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Technical Report No. 133

HYDROGRAPHIC AND CURRENT DATA, BERING STRAIT 5-7 August 1964

by

K. Aagaard and L. K. Coachman

Arctic Institute of North America
Grant No. ONR 354
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Reference M65-37
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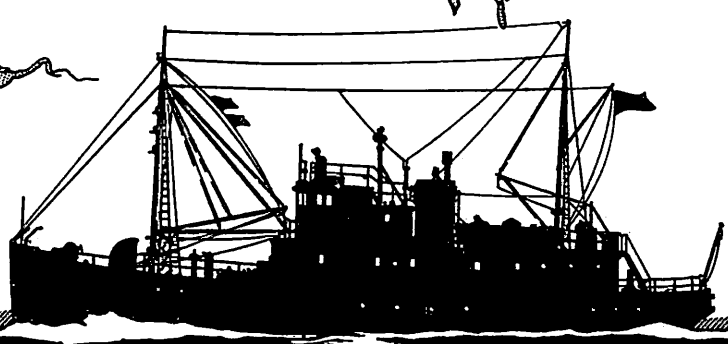

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RICHARD H. FLEMING
CHAIRMAN

L. K. COACHMAN
PRINCIPAL INVESTIGATOR

ABSTRACT

This report contains hydrographic and current data obtained in Bering Strait during 5-7 August 1964 from the USCGC Northwind by scientific personnel from the Department of Oceanography, University of Washington, and the United States Naval Oceanographic Office. These data were collected as part of a study which has among its objectives the description of the flow through Bering Strait.

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INTRODUCTION

An observational program prerequisite to assessing the flow pattern through Bering Strait, calculating the transport of water, salt and heat, and formulating an adequate model of the flow and its variations, must have the following characteristics:

(1) Observations of currents and water properties must be made in considerable detail in both horizontal and vertical extent. A rather wide range of speeds can be anticipated across the Strait (cf., e.g., Ratmanov, 1937 a, b; Barnes and Thompson, 1938; Bloom, 1964; Fleming and Heggarty, 1966), and during summer a strong velocity shear may be associated with the pronounced pycnocline (cf. Lesser and Pickard 1950, p. 6).

(2) Observations must be repeated in order to measure accelerations and changes in water properties, and these repeated observations must be arranged in time and space in such a manner that the significant fluctuations, whether periodic or aperiodic, can be defined unambiguously. This may, for example, require special care to distinguish between oscillations of similar period, such as tidal oscillations (approximately 12 hours) and inertial oscillations (13.2 hours at the latitude of Bering Strait). Ultimately the observational program must extend throughout the year (see Maksimov, 1945; Meilakh, 1958; Fedorova and Yankina, 1964; Bloom, 1964). It may prove possible to determine the flow regime in sufficient detail to enable adequate monitoring of the entire regime by certain selected measurements, but the detailed knowledge necessary to employ such simplified procedure is not presently available (contrast Bloom, 1964).

(3) Observations should be extended north and south of the Strait, to permit calculation of meridional variations in velocity and water properties.

(4) Simultaneously with the above observations, the level of the sea surface should be monitored both in the Strait and in the Bering and Chukchi seas.

METHODS

The Northwind survey 1964 was conducted 5-7 August 1964, by the University of Washington and the U.S. Naval Oceanographic Office. The measurements were planned with points 1-3 (above) in mind; due to ice-breaking commitments only 1, 2 were accomplished, and these not in the detail envisioned.

The location of stations (Fig. 1) was restricted by the requirement of remaining outside USSR territorial waters (ca. 22 km); thus the observations across the western channel were taken from the bay south of Cape Dezhneva toward a point south of the Diomede Islands. To the north

and west of station 9, i.e., in the bay south of Cape Dezhneva, the bottom lies at depths less than one-half those in the western channel proper. We believe that by locating the stations as shown, only a nominal amount of the flow through the Strait was missed.

At each station the ship was anchored. At stations 2-7 and 9-16 hydrographic casts were made for temperature, salinity and dissolved oxygen, and analyses were made by standard methods. Direct current measurements to within five meters of the bottom were made at all stations. A buoy with three meters of the Roberts type suspended at depths of 2, 20, and 38 m was located at station 8, and the signals were monitored a aboard the Northwind. Repeated stations were obtained at 1, 4, and 2, 16. The observations are given in Tables 1 and 2.

Currents were measured by two direct-reading Kelvin-Hughes current meters lowered with the hydrographic wire as supporting cable, heavy weights attached. No roll of the vessel occurred during the measurements, and as well as could be ascertained by visual observations and checks of the ship's heading, the icebreaker rode to anchor without yawing. To compensate for magnetic effects of the ship's hull, current directions measured in the upper ten meters were realigned to agree with visual surface observations, related to the ship's gyro compass. Wherever visual observations were not available, the current directions in the upper layer have been extrapolated from deeper measurements.

The meters were calibrated at the University of Washington; speed values reported are reliable to $\pm$ 5 cm sec^{-1} and directions probably to $\pm$ 10°. However, fluctuations of this amount were frequently noted in the instantaneous currents, and so the meters were held at each depth for a few minutes and averages recorded.

ACKNOWLEDGMENTS

The assistance in the field of W. Gsell and R. Magan, U.S. Naval Oceanographic Office, and A. S. Frisch, J. A. Galt, and R. S. Winter, University of Washington, is gratefully acknowledged. The officers and men of the USCGC Northwind were most cooperative. Financial assistance was provided by the Arctic Institute of North America and the Office of Naval Research.

EXPLANATION OF DATA TABLES

Abbreviations and Headings Used in Data Tables

Station	Consecutive station number
Date	Month/day/year, Greenwich mean time
Hr (Hour)	Span of observations, Greenwich mean time
Lat (Latitude)	Degrees and minutes, N(North)
Long (Longitude)	Degrees and minutes, W(West)
Sdg (Sounding)	Depth of water in meters
Wspd (Wind speed)	In knots
Dir (Wind direction)	Direction from which the wind comes. See code, page 4
Bar (Barometric pressure)	To obtain barometric pressure in millibars, add 900 if number is greater than 50; add 1000 if number is less than 50.
Cl (Cloud type)	See code, page 4
Amt (Cloud cover)	See code, page 4
Dry (Air temperature, dry bulb)	In tenths of degrees Celsius
Wet (Air temperature, wet bulb)	In tenths of degrees Celsius
Depth	Depth in meters of observation
t (Water temperature)	In degrees Celsius
S (Salinity)	In parts per thousand
σt (Sigma-t)	An expression for the density of sea water at atmospheric pressure and the in situ temperature and salinity, obtained from the equation: Sigma-t = (Density -1) x 1000
O_2 (Oxygen concentration)	Concentration of dissolved oxygen per liter of sea water, expressed in milliliters of oxygen gas at normal pressure and 20°C
Current speed	In centimeters per second
Current direction	Direction toward which the current sets. In degrees true.

Codes Used for Reporting Observations

Taken from U.S. Navy Hydrographic Office Publication No. 606-c, Hydrographic Office Observers Manual, Bathythermograph Observations" and U.S. Navy Hydrographic Office Publication No. 607, "Instruction Manual for Oceanographic Observations."

Direction (H.O. 607)

Code

01 to 36	Each value represents one tenth of the true direction in degrees, measured clockwise from the north, with 36 representing true north.

Cloud Type (H.O. 607)

Code

0	Stratus or fractostratus
1	Cirrus
2	Cirrostratus
3	Cirrocumulus
4	Altocumulus
5	Altostratus
6	Stratocumulus
7	Nimbostratus
8	Cumulus or fractocumulus
9	Cumulonimbus

Cloud Amount (H.O. 606-c, WMO 60)

Code

0	No clouds
1	Less than 1/10, or 1/10
2	2/10 and 3/10
3	4/10
4	5/10
5	6/10
6	7/10 and 8/10
7	9/10 and 9/10 plus
8	10/10
9	Sky obscured

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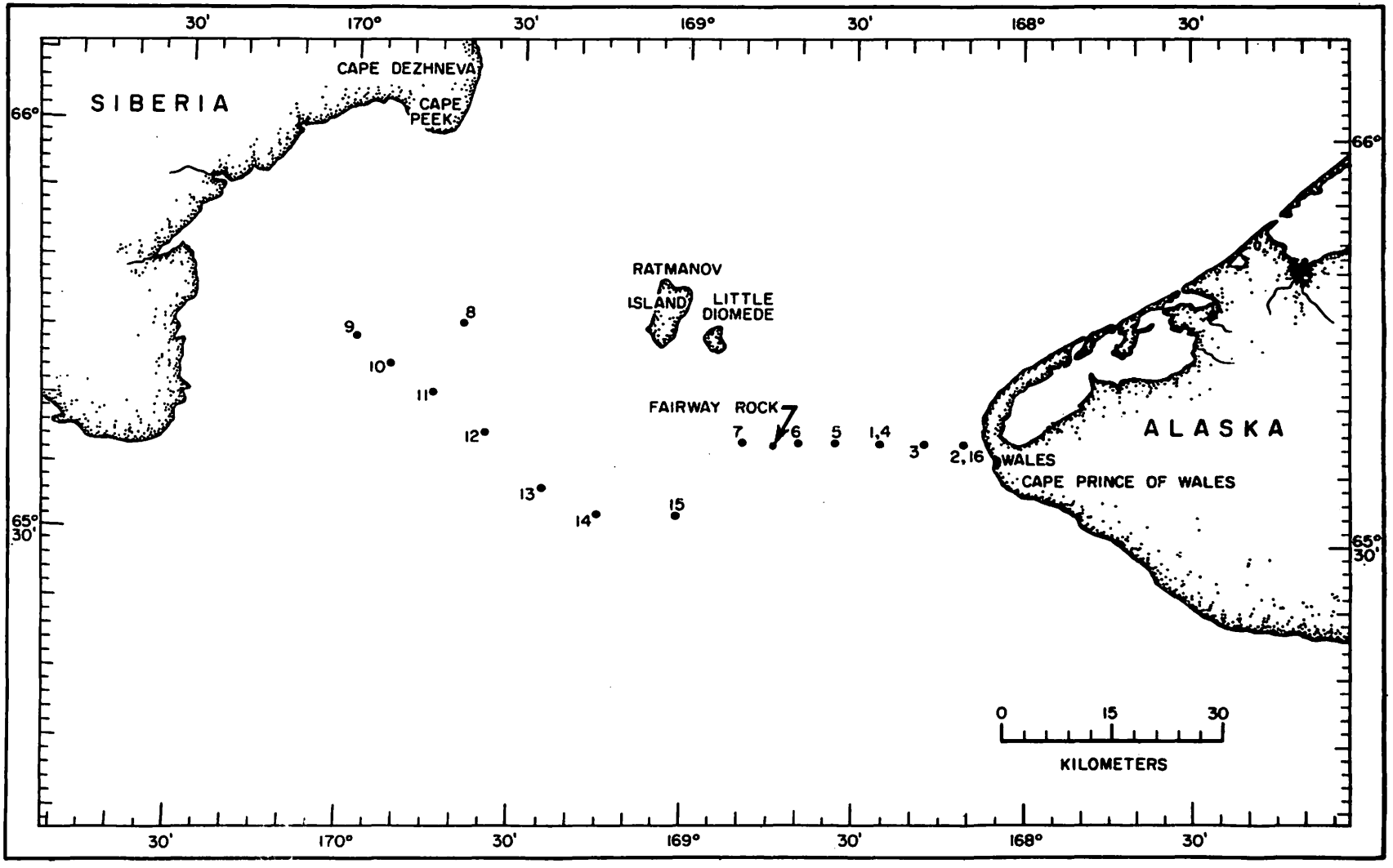

Fig. 1. Location of Northwind stations, 5-7 August 1964.

DATA TABLES

Table 1

Hydrographic Observations and Kelvin-Hughes Current Meter Measurements

Station 01 Date 08/05/64 Hr 0030-0055 Lat 65-38N Long 168-26W
Sdg 48 Wspd -- Dir -- Bar -- Cl -- Amt -- Dry -- Wet --

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
2	-	-	-	-	55	000
5	-	-	-	-	30	000
10	-	-	-	-	20	000
25	-	-	-	-	50	330
28	-	-	-	-	50	335
30	-	-	-	-	45	335
33	-	-	-	-	35	335
37	-	-	-	-	35	335

Station 02 Date 08/05/64 Hr 1100-1135 Lat 65-38N Long 168 11W
Sdg 33 Wspd 22 Dir 05 Bar 16 Cl 6 Amt 5 Dry 076 Wet 070

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	6.64	29.85	23.44	7.37	-	-
2	-	-	-	-	90	355
5	6.59	29.83	23.42	7.30	-	-
9	5.52	30.12	23.79	7.73	-	-
10	-	-	-	-	80	355
14	3.38	30.72	24.47	8.03	90	325
18	2.05	31.30	25.04	8.37	-	-
19	-	-	-	-	50	345
23	1.90	31.38	25.10	8.41	-	-
27	1.92	31.39	25.11	8.41	-	-
28	-	-	-	-	30	315

Table 1 continued

Station 03 Date 08/05/64 Hr 1255-1320 Lat 65-38N Long 168-18W
Sdg 44 Wspd 15 Dir 05 Bar 16 Cl 6 Amt 5 Dry 075 Wet 070

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	6.30	30.15	23.72	7.52	-	-
2	-	-	-	-	95	340
5	6.28	30.14	23.71	7.57	-	-
9	6.31	30.18	23.74	7.52	-	-
10	-	-	-	-	95	340
14	2.03	31.64	25.31	8.51	60	335
19	2.10	31.64	25.30	8.31	45	335
23	-	-	-	-	45	285
24	2.08	31.69	25.34	8.48	-	-
28	2.10	31.69	25.34	8.58	40	335
33	2.12	31.69	25.34	8.48	-	-
36	-	-	-	-	40	335
38	2.11	31.68	25.33	8.54	-	-
39	-	-	-	-	35	305

Station 04 Date 08/05/64 Hr 1445-1510 Lat 65-38N Long 168-26W
Sdg 48 Wspd 16 Dir 06 Bar 14 Cl 6 Amt 5 Dry 071 Wet 069

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	9.42	30.95	23.91	6.97	-	-
2	-	-	-	-	70	345
5	9.42	30.96	23.92	6.97	-	-
10	9.36	30.96	23.93	6.90	70	345
15	3.97	-	-	7.68	65	340
19	3.50	31.95	25.43	7.82	55	305
24	3.52	31.96	25.44	7.79	55	295
28	-	-	-	-	50	285
29	3.56	31.97	25.44	7.99	-	-
34	3.61	31.97	25.44	7.74	-	-
37	-	-	-	-	45	280
39	3.65	32.00	25.46	7.69	-	-
44	3.67	32.01	25.46	7.64	-	-
45	-	-	-	-	35	280

Table 1 continued

Station 05 Date 08/05/64 Hr 1640-1700 Lat 65-38N Long 168-34W
Sdg 51 Wspd 20 Dir 04 Bar 15 Cl 6 Amt 5 Dry 071 Wet 069

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	8.72	30.85	23.94	7.07	-	-
2	-	-	-	-	75	330
5	8.69	30.86	23.95	7.40	-	-
9	8.62	30.85	23.96	7.21	-	-
10	-	-	-	-	70	330
14	4.70	32.06	25.40	-	80	335
19	4.30	32.22	25.57	7.81	95	325
23	-	-	-	-	90	315
24	2.52	32.39	25.87	7.78	-	-
27	-	-	-	-	70	305
28	2.03	32.44	25.94	8.04	-	-
33	1.73	32.46	25.99	7.88	-	-
35	-	-	-	-	50	295
38	1.65	32.46	25.99	-	-	-
41	-	-	-	-	45	290
42	1.56	32.47	26.00	7.48	-	-
47	1.55	32.48	26.00	7.73	-	-

Table 1 continued

Station 06 Date 08/05/64 Hr 1800-1845 Lat 65-38N Long 168-40W
Sdg 50 Wspd 18 Dir 34 Bar -- Cl 6 Amt 6 Dry 080 Wet 072

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	10.62	30.38	23.27	7.45	-	-
2	-	-	-	-	55	005
5	10.60	30.40	23.29	6.82	-	-
10	10.56	30.41	23.31	6.65	55	005
15	2.70	32.12	25.64	-	50	010
20	1.38	32.50	26.04	7.98	50	015
24	-	-	-	-	35	335
25	1.37	32.50	26.04	7.86	-	-
29	-	-	-	-	40	345
30	1.37	32.49	26.03	7.93	-	-
34	1.34	32.49	26.03	8.03	-	-
39	1.36	32.49	26.03	8.09	40	340
43	-	-	-	-	50	335
44	1.33	32.50	26.04	8.03	-	-

Table 1 continued

Station 07 Date 08/05/64 Hr 2040-2110 Lat 65-38N Long 168-50W
Sdg 49 Wspd 18 Dir 36 Bar 14 Cl -- Amt -- Dry 074 Wet 069

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	9.96	31.28	24.08	7.00	-	-
2	-	-	-	-	60	015
5	9.91	31.28	24.09	6.86	-	-
9	9.84	31.29	24.11	6.93	-	-
10	-	-	-	-	60	015
14	9.16	31.54	24.41	-	-	-
15	-	-	-	-	40	015
19	1.24	32.61	26.14	6.83	-	-
20	-	-	-	-	45	005
24	1.09	32.71	26.22	6.55	-	-
28	1.09	32.67	26.19	6.69	-	-
29	-	-	-	-	40	345
33	1.04	32.68	26.20	6.60	-	-
38	1.08	32.68	26.19	6.50	-	-
39	-	-	-	-	35	335
42	1.04	32.68	26.20	6.60	40	335

Station 08 Date 08/06/64 Hr 0700-0710 Lat 65-46N Long 169-40W
Sdg 50 Wspd -- Dir -- Bar -- Cl -- Amt -- Dry -- Wet --

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
2	-	-	-	-	35	340
10	-	-	-	-	35	335
20	-	-	-	-	40	005
30	-	-	-	-	35	335
38	-	-	-	-	30	335

Table 1 continued

Station 09 Date 08/06/64 Hr 0945-1035 Lat 65-45N Long 169-59W
Sdg 37 Wspd 08 Dir 02 Bar 11 Cl 6 Amt 4 Dry 062 Wet 054

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	4.37	32.80	26.02	8.67	-	-
2	-	-	-	-	20	005
5	4.40	32.80	26.02	-	-	-
10	4.28	32.80	26.03	8.68	20	005
15	4.25	32.81	26.04	8.73	25	005
20	3.40	32.87	26.18	7.53	25	345
25	1.95	32.95	26.36	6.30	25	345
30	1.93	32.96	26.37	6.23	20	340
35	-	-	-	-	25	335

Station 10 Date 08/06/64 Hr 1125-1140 Lat 65-43N Long 169-53W
Sdg 45 Wspd 18 Dir 04 Bar 10 Cl 8 Amt 3 Dry 059 Wet 047

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	2.94	32.92	26.25	8.23	-	-
2	-	-	-	-	25	290
5	2.93	32.93	26.26	8.51	-	-
10	2.84	32.93	26.27	8.42	25	290
15	2.17	32.96	26.35	7.00	-	-
20	2.02	32.96	26.36	6.74	30	340
25	2.04	32.96	26.36	6.57	30	340
30	2.02	32.97	26.37	6.50	30	320
35	2.00	33.01	26.40	6.58	30	320
40	2.00	-	-	6.65	20	305

Table 1 continued

Station 11 Date 08/06/64 Hr 1305-1325 Lat 65-41N Long 169-45W
Sdg 45 Wspd 09 Dir 04 Bar 10 Cl 6 Amt 2 Dry 063 Wet 052

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	3.39	32.92	26.22	8.28	-	-
2	-	-	-	-	25	330
5	3.42	32.93	26.22	8.58	60	330
10	3.31	32.92	26.23	8.70	35	330
15	3.31	32.93	26.23	8.73	-	-
20	2.68	32.96	26.31	7.66	40	005
25	2.14	33.00	26.39	6.87	-	-
30	2.13	33.00	26.39	6.87	35	335
34	2.11	33.01	26.40	6.80	-	-
39	2.12	32.99	26.38	6.85	-	-
40	-	-	-	-	30	330
42	2.11	32.97	26.37	6.87	-	-

Station 12 Date 08/06/64 Hr 1445-1505 Lat 65-38N Long 169-36W
Sdg 48 Wspd 13 Dir 05 Bar 10 Cl 6 Amt 7 Dry 070 Wet 062

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	3.24	32.88	26.20	8.57	-	-
2	-	-	-	-	55	350
5	3.27	32.90	26.21	8.83	-	-
10	3.17	32.90	26.22	8.53	55	350
14	2.73	32.92	26.28	8.14	-	-
15	-	-	-	-	60	340
19	1.84	32.99	26.40	6.43	-	-
20	-	-	-	-	40	000
24	1.82	32.98	26.40	6.37	-	-
25	-	-	-	-	45	345
29	1.80	32.99	26.40	6.36	-	-
30	-	-	-	-	30	320
34	1.79	32.99	26.40	6.43	-	-
39	1.83	32.98	26.40	6.34	30	325
43	1.78	32.99	26.40	6.27	35	325

Table 1 continued

Station 13 Date 08/06/64 Hr 1635-1655 Lat 65-34N Long 169-26W
Sdg 49 Wspd 17 Dir 05 Bar 10 Cl 0 Amt 6 Dry 072 Wet 068

Dept m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	3.16	32.83	26.16	8.70	-	-
2	-	-	-	-	70	350
5	3.17	32.80	26.14	8.90	-	-
10	3.07	32.75	26.11	8.72	70	350
15	3.10	32.75	26.11	8.72	60	345
19	-	-	-	-	60	355
20	1.86	32.85	26.28	6.63	-	-
25	1.72	32.84	26.29	6.43	-	-
29	-	-	-	-	50	335
30	1.69	32.86	26.31	6.37	-	-
33	-	-	-	-	40	330
34	1.66	32.85	26.30	6.51	-	-
38	-	-	-	-	40	320
44	1.66	32.87	26.32	6.37	30	315

Station 14 Date 08/06/64 Hr 1810-1830 Lat 65-32N Long 169-16W
Sdg 40 Wspd 07 Dir 05 Bar 11 Cl 0 Amt 6 Dry 081 Wet 078

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	2.87	32.68	26.06	8.48	-	-
2	-	-	-	-	60	350
5	2.89	32.68	26.06	8.54	-	-
10	2.84	32.69	26.08	8.42	55	350
14	2.36	32.73	26.14	7.68	-	-
15	-	-	-	-	55	340
19	1.73	32.70	26.18	7.22	-	-
20	-	-	-	-	45	345
24	1.68	32.70	26.18	7.07	-	-
29	1.62	32.70	26.18	6.97	40	340
34	1.59	32.69	26.18	7.06	40	320

Table 1 continued

Station 15 Date 08/06/64 Hr 1935-1955 Lat 65-32N Long 169-02W
Sdg 53 Wspd 03 Dir 09 Bar 10 Cl 6 Amt 3 Dry 100 Wet 090

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	5.21	32.27	25.52	8.92	-	-
2	-	-	-	-	70	330
5	4.02	32.39	25.73	8.87	60	330
10	2.30	32.59	26.04	8.14	55	330
14	1.88	32.62	26.10	7.72	-	-
19	1.55	32.64	26.14	7.31	-	-
20	-	-	-	-	45	345
24	1.54	32.64	26.14	7.23	40	330
29	1.49	32.64	26.14	7.34	40	320
34	1.45	32.65	26.16	7.22	-	-
39	1.43	32.66	26.17	7.15	35	310
43	1.41	32.65	26.16	7.22	30	310
48	1.41	32.66	26.17	7.22	25	300

Station 16 Date 08/07/64 Hr 0520-0540 Lat 65-38N Long 168-11W
Sdg 35 Wspd 11 Dir 02 Bar 12 Cl 6 Amt 6 Dry 130 Wet 118

Depth m	t °C	S °/oo	σ_t	O_2 ml L^{-1}	Current speed cm sec^{-1}	Current direction, toward °T
0	11.42	28.11	21.38	6.55	-	-
2	-	-	-	-	155	340
4	11.33	28.24	21.49	6.53	145	340
8	10.56	29.86	22.88	6.55	130	340
12	6.37	30.15	23.71	7.43	100	345
15	5.52	30.18	23.83	7.70	70	350
19	5.20	30.27	23.94	7.65	60	330
21	-	-	-	-	40	320
23	4.80	30.41	24.09	7.70	-	-
25	-	-	-	-	30	320
27	4.35	30.56	24.25	7.95	-	-

Table 2

Roberts Current Meter Measurements (Station 8)

6-7 August 1964

Day	Hour GMT	At 2 meters Speed cm sec^{-1}	At 2 meters Direction, toward °T	At 20 meters Speed cm sec^{-1}	At 20 meters Direction, toward °T	At 38 meters Speed cm sec^{-1}	At 38 meters Direction, toward °T
6	0654	35	-	40	035	35	015
	0724	45	345	40	020	40	020
	0754	30	-	35	020	40	020
	0824	35	280	45	020	40	020
	0854	40	340	45	020	35	020
	0925	35	-	40	020	40	020
	0955	30	270	45	020	35	030
	1024	35	310	45	020	40	030
	1054	35	300	45	020	40	020
	1124	-	-	45	020	40	020
	1154	40	350	45	-	40	020
	1224	40	320	45	000	40	020
	1254	30	270	45	020	40	020
	1324	40	040	50	020	45	020
	1354	45	-	50	020	45	020
	1424	45	345	50	020	45	020
	1454	40	330	45	010	50	020
	1523	45	330	60	020	45	020
	1553	55	065	55	020	45	020
	1623	55	050	60	020	50	020
	1653	50	110	55	020	40	020
	1723	50	075	55	020	55	020
	1753	60	035	60	020	55	020
	1823	55	-	60	020	55	020
	1923	40	055	55	020	50	020
	1954	50	345	50	-	40	-
	2023	50	055	50	050	50	-
	2054	45	-	55	-	50	-
	2124	45	-	50	-	45	-
	2154	35	-	55	-	45	-
	2224	40	-	45	-	40	-
	2254	40	040	50	-	40	-
	2324	35	310	50	-	40	-
	2354	35	-	45	-	45	-

Table 2 continued

Day	Hour GMT	At 2 meters Speed cm sec^{-1}	At 2 meters Direction, toward °T	At 20 meters Speed cm sec^{-1}	At 20 meters Direction, toward °T	At 38 meters Speed cm sec^{-1}	At 38 meters Direction, toward °T
7	0024	30	080	50	-	50	-
	0054	40	-	55	-	45	-
	0124	45	355	40	-	40	-
	0154	45	-	55	-	50	-
	0223	50	350	50	-	45	-
	0253	50	-	50	-	50	-
	0323	50	-	50	-	45	-
	0353	55	-	40	-	45	-
	0423	45	005	55	-	45	-
	0453	55	040	50	-	50	-
	0523	60	-	-	-	45	-
	0623	60	-	55	-	50	-
	0653	60	-	-	-	50	-
	0723	55	-	55	-	50	-
	0753	55	-	55	-	50	-
	0823	55	-	-	-	45	-
	0853	50	-	-	-	60	-
	0923	50	-	55	-	50	-
	0953	45	-	55	-	50	-
	1023	40	-	55	-	50	-
	1153	-	-	60	-	50	-
	1253	30	-	-	-	45	-

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