

BATHYMETRIC CHART OF THE ARCTIC OCEAN ALONG THE ROUTE OF T-3 APRIL 1952 TO OCTOBER 1953

by A. P. CRARY

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During United States Air Force operations on Fletcher's Ice Island, commonly known as T-3 (Crary, Cotell, and Sexton, 1952), an opportunity was presented for the collection of data on Arctic Ocean depths and for certain geophysical studies pertaining to the strata underlying the ocean. Included in the latter category are gravitation, refraction, and reflection data. This report briefly presents the bathymetric data. A later more comprehensive report will cover details of the bathymetry as well as the results of the geophysical studies.

To study the character of the ice island, a wide variety of portable seismic equipment was used, including a standard seismic prospecting unit, with geophones and amplifiers from the Century Geophysical Corporation, and a 12-galvanometer oscillograph of the Heiland Research Corporation. Except for a few instances, all depths were obtained with this equipment while using electric detonators as the source of acoustic energy. In the 18-month period, 218 depth determinations were obtained. During this time the island moved about 1500 km in an erratic course generally southeast, the total path ranging between the 85th and 89th parallels of latitude and between the 75th and 165th west meridians.

The island, averaging about 165 feet thick, was a poor platform for the sonic depth studies. Efficient explosions could be obtained only with considerable trouble, and the varying island thicknesses would have made dip studies unreliable. Hence, all operations were made off the edge of the island on the ice pack. A two-directional array of four to eight detectors with distances of 120 to 600 meters on a side was used for about 75 per cent of the depth shots; the remainder were made with a single detector. During December 1953, an open lead formed immediately off the island and carried the equipment more than a mile off shore. Until this was located and reset, a few depths were obtained with a Brush Development Company pen and ink recorder. During March 1953 pack-ice pressure against the island caused some damage to the oscillograph. Although an array was again set up in May 1953, the dip results thereafter were unreliable except on a few records. Fortunately, the drift of the island during this latter period was such that the area was eventually well covered and the depth changes were relatively small.

The island locations were obtained from sun or star lines about twice a week. Most of the locations are believed to be accurate to within about a mile, and many to within half a mile. The depth shots were located by interpolation between the astronomical fixes. In some cases of erratic island drift over rapidly changing depths, the observed depths and dips do not conform. In these cases more weight was given to the dip information, since the directional control was at all times sufficiently accurate for the purpose. The dip values are especially important in mapping the nor-

thern and western areas. Because the movement of the island could in no way be controlled, many interesting features could be only partially examined, but in places of high dip these data were of great assistance in obtaining the correct strike of the ocean bottom.

The depths were determined by finding the corrected time to 0.001 second of the reflected sound wave, then computing the water depth using the velocity determined by the formulae $V (m/sec) = 1442 + 6.8 T$ for total travel time, T , more than 3.5 seconds, and $V (m/sec) = 1443 + 6.7 T$ for travel times less than 3.5 seconds. These formulae agree with figures given by Kuwahara (1939) for the velocity dependence on salinity, temperature, and pressure, and the information available on the temperatures and salinities in the Arctic Ocean. The dips of the ocean floor were also calculated, using the above velocities, on the assumption of straight-line travel paths. Account was taken of the dips in obtaining the vertical depths used in the contouring. The timing reed of the oscillograph was checked regularly with a special 10-second break-circuit chronometer which was the timepiece for the astronomical observations of position. This instrument had a rate well known from radio checks with WWV time signals.

Figure 1 shows the results of the bathymetric work. The depths are relatively shallow, considering the data obtained from previous work in the central Arctic basin during drifts of the FRAM (Nansen, 1904), SEDOV (Badigin, 1940), and the NORTH POLE party (Papanin, 1947). Depths along the T-3 route nowhere exceeded 3950 meters, while the minimum depth obtained was 1340 meters.

The most striking feature is a steep rise of 500 to 1500 meters running east and west across the mapped area. This scarp was crossed several times, showing in several places dips of 10° - 23° , although the depth change usually occurred between consecutive depth shots without indication of dip. During the first month of operation in the western part of the outlined area, and before all scientific equipment had been delivered, only a few depths were obtained, and these without dip control. The possible extension of the scarp in this area is shown in dashed lines and is located on the evidence of the gravity-meter readings. These were obtained daily during this period and later showed good correlation with water depths when both types of data were available.

North of the scarp and in the western part is an extremely flat basin dipping at most 1 part in 1000. At about 105° W. longitude, this valley narrows into the mouth of a canyon which rises about 1500 meters in 120 kilometers toward the eastern part of the area. Along the northern edge of this basin the rise is not so abrupt, except in the far northwestern corner. A limited stay here precluded any detailed mapping, but the dips were 5° to 16° and generally southerly. The recurrence of increased depths running northward has been interpreted as faulting. The correlation of this rise with that noted farther east is questionable. The latter is more uniform, and the dips are gentler. A high figure of 1610 meters was obtained here, but dips are still fairly steep (6° - 8° SW.). The deep polar basin near the North Pole lies farther along on this same trend. The intervening ridge may well rise to within 1000 meters or less of sea level.

South of the main scarp the elevations fall off less abruptly into another valley, again extremely flat on the western side and rising finally toward the east where it is only partially mapped but appears to turn southeast. Still farther south, a rise out of this basin is indicated along the western side by a single depth with no dip control, and farther east by a high point near 120° W. Long. and 88° N., Lat. where the track of the island turned north.

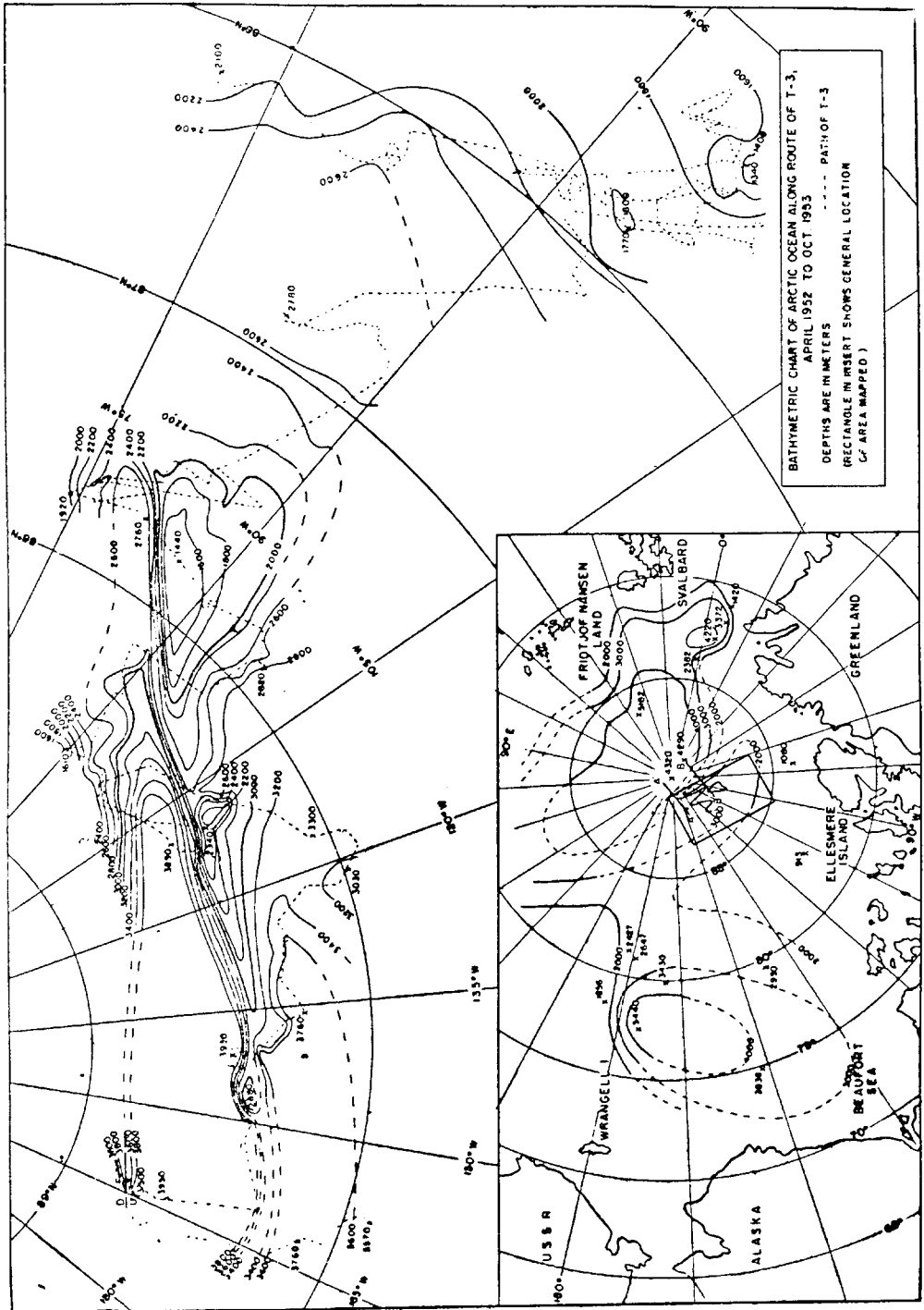


Fig. 1

Through the eastern areas, where the water depths are all less than 3000 meters, runs a broad, east-west trough with a low of 2780 meters. This trough appears to branch out toward the west around the indicated high points near 88° N. Lat. In the southeastern areas are two small, conical mounds of 100 to 200 meters of closure in the gradual rise south of the broad trough. The southern mound has a minimum depth of 1340 meters and is still undefined toward the south.

On 3 May 1952, a plane landed at the geographical North Pole when the island was only 75 nautical miles from the pole. A sounding was made here of 4320 meters, comparing closely with the depths of 4290 meters obtained during the Russian NORTH POLE drift at 88°54' N. and 20° W.

The relation of the depths mapped from T-3 with others in the central Arctic basin are illustrated in the insert of Figure 1. Cross sections (Fig. 2) show the ridge and valley system in this area. The abrupt change to the flat basins on the western cross section (A) is well determined by the dip analysis. The flat basins vary considerably in depth. Profile BB of Figure 2 has the general appearance of submarine canyons. The basins to the west are probably formed individually by the gradual filling of these canyons.

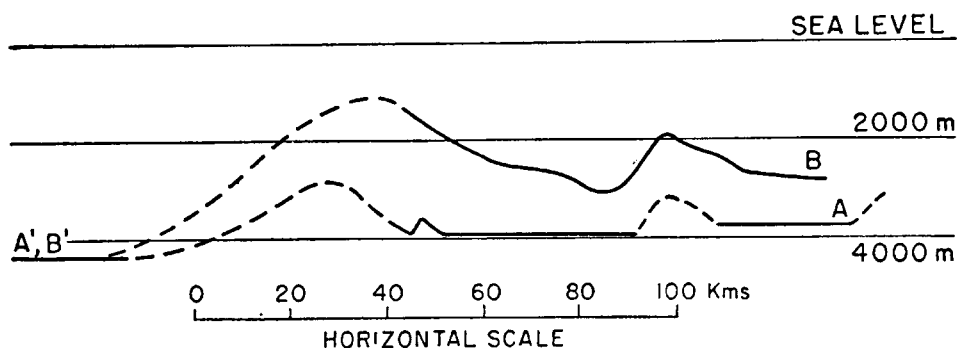


FIGURE 2.—BATHYMETRIC SECTIONS ACROSS SURVEYED AREA
See Figure 1 for location of sections.

The results of the depths mapped suggest that the Arctic Ocean deep basin is perhaps limited to two areas north of Siberia and north-west of Alaska. Recent depths obtained in the area north of Alaska by Worthington (1953) and Cary, Cotell, and Oliver (1952) would alter somewhat the depth mapping by Emery (1949). The postulation of a generally shallow Arctic area with two separate basins appears more probable than that of a narrow submarine ridge. More detailed mapping must await further soundings. These should be forthcoming soon if the route of T-3 passes into the central Arctic Ocean area.

ACKNOWLEDGEMENTS

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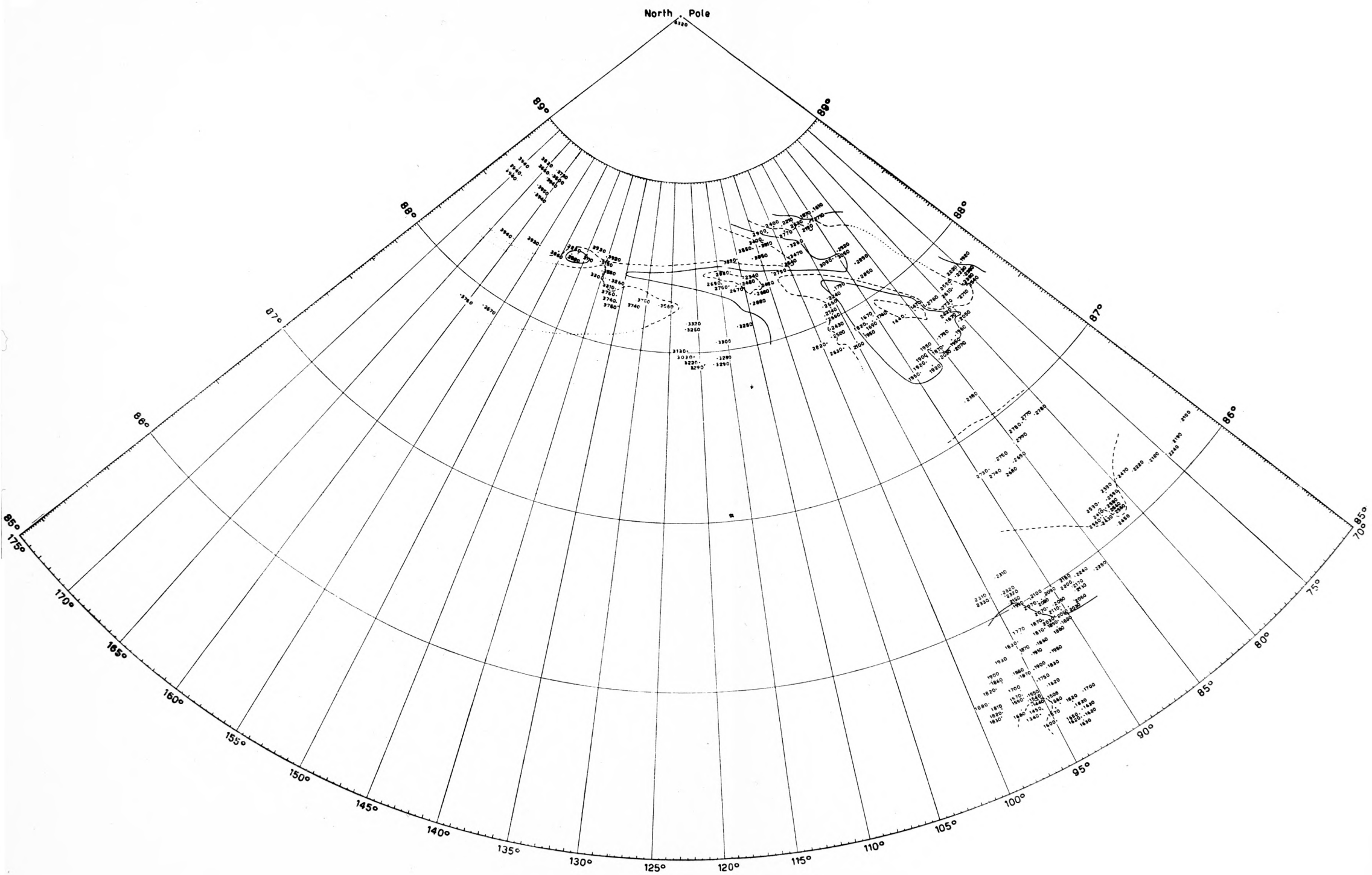
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OCEAN DEPTHS ALONG THE PATH OF T-3, APRIL 1952 TO OCTOBER 1953

DATE	TIME (GCT)	LATITUDE (North)	LONGITUDE (West)	DEPTH (meters)
April 1952				
25	08:30	87° 55'	157° 40'	3570
30	09:00	88° 07'	161° 30'	3760
May 1952				
3		NORTH POLE		4320*
8	22:00	88° 37'	168° 20'	3940
10	05:55	88° 39'	168° 20'	3940
12	04:45	88° 43'	168° 00'	3940
13	03:53	88° 44'	165° 20'	3940
14	04:25	88° 46'	163° 00'	3660
14	19:10	88° 47'	162° 30'	3500
15	09:00	88° 48'	163° 00'	3650
15	21:00	88° 49'	163° 30'	3830
16	21:30	88° 49'	162° 30'	3730
17	22:30	88° 45'	163° 00'	3940
19	01:45	88° 38'	163° 50'	3950
19	20:00	88° 34'	163° 00'	3940
21	20:50	88° 20'	160° 30'	3940
24	21:30	88° 23'	155° 10'	3930
26	19:30	88° 25'	150° 20'	3860
27	24:00	88° 26'	147° 40'	2880
28	02:50	88° 27'	146° 40'	2860
28	19:00	88° 28'	144° 40'	3110
31	21:00	88° 30'	142° 30'	3930
June 1952				
2	02:30	88° 29'	140° 30'	3920
3	20:05	88° 28'	141° 30'	3580
7	05:15	88° 27'	141° 10'	3150
7	18:30	88° 26'	141° 00'	3150
8	00:45	88° 25'	141° 00'	3510
8	01:10	88° 24'	140° 30'	3580
8	19:30	88° 22'	139° 30'	3300
9	00:30	88° 21'	138° 50'	3260
9	08:00	88° 19'	137° 00'	3310
9	21:50	88° 18'	136° 30'	3670
11	03:30	88° 17'	136° 30'	3760
12	04:30	88° 16'	136° 30'	3760
13	19:45	88° 16'	136° 20'	3740
15	19:50	88° 14'	135° 50'	3750
17	18:45	88° 16'	134° 00'	3740
18	20:00	88° 18'	132° 20'	3750
21	06:00	88° 17'	127° 40'	3560
24	05:00	88° 11'	122° 20'	3320
25	02:30	88° 09'	122° 20'	3250
27	18:30	88° 01'	122° 00'	3130
29	08:40	87° 59'	121° 00'	3030
30	11:00	87° 57'	120° 00'	3220

* This sounding was not taken along the path of T-3, but a party from T-3 took the sounding on the date indicated.



DATE	TIME (GCT)	LATITUDE (North)	LONGITUDE (West)	DEPTH (meters)
July 1952				
1	12:00	87° 56'	119° 10'	3290
2	12:00	87° 56'	118° 40'	3290
3	14:45	87° 56'	118° 10'	3290
4	13:30	87° 56'	117° 40'	3290
5	13:50	87° 58'	117° 00'	3280
7	14:45	88° 04'	116° 40'	3300
10	14:45	88° 08'	112° 40'	3280
12	10:00	88° 15'	109° 30'	2880
12	21:00	88° 18'	108° 20'	2680
13	09:30	88° 20'	107° 00'	2490
14	15:35	88° 23'	103° 50'	2790
15	18:30	88° 25'	100° 40'	3540
16	10:45	88° 26'	99° 00'	3470
17	10:00	88° 29'	98° 10'	3260
18	11:30	88° 35'	96° 40'	2460
19	09:00	88° 37'	97° 40'	2210
20	11:30	88° 37'	99° 20'	2510
21	17:40	88° 36'	101° 10'	2820
22	17:45	88° 35'	103° 10'	3400
24	09:40	88° 33'	106° 00'	3850
26	09:00	88° 31'	110° 10'	3890
28	09:00	88° 27'	112° 10'	2880
29	14:00	88° 23'	114° 40'	2690
30	17:00	88° 22'	113° 00'	2760
31	17:00	88° 22'	111° 40'	2670
Aug. 1952				
1	14:40	88° 22'	110° 40'	2480
2	16:30	88° 24'	109° 40'	2340
4	09:40	88° 30'	106° 50'	3850
5	09:40	88° 33'	104° 30'	3810
6	14:45	88° 35'	102° 30'	3340
7	16:30	88° 37'	101° 20'	2900
8	15:40	88° 38'	99° 30'	2400
10	13:15	88° 35'	97° 30'	2770
11	14:40	88° 34'	93° 50'	2630
12	15:15	88° 35'	91° 00'	1870
13	07:45	88° 35'	90° 00'	1660
13	17:10	88° 36'	89° 00'	1610
14	16:00	88° 33'	91° 20'	2190
15	15:45	88° 27'	91° 00'	2550
16	16:00	88° 23'	90° 10'	2710
17	12:00	88° 20'	89° 30'	2920
19	12:00	88° 18'	91° 00'	3090
21	12:00	88° 17'	90° 20'	3050
23	15:40	88° 13'	88° 00'	2890
25	11:30	88° 08'	89° 10'	2850
26	20:00	88° 08'	94° 00'	1790
27	09:30	88° 07'	95° 40'	2240
28	18:00	88° 05'	97° 10'	2660
29	11:50	88° 02'	97° 20'	2740
29	16:00	88° 01'	97° 20'	2660
31	12:15	87° 57'	97° 30'	2430
Sept. 1952				
1	19:20	87° 54'	98° 00'	2580
3	16:10	87° 53'	99° 00'	2820
5	07:50	87° 49'	97° 00'	2630
6	14:15	87° 49'	94° 40'	2100
7	09:10	87° 50'	93° 10'	1950
8	14:45	87° 52'	91° 40'	1820
9	20:00	87° 52'	91° 00'	1690
10	16:45	87° 53'	90° 40'	1670
12	15:00	87° 52'	90° 10'	1740

DATE	TIME	LATITUDE	LONGITUDE	DEPTH
Feb. 1953	(GCT)	(North)	(West)	(meters)
8	18:20	85° 34'	98° 50'	1880
10	15:00	85° 37'	97° 50'	1820
11	18:00	85° 38'	97° 10'	1860
15		85° 39'	96° 10'	1880
20		85° 37'	95° 50'	1870
22		85° 33'	96° 10'	1700
24		85° 31'	96° 10'	1570
25		85° 30'	96° 10'	1590
27	17:30	85° 30'	95° 50'	1550
March 1953				
2	06:50	85° 29'	96° 00'	1540
3	01:30	85° 30'	96° 10'	1510
7	19:30	85° 30'	96° 00'	1560
14	20:00	85° 37'	94° 30'	1900
15	19:30	85° 44'	93° 30'	1860
18	20:10	85° 47'	92° 10'	1810
21	16:10	85° 46'	91° 10'	1880
25	16:00	85° 46'	90° 50'	1880
27	14:50	85° 47'	90° 50'	1890
30	17:00	85° 50'	91° 00'	2030
April 1953				
2	10:00	85° 53'	90° 50'	2090
4	19:45	85° 51'	90° 10'	2110
8	16:10	85° 53'	91° 10'	2070
11	17:00	85° 50'	91° 00'	2030
14	17:00	85° 50'	90° 40'	2030
18	15:00	85° 48'	90° 50'	2020
21	11:15	85° 51'	89° 40'	2030
22	09:15	85° 52'	89° 10'	2080
23	20:00	85° 54'	88° 30'	2130
26	20:40	85° 58'	88° 10'	2180
27	20:00	85° 58'	87° 50'	2240
29	20:30	85° 57'	88° 10'	2200
30	10:30	85° 56'	88° 30'	2170
May 1953				
2	19:30	85° 46'	90° 50'	1810
4	07:30	85° 39'	92° 50'	1980
5	08:00	85° 35'	93° 40'	1830
6	10:20	85° 30'	94° 20'	1620
7	08:10	85° 26'	94° 50'	1500
8	08:40	85° 23'	95° 20'	1450
9	10:50	85° 22'	95° 40'	1340
10	09:40	85° 22'	95° 40'	1380
12	09:10	85° 22'	95° 10'	1470
14	09:00	85° 21'	94° 30'	1570
15	09:30	85° 22'	94° 00'	1660
18	10:00	85° 22'	93° 40'	1630
21	09:50	85° 20'	93° 10'	1620
24	19:40	85° 15'	93° 10'	1650
26	10:25	85° 14'	93° 10'	1620
28	11:30	85° 14'	93° 00'	1620
30	09:00	85° 14'	93° 10'	1620
June 1953				
2	09:00	85° 13'	93° 10'	1630
5	08:45	85° 16'	92° 50'	1630
7	08:25	85° 22'	92° 10'	1700
10	08:45	85° 21'	93° 10'	1630
14	11:00	85° 20'	93° 30'	1640
16	09:45	85° 18'	93° 10'	1640
17	20:00	85° 18'	93° 20'	1620
21	10:25	85° 21'	93° 20'	1660

DATE	TIME	LATITUDE	LONGITUDE	DEPTH
Sept. 1952	(GCT)	(North)	(West)	(meters)
14	18:40	87° 48'	86° 00'	1440
15	14:10	87° 47'	84° 30'	1470
16	14:00	87° 46'	82° 40'	2760
18	09:30	87° 45'	77° 40'	2590
19	10:30	87° 46'	76° 30'	2230
20	10:00	87° 47'	75° 30'	2220
22	08:30	87° 48'	74° 20'	1920
23	16:30	87° 44'	75° 30'	2380
24	22:20	87° 40'	78° 30'	2710
25	13:30	87° 39'	80° 00'	2420
26	16:00	87° 37'	82° 10'	1670
27	15:10	87° 34'	84° 30'	1790
28	15:30	87° 33'	86° 00'	1950
30	09:30	87° 31'	87° 20'	1900
30	20:20	87° 30'	87° 40'	1920
Oct. 1952				
2	20:00	87° 28'	89° 10'	1950
4	16:30	87° 28'	87° 20'	1920
5	16:20	87° 28'	86° 00'	2030
7	PM	87° 27'	83° 40'	2070
12	13:50	87° 31'	84° 30'	1870
14	16:15	87° 31'	82° 20'	1960
16	13:15	87° 34'	80° 30'	2050
17	13:10	87° 40'	79° 40'	2730
18	11:15	87° 44'	78° 00'	2610
20	11:00	87° 44'	76° 30'	2320
22	20:00	87° 43'	76° 30'	2360
23	20:00	87° 41'	76° 20'	2540
27	12:00	87° 31'	83° 00'	1950
Nov. 1952				
1	09:30	87° 10'	87° 00'	2380
7	09:00	86° 46'	89° 00'	2730
12	04:00	86° 45'	88° 00'	2740
16	04:00	86° 47'	88° 00'	2750
24	03:30	86° 42'	87° 20'	2680
29	03:00	86° 43'	86° 30'	2690
Dec. 1952				
2	03:00	86° 48'	85° 10'	2770
5	03:00	86° 52'	82° 40'	2770
10	04:00	86° 51'	81° 40'	2780
14	06:00	86° 52'	83° 10'	2780
25	15:00	86° 12'	93° 40'	2310
28	14:30	86° 08'	94° 50'	2310
30	18:00	86° 07'	95° 10'	2330
Jan. 1953				
1	15:00	86° 06'	94° 00'	2320
3	14:30	86° 05'	93° 50'	2320
5	19:00	86° 02'	93° 40'	2150
6	18:00	86° 00'	93° 40'	1990
8	14:00	85° 59'	92° 00'	2100
12	03:00	85° 57'	91° 10'	2090
14	08:30	85° 57'	91° 10'	2080
16	06:00	85° 57'	91° 20'	2080
18	09:30	85° 57'	91° 10'	2090
20	05:30	85° 57'	90° 50'	2090
23	05:10	85° 57'	91° 30'	2070
Feb. 1953				
1	03:30	85° 29'	98° 10'	1820
2	03:00	85° 28'	98° 20'	1830
4	02:30	85° 30'	98° 10'	1810

DATE	TIME	LATITUDE	LONGITUDE	DEPTH
June 1953	(GCT)	(North)	(West)	(meters)
24	08:30	85° 17'	94° 50'	1600
27	09:00	85° 20'	95° 10'	1600
29	09:00	85° 24'	95° 20'	1460
30	10:35	85° 26'	95° 50'	1440
July 1953				
3	09:10	85° 28'	96° 40'	1680
6	10:00	85° 33'	94° 40'	1750
9	09:00	85° 42'	94° 10'	1910
12	09:30	85° 44'	94° 50'	1870
15	11:20	85° 44'	96° 10'	1930
19	18:00	85° 42'	96° 50'	1900
22	09:30	85° 48'	94° 40'	1830
23	09:45	85° 50'	94° 10'	1770
26	10:00	85° 50'	92° 00'	1870
28	11:10	85° 50'	90° 20'	2050
30	10:20	85° 52'	89° 00'	2060
Aug. 1953				
4	20:35	85° 56'	86° 10'	2280
11	16:20	86° 03'	82° 20'	2450
13	11:00	86° 08'	82° 40'	2430
15	09:40	86° 13'	82° 20'	2590
17	11:30	86° 10'	82° 10'	2580
21	21:45	86° 07'	81° 50'	2550
25	20:45	86° 08'	82° 10'	2550
28	17:10	86° 09'	82° 50'	2410
Sept 1953				
1	14:50	86° 09'	83° 00'	2560
4	11:15	86° 12'	81° 40'	2590
8	15:30	86° 14'	81° 10'	2590
10	17:15	86° 15'	79° 40'	2470
13	10:45	86° 13'	78° 10'	2220
15	17:00	86° 11'	76° 40'	2180
18	16:25	86° 09'	75° 00'	2240
22	10:35	86° 10'	74° 00'	2190
25	17:15	86° 12'	72° 00'	2100