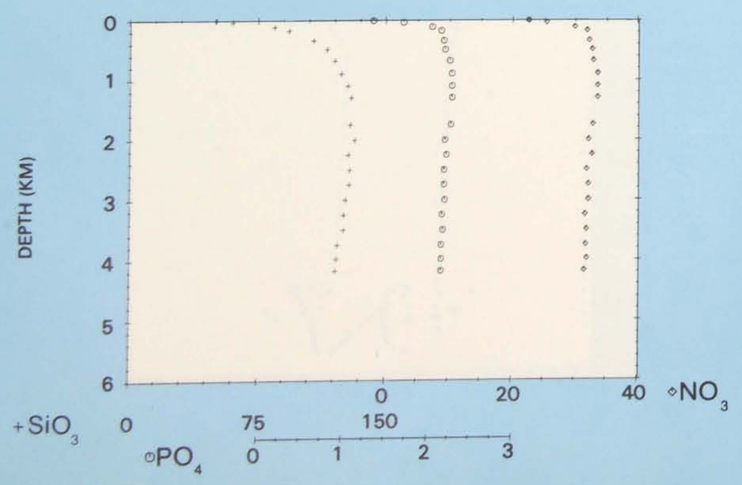


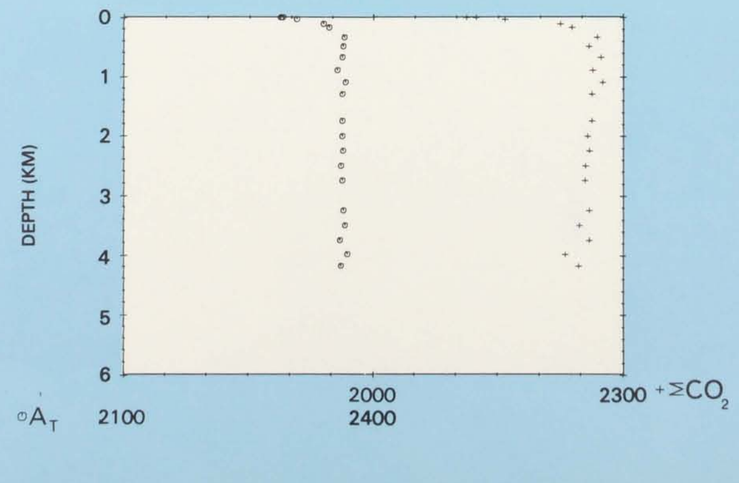












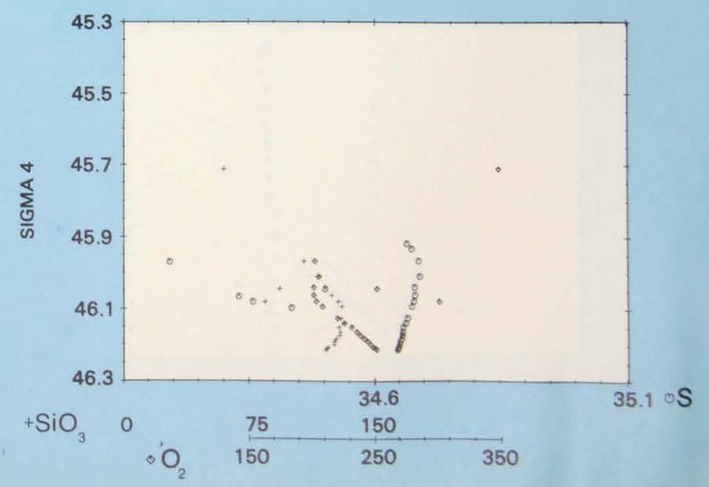
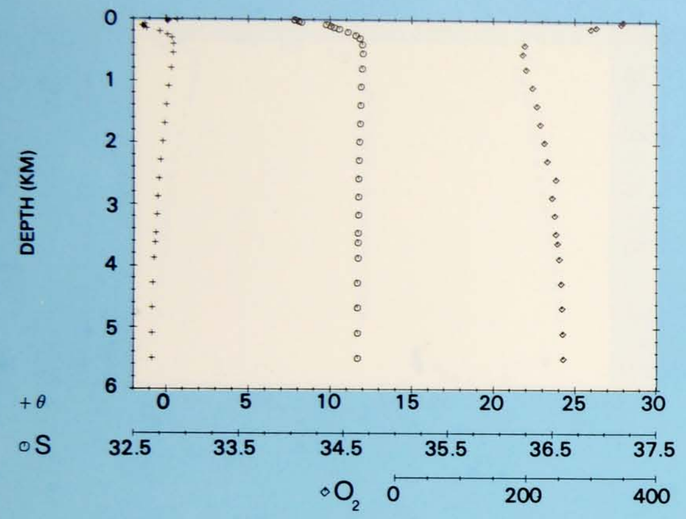
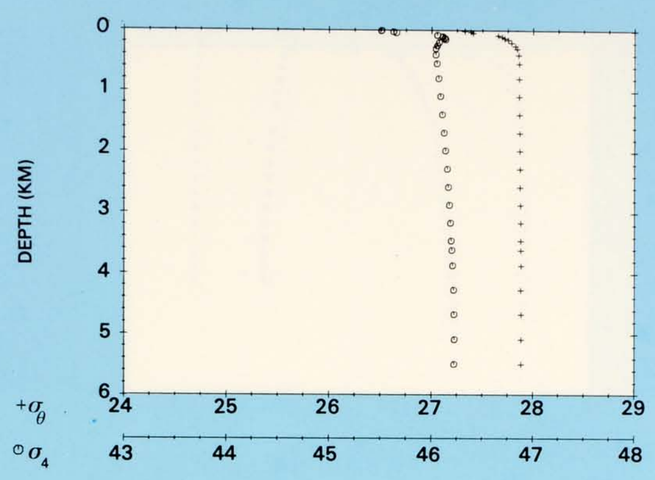


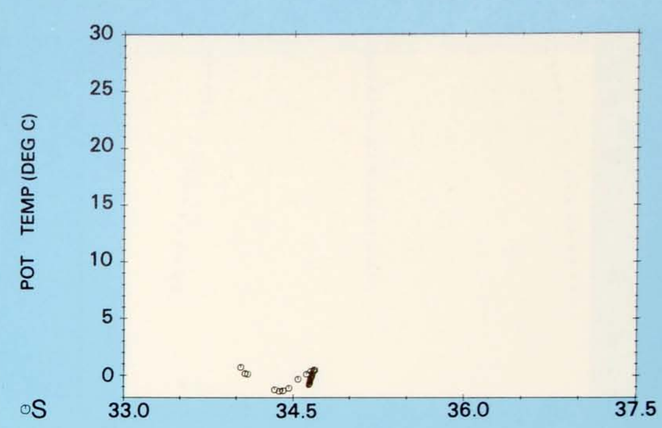
PLATE 148

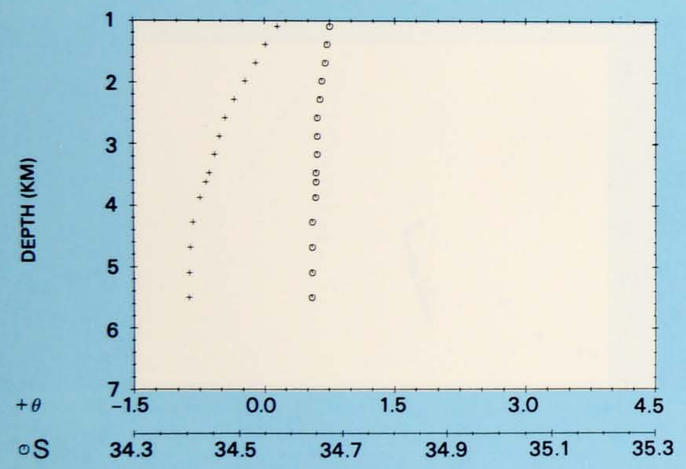
Station 88.
Latitude 59° 20′ S,
Longitude 4° 51′ W.
21 January 1973.

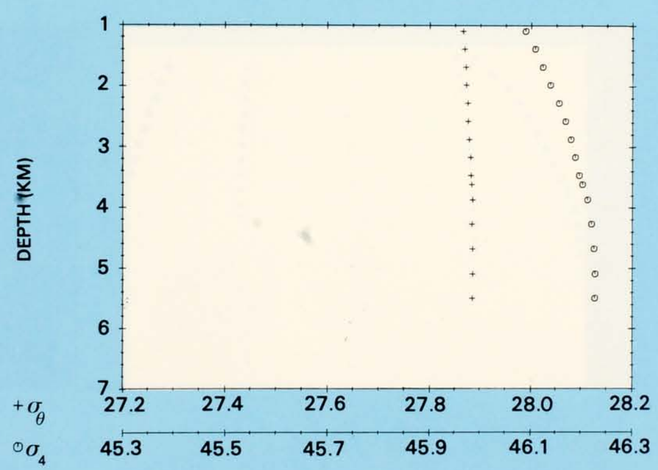
PROPERTY–PROPERTY PLOTS
STATION 88

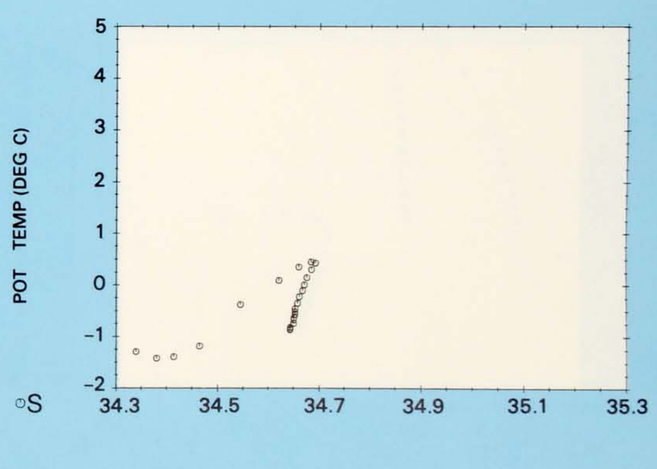


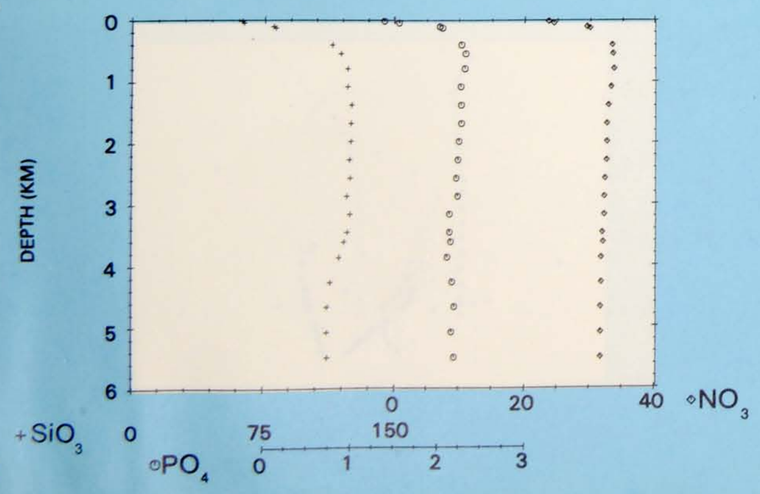


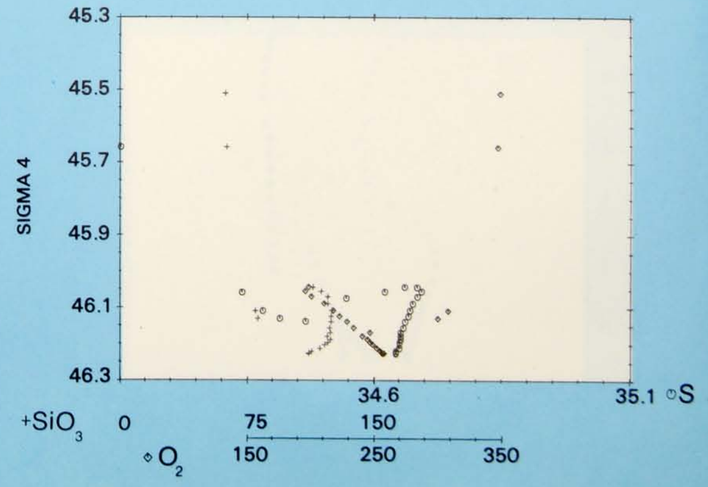








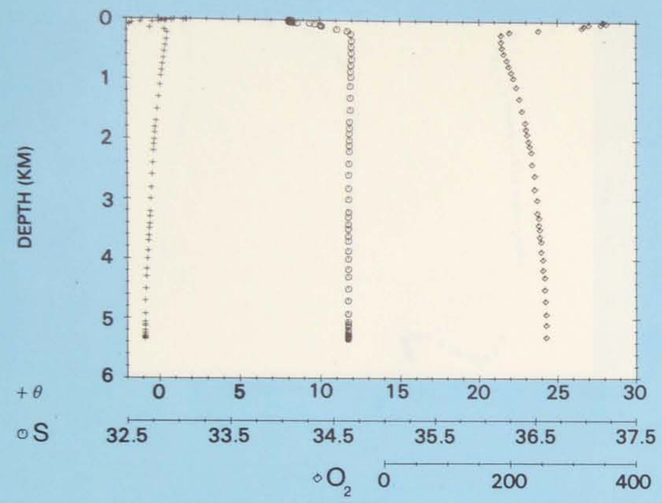


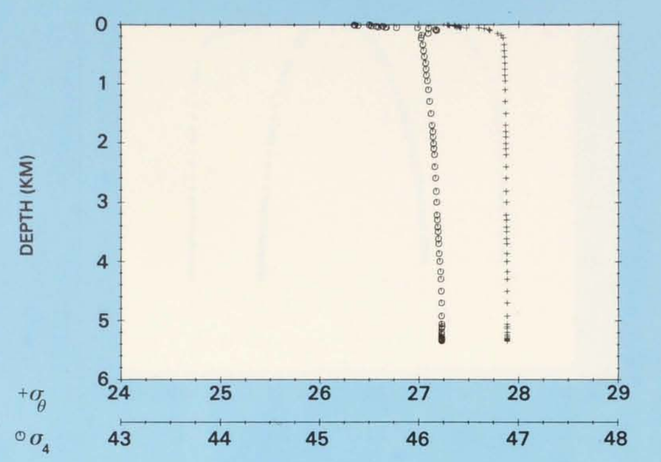


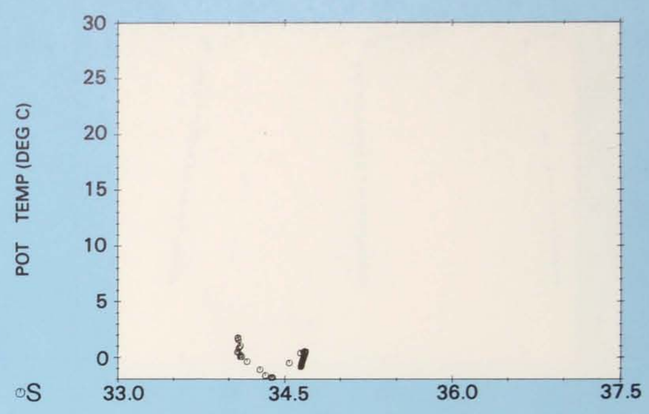
PROPERTY–PROPERTY PLOTS
STATION 89

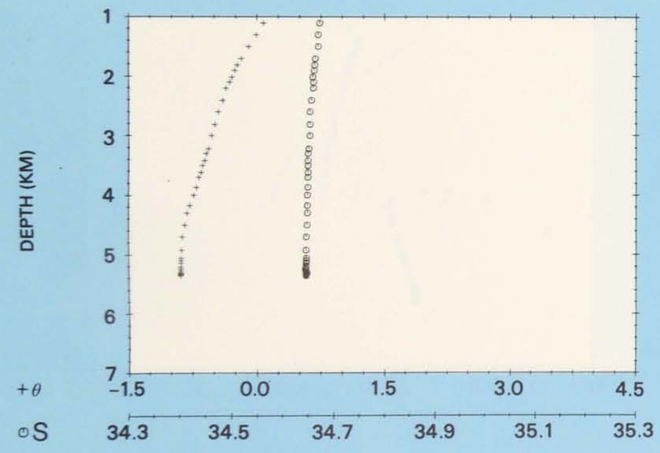
PLATE 149

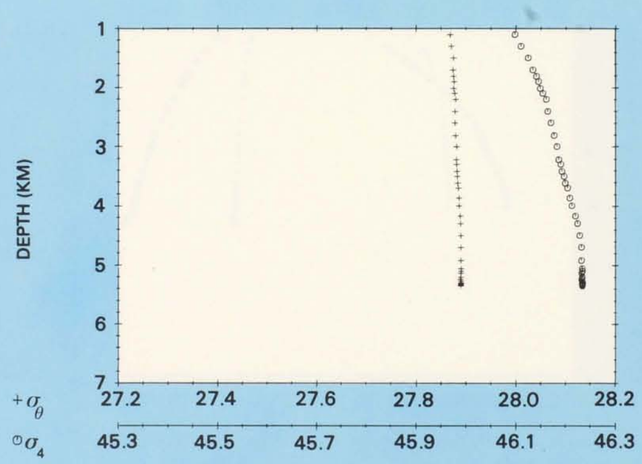
Station 89.
Latitude 60° 01′ S,
Longitude 0° 01′ E.
22 January 1973.

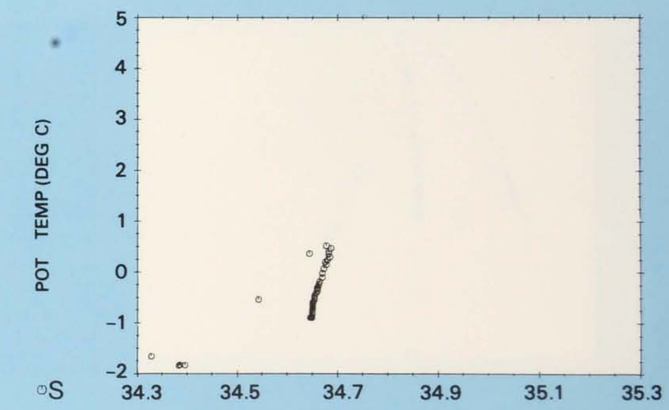


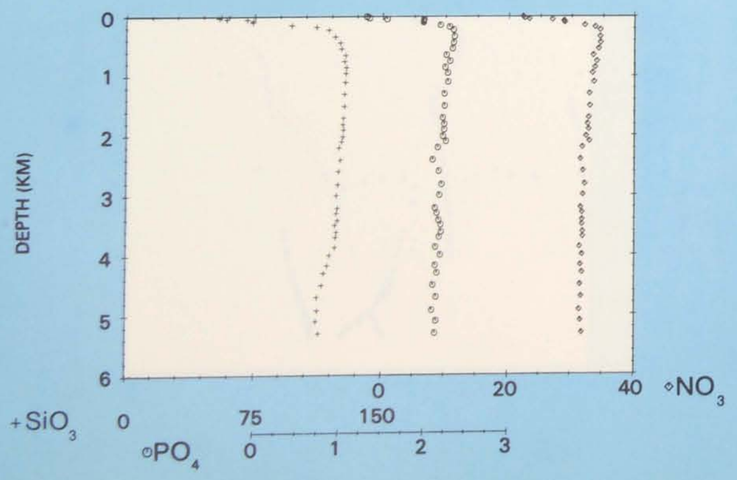


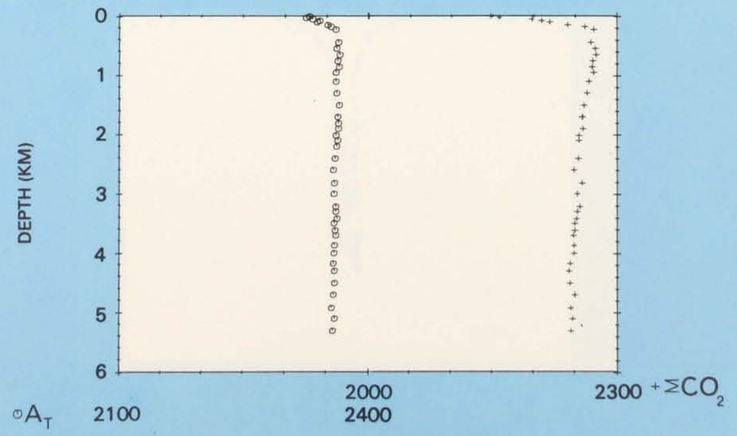












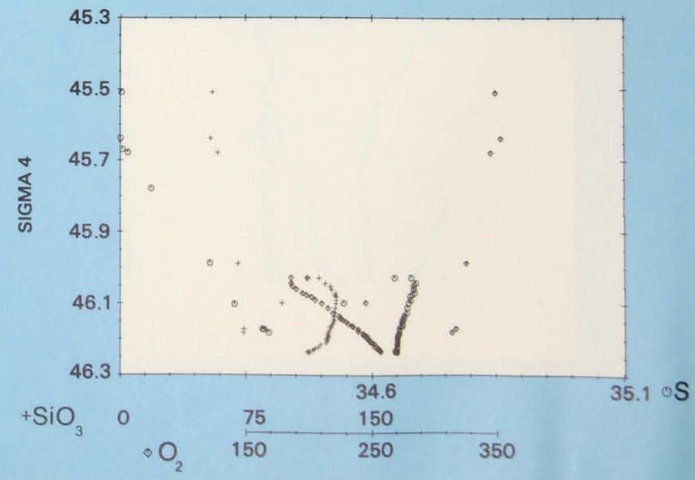
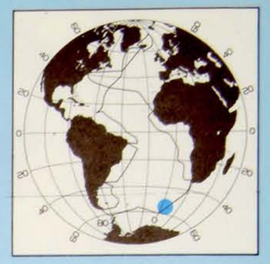
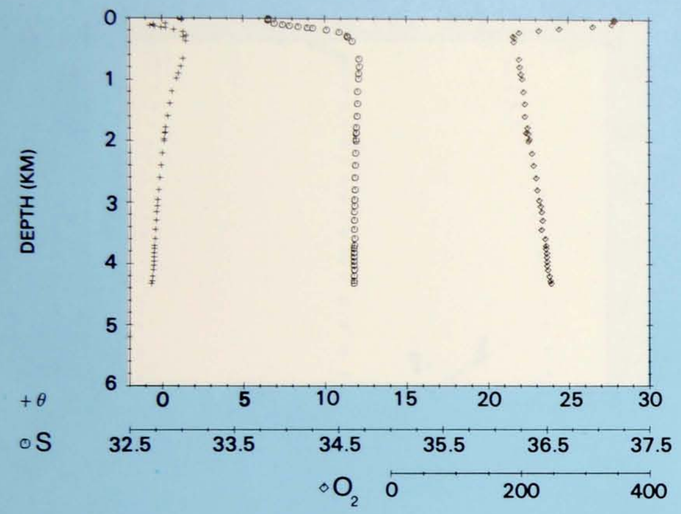


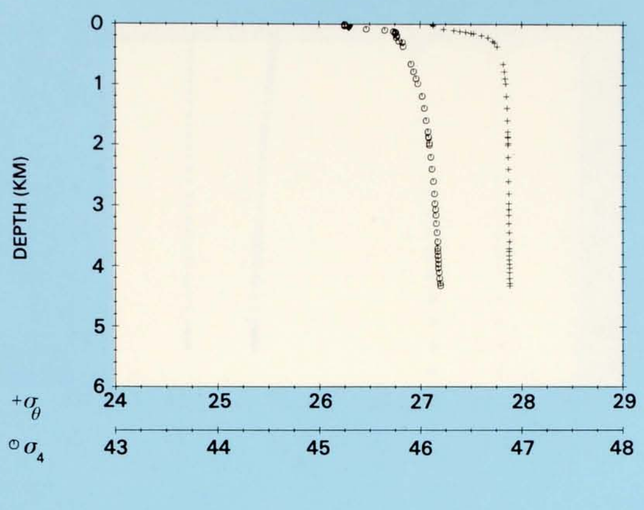
PLATE 150

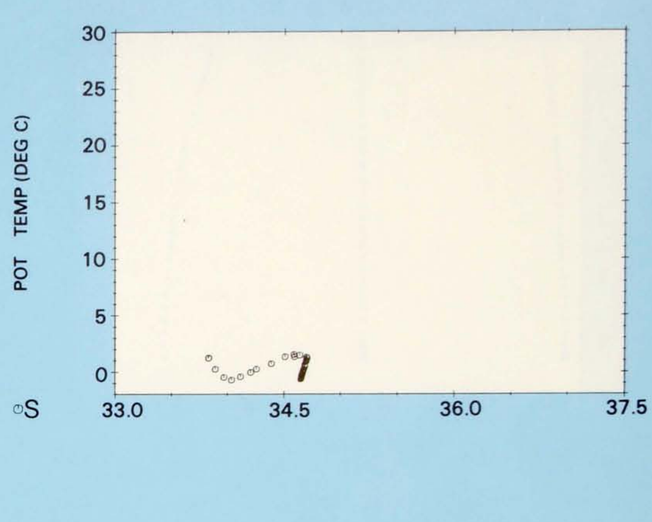
Station 90.
Latitude 56° 25′ S,
Longitude 4° 30′ E.
26 January 1973.

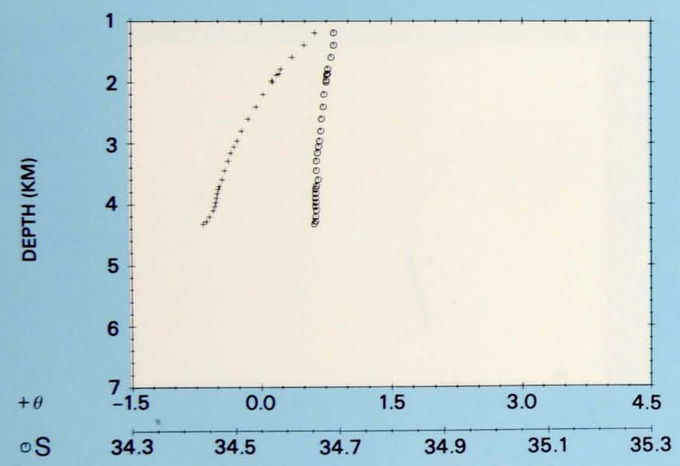
PROPERTY–PROPERTY PLOTS
STATION 90

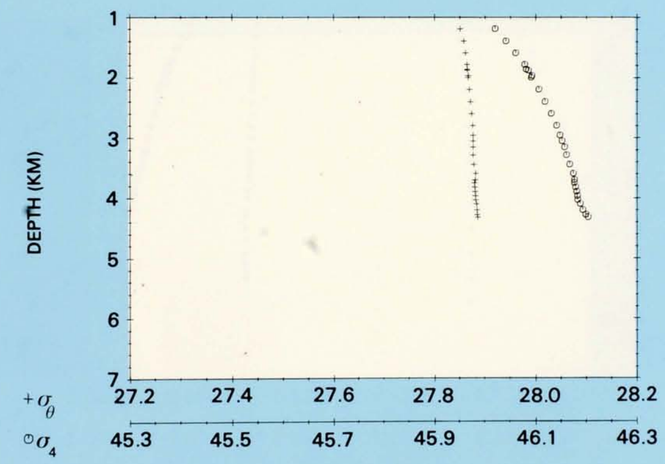


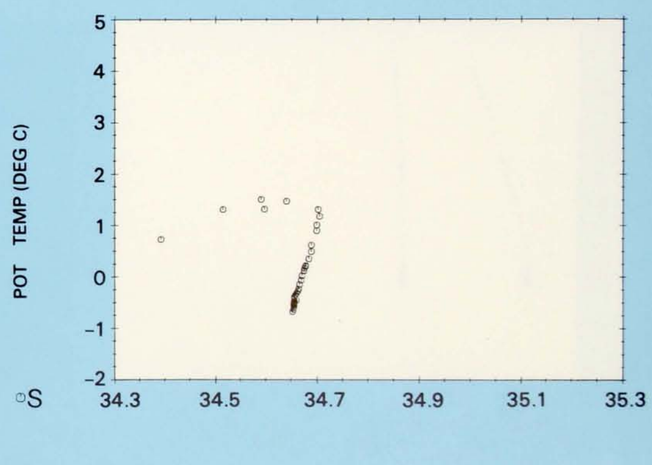


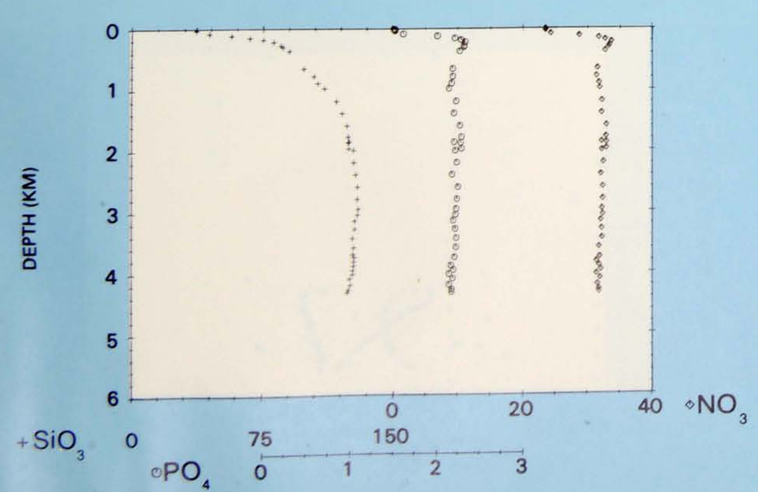


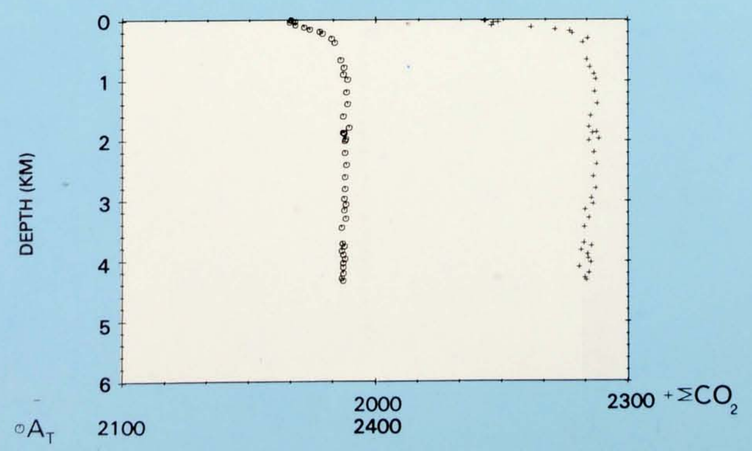


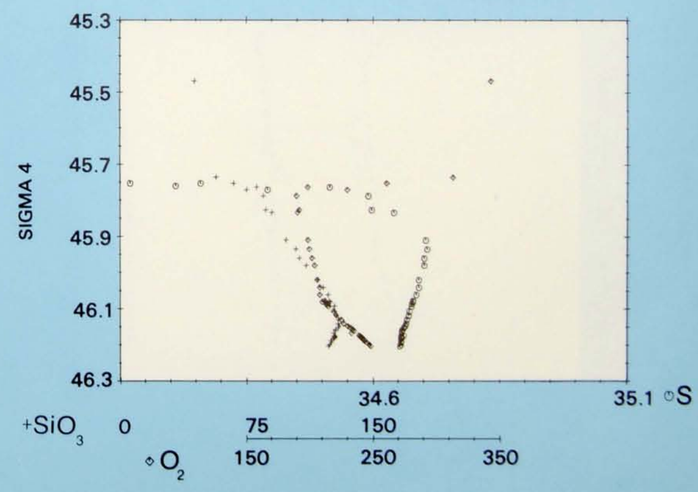


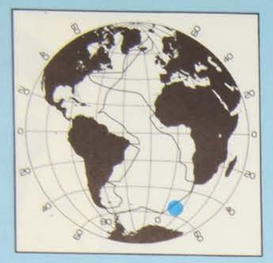








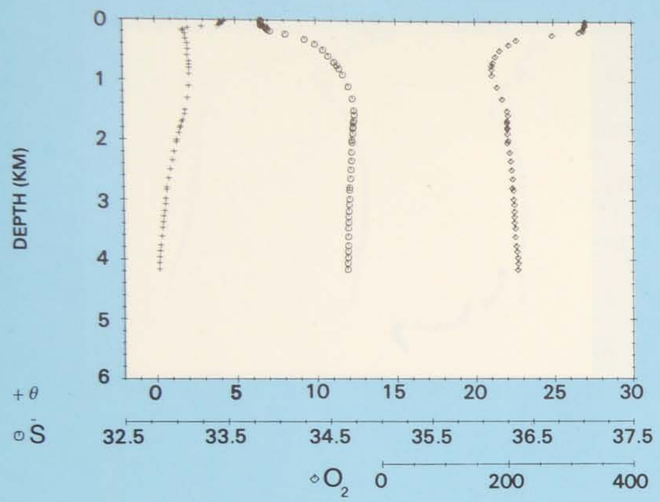


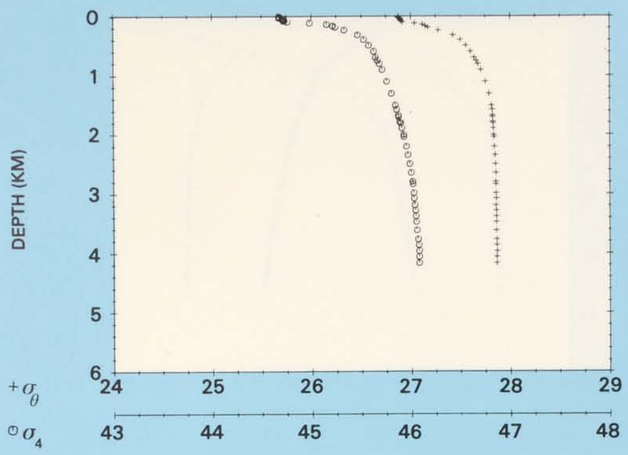


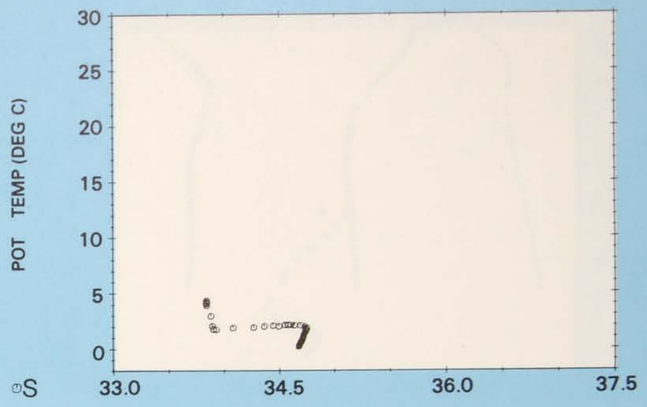
PROPERTY–PROPERTY PLOTS
STATION 91

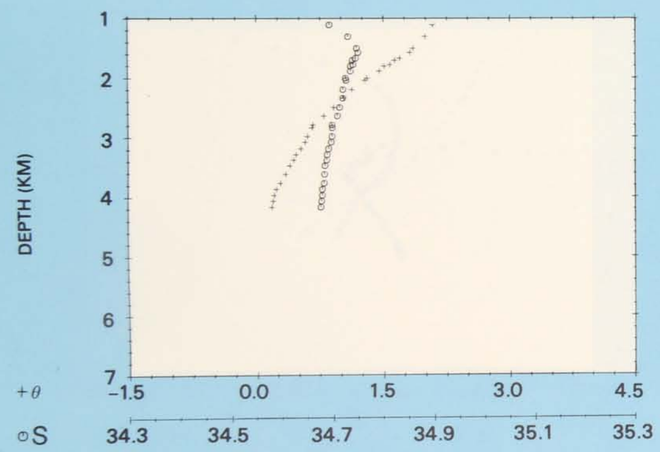
PLATE 151

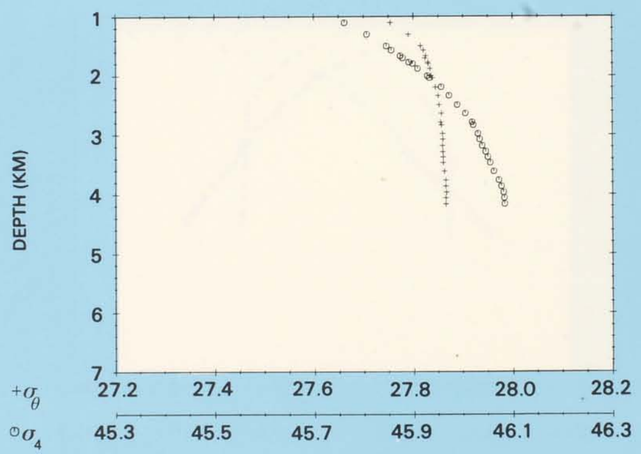
Station 91.
Latitude 49° 34′ S,
Longitude 11° 28′ E.
29 January 1973.

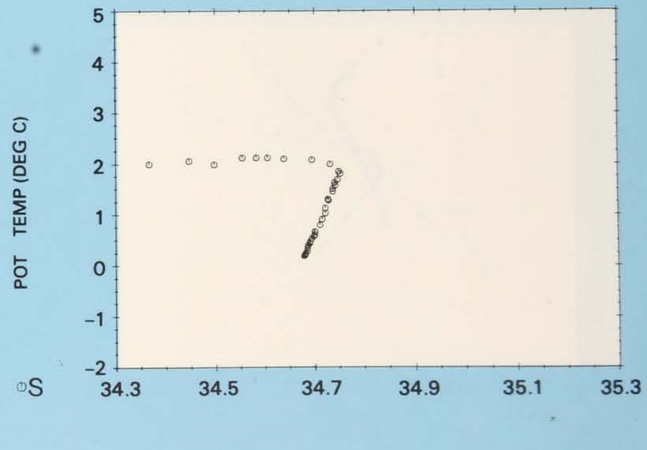


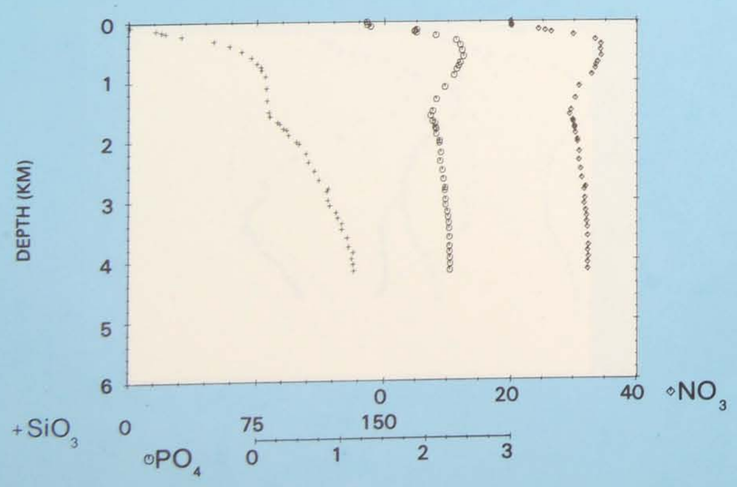


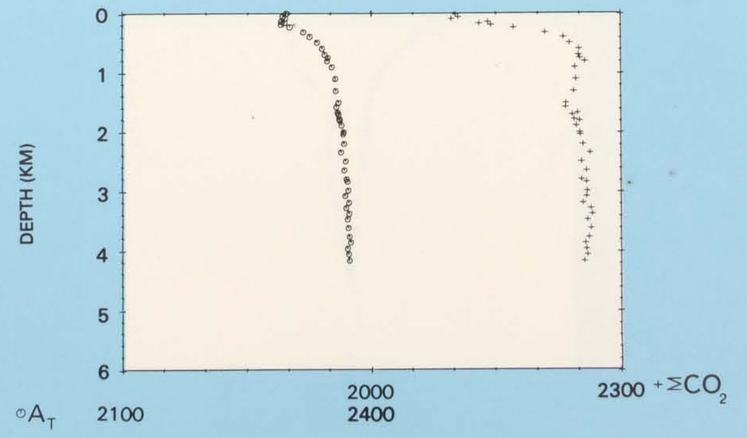












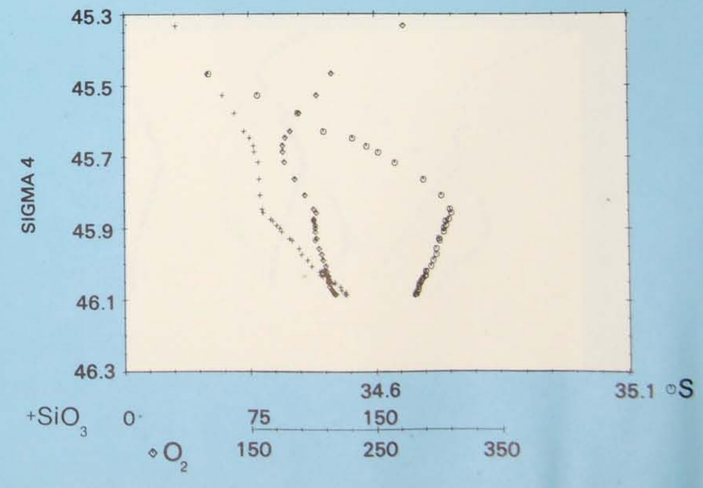
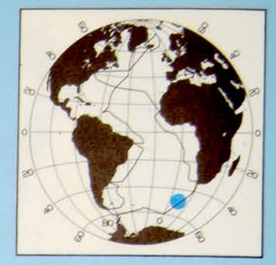
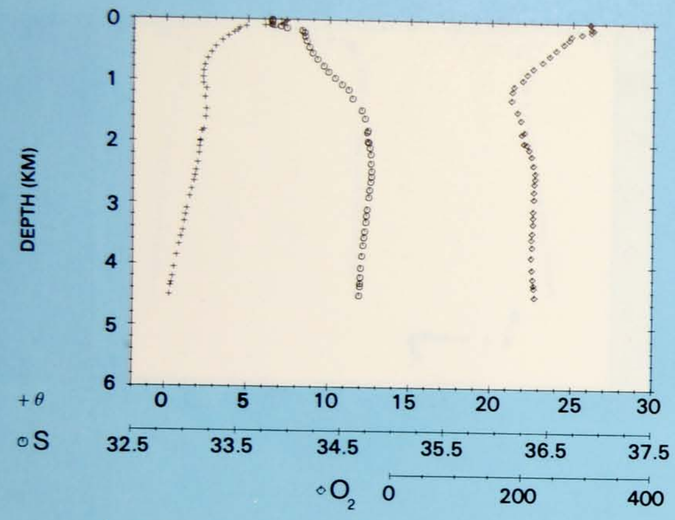


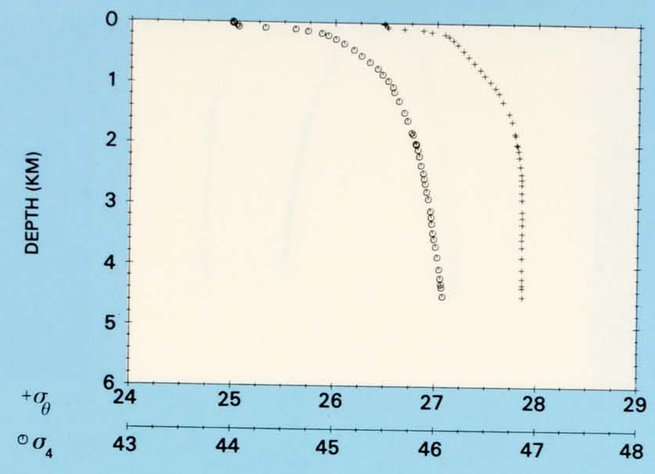
PLATE 152

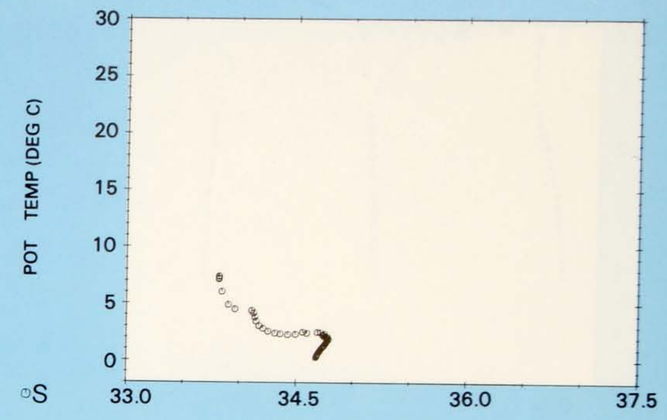
Station 92.
Latitude 46° 11′ S,
Longitude 14° 36′ E.
31 January 1973.

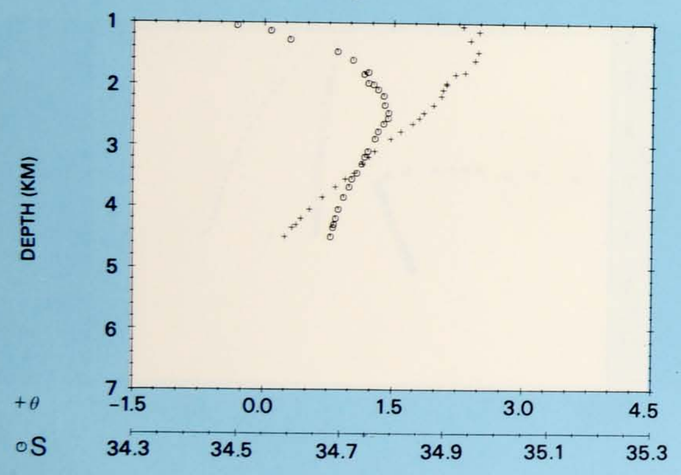
PROPERTY–PROPERTY PLOTS
STATION 92

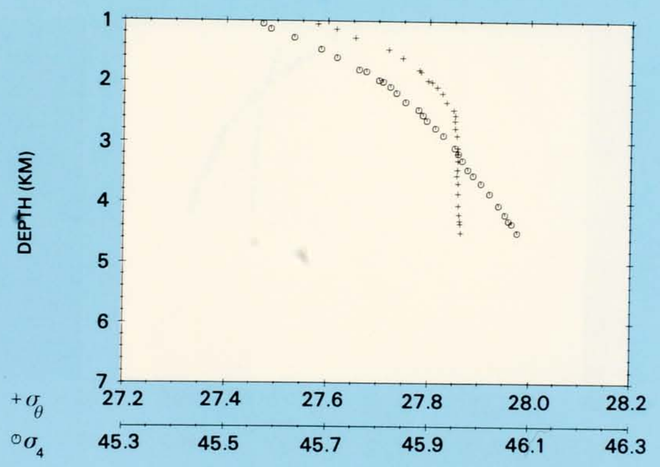


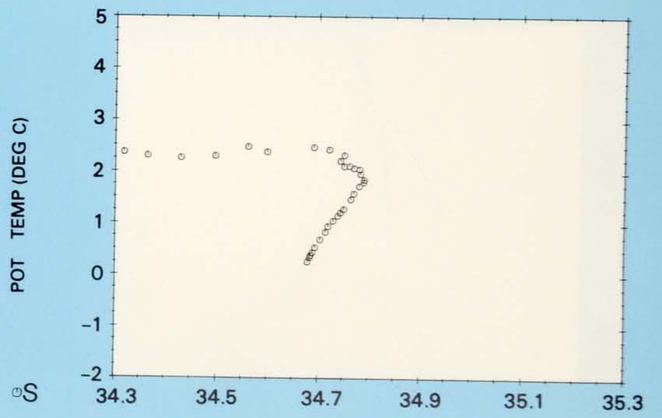


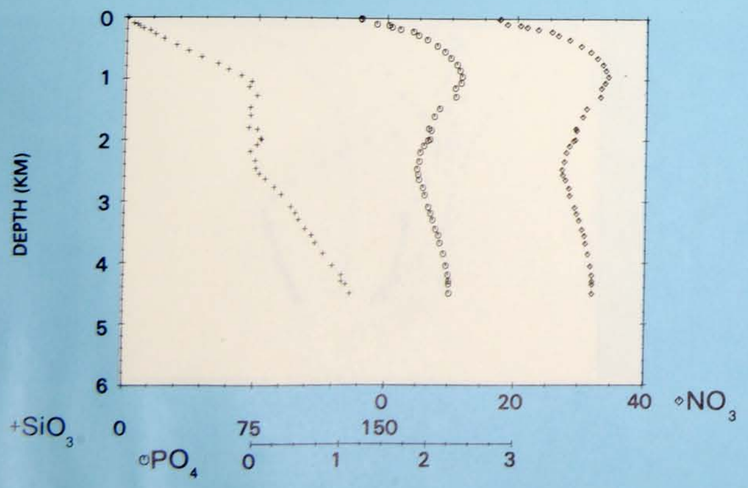


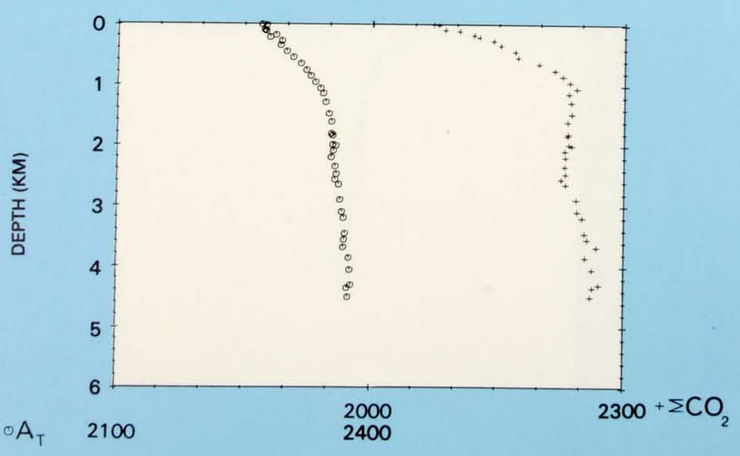


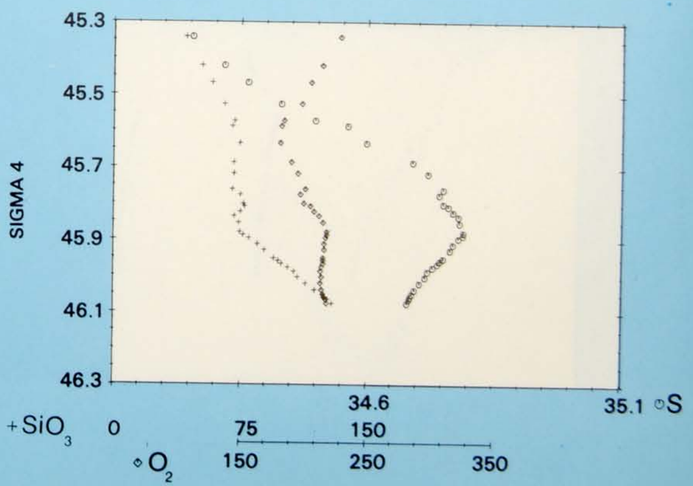








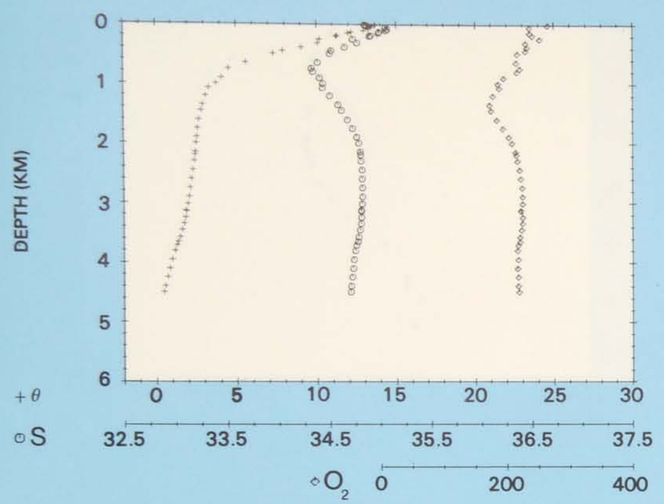


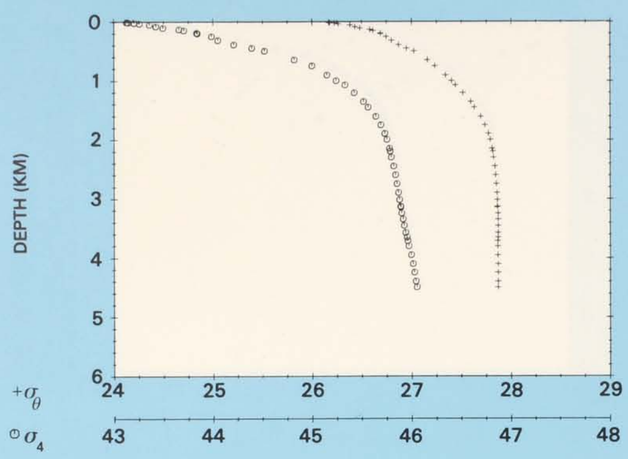


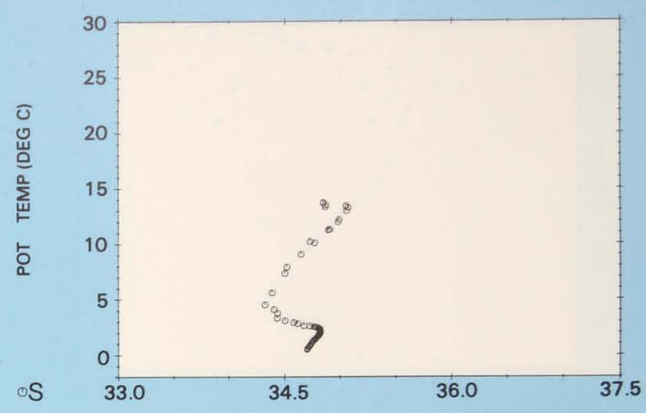
PROPERTY–PROPERTY PLOTS
STATION 93

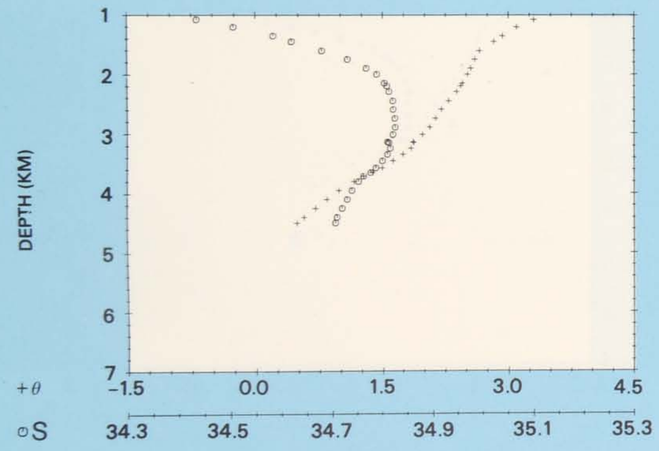
PLATE 153

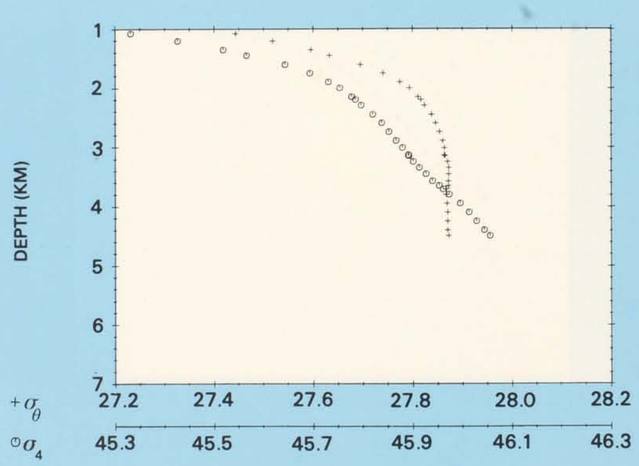
Station 93.
Latitude 41° 46′ S,
Longitude 18° 27′ E.
2 February 1973.

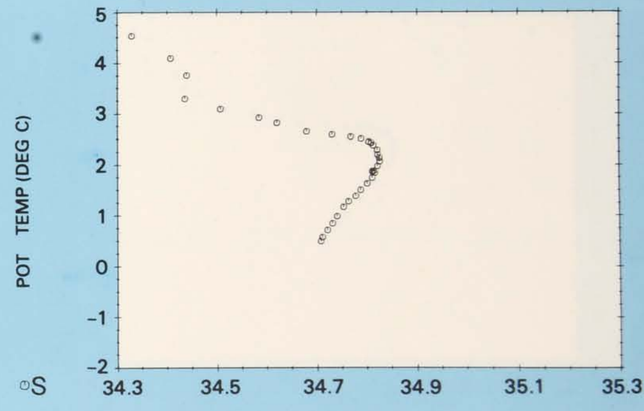


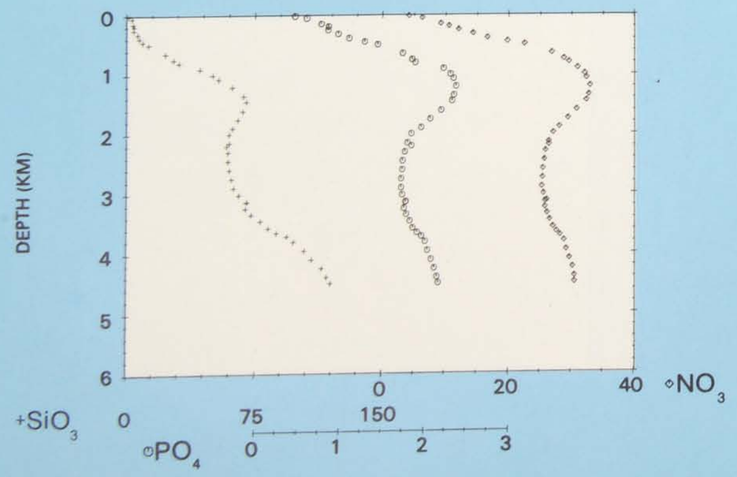


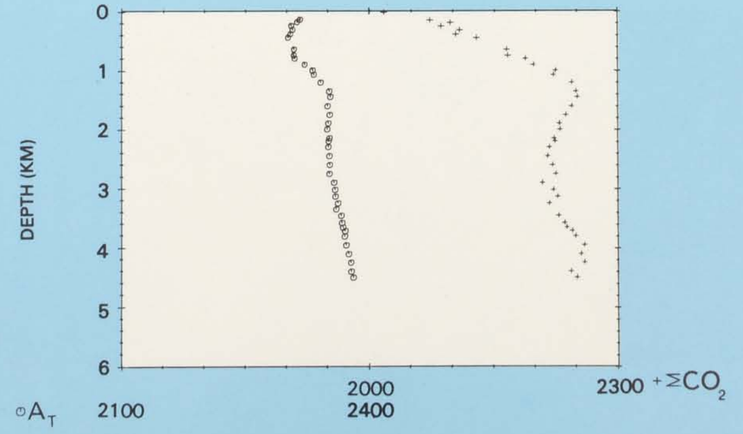












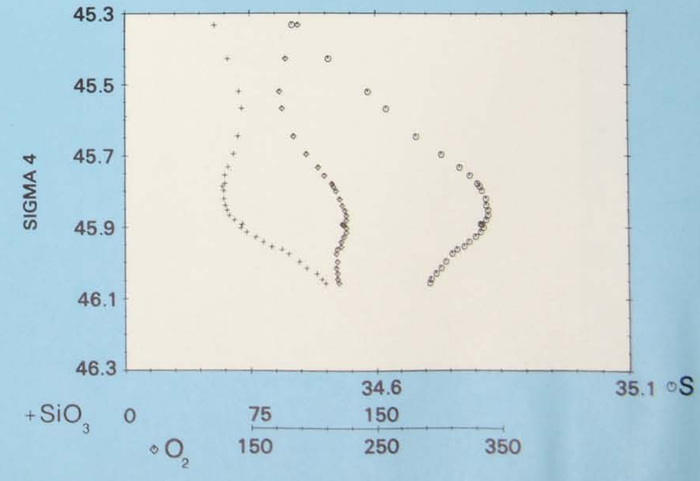
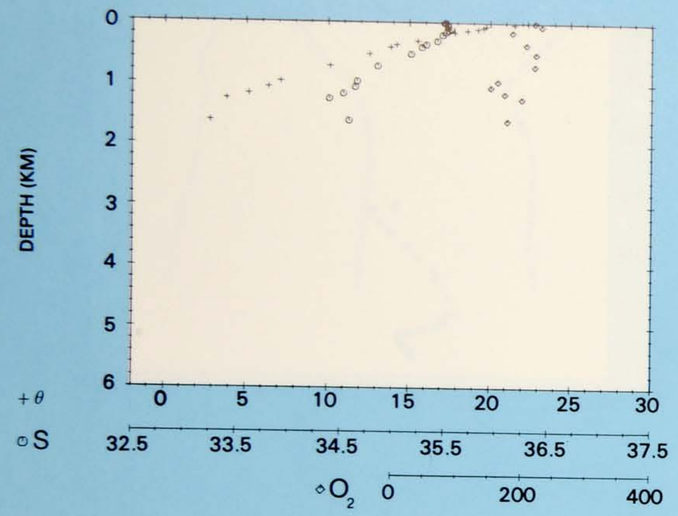
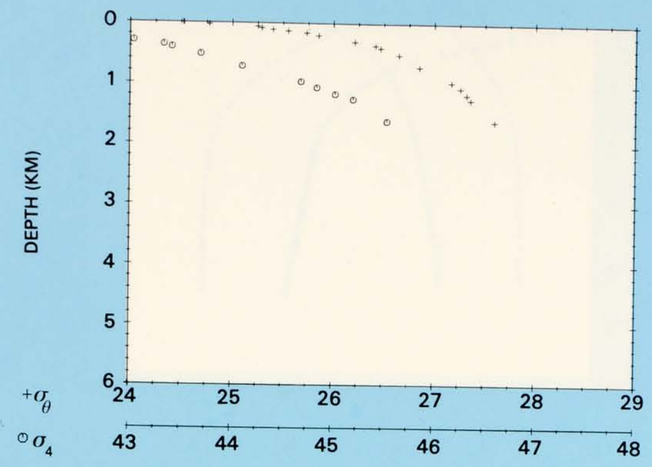


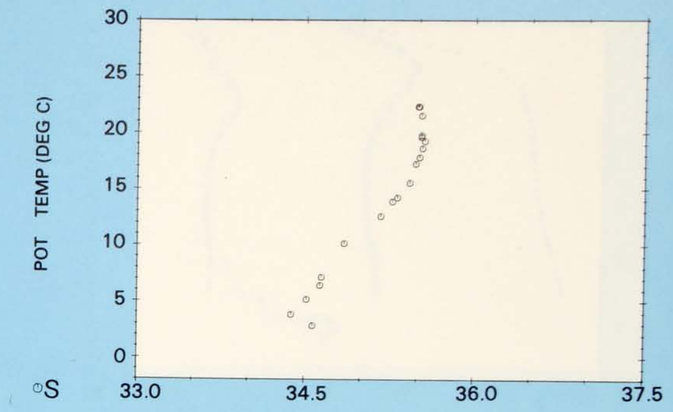
PLATE 154

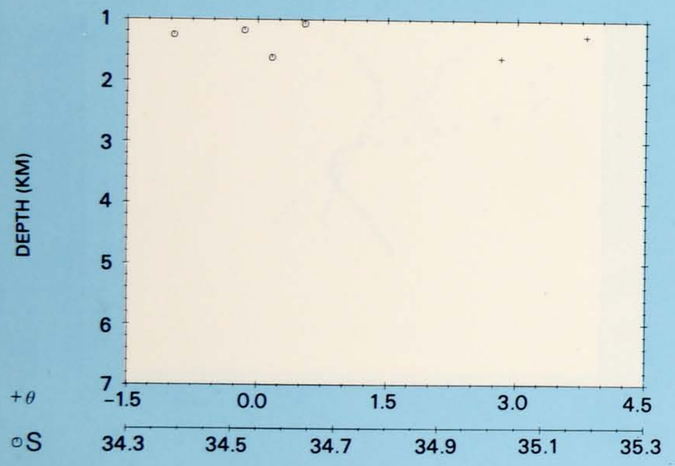
Station 94.
Latitude 38° 18′ S,
Longitude 19° 23′ E.
3 February 1973.

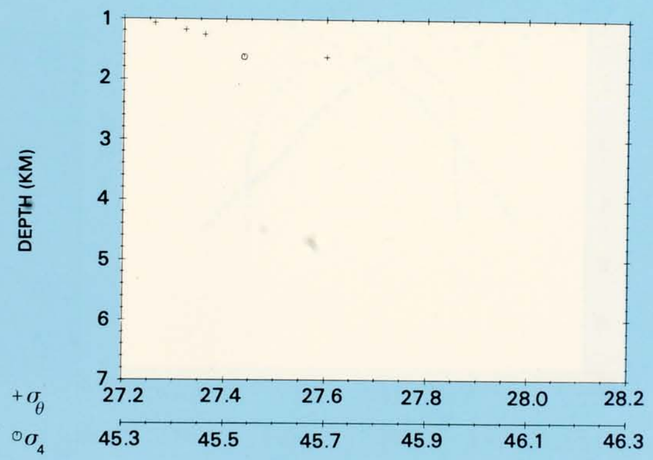
PROPERTY–PROPERTY PLOTS
STATION 94

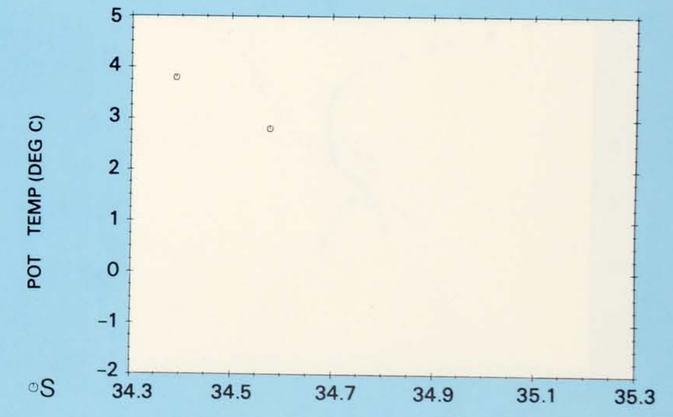


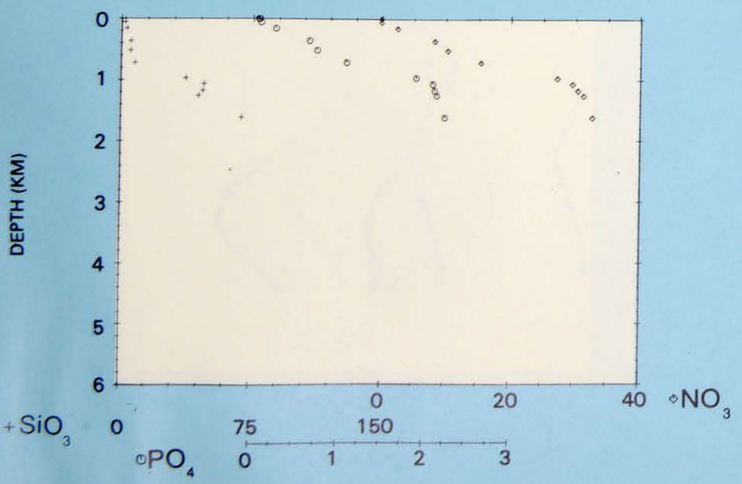


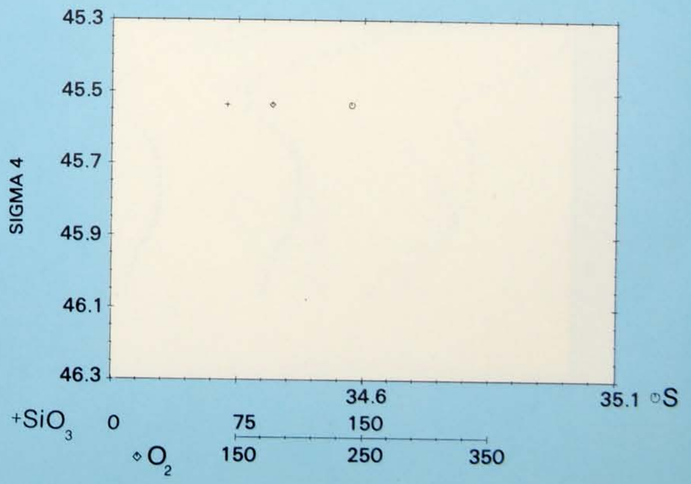








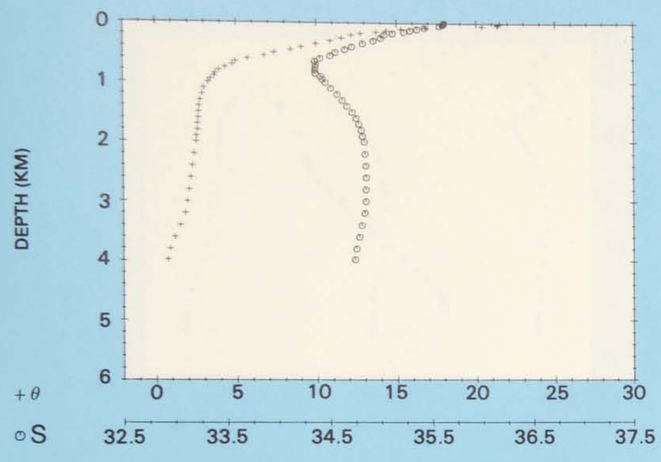


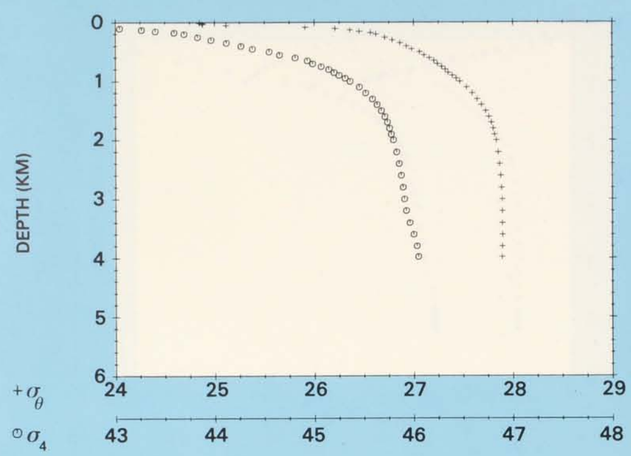


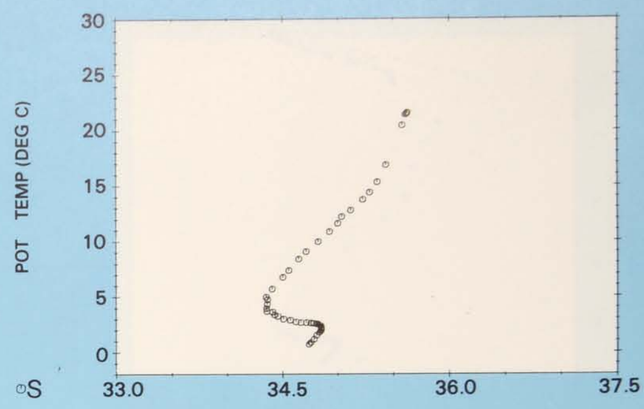
PROPERTY–PROPERTY PLOTS
STATION 100

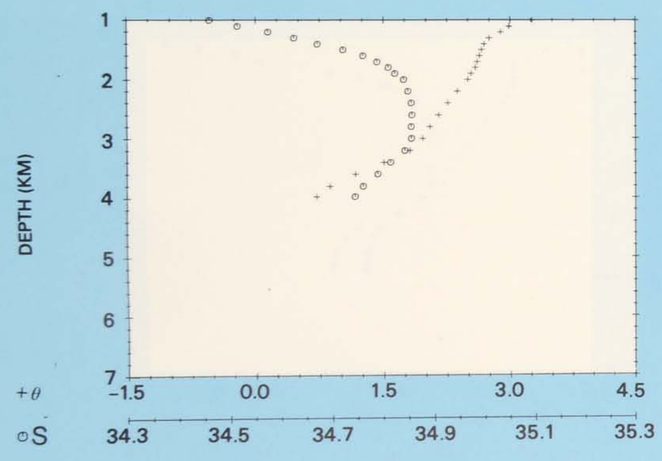
PLATE 155

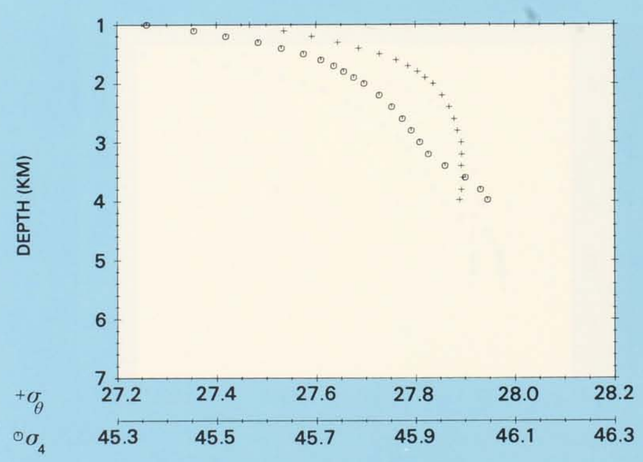
Station 100.
Latitude 33° 09′ S,
Longitude 13° 17′ E.
11 February 1973.











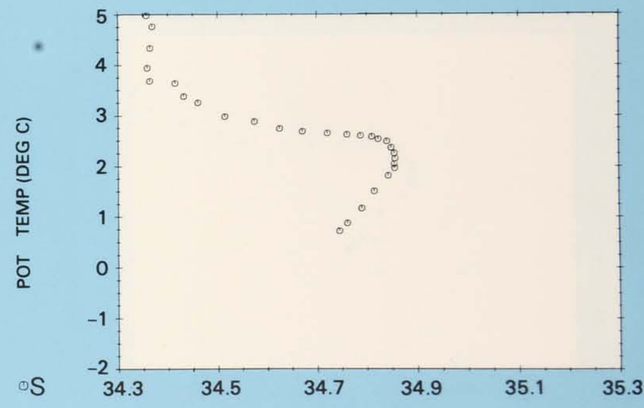
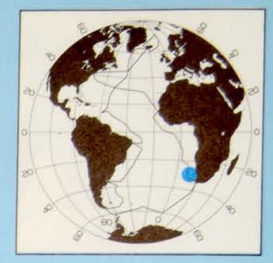
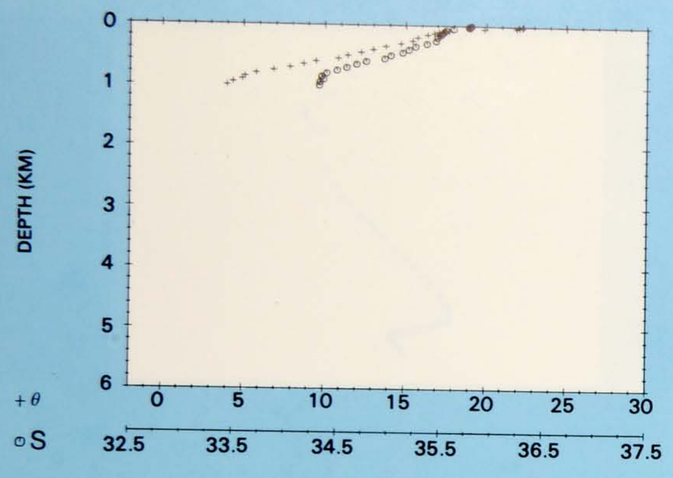


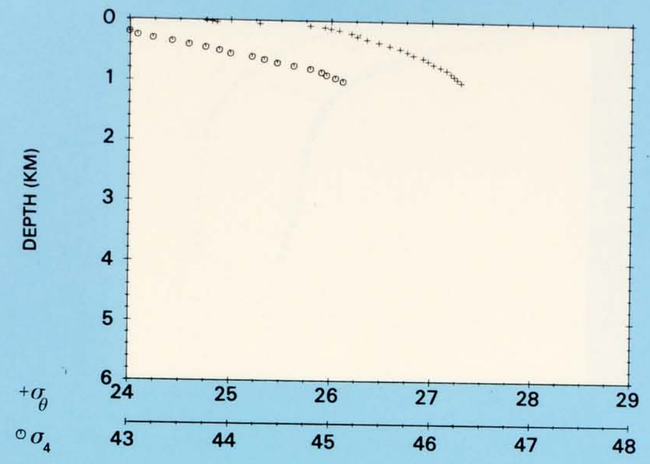
PLATE 156

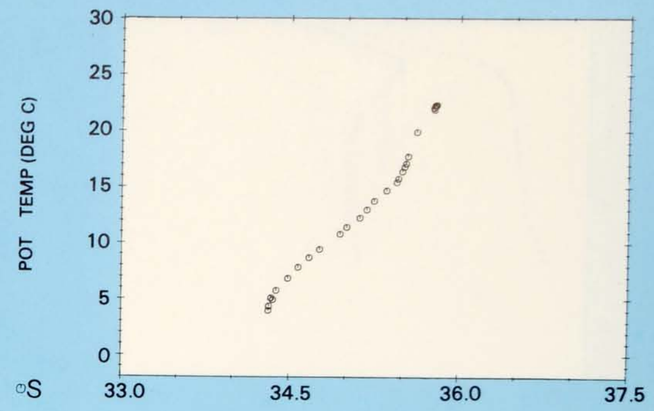
Station 101.
Latitude 31° 58′ S,
Longitude 10° 48′ E.
12 February 1973.

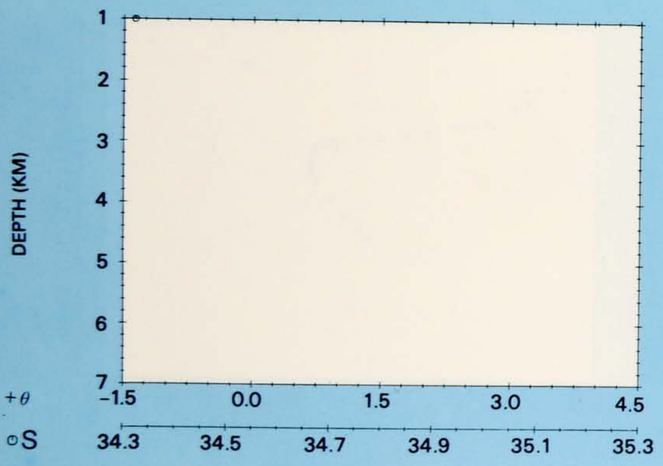
PROPERTY–PROPERTY PLOTS
STATION 101

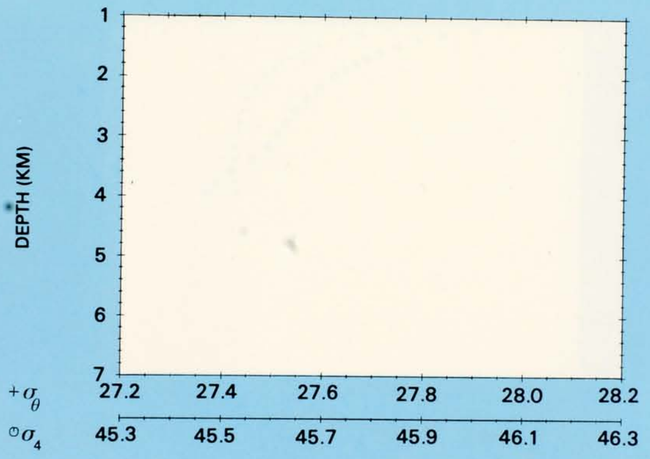


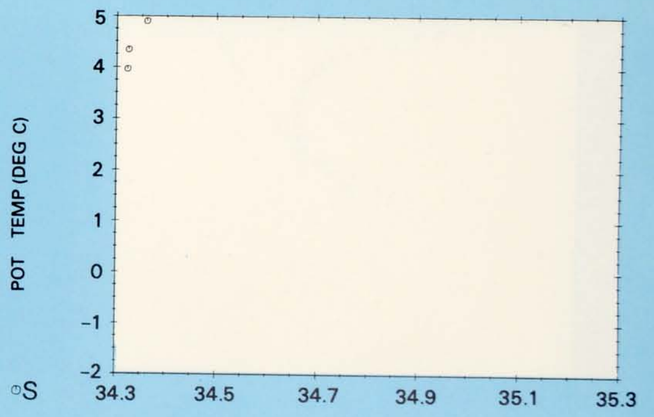








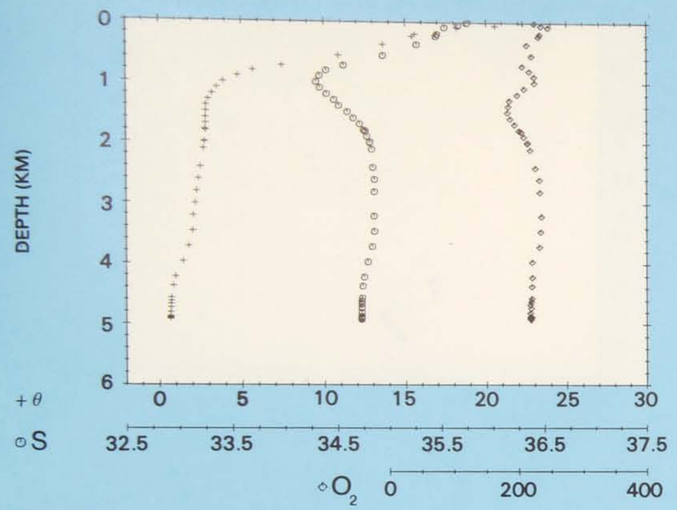


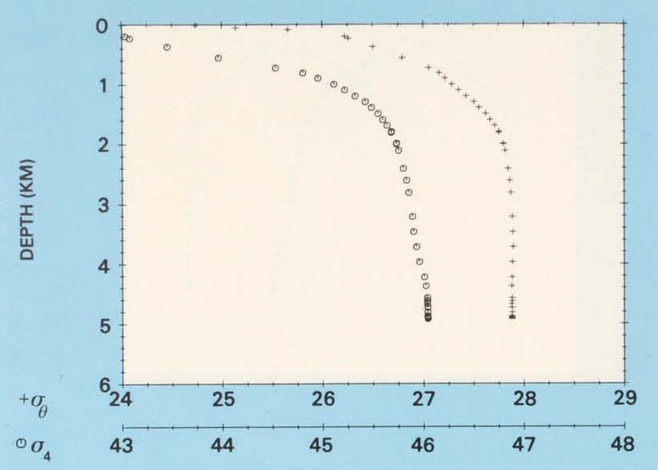


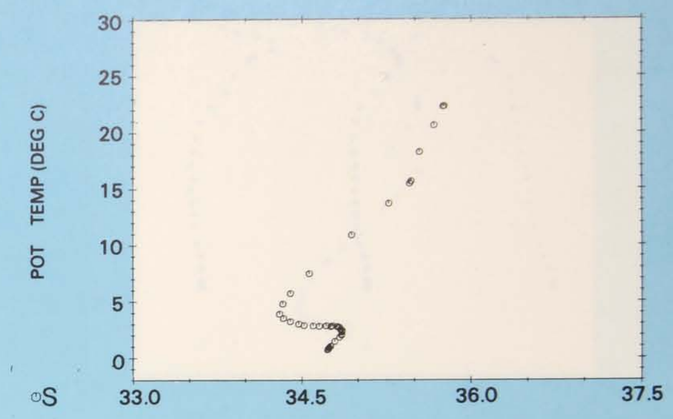
PROPERTY–PROPERTY PLOTS
STATION 102

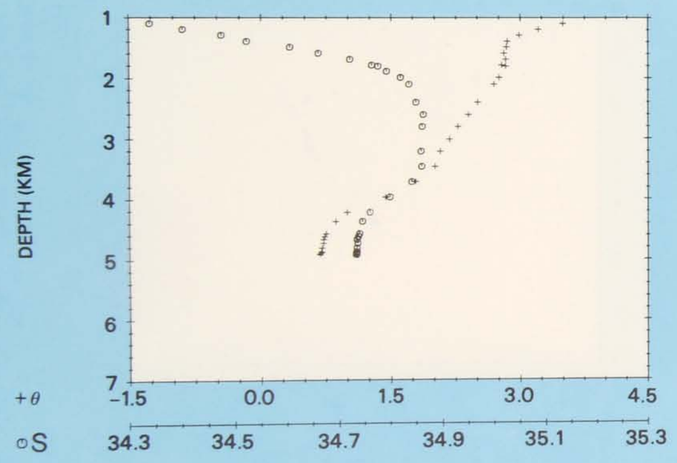
PLATE 157

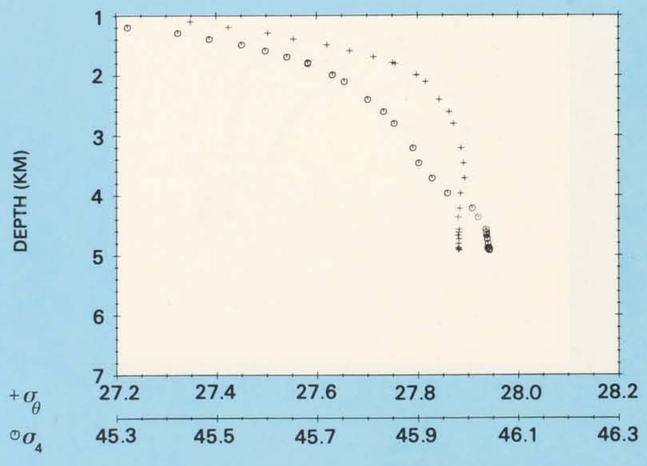
Station 102.
Latitude 31° 31′ S,
Longitude 9° 26′ E.
12 February 1973.

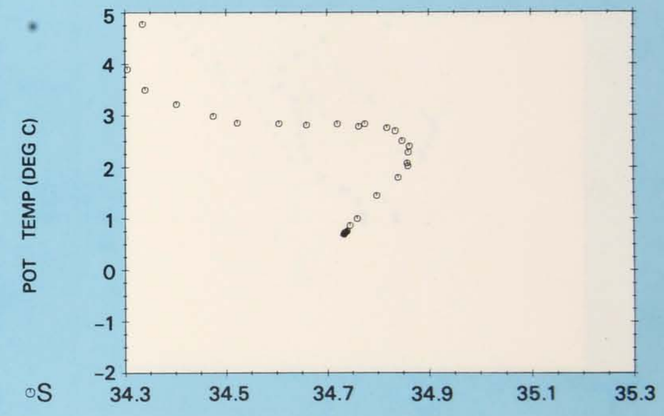


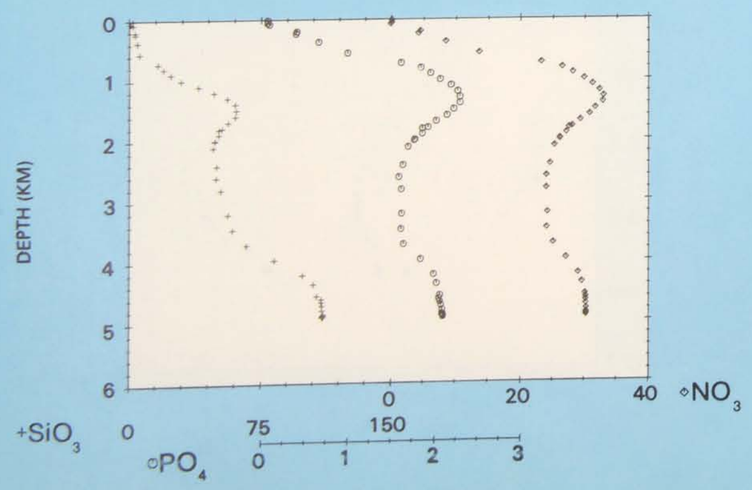


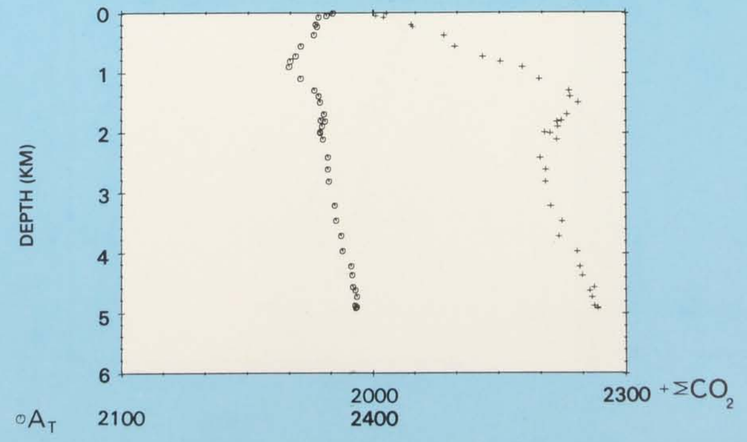












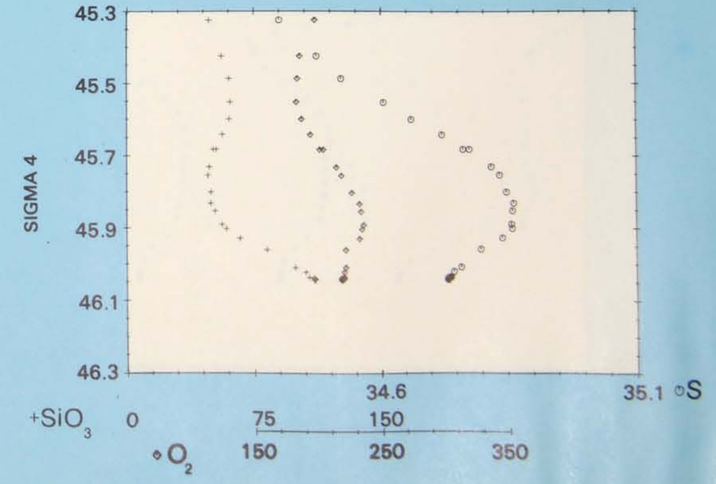
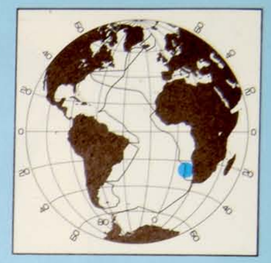
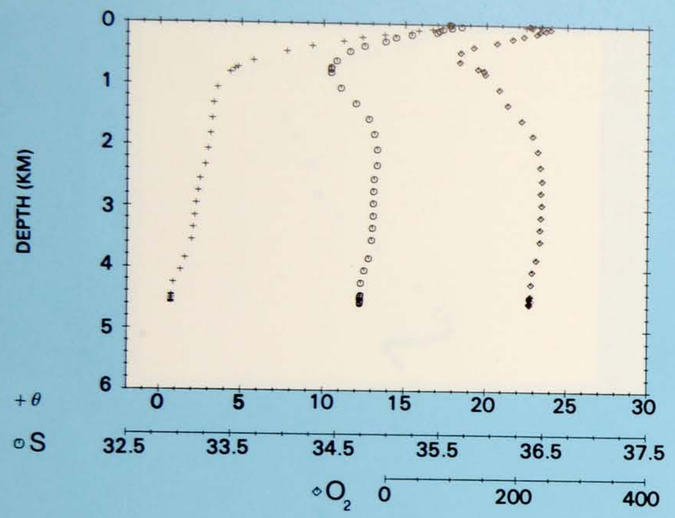


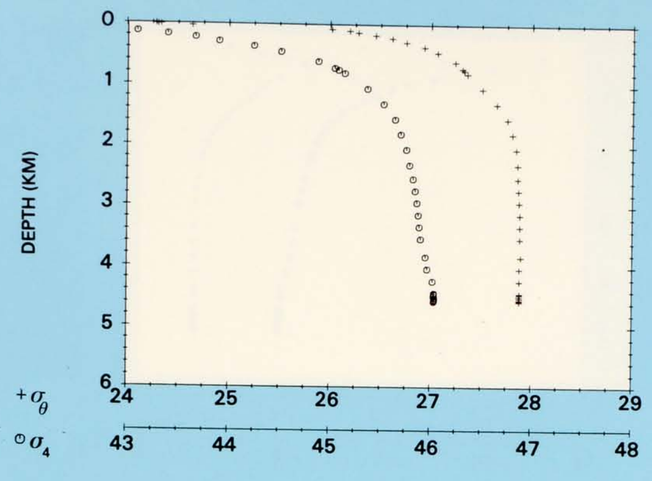
PLATE 158

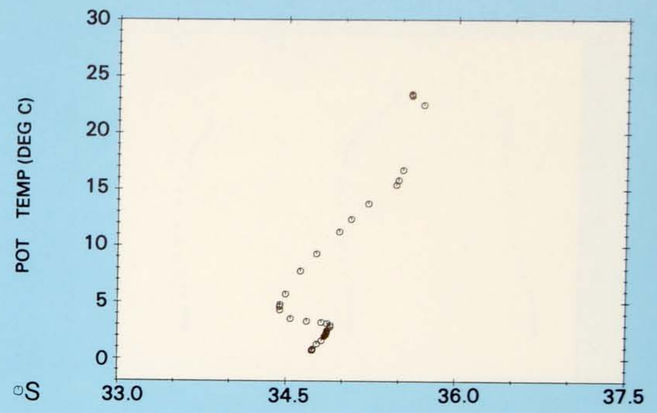
Station 103.
Latitude 23° 59′ S,
Longitude 8° 30′ E.
17 February 1973.

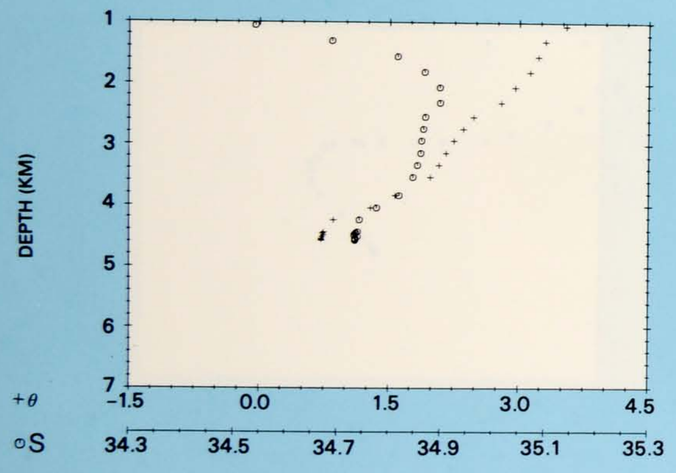
PROPERTY–PROPERTY PLOTS
STATION 103

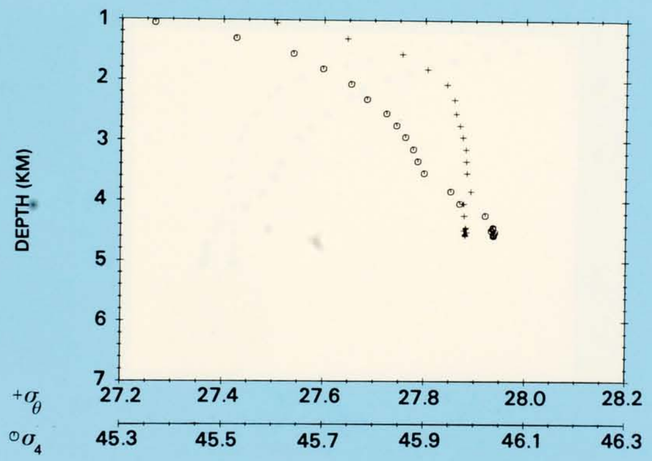


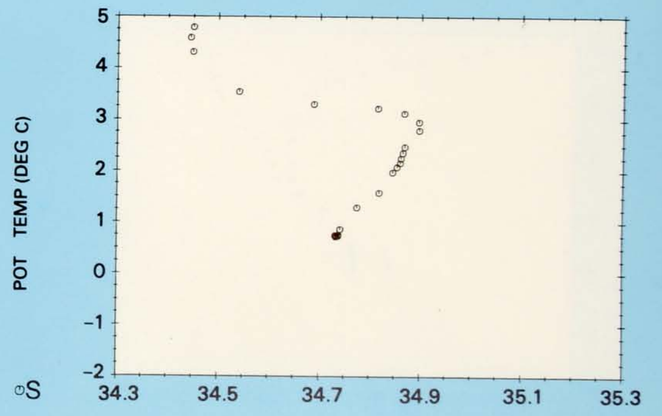


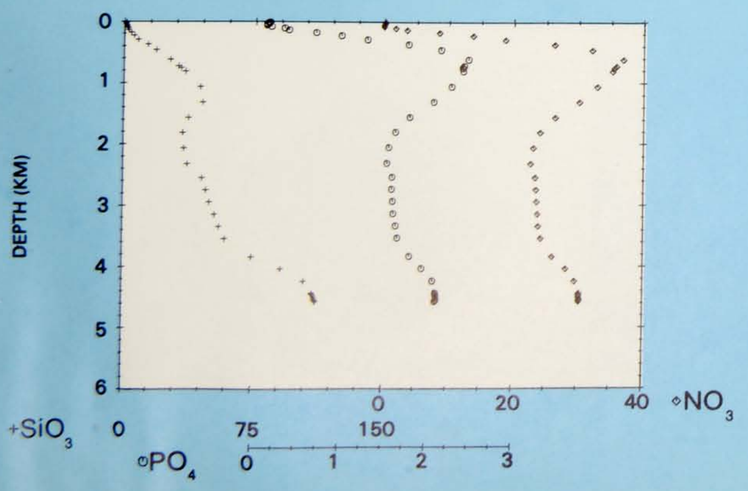


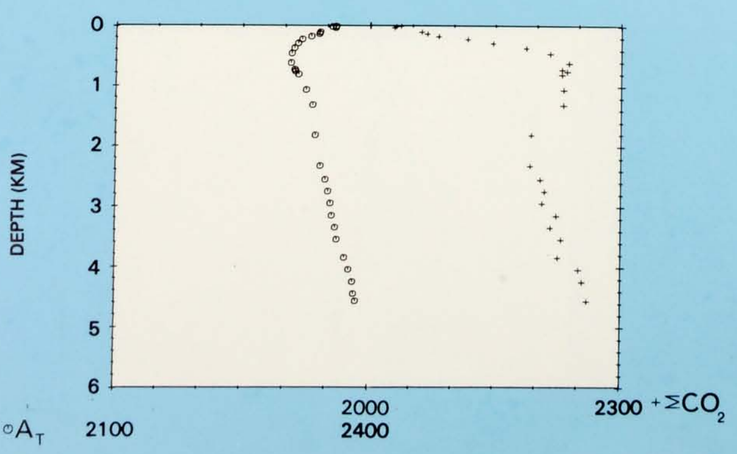


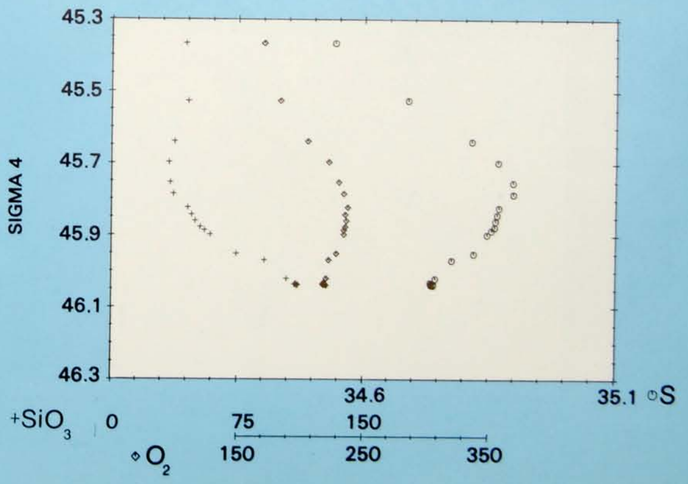








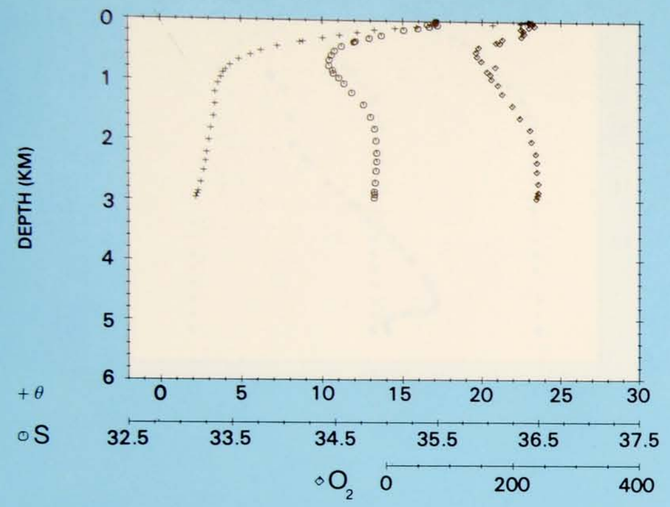


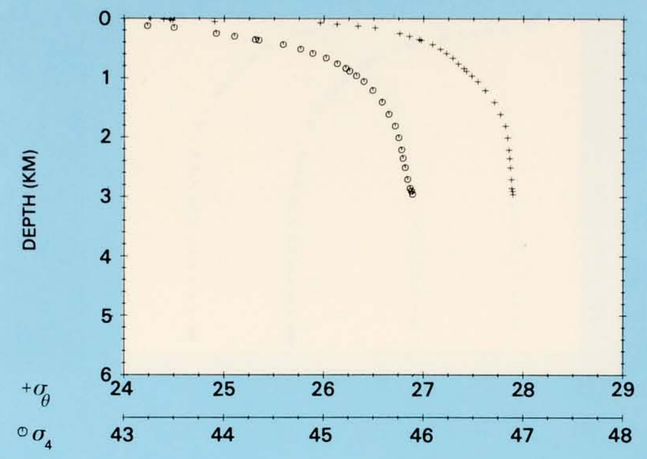


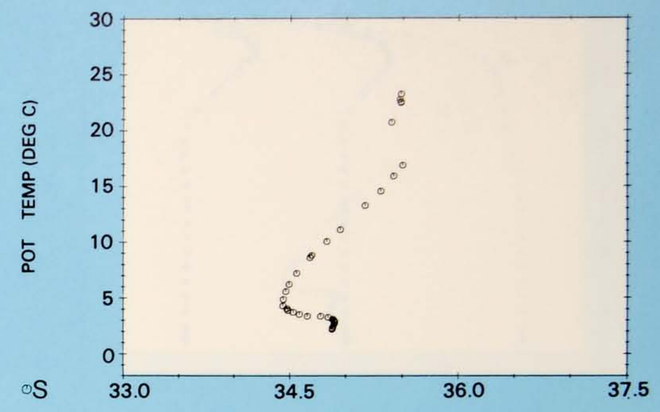
PROPERTY–PROPERTY PLOTS
STATION 104

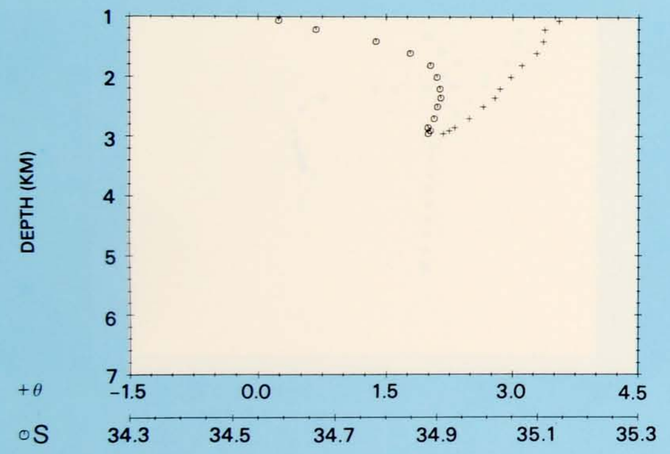
PLATE 159

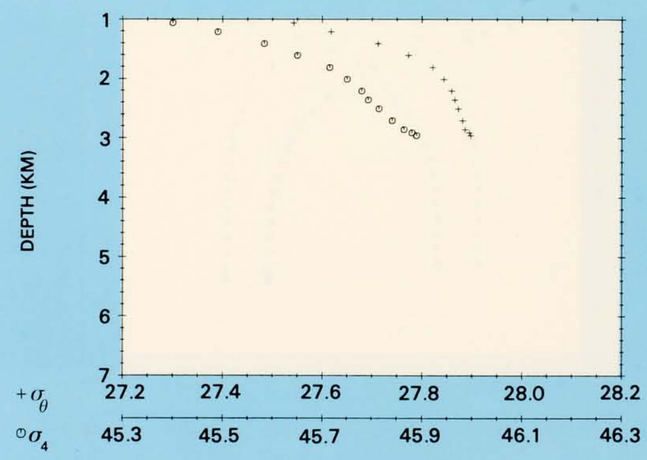
Station 104.
Latitude 22° 00′ S,
Longitude 7° 14′ E.
18 February 1973.

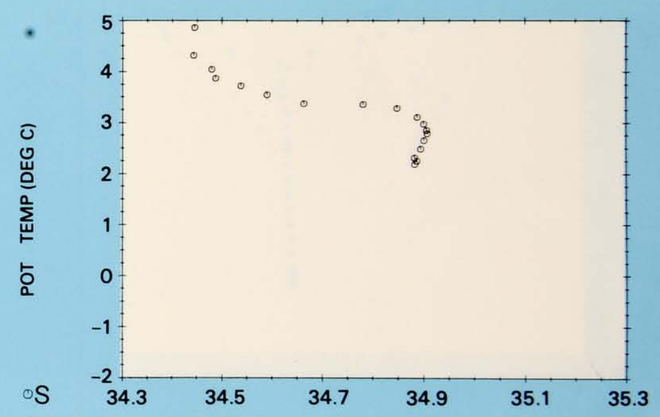


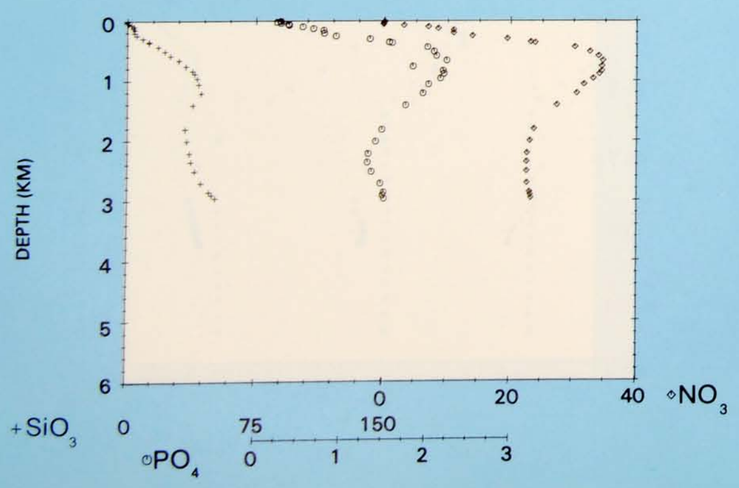












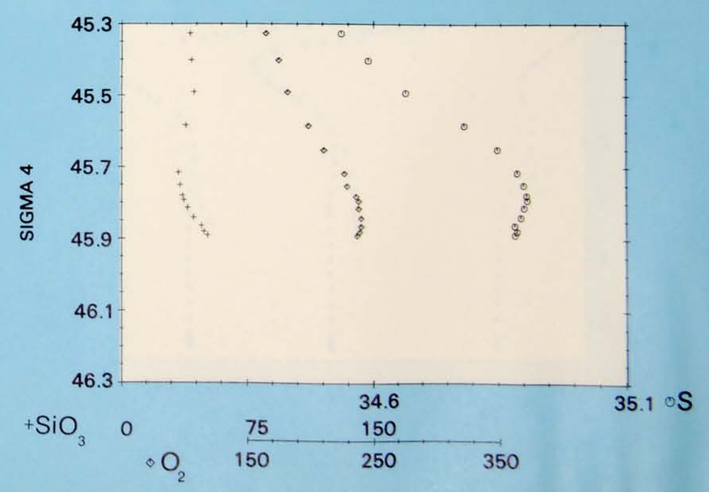
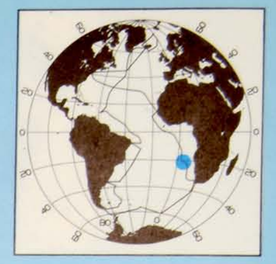
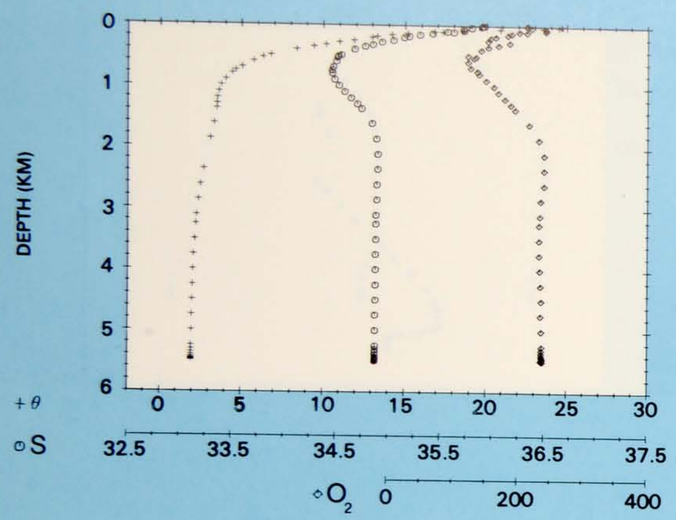


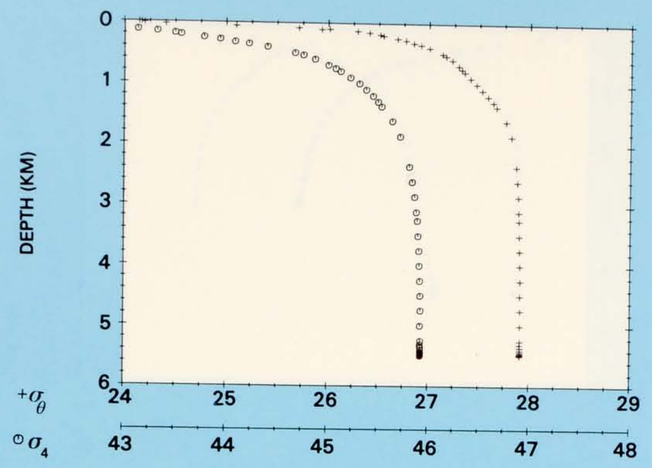
PLATE 160

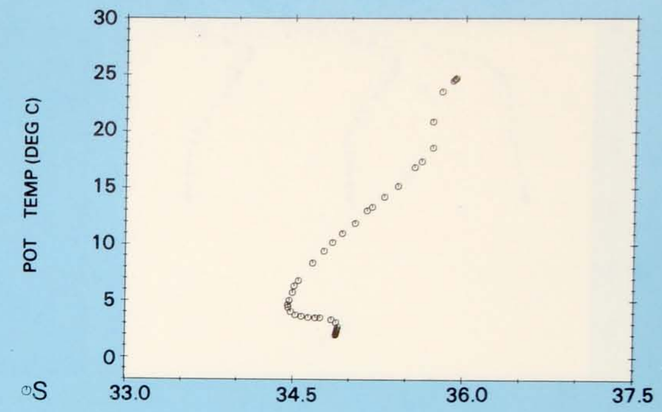
Station 105.
Latitude 20° 00′ S,
Longitude 2° 00′ E.
20 February 1973.

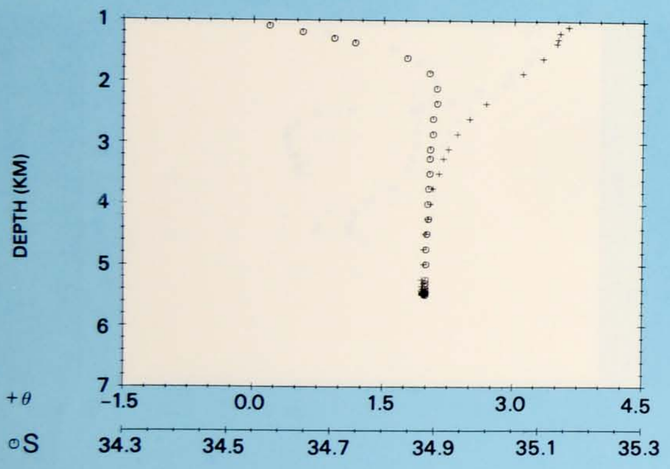
PROPERTY–PROPERTY PLOTS
STATION 105

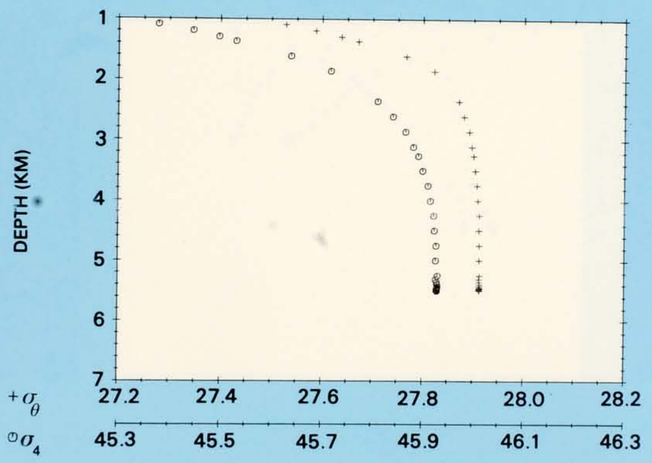


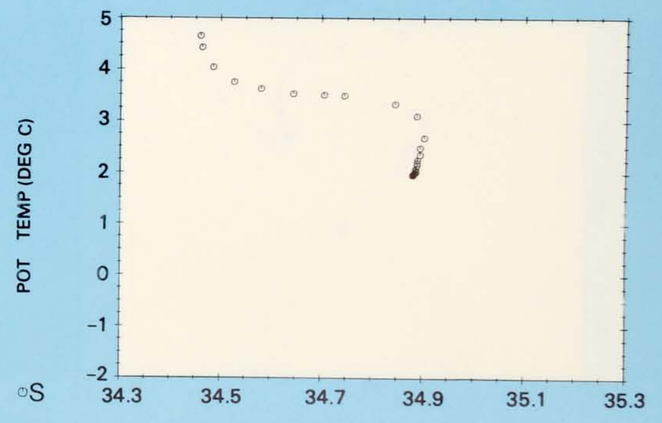


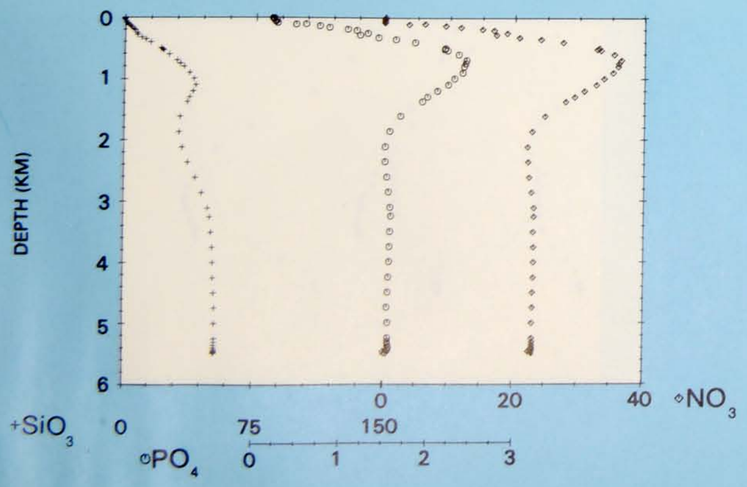


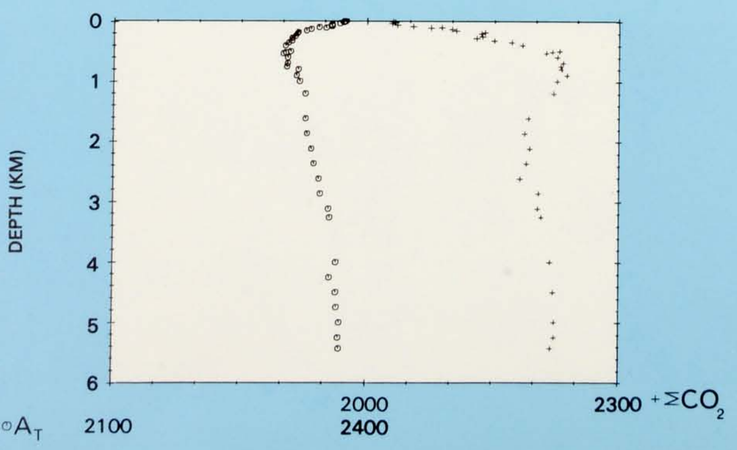


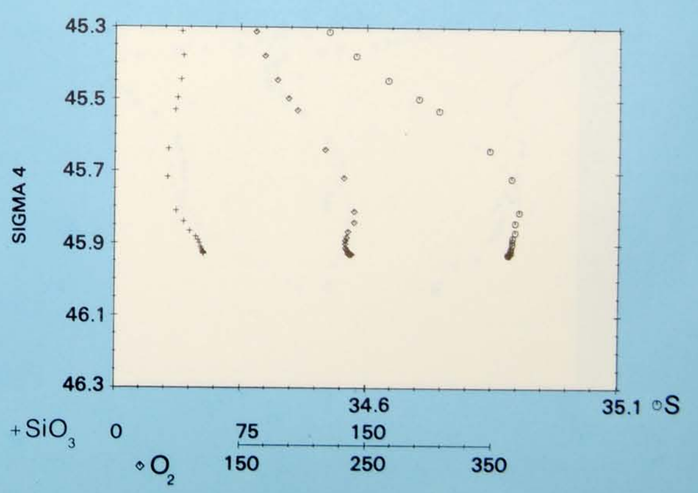


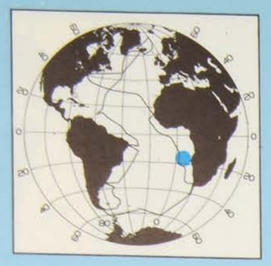








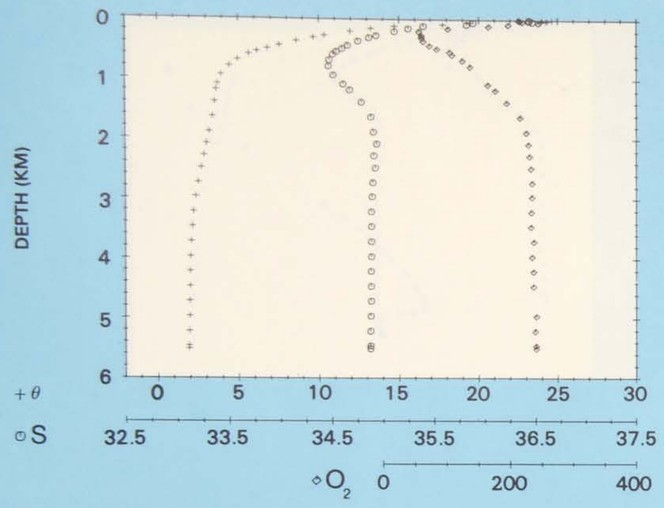


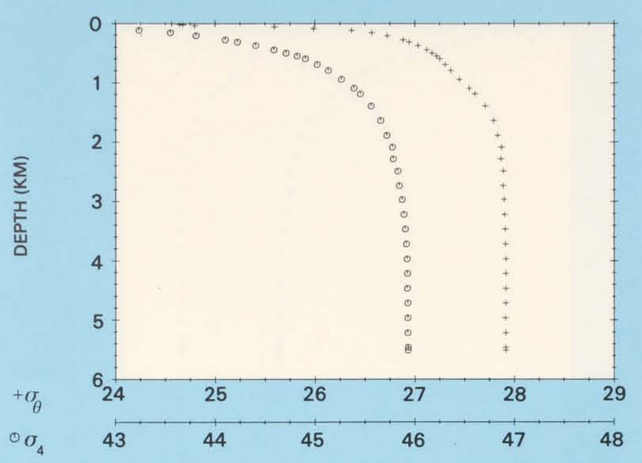


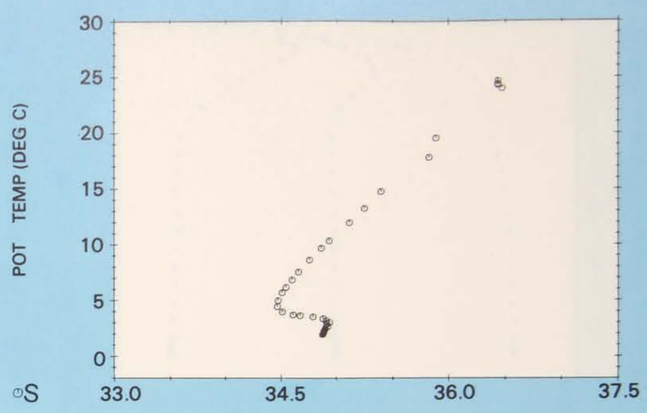
PROPERTY–PROPERTY PLOTS
STATION 106

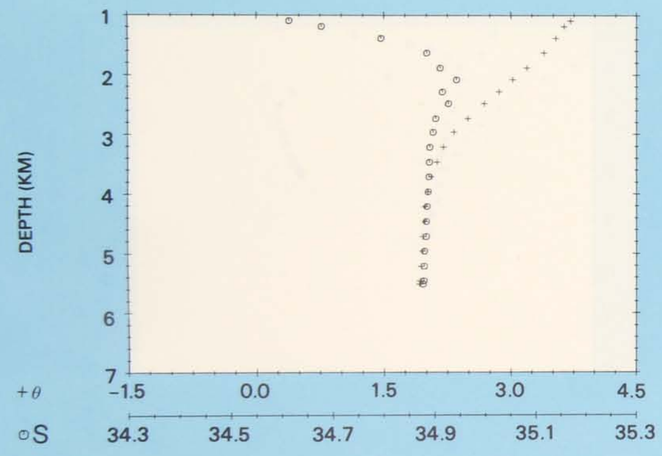
PLATE 161

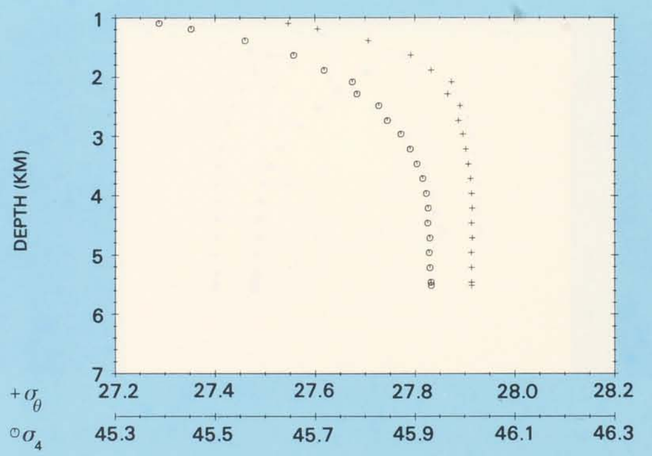
Station 106.
Latitude 15° 59′ S,
Longitude 1° 58′ E.
21 February 1973.

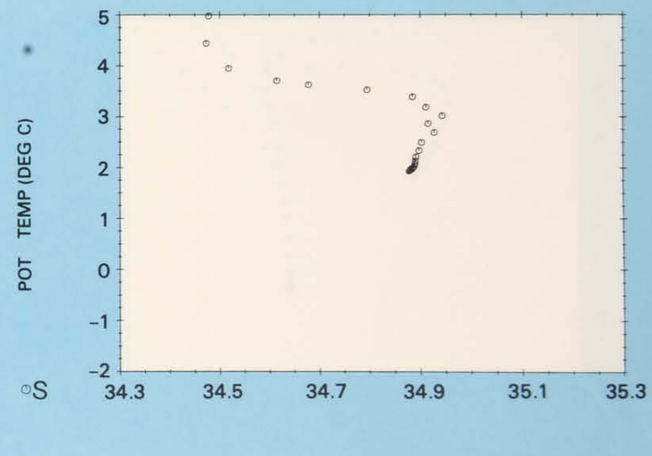


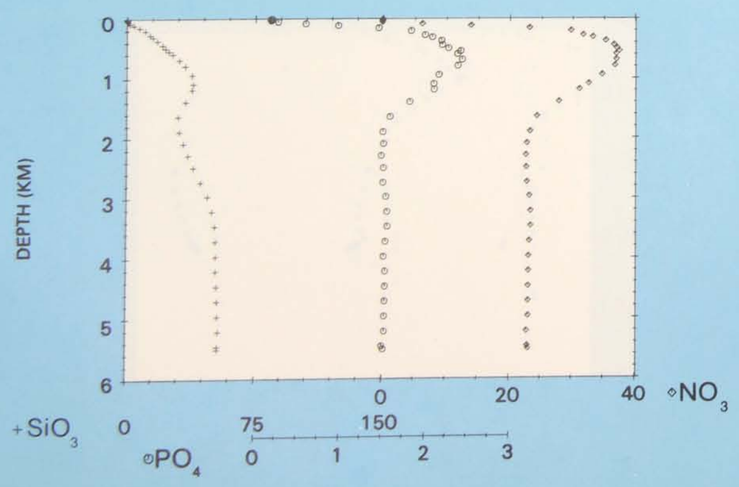












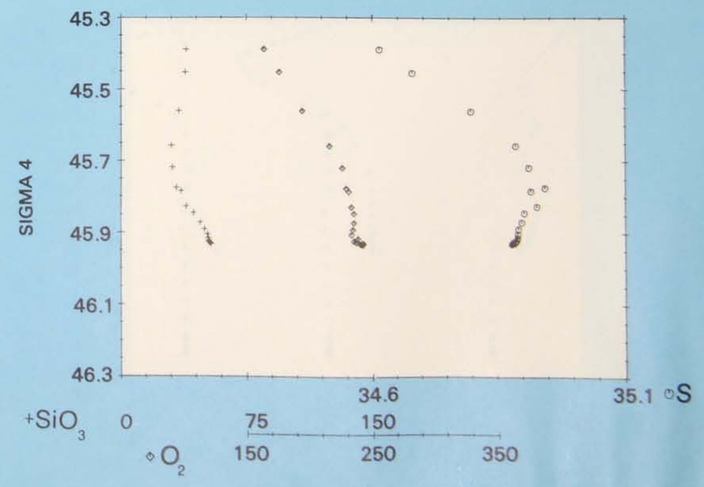
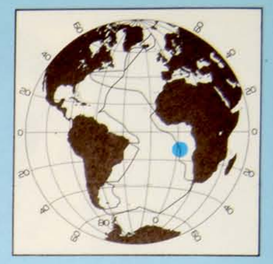
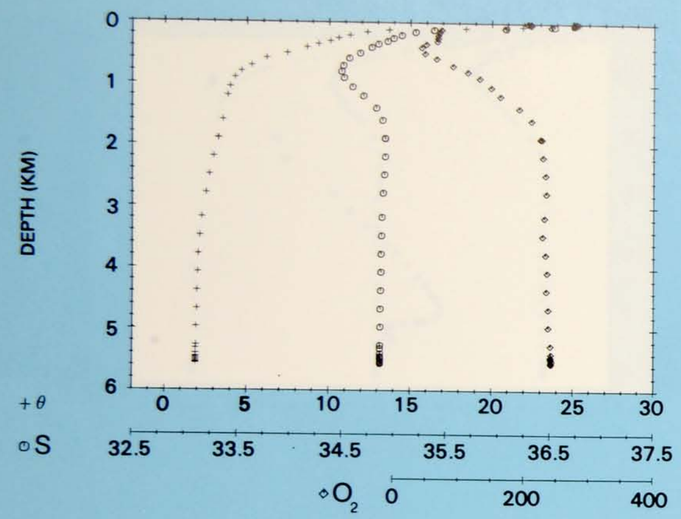


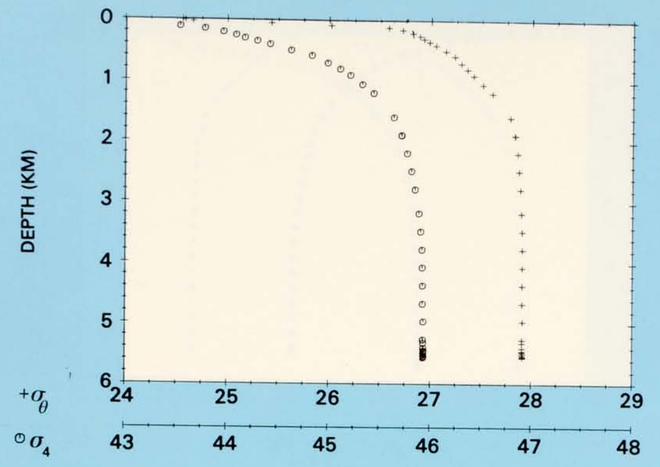
PLATE 162

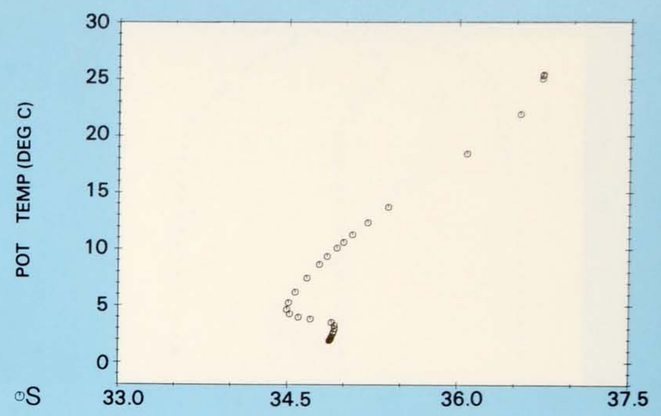
Station 107.
Latitude 12° 00′ S.
Longitude 2° 00′ E.
22 February 1973.

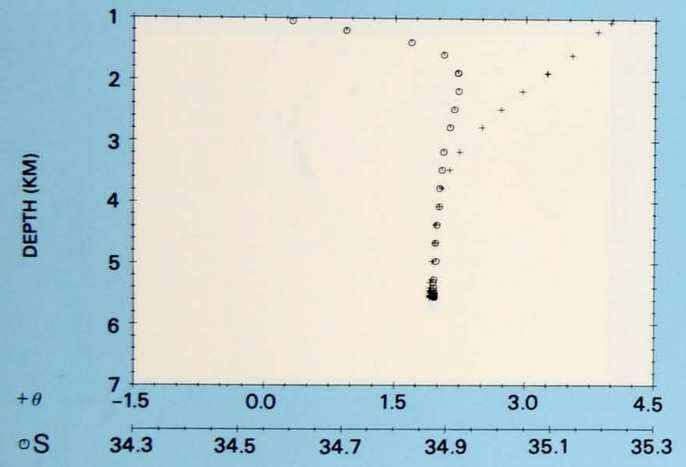
PROPERTY–PROPERTY PLOTS
STATION 107

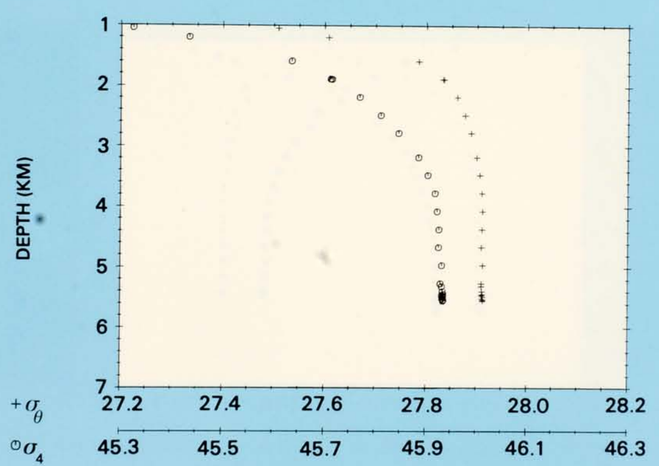


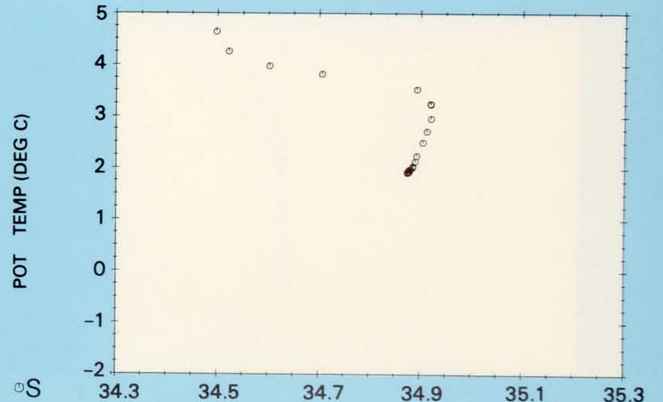


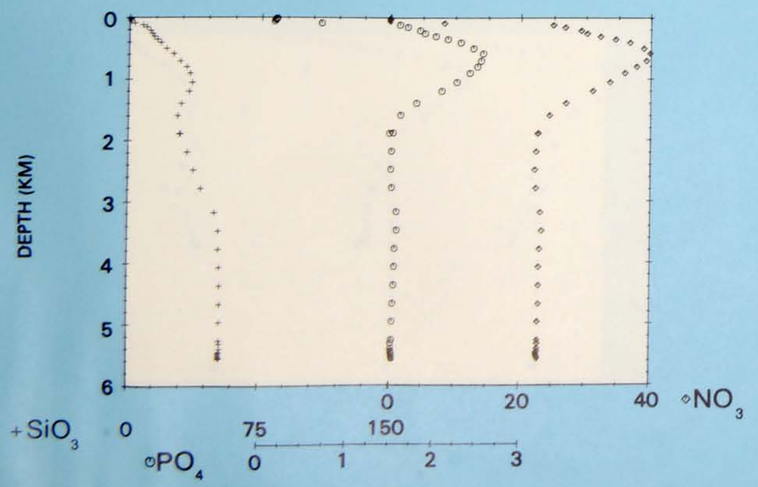


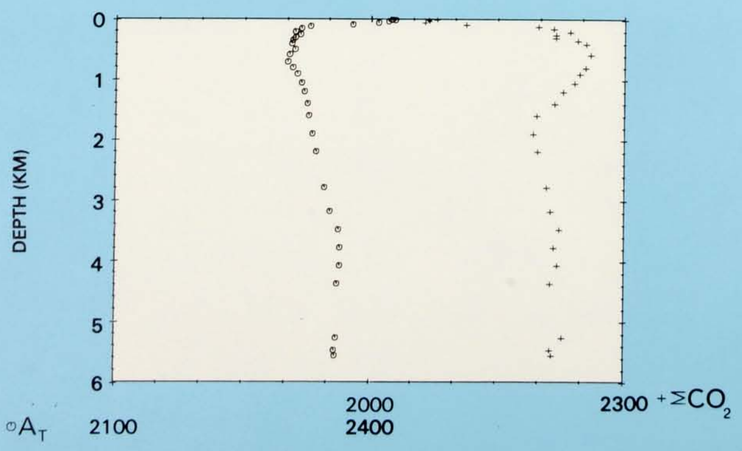


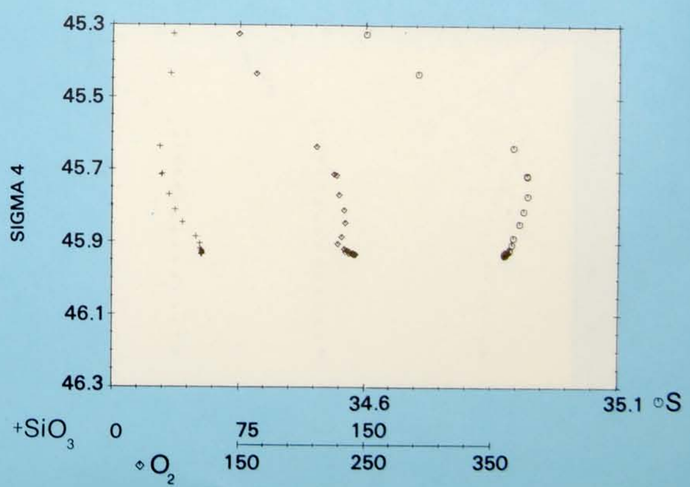


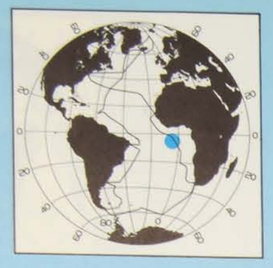








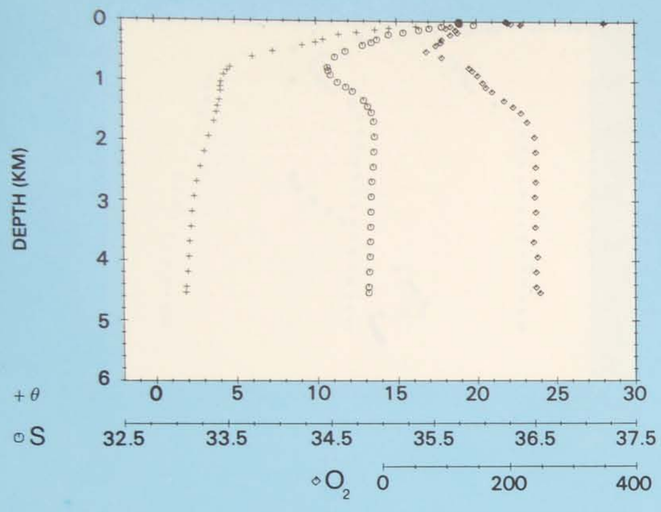


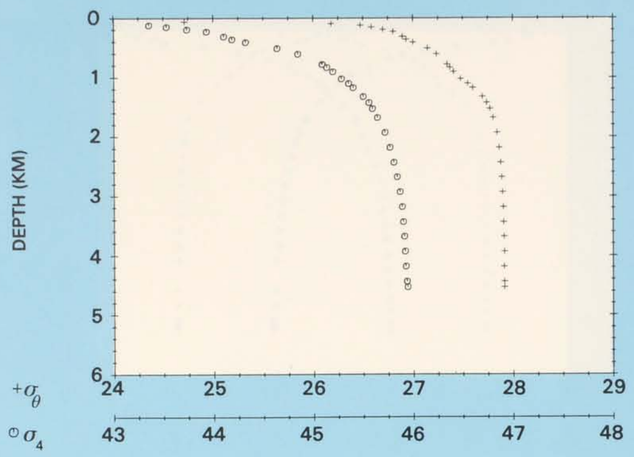


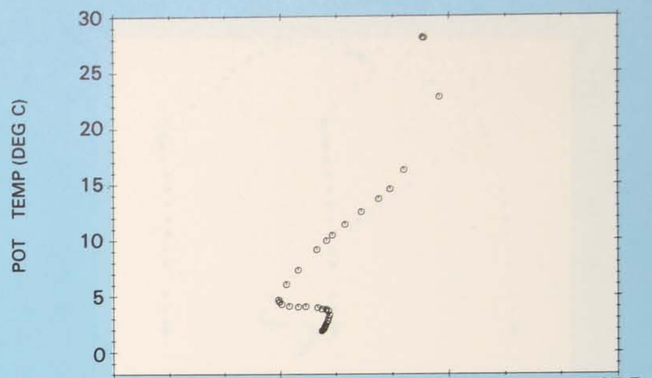
PROPERTY–PROPERTY PLOTS
STATION 108

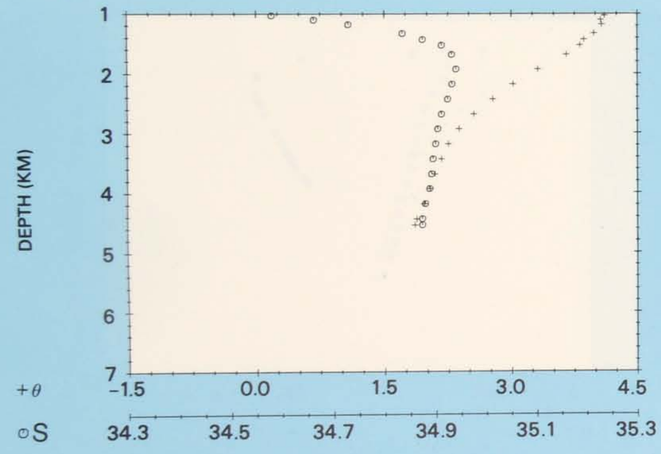
PLATE 163

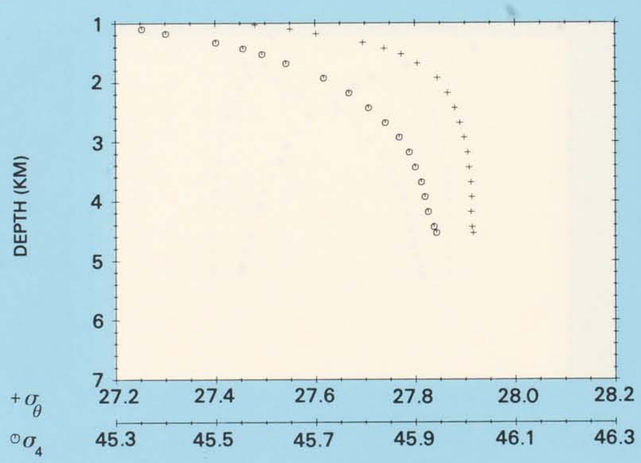
Station 108.
Latitude 5° 20′ S,
Longitude 2° 25′ W.
25 February 1973.

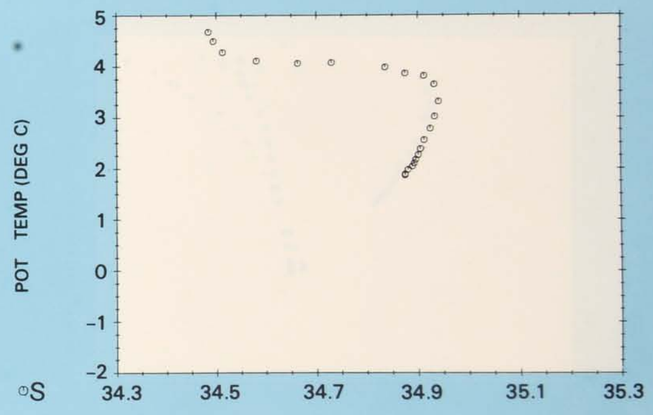


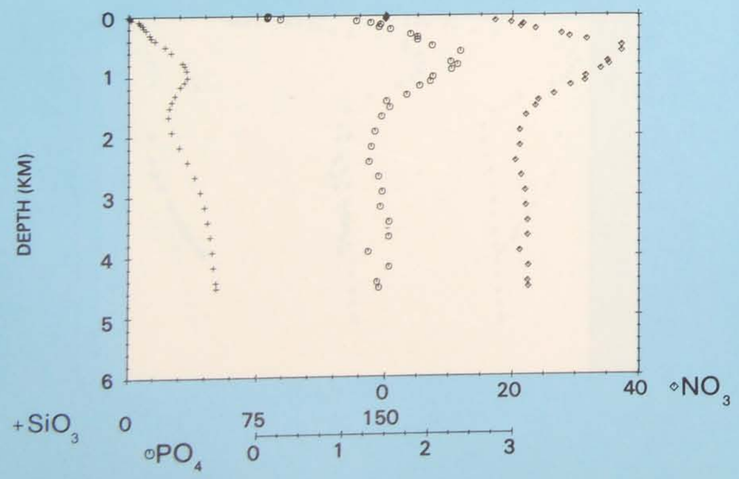












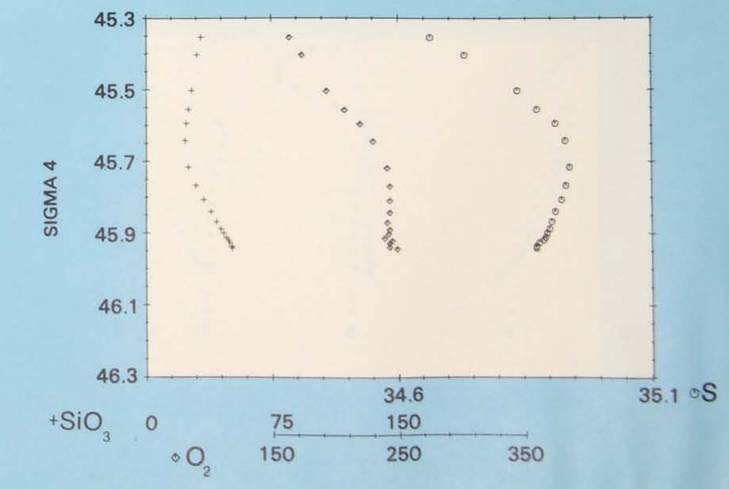
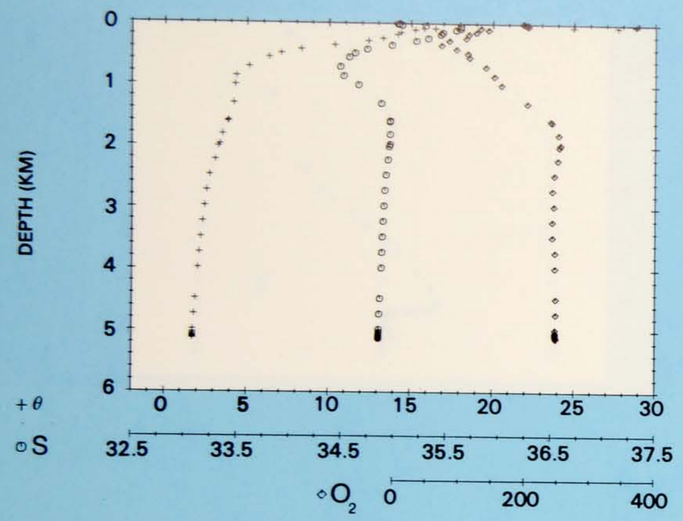
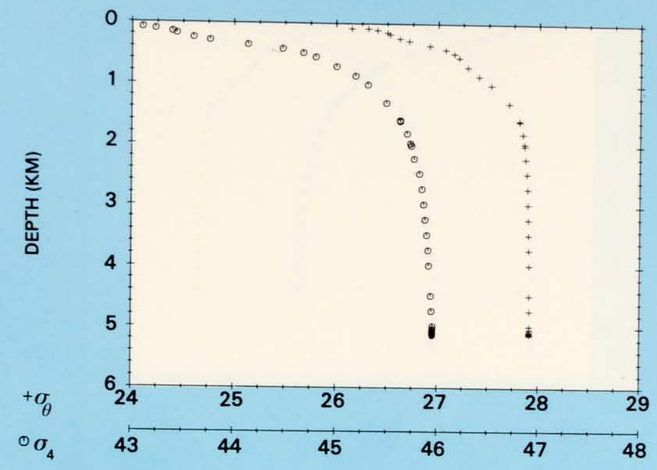


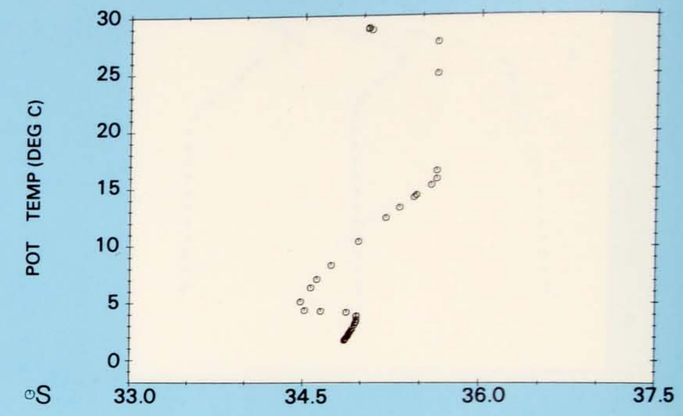
PLATE 164

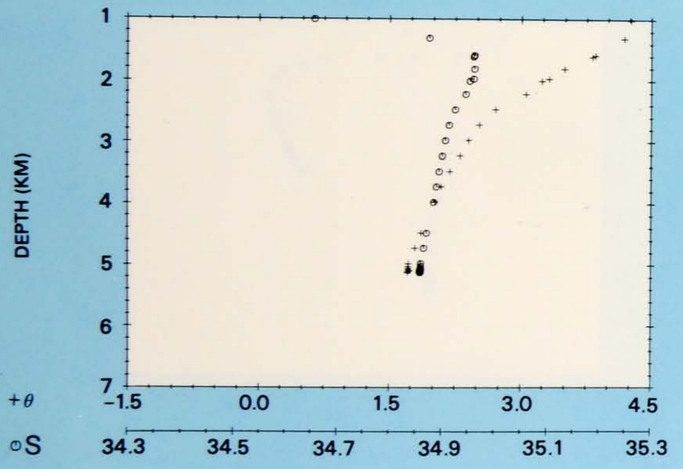
Station 109.
Latitude 2° 00′ S,
Longitude 4° 30′ W.
26 February 1973.

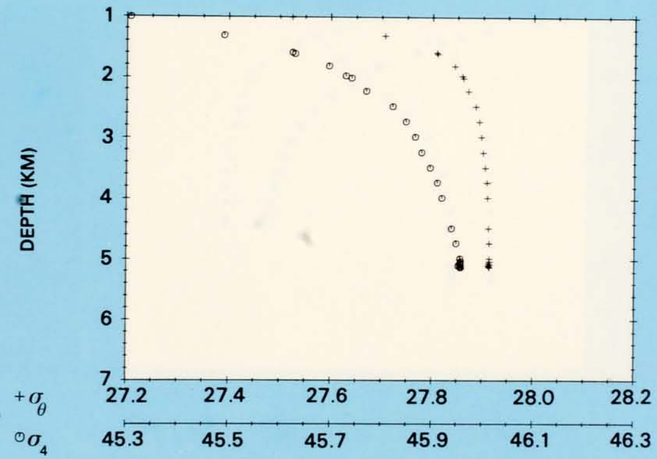
PROPERTY–PROPERTY PLOTS
STATION 109

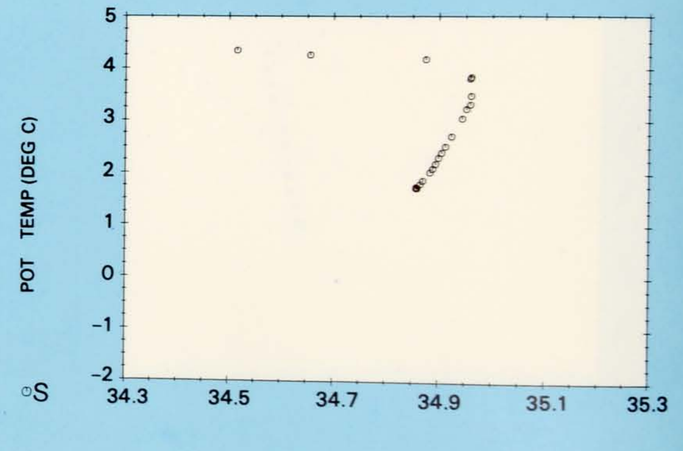


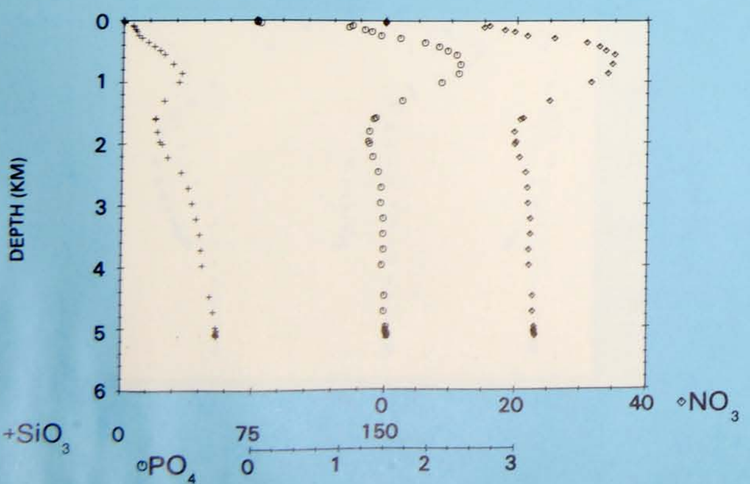


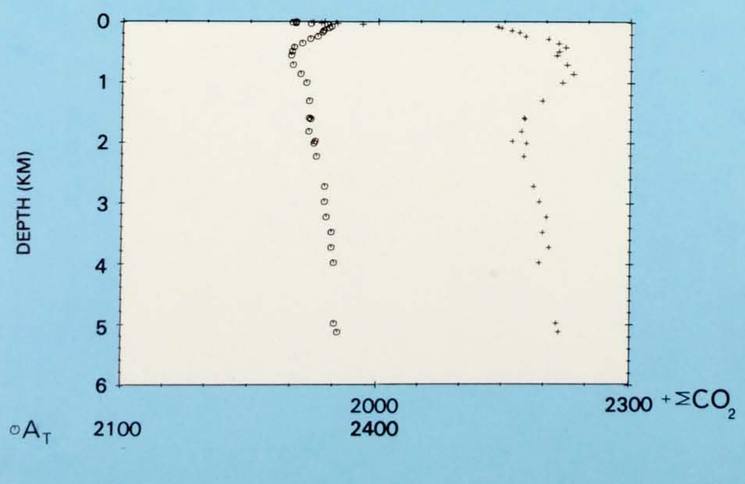


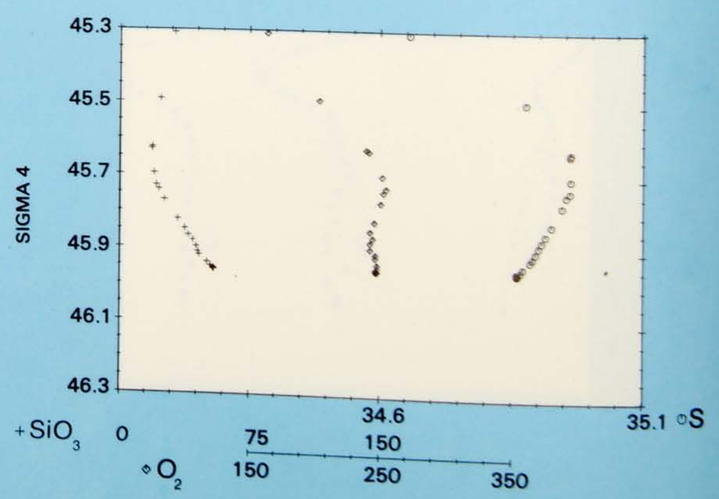


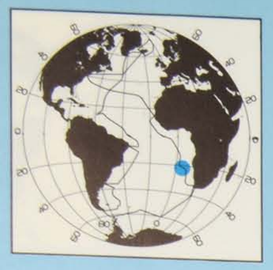








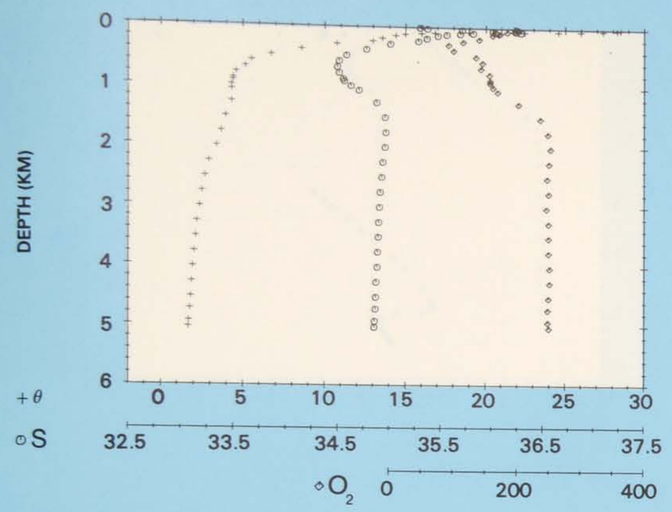


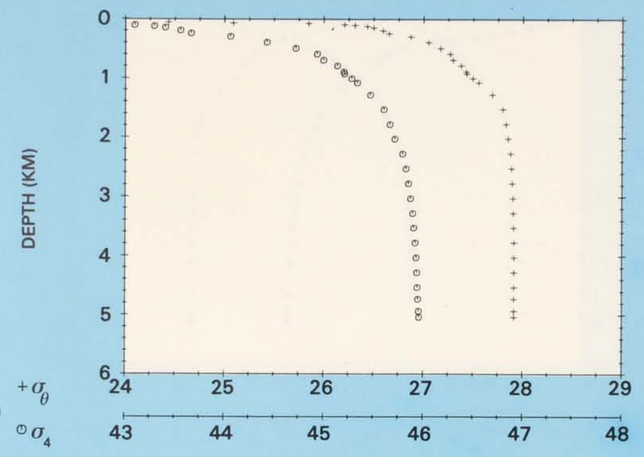


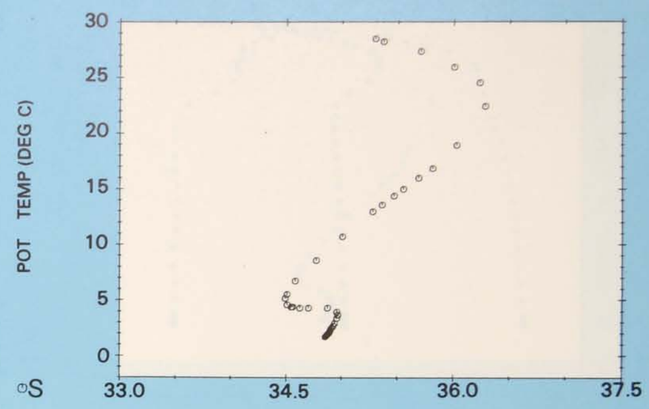
PROPERTY–PROPERTY PLOTS
STATION 110

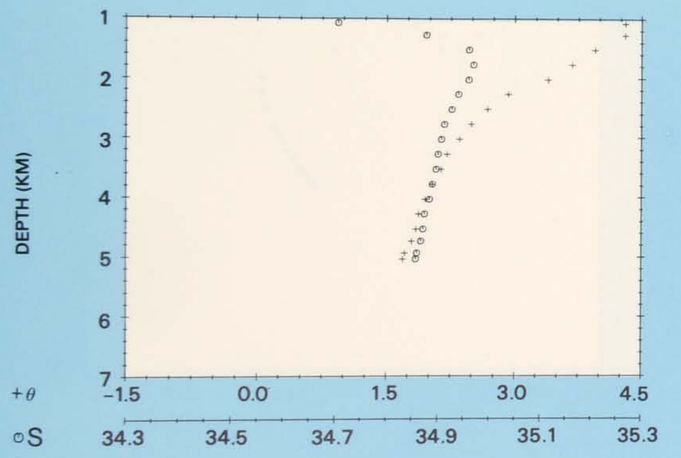
PLATE 165

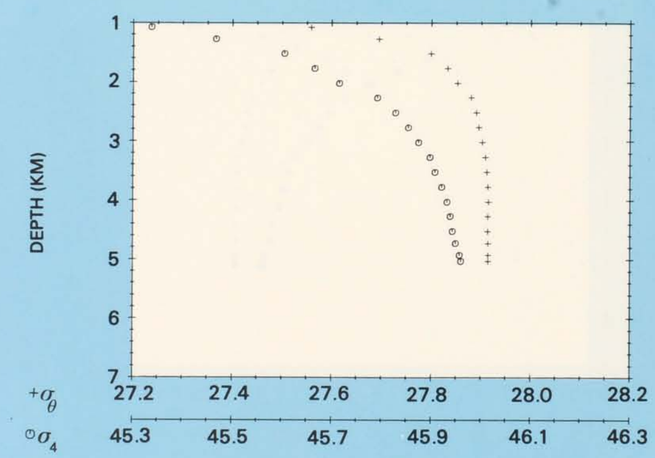
Station 110.
Latitude 0° 00′ S,
Longitude 9° 11′ W.
28 February 1973.

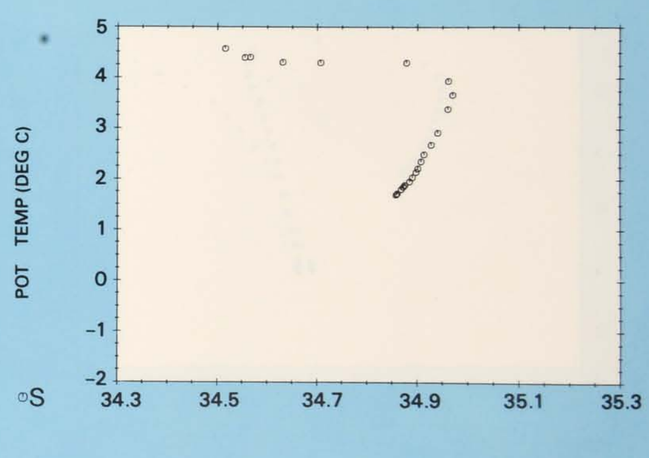


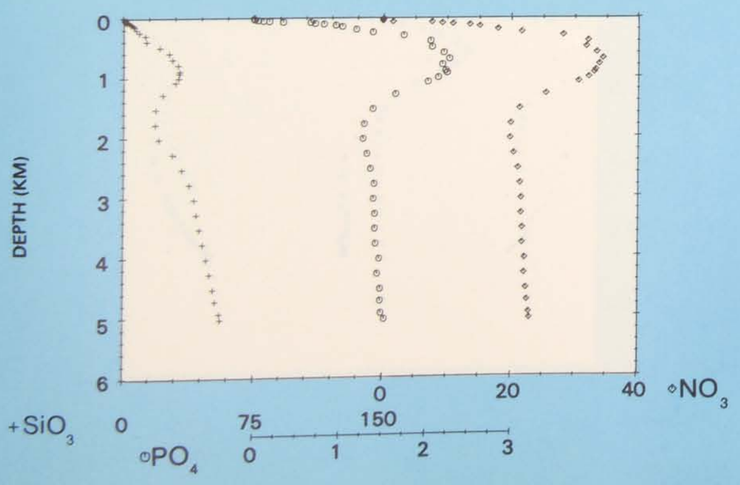












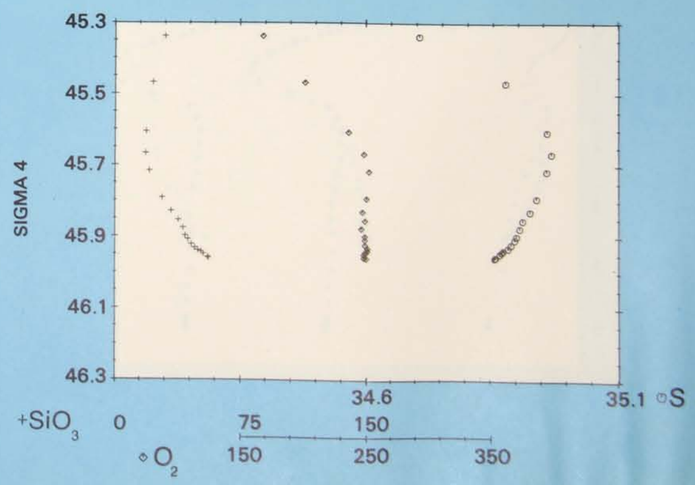
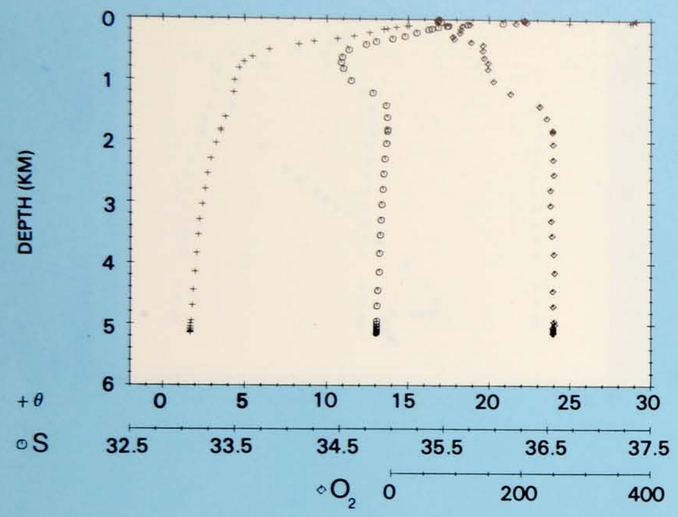
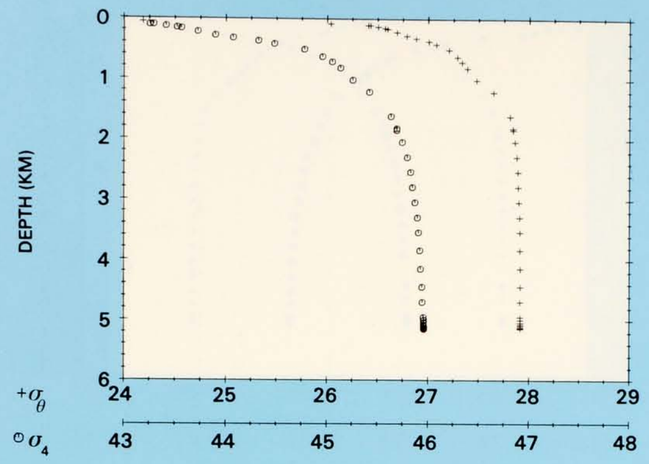


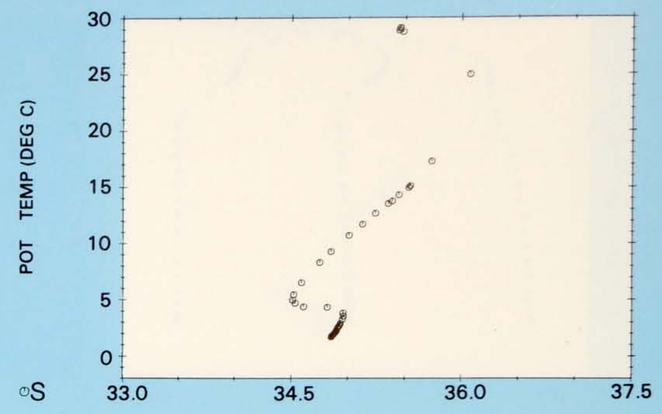
PLATE 166

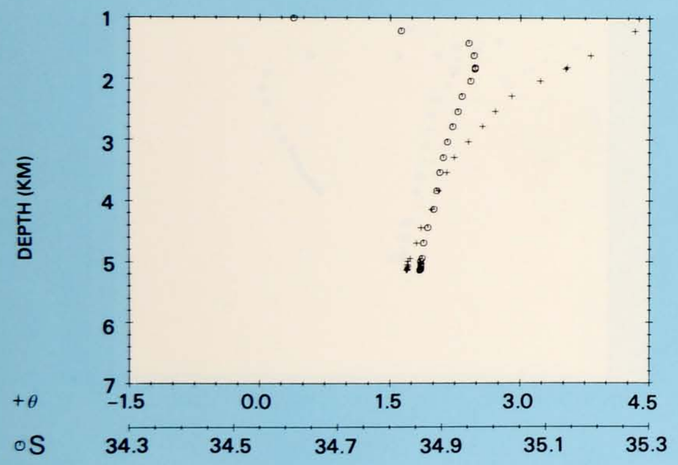
Station 111.
Latitude 2° 00′ N,
Longitude 14° 01′ W.
1 March 1973.

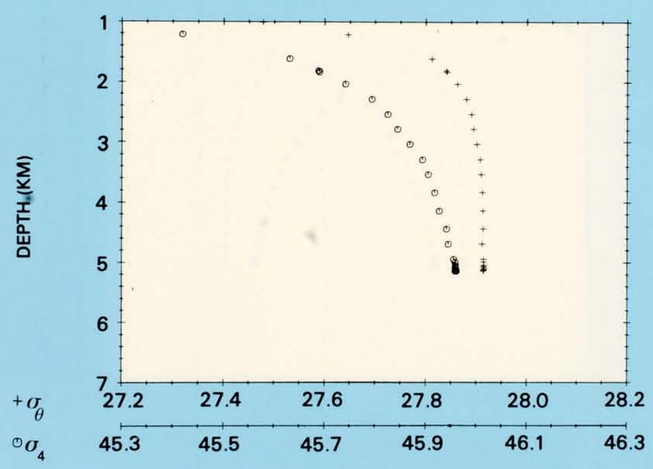
PROPERTY–PROPERTY PLOTS
STATION 111

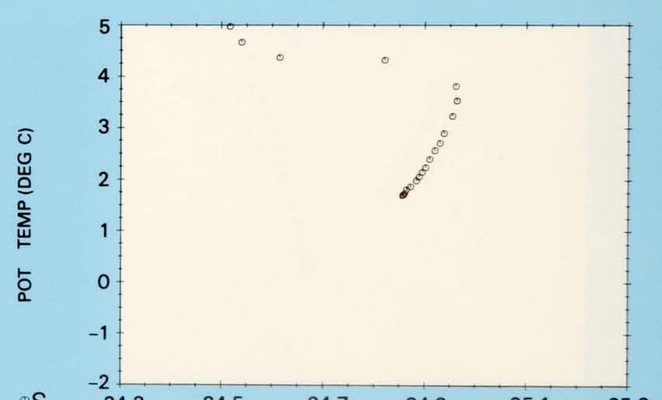


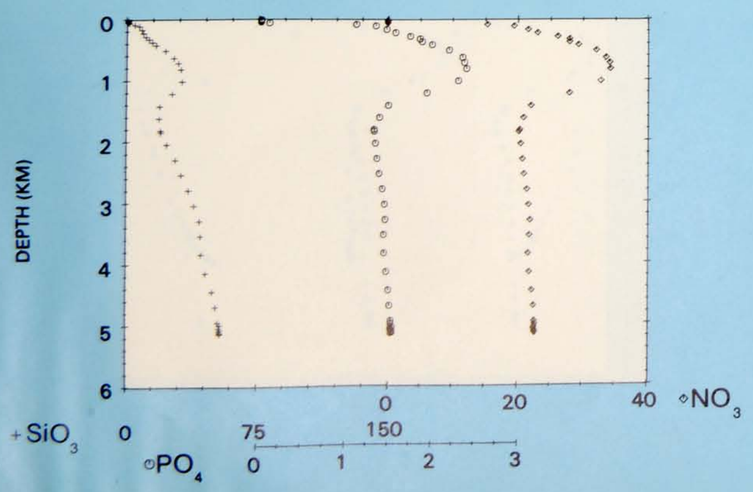


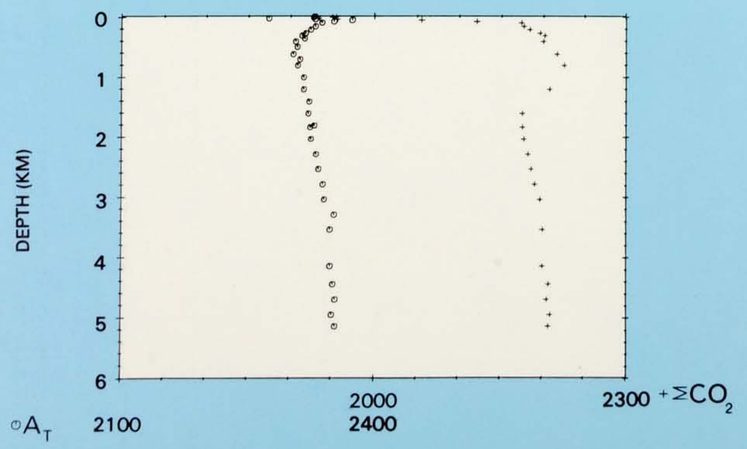


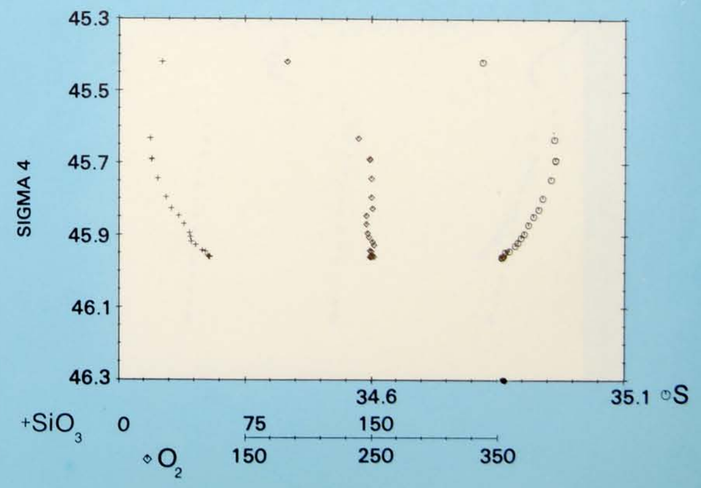








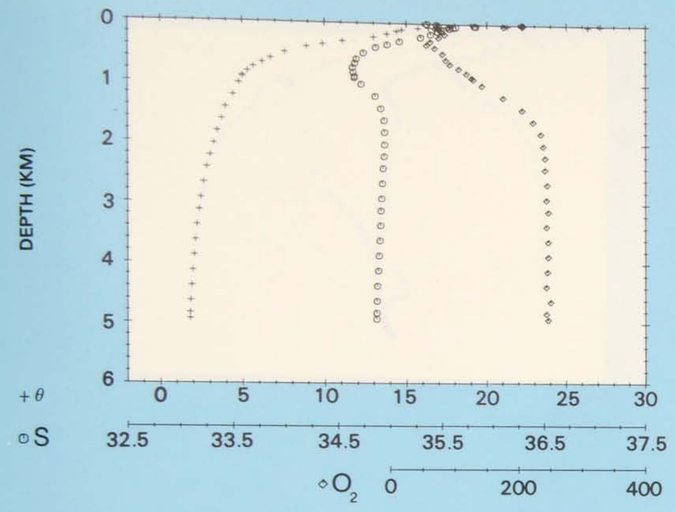


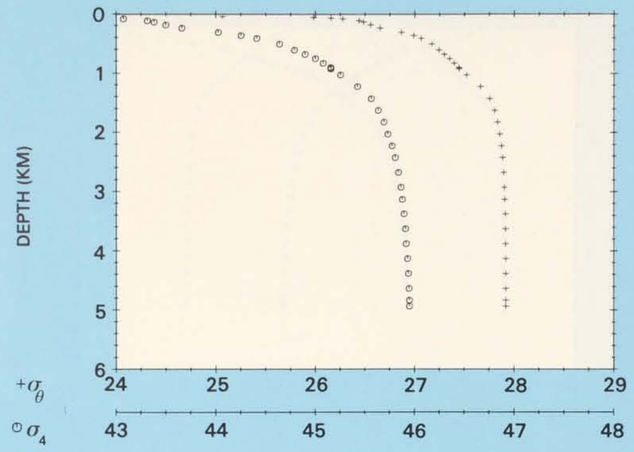


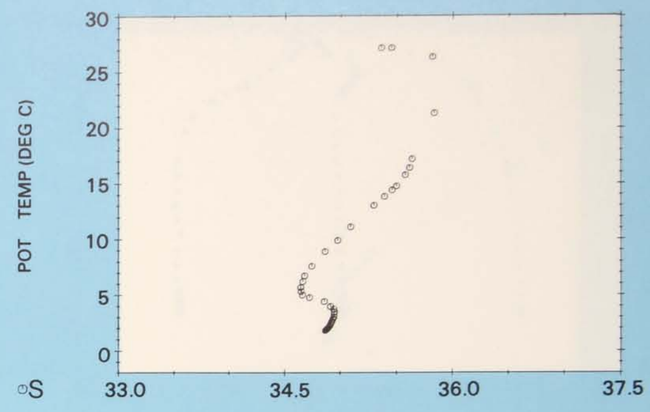
PROPERTY–PROPERTY PLOTS
STATION 112

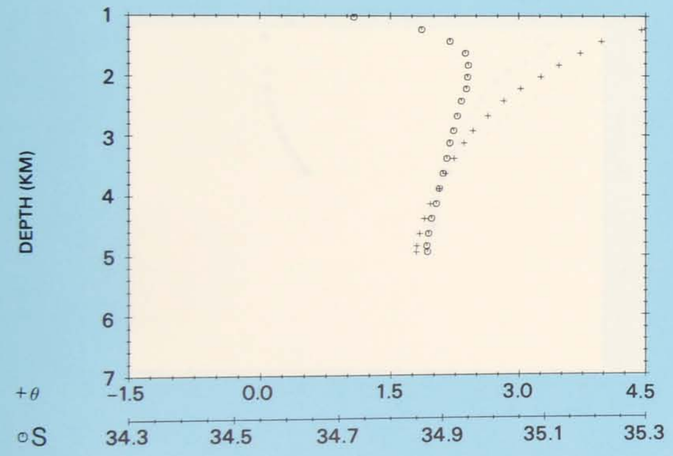
PLATE 167

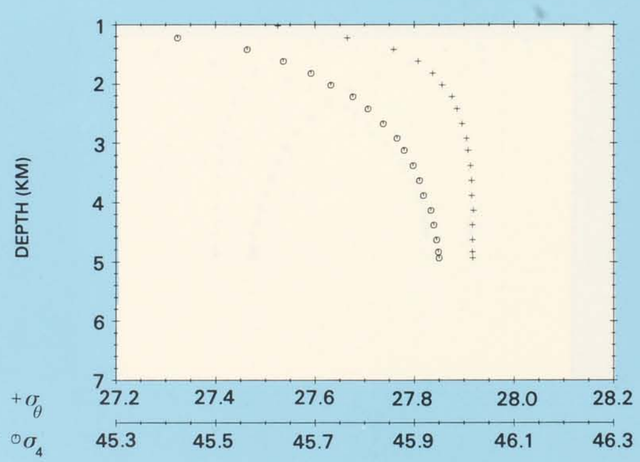
Station 112.
Latitude 6° 20′ N,
Longitude 7° 16′ W.
3 March 1973.

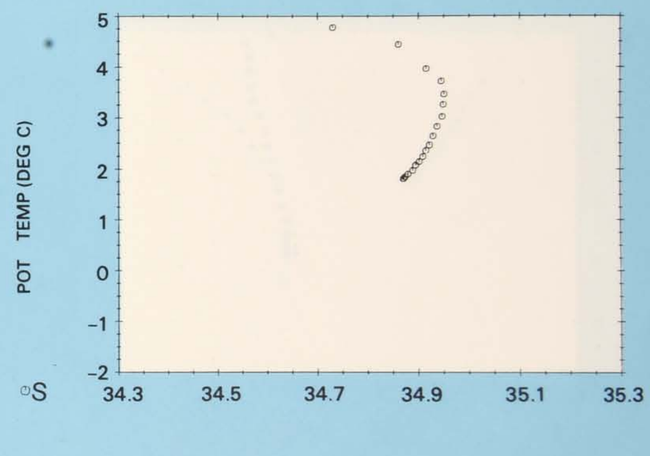


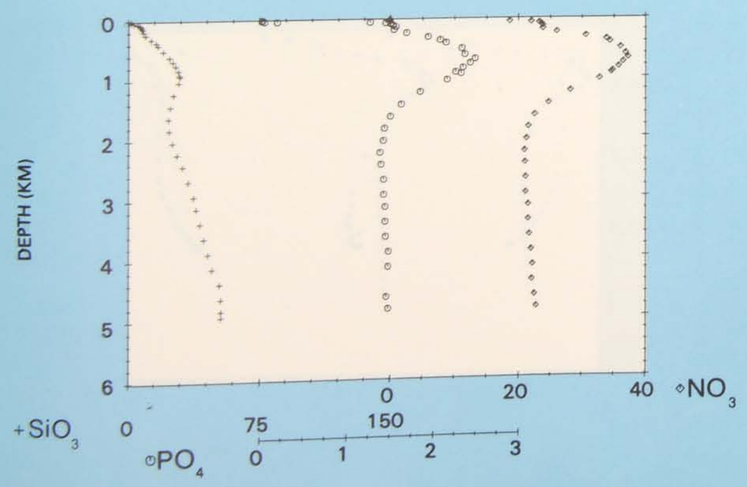












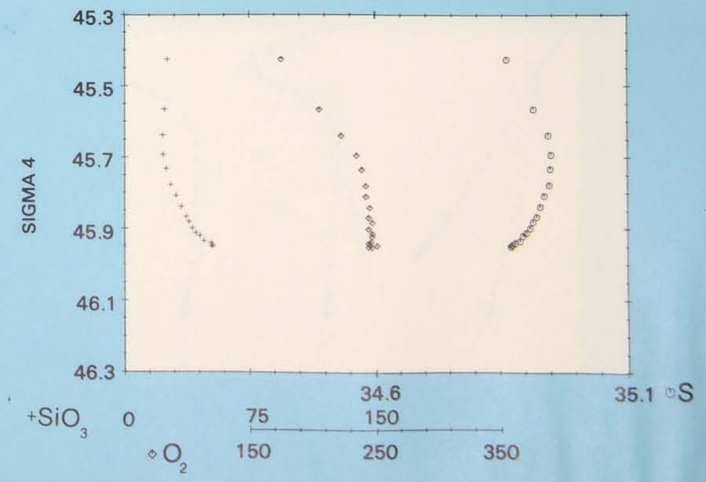
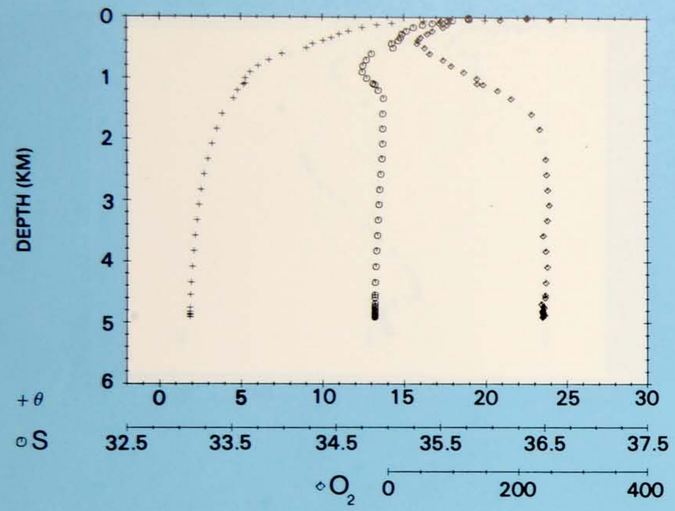
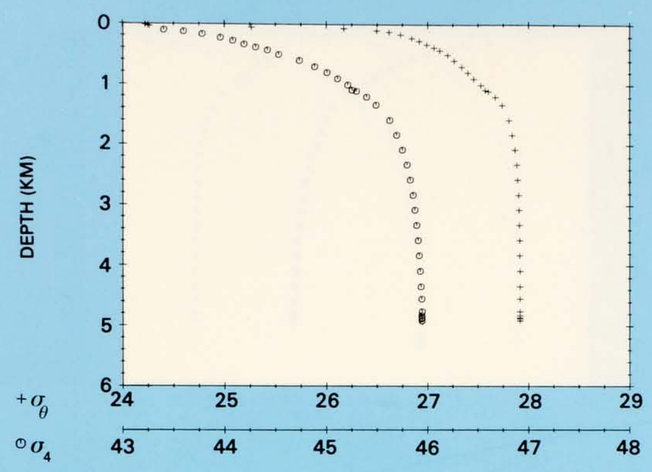


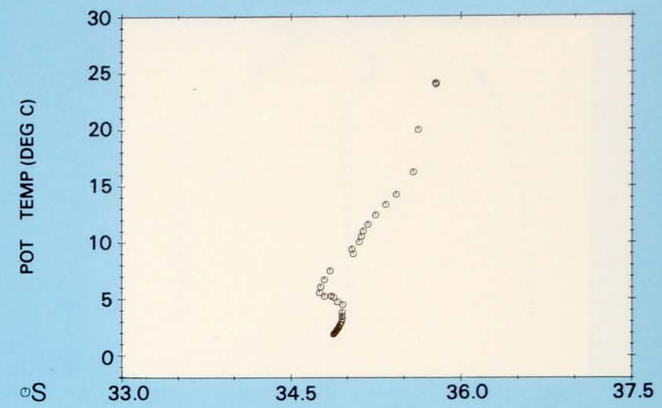
PLATE 168

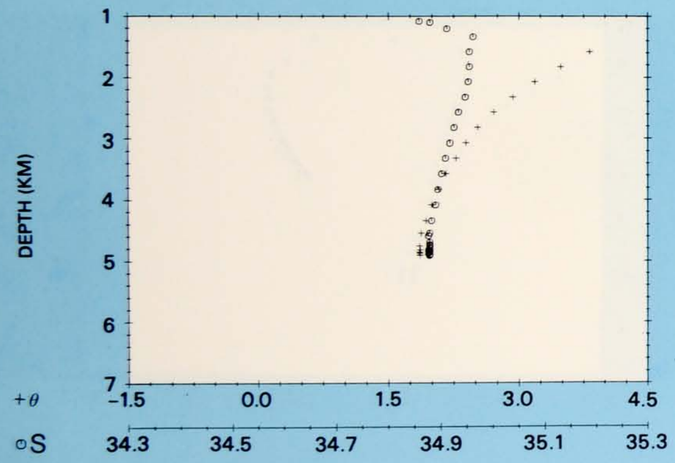
Station 113.
Latitude 10° 59′ N,
Longitude 20° 32′ W.
5 March 1973.

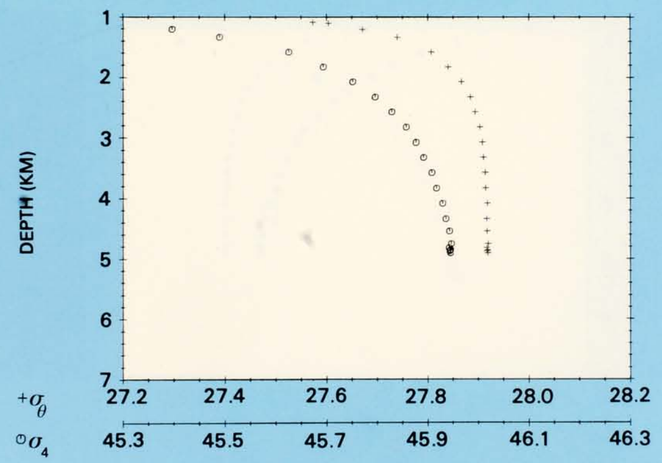
PROPERTY–PROPERTY PLOTS
STATION 113

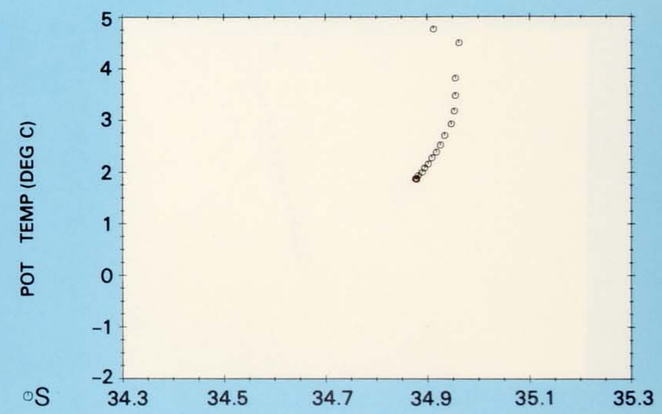


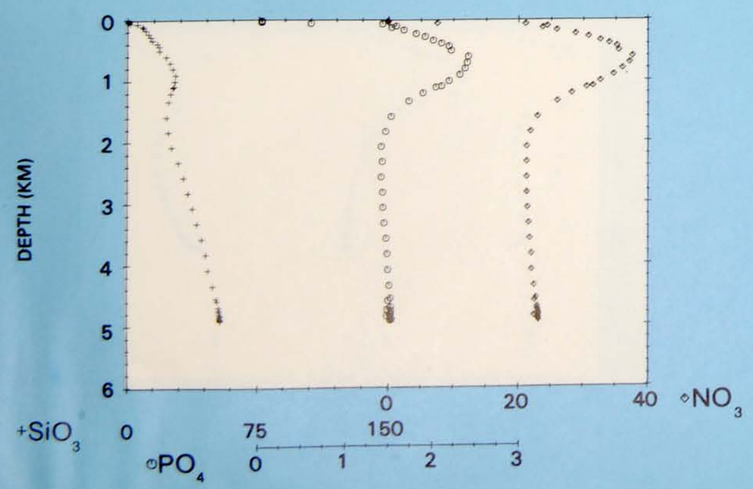


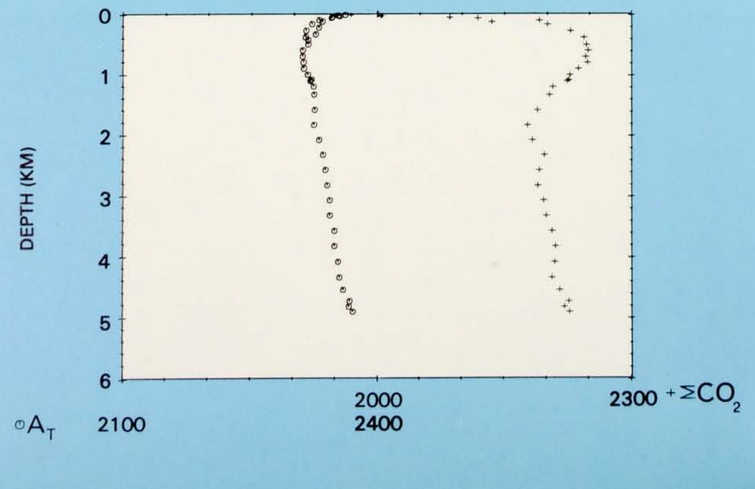


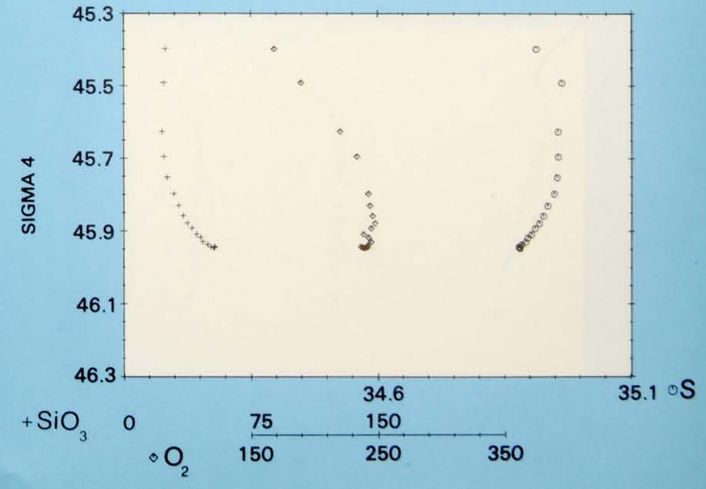








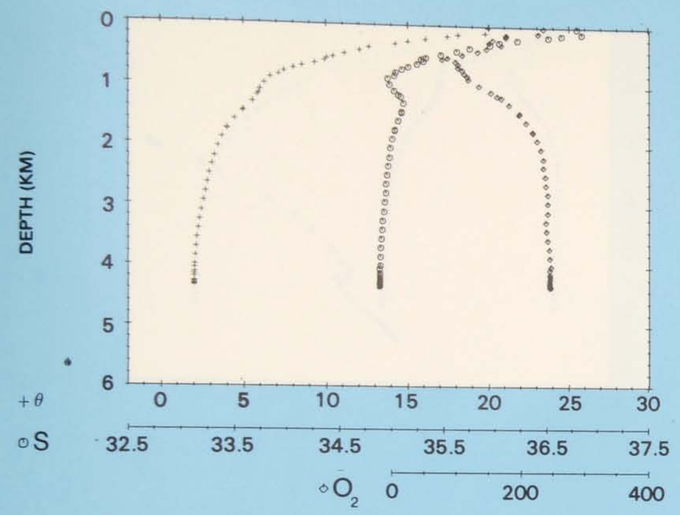


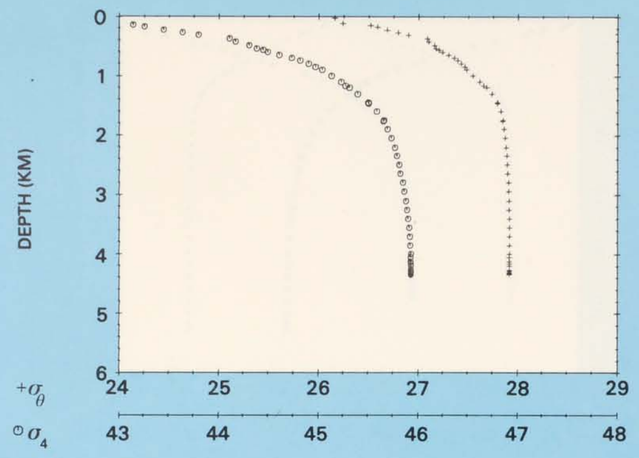


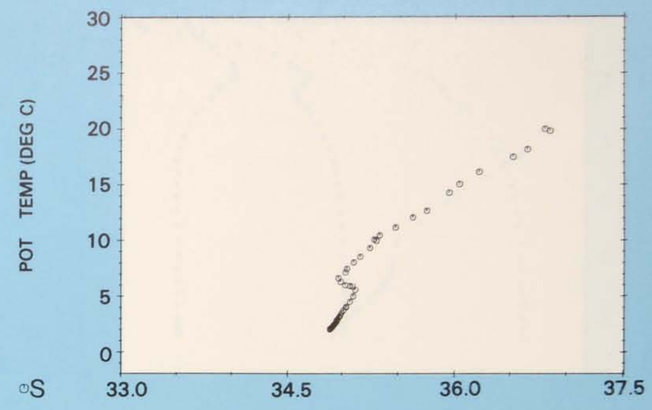
PROPERTY–PROPERTY PLOTS
STATION 114

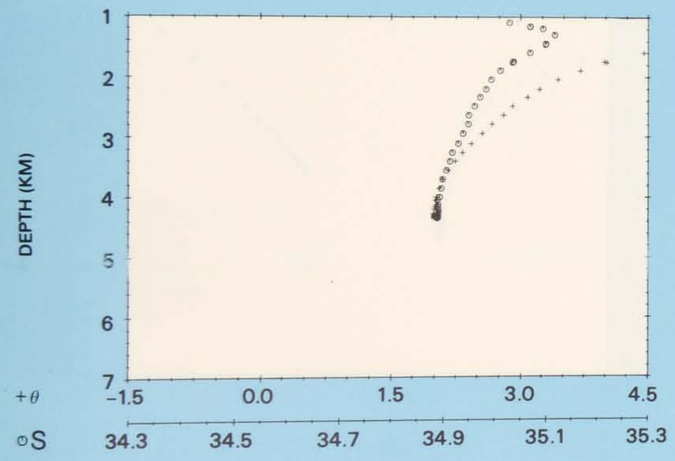
PLATE 169

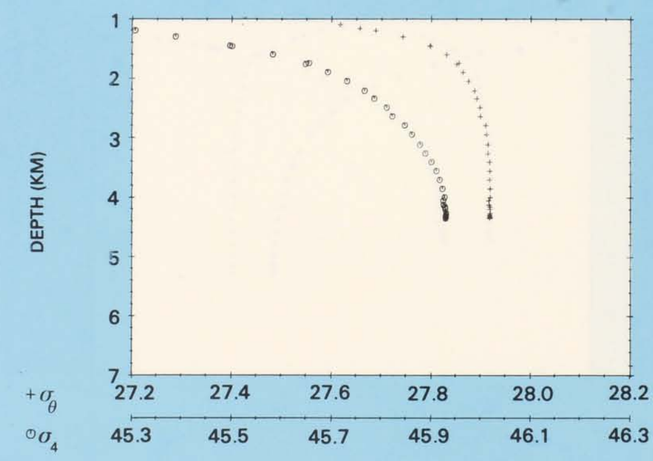
Station 114.
Latitude 21° 10′ N,
Longitude 21° 46′ W.
12 March 1973.

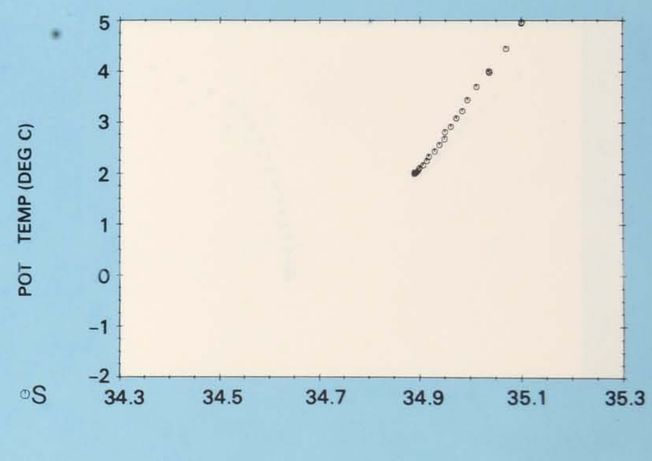


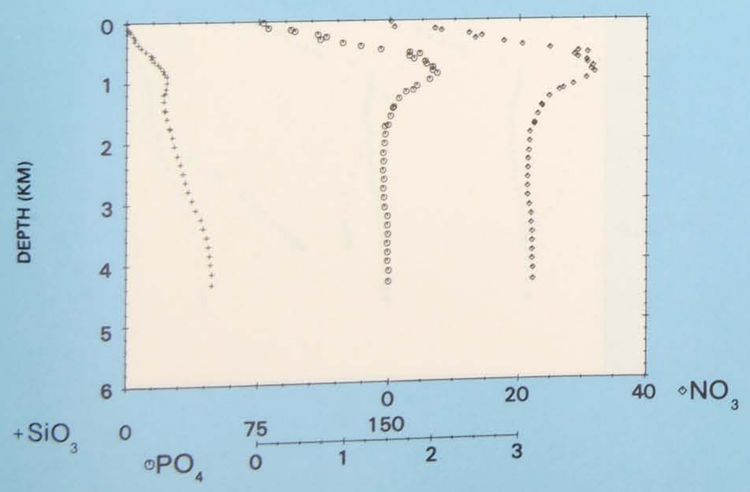


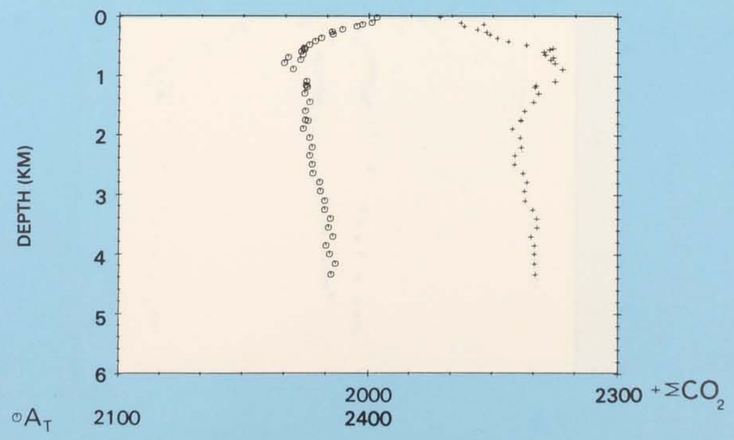












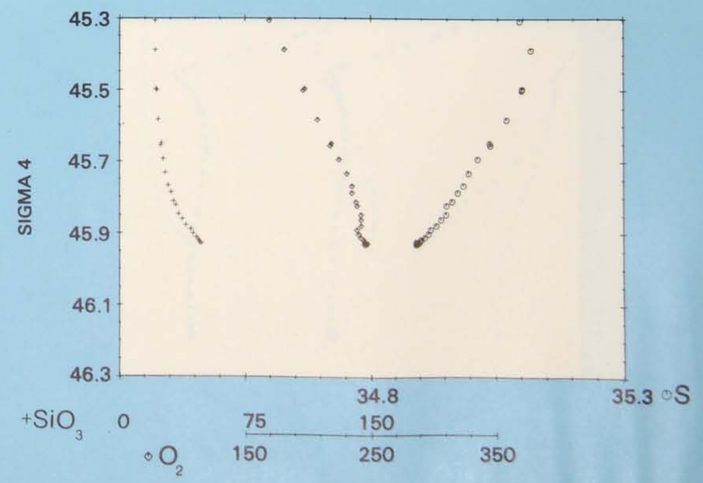
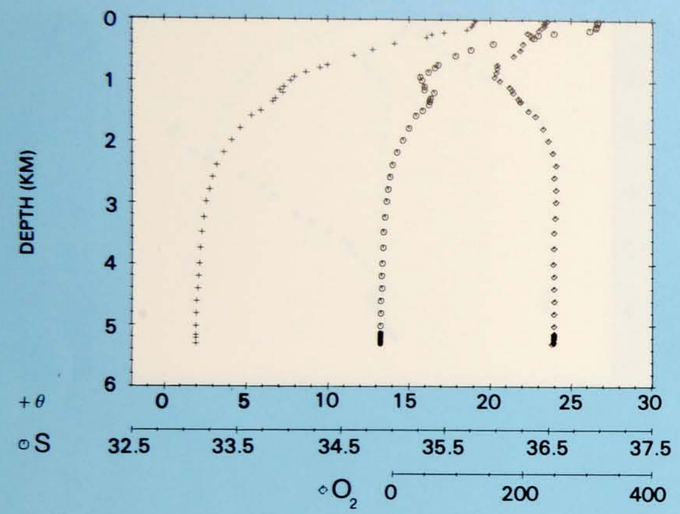
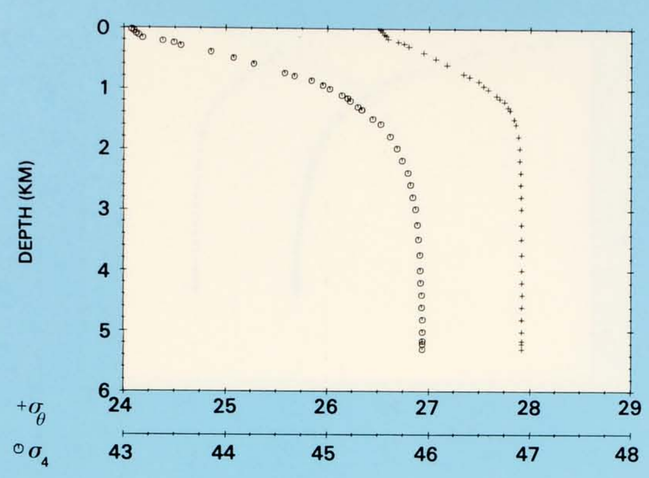


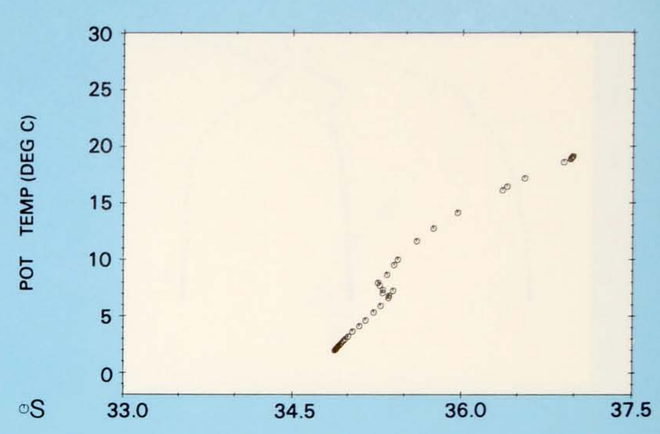
PLATE 170

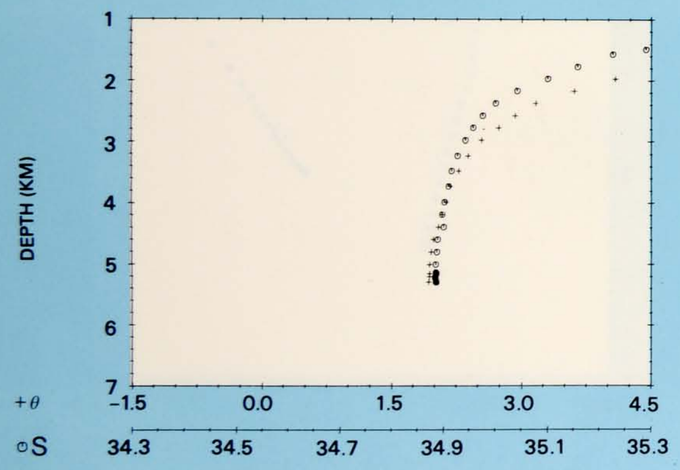
Station 115.
Latitude 28° 01′ N,
Longitude 26° 00′ W.
15 March 1973.

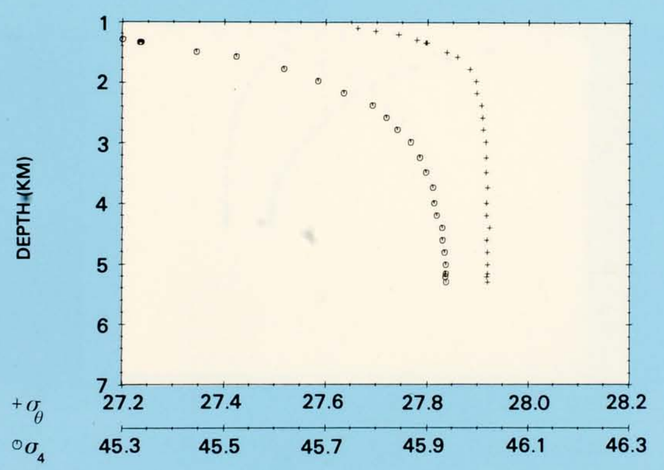
PROPERTY–PROPERTY PLOTS
STATION 115

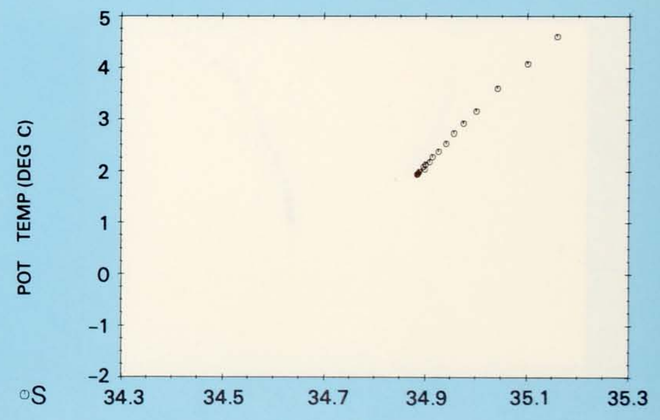


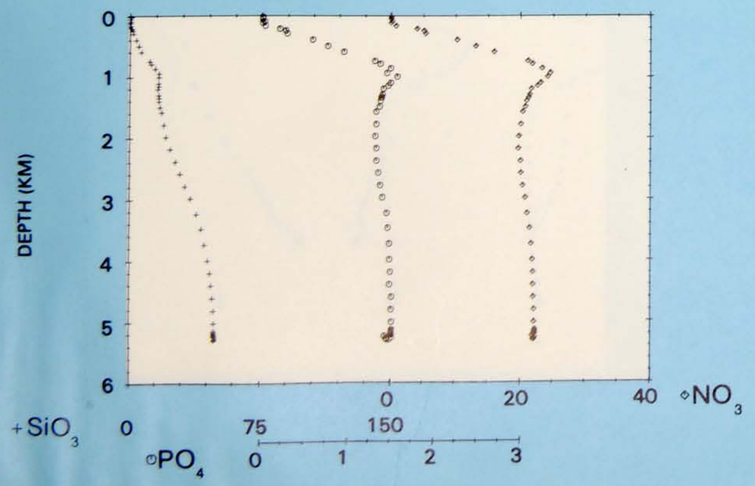


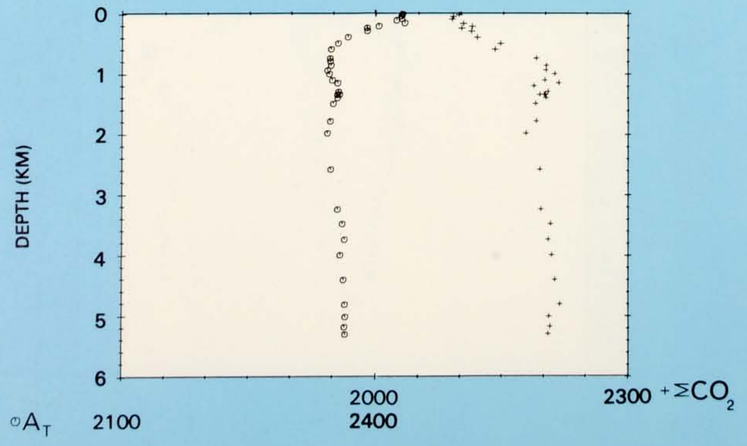


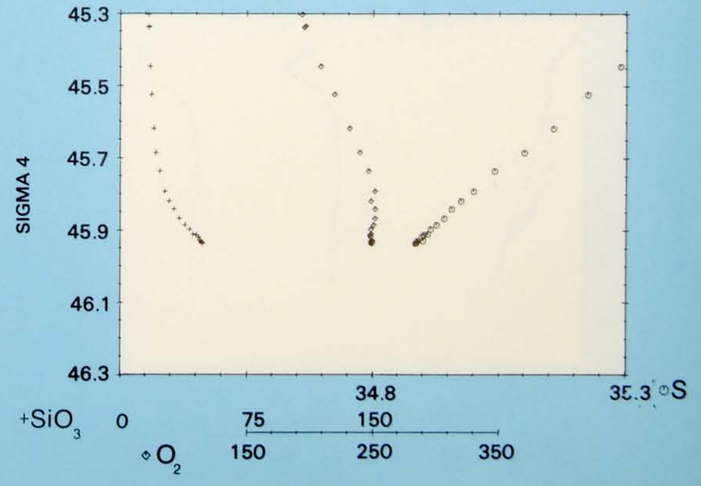








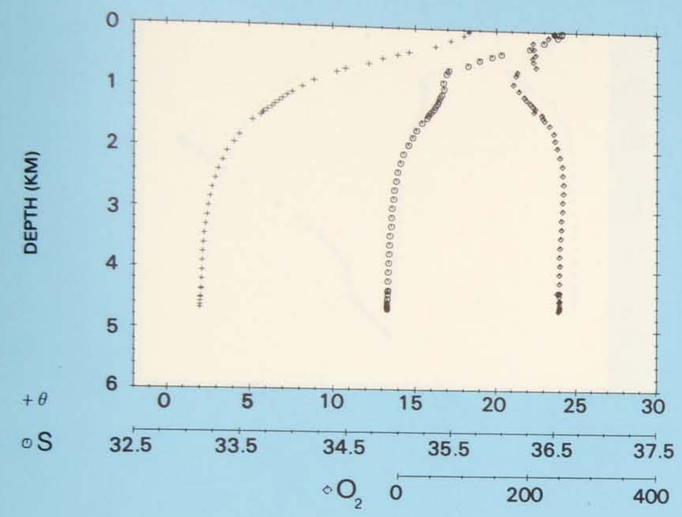


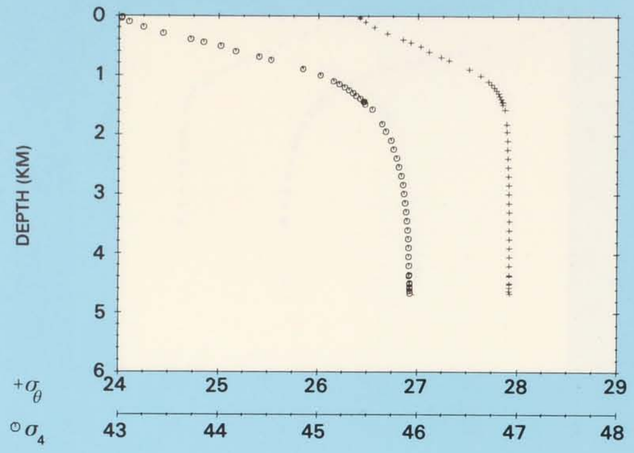


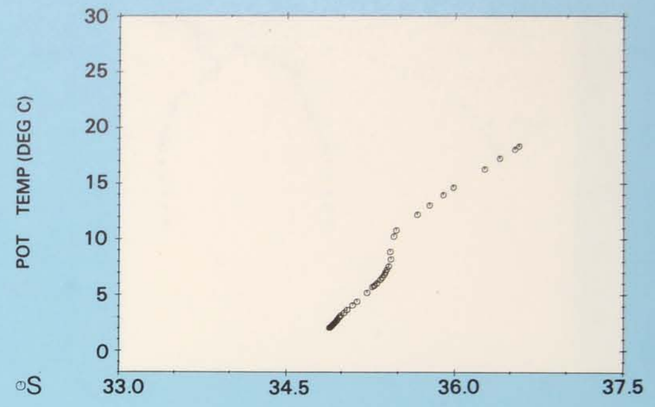
PROPERTY–PROPERTY PLOTS
STATION 116

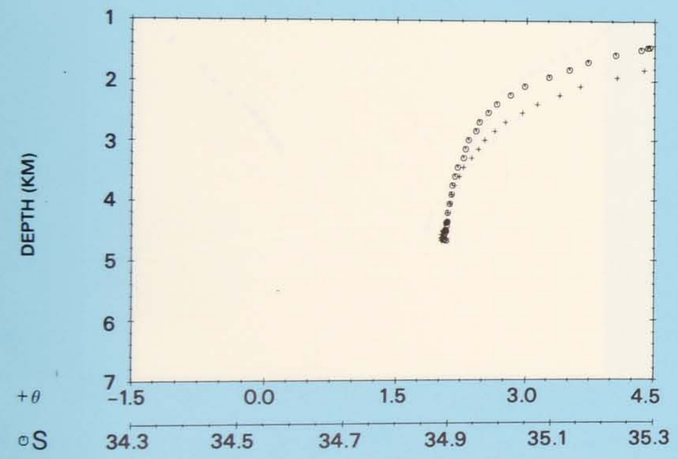
PLATE 171

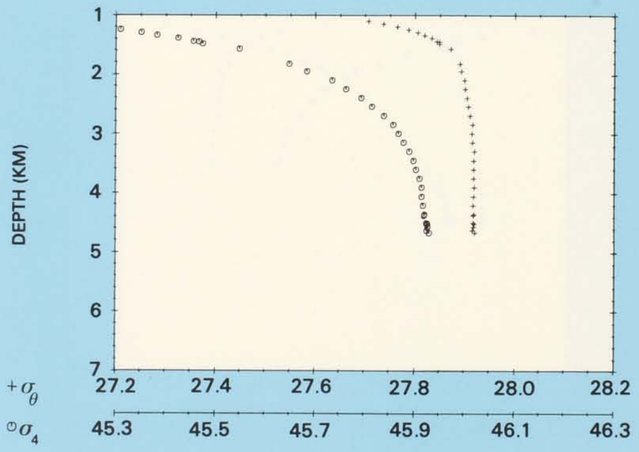
Station 116.
Latitude 29° 56′ N,
Longitude 30° 24′ W.
18 March 1973.

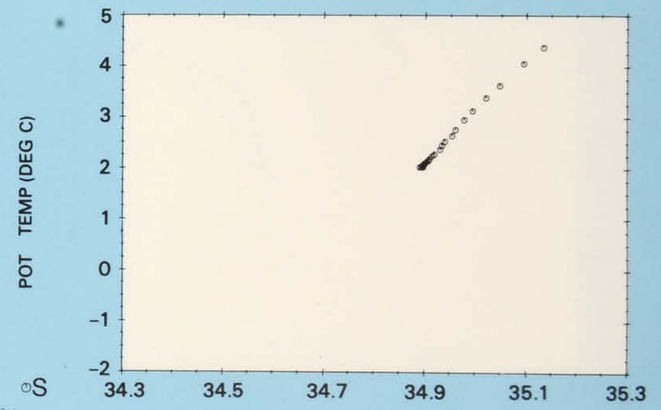


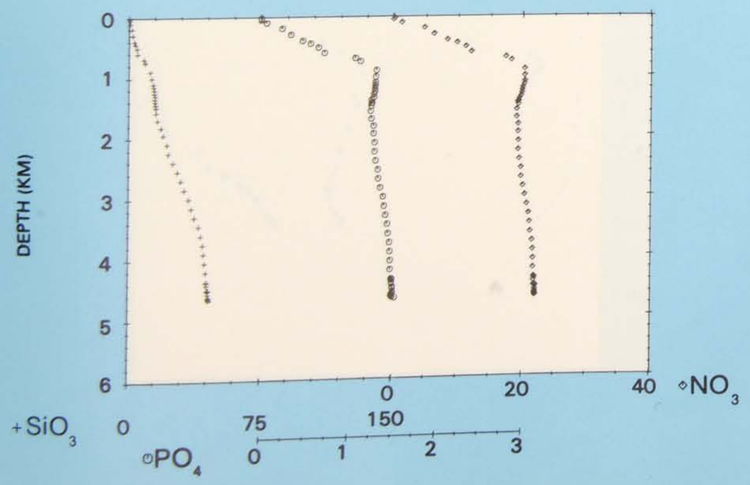


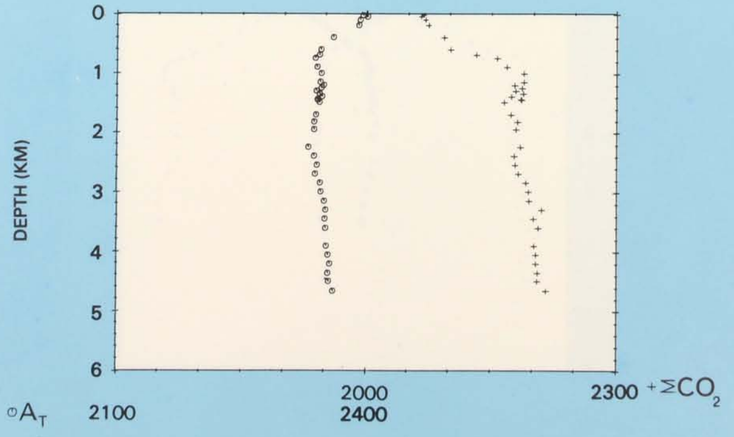












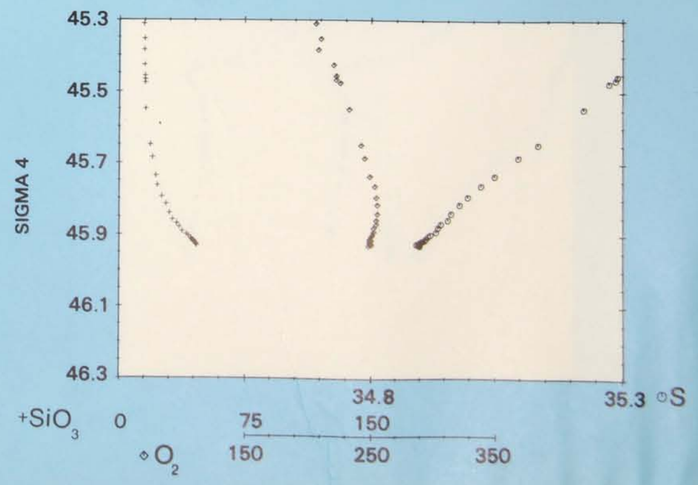
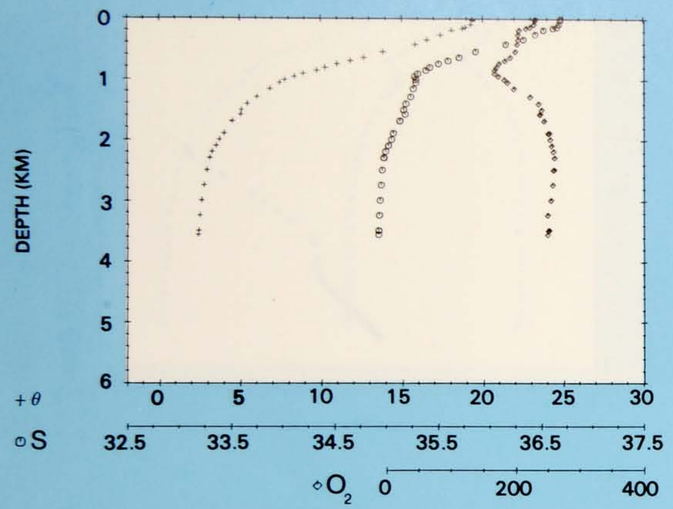
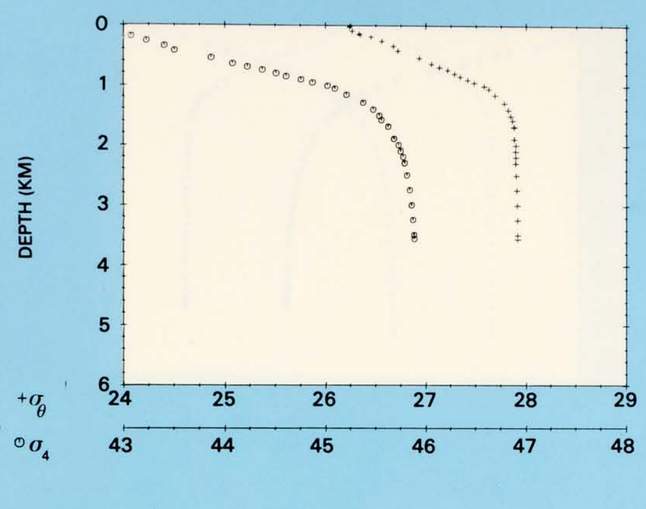


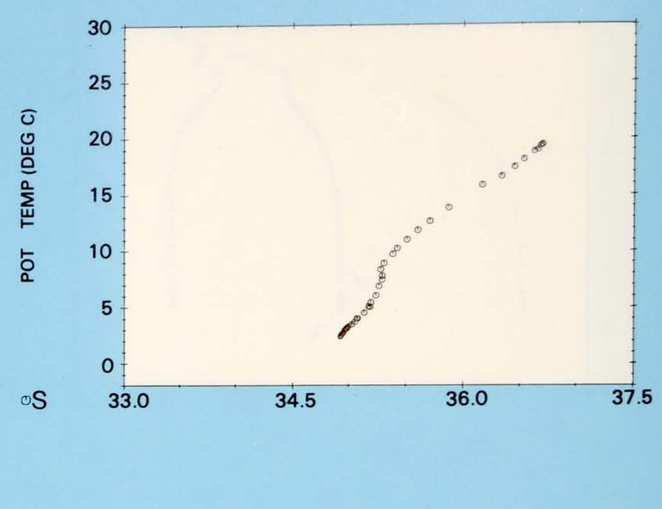
PLATE 172

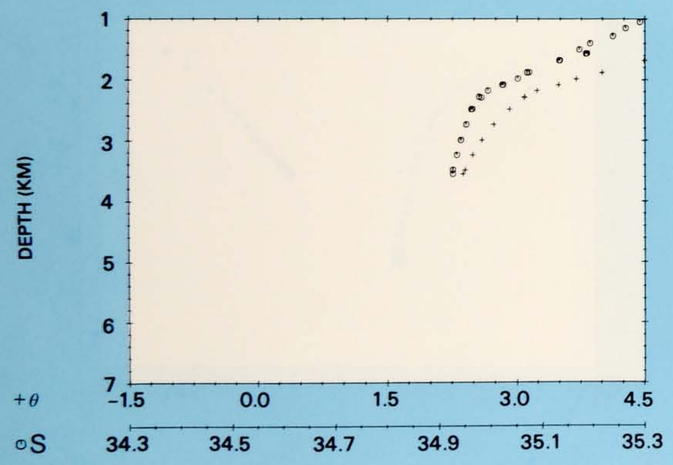
Station 117.
Latitude 30° 40' N,
Longitude 38° 58' W.
20 March 1973.

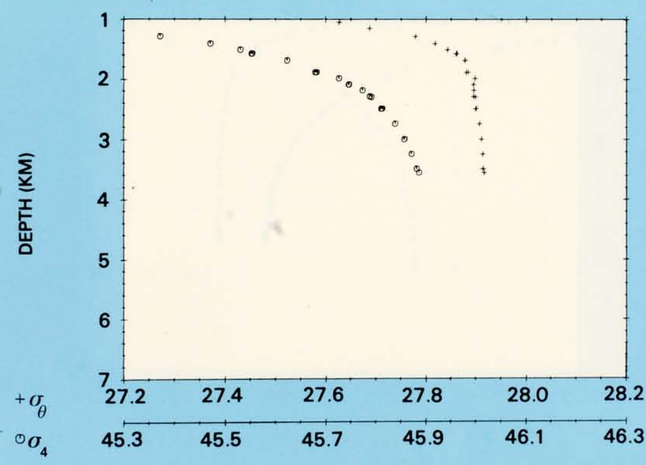
PROPERTY–PROPERTY PLOTS
STATION 117

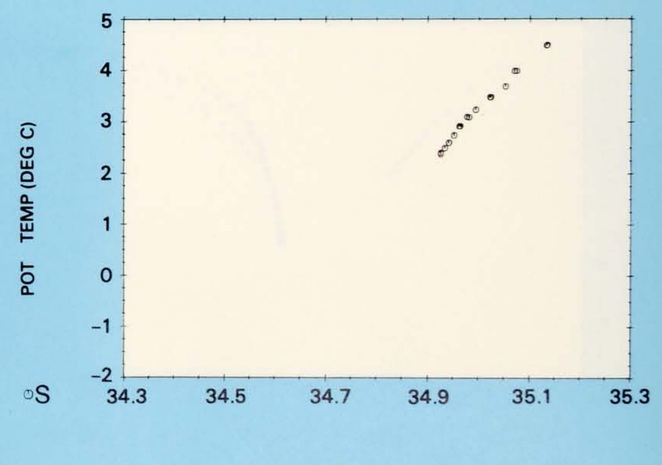


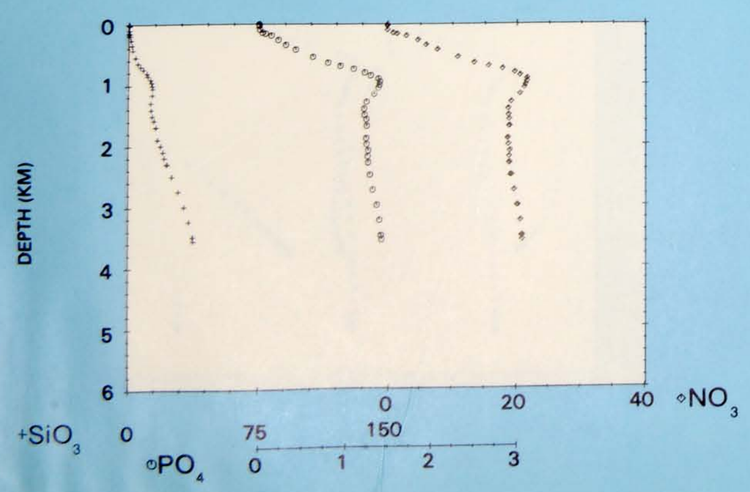


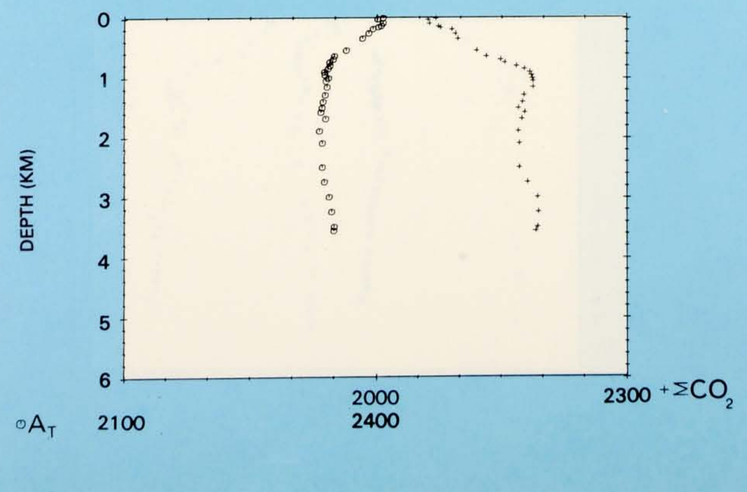


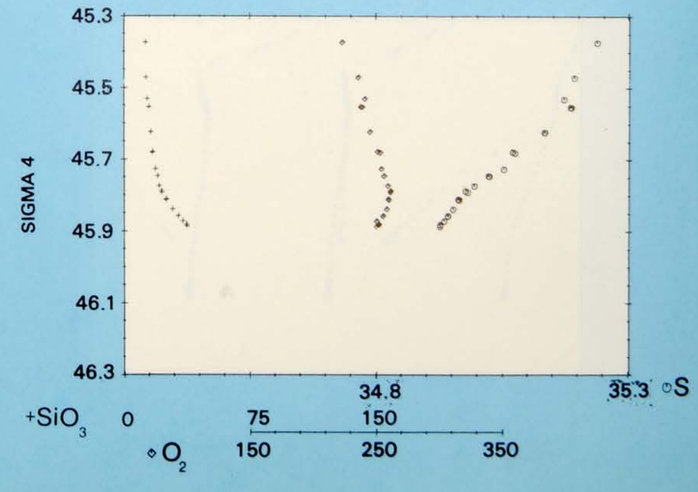


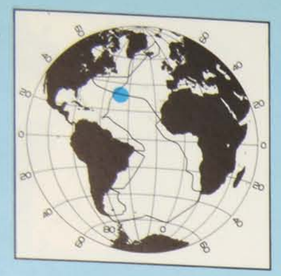








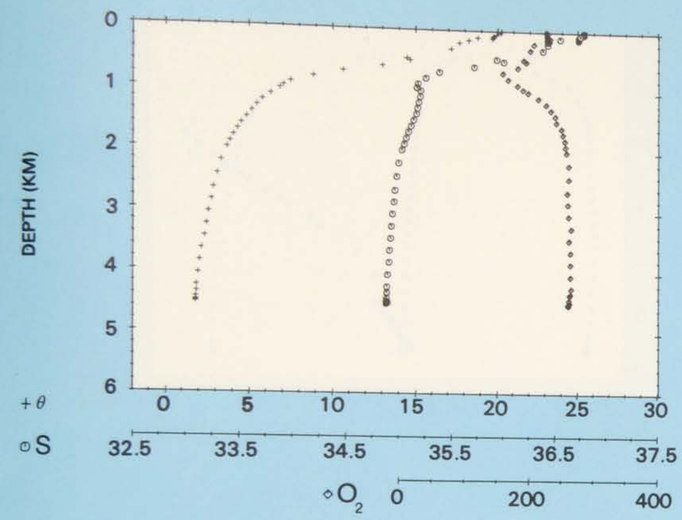


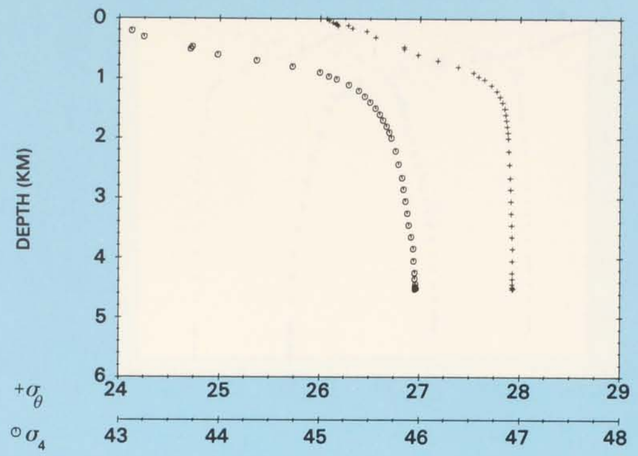


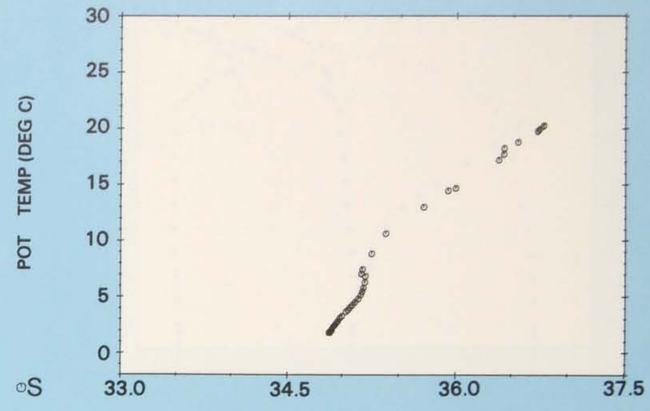
PROPERTY–PROPERTY PLOTS
STATION 118

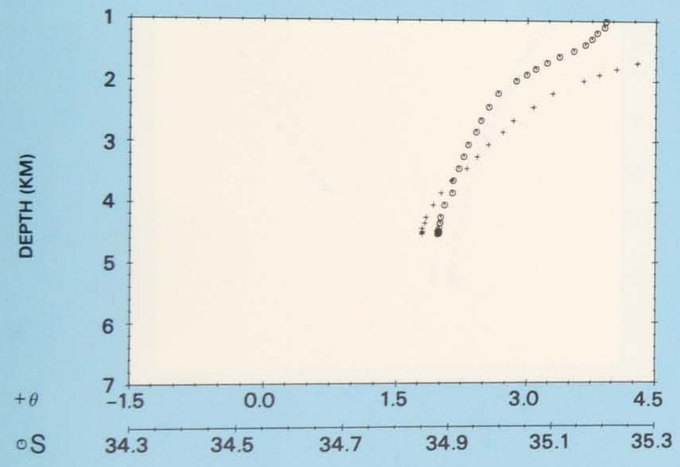
PLATE 173

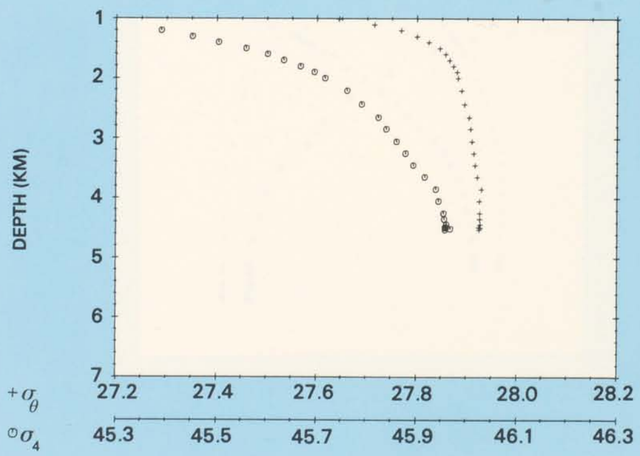
Station 118.
Latitude 31° 18′ N,
Longitude 45° 38′ W.
23 March 1973.

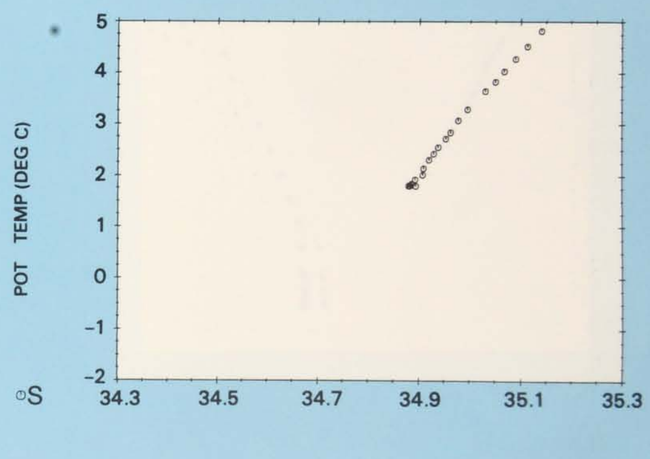


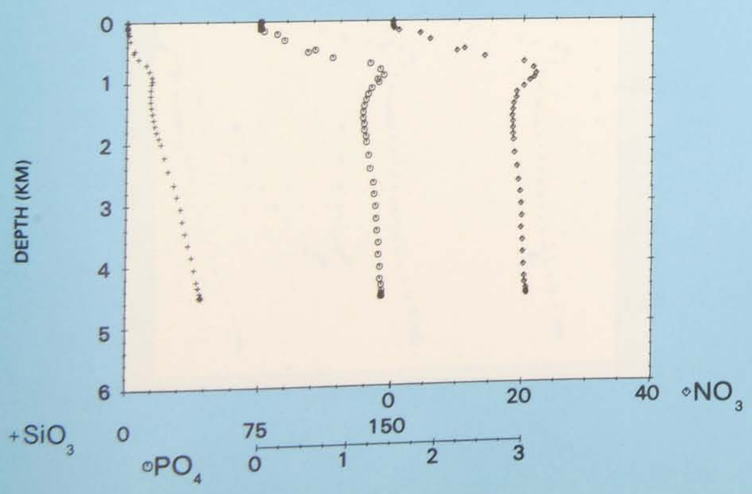


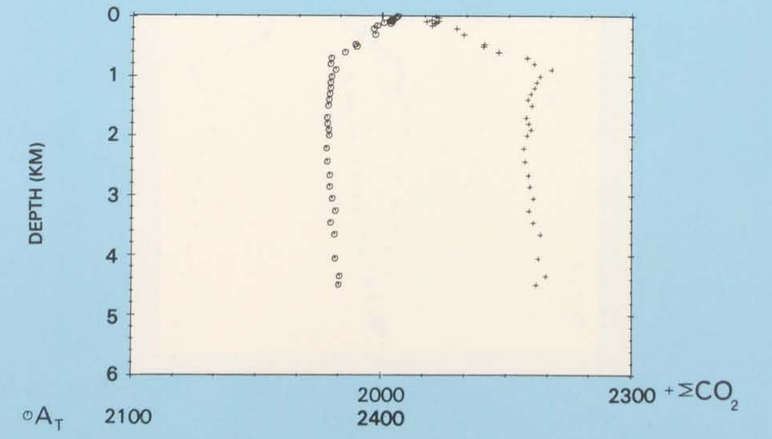












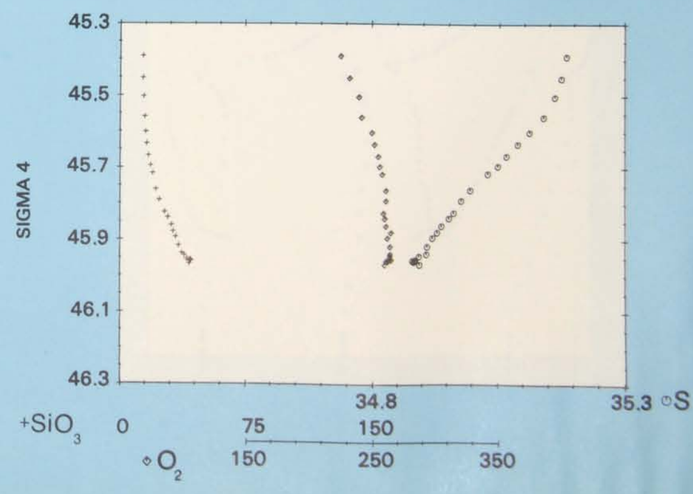
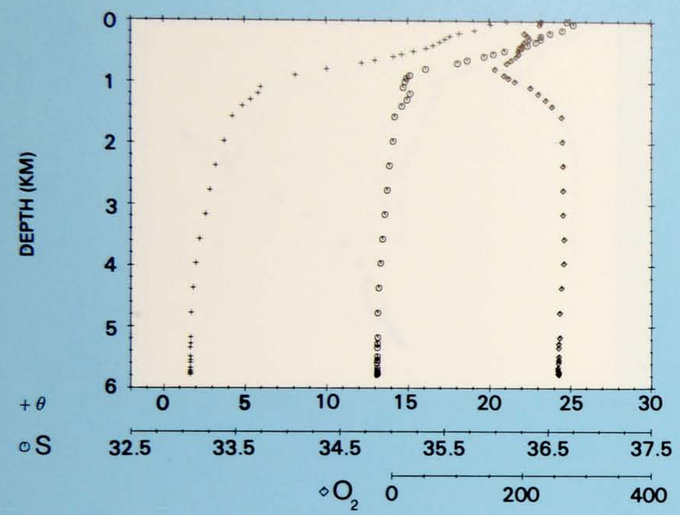
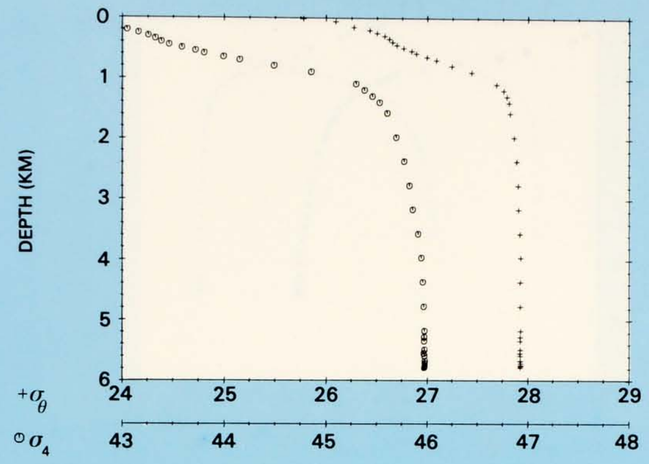


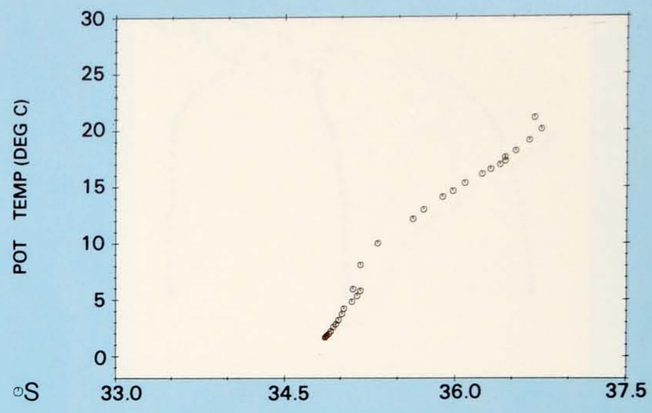
PLATE 174

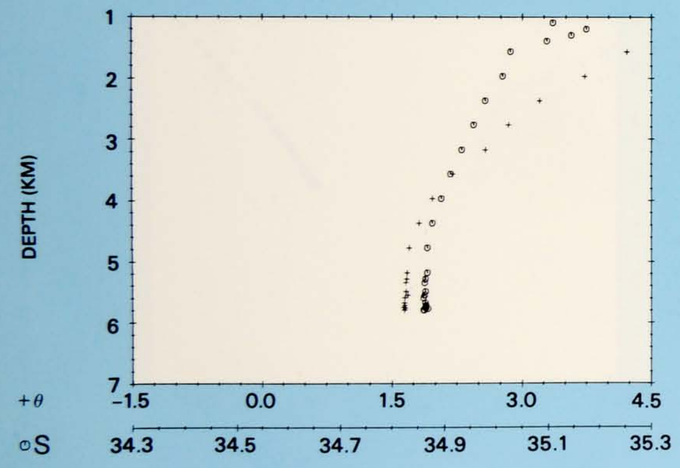
Station 119.
Latitude 31° 49′ N,
Longitude 50° 53′ W.
25 March 1973.

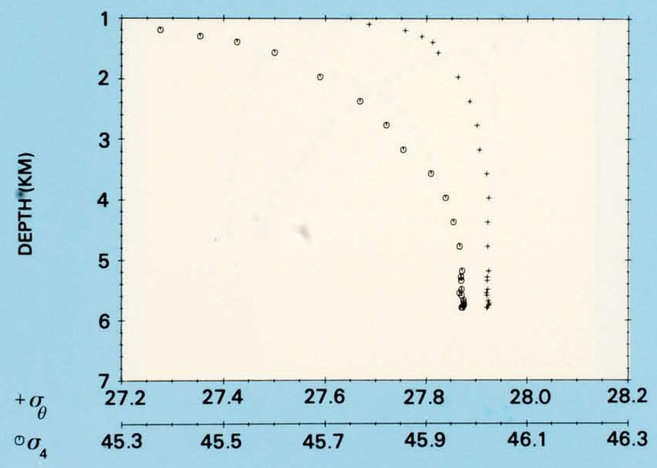
PROPERTY–PROPERTY PLOTS
STATION 119

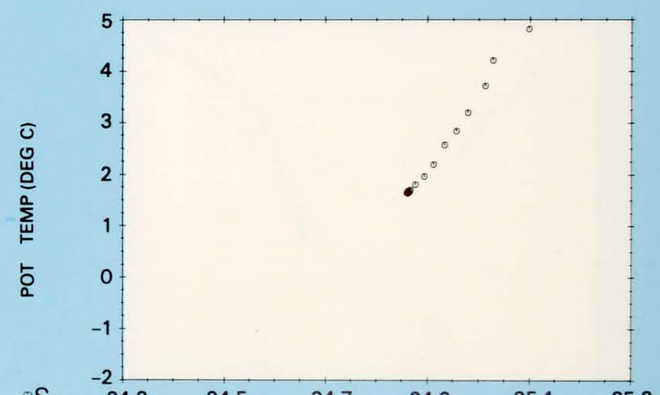


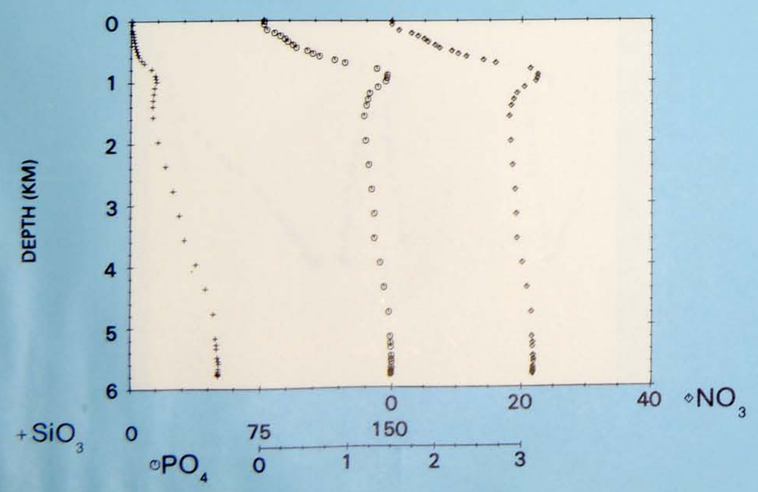


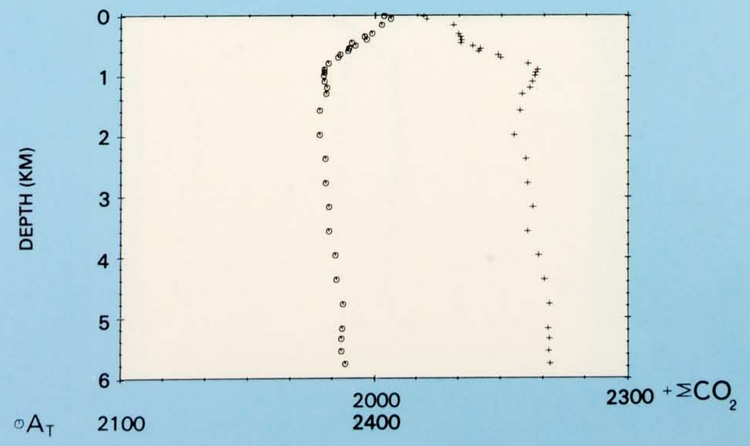


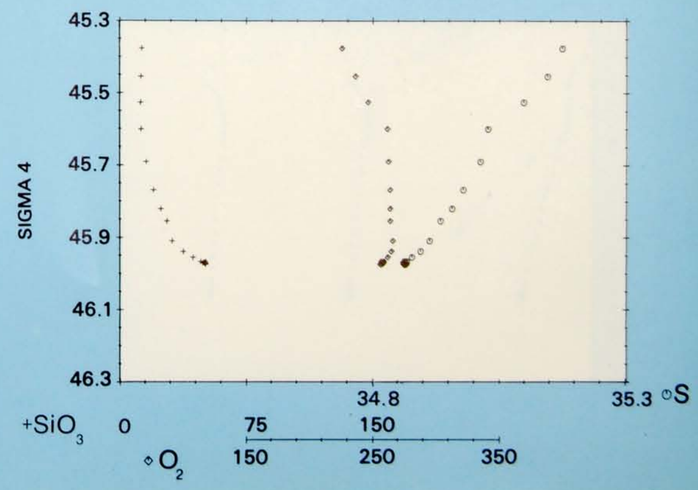








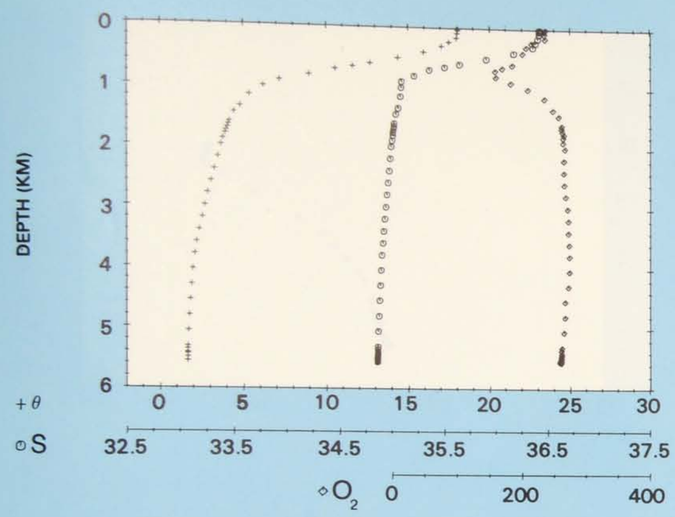


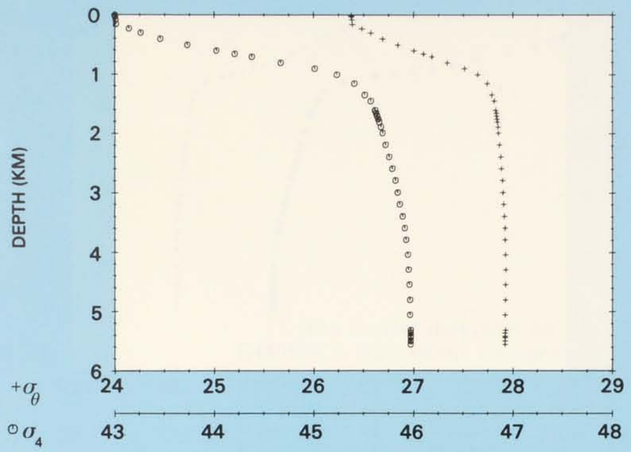


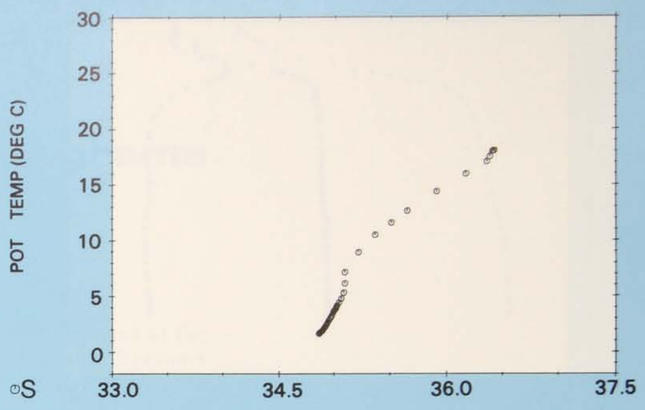
PROPERTY–PROPERTY PLOTS
STATION 120

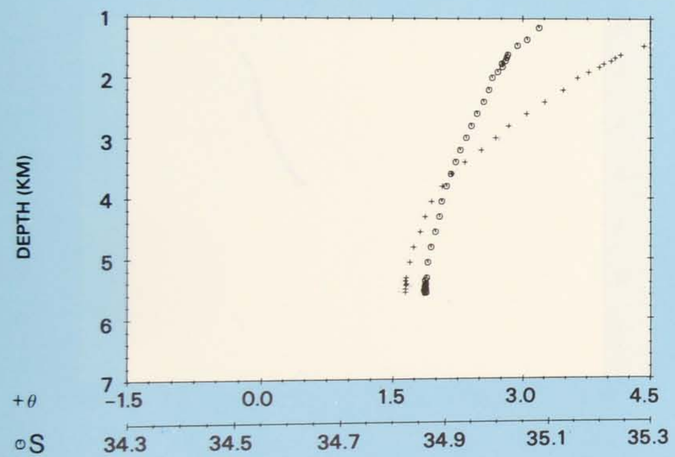
PLATE 175

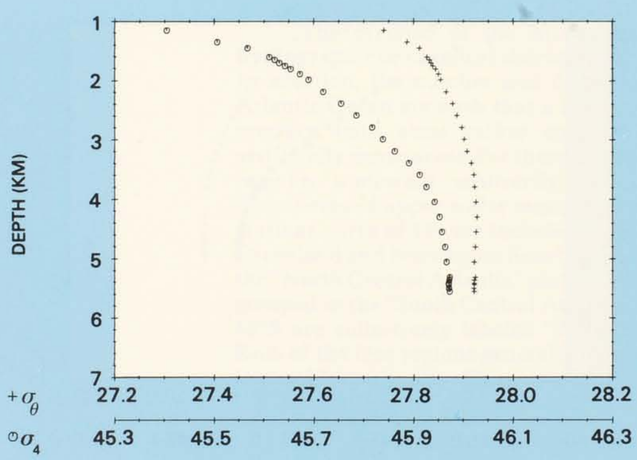
Station 120.
Latitude 33° 16′ N,
Longitude 56° 33 W.
27 March 1973.

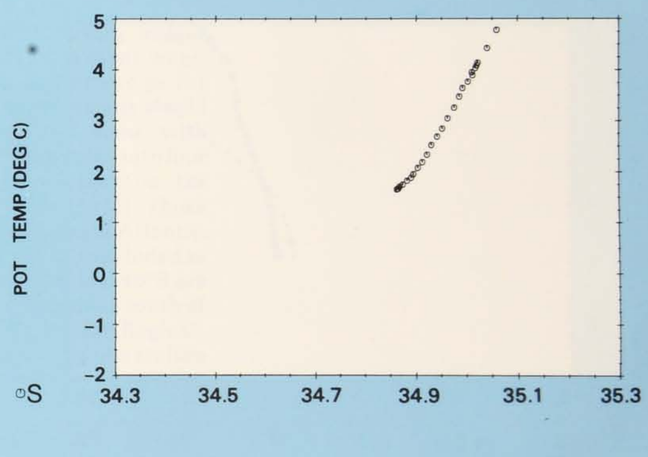


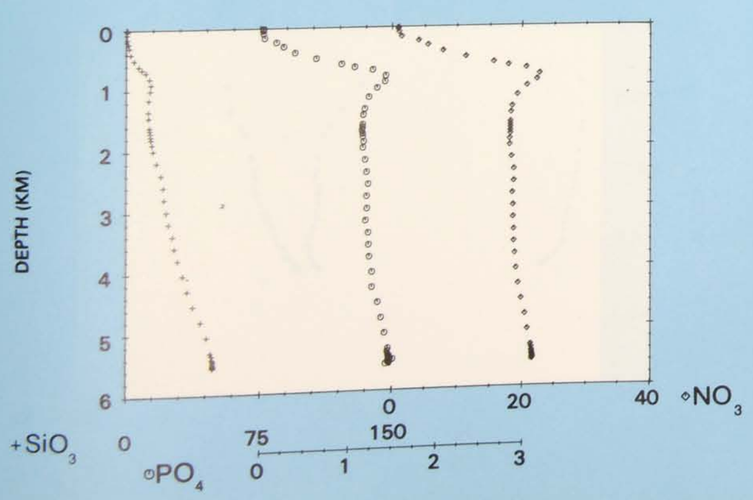


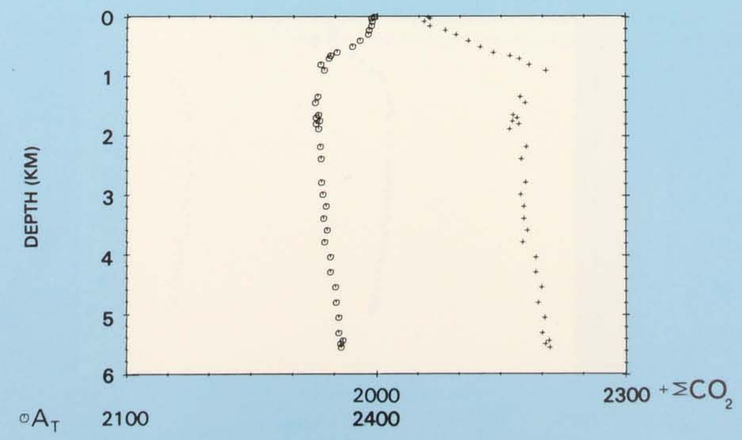












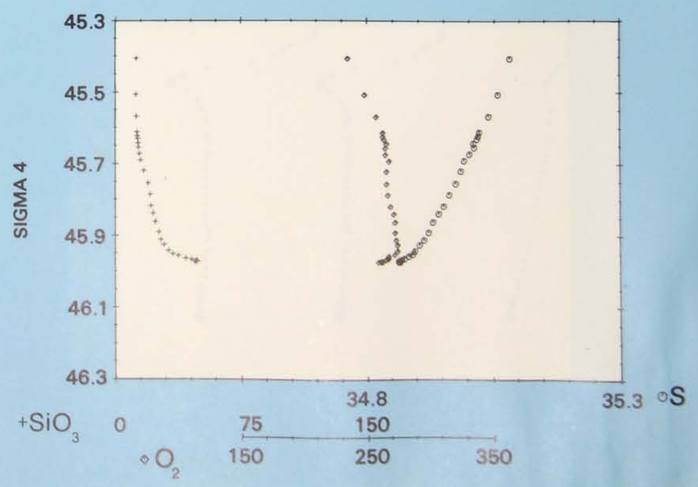
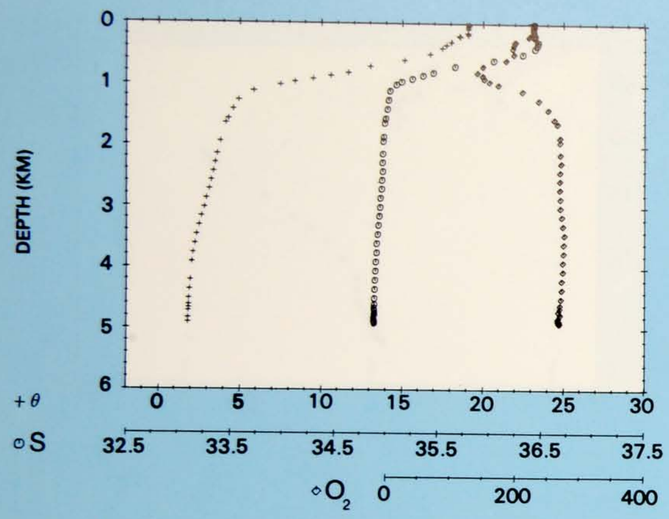
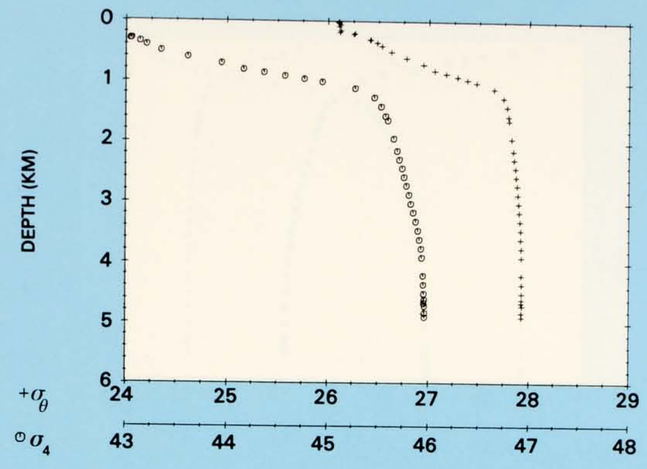


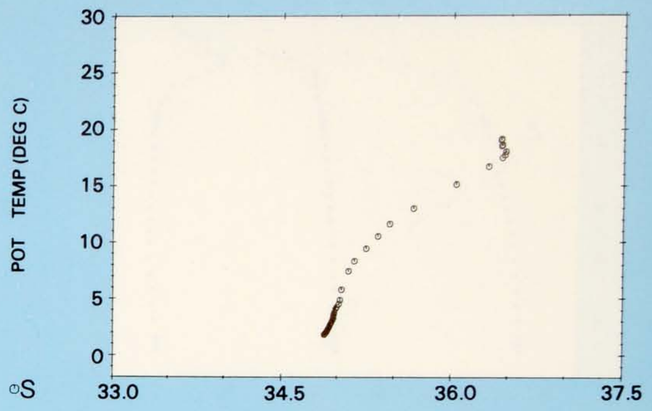
PLATE 176

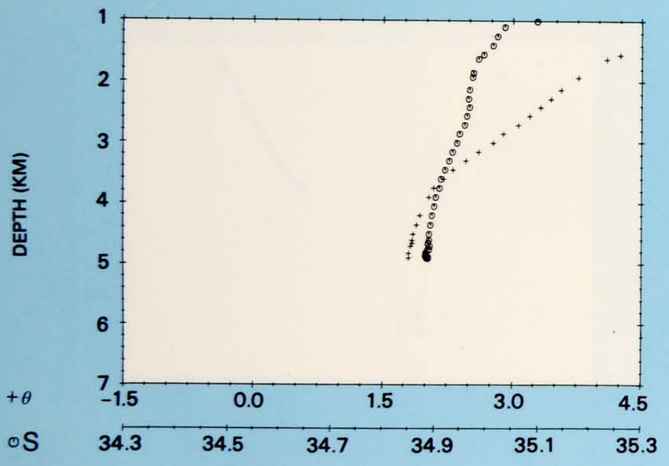
Station 121.
Latitude 35° 59′ N,
Longitude 67° 59′ W.
30 March 1973.

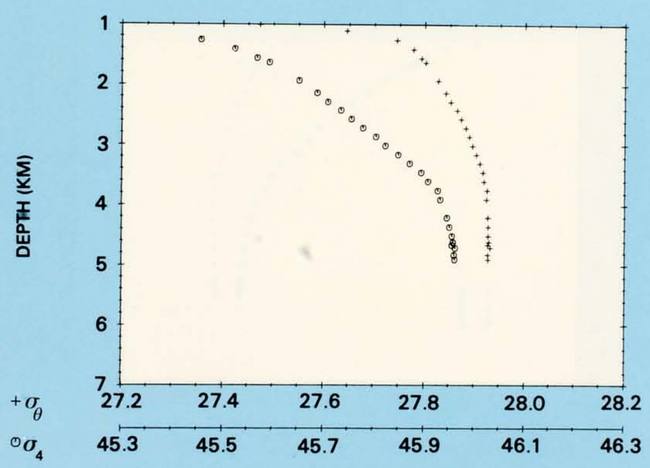
PROPERTY–PROPERTY PLOTS
STATION 121

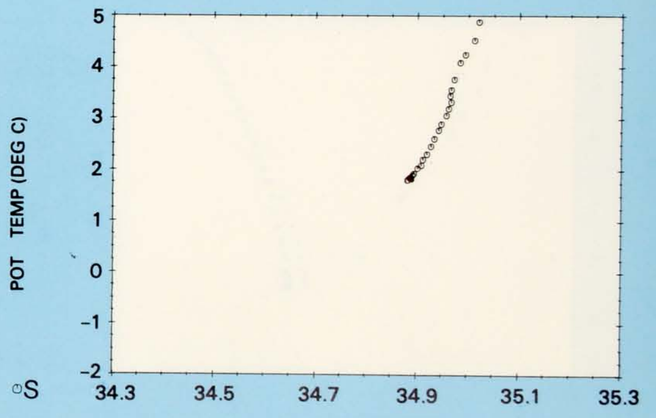


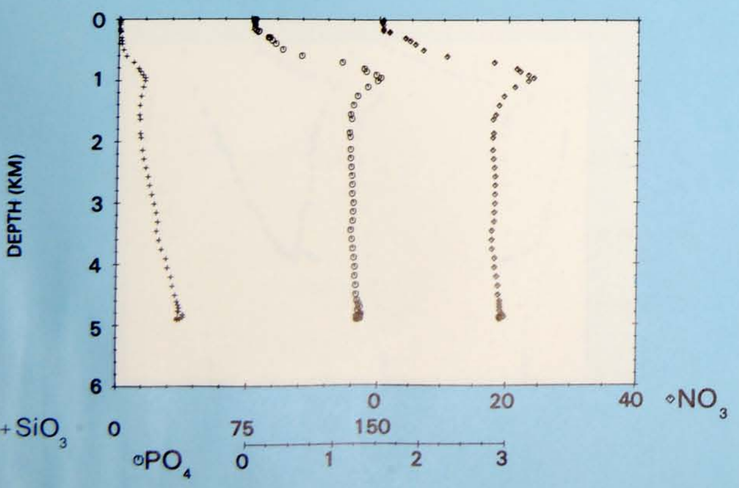


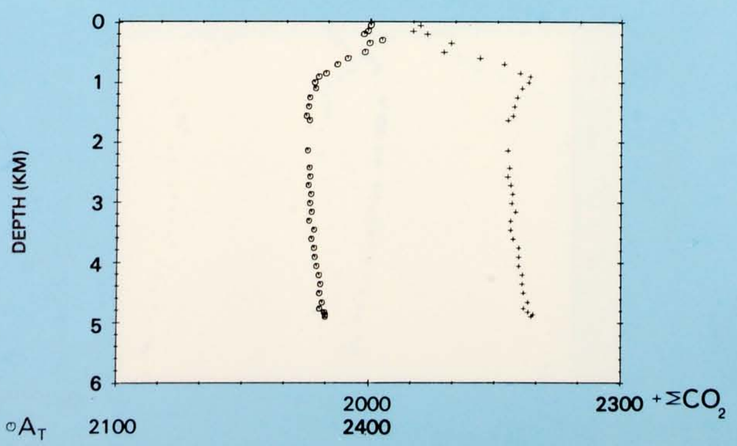


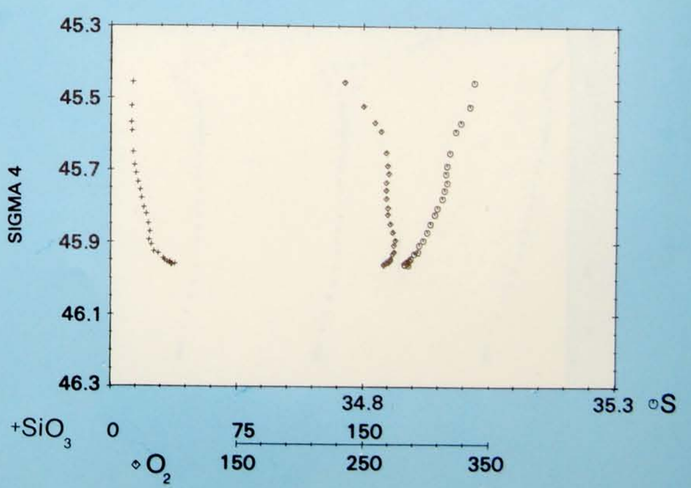












CHAPTER 3

Scatter Diagrams

The scatter diagrams on the following pages were prepared at the GEOSECS Operations Group computer facility. Two types of diagrams have been included: those on which are plotted values of two properties from all stations and depths sampled during the entire expedition, and those from all stations and depths in selected regions. A total of eight hydrographic and chemical properties were used to produce twenty-five scatter diagrams of the former type. Of these, nine property-property combinations were selected for the latter type.

The division of the Atlantic Ocean into regions having unique hydrographic or chemical characteristics can be interpreted in many ways. In addition, the number and distribution of GEOSECS stations in the Atlantic Ocean are such that a division into more than 4-5 regions would produce both some rather sparse scatter diagrams and some with artificially dense areas. For these reasons the Atlantic was divided into four regions, somewhat arbitrarily, but based for the most part on the boundaries of upper water masses given by Sverdrup *et al.*, (1942). Those stations north of 43° are included in the diagrams labeled "North Atlantic, Greenland and Norwegian Seas". The area from 10°N to 43°N is included as the "North Central Atlantic" plots. All stations between 10°N and 40°S are grouped in the "South Central Atlantic" diagrams, and all stations south of 40°S are collectively labeled "South Atlantic and Circumpolar Region". Each of the four regions generally overlaps adjacent regions by one station to provide continuity. The scales of some properties have been exanded on the regional scatter diagrams to amplify details in the deep water.

Reference

H.U. Sverdrup, M.W. Johnson, and R.H. Fleming, *The Oceans; Their Physics, Chemistry, and General Biology*, Prentice-Hall, Englewood Cliffs, N.J. (1942).

SCATTER DIAGRAMS

PLATE 177
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

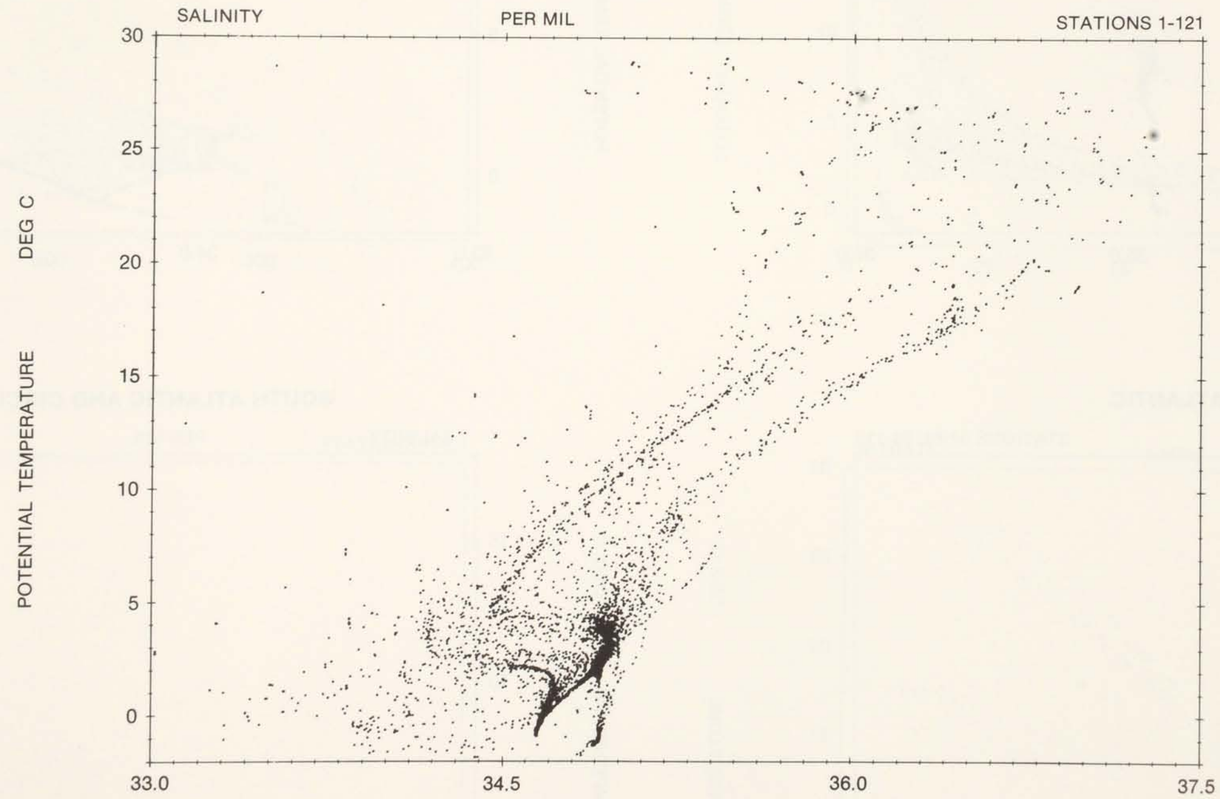
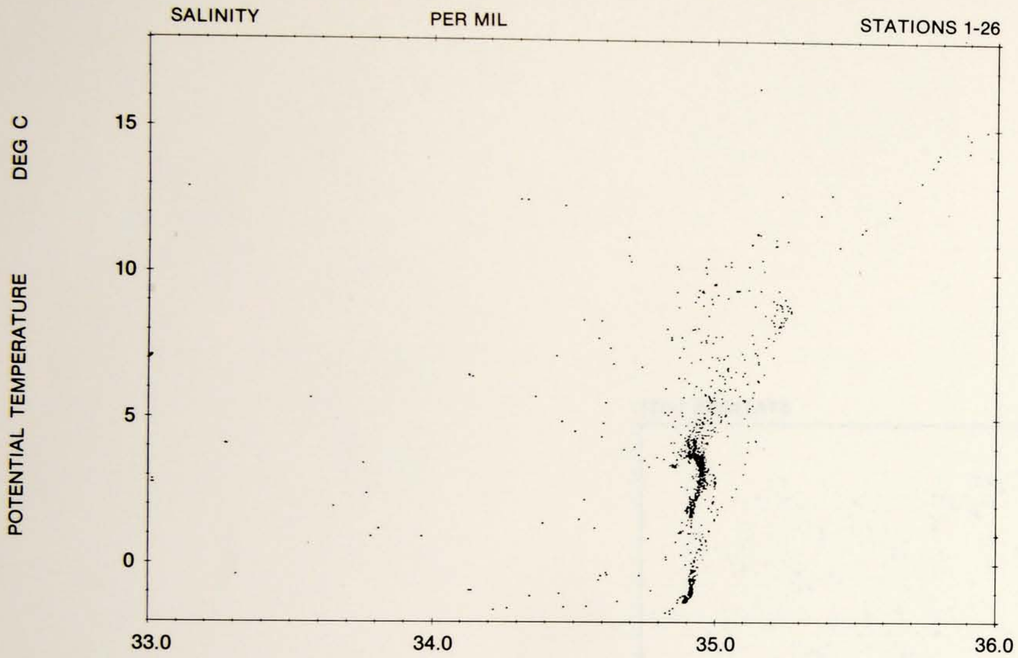


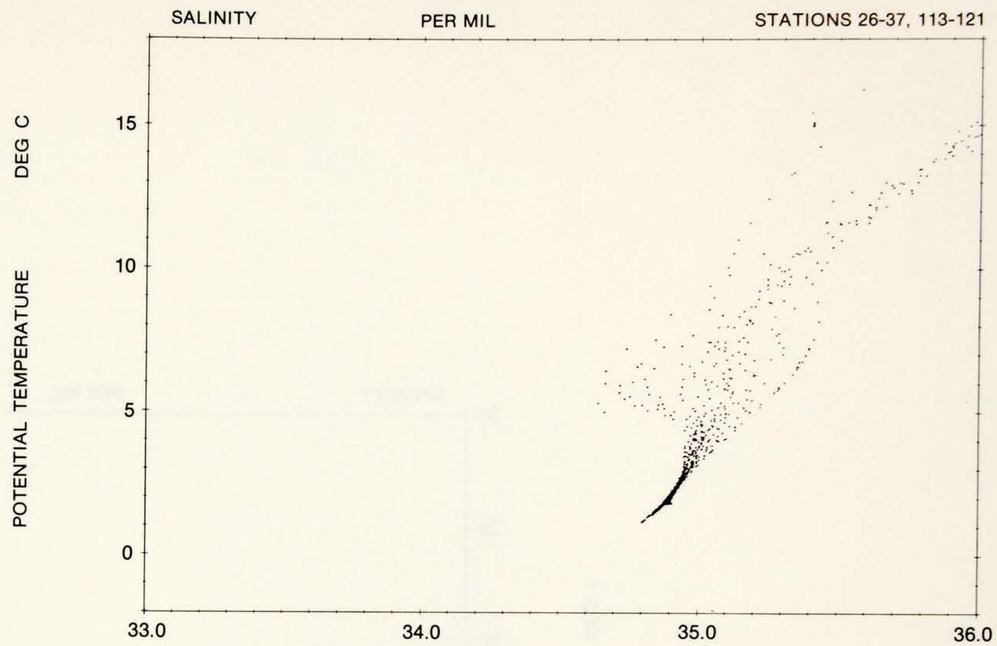
PLATE 178
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

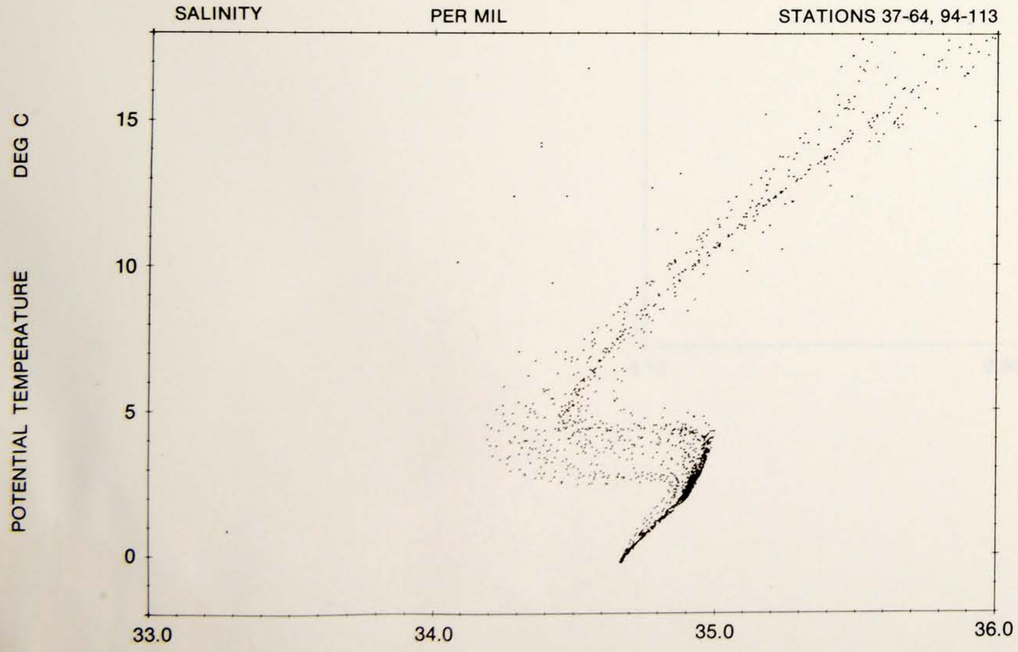
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



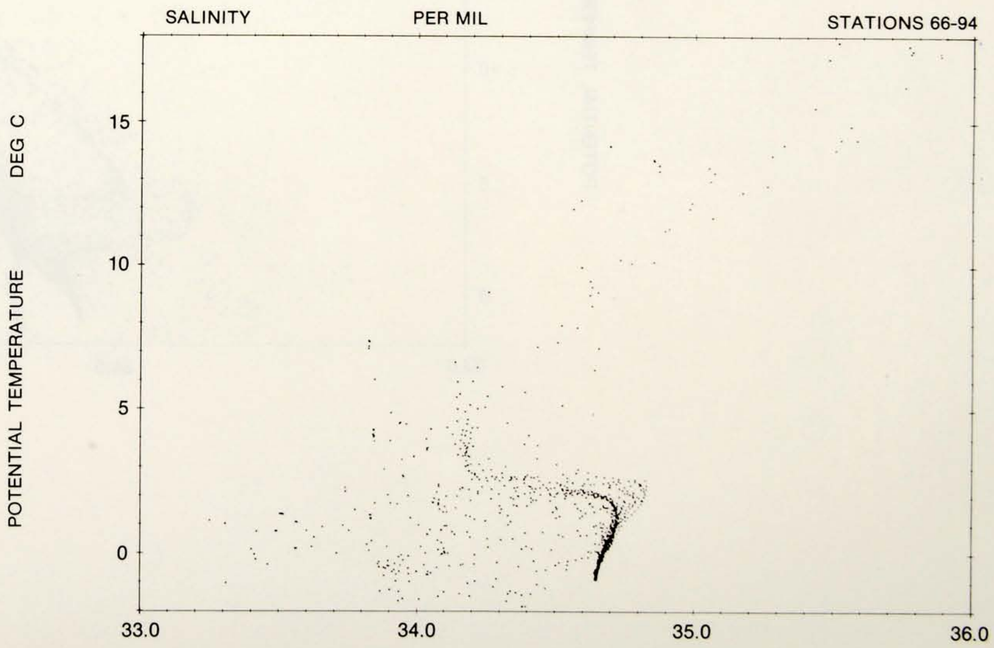
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC

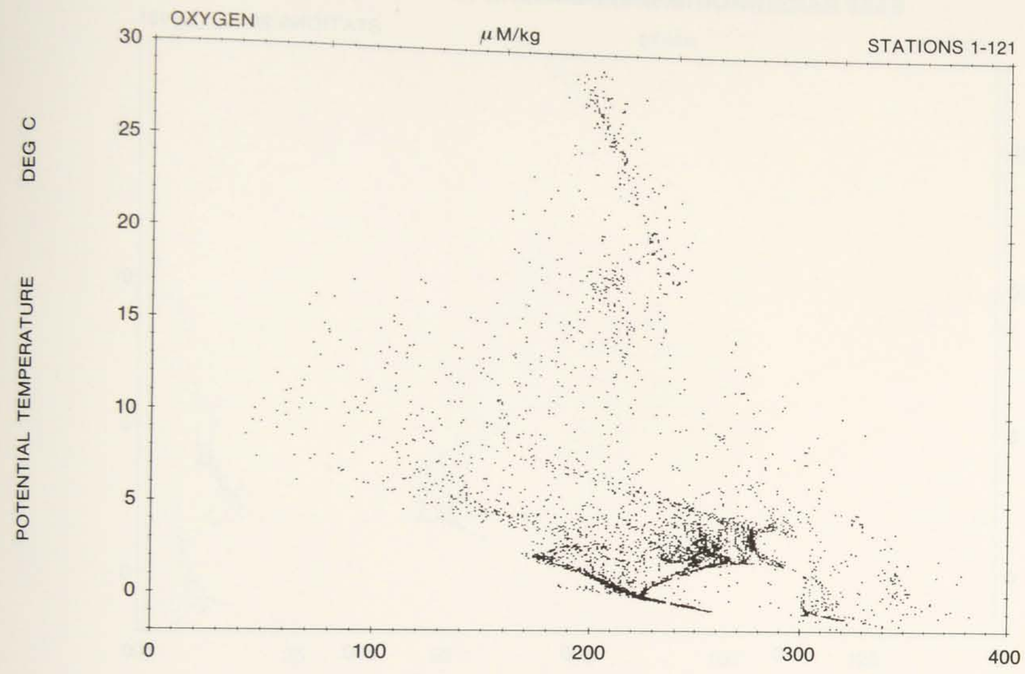


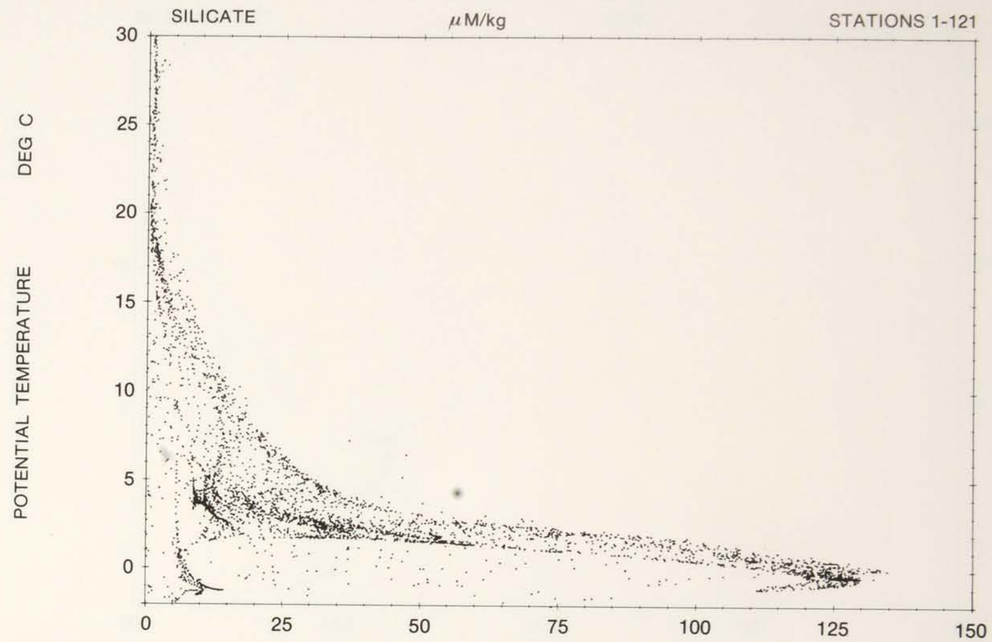
SOUTH ATLANTIC AND CIRCUMPOLAR REGION

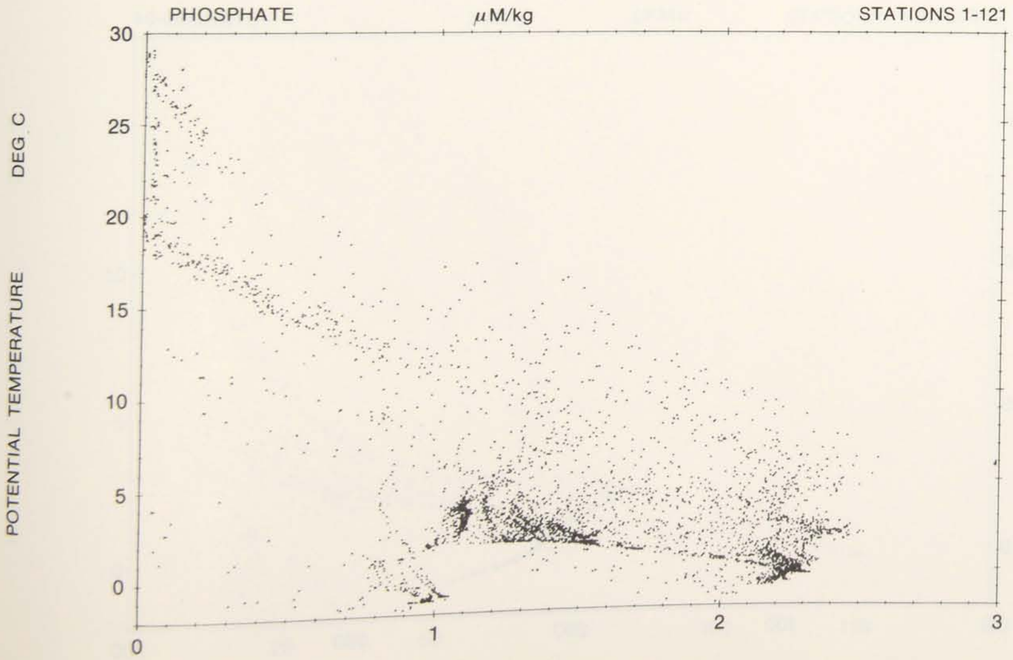


SCATTER DIAGRAMS

PLATE 179
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973







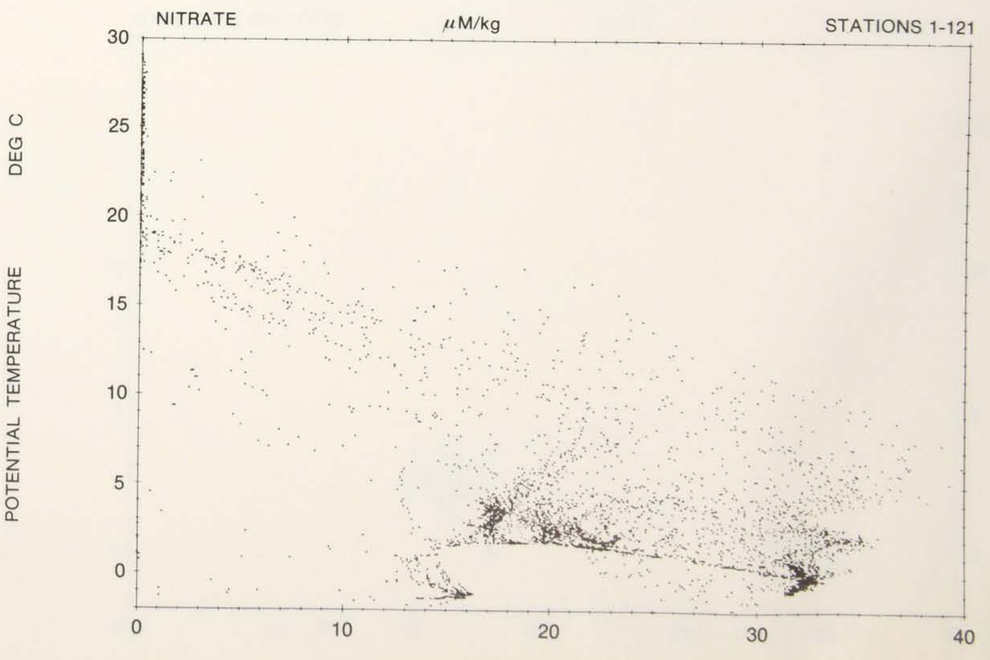
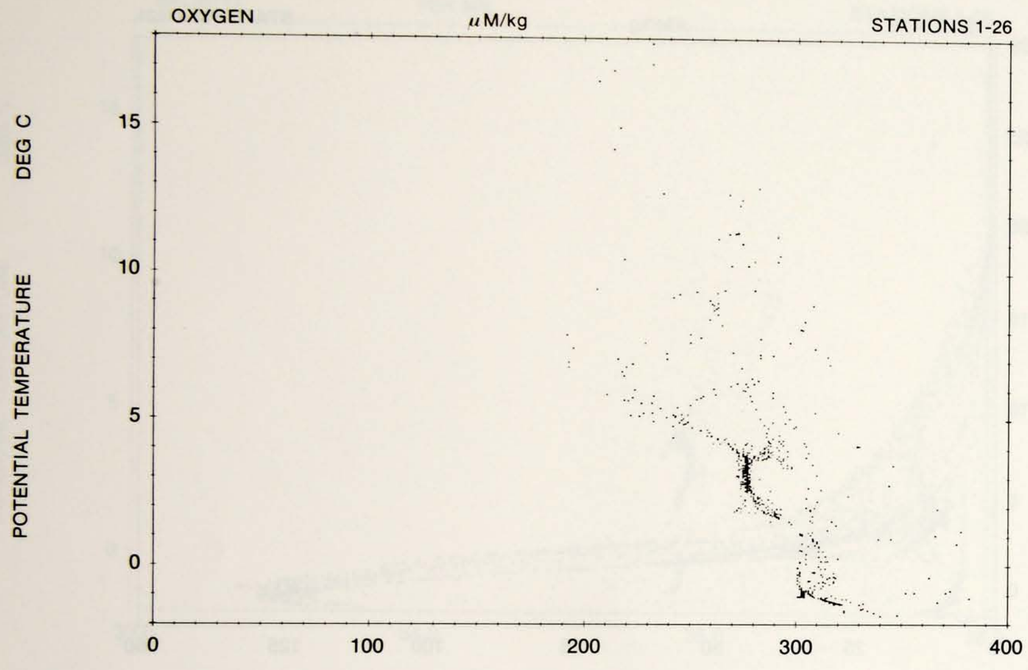


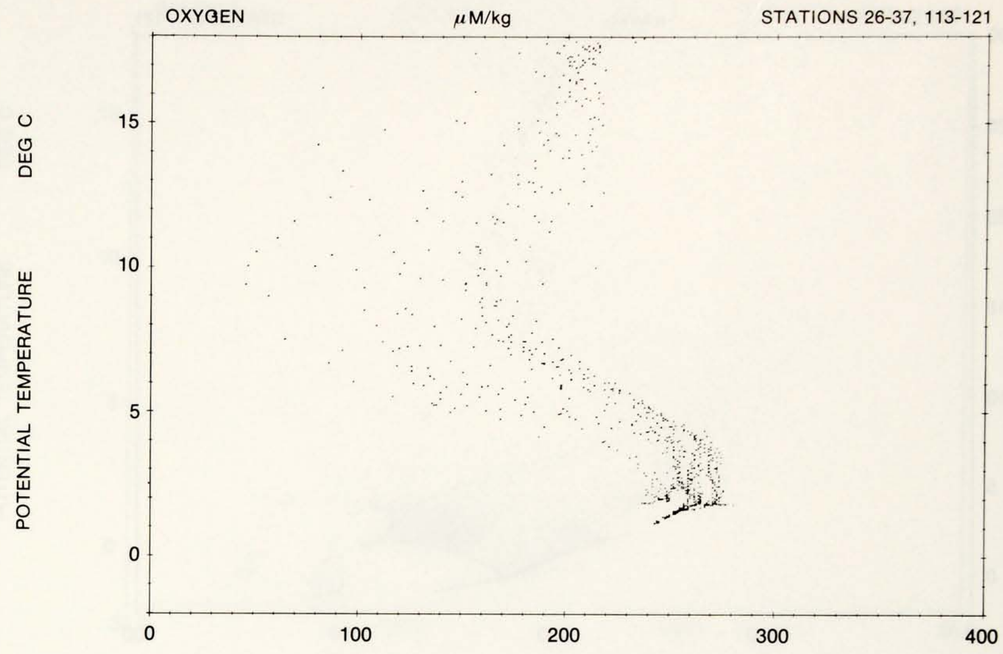
PLATE 180
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

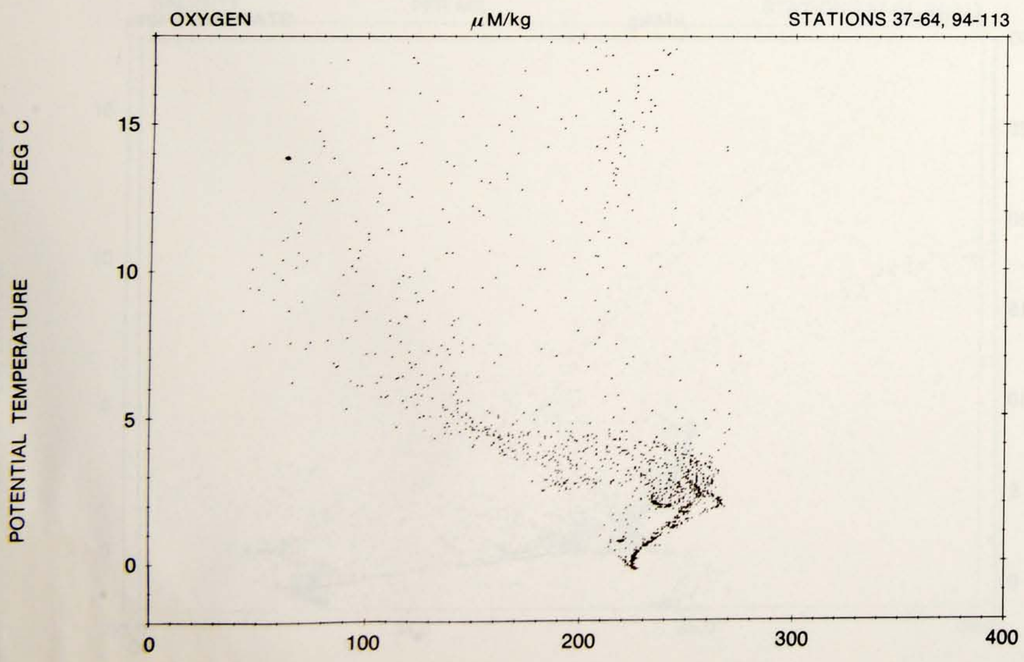
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



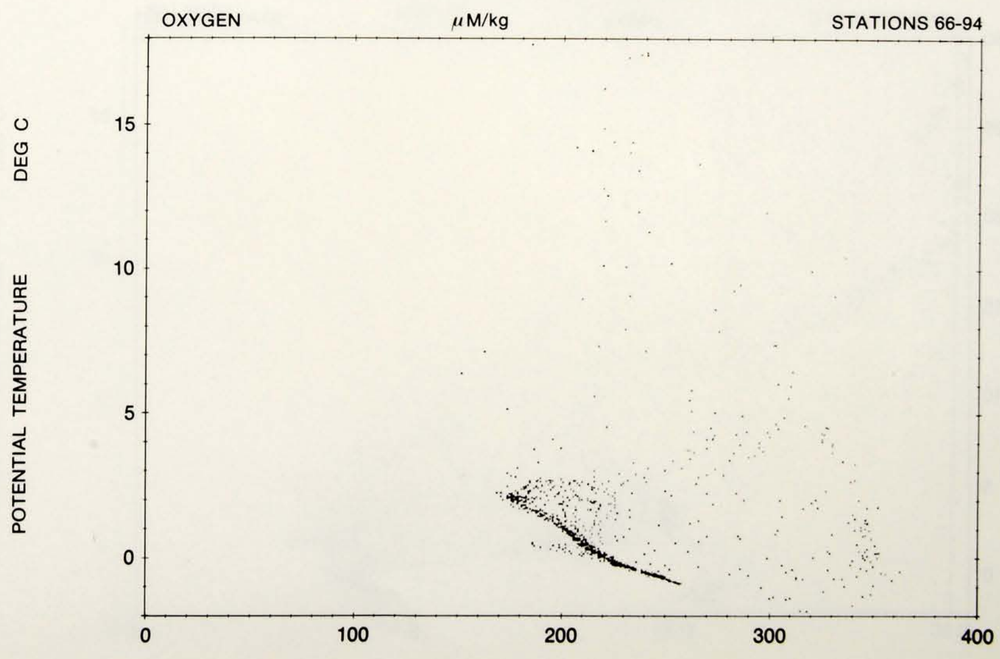
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC



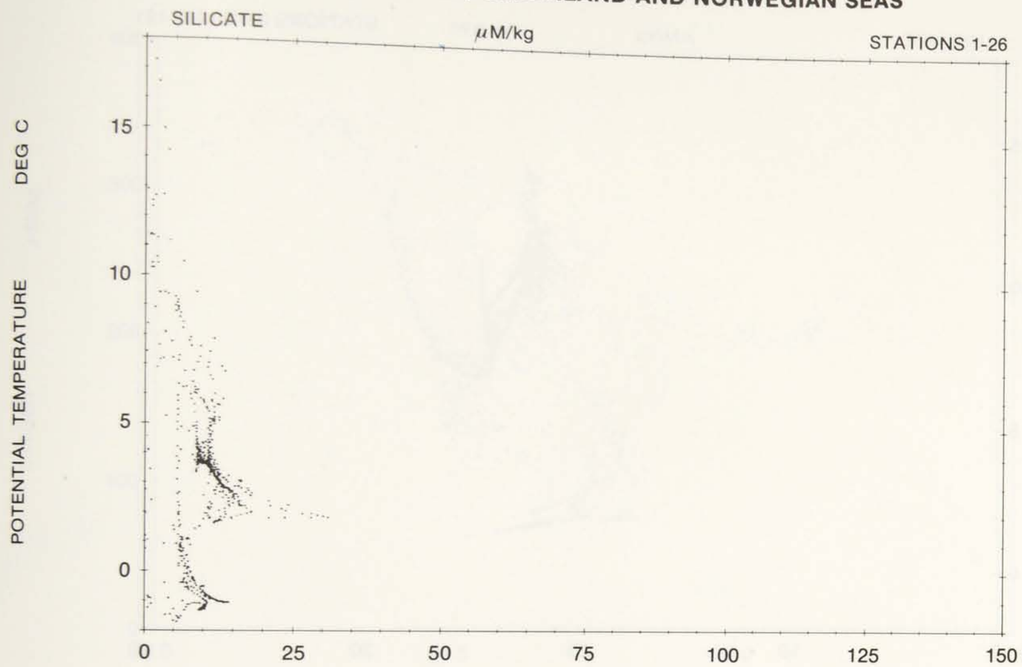
SOUTH ATLANTIC AND CIRCUMPOLAR REGION



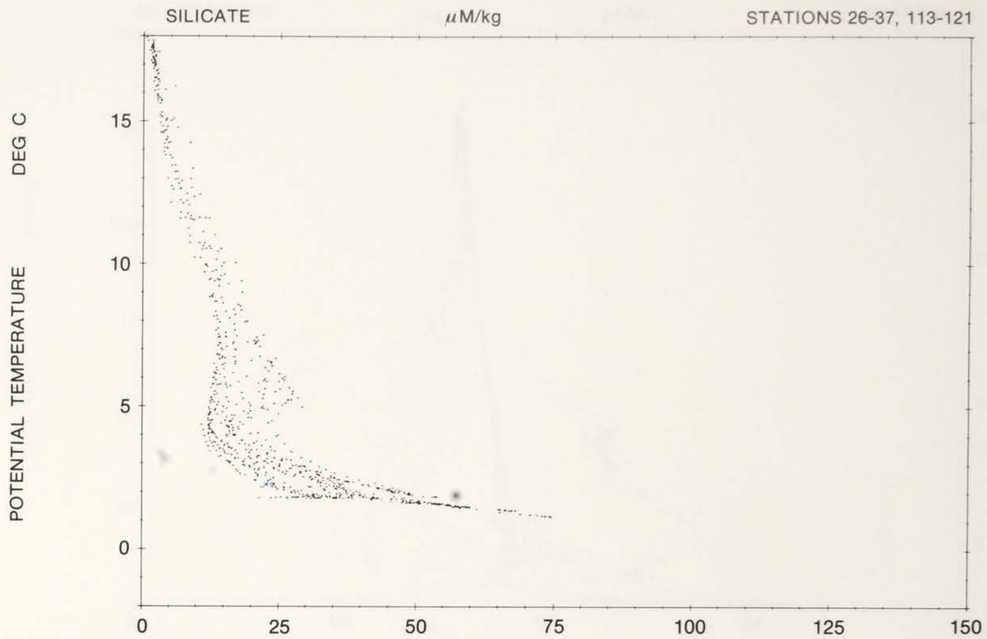
SCATTER DIAGRAMS

PLATE 181
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

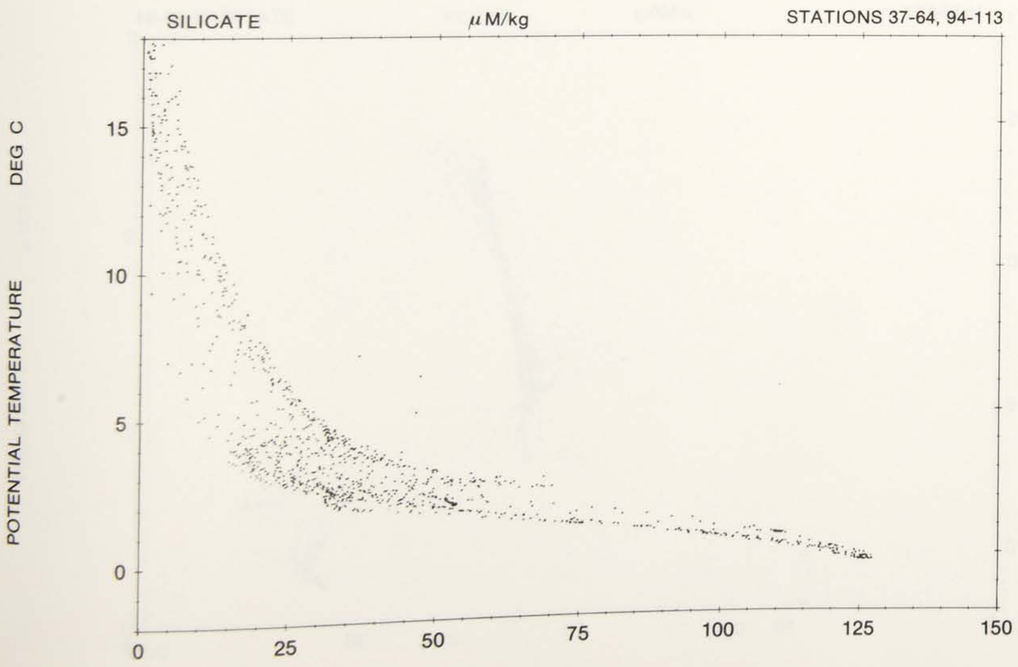
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC



SOUTH ATLANTIC AND CIRCUMPOLAR REGION

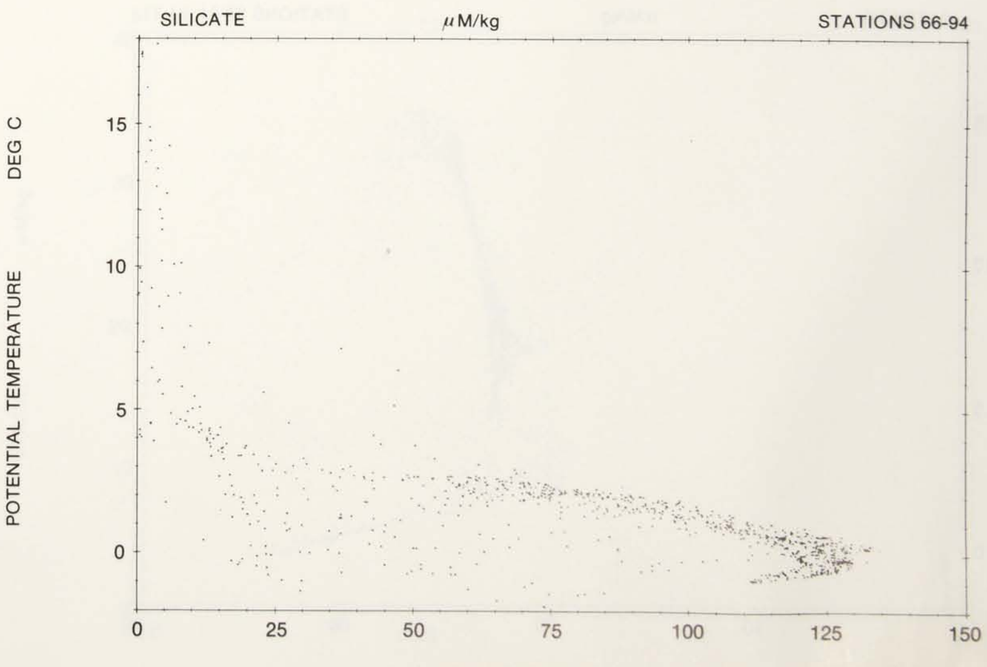
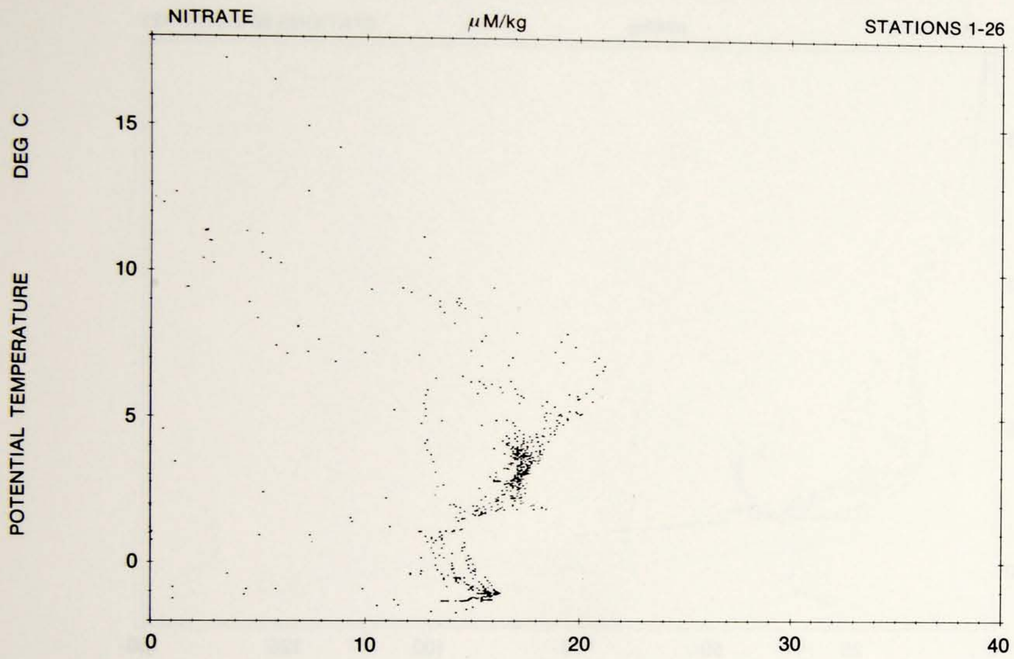


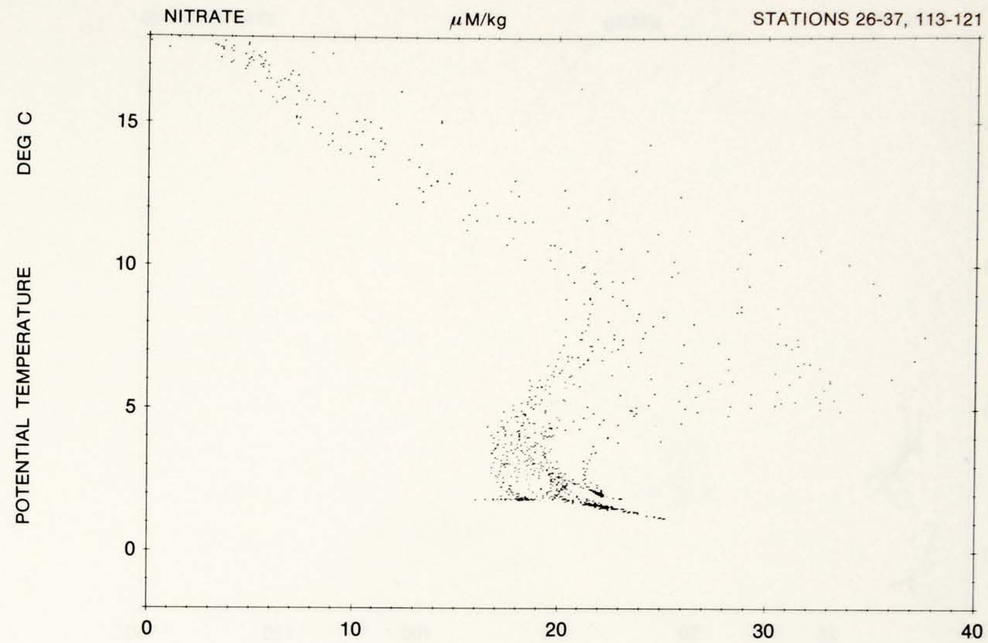
PLATE 182
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

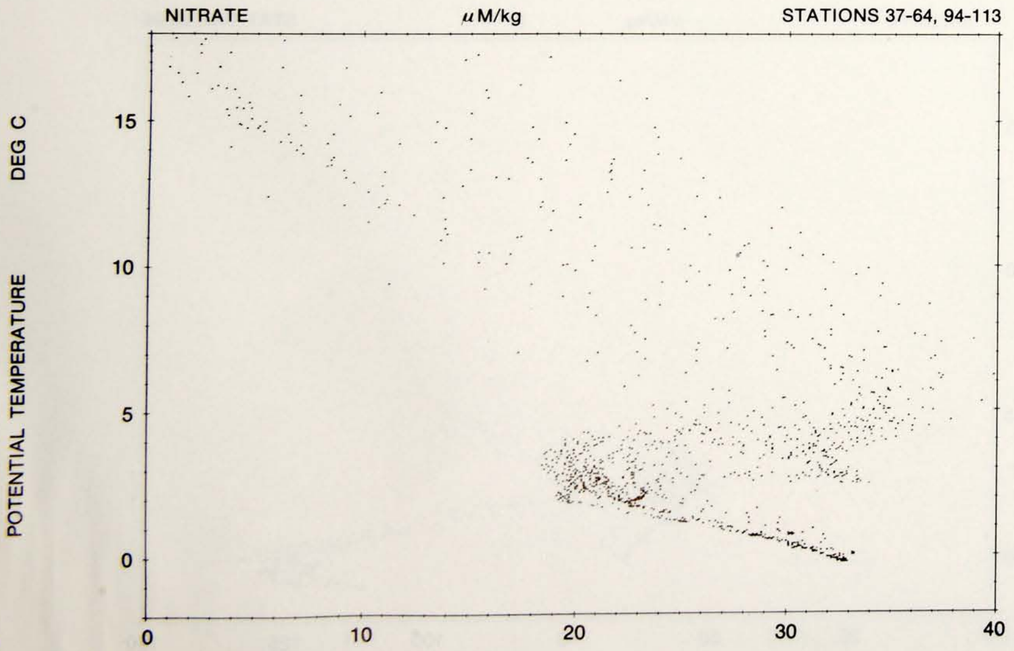
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



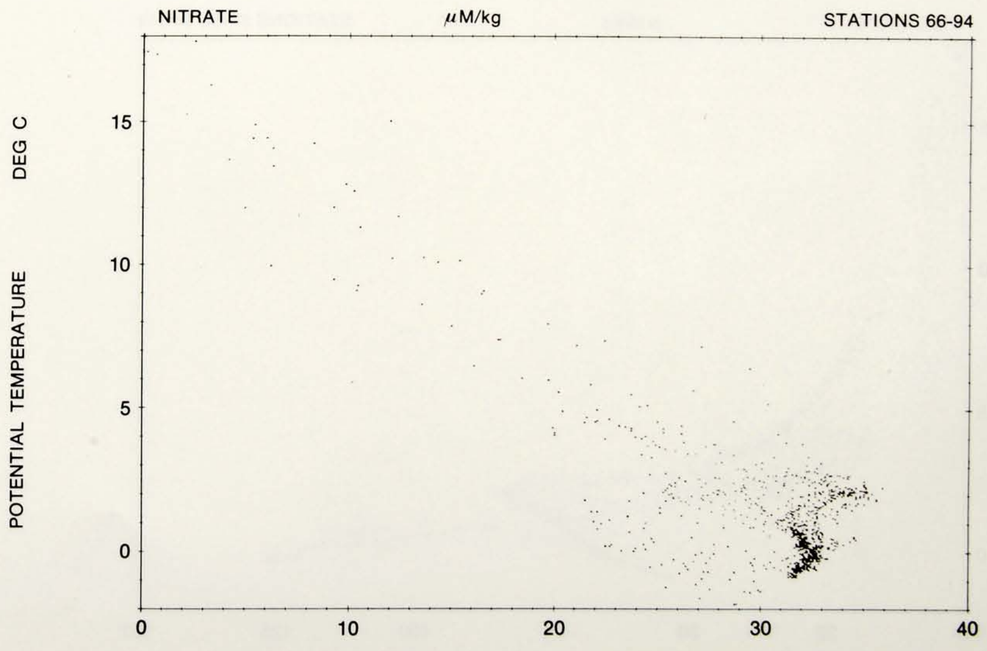
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC

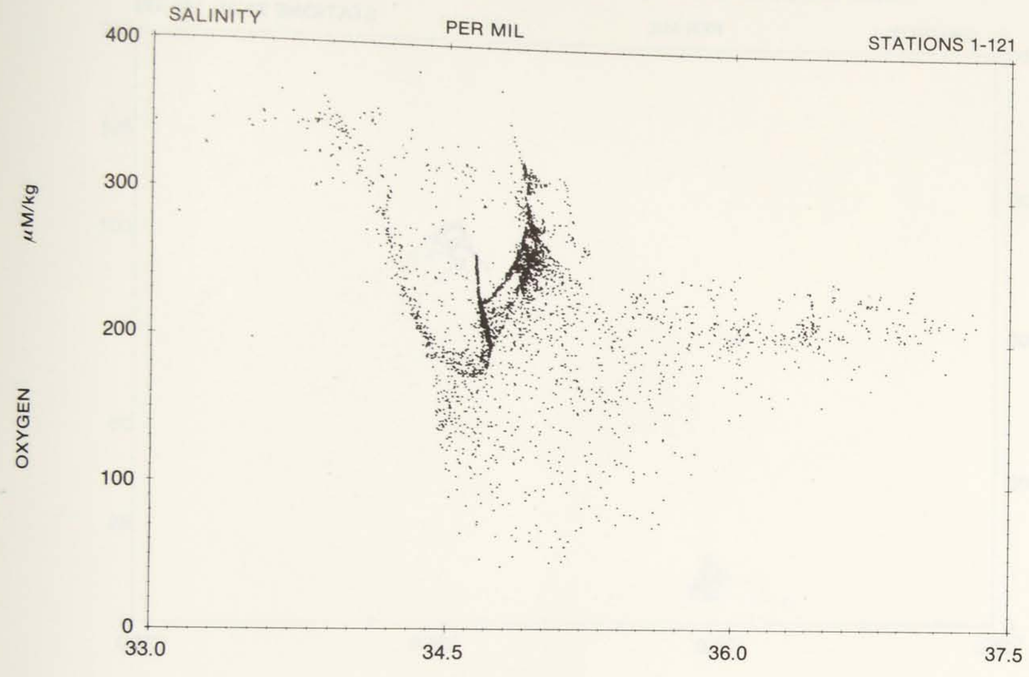


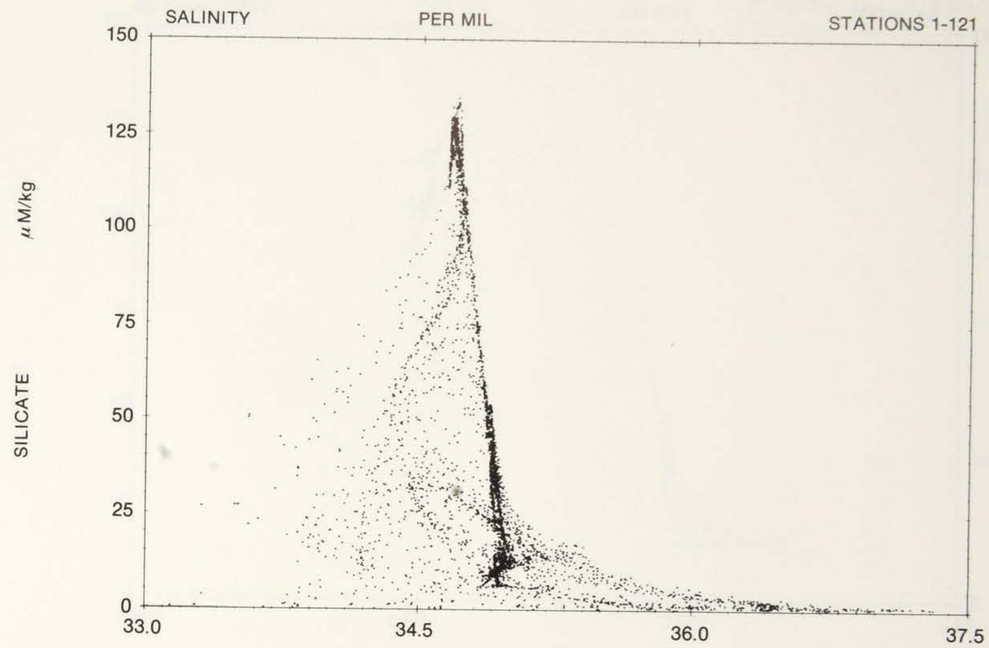
SOUTH ATLANTIC AND CIRCUMPOLAR REGION

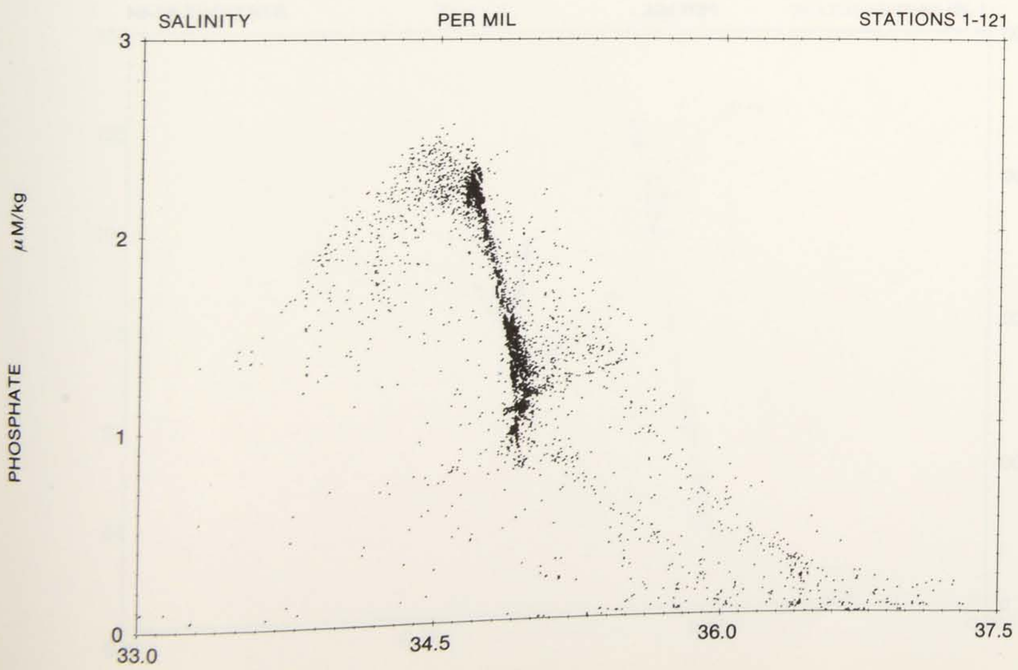


SCATTER DIAGRAMS

PLATE 183
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973







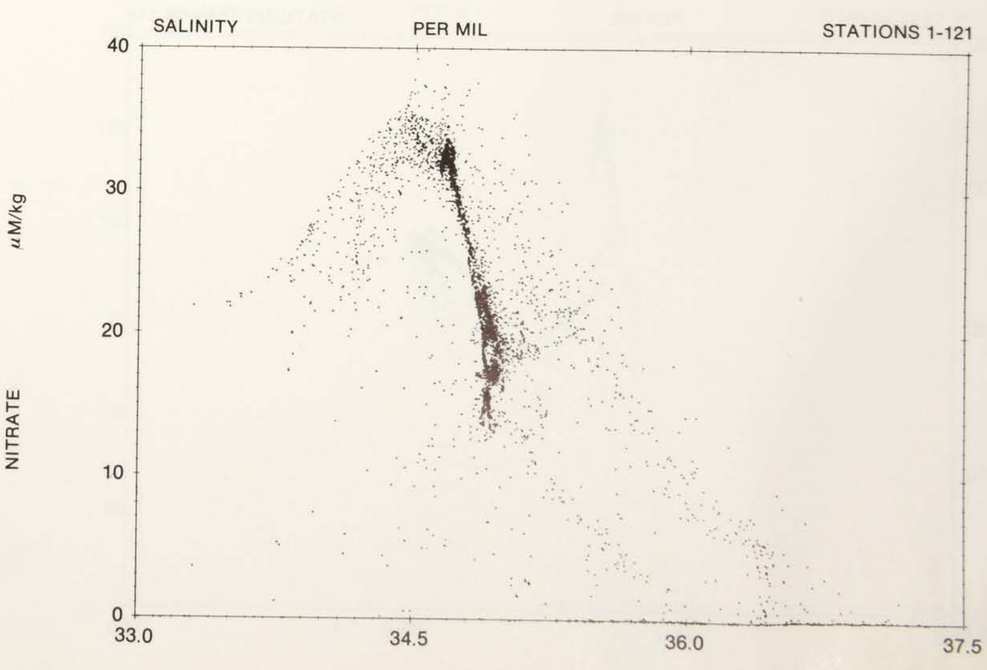
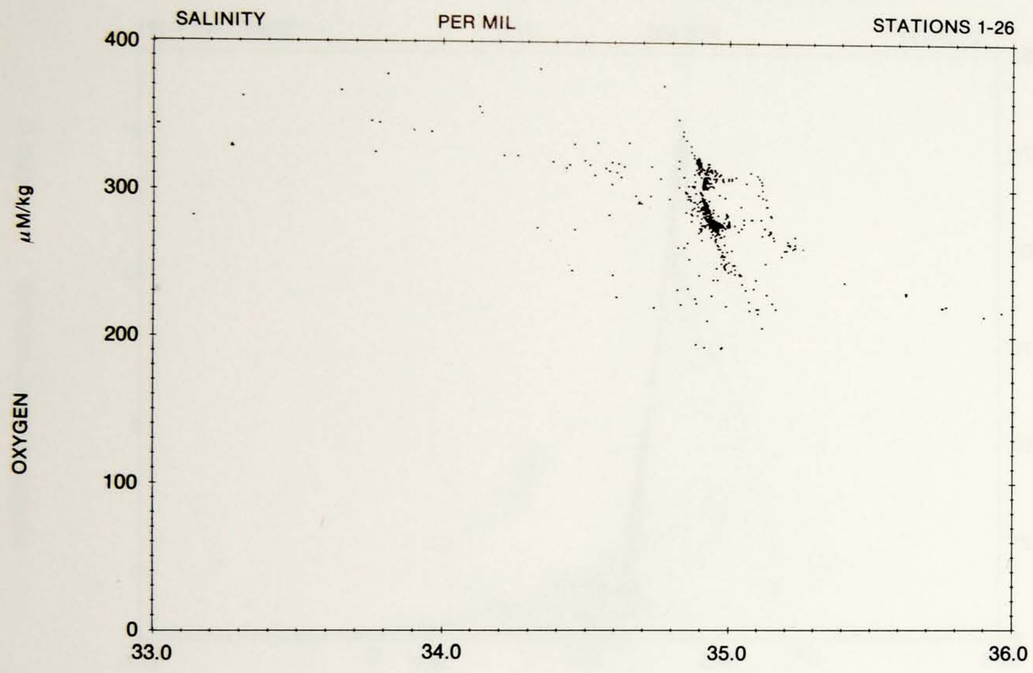


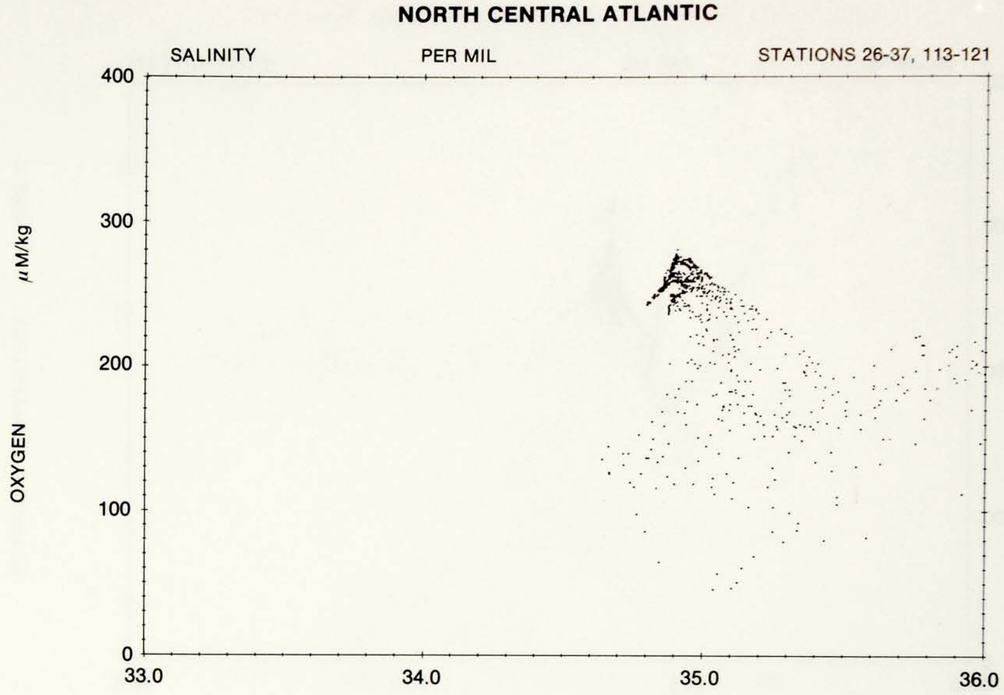
PLATE 184
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

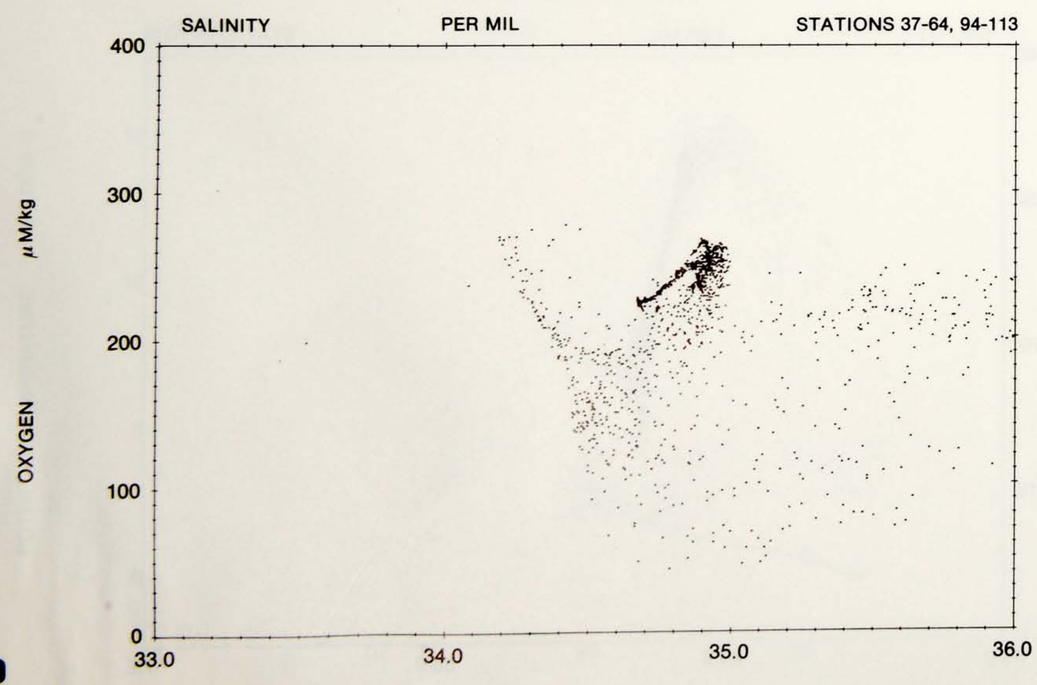
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



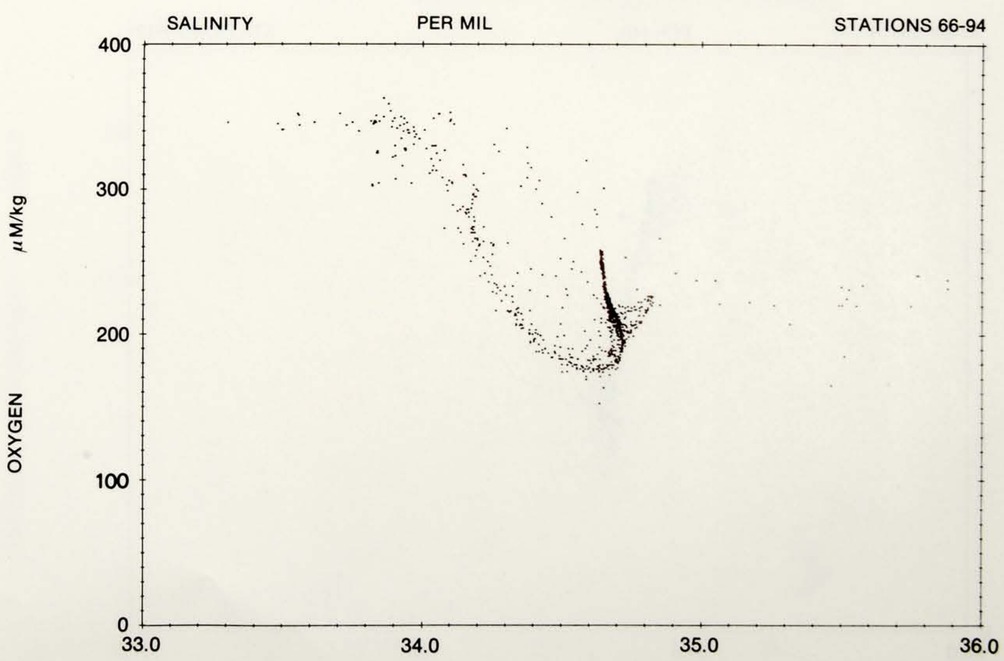
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC



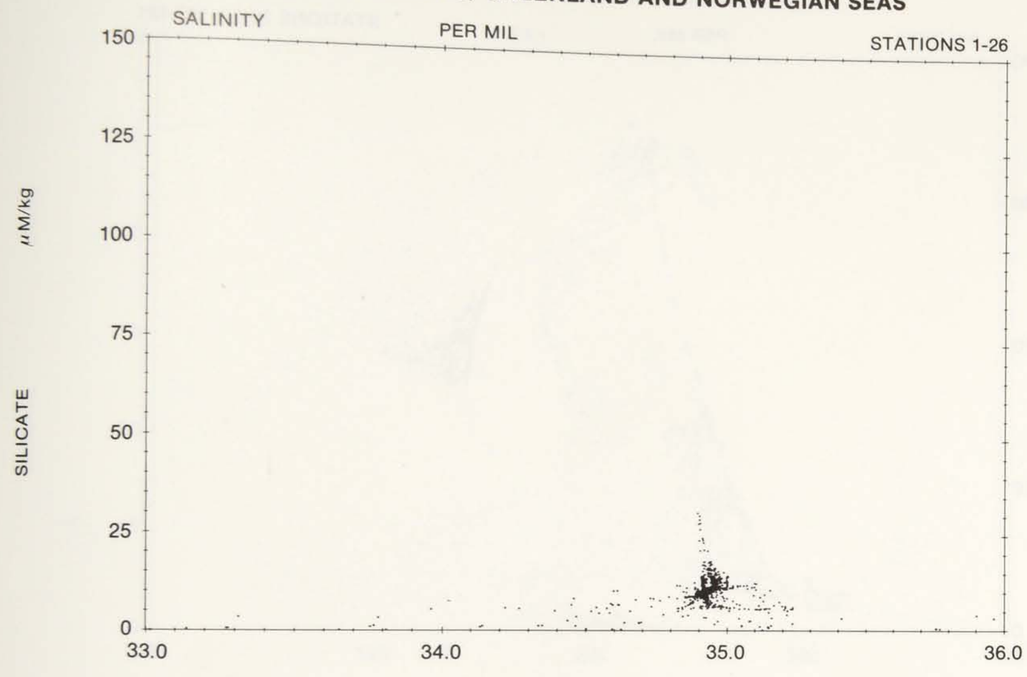
SOUTH ATLANTIC AND CIRCUMPOLAR REGION



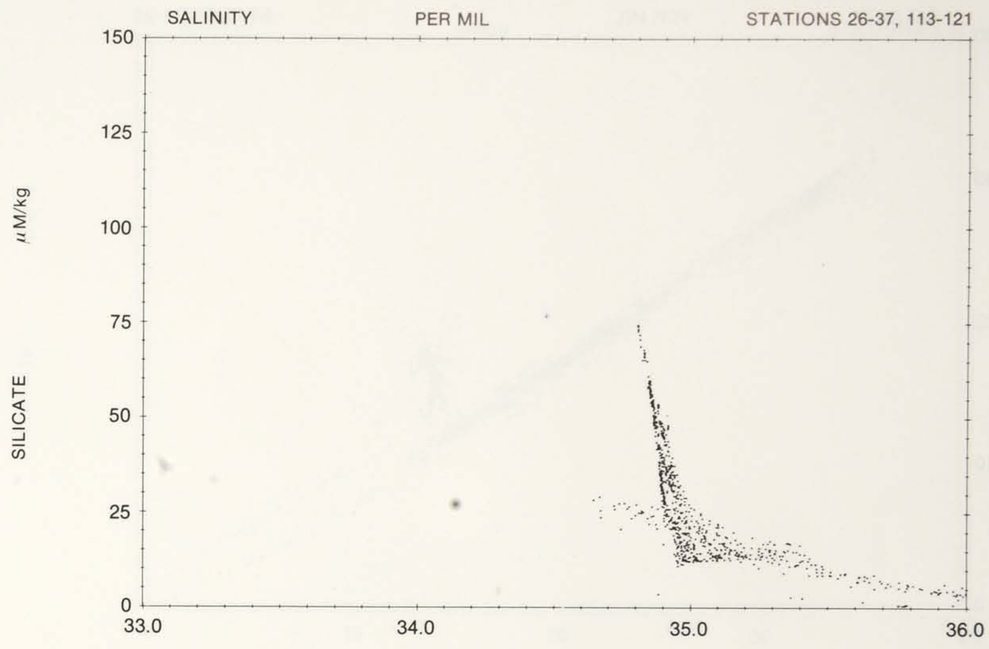
SCATTER DIAGRAMS

PLATE 185
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



NORTH CENTRAL ATLANTIC



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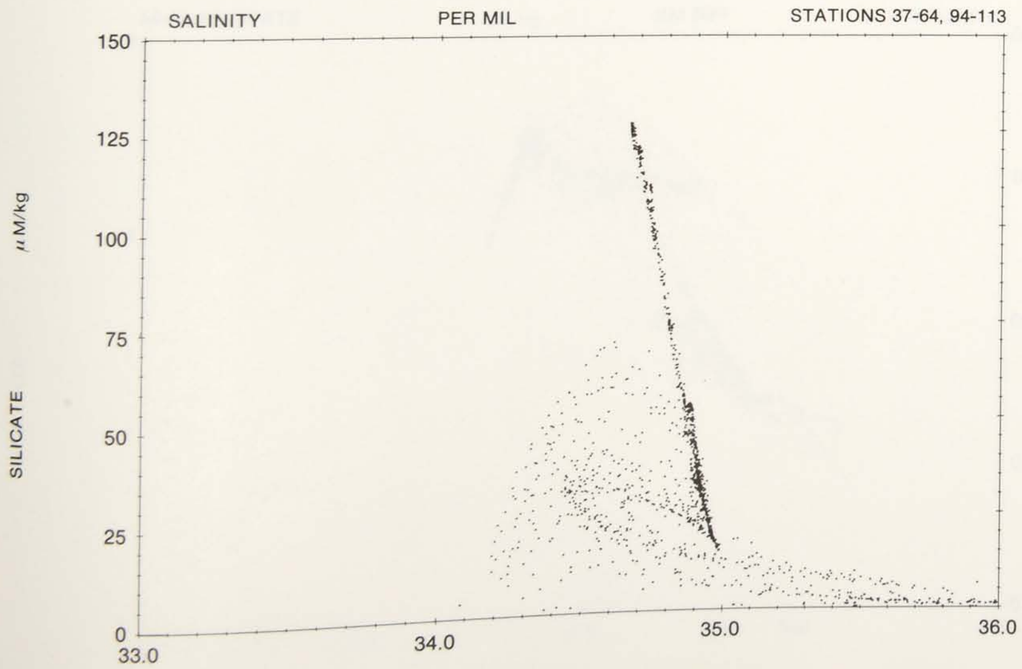


SOUTH ATLANTIC AND CIRCUMPOLAR REGION

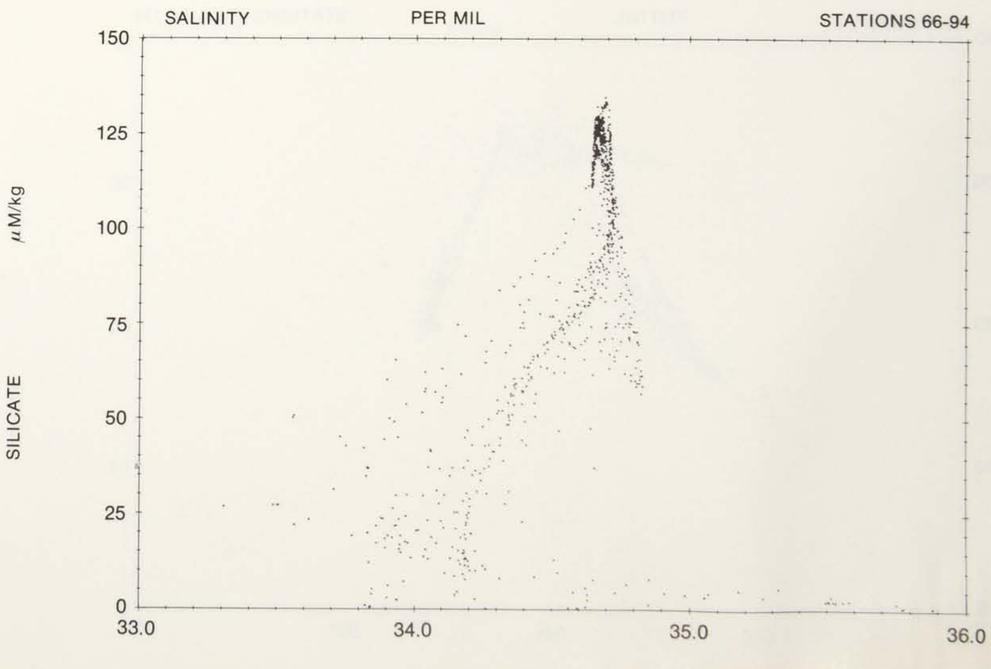
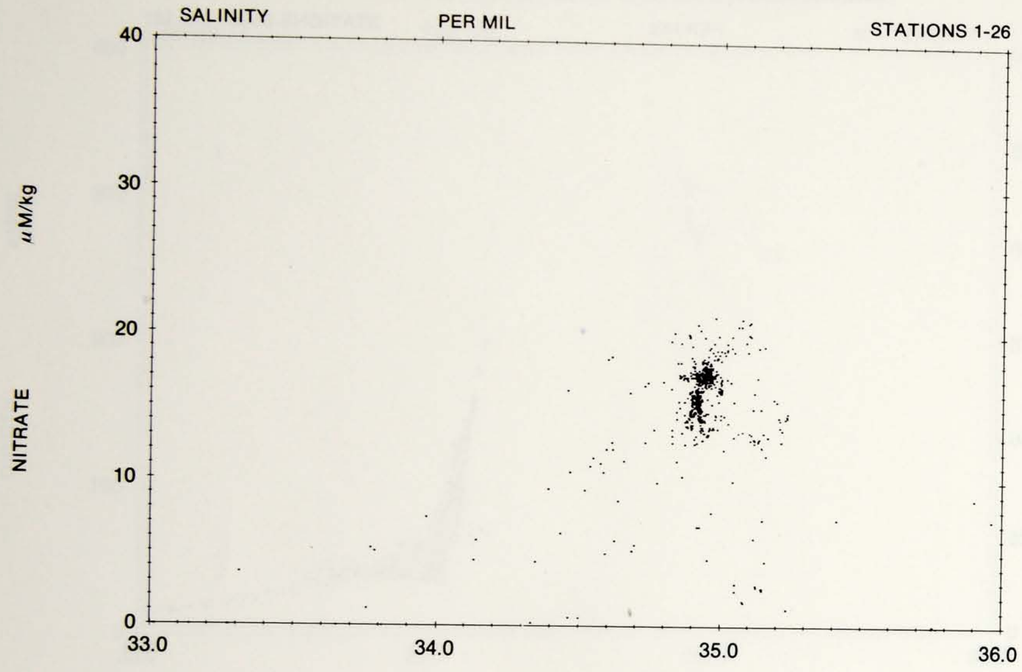


PLATE 186
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



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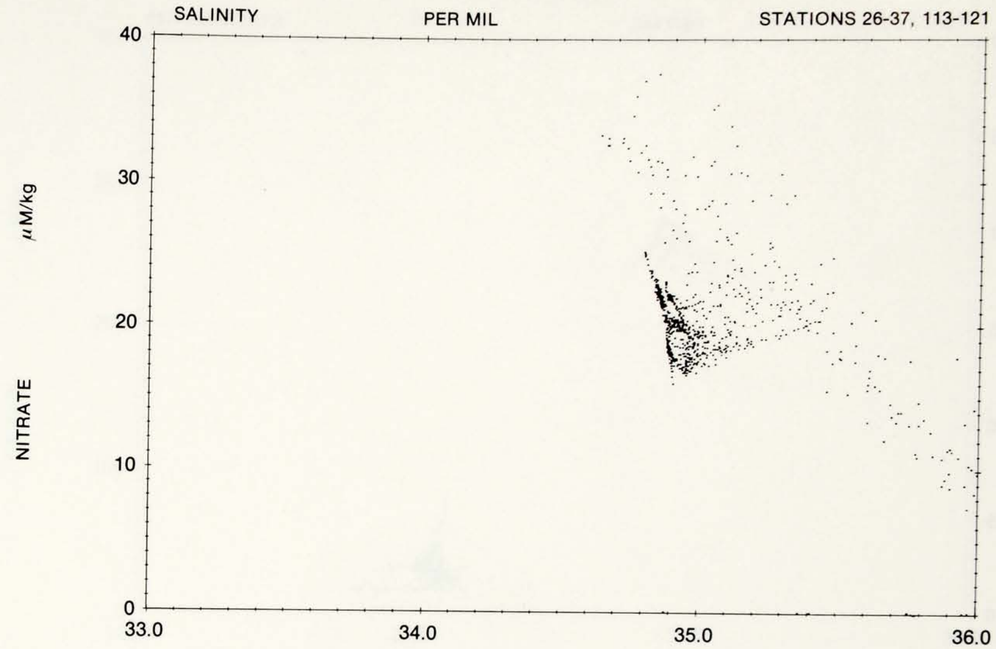

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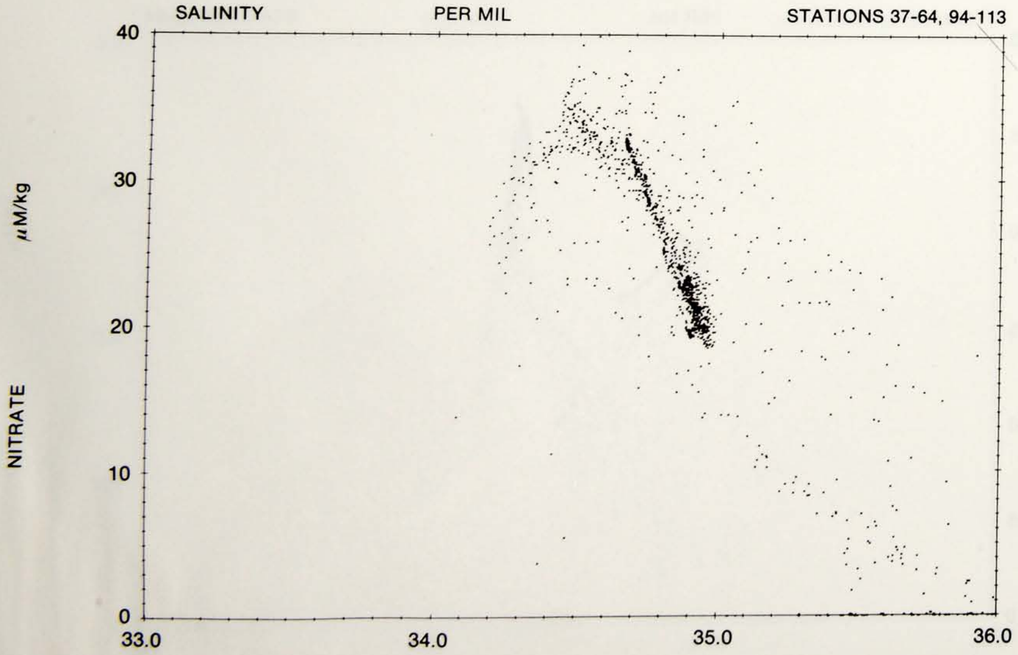
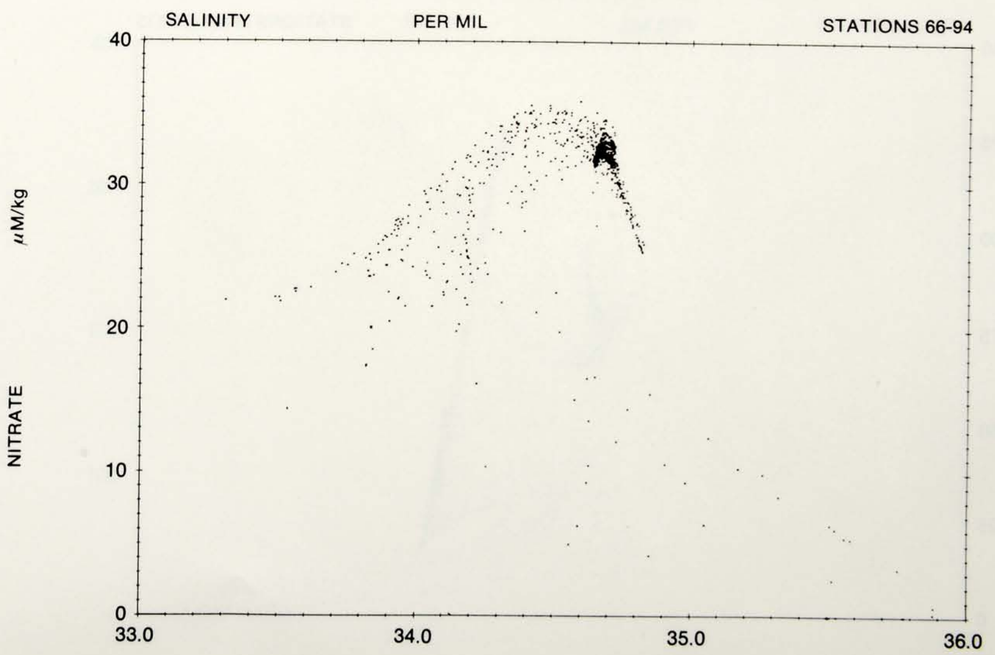
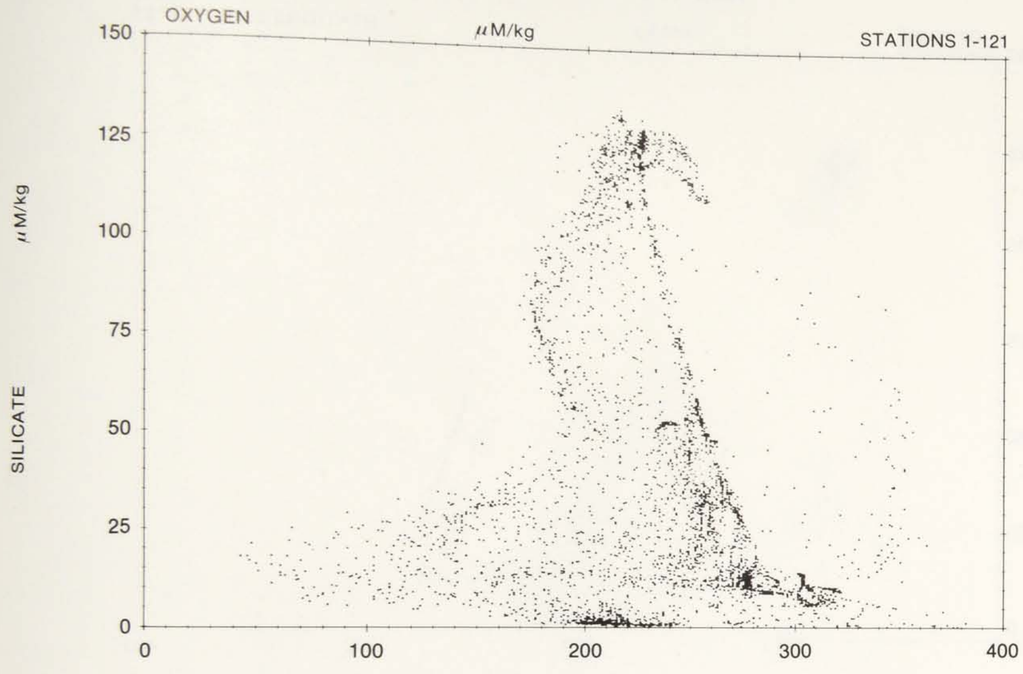


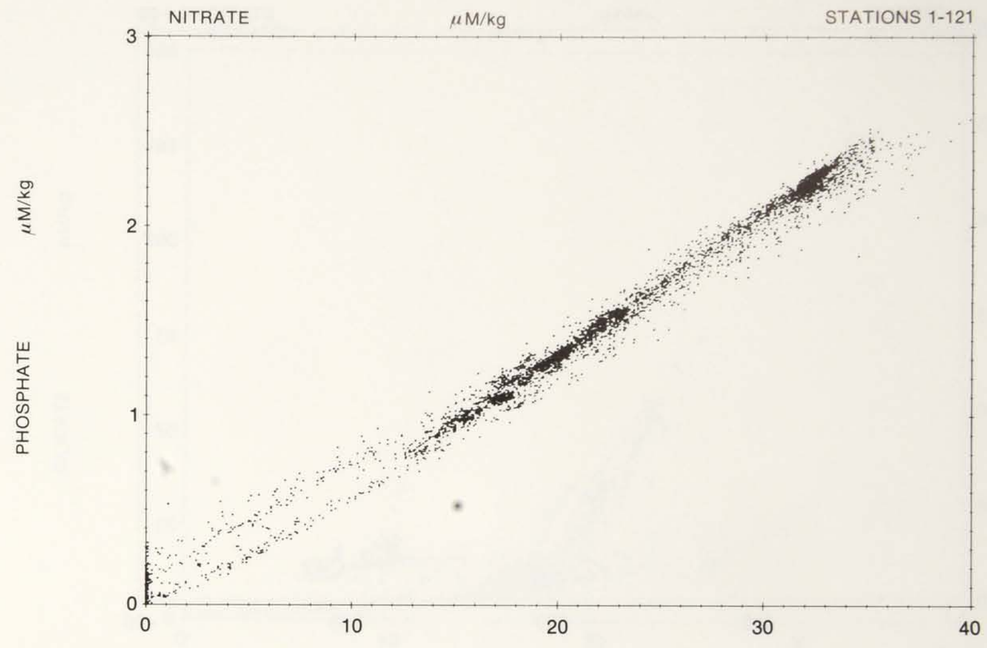
SOUTH ATLANTIC AND CIRCUMPOLAR REGION

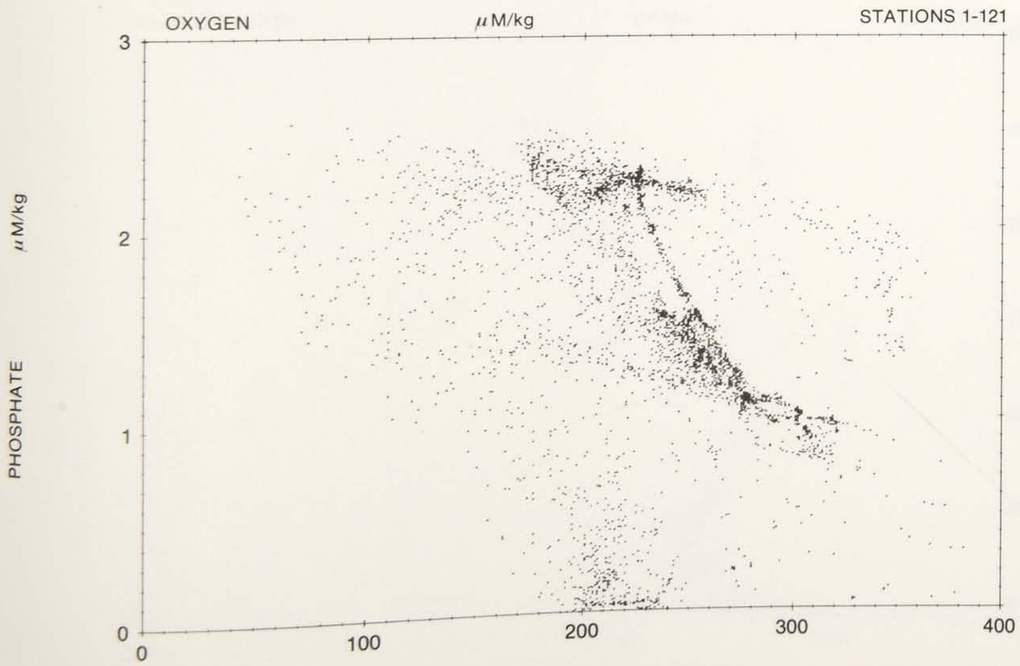


SCATTER DIAGRAMS

PLATE 187
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973







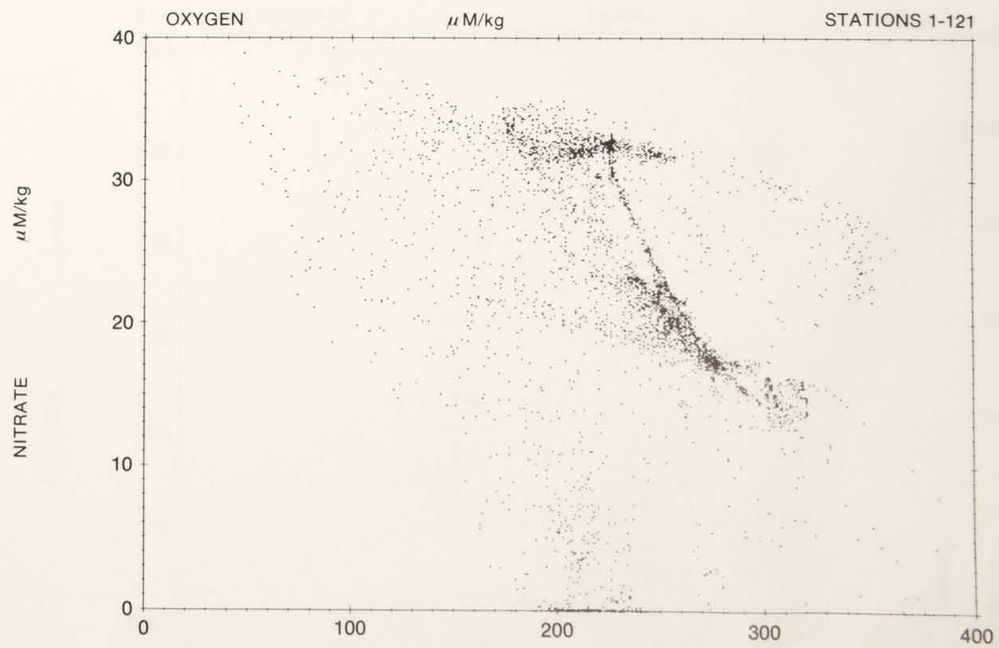
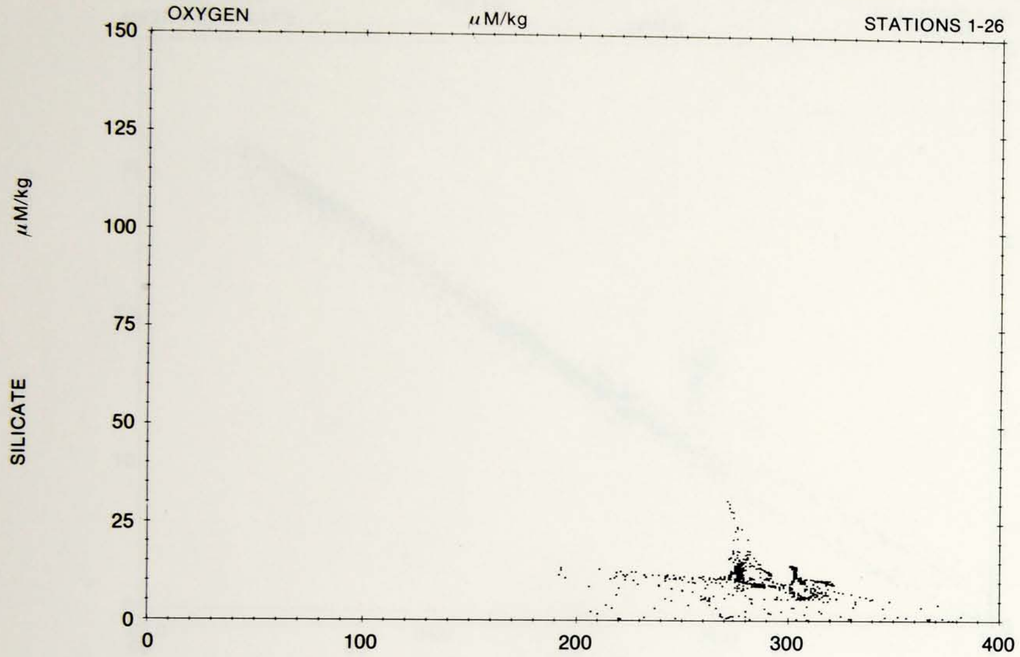


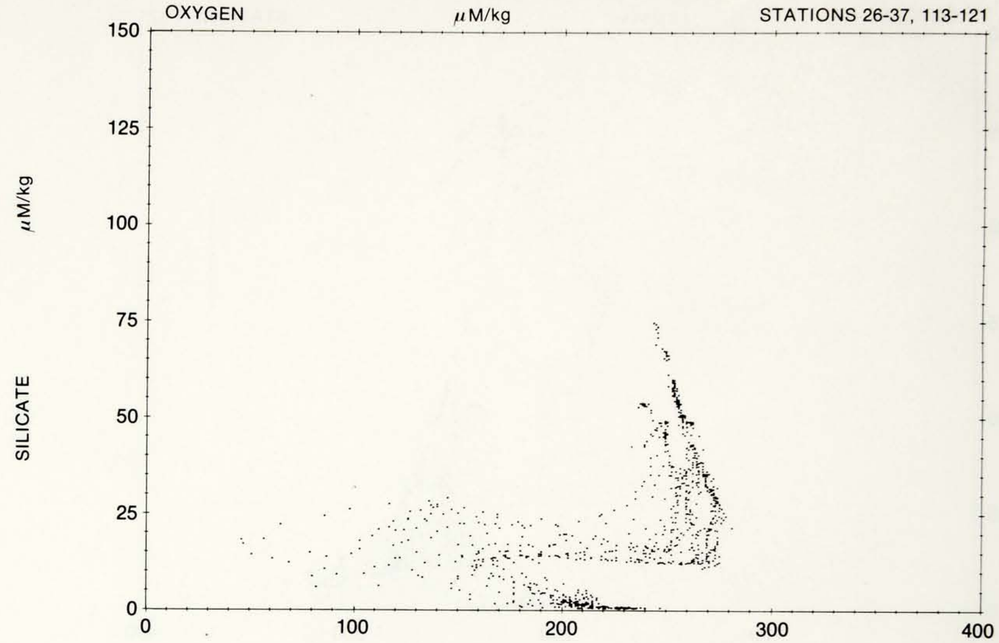
PLATE 188
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

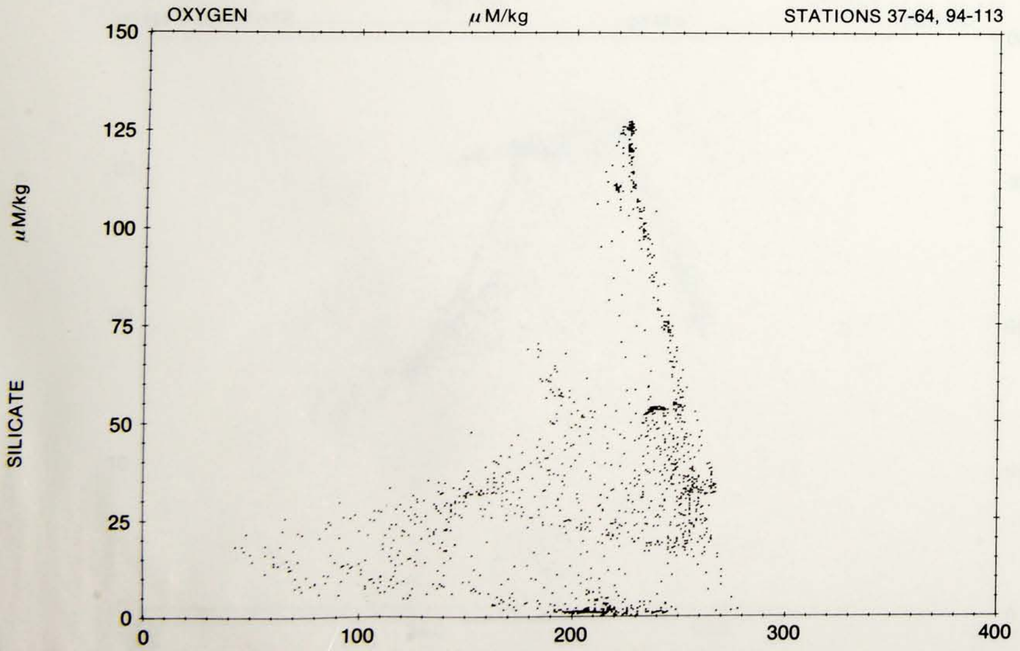
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



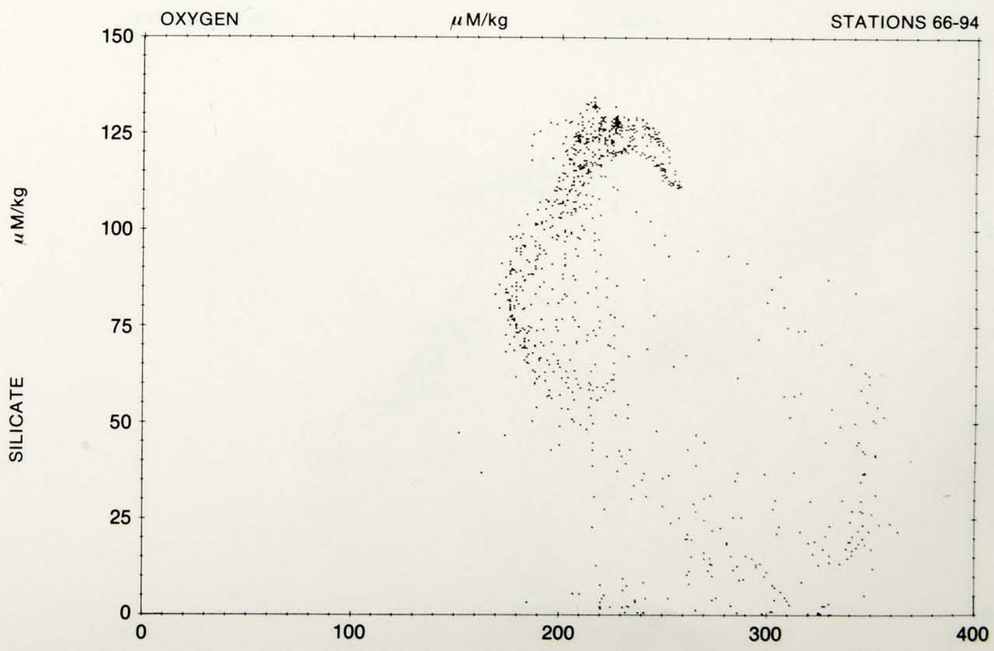
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC

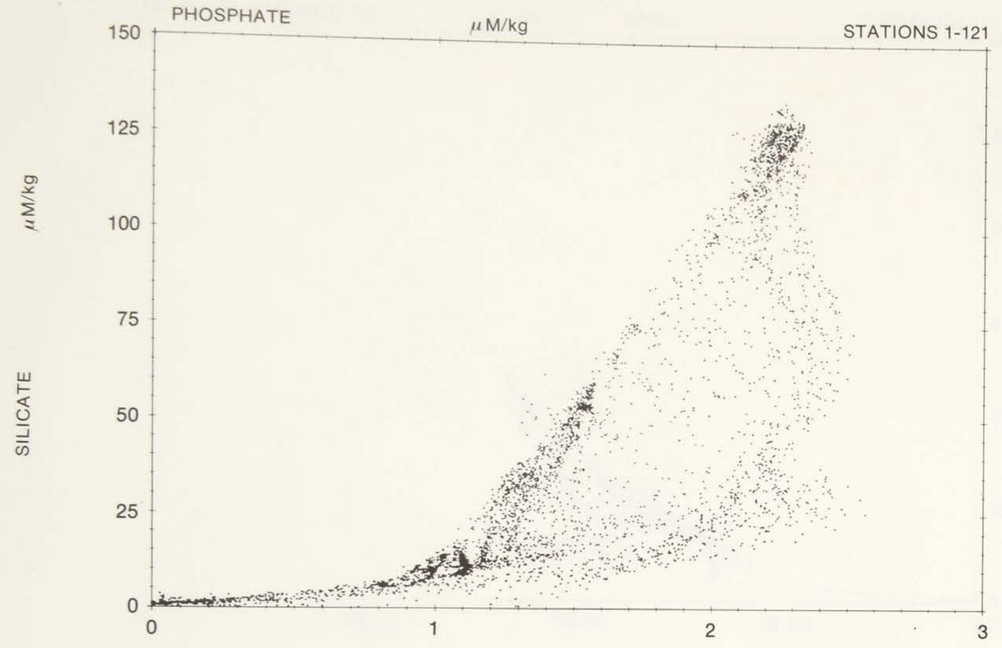


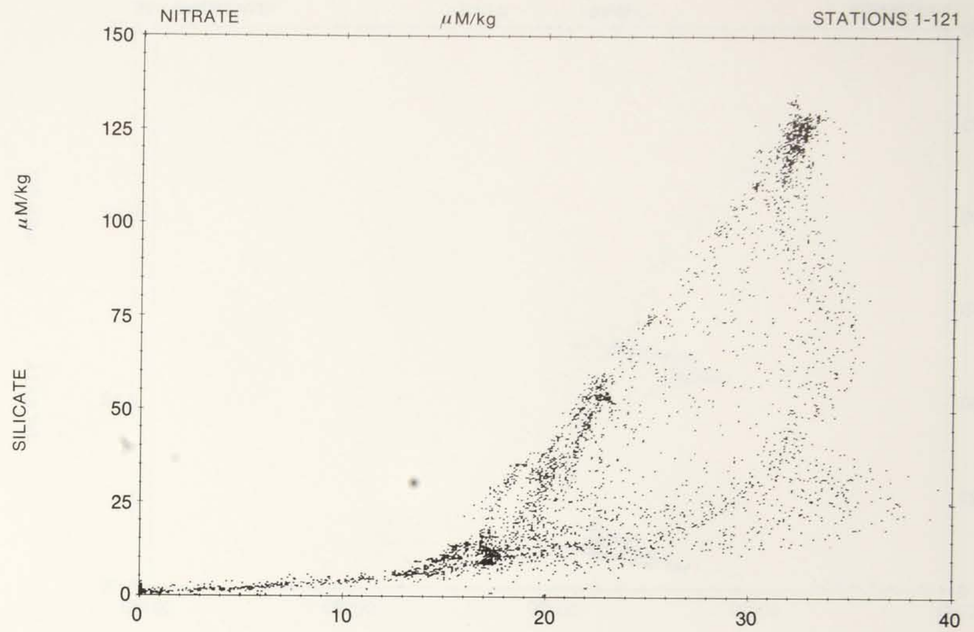
SOUTH ATLANTIC AND CIRCUMPOLAR REGION

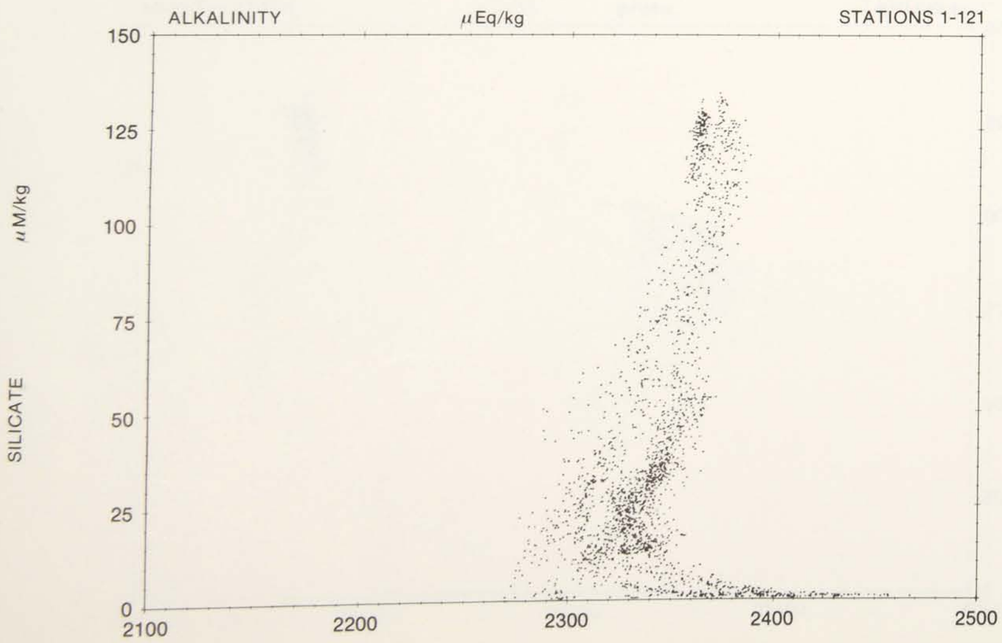


SCATTER DIAGRAMS

PLATE 189
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973







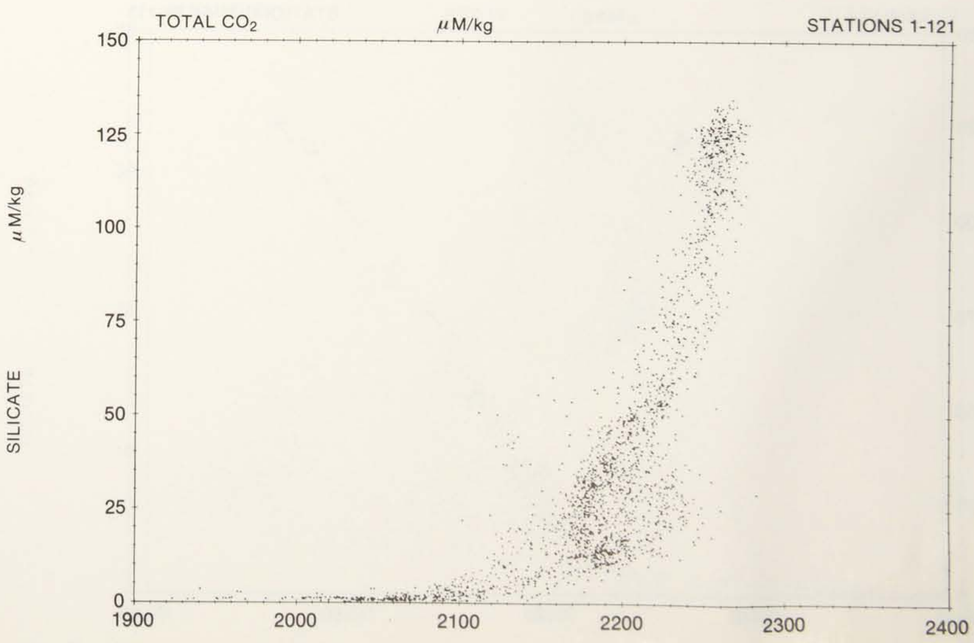
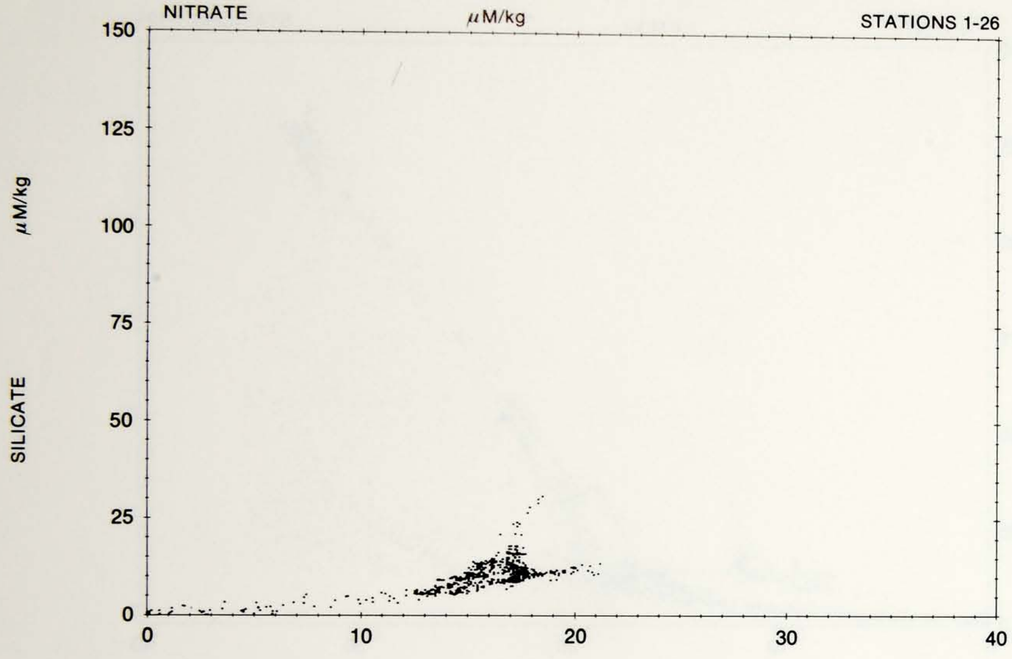


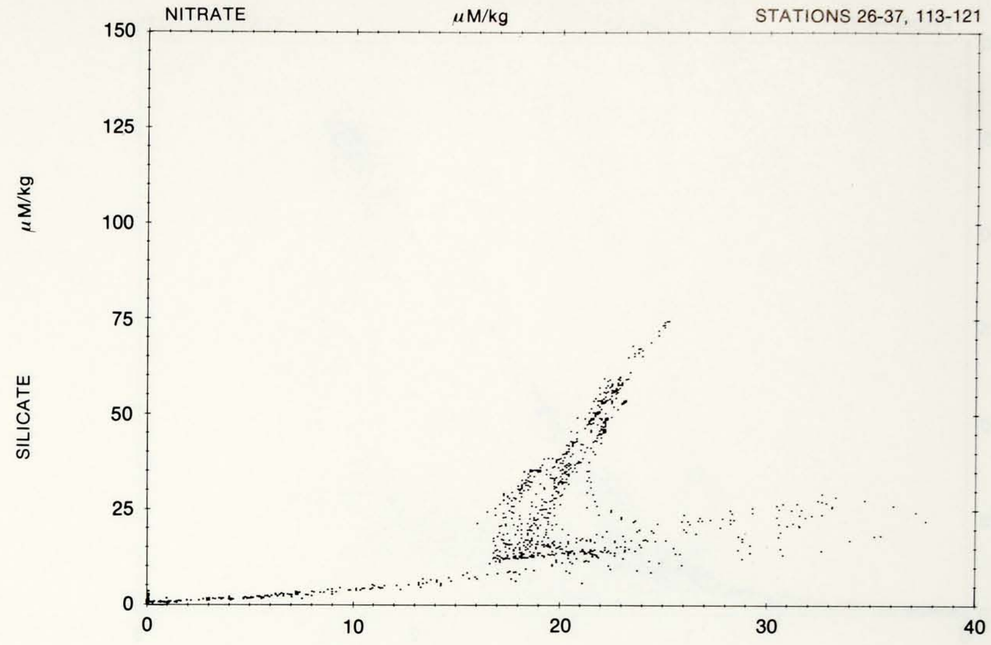
PLATE 190
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS

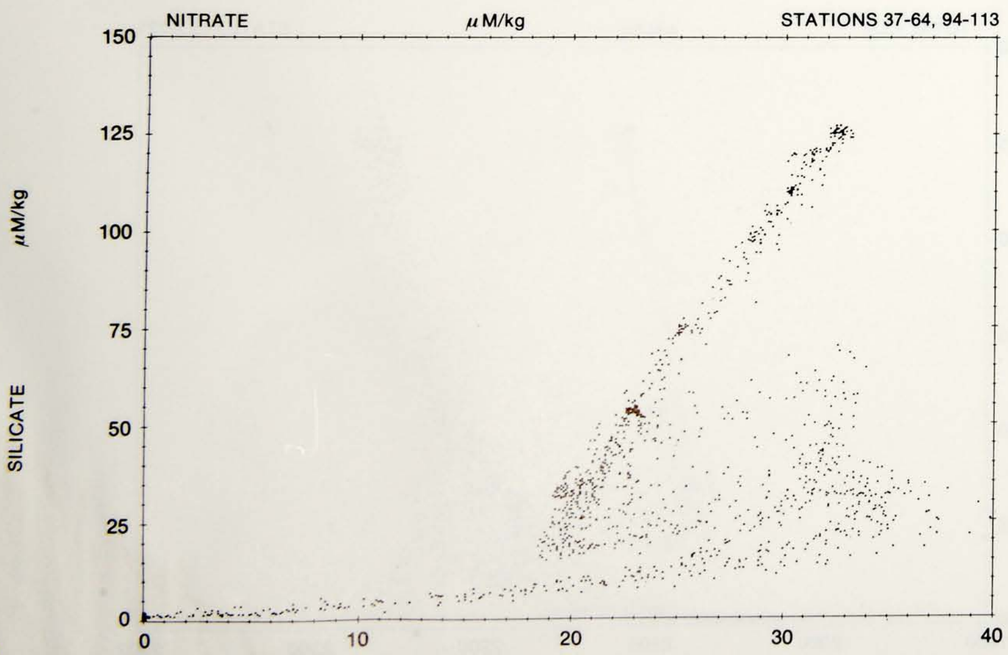
NORTH ATLANTIC, GREENLAND AND NORWEGIAN SEAS



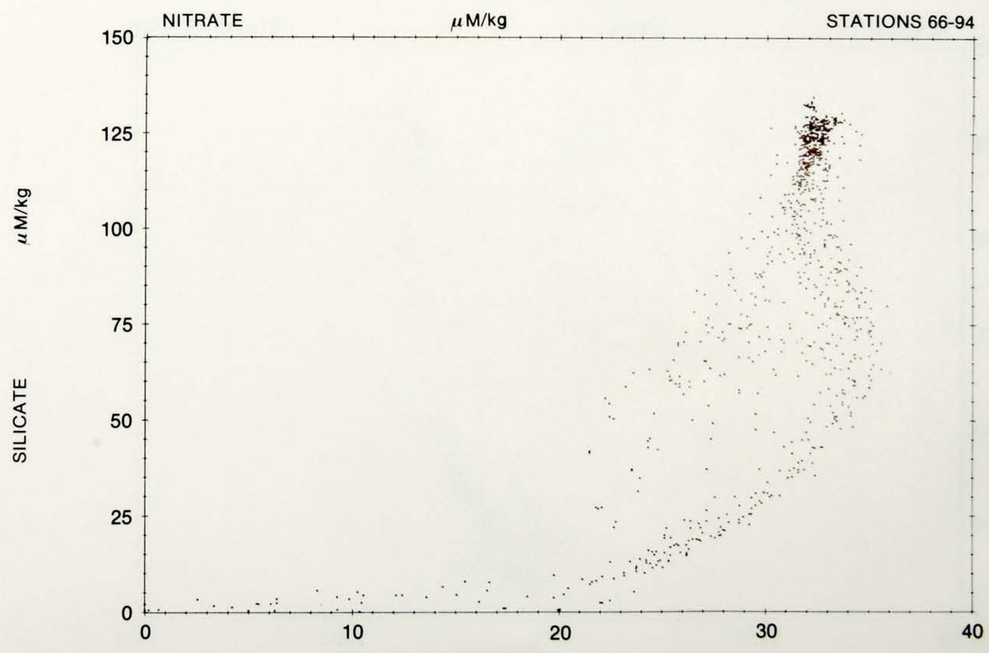
NORTH CENTRAL ATLANTIC



SOUTH CENTRAL ATLANTIC

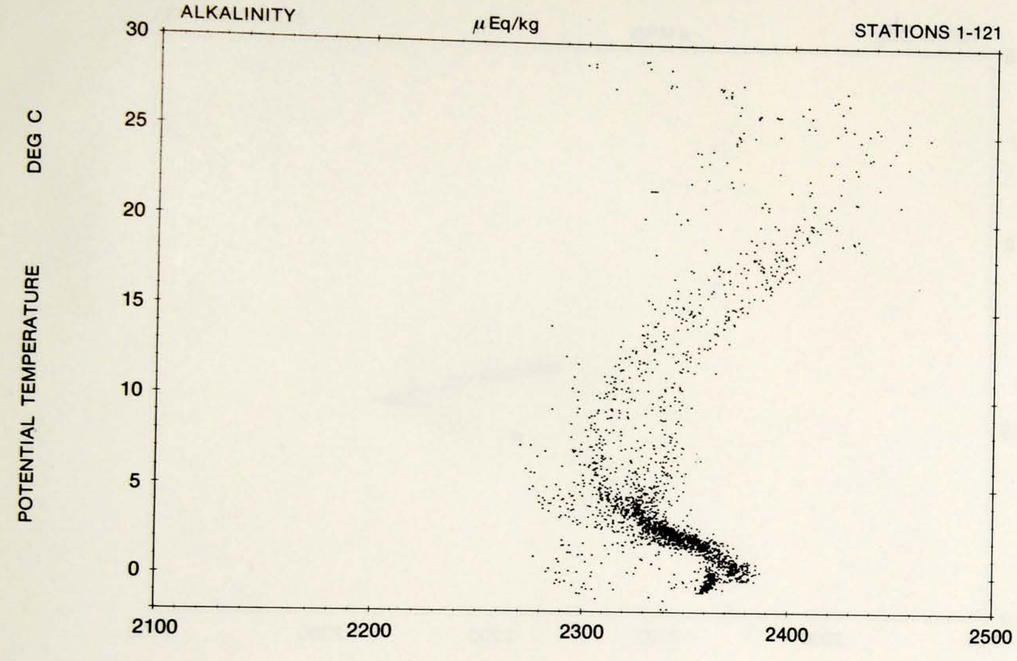


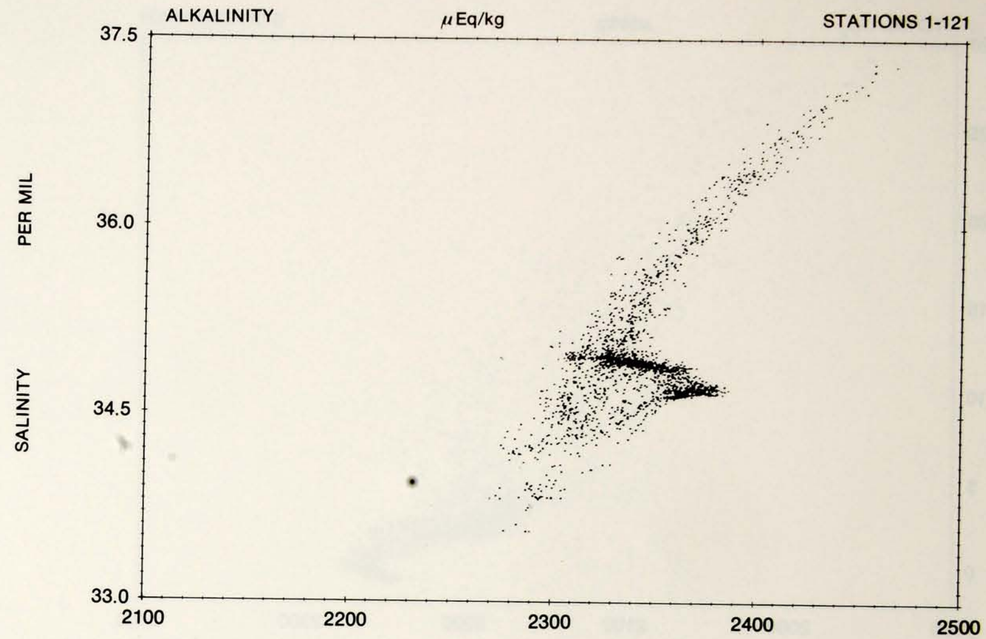
SOUTH ATLANTIC AND CIRCUMPOLAR REGION

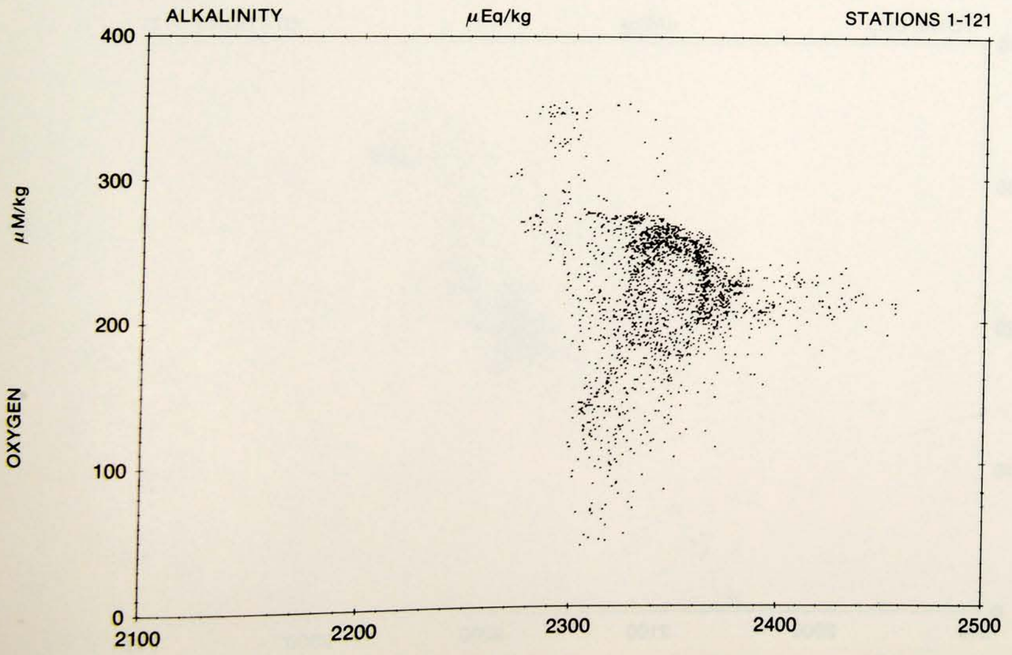


SCATTER DIAGRAMS

PLATE 191
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973







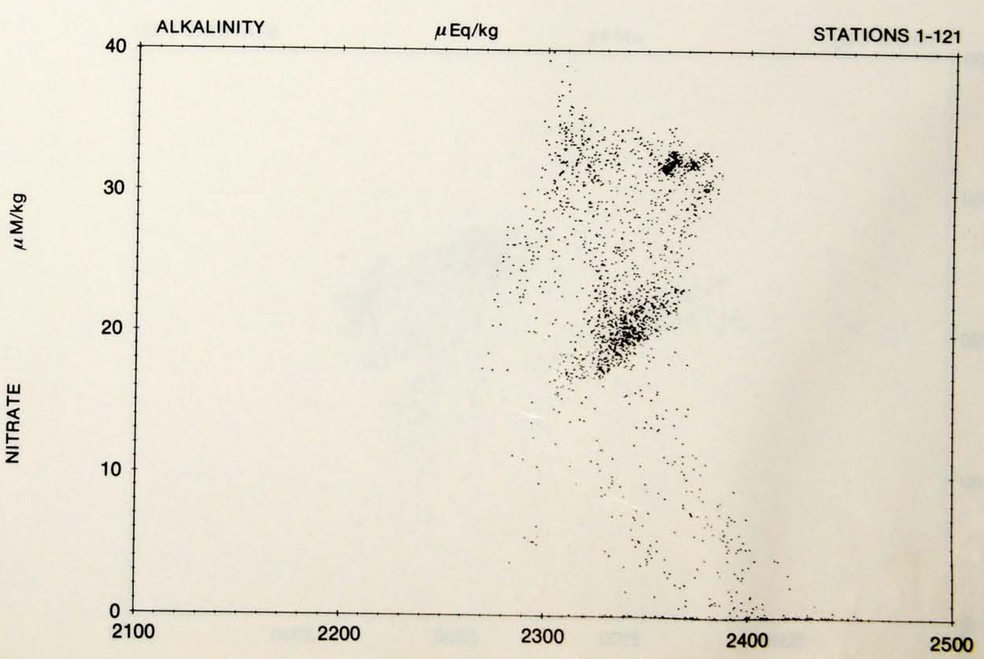
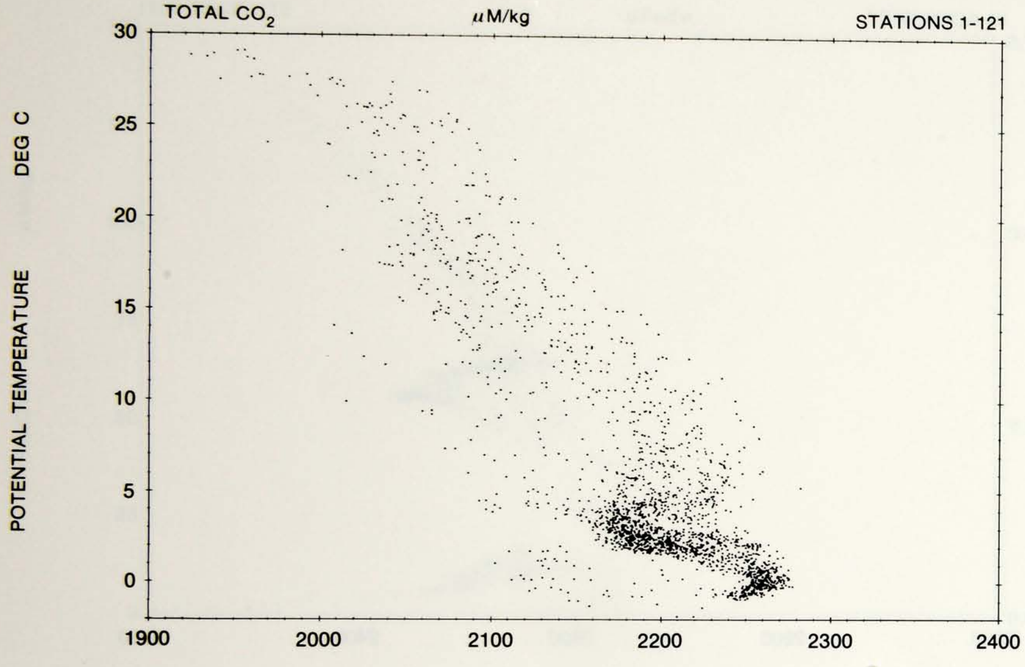
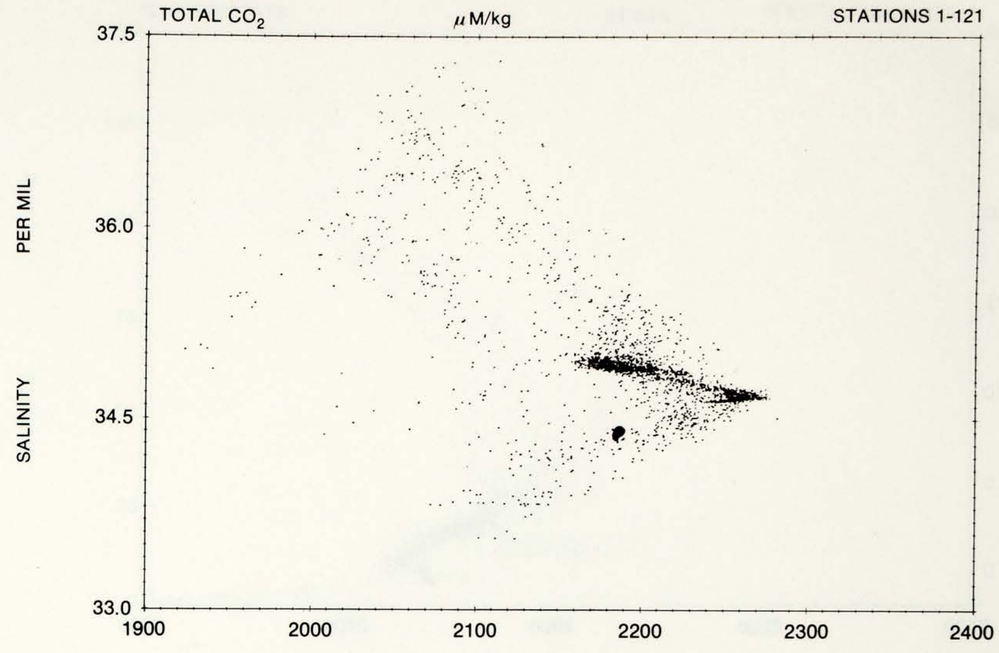


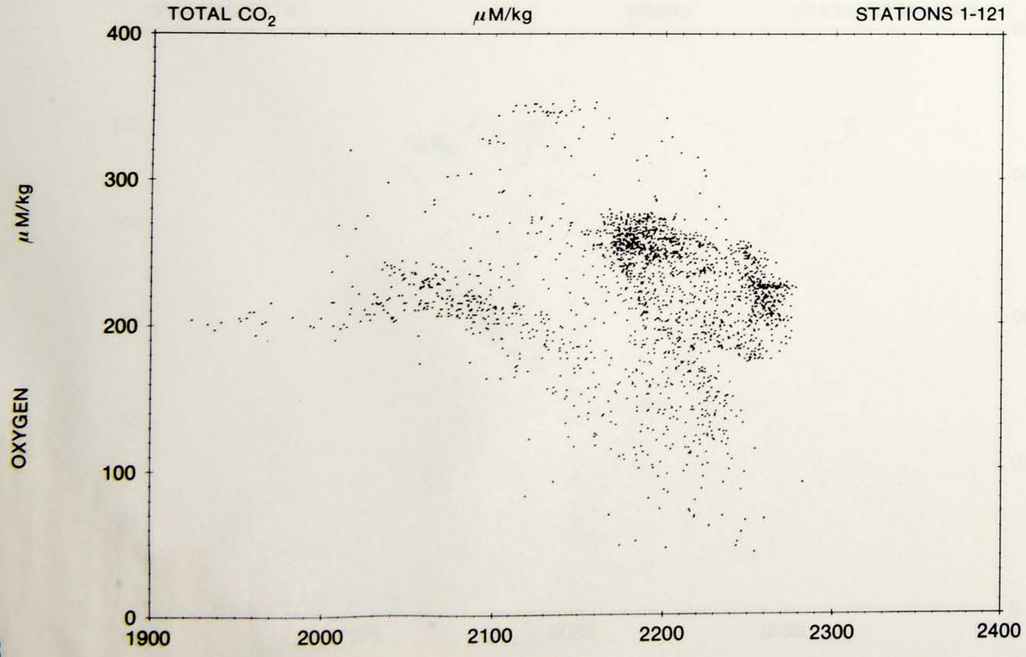
PLATE 192

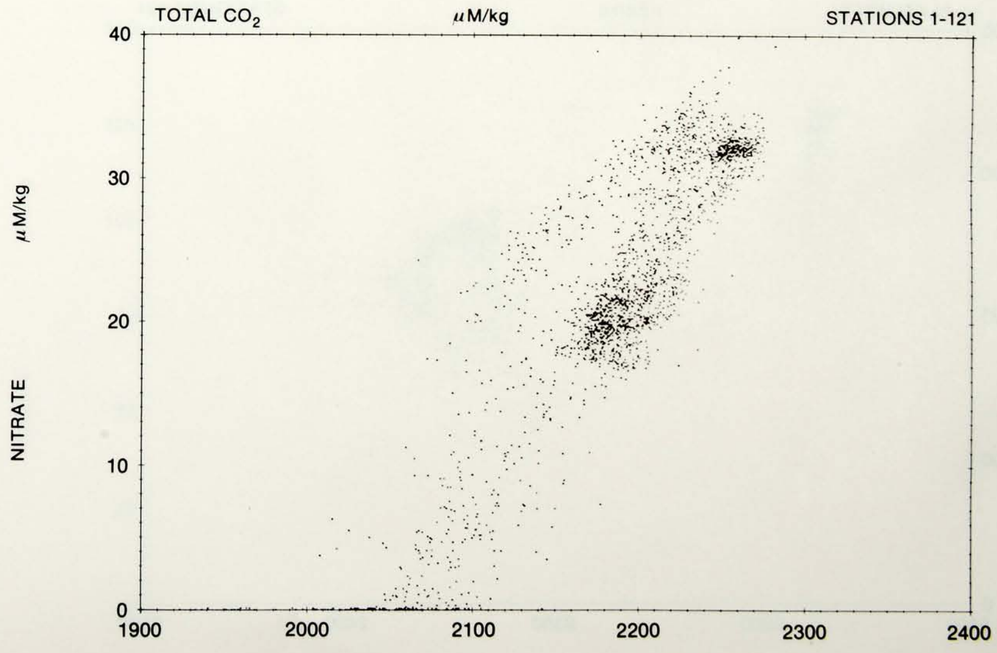
GEOSECS Atlantic Expedition
R/V KNORR
July, 1972 to April, 1973

SCATTER DIAGRAMS









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