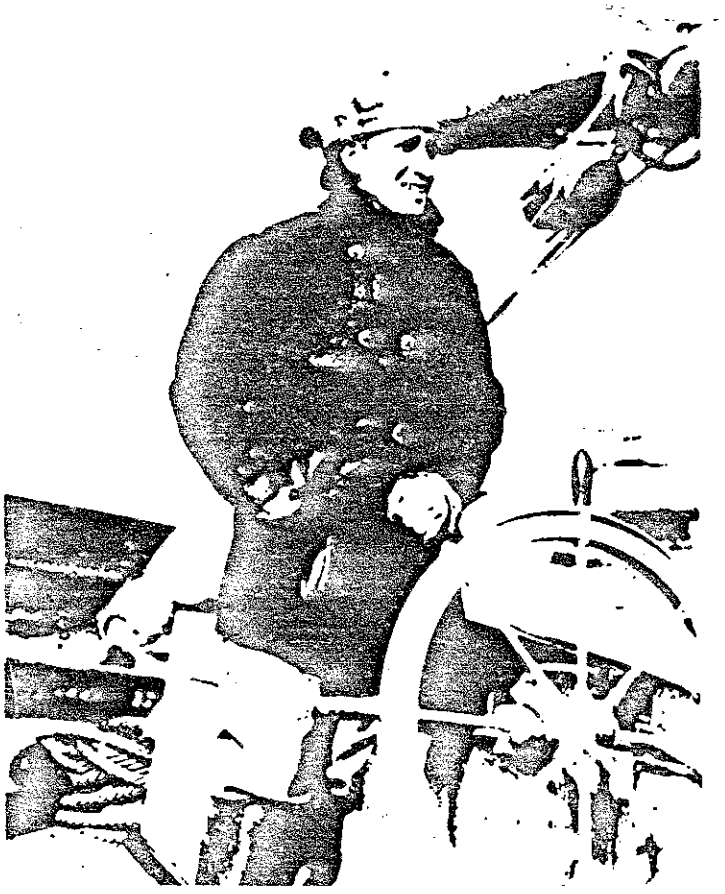
DATA REPORT

CHEMICAL AND BIOCHEMICAL DATA OBTAINED BY BIGELOW LABORATORY INVESTIGATORS

FRAM III · 1981

edited by
N. Garfield, L.A. Codispoti, and T.T. Packard

Technical Report No. 26



Henry Bigelow

BIGELOW LABORATORY
for
OCEAN SCIENCES

a division of northeastern research foundation inc

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Chemical and biochemical data obtained by

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Bigelow Laboratory for Ocean Sciences

McKown Point

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ACKNOWLEDGMENTS

Technical assistance preparing equipment for the project was provided by G. Friederich and P. Garfield. Mary Silver provided the methodology for collecting and preparing samples for electron microscopy. In addition, G. Friederich analyzed the frozen nutrient samples, P. Garfield analyzed the particulate organic carbon and particulate organic nitrogen samples and M. Keller processed samples for the electron microscope. Andy Heiberg was in charge of logistics, and logistical support for FRAM III was provided by the 612th QM Company (U.S. Army) and the 317th and 62nd Tactical Airwings (U.S. Air Force). Pat Oathout typed this manuscript.

Particular thanks are due to the "seasoned" FRAM colleagues, led by chief scientist Ken Hunkins and camp manager Allen Hilscher, who provided advice and assistance at the FRAM III site.

This work was supported by the National Science Foundation under Grant DPP-825744.

INTRODUCTION

Drifting ice station FRAM-III was one of a series of scientific investigations conducted from camps located on the pack ice of the Arctic Ocean (Figure 1). Manley *et al.* (1982) present a summary of the FRAM scientific program.

During the first half of the experiment (3-16 April 1981), two investigators (L.A. Codispoti and T.T. Packard) from the Bigelow Laboratory studied the chemical and biochemical properties of the water column in the Eurasian Basin. Their observations included on-site analysis of samples collected from just beneath the ice cover to a depth of 4,100 m for dissolved oxygen, ammonium, dissolved silicon, nitrate, nitrite, and reactive phosphorus. On-site determinations of the activity of of the respiratory electron transport system (ETS) were also made on eight samples taken from depths as great as 2,000 m. Preserved samples were returned to the Bigelow Laboratory for examination with a scanning electron microscope and for the determination of their nutrient, chlorophyll, phaeophytin, particulate organic nitrogen and particulate organic carbon contents.

All of the laboratory work has been completed, and our initial analysis shows that metabolic rates in the FRAM III water column are extremely low. Nitrite and ammonium concentrations were zero or very close to zero throughout the water column, and ETS activities were low in the upper 125 m and undetectable below that depth. This was the first time that ETS activity could not be detected in deep-sea samples. These data showing low metabolic rates will prove useful (when combined with data from other regions) in clarifying the relative importance of

Dissolved Oxygen

Oxygen concentrations were determined using the Chesapeake Bay Institute modification of the Winkler method (Carpenter, 1965).

Inorganic Nutrients

Nutrient analyses were made using Technicon AutoAnalyzer procedures based on the manual method of Murphy and Riley (1962) for reactive phosphorus and the methods of Armstrong, Stearns and Strickland (1967) for dissolved silicon, nitrite, and nitrate. Ammonium was measured by the phenol-hypochlorite method of Koroleff (1970), as adapted to the AutoAnalyzer by Slawyk and MacIsaac (1972). The automated methods used have been described by Friederich and Whitledge (1972). At the first three stations, two sets of samples were collected; one set was analyzed immediately and the second set was frozen and returned to Bigelow for analysis. Samples from succeeding stations were frozen for later laboratory analysis. Figures 3 and 4 compare samples analyzed on site with those frozen and returned to the laboratory.

Particulate Organic Carbon and Nitrogen

Particulate organic carbon (POC) and particulate organic nitrogen (PON) were determined using the procedure of Sharp (1973). POC and PON were measured on samples filtered through pre-combusted Whatman GF/F glass fiber filters using a CHN analyzer (Hewlett-Packard FSM 185) interfaced with a Hewlett Packard (3380A) integrator. The frozen filters were stored for several weeks before analysis.

Chlorophyll a and Phaeopigments

Chlorophyll *a* was determined by the fluorometric technique (Yentsch and Menzel, 1963; Holm-Hansen *et al.* 1965) using a Turner Design model 10-005 R fluorometer, standardized with a chlorophyll *a* solution (Sigma Chemical Co.).

contamination or low quality reagents. The ETS activity was calculated by the equation:

$$\text{ETS } (\mu l\ O_2\ h^{-1}\ \ell^{-1}) = 60 \times S \times H \times (COD-RB) \ /\ 1.42 \times f \times V \times t$$

where H is the crude homogenate volume in milliter ($\sim$ 5.5 ml), S is the volume of the quenched reaction mixture ($\sim$ 6.0 ml), COD is the corrected absorbance (absorbance of the assay minus the pigment blank), RB is the reagent blank, V is the volume of the seawater filtered, f is the volume of the homogenate used in the assay ($\sim$ 1 ml), and t is the reaction time ($\sim$ 20 minutes). The two constants, 60 and 1.42, convert the measurements to units of hours and oxygen volume (μl). The result was then corrected for temperature by the equation:

$$\text{ETS } (\textit{in situ} \text{ temp}) = \text{ETS (incubation temp)} \times e^{Ea \left\{\frac{1}{T_1} - \frac{1}{T_2}\right\} \times R^{-1}}$$

where Ea = 15,000 Kcal mole^{-1}, R = 1.98 Kcal mole^{-1} degree^{-1}, and T_1 and T_2 are the incubation and *in situ* temperatures in degrees Kelvin.

Respiration rates were calculated from ETS activities using an experimentally derived R/ETS ratio of 0.43 for stationary phase (Christensen *et al.*, 1980). Since this ratio was determined using a less sensitive ETS assay technique (no Triton X-100), the ETS activities reported in this study were first divided by 4.44 (Christensen and Packard, 1979) then multiplied by 0.43 to obtain *in situ* respiration rates.

Light Transmission

On 6 April 1981, 4 casts were made to measure the percent light transmission from just below the ice to 135 m. A Hydro-products transmissometer (Model 9125) was used to make the observations. Unfortunately, voltage fluctuations in the Fram III AC power supply

Temperature and Salinity

Temperature and salinity values reported for chemical stations are the raw values from the CTD manually corrected using calibration information supplied by T. Manley (personal communication). Some of the deep salinity values are higher by approximately 0.1 °/oo than historical salinity values. All salinity values obtained from the CTD should be regarded as preliminary until final editing by the Fram-III physical oceanographers has been completed. Temperatures for the biochemical casts were obtained from the protected reversing thermometers.

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Bigelow Laboratory Participants

Investigator	
Louis A. Codispoti	Chemical parameters
Theodore T. Packard	Biochemical parameters

Inquiries

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West Boothbay Harbor, Maine 04575

Explanation of Data Units

Station number	CTD hydrocast number
Latitude	In degrees, minutes and decimal minutes for each cast
Longitude	In degrees, minutes and decimal minutes for each cast
Date	Greenwich date
Time	Greenwich mean time of start of each cast
Sonic depth	Depth of water in meters as determined by the eco-sounding system
Sampling depth	Depth of water samples in decibars determined from CTD data, meter wheel or thermometric depths
Temperature	In degrees celsius
Salinity	In 1978 practical salinity scale
Oxygen	Observed dissolved O_2 concentration in ml/ℓ
Fluorometric chlorophyll	In nanograms per liter
Phosphate	Reactive phosphorous in microgram atoms per liter
Dissolved Silicon	In microgram atoms per liter
Nitrate	In micromoles per liter
Nitrite	In micromoles per liter
Ammonium	In micromoles per liter
ETS	Electron transport system activity measured in micro-liters of oxygen per hour per liter
Respiration	In nanoliters of oxygen per hour per liter
Phaeopigments	In nanograms per liter
Phaeopigments & chlorophyll	In nanograms per liter
Carbon	Particulate organic carbon in micrograms carbon per liter
Nitrogen	Particulate organic nitrogen in micrograms nitrogen per liter

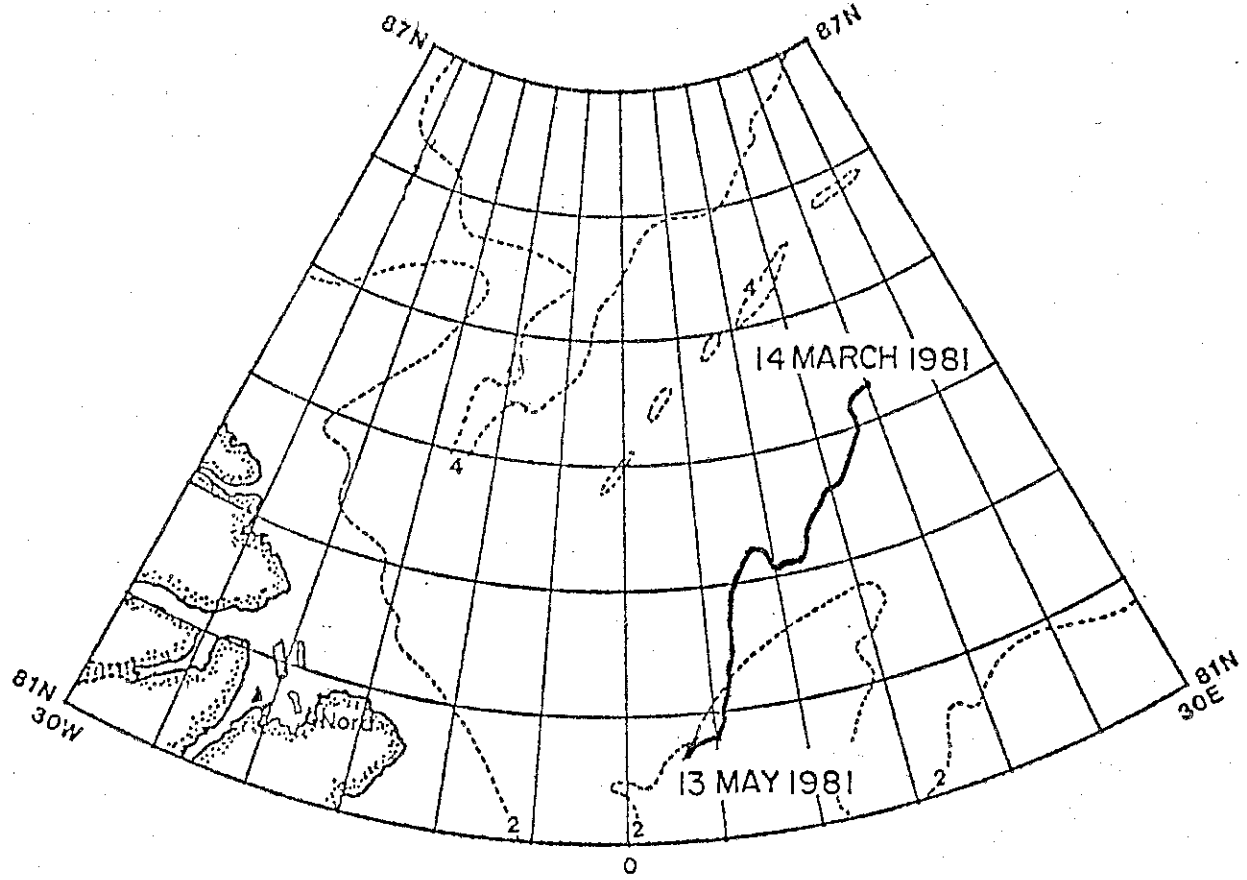

Figure 1. Drift track of Fram III in relation to the northeast coast of Greenland and local bottom topography. Dashed lines are depth contours, depths are given in km. Adapted from Hunkins et al. (1981).

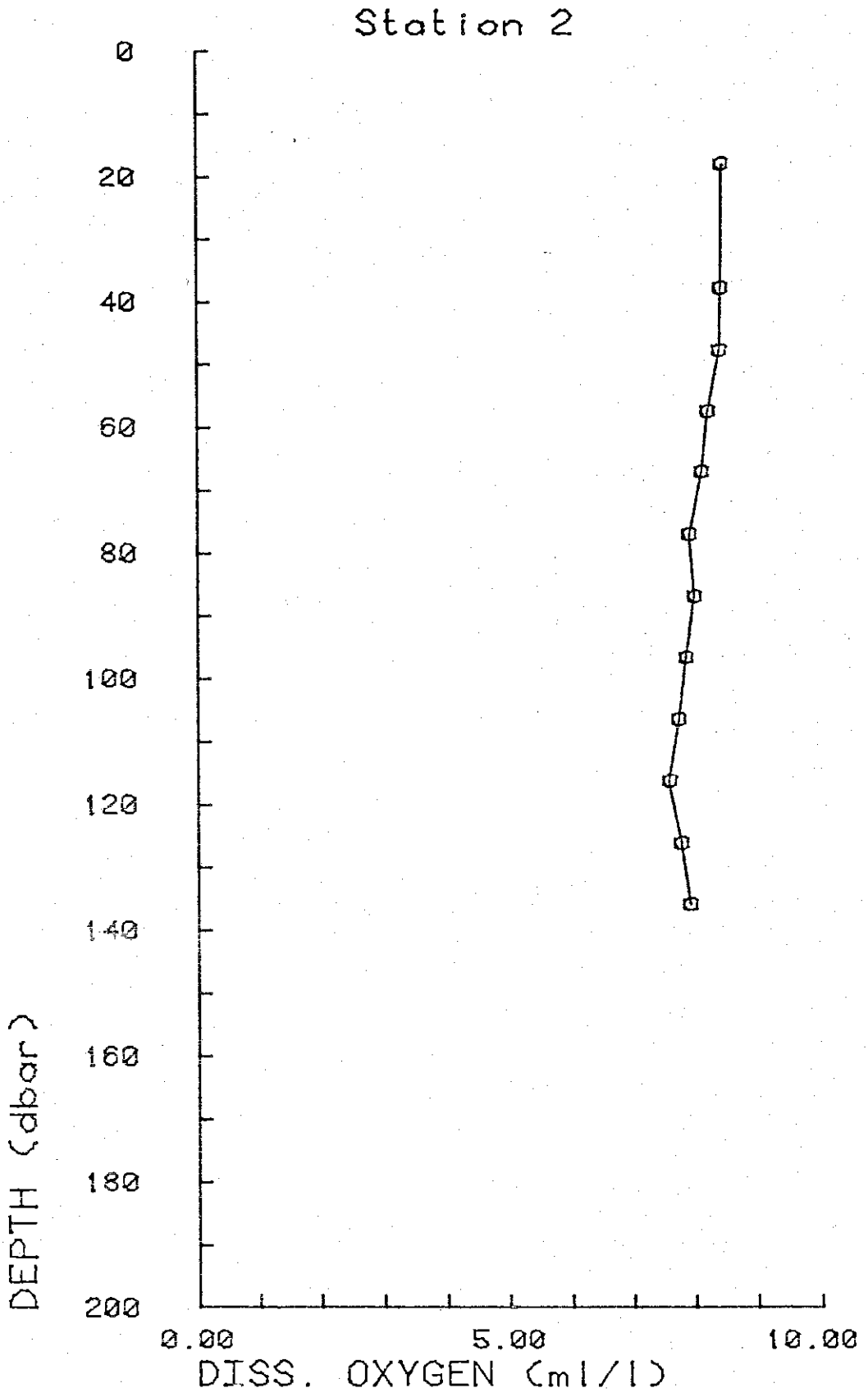

Figure 3a. Dissolved oxygen data for station 2.

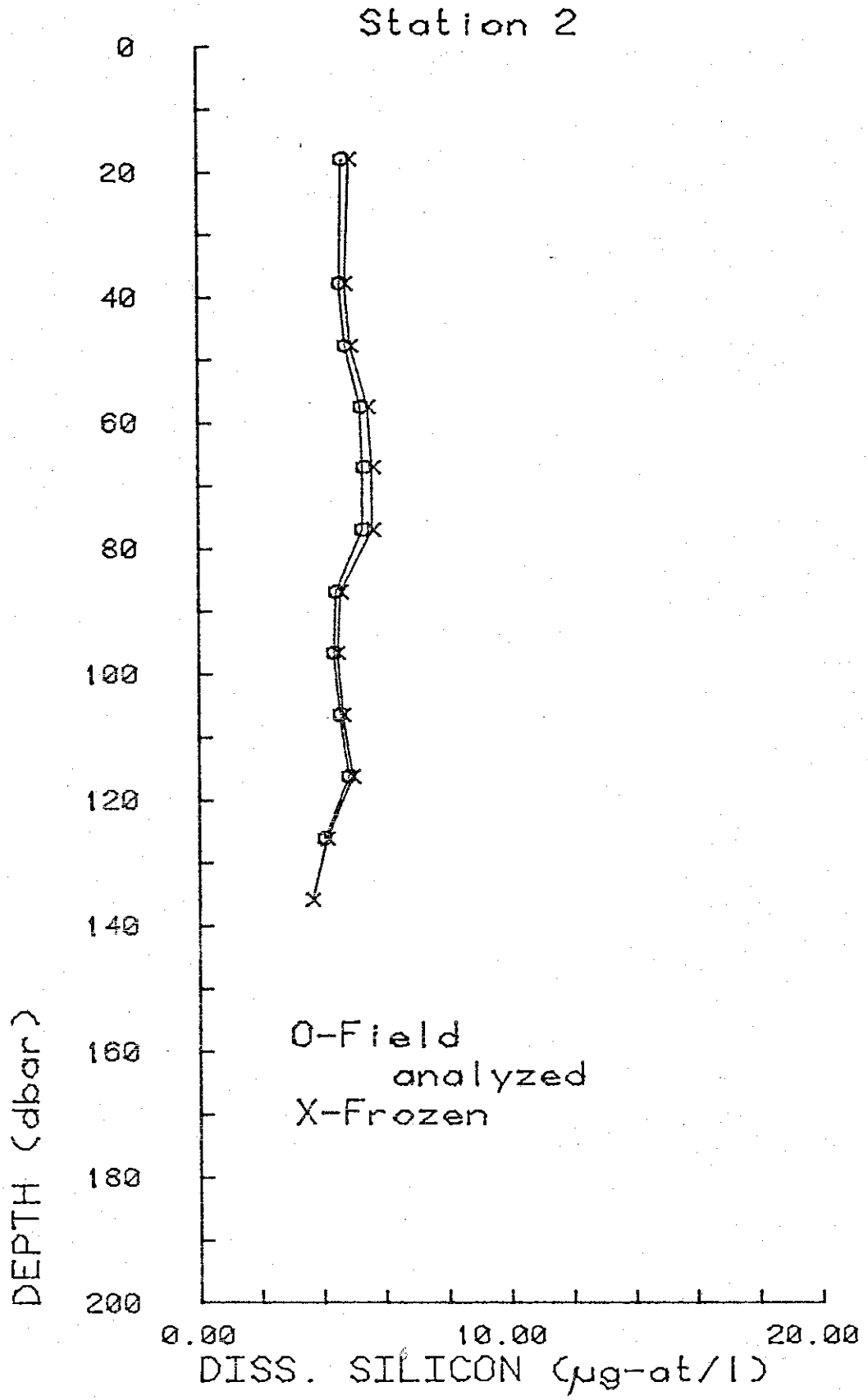

Figure 3c. Dissolved silicon for station 2.

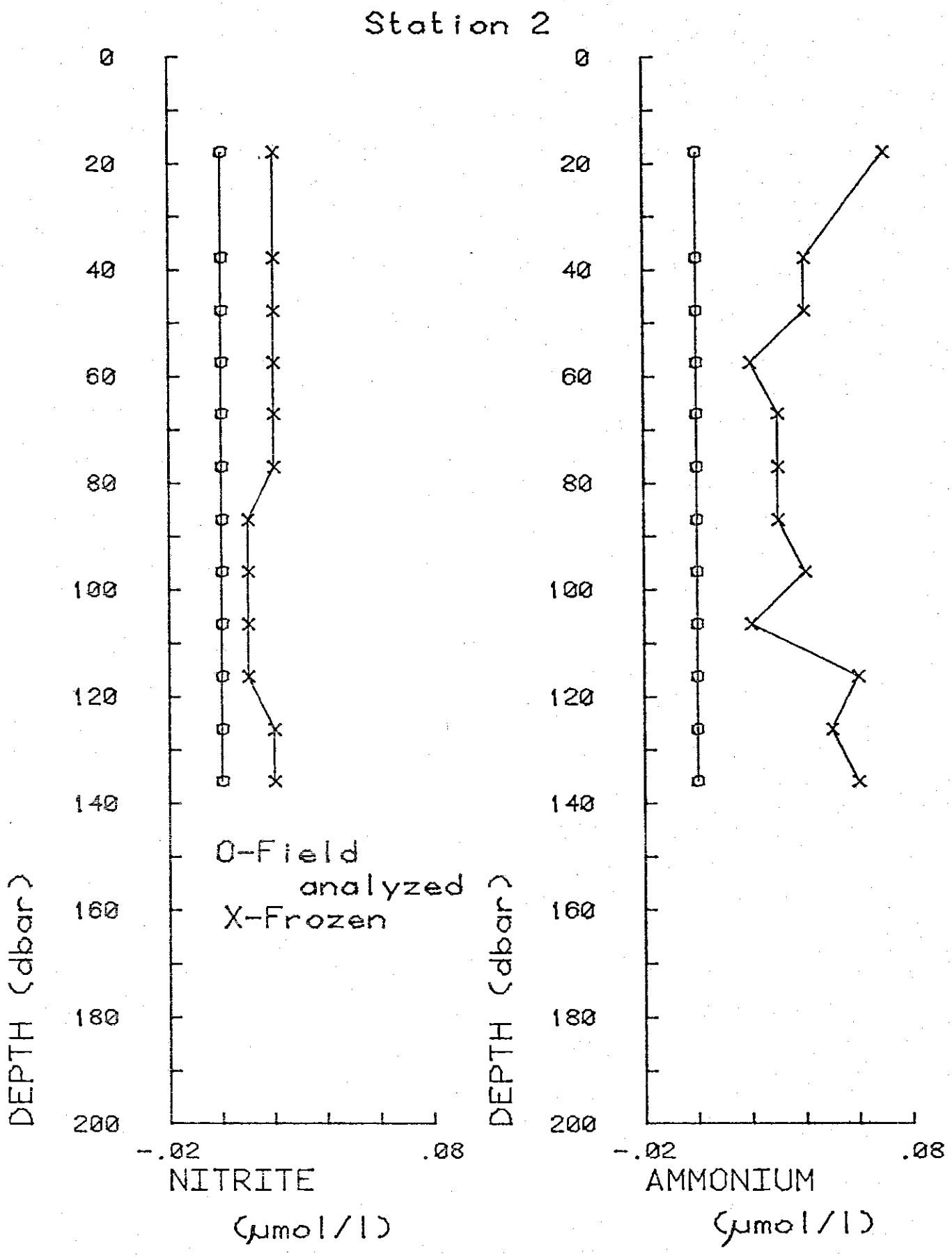

Figure 3e. Nitrite and ammonium data for station 2. Note ϕ offset in diagrams.

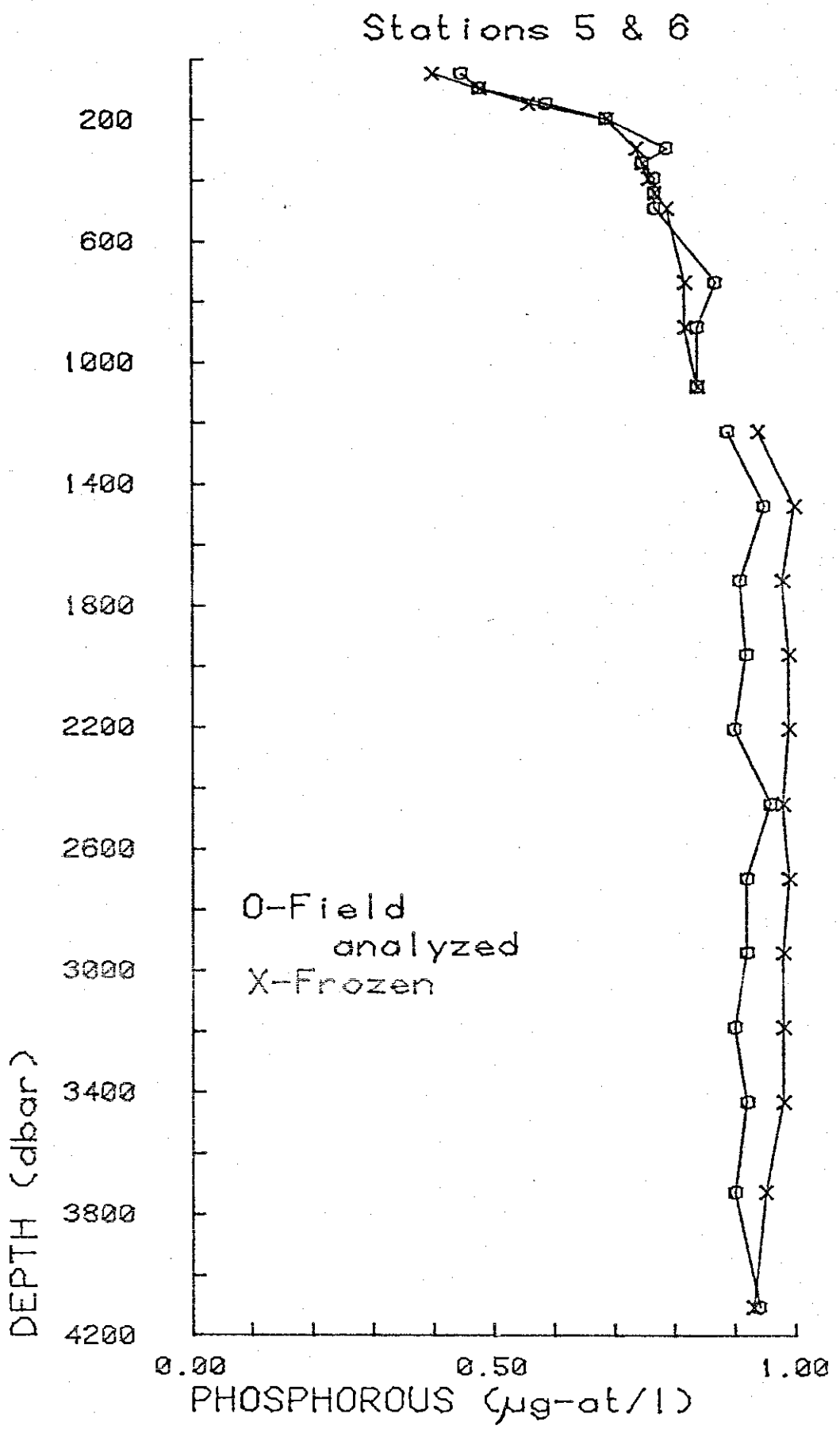

Figure 4b. Reactive phosphorus for stations 5 and 6.

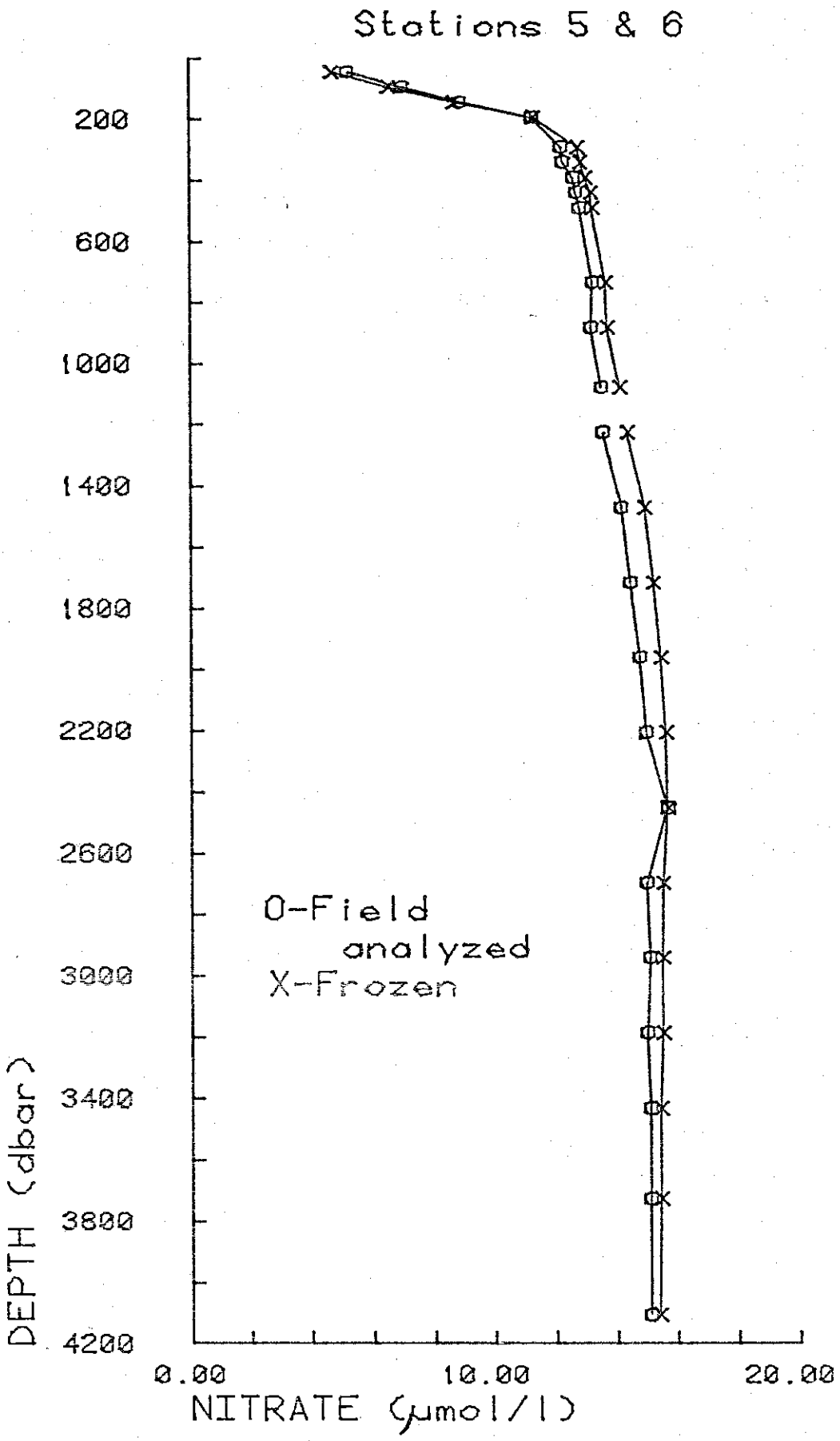

Figure 4d. Nitrate data for stations 5 and 6.

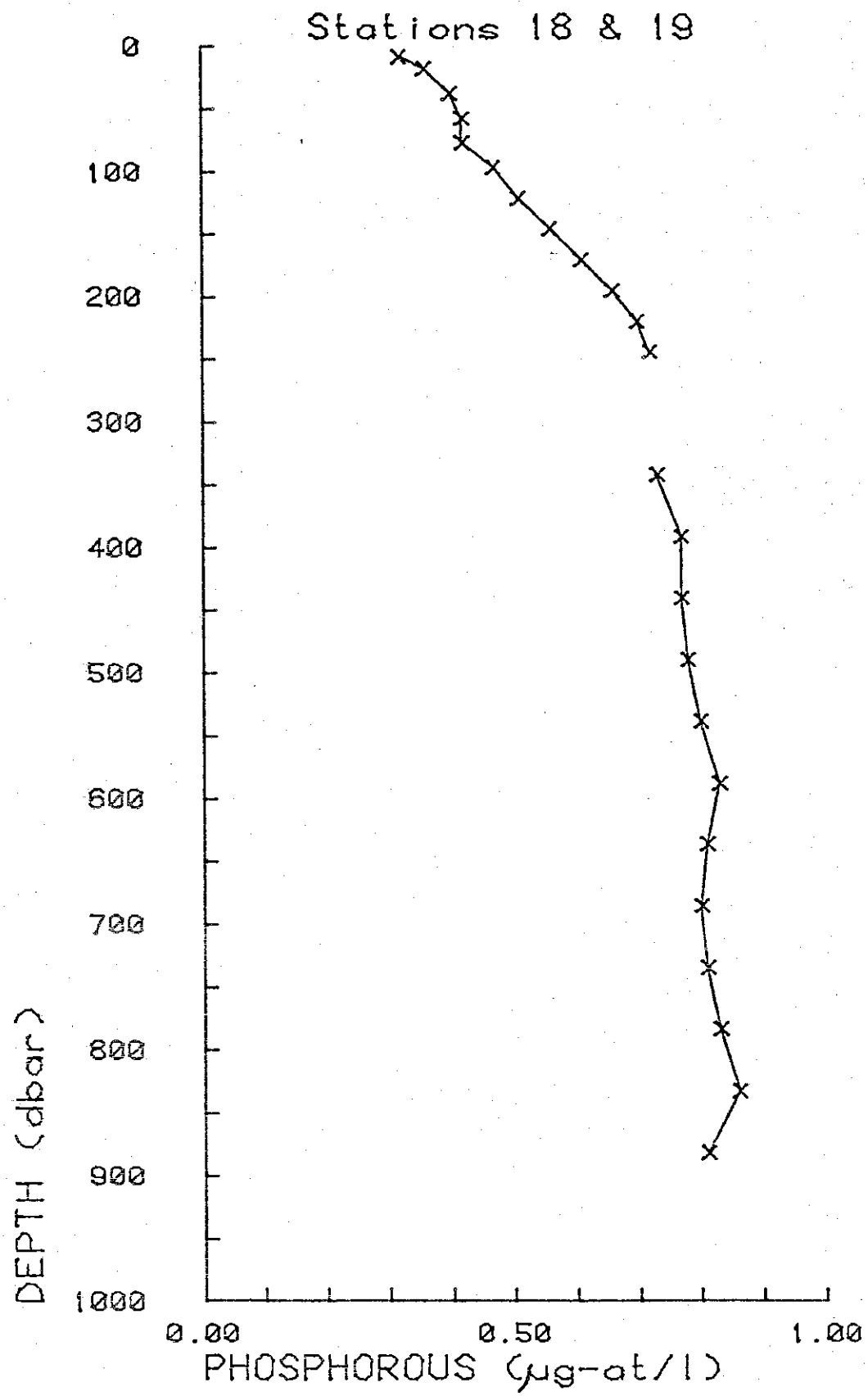

Figure 5a. Reactive phosphorus data for stations 18 and 19.

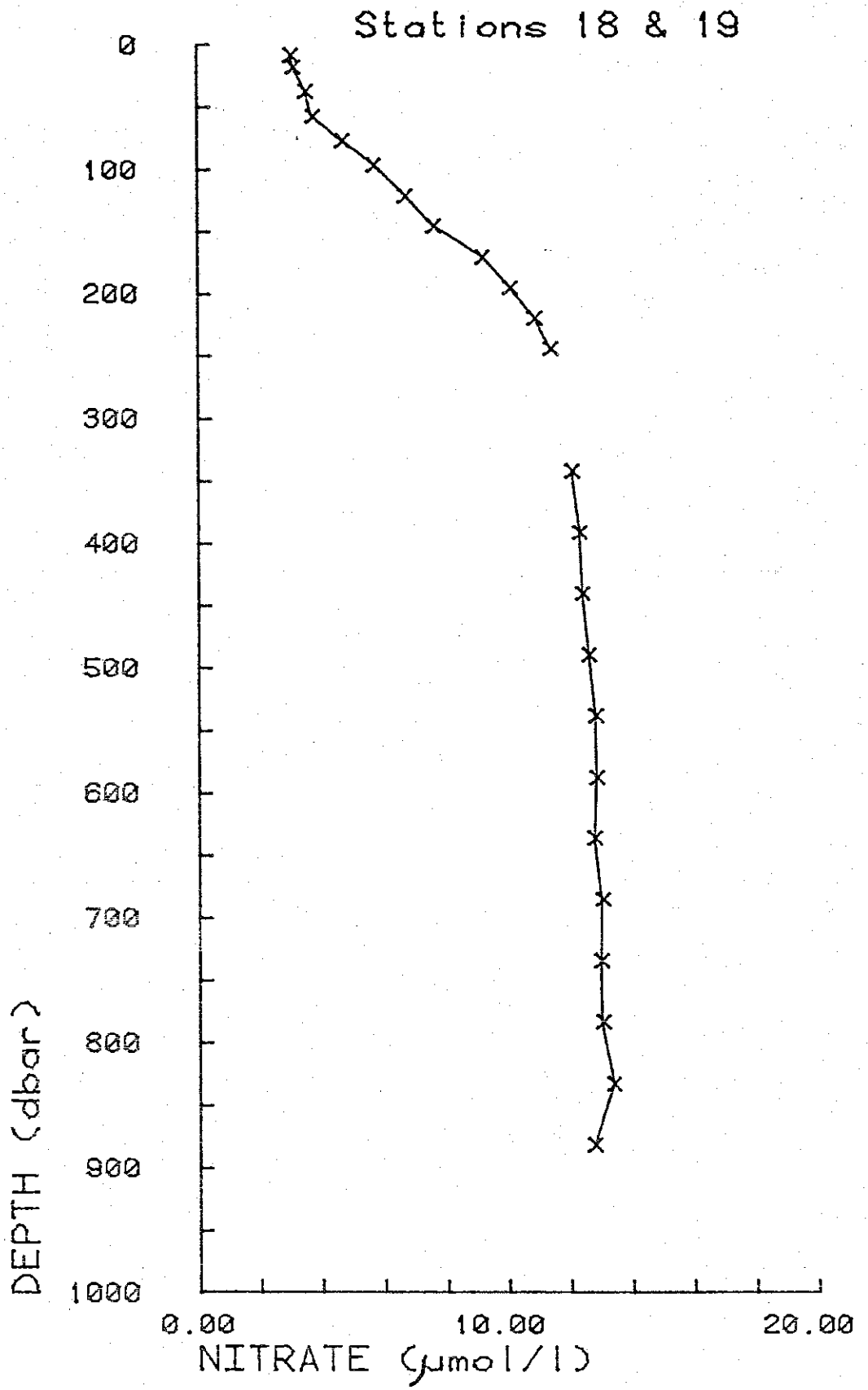

Figure 5c. Nitrate data for stations 18 and 19.

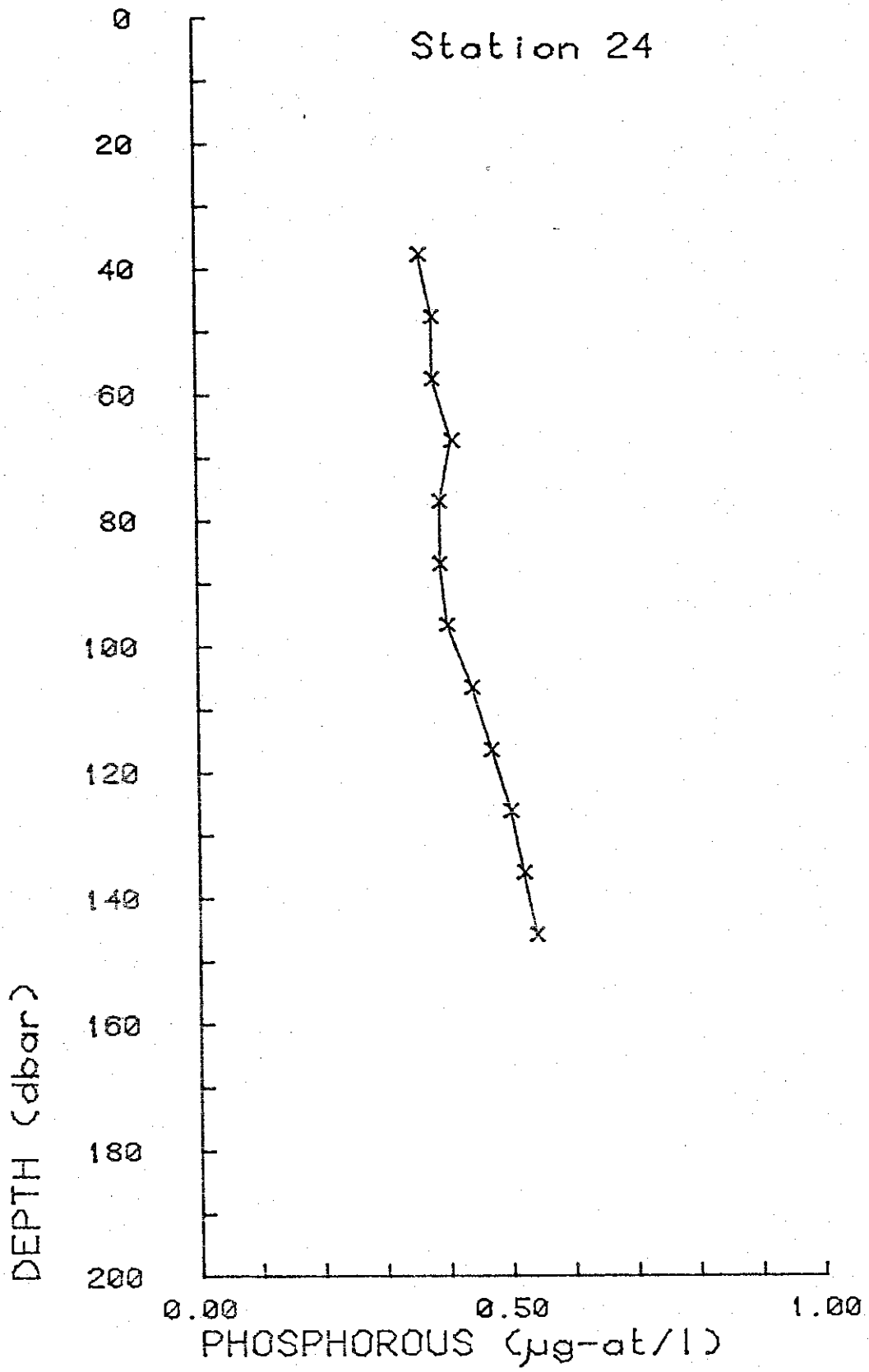

Figure 6a. Reactive phosphorus data for station 24.

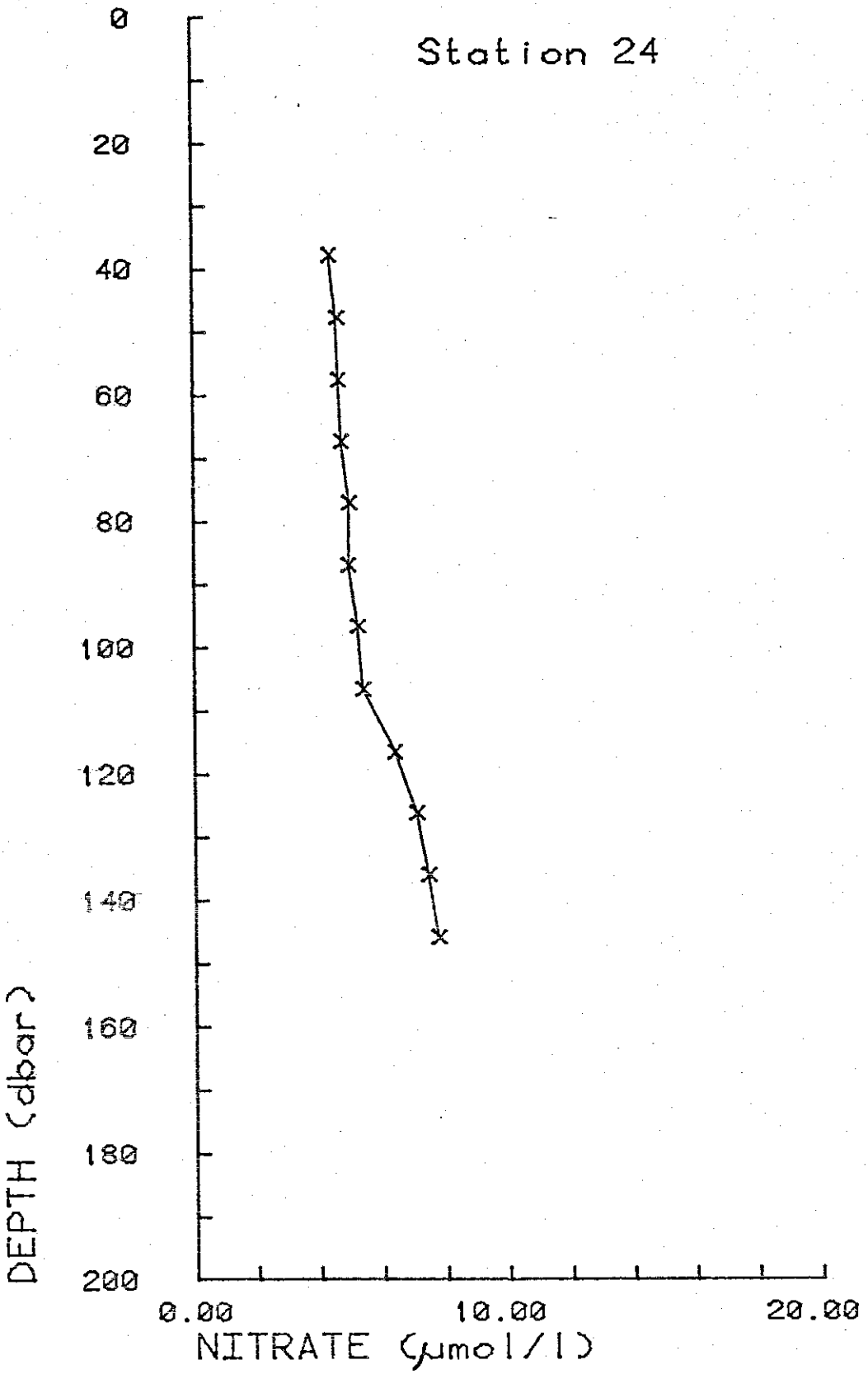

Figure 6c. Nitrate data for station 24.

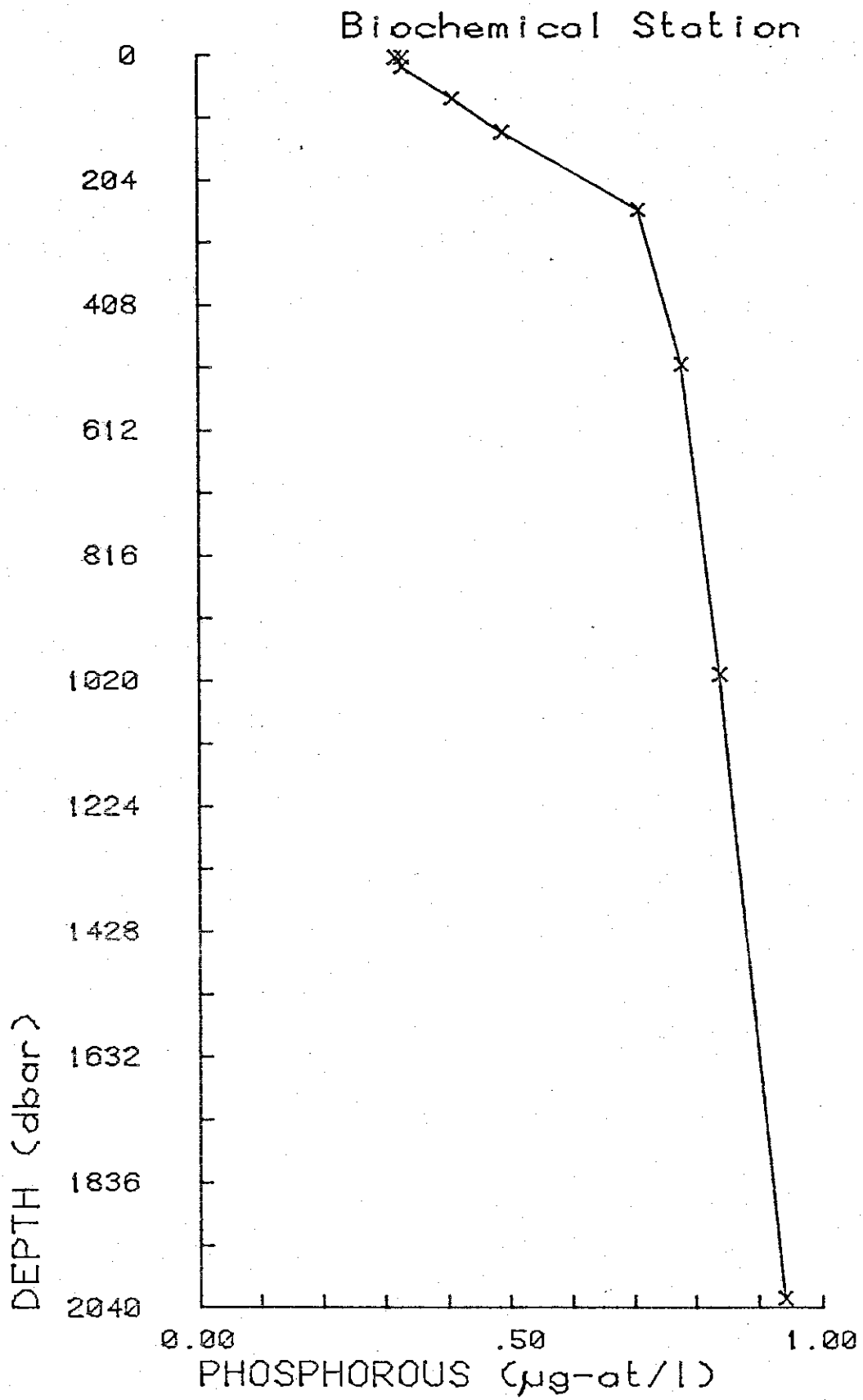

Figure 7a. Reactive phosphorus data for the biochemical station.

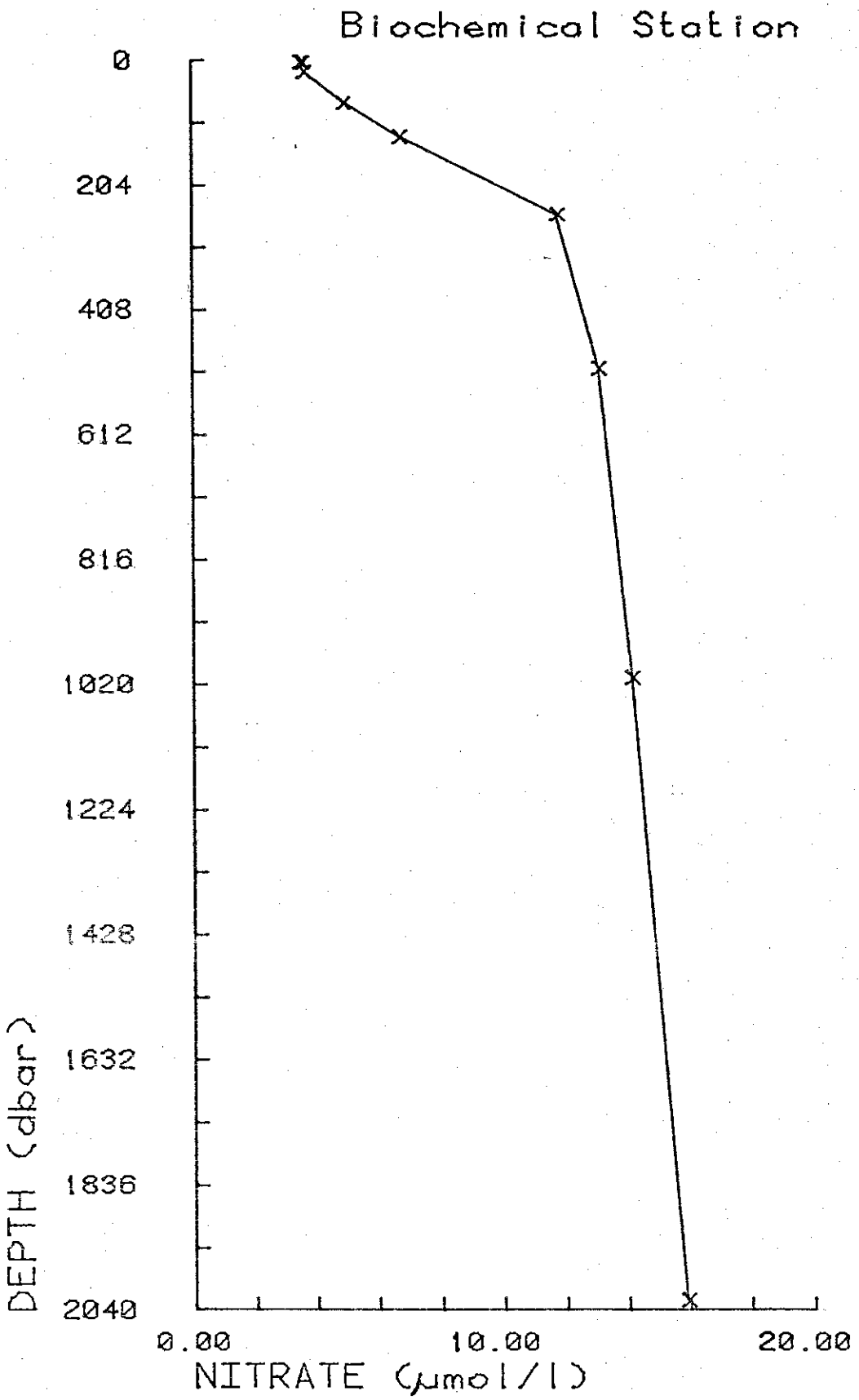

Figure 7c. Nitrate data for the biochemical station.

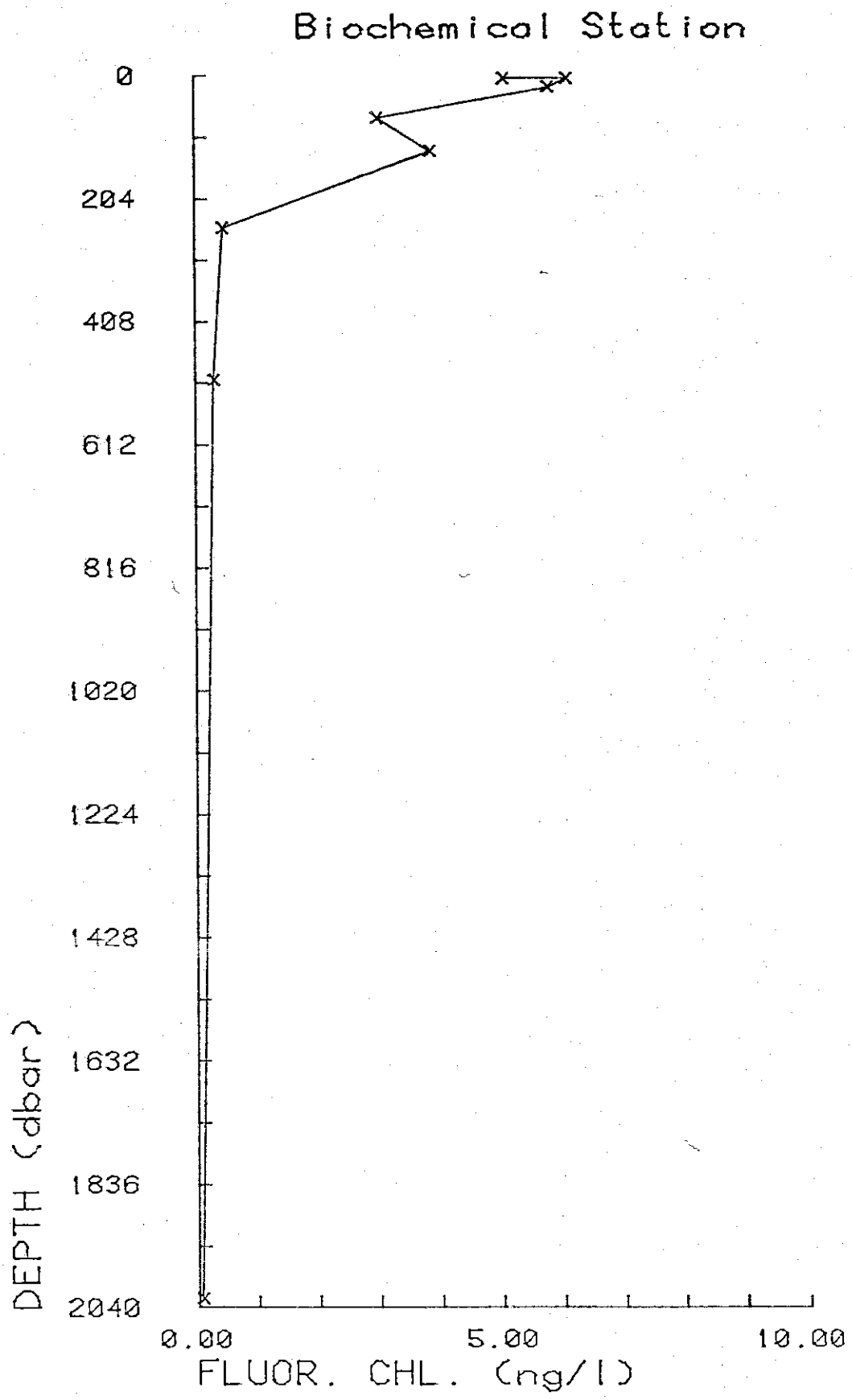

Figure 7e. Fluorometric chlorophyll a data for the biochemical station.

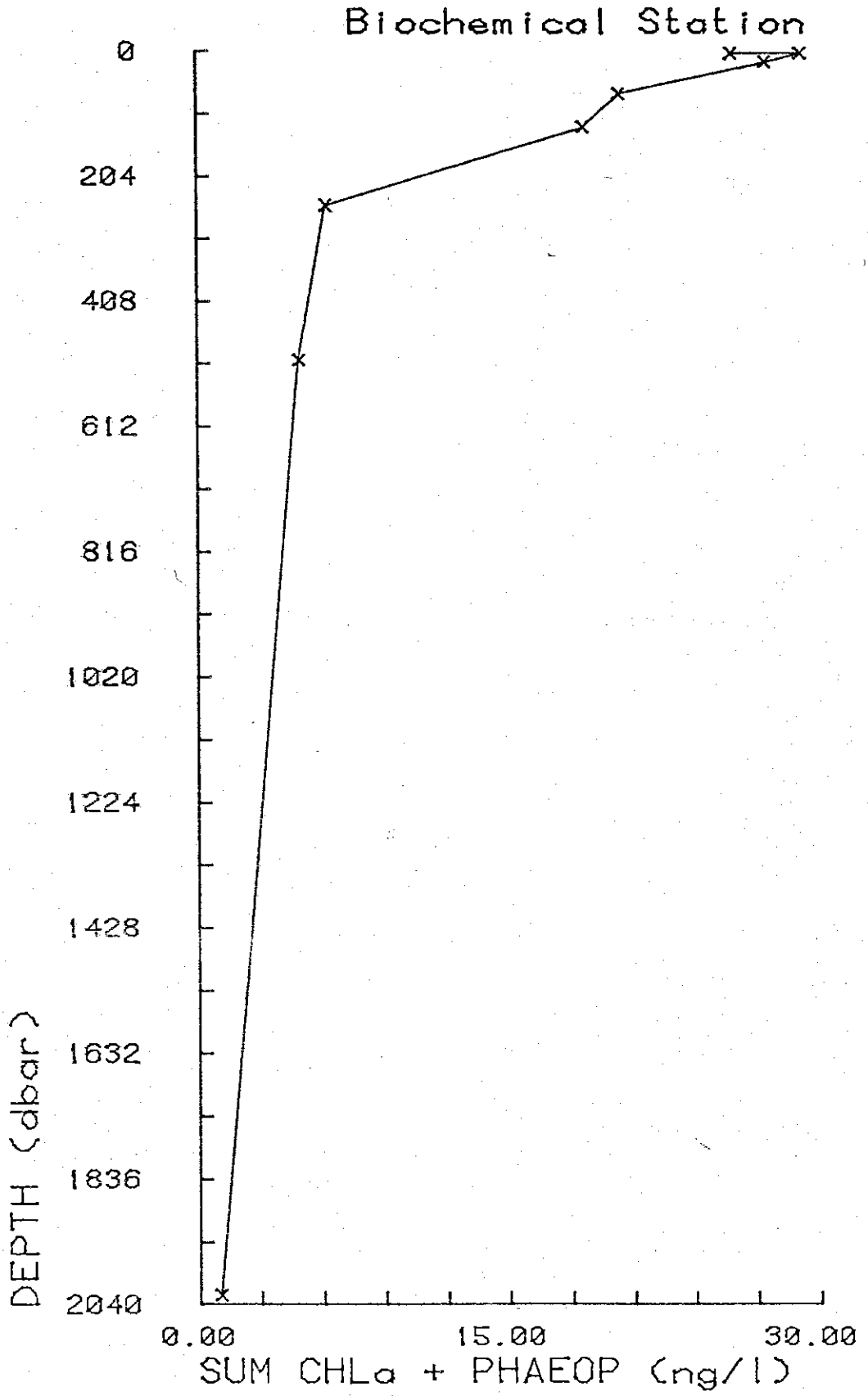

Figure 7g. The sum of chlorophyll-a and phaeopigment data for the biochemical station.

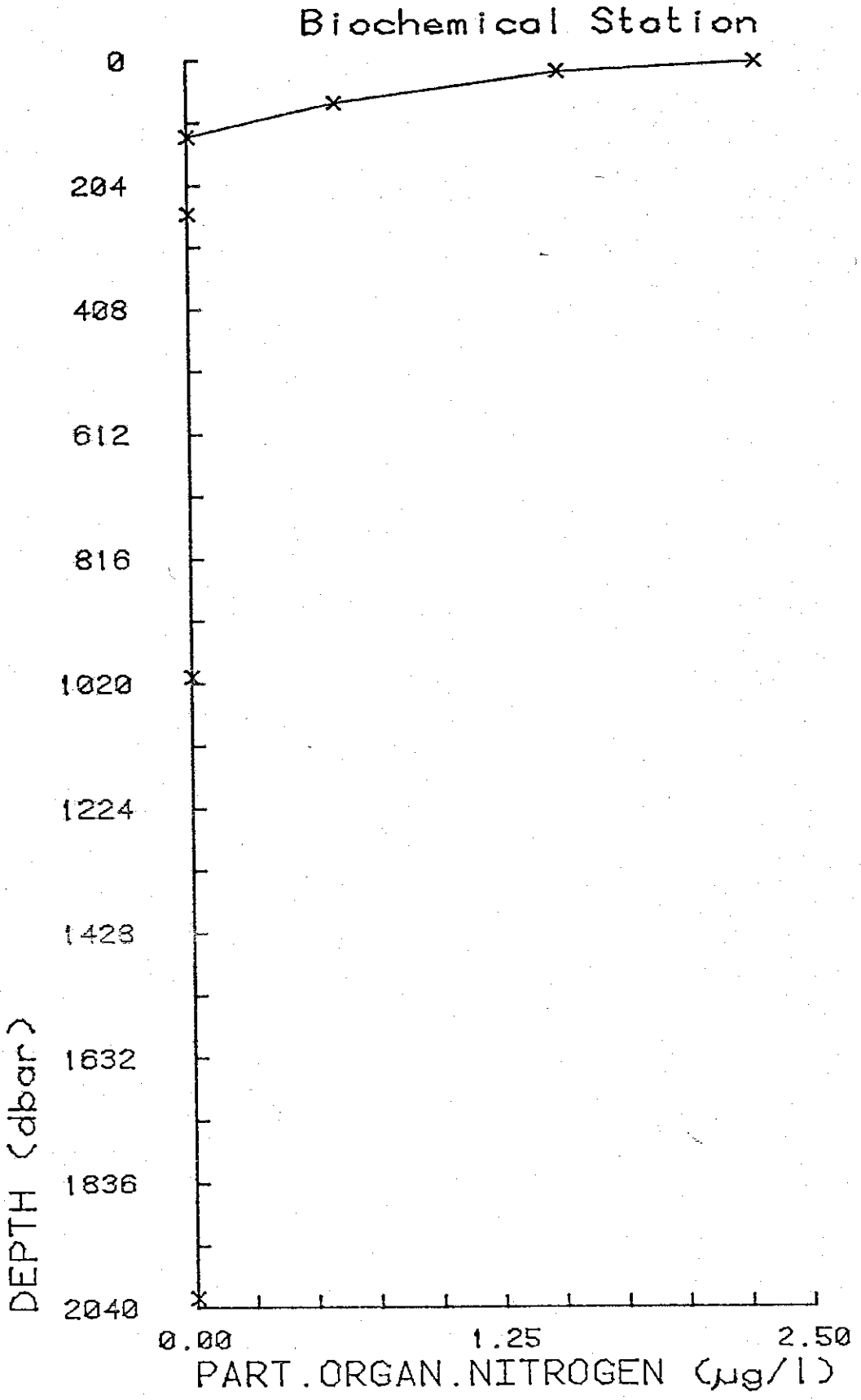

Figure 7i. Particulate organic nitrogen data for the biochemical station.

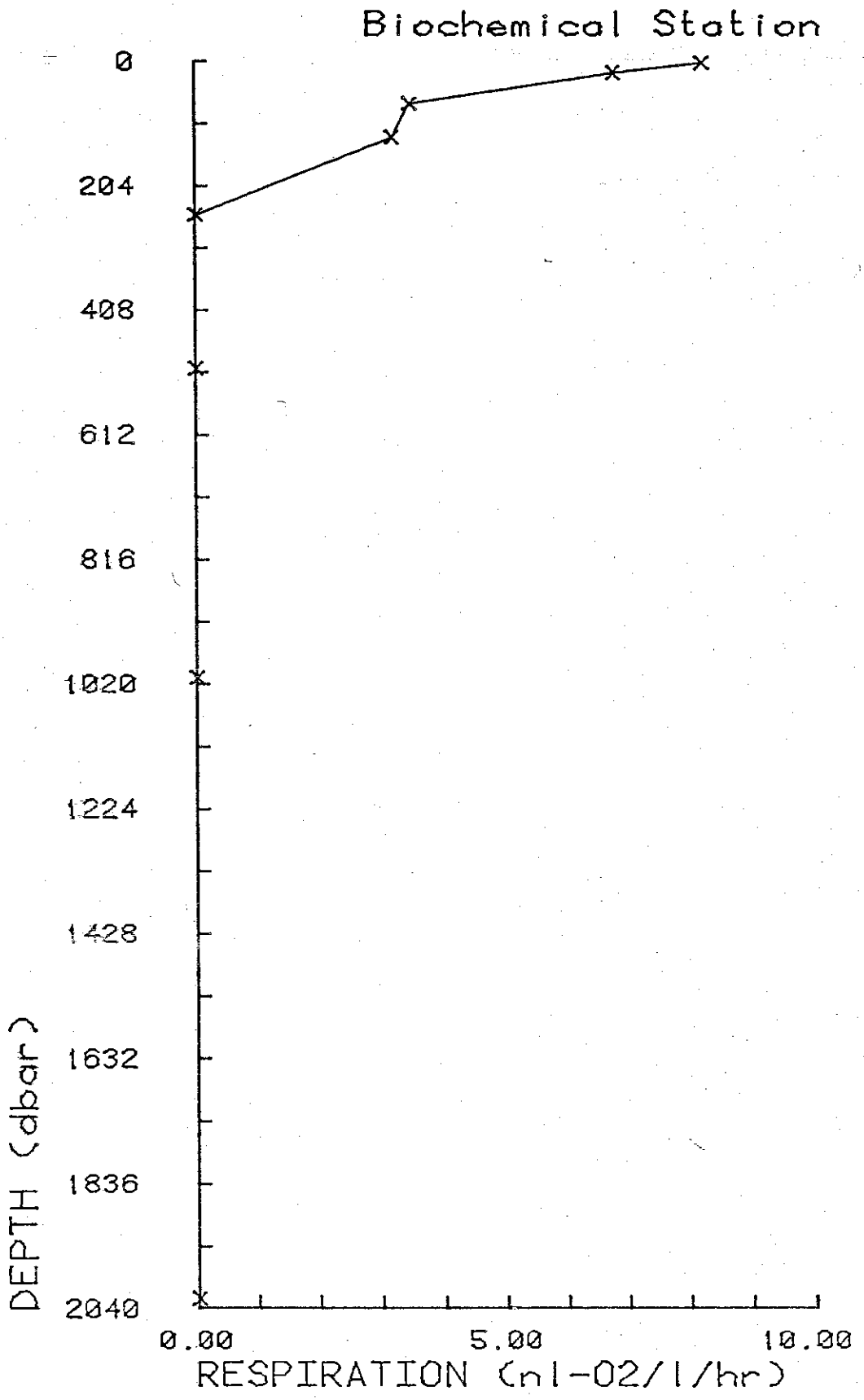

Figure 7k. Respiration rates determined from ETS activity for the biochemical station.

1981 FRAM III - BIGELOW LABORATORY COMPONENT

STATION	LATITUDE	LONGITUDE	DATE (GMT)	TIME (GMT)	SONIC DEPTH (M)
2	83° 05.28'N	09° 55.35'E	8 April 1981	1100	4009

DEPTH	TEMPERATURE	SALINITY	OXYGEN	PHOSPHATE	DISSOLVED SILICON	NITRATE	NITRITE	AMMONIUM
18.0	-1.83	33.215	8.46	.35	4.91	2.49	.02	.07
37.8	-1.84	33.328	8.44	.36	4.76	2.73	.02	.04
47.7	-1.84	33.338	8.41	.39	4.93	3.09	.02	.04
57.5	-1.81	33.466	8.23	.42	5.49	3.49	.02	.02
67.1	-1.78	33.707	8.12	.46	5.63	3.97	.02	.03
77.1	-1.78	33.925	7.92	.46	5.63	3.97	.02	.03
86.9	-1.73	34.040	8.00	.47	4.59	4.65	.01	.03
96.7	-1.68	34.170	7.86	.50	4.49	5.41	.01	.04
106.6	-1.64*	34.220	7.74	.53	4.66	6.01	.01	.02
116.3	-1.54*	34.263	7.58	.53	4.96	6.25	.01	.06
126.2	-1.63	34.304	7.78	.50	4.13	6.16	.02	.05
136.0	-1.66	34.307	7.92	.48	3.64	5.96	.02	.06

FIELD ANALYZED SAMPLES

DEPTH	PHOSPHATE	DISSOLVED SILICON	NITRATE	NITRITE	AMMONIUM
18.0	.46	4.65	-	0.00	0.00
37.8	.47	4.58	-	0.00	0.00
47.7	.50	4.75	-	0.00	0.00
57.5	.54	5.26	-	0.00	0.00
67.1	-	5.33	-	0.00	0.00
77.1	.58	5.28	-	0.00	0.00
86.9	.55	4.42	-	0.00	0.00
96.7	.57	4.36	-	0.00	0.00
106.6	.58	4.56	-	0.00	0.00
116.3	.58	4.83	-	0.00	0.00
126.2	.55	4.05	-	0.00	0.00
136.0	.50	-	-	0.00	0.00

- Data not available
* Questionable

1981 FRAM III - BIGELOW LABORATORY COMPONENT

STATION	LATITUDE	LONGITUDE	DATE (GMT)	TIME (GMT)	SONIC DEPTH (M)
6	83° 15.30'N	08° 24.23'E	10 April 1981	1730	4025

DEPTH	TEMPERATURE	SALINITY	OXYGEN	PHOSPHATE	DISSOLVED SILICON	NITRATE	NITRITE	AMMONIUM
47.1	-1.78	33.381	8.20	.40	6.37	4.71	0.00	.05
96.6	-1.67	34.156	7.84	.48	4.32	6.57	0.00	.08
145.5	-0.91	34.399	7.46	.56	5.12	8.71	0.00	.05
195.1	1.04	34.733	7.12	.69	5.69	11.3	0.00	.02
293.0	1.86	34.918	7.14	.74	5.81	12.8	0.00	.02
342.2	1.70	34.966	7.15	.75	5.99	12.9	0.00	.03
391.4	1.51	34.940	7.15	.76	6.16	13.1	0.00	.02
440.4	1.23	34.933	7.15	.77	6.49	13.2	0.00	.02
489.5	1.00	34.935	7.00	.79	6.66	13.3	0.00	.01
734.5	0.48	34.957	7.01	.82	7.20	13.7	0.00	.03
882.0	0.10	34.951	7.09	.82	7.58	13.8	0.00	.03
1078.6	-0.20	34.953	7.05	.84	8.35	14.2	0.00	.01

FIELD ANALYZED SAMPLES

DEPTH	PHOSPHATE	DISSOLVED SILICON	NITRATE	NITRITE	AMMONIUM
47.1	.45	6.10	5.23	0.00	0.00
96.6	.48	4.30	7.02	0.00	0.00
145.5	.59	5.10	8.94	0.00	0.00
195.1	.69	5.50	11.3	0.00	0.00
293.0	.79	5.70	12.3	0.00	0.00
342.2	.75	5.70	12.3	0.00	0.00
391.4	.77	6.00	12.7	0.00	0.00
440.4	.77	6.20	12.7	0.00	0.00
489.5	.77	6.40	12.9	0.00	0.00
734.5	.87	7.30	13.3	0.00	0.00
882.0	.84	7.20	13.2	0.00	0.00
1078.6	.84	7.90	13.6	0.00	0.00

1981 FRAM III - BIGELOW LABORATORY COMPONENT

STATION	LATITUDE	LONGITUDE	DATE (GMT)	TIME (GMT)	SONIC DEPTH (M)
19	83° 00.80'N	07° 01.43'E	14 April 1981	2000	4012

DEPTH	TEMPERATURE	SALINITY	OXYGEN	PHOSPHATE	DISSOLVED SILICON	NITRATE	NITRITE	AMMONIUM
342.1	1.23	34.918	-	.73	6.18	12.1	.02	.05
391.2	1.18	34.935	-	.77	6.36	12.3	.01	.04
440.3	1.01	34.935	-	.77	6.46	12.4	.01	.05
489.7	0.94	34.947	-	.78	6.64	12.6	.01	.03
538.5	0.80	34.951	-	.80	6.66	12.8	.02	.04
587.5	0.65	34.949	-	.83	6.80	12.8	.02	.04
636.2	0.59	34.961	-	.81	6.98	12.8	.02	.03
685.6	0.42	34.961	-	.80	7.15	13.0	.02	.04
734.9	0.31	34.961	-	.81	7.17	13.0	.01	.03
783.6	0.19	34.964	-	.83	7.33	13.0	.01	.02
833.1	0.10	34.962	-	.86	7.61	13.4	.02	.07
882.1	0.01	34.961	-	.81	7.46	12.7	.01	.03

- Data not available

1981 FRAM III - BIGELOW LABORATORY COMPONENT

STATION	LATITUDE	LONGITUDE	DATE (GMT)	TIME (GMT)	SONIC DEPTH (M)
BC[1]	83° 03.85- 82° 57.93'N	07° 14.40- 06° 58.97'E	13-15 April 1981		4024-3982

DEPTH	TEMPERATURE**	SALINITY	OXYGEN	DISSOLVED PHOSPHATE	SILICON	NITRATE	NITRITE	AMMONIUM	CHLOROPHYLL	PHAEOPIGMENT
5.	-1.76	-	-	.32	5.80	3.63	0.00	.01	5.05	20.83
5.	-1.76	-	-	.33	5.77	3.54	0.00	.01	6.09	23.13
20.	-1.41	-	-	.33	5.44	3.66	0.00	.01	5.78	21.52
71.	-1.90	-	-	.41	5.06	4.95	0.00	-	3.00	17.38
126.	-1.64	-	-	.49	4.96	6.76	0.00	-	3.85	14.78
253.	.80	-	-	.71	6.23	11.8	0.00	-	.46	5.73
505.	.97	-	-	.78	6.69	13.1	0.00	-	.30	4.60
1010.	-.18	-	-	.84	8.39	14.2	0.00	-	-	-
2025.	-.78	-	-	.94	12.0	15.9	0.00	-	.06	.93

DEPTH	SUM CHL & PHAE	CARBON	NITROGEN	ETS	RESPIRATION
5.	25.88	11.0	2.3	.085	8.2
5.	29.22	-	-	-	-
20.	27.50	12.9	1.5	.070	6.8
71.	20.38	5.4	.6	.036	3.5
126.	18.63	11.1	0.0	.033	3.2
253.	6.19	6.2	0.0*	0.000	0.0
505.	4.90	4.9	1.4*	0.000	0.0
1010.	-	0.0*	0.0	0.000	0.0
2025	.99	4.8*	0.0	0.000	0.0

- Data not available

1 See text and Table 1 for sampling locations

* Questionable data

** These temperatures are from protected reversing thermometers