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GEOPHYSICAL AND OCEANOGRAPHIC RESEARCH IN THE ARCTIC OCEAN

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Abstract

The use of stations on drifting pack ice for geophysical and oceanographic studies of the Arctic Ocean proved highly successful. The investigations by Lamont Geological Observatory from Drifting Stations Alpha, Bravo and Charlie provided new information about the environment of the Arctic Ocean. A prominent topographic feature, the Alpha Rise, was delineated and mapped from Station Alpha. The floor of the Arctic Ocean was observed directly for the first time in submarine bottom photographs. Unique deposits of gravel were found on the ocean floor and found to have been ice-rafted from a glacial shore area. Acoustic wave propagation in the ice revealed large seasonal changes in velocity. The Chukchi Rise was delineated in detail with fathograms produced by a precision depth recorder on Station Charlie. Long range deep-water underwater sound transmission was also observed from this station and the results interpreted in terms of normal mode theory. Finally, at Station Bravo, shallow-water underwater sound transmission was observed and found to agree with theory for normal modes propagating in an ice-water-sediment system.

Introduction

The program in the Arctic of the United States of America during the International Geophysical Year (1957-1958) included a drifting pack ice station in the Arctic Ocean. This pack ice station, Drifting Station Alpha, was a joint effort of the United States Air Force and the United States National Committee for the IGY. The geophysical studies of ice, ocean and ocean floor were carried out by Lamont Geological Observatory under contract from the Geophysical Research Directorate of Air Force Cambridge Research Center. These geophysical studies are the subject of this report. The original contract provided for work at Station Alpha but it was extended to cover further work on Drifting Station Charlie (1959) and on Drifting Station Bravo (T-3, 1960). This report is a summary of the work done only. Detailed results of the findings of this project are found in the papers and scientific reports published under the contract and listed in the bibliography.

Individuals responsible for the work at the ice stations were as follows:

Station Alpha - summer 1957 - Maurice Davidson
Kenneth Hunkins
winter 1957-58 - Frans van der Hoeven
spring 1958 - Kenneth Hunkins
summer 1958 - Kenneth Hunkins
Bryan Isacks
Gary Latham
autumn 1958 - George Cvijanovich

Station Charlie - spring and summer 1959 - George Cvijanovich
Arthur Hubbard
Henry Kutschale
William Cromie

Station Charlie - autumn and winter 1959 - Thomas Herron
Roy Willie
Charles Chance

Station Bravo (T-3) - spring 1960 - Kenneth Hunkins
Henry Kutschale
Thomas Herron

autumn 1960 - Thomas Herron
Richard Knapp

During the course of the work at Station Alpha, a combined laboratory was occupied with the Micrometeorological Program of the University of Washington. The laboratory was a double Jamesway but proved generally satisfactory. The building was moved once in May 1958 during a general camp move to an adjacent floe. The program at this station included seismic depth soundings on a daily or twice-daily basis, seismic studies of sea ice, recording of magnetic elements with an Askania variometer, daily gravity readings, daily current readings with a Gurley Current meter and some readings with drag meters and Roberts current meters. The program at Alpha also included seismic refraction work during 1958 and the operation of an All-Sky Camera and Durral Patrol Spectrograph during the winter darkness. Some investigations of ice strain and telluric currents were also done. Oceanography included bottom coring, dredging, bottom photography and two hydrographic stations. The navigation of the station was determined with daily celestial fires when cloud cover permitted.

After the evacuation of station Alpha in November 1958, plans were begun for a new drifting station. This station, Charlie, was occupied in the spring of 1959. The Lamont programs of seismic soundings, bottom coring, dredging and bottom photography were all continued at this station. They

have proved to be successful techniques which yield important data in the Arctic Ocean. New instruments were adapted or developed for this station. These included a microbarovariograph to record small air pressure oscillations, a precision depth recorder for continuous sounding, a nuclear precession magnetometer for the total magnetic vector, a long period seismometer for detection of earthquakes and ice motion. This program was continued until the evacuation of Station Charlie in January, 1960.

During the spring of 1960, a program of seismic refraction measurements was executed at T-3. A seismic spread was placed on the ice near the ice island and shots were fired at varying distances. Transportation was by the Cessna airplanes from Arctic Research Laboratory and by Weasel tracked vehicle. Some ice tremor studies were also made. The work at T-3 was continued again in the fall with the installation of a microbarovariograph, a nuclear precession magnetometer and a long period seismograph.

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During the [illegible] refraction measurements [illegible] on the ice [illegible] thickness. Interpretation [illegible] T-3 [illegible] a [illegible].

I. MARINE GEOPHYSICS

Seismology

Reflection measurements were made at all three stations using portable exploration seismographs and geophone pick-ups on the ice. This method produced excellent measurements of the ocean depth and dip. The energy source for these measurements was usually $\frac{1}{4}$ pound of dynamite exploded at a depth of ten feet or near the base of the ice. The primary problem in this field work was deeping the shot hole free of broken ice. The ten foot depth was found to be helpful. Shallower shots broke out the hole and deeper shots produced bubble pulses with undesirably long interval. A light bulb with quilts over it was usually sufficient at the top of the ice hole to keep it unfrozen when not in use. Thaw wires down the hole were also partially successful.

The reflection records produced information on sub-bottom as well as bottom reflecting horizons. These sub-bottom reflections are characterized as a low frequency arrival after the bottom reflection. In order to study the relative amplitude of these arrivals it was found desirable to use linear amplification and no automatic gain control. For deep water work it was also desirable to use no filters so that no events were missed. In shallow water it is sometimes necessary to use filters to eliminate the surface waves and water noise from the shot. The seismic reflection measurements produce valuable information on depth and dip but the profile is not continuous. A precision depth recorder was used at Station Charlie to provide continuous depth sounding. This proved a successful method for use on ice floes and the records do not suffer from the irregularities due to ship motion which occur on records taken from research vessels. The drifting ice station cannot produce the amount of bathymetric data that a submarine cruising beneath the ice can. But the data is probably more precise as to position and depth.

In addition the data from the floating stations can be correlated with the seismic studies which give the dip and depth of sub-bottom reflections as well. On many of the echo sounder records taken at Station Charlie, an arrival immediately after the first bottom echo is noted. This is probably a reflection from a sub-bottom layer. However, the outgoing ping was not recorded on the fathogram and there is a small possibility that it is a product of the outgoing ping wave shape. Future depth sounder models will incorporate a circuit to record the outgoing ping directly on the fathogram.

Seismic refraction studies were made at Station Alpha during 1958 and at T-3 during 1960. The traverses at Alpha were made on foot with the equipment pulled on sled. In the summer a rubber one-man rubber life raft was tied on the sled and was used for crossing leads. The inflated raft was towed until a lead was reached, then the raft was launched for crossing the lead. The sled was not detached. Communications proved to be the biggest difficulty. Efficient radios on a frequency low enough to be dependable were not available. In the spring a back-pack of a spool of line wire was used to lay a telephone line. This worked on one occasion out to five miles. The wire was inexpensive enough to abandon after use. However, it was delicate and difficult to handle. For the successful shots the time difference between the air-wave and water-wave arrival was used for timing. This method involves some error and is useful for short distance but could not be continued to large distance due to the attenuation and uncertain velocity of the air wave. The refracted wave from beneath the crust was not obtained as a first arrival. The highest velocity found was 6.44 km/sec. at a depth of 5 km. The layering resembles an oceanic section but more study is needed to definitely delineate Arctic Ocean structure. The refraction arrivals were recorded on geophones and the various arrivals are clearly seen on the oscillograph record. Another advantage in recording in this area is the low noise level. The usual ship noises and water noise encountered at sea

with hydrophones are absent.

Seismic refraction work was continued at ice island, T-3, during March, April and May, 1960. Arrangements were made with Max Brewer at Arctic Research Lab, Point Barrow, for the use of his Cessna airplanes in order to reach greater distances. Landings were made on pack ice and explosions detonated which were received at T-3 on a geophone array. The work proved the feasibility of the method and some good records were obtained. Traverses were also made along the edge of the island and shots made out to about 8 km. The original intention was to study crustal structure in the Arctic Ocean basin. However, the station drifted over the continental shelf during March and all subsequent work was done in relatively shallow water. Refracted arrivals were not clear and this may be due to thick layering or to confused and disrupted layers. The arrivals were largely due to normal mode propagation in the ice-water-sediment system. These dispersed arrivals are to be interpreted by comparison with theoretical models calculated on an electronic computer. This data reduction and interpretation is still in progress. At present it appears that an excellent fit of theory to experiment can be made which results in an interpretation of the sedimentary layers of the continental shelf off Point Barrow.

A long-period vertical spregnether seismograph was operated at Station Charlie. The background of ice wave motion in the 30 to 50 second period range was high. The only earthquake which was detected was that of Wyoming-Montana, August, 1960. The background motion shows no clear correlation with local winds and pressure. Power spectrum analyses have been made of some of the records.

Oceanography

All the oceanographic work was performed with the aid of an American Hoist Co. winch, powered by a Wisconsin four-cylinder gasoline motor. The system was bulky but it possessed the required power for the heavier equipment, such as piston corer and bottom camera. The cable from the winch was passed over a meter wheel supported by a tripod and then down through the hydrographic hole. An external counter was provided so that the wire length was easily read by the winch operator. A dynamometer was used to permit a sensitive determination of the ocean bottom. This was constructed by supporting the meter block from one end of a lever which was held down at the other end by a heavy-duty spring scale. The winch, tripod and hydrographic hole were enclosed during the winter months. During summer, operations could be done outside. The most pressing problem in the winter was the maintenance of an ice-free hole. This was done at first with a system of covers and heaters. Later the heating of the hydrographic shelter proved to be a better solution.

Bottom cores up to seven feet in length were taken with an Ewing piston corer. The cores from Station Alpha have been examined and have revealed a somewhat persistent layering in this area. A dark foraminiferal layer overlies a lighter, sandy, barren section. This is described more fully in the other publications. The cores from Station Charlie have not yet been examined in detail. The implications of this layering for ice age theory are not fully appreciated, but any theory must explain these new facts.

The first dredges at Alpha revealed the presence of gravel on the deep-sea floor. This gravel was apparently rafted out on ice floes and dropped to fall to its present location. Subsequent studies on Charlie and

T-3 have also included dredging operations to continue the areal study of the gravels. The gravels of Station Alpha have been the subject of a published study. The results of a study on the molluscs dredged in these operations have also been published.

The Arctic Ocean floor has been observed directly on bottom photographs for the first time. Camera stations were made from Station Alpha and Station Charlie. Photographs were taken both in the relatively deep water of the Alpha Rise and in the relatively shallow water of the Chukchi Rise. The Ewing underwater camera functioned well and needed no special adaptation to the Arctic Ocean. The only care needed was in the summer when a layer of fresh water was on the hydro hole. Then, as a piece of gear was lowered, it might pick up some fresh water which would freeze as soon as it hit the colder saline water below. The best solution was to keep the instrument warm in a building until just before it was lowered. This ice layer was a nuisance to Nansen bottles and nets as well as to the camera. Only a few colored pictures were taken. The color emulsion is very sensitive to moisture and most of the film was washed out. It is necessary to have the camera case very dry for color work.

Underwater sound was investigated at all three stations and received particular emphasis at Station Charlie and on T-3. At Station Charlie many recordings of shots by the Navy at T-3 were recorded using hydrophones and an oscillographic camera. The records have yielded to interpretation as normal mode propagation and the results will be published soon. The Arctic Ocean proved to be an efficient wave guide for low-frequency sound. The sound energy is trapped along a surface axis and charges of several pounds are probably detectable throughout the Arctic Ocean. Calculations of frequency versus velocity were made for waves in a velocity structure which

was close to that found by temperature-salinity measurements. The theory gave good agreement with the observed waves. At T-3, shallow-water sound propagation was studied and the results are now being analyzed. The data will show the features of shallow-water propagation on the Arctic Ocean continental shelf and give information about the sediments. The results show that underwater sound travels easily throughout the Arctic Ocean. Phenomena, natural or artificial which set up an acoustic disturbance should be readily detectable in all parts of the Arctic Ocean with relatively simple listening gear.

Magnetic Studies

At Alpha, two instruments were used to measure the earth's magnetic field. An Askania recording variometer was used to give a continous record of the relative value of the D, Z and H components. Records were made of photographic paper. A transit magnetometer was used to determine the absolute values of the D and H components at intervals. A summary of these D and H measurements on Alpha is included in the appendix to this report. These values have some interest for the magnetic map of the Arctic to be used for navigation. The field is generally so disturbed, however, that continuous records must be made.

A nuclear resonance magnetometer was used on Drifting Station Charlie. The instrument was read every 15 minutes for an absolute value of the total vector. The data shows significant magnetic anomalies over the flanks of the Chukchi Rise. This data has been interpreted and will be published. Difficulties are found in interpretation due to the large disturbance effects. However, these can to a large extent be separated from geological effects by comparison with records made at Pt. Barrow.

Gravity Observations

A Frost-type gravimeter from the University of Wisconsin was operated on Station Alpha. During much of its operation at this station, the motion proved erratic and gravity readings proved difficult. The motion of the floe was often sufficient to cause the boom to swing against the stops. Despite this, many readings were made. Ties proved another difficulty. Ties to known gravity points were made when a Worden high-range gravity meter was brought in by someone from the University of Wisconsin. The data was unfortunately left untied at the end of the station occupation since the evacuation was too rapid to permit a tie.

The gravimeter at Alpha was read, whenever possible, for a period of five minutes at three-second intervals. These readings showed the long-period motion (20 to 40 second period) that had been observed previously by Crary. This wave motion has been examined in some detail and several records were analyzed by Fourier's method. It is believed that these waves are associated with the group and phase velocity minimum lying between the branches of the dispersion curve associated with gravity waves and with flexural waves for an ice-covered ocean. Calculations of the entire long-period dispersion curve for the Arctic Ocean situation have been made and the velocity minimum occurs in the range of observed periods. It might be expected that large amplitudes would be found at this minimum. Clear proof that these are traveling waves is lacking, although it seems highly likely that this is the case. A tripartits array of gravimeters or long-period seismographs would settle this question and allow determination of phase velocities and directional spectra if they are, indeed, traveling waves.

II. STUDY OF THE STRUCTURE AND CHARACTERISTICS OF SEA ICE

Seismic methods were used to investigate surface waves of various

types in sea ice. The waves were generated with explosives, blasting caps and falling weights. The waves were recorded with an HTL - 7000-B seismograph system. Detectors were 2 cps and 14 cps geophones. Many records were made for the study of wave propagation in sea ice. The results of these studies were reported in the Journal of Geophysical Research, October 1960. Thickness and density measurements were also made and reported in the same paper.

Some studies of ice tremors were also made. The general level of ice tremors did not seem to be high at Alpha, although the seismograph was turned on daily for brief periods. The author saw them only briefly in September, 1957 and weak ones in the spring of 1958. Apparently they were observed and heard by van der Hoeven at intervals during the winter. The tremors recorded in September, 1957, traveled chiefly with the shear velocity and were predominantly impulsive, although some flexural waves were seen. Tremors were recorded on the sea ice at T-3, Colby Bay in 1960 and the percentage of flexural waves seemed higher and the source more localized. Several recordings were made on magnetic tape and full analysis of these is yet to be completed. Ice tremors are the largest source of background noise in the Arctic ocean and deserve careful study. Recordings are being made at T-3 this winter to increase our knowledge of this phenomenon.

III. PACK ICE MOVEMENT

Data were collected at Drifting Stations Alpha and Charlie for the continuing study, by Mrs. Irene Cotell, of the drift of ice in the Arctic Ocean. Navigation and wind observations are the most important data for these studies. Celestial navigation at Alpha was done by Lamont scientists throughout its occupation. At Charlie, navigation was done by University of Washington scientists during the entire drift and simultaneously by Lamont scientists during the winter. Results of these observations are included in

the appendix. Wind data were collected from the U. S. Weather Bureau at the stations and forwarded to Mrs. Cotell.

Drift of the ice was also studied by measuring currents beneath the ice, Gurley current meters (bucket-wheel type) were used and proved only partially satisfactory. Their calibration depends on the condition of the bearing and the commutator box must be filled with oil or glycerine to prevent shorting by salt water. At Station Alpha currents were read at various depths in an attempt to find the velocity gradient beneath the ice and the "roughness factor" of the ice. A biplane drag meter was also read at various depths to describe the Ekman circle pattern beneath the ice. During the summer of 1958 at Alpha, two Gurley meters were read simultaneously at different depths and then interchanged to eliminate instrument calibration differences. A biplane drag meter was maintained at a large depth. Currents were read twice daily during this period in an intensive effort to delineate current patterns beneath a wind driven ice floe. A Roberts radio current meter was to be used for the continuous recording of current, but proved too insensitive for the small magnitudes of current involved. Only at one instance was the drift rapid enough to permit its use at Alpha.

A meter designed by Dr. Thorndike to measure bottom currents was also given trial at both Alpha and Charlie; difficulties of operation prevented successful measurements at either station.

In addition measurements of absolute velocity of the floe over the ocean bottom were made with two different techniques. At Station Charlie, the PDR provided opportunity to make drift measurements by calculations from the "highlights" recorded on the fathograms. This method involves a simple calculation using the hyperbolic reflection from a "highlight." The method was first developed at Lamont to measure the absolute speed of a ship over the bottom. The second method involves dropping a charge on the bottom

beneath the seismograph array in shallow water and then detonating it after a known time and measuring the arrival time at the various geophones. The first method required a PDR and a rough bottom with many "highlights", the second requires a seismograph system and shallow water.

Measurements of tilt and strain in sea ice were attempted at Station Alpha but the results were generally unsatisfactory. The first instrument was a sensitive bubble-level gage to measure tilt of the ice. Two bubble-levels with a long radius of curvature were mounted perpendicular to each other on an aluminum plate. The plate was triangular with micrometer screws at the acute angles to regulate the elevation of the corners. The three instrument legs were placed on wooden posts which had been frozen to a depth of about two feet in the ice. The procedure was to relevel the instrument twice daily with the micrometer screws and take the reading from them. The readings appeared quite erratic and there has been doubt as to whether the readings actually represent ice tilt. It was felt that factors such as thermal warping of the plate, recrystallization around the supports and imperfections in the screws may have produced effects as large as those of ice tilt. Another instrument was developed at Alpha to measure ice strain. This instrument was constructed by freezing two large iron pipes to a depth of several feet in the ice with about 30 feet of separation. An invar wire was attached to one post and led over a precision pulley on the other. A weight was attached to this end and the weight rested against a dial gage sensitive to about 10^{-4} inches. The dial gage was read twice daily. Here too, doubt was felt about the meaning of the experiment. Apparently the invar wire chosen was of too small diameter and a slow plastic deformation took place. In the future, it would be wise to use wire with as large a diameter as will freely run over the pulley. Three strain meters in a

rosette array would serve to determine the strain field in the ice; with knowledge of the elastic parameters this could be translated to the stress field.

Implications for future research

The use of stations on drifting pack ice as bases for geophysical and oceanographic studies of the Arctic Ocean proved highly successful. The work done under this contract included the first U. S. geophysical studies from pack ice stations and showed that the stations set up by the U. S. Air Force were suitable for detailed precise studies of the Arctic Ocean environment. Instruments of considerable size and complexity were used for the first time in the Arctic Ocean; included among these new instruments were a precision depth recorder, a nuclear resonance magnetometer, an all-sky camera, a submarine bottom camera, an Askania magnetic variometer, a microbarovariograph and a long-period seismograph. All these instruments functioned and added greatly to our knowledge of the Arctic Ocean environment - crust, sea, ice and atmosphere.

Future research should emphasize continued areal geophysical coverage of the Arctic Ocean. The ice station is probably the best platform for deep sub-bottom reflection soundings. Many questions about the extent of the deep reflector observed by Crary and from Alpha are still unanswered. The change along the strike of the Alpha Rise in record characteristics, from the single deep reflector on the east to multiple reflectors in the east to multiple reflectors in the west is unexplained. Probably fathograms made from Atomic submarines will furnish more rapid surveillance of bottom topography but the fathograms from ice stations furnish a study in detail of a particular area. Furthermore, the fathogram furnishes a unique method for the determination of the velocity of the floe over the bottom. Still

better methods of measuring velocity are needed, however. It may be possible to drop sonic bouys onto the bottom and use them for ranging.

The gravity and magnetic fields deserve more investigation in this region. Gravity must be well known in this region to describe the crustal features. Magnetic studies should continue to be directed both toward geological anomalies and toward rapid field variations.

New techniques should be used to find the ways in which the Arctic Ocean resembles or differs from the other oceans of the world. One measurement deserving immediate consideration is the vertical heat flow from the Arctic Ocean floor. A "thermograd" instrument has been developed at Lamont for this purpose and has been used successfully in other oceans.

The circulation of sea water may be studied by radiocarbon dating of the various water masses. This has not yet been done systematically. Circulation in the Arctic Ocean and its exchange with Atlantic waters is undoubtedly extremely important for world climate and deserves concentrated study.

Wave motion in the Arctic Ocean is of much longer period than that found in open seas. This wave motion has received some theoretical treatment but further experiment is needed. Tripartite arrays of long-period seismometer could be used to find the directional spectrum of these waves. Such seismometers might also detect minor earthquakes in the Arctic.

The submarine geology of this ocean is only beginning to be known. The depth of the crust has not yet been measured and should be one of the first objectives for future work. The depth to the Mohorovicic discontinuity has special interest since it is claimed by some USSR geologists that the Arctic Ocean is a portion of sunken continent. If so we might expect a thicker crust than is normal for ocean basins of this size. Preliminary refraction seismic work at Alpha indicated that the Arctic Ocean may not differ greatly in crustal structure from other oceans.

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MEASUREMENTS OF MAGNETIC DECLINATION AND

HORIZONTAL INTENSITY MADE AT

DRIFTING STATION ALPHA (1958)

(USC&GS Transit Magnetometer # 38974,
Ht. of Instr. -130 cm. above ice)

Time (GMT)	Date	Latitude (N)	Longitude (W)	D	H (gauss)
2143-2201	26 March	83° 47.2'	153° 00'	63°28'	
0042-0110	27 "	"	"		0.01379
1957-2024	1 April	83° 48.0'	152° 45'	71°20'	
2024-2056	1 "	"	"		0.01660
2130-2152	12 "	83° 50.8'	151° 50'	78°00'	
0122-0149	13 "	83° 51.1'	151° 49'		0.01559
0100-0119	1 May	83° 54'	152° 39'	75°03'	
0119-0142	1 "	"	"		0.01496
0058-0116	12 "	83° 43.7'	153° 12'	56°21'	
0116-0132	12 "	"	"		0.01745
0027-0052	4 June	83° 56.0'	151° 40'	91°51'	
0052-0113	4 "	"	"		0.01907
2045-2143	30 "	84° 40.6'	147° 50'	91°18'	
0113-0137	15 July	84° 33.1'	142° 37'	137°36'	
0145-0202	15 "	"	"		0.01419
2014-2056	22 "	84° 39.1'	142° 22'	157°36'	
2112-2143	22 "	"	"		0.01455
1912-1937	29 "	85° 01'	138° 00'	118°00'	
2003-2025	29 "	"	"		0.01426
2021-2041	5 August	85° 03.0'	138° 53'	122°42'	
2157-2219	5 "	"	"		0.01298
2053-2114	12 "	84° 58'	136° 05'	130°19'	
2121-2142	12 "	"	"		0.01363
2203-2222	15 "	85° 00'	135½°	122°30'	0.01450
2222-2239	15 "	"	"		
1935-2010	19 "	85° 01.8'	134° 31'	123°30'	
2042-2109	19 "	"	"		0.01413
2333-0011	22-23 "	85°	132°	141°30'	
0045-0115	23 "	"	"		0.01103
0058-0116	26 "	85° 04.8'	130° 40'	145°06'	
0116-0137	26 "	"	"		0.01344
2338-2400	29 "	85° 15'	129°	171°00'	
0000-0030	30 "	"	"		0.00964
0213-0234	3 September	85° 26.5'	128° 16'	208°36'	
0220-0255	6 "	85° 41.1'	127° 17'		0.01010
0144-0215	6 "	"	"	207°24'	
0122-0150	10 "	85° 54.7'	123° 34'	189°12'	
0159-0220	10 "	"	"		0.02105
0052-0103	12 "	85° 50'	122°	178°06'	
0103-0129	13 "	"	"		0.02400
2032-2109	16 "	85° 54'	123° 33'	172°06'	
2120-2150	16 "	"	"		0.01956

APPENDIXES

1. Navigation Data - Station Charlie - 26 October 1959 to 6 January 1960.
2. Locations of Drifting Station Alpha from 8 June 1957 to 3 November 1958.
3. Results of depth soundings taken at Drifting Station Bravo (T-3) in the Arctic Ocean - 26 March 1960 to 14 May 1960.
4. Results of depth soundings taken from Drifting Station A in the Arctic Ocean during the IGY, 1957-1958.

RESULTS OF DEPTH SOUNDINGS TAKEN FROM DRIFTING STATION A IN THE ARCTIC OCEAN DURING THE INTERNATIONAL GEOPHYSICAL YEAR, 1957-1958.

(All soundings were made with sonic reflections from an explosive source, except where otherwise noted. Sounding positions are interpolated between astronomic fixes and accuracy varies probably from one to five tenths of a nautical mile in most cases. Depths have been corrected using Matthews "Tables of the velocity of sound in pure water and sea water," London, 1939.)

POSITION IN DEGREES AND MINUTES		DEPTH IN METERS	DIP IN DEGREES	AZIMUTH OF DIP IN DEGREES
LATITUDE	LONGITUDE			
81-07	160-21	3320	(wire sounding)	
82-12.2	164-34	3665	0.0	-
82-31.3	164-58	3625	0.3	254
82-52.6	165-29	3647	17.4	233
83-00.2	165-46	3670	2.5	058
83-01.1	165-55	3641	1.2	079
83-00.4	166-14	3549	3.2	011
82-58.0	166-25	3527	4.3	047
82-54.3	166-33	3426	3.1	242
82-50.4	166-45	3514	2.2	253
82-48.0	166-51	3597	1.7	203
82-45.1	166-49	3666	3.2	231
82-44.1	166-44	3671	3.0	221
82-46.8	166-38	3656	3.2	260
82-48.7	166-49	3565	1.4	183
82-51.6	167-04	3537	0.4	100
82-53.9	167-16	3511	1.4	085
82-54.5	167-21	3488	0.7	219
82-53.8	167-36	3402	1.7	180
82-51.8	167-46	3329	2.3	269
82-52.9	167-22	3190	0.8	015
82-54.5	167-16	3159	1.8	241
82-56.1	167-10	3136	1.0	256
82-58.8	167-09	3113	0.1	292
83-01.5	167-14	3093	0.7	338
83-03.2	167-16	3112	2.0	333
83-05.2	167-15	3161	1.8	358
83-06.0	167-14	3188	0.9	355
83-09.7	167-21	3190	0.7	035
83-14.2	167-34	3183	0.3	007
83-14.5	167-20	3187	0.7	348
83-12.3	167-00	3177	0.8	308
83-14.6	166-34	3220	0.3	072
83-18.0	166-20	3268	1.2	038
83-23.5	166-13	3237	0.6	268
83-31.0	166-13	3185	0.8	115
83-33.7	166-21	3152	0.3	300
83-36.0	166-24	3133	0.5	190
83-37.9	166-26	3117	0.7	237
83-39.2	166-23	3106	0.5	044
83-44.8	166-33	3079	0.7	275
83-49.7	166-50	2971	3.6	120
83-53.0	167-17	1814	1.9	190
83-55.6	168-27	1604	2.5	191
83-53.3	168-50	1559	1.1	183
83-51.9	168-46	1568	1.2	226

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
83-50.4	168-24	1559	1.0	195
83-50.7	167-58	1514	0.2	167
83-52.9	167-41	1480	4.1	274
83-54.0	167-31	1450	1.6	003
83-56.4	167-08	1515	3.7	035
83-57.9	166-55	1563	4.4	295
83-59.9	166-37	1535	0.7	246
84-01.3	166-24	1482	0.9	223
84-03.0	166-10	1425	1.7	300
84-04.9	166-12	1520	2.2	299
84-06.2	166-17	1562	3.9	281
84-06.3	166-33	1808	5.5	149
84-06.2	166-48	1872	8.3	337
84-06.4	166-59	2358	2.6	341
84-06.5	167-04	2384	1.1	353
84-07.0	167-19	2447	0.4	030
84-07.8	167-33	2497	0.4	091
84-08.5	167-48	2449	0.4	091
84-09.5	167-58	2434	0.7	124
84-10.2	168-11	2407	0.7	125
84-11.5	168-23	2392	0.7	125
84-13.1	168-33	2314	1.4	349
84-16.7	168-41	2238	2.1	140
84-20.4	168-50	2084	2.3	140
84-22.7	169-02	1972	0.4	010
84-24.0	169-09	1987	0.4	046
84-25.0	169-15	2000	0.5	095
84-27.0	169-26	1969	0.4	041
84-33.2	169-44	1921	0.6	009
84-37.2	169-25	1995	1.2	031
84-40.5	169-17	1960	0.9	108
84-42.3	169-29	1986	0.4	031
84-41.9	169-59	1949	1.2	115
84-39.7	170-03	1995	0.8	104
84-41.4	170-34	1997	0.8	112
84-40.6	171-17	2021	0.5	108
84-39.1	171-38	2049	0.5	093
84-37.4	171-29	1961	0.6	018
84-37.2	171-20	1927	1.2	337
84-36.8	171-09	1972	2.3	003
84-40.3	170-50	2024	1.7	002
84-41.9	170-57	2017	1.5	012
84-42.6	171-11	2029	1.3	358
84-42.1	171-27	2038	1.3	010
84-40.4	171-41	2024	1.4	345
84-39.1	171-03	2050	1.8	343
84-40.1	170-45	2028	0.2	224
84-43.0	170-18	2026	0.4	035

POSITION LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
84-45.2	170-03	2000	0.6	214
84-47.8	169-50	1812	1.9	317
84-56.0	169-00	1588	0.7	351
84-59.3	168-39	1582	1.5	075
85-00.5	168-37	1565	1.5	032
85-01.8	168-46	1581	1.3	035
85-21.1	167-47	1934	2.8	025
85-22.2	167-32	1959	3.2	007
85-24.1	167-24	2020	9.5	335
85-28.0	167-56	2782	0.5	101
85-30.0	167-47	2499	5.5	191
85-29.5	167-54	2757	1.4	190
85-29.0	168-01	2749	2.0	137
85-28.4	168-09	2749	2.1	178
*-85-28.1	168-08	2690	4.8	145
85-27.4	168-33	2670	13.0	166
85-26.2	169-15	2702	6.3	122
85-24.5	169-21	2715	2.0	000
85-23.3	169-10	2374	6.0	302
85-23.2	169-08	2380	8.1	302
85-23.0	169-00	2166	5.3	345
85-24.0	168-58	2153	1.6	030
85-24.9	169-08	2700	12.1	303
85-25.7	169-28	2705	0.6	090
85-26.1	169-42	2445	5.4	233
85-27.2	169-58	2228	2.0	027
85-27.7	170-06	2185	1.9	054
85-28.7	170-22	2156	3.1	055
85-30.0	170-42	2038	3.6	043
85-31.0	170-58	1937	3.4	349
85-31.6	171-02	1841	1.9	095
85-31.0	171-49	1745	5.2	004
85-31.0	171-50	1741	4.8	008
85-29.9	171-57	1715	5.8	004
85-28.7	172-07	1779	5.5	007
85-25.6	172-30	1562	3.7	053
85-22.9	172-41	1551	10.0	012
85-21.3	172-46	1509	6.2	346
85-16.9	172-37	2139	3.5	352
85-14.1	172-32	2018	0.9	224
85-10.4	172-26	1954	1.3	314
85-09.4	172-24	1820	4.2	314
85-07.6	172-21	1519	1.5	314
85-07.5	172-21	1448	1.0	313
85-05.7	172-18	1432	0.7	237
85-04.7	172-16	1436	0.6	213
85-03.4	172-14	1450	0.5	218
* 85-28.3	168-08	2742	1.6	165

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
85-02.8	172-13	1475	0.3	245
85-02.1	172-14	1612	3.5	335
85-02.3	172-18	1732	4.2	197
85-01.5	172-45	1746	1.2	307
84-59.9	173-31	1755	13.4	306
85-00.9	173-05	1745	0.9	018
84-58.8	173-59	1662	3.4	247
84-59.3	175-20	1681	3.2	336
85-00.1	175-18	1710	5.3	335
84-59.9	175-46	1745	1.0	334
85-00.5	175-52	1747	2.0	051
85-00.9	176-12	1757	1.9	319
85-01.6	176-17	2520	1.6	318
85-02.3	176-09	2510	2.1	318
85-02.0	175-58	1709	5.6	016
84-54.8	176-09	1708	2.4	237
84-54.8	176-05	1686	2.5	327
84-49.0	176-20	1943	0.8	327
84-47.3	176-21	2034	0.6	327
84-38.0	176-11	2014	2.6	053
84-43.0	176-04	2177	28.7	324
84-30.2	174-53	1818	0.6	200
84-30.5	174-57	1827	1.2	203
84-32.5	174-03	2012	2.6	293
84-36.7	174-30	2057	1.2	294
84-42.8	175-12	2061	1.4	294
84-45.4	175-14	1874	7.3	294
84-55.8	175-19	1904	3.2	012
84-58.7	175-15	1903	4.0	305
85-04.2	174-40	1797	1.3	305
85-05.6	172-16	1531	1.2	220
85-05.9	173-39	1664	1.5	205
85-05.6	171-25	1497	26.0	312
85-04.8	171-44	1440	1.2	311
85-02.9	170-48	1427	0.8	345
85-02.9	171-00	1426	0.3	073
85-01.1	170-16	1535	28.8	212
85-00.7	170-06	1445	0.9	044
85-00.0	169-52	1434	1.4	017
84-59.3	169-38	1441	1.1	041
84-58.0	169-05	1560	1.2	311
84-50.1	168-39	1615	1.2	311
84-51.1	168-07	1887	1.2	311
84-48.7	168-01	1836	1.7	311
84-46.1	168-28	1892	1.1	230
84-45.3	168-42	1917	1.2	320
84-43.3	169-32	1968	1.7	320
84-42.4	169-31	1910	0.8	321

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
84-38.3	169-41	2015	1.6	168
84-36.8	170-04	2029	0.6	061
84-35.2	170-33	1953	0.8	331
84-34.0	170-56	1904	0.6	021
84-34.3	170-45	1918	1.5	037
84-34.3	170-52	1906	0.6	022
84-34.9	170-47	1910	1.0	058
84-35.6	170-39	1915	1.2	041
84-34.7	170-30	1913	1.0	058
84-34.0	170-16	1903	1.2	041
84-29.2	169-57	1905	0.8	069
84-27.2	169-50	1907	0.9	045
84-25.9	169-37	1929	1.3	315
84-25.0	169-31	1957	1.4	316
84-23.4	169-23	1959	0.4	049
84-20.9	169-10	2078	2.7	319
84-17.5	168-53	2320	1.4	073
84-16.0	168-45	2392	0.8	343
84-15.1	168-33	2411	0.8	344
84-14.1	168-18	2429	0.2	254
84-14.3	168-08	2408	0.2	247
84-14.9	167-47	2399	0.4	021
84-15.6	167-37	2411	0.7	053
84-17.3	167-24	2417	0.7	323
84-17.9	167-10	2397	0.7	323
84-19.3	166-36	2351	1.4	323
84-19.6	166-30	2343	0.7	177
84-20.3	166-11	2313	0.5	351
84-21.6	166-14	2299	0.8	352
84-24.8	166-09	2283	1.3	194
84-24.1	165-52	2258	2.2	311
84-24.6	166-02	2274	0.6	219
84-17.1	165-30	2330	0.5	311
84-22.2	165-45	2226	4.6	311
84-10.7	165-22	2271	1.0	007
84-14.7	165-27	2341	0.7	312
84-06.9	165-21	2041	5.0	015
84-01.0	165-21	1726	2.4	340
83-57.5	165-26	2045	12.5	340
83-55.1	165-25	2653	8.7	341
83-51.8	165-28	2929	2.8	076
83-50.2	165-30	2947	2.6	346
83-47.7	165-34	2997	1.9	346
83-47.7	165-40	3004	0.6	346
83-47.8	165-48	2993	4.4	346
83-46.5	165-52	3017	0.9	346
83-44.6	165-58	3040	0.4	184
83-42.6	166-12	3063	0.3	356

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
83-42.4	166-14	3069	0.3	042
83-41.5	166-13	3079	0.3	320
83-40.4	166-01	3082	0.4	185
83-40.1	165-37	3078	0.8	358
83-40.5	165-28	3075	0.4	359
83-41.4	165-09	3058	0.6	229
83-41.3	164-40	2930	2.6	233
83-41.4	165-00	3031	0.6	228
83-41.2	164-30	2862	1.3	054
83-41.0	164-12	2811	0.2	269
83-40.9	164-06	2810	1.1	208
83-40.7	163-58	2803	0.8	219
83-40.1	164-00	2818	1.4	332
83-38.6	164-03	2843	0.7	332
83-37.3	164-34	2809	2.9	054
83-38.7	164-48	2992	1.7	324
83-43.0	164-47	2921	0.7	324
83-46.0	164-39	2926	1.2	323
83-47.1	164-41	2947	0.5	323
83-47.3	164-43	2972	3.4	324
83-47.8	164-56	2993	0.6	325
83-49.1	165-03	2996	1.0	325
83-48.9	165-06	2999	0.1	212
83-47.8	165-06	3004	1.6	276
83-45.9	164-44	2918	1.7	014
83-39.6	163-48	2814	0.7	002
83-36.1	163-29	2835	0.6	002
83-34.3	163-19	2785	1.0	002
83-31.7	163-03	2673	1.9	003
83-31.8	162-53	2700	1.7	197
83-33.1	162-37	2470	1.8	209
83-33.5	162-23	2267	3.7	190
83-34.0	162-14	2479	5.6	042
83-35.0	161-59	2534	1.3	081
83-35.8	161-51	2458	2.4	002
83-37.7	161-45	2468	2.0	002
83-38.6	161-40	2474	1.8	003
83-38.6	161-35	2476	1.2	003
83-37.9	161-40	2479	0.5	033
83-37.7	161-38	2479	0.2	350
83-38.0	161-34	2478	0.8	350
83-37.0	161-46	2485	2.9	351
83-36.8	161-45	2585	2.9	222
83-37.5	161-39	2517	3.6	344
83-38.9	161-29	2502	1.9	045
83-39.7	161-23	2526	1.5	344
83-41.4	161-01	2549	0.3	344
83-44.1	160-40	2536	0.3	345

POSITION LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
83-44.8	160-25	2541	0.7	259
83-42.1	160-25	2487	1.4	350
83-34.5	159-25	2730	3.4	094
83-27.2	158-55	2913	1.7	004
83-15.2	159-01	3079	1.1	075
83-15.8	159-13	2920	5.4	098
83-13.3	159-10	2979	1.4	075
83-12.9	158-52	3124	1.9	035
83-14.9	158-19	3247	1.1	001
83-21.0	157-12	3228	1.6	247
83-27.1	156-40	2973	2.0	338
83-29.8	156-48	2875	0.9	338
83-30.9	156-51	2861	3.2	210
83-30.4	157-00	2862	1.9	085
83-28.8	157-05	2906	3.1	355
83-27.0	157-36	3009	2.0	355
83-24.0	158-07	3096	0.4	356
83-22.7	158-30	3156	1.2	356
83-24.0	158-23	3156	1.8	356
83-24.7	158-20	3143	1.3	357
83-25.1	158-30	3096	1.4	357
83-26.1	158-12	3047	1.5	357
83-26.0	157-52	3067	2.1	091
83-25.7	157-24	3169	1.5	204
83-26.4	156-49	3044	1.4	068
83-26.5	156-31	3016	1.4	339
83-27.7	156-22	2981	1.6	339
83-29.5	156-25	2946	1.3	339
83-32.2	156-42	2849	0.7	079
83-39.5	157-22	2658	0.4	210
83-43.2	157-44	2203	6.5	021
83-42.8	157-40	2295	8.8	022
83-43.9	157-32	2143	5.3	022
83-45.6	157-29	2130	0.2	022
83-45.7	157-16	2051	0.7	023
83-44.8	156-54	2112	6.3	023
83-44.7	155-52	2307	0.8	117
83-45.7	155-27	2304	0.9	028
83-45.2	155-26	2271	1.6	028
83-44.3	155-20	2203	1.3	028
83-43.7	155-04	2198	1.2	029
83-44.5	155-03	2195	1.0	029
83-45.2	155-05	2199	0.8	029
83-45.5	155-02	2186	0.2	030
83-45.4	154-59	2186	0.2	030
83-46.3	155-07	2188	3.7	211
83-46.1	155-15	2186	0.2	030
83-45.6	155-10	2186	0.2	114

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
83-43.6	155-00	2184	1.0	024
83-42.5	154-42	2158	5.8	025
83-41.6	154-23	2261	1.5	025
83-41.1	154-14	2310	5.2	113
83-40.5	154-04	2528	3.4	024
83-37.1	154-10	2705	8.5	074
83-31.6	154-15	2843	4.2	117
83-29.9	154-16	2948	2.5	028
83-30.8	154-29	2920	4.4	028
83-33.4	154-25	2818	5.8	028
83-34.4	154-13	2833	4.9	072
83-36.2	154-07	2794	3.3	097
83-38.3	154-04	2831	2.0	007
83-40.7	154-15	2659	3.7	008
83-45.1	153-55	2613	1.8	108
83-44.6	153-58	2584	1.6	018
83-44.9	153-52	2554	4.0	099
83-45.3	154-06	2482	4.6	101
83-45.1	153-56	2589	3.2	121
83-43.1	153-53	2677	2.3	082
83-41.2	153-55	2657	1.5	104
83-38.5	153-57	2822	2.0	014
83-36.3	153-41	2953	1.4	015
83-35.3	153-37	2916	1.5	251
83-42.2	153-30	2780	5.3	242
83-45.3	153-37	2714	3.7	236
83-45.9	153-37	2677	3.6	240
83-51.8	153-37	2284	5.9	287
83-50.7	153-34	2311	4.8	291
83-48.7	153-46	2488	8.3	232
83-46.7	153-45	2596	5.4	242
83-46.5	153-17	2612	5.6	247
83-47.9	152-53	2603	1.8	010
83-48.0	152-38	2675	7.9	245
83-48.1	152-20	2737	8.0	238
83-48.6	152-20	2725	4.8	234
83-48.3	152-29	2686	3.4	024
83-48.0	152-37	2565	7.4	241
83-47.6	152-28	2683	4.2	017
83-47.6	152-22	2713	6.1	225
83-49.8	152-29	2668	6.5	221
83-49.0	152-28	2693	8.5	226
83-45.4	152-04	2859	3.6	252
83-45.7	151-50	2881	4.6	295
83-47.3	151-46	2864	3.2	266
83-49.1	151-52	2856	6.6	275
83-50.7	151-50	2774	5.6	280
83-52.4	151-56	2743	4.6	254

POSITION LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
83-52.5	151-55	2740	3.3	267
83-52.4	151-55	2744	3.9	268
83-52.5	151-53	2742	4.1	267
83-53.0	151-55	2741	3.6	267
83-53.2	151-58	2741	4.5	260
83-54.7	152-02	2712	4.2	279
83-56.4	152-02	2656	5.3	270
83-57.5	152-00	2608	6.5	267
83-58.0	151-58	2605	5.4	267
83-57.8	151-55	2590	3.9	239
83-58.4	151-36	2611	4.7	252
83-59	151-33	2612	4.9	279
83-59	151-35	2534	4.2	241
84-00	152-31	2393	5.2	267
84-00.1	152-32	2436	7.2	268
83-57.6	152-35	2371	12.5	280
83-55.1	152-38	2302	4.2	268
83-51.9	152-45	2259	3.9	283
83-41.2	153-14	2774	4.7	257
83-40.7	153-05	2828	3.6	251
83-46.5	153-28	2652	5.8	251
83-46.1	153-40	2567	3.8	241
83-46.5	153-41	2625	4.4	249
83-44.0	153-20	2700	3.1	015
83-43.6	153-28	2776	5.6	257
83-43.5	152-50	2781	3.7	251
83-44.4	152-32	2850	4.7	260
83-49.4	151-56	2844	1.4	017
83-49.4	151-47	2839	2.1	123
83-50.0	151-31	2813	2.6	158
83-52.8	151-27	2780	2.6	138
83-55.7	151-34	2660	2.8	236
83-55.7	151-38	2646	1.5	215
83-55.1	151-36	2658	9.3	320
83-55.1	151-35	2657	4.9	313
83-55.3	151-21	2603	3.6	103
83-56.0	151-15	2322	21.3	129
83-56.4	151-31	2643	1.5	080
83-56.7	151-43	2638	0.8	284
83-56.7	151-54	2600	1.2	105
83-55.2	151-28	2482	18.5	049
83-54.2	151-12	2687	4.6	086
83-56.0	151-10	2657	3.0	186
83-55.8	151-41	2627	1.5	040
83-55.4	151-59	2588	5.4	107
83-59.0	151-26	2603	0.3	064
84-03.5	151-07	2575	3.8	045
84-08.5	150-43	2447	5.6	036

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
84-09.0	150-37	2472	6.4	199
84-09.2	150-22	2453	0.6	278
84-09.3	150-12	2429	1.3	217
84-09.7	149-46	1882	9.5	263
84-10.2	149-35	1827	16.4	178
84-11.3	149-28	2645	0.8	019
84-11.9	149-26	2556	13.4	271
84-13.8	149-20	1849	3.0	276
84-15.0	149-16	1713	7.5	261
84-16.2	149-12	1659	6.2	002
84-17.0	149-08	1777	6.8	023
84-18.4	149-01	1741	1.1	321
84-19.8	148-58	1759	2.8	231
84-22.0	148-53	1783	2.8	293
84-22.9	148-46	1640	2.1	254
84-23.1	148-38	1647	1.7	051
84-24.1	148-32	1642	0.6	141
84-27.5	148-30	1688	0.0	-
84-29.0	148-09	1706	2.5	231
84-30.8	147-59	1732	5.0	321
84-32.0	147-53	1781	1.5	300
84-33.1	147-44	1750	0.8	278
84-34.0	147-50	1773	5.0	116
84-33.0	147-58	1793	7.9	061
84-32.7	147-41	1800	9.4	223
84-35.0	147-36	1771	7.4	306
84-36.8	147-35	1900	4.0	225
84-38.0	147-34	1889	2.7	348
84-38.4	147-33	1848	6.5	161
84-38.9	147-37	1925	17.5	113
84-36.5	147-38	1876	5.6	139
84-37.2	147-34	1853	7.9	066
84-36.1	147-38	1886	1.4	003
84-34.6	147-49	1871	19.6	048
84-35.1	147-42	1894	4.5	084
84-36.7	147-43	1934	3.7	300
84-37.1	147-43	1932	8.3	255
84-37.5	147-45	1983	7.5	339
84-40.1	147-55	1770	5.1	296
84-40.8	147-53	1822	5.6	299
84-41.5	147-48	1758	8.1	154
84-41.4	147-37	1902	8.5	314
84-41.3	147-31	1837	4.8	146
84-41.1	147-24	1857	2.3	313
84-41.2	147-18	1809	6.2	147
84-41.1	147-10	1889	1.5	168
84-40.9	147-11	1830	13.7	304
84-39.5	147-16	1864	2.0	147

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
84-37.8	146-58	2011	9.3	126
84-36.7	146-49	2132	1.7	058
84-34.8	146-39	1919	3.2	110
84-33.7	146-28	2201	9.3	130
84-32.7	146-16	2310	2.6	205
84-32.0	146-10	2343	0.3	330
84-31.7	146-05	2306	1.4	188
84-31.9	145-48	2313	1.5	173
84-31.8	145-11	2301	0.8	287
84-31.0	144-54	2294	2.7	217
84-31.0	144-34	2144	4.4	108
84-31.2	144-06	2167	2.8	148
84-32.2	143-32	2118	0.8	288
84-32.1	143-15	2122	2.1	356
84-31.9	142-54	2147	1.1	062
84-31.8	142-35	2121	6.0	221
84-32.1	142-33	2144	7.2	100
84-32.4	142-31	2156	3.1	322
84-33.2	142-26	2158	2.5	242
84-33.0	142-50	2135	2.6	201
84-31.9	143-15	2156	1.6	293
84-32.1	143-42	2163	2.8	294
84-32.7	143-58	2170	3.6	150
84-33.0	143-26	2116	2.1	127
84-32.8	143-23	2181	2.0	248
84-32.6	143-44	2170	2.9	044
84-32.8	143-34	2174	0.6	036
84-33.0	143-24	2159	-	-
84-33.6	143-23	2130	5.0	293
84-34.0	143-22	2131	6.7	299
84-35.3	143-20	2219	1.4	330
84-36.0	143-12	2216	5.2	042
84-37.2	142-29	2152	1.2	330
84-38.2	141-53	2179	2.6	062
84-39.2	141-19	2158	3.7	257
84-40.3	140-43	2132	3.7	258
84-42.2	140-19	2056	6.9	274
84-44.2	140-10	1918	3.3	275
84-46.2	140-05	2038	6.9	300
84-47.2	140-04	2085	6.0	291
84-48.3	140-04	2079	4.1	342
84-48.8	140-03	2128	2.8	310
84-49.3	139-57	2119	2.3	341
84-49.8	139-52	2072	5.4	293
84-50.4	139-45	2048	8.7	261
84-51.1	139-39	2016	4.5	342
84-51.8	139-33	1988	0.8	303
84-52.4	139-27	1899	6.7	305

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
84-53.7	139-15	1884	5.9	269
84-54.3	139-08	1829	2.5	263
84-55.7	138-56	1688	5.1	253
84-57.6	138-37	1714	4.2	301
84-59.6	138-19	1800	2.8	309
*=85-00.9	138-01	1817	4.4	309
85-01.2	137-42	1813	1.6	324
85-01.3	137-44	1833	9.6	272
85-01.7	137-53	1802	5.9	026
85-02.2	138-05	1875	5.8	106
85-03.5	138-36	2042	2.8	182
85-03.6	138-50	2075	2.2	138
85-02.8	138-54	2073	2.0	103
85-02.4	138-56	2079	1.4	087
85-02.0	138-59	2082	1.9	240
85-01.9	138-46	2063	2.0	132
85-01.9	138-24	1958	1.5	109
85-02.0	138-04	1843	2.4	122
85-01.9	137-32	1836	2.0	102
85-00.2	137-04	1865	4.0	222
85-00.0	136-52	1950	3.1	114
84-59.3	136-33	1982	1.3	242
84-58.4	136-13	1966	1.7	168
84-58.1	135-59	1951	4.8	068
84-59.0	136-00	1978	4.5	182
84-59.7	136-02	1968	3.4	090
85-00.4	136-06	1964	2.4	123
85-01.2	136-14	1969	1.4	087
85-03.1	136-32	1943	2.3	342
85-06.3	136-38	1922	2.0	282
85-06.4	136-11	1896	1.6	131
85-07.1	136-14	1862	5.4	095
85-06.0	135-32	1881	5.3	125
85-02.9	135-04	1878	0.6	019
85-02.7	134-47	1898	2.2	354
85-01.3	133-58	1846	3.4	258
84-59.3	133-37	1827	-	-
84-59.1	133-16	1794	6.2	228
85-00.2	132-45	1761	6.5	265
85-02.1	131-55	1724	1.3	203
85-03.6	131-13	1703	6.8	262
85-05.0	130-35	1717	4.8	118
85-05.5	130.16	1738	6.1	344
85-06.6	129-59	1806	0.6	243
85-08.7	129-50	1776	2.8	136
85-10.6	129-42	1715	2.7	214
85-15.0	129-15	1769	1.6	033
*85-01.4	137-52	1776	2.0	010

POSITION				
LATITUDE	LONGITUDE	DEPTH	DIP	DIP AZ.
85.20.2	128-48	1878	3.6	318
85-23.4	128-32	1961	0.8	094
85-27.7	128-11	1761	6.5	187
85-33.4	127-47	1589	2.8	101
85-38.8	127-26	1388	2.1	119
85-45.0	126-18	1478	2.3	217
85-48.2	125-29	1428	1.0	311
85-51.4	124-39	2200	3.1	126
85-54.2	123-51	2111	13.0	094
85-44.9	120-14	1518	0.6	175
85-44.4	120-17	1419	-	-
85-41.8	120-36	1124	1.6	206
85-40.8	120-42	1066	4.2	205
85-39.5	120-31	1030	8.0	012
85-40.5	119-58	1047	2.3	024
85-43.4	119-38	1720	8.2	033
85-49.5	119-25	2228	9.1	075
85-52.5	120-11	2672	2.7	028
85-55.7	119-47	2574	3.7	185
85-57.3	119-31	2471	1.1	266
85-59.1	119-21	2380	6.6	008
86-00.6	119-20	2369	2.0	356
86-02.0	119-25	2404	2.5	169
86-03.3	119-50	2450	22.0	205
86-04.3	120-06	2348	2.3	185
86-06.0	120-35	1875	19.5	184
86-07.8	121-04	1539	-	-
86-08.6	121-18	1401	6.9	209
86-18.5	121-44	1494	-	-
86-25.3	120-50	1580	-	-
86-25.2	118-06	1644	-	-
86-13.1	114-57	1220	-	-
86-11.8	114-32	1162	-	-
86-09.9	113-56	1152	-	-
86-10.3	113-44	1140	-	-

LOCATIONS OF DRIFTING STATION ALPHA FROM JUNE 8, 1957 TO NOVEMBER 3, 1958

EXPLANATION:

TIME: of fix to nearest hour G M T

NO. OF LOP'S: followed by a letter indicating bodies shot to obtain the lines of position, thus:

S = SUN

M = MOON

X = STAR OR PLANET

ERROR: is radius of circle inscribed in LOP polygon in nautical miles. Asterisk indicates radius of circumscribed circle, taken for small angles between LOP'S

LOCATIONS OF DRIFTING STATION ALPHA

DATE	TIME GMT	LATITUDE NORTH	LONGITUDE WEST	NO. LOPS	ERROR	AZIMUTH OF REF. LINE
1957						
8 June	1100	80° 51'	160° 17'			
9	1100	80° 54'	159° 29'			
11	1100	81° 02'	159° 48'			
12	1100	81° 05'	160° 00'			
14	1100	81° 10'	160° 42'			
15	2300	81° 09'	161° 28'			
16	2300	81° 11'	162° 01'			
17	2300	81° 15'	163° 48'			
18	2300	81° 14'	163° 50'			
23	2300	81° 06'	162° 48'			
26	2300	81° 22'	163° 36'			
28	2100	81° 30'	164° 25'			
29	1100	81° 36'	164° 36'			
30	1100	81° 38'	164° 34'			
5 July	0100	81° 56.5'	164° 55'	3s	0.8*mi.	297.6
6	0900	82° 09.8'	164° 29'	3s	0.1	299.3
7	1200	82° 12.7'	164° 35'	4s	1.0	299.5
8	1200	82° 14.6'	165° 28'	4s	0.4	298.8
9	0900	82° 26.8'	165° 43'	1s		299.7
13	0900	82° 33.3'	166° 05'	2s		302.6
15	2200	82° 43.0'	165° 39'	2s		302.3
16	1200	82° 52.6'	165° 29'	3s	0.1	301.5
22	1900	82° 45.2'	166° 50'	3s	0.1	295.8
25	1200	82° 54.6'	167° 23'	4s	0.4	295.2
26	2200	82° 51.3'	167° 48'	3s	0.3	293.0
28	2300	82° 59.4'	167° 11'	4s	0.3	288.2
29	2200	83° 03.6'	167° 17'	3s	0.1	287.6
30	2100	83° 06.0'	167° 14'	3s	0.3	284.6
31	2300	83° 15.0'	167° 28'	4s	0.7	284.7
1 August	2200	83° 12.4'	166° 52'	2s		286.5
2	2200	83° 19.0'	166° 18'	3s	0.3	282.4
4	2400	83° 37.4'	166° 27'	4s	0.4	279.7
5	2300	83° 39.7'	166° 22'	3s	0.2	281.5
7	0900	83° 53.2'	167° 19'	3s	0.2	285.4
9	0400	83° 53.0'	168° 51'	2s		285.0
10	2200	83° 53.0'	167° 40'	4s	0.2	286.5
13	1800	84° 02.8'	166° 10'	2s		289.2
14	1600	84° 06.0'	166° 14'	2s		288.6
19	1800	84° 12.5'	168° 31'	2s		285.6
20	2200	84° 21.0'	168° 52'	2s		282.3
22	2100	84° 27.7'	169° 30'	4s	0.3	274.2
24	2400	84° 42.5'	169° 31'	3s	0.6	266.7
25	2400	84° 40.3'	169° 58'	2s		270.0
27	2000	84° 37.5'	171° 30'	2s		286.3
28	2200	84° 36.7'	171° 05'	4s	0.4	287.9
29	2300	84° 42.5'	171° 05'	3s	0.3	284.0
31	2200	84° 39.9'	171° 41'	3s	0.4	282.9
3 Sept.	2000	84° 51.2'	169° 32'	2s		278.6

DATE	TIME GMT	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
SEPT.4	2000	84° 59.3'	168° 39'	3s	0.1	281.4
5	2300	85° 01.2'	168° 51'	3s	0.3	282.4
7	2200	85° 11.2'	167° 10'	2s		288.0
9	2000	85° 22.5'	165° 28'	2s		292.4
11	0100	85° 20.0'	167° 00'	2s		292.2
11	2400	85° 21.8'	167° 40'	3s	0.3	292.4
12	2300	85° 23.5'	167° 25'	3s	0.4	295.0
14	2400	85° 30.4'	167° 42'	3s	0.1	297.8
16	2200	85° 28.4'	168° 09'	3s	0.2	297.6
17	2000	85° 28.1'	168° 08'	2m, 1s	0.2	298.3
18	2200	85° 26.0'	169° 22'	2s, 1m	0.3	297.8
19	2200	85° 23.1'	169° 06'	2s, 1m	0.3	297.7
20	2200	85° 23.1'	168° 57'	4s	0.4	297.2
22	2200	85° 26.7'	169° 50'	4s	0.5	295.6
25	2300	85° 31.8'	171° 10'	3s	0.4	296.7
OCT.1	0800	85° 20.7'	172° 44'	2s		298.0
7	0800	85° 01.9'	172° 11'	3x	0.1	296.0
8	0600	85° 02.3'	172° 18'	3x	0.1	295.2
9	0600	85° 00.9'	173° 05'	3x	0.3	294.4
10	0400	84° 58.8'	173° 57'	3m	0.1	295.0
12	2000	85° 00.9'	176° 12'	4m	0.3	290.9
14	0300	85° 02.5'	176° 07'	3m	0.2	289.5
18	1400	84° 30.4'	174° 15'	3m	0.1	293.9

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
19 OCT.	1000	84° 38.6'	174° 47'	3x	0.2	293.3
21	1900	85° 03.6'	174° 52'	3s	0.2	293.2
22	2000	85° 05.5'	172° 02'	4x	0.4	295.8
23	2100	85° 05.6'	171° 22'	2x		298.3
25	0300	85° 01.8'	170° 34'	3x	0.4	301.2
26	0600	85° 00.7'	170° 04'	4x	0.3	301.9
27	0200	85° 00.5'	169° 49'	3x	0.1	301.2
29	0400	84° 48.8'	167° 59'	3x	0.3	300.2
30	1900	84° 43.4'	169° 07'	4x	0.3	299.6
31	0300	84° 42.4'	169° 31'	4x	0.1	301.7
31	2000	84° 38'	169° 42'	4x	0.4	300.0
1 NOV.	2100	84° 35.0'	170° 36'	4x	0.2	300.2
2	2000	84° 34.0'	170° 57'	3x	0.3	300.4
3	2400	84° 34.8'	170° 44'	4x	0.2	301.5
4	2000	84° 35.7'	170° 38'	4x	0.2	303.0
5	2100	84° 32.5'	170° 10'	4x	0.2	303.2
6	2000	84° 28.3'	169° 58'	4x	0.2	303.5
7	2100	84° 25.5'	169° 37'	4x	0.2	304.2
8	1900	84° 24.4'	169° 37'	4x	0.4	305.4
9	1900	84° 21.5'	169° 18'	5x	1.2	306.1
10	2000	84° 18.4'	169° 06'	4x	0.3	307.0
11	2000	84° 15.9'	168° 44'	4x	0.1	307.1
12	2000	84° 14.0'	168° 17'	5x	0.6	302.6
13	2400	84° 15.2'	167° 40'	4x	0.5	308.8

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
14 NOV.	1900	84° 17.3'	167° 24'	4x	0.7	309.1
16	1900	84° 20.2'	166° 16'	3x	0.3	310.6
17	2100	84° 24.9'	166° 08'	4x	0.4	309.4
18	2100	84° 24'	165° 50'	3x	1.0	310.1
19	2000	84° 16.8'	165° 29'	4x	0.2	310.7
20	2000	84° 10.7'	165° 22'	5x	0.8	312.3
21	2000	84° 03.4'	165° 20'	4x	0.3	312.5
22	1900	83° 57.3'	165° 23'	5x	0.6	313.1
23	2000	83° 51.8'	165° 28'	3x	0.5	313.3
24	2000	83° 47.7'	165° 34'	4x	0.3	314.6
25	1900	83° 47.8'	165° 48'	4x	0.4	314.7
26	1900	83° 44.6'	165° 58'	4x	0.2	315.1
27	2000	83° 42.5'	166° 13'	4x	0.2	315.0
28	2100	83° 42.3'	166° 17'	4x	0.3	315.4
29	2100	83° 40.5'	166° 00'	5x	0.7	316.5
30	1900	83° 40.0'	165° 39'	4x	0.2	317.4
1 DEC.	2200	83° 41.5'	165° 08'	4x	0.1	317.6
2	1900	83° 41.3'	164° 40'	4x	0.4	318.9
3	2000	83° 41.0'	164° 12'	4x	0.3	319.9
4	1900	83° 40.7'	163° 58'	5x	0.7	320.4
6	1900	83° 37.1'	164° 44'	5x	0.3	320.1
7	2000	83° 41.8'	164° 55'	5x	0.2	320.5
8	2000	83° 45.0'	164° 36'	4x	0.3	321.0
9	2000	83° 47.2'	164° 42'	4x	0.2	321.1

DATE	TIDE	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
10	2000	83° 47.8'	164° 55'	4x	0.4	321.6
11	2000	83° 47.7'	164° 58'	4x	0.3	321.6
12	1900	83° 49.5'	165° 04'	4x	0.2	322.3
13	2000	83° 48.0'	165° 08'	4x	0.3	322.0
14	2000	83° 47.5'	165° 02'	3x	0.2	322.8
15	1900	83° 42.2'	164° 02'	4x	0.4	323.7
16	2100	83° 37.5'	163° 27'	4x	0.4	324.9
17	2000	83° 32.1'	163° 07'	4x	0.4	325.6
18	1900	83° 31.2'	162° 57'	4x	0.4	325.7
19	2000	83° 32.8'	162° 46'	4x	0.4	326.4
20	1900	83° 33.5'	162° 23'	3x	0.2	327.4
21	2400	83° 35.3'	161° 53'	4x	0.3	328.5
22	2200	83° 37.5'	161° 46'	4x	0.2	329.2
23	2200	83° 38.5'	161° 44'	4x	0.6	329.5
24	2000	83° 38.8'	161° 34'	4x	0.3	329.4
26	1900	83° 37.5'	161° 42'	4x	0.5	329.3
27	2000	83° 38.0'	161° 33'	4x	0.6*	329.5
28	1900	83° 38.0'	161° 37'	4x	0.3	329.9
29	2200	83° 37'	161° 46'	4x	0.8	329.6
30	2200	83° 36.9'	161° 45'	4x	0.6	329.5
31	1900	83° 36.7'	161° 45'	4x	0.2	329.4
1 JAN. 1958	2200	83° 38.5'	161° 30'	4x	0.4	329.3
2	2200	83° 39.6'	161° 28'	3x	0.7	329.3
3	2 00	83° 40.0'	161° 16'	4x	0.4	328.4
4	2 00	83° 44.0'	160° 32'	3x	0.2	328.3

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
5	2200	83°44.2'	160°47'	3x	0.1	328.9
6	2000	83°45.2'	160°16'	4x	0.5	329.3
7	1900	83°44.1'	160°42'	4x	0.3	329.2
8	2400	83°36.0'	159°33'	4x	0.3	331.1
9	2300	83°29.4'	158°56'	4x	0.3	330.4
11	0300	83°15.0'	159°00'	3x	0.5	330.8
11	2400	83°16.6'	159°11'	4x	0.1	331.1
12	2200	83°14.0'	159°18'	4x	0.3	331.7
13	2100	83°12.5'	159°02'	4x	0.4	332.6
14	2000	83°13.8'	158°30'	4x	0.8	333.7
16	2100	83°25.8'	156°37'	4x	0.4	334.9
19	0200	83°31.0'	156°50'	4x	0.5	333.8
20	0300	83°30.5'	157°00'	3x	0.4	333.5
20	2300	83°29.2'	156°57'	4x	0.1	334.7
21	2000	83°27.6'	157°30'	4x	0.8	334.6
23	1900	83°22.0'	158°27'	4x	0.3	333.7
24	1900	83°23.5'	158°28'	5x	0.4	333.6
25	2100	83°24.5'	158°16'	4x	0.4	334.2
26	2400	83°25.4'	158°34'	4x	0.8	334.7
27	1900	83°24.3'	158°22'	3x	0.1	334.9
28	1900	83°26.8'	158°00'	4x	0.3	334.7
29	1900	83°25.1'	157°44'	5x	0.4	335.6
30	2200	83°26.5'	156°54'	7x	0.5	337.8
31	2000	83°26.2'	156°37'	4x	0.5	337.8
1 FEB.	2000	83°27.0'	156°22'	4x	0.6	339.4

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
2 FEB.	2200	83°28.8'	156°21'	4x	0.4	339.9
3	2000	83°31.0'	156°35'	4x	0.1	340.0
5	1900	83°43.2'	157°42'	6x	0.1	338.0
6	1900	83°43.1'	157°45'	4x	0.2	337.6
7	1900	83°42.4'	157°30'	4x	0.1	338.6
8	1900	83°45.4'	157°34'	4x	0.4	339.2
9	2300	83°46.0'	157°21'	5x	0.4	339.3
10	1900	83°44.9'	157°03'	4x	0.2	339.7
12	0400	83°44.2'	156°02'	3x	0.9	341.0
12	1900	83°45.8'	155°28'	4x	0.3	341.2
13	1900	83°45.6'	155°25'	4x	0.2	341.2
14	2000	83°44.7'	155°28'	4x	0.3	341.5
15	2000	83°43.7'	155°07'	4x	0.2	341.9
18	1900	83°45.8'	155°05'	4x	0.5	341.6
19	1900	83°45.1'	154°59'	3x	0.3	341.5
20	1900	83°45.8'	154°59'	3x	0.5	341.7
21	1900	83°46.3'	155°17'	4x	0.2	341.0
23	0500	83°45.6'	155°10'	3x	0.1	341.7
24	0600	83°43.5'	154°59'	4x	0.5	341.5
26	0300	83°41.6'	154°24'	4x	0.1	341.2
28	0300	83°40.7'	154°04'	4x	0.5	342.9
1 MARCH	0300	83°37.4'	154°10'	4x	0.3	342.6
2	0300	83°31.8'	154°15'	4x	0.2	342.3
3	0600	83°29.8'	154°16'	2x		341.4

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
4 MARCH	0300	83°30.6'	154°29'	4x	0.2	341.5
5	0300	83°33.3'	154°27'	4x	0.1	341.8
6	0300	83°34.3'	154°13'	3x	0.4	343.0
8	0300	83°38.0'	154°03'	4x	0.3	344.6
9	0700	83°41.0'	154°16'	4x	0.1	346.7
10	0700	83°45.3'	153°53'	4x	0.3	348.9
11	0700	83°44.7'	153°58'	4x	0.3	349.4
12	0600	83°45.0'	153°50'	5x	0.5	350.1
13	0700	83°45.4'	154°08'	4x	0.2	349.7
14	0700	83°45.0'	153°54'	4x	0.2	350.4
15	0700	83°42.9'	153°53'	4x	0.2	350.5
17	0700	83°38.0'	153°58'	3x	0.4	350.6
18	0800	83°36.1'	153°39'	4x	0.2	351.3
19	1000	83°35.1'	153°37'	4x	0.2	351.5
21	1000	83°47.2'	153°22'	4x	0.2	352.0
22	0800	83°52.5'	153°38'	4x	0.8	352.2
23	1000	83°50.2'	153°33'	5x	0.2	252.7
24	0900	83°48.5'	153°48'	4x	0.2	358.8
25	1000	83°46.3'	153°44'	4x	0.1	353.0
26	0900	83°46.5'	153°11'	4x	0.5	353.6
27	0900	83°48.2'	152°49'	4x	0.15	353.1
28	1000	83°48.0'	152°36'	1m		
28	2300	83°48.0'	152°20'	1m,1s		353.4
30	2300	83°49'	152°20'	1m,1s		354.4
31	0900	83°47.7'	152°38'	4x,1m	0.9	354.1

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
1 APRIL	0900	83°48.2'	152°50'	4x	0.1	353.8
2	0900	83°48.0'	152°33'	4x	0.25	354.2
3	0900	83°47.6'	152°27'	4x	0.5	354.1
4	0900	83°47.6'	152°21'	5x	0.6	354.1
5	1000	83°50.4'	152°30'	3x	0.1	354.2
6	2200	83°47.7'	152°27'	2x		354.6
7	1000	83°47.8'	152°18'	4x	0.2	355.2
8	1000	83°45.9'	152°29'	4x	0.3	355.3
9	1000	83°45.3'	151°58'	4x	0.3	356.9
10	1000	83°45.8'	151°48'	4x	0.2	357.3
11	1000	83°47.8'	151°45'	5x	0.3	357.9
12	1000	83°49.5'	151°54'	4x	0.2	358.9
13	1000	83°51.1'	151°49'	3x	0.2	000.5
14	1000	83°52.8'	151°58'	4x	0.25	000.3
15	1000	83°52.4'	151°55'	4x	0.2	000.3
16	1000	83°52.4'	151°55'	4x	0.1	000.5
17	1000	83°52.5'	151°52'	3x	0.6	000.4
18	2200	83°53.4'		1s,noon		000.0
19	1000	83°53.1'	151°58'	2x,2s	0.4	000.1
20	1400	83°55. 9'	152°05'	2x,1s	0.1	359.4
21	1000	83°56.7'	151°58'	4x	0.1	000.1
22	1000	83°57.9'	152°00'	4x	0.8	000.5
23	1500	83°58.1'	151°56'	3s	0.1	359.6
24	1400	83°57.5'	151°53'	3s,1m	0.1	358.9
25	1500	83°59'	151°30'	4s	1.0	359.0

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
26 APRIL	1100	83°59'	151°37'	3x,1s	0.5	358.1
28	2200	84°00.7'	152°31'	3s	0.1	359.3
1 MAY	2200	83°53.5'	152°40'	3s	0.7	357.8
2	2100	83°48.3	153°06'	2s		356.7
3	2200	83°42'	153°20'	D.R., 1s		356.6
4	2400	83°39.3'	153°01'	3s	0.1	355.4
6	0200	83°46.5'	153°20'	3m	1.1*	356.7
7	0400	83°45.6'	153°28'	3s	0.1	357.2
7	2000	83°45.6'	153°41'	3s	0.3	356.7
8	2000	83°46.9'	153°38'	3s	0.1	356.1
9	2000	83°45.8'	153°47'	3s	0.1	356.9
10	2200	83°44.2'	153°23'	3s	0.3	356.6
11	2000	83°43.7'	153°17'	3s	0.4*	357.1
12	2300	83°43.4'	152°53'	3s	0.3	356.5
13	2000	83°43.9'	152°44'	3s	0.5	357.0
14	2200	83°45.3'	152°10'	3s	0.1	358.0
16	2000	83°47.0'	152°32'	3s	0.3	358.6
17	1900	83°48.3'	152°28'	2s		358.4
CAMP MOVED TO NEW FLOE (NEW REFERENCE LINE)						
18	2200	83°49.6'	151°57'	3s	0.4*	54.4
19	2300	83°49.4'	152°01'	3s	0.2	54.4
21	2000	83°49.4'	151°38'	3s	0.1	56.1
22	2100	83°51.3'	151°28'	3s	0.3	56.9

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
23 MAY	2000	83°55.6'	151°32'	3s	0.1	57.0
25	2300	83°55.7	151°37'	3s	0.1	56.6
26	2000	83°55.0'	151°28'	3s	0.1	57.0
27	2000	83°55.9'	151°12'	3s	0.1	57.8
29	2100	83°56.6'	151°36'	3s	0.9	57.9
30	2100	83°57.8'	152°06'	3s	0.9*	59.0
31	2300	83°55.6'	151°33'	3s	1.6*	60.0
1 JUNE	2100	83°54.0'	151°14'	3s	0.5	61.2
2	1800	83°54.6	151°10'	2s		61.2
3	2100	83°57.4'	151°27'	3s	0.1	61.7
4	0200	83°55.9'	151°41'	2s		62.1
5	0300	83°55.3'	152°00'	2s		62.3
5	1900	83°58.4'	151°30'	3s	0.1	62.5
6	2100	84°01.5'	151°20'	2s		63.2
7	2000	84°08.5'	150°43'	3s	0.9*	63.5
8	2200	84°09.2'	150°23'	3s	0.1	62.3
9	2000	84°09.6'	149°47'	3s	0.2	62.8
10	2200	84°11.5'	149°27'	3s	0.5	63.5
11	2000	84°13.8'	149°20'	3s	0.4	62.3
12	2000	84°16.3'	149°11'	3s	0.1	51.6
13	2000	84°18.5'	149°01'	4s	0.1	51.0
14	1000	84°20.6'	148°56'	2s		50.9
14	2200	84°22.6'	148°51'	4s	0.1	
15	2200	84°23.1'	148°37'	4s	0.2	51.2

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
16 JUNE	2100	84°27.7'	148°28'	3s	0.3	50.9
17	1900	84°30.9'	147°59'	3s	0.1	51.2
18	2000	84°33.2'	147°42'	3s	0.2	52.5
19	2300	84°33.2'	148°07'	4s	0.3	52.4
21	0300	84°32.6'	147°42'	3s	0.2	53.0
22	0100	84°34.7'	147°37'	3s	0.2	52.8
24	0300	84°38.3'	147°33'	5s	0.2	54.0
24	2300	84°39.0'	147°38'	3s	0.2	54.7
25	2000	84°37.1'	147°34'	3s	0.3	57.7
26	1900	84°34.6'	147°49'	2s		57.2
29	0300	84°37.3'	147°44'	3s	0.2	56.8
30	2300	84°41.0'	147°51'	3s	0.1	55.7
1 JULY	2000	84°41.4'	147°35'	3s	0.1	56.0
3	0000	84°41.0'	147°21'	3s	0.1	56.4
3	2100	84°41.1'	147°09'	3s	0.1	56.9
4	2200	84°40.1'	147°15'	3s	0.1	57.1
5	2300	84°37.6'	146°54'	4s	0.3	57.2
6	2200	84°34.5'	146°37'	3s	0.4	57.4
8	0100	84°32.4'	146°12'	3s	0.1	60.0
8	2000	84°31.6'	146°04'	3s	0.1	61.5
10	0700	84°30.9'	144°47'	3s	0.3	62.4
10	2200	84°31.0'	144°28'	4s	0.4	63.4
13	0200	84°31.7'	142°36'	3s	0.7*	62.1
14	0200	84°32.2'	142°32'	3s	0.3	61.7

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
14 JULY	2200	84°33.4'	142°25'	3s	0.5	61.8
15	2300	84°31.5'	143°28'	3s	0.6	58.7
16	2200	84°32.9'	144°03'	3s	0.6	59.6
18	0300	84°32.6'	143°45'	3s	0.1	60.7
18	2300	84°32.9'	143°29'	3s	0.1	61.9
21	0200	84°35.7'	143°21'	2s		60.1
23	1300	84°40.8'	140°26'	2s		73.8
24	0100	84°43.6'	140°11'	3s	0.4	74.5
24	2100	84°46.5'	140°03'	3s	0.8	76.8
25	2300	84°48.5'	140°04'	3s	0.2	76.9
1 AUGUST	1200	85°01.5'	138°00'	4s	0.2	84.5
2	0400	85°01.2'	137°41'	5s	0.9	84.8
4	0000	85°02.4'	138°12'	3s	0.3	85.6
4	2100	85°04.0'	138°48'	3s	0.2	86.7
6	1900	85°02.0'	138°58'	3s	0.2	86.9
7	2100	85°01.9'	138°18'	3s	0.2	86.9
9	2100	84°59.8'	136°45'	4s	0.4	87.3
11	0100	84°58'	136°05'	3s	0.6	88.4
18	0600	85°02.9'	135°03'	3s	0.2	85.5
18	2100	85°03.2'	135°05'	3s	0.3	85.0
20	0300	85°01.5'	134°00'	3s		82.7
20	2100	85°00.3'	133°54'	3s		83.7
21	2300	84°58.7'	133°26'	4s		84.4

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
26 AUGUST	0100	85°04.8'	130°40'	5s		90.1
26	2100	85°05.4'	130°23'	3s		88.6
27	1800	85°05.6'	130°04'	2s		89.8
3 SEPT.	0000	85°26.5'	128°16'	2s		94.1
3	2300	85°32.0'	127°52'	2s		95.4
5	1500	85°41.1'	127°17'	2s		96.4
9	0100	85°54'	124°00'	2s,2m	0.2	99.3
9	2200	85°54.7'	123°34'	3s,1m	0.4	101.1
12	2100	85°50.0'	122°00'	3s	0.3	124.6
15	1900	85°56.4'	122°35'	3s	0.2	123.7
17	2100	85°51.7'	123°31'	3s	0.2	102.3
18	1900	85°51.5'	122°47'	2s		76.4
23	0800	85°47.8'	120°29'	3x	0.3	87.2
26	0800	85°49'	119°45'	4x	0.4	86.8
2 OCT	2200	85°38.7'	120°40'	3m,1s	0.2	84.0
3	0500	85°39.5'	120°31'	3s	0.3	83.8
3	2230	85°39.3'	120°05'	3m	0.3	83.6
4	0830	85°41.0'	119°55'	4s	0.5	83.8
7	1100	85°53.1'	120°25'	3s	0.1	86.3
8	0300	85°52.5'	120°21'	4s	0.2	86.4
11	0700	85°57.4'	119°29'	5s	0.1	86.5
14	0700	86°02.5'	119°30'	5s	0.1	85.6
15	0600	86°03.4'	119°52'	5s	0.2	86.0

DATE	TIME	LATITUDE NORTH	LONGITUDE WEST	NO. LOP'S	ERROR	AZIMUTH
20 OCT.	0700	86°09.2'	121°28'	4s	0.3	88.6
21	2000	86°15'	122°10'	4s	0.3	98.3
22	0800	86°20'	121°32'	3s	0.2	99.8
26	2000	86°23.3'	116°37'	4s	0.3	112.3
28	0800	86°20.9'	116°10'	3s	0.2	112.2
1 NOV.	0200	86°09.5'	114°08'	4s	0.5	113.2
3	0500	86°11.5'	113°08'	3s	0.4	112.6

Navigation Data -- Station Charlie

Navigator - Lamont

Month	Day	Hour G.M.T.	North Latitude	West Longitude	Reference line bearing	No. of L.O.P's	Radius of error
October	26	1000	77°59.9	171°38'	N 156° E	4	0.6
November	15	0800	77°52.6	172°17'	N 164° E	4	0.8
November	16	0700	77°53.9	172°22'	N 165° E	4	0.3
November	21	2000	77°49.8	172°33'	N 168° E	3	0.1
November	24	0700	77°51.7'	172°38'	N 169° E	6	0.2
November	30	0600	77°38.2	172°22'	N 176° E	3	0.2
December	1	0500	77°37.7	172°43'	N 178° E	4	0.7
December	2	0400	77°38.0	173°02'	N 179° W	4	0.5
December	3	0400	77°35.9	173°12'	N 178° W	4	0.4
December	5	2400	77°18.7	171°53'	N 175° W	3	0.1
December	6	2400	77°09.9	172°00'	N 175° W	4	0.3
December	10	0500	76°58.1	171°25'	N 177° W	4	0.2
December	11	0500	76°57.4	171°16'	N 176° W	4	0.2
December	13	0500	76°55.6	170°36'	N 177° W		
December	15	1300	76°59.3	169°47'	N 179° E	4	0.2
December	17	0400	77°02.2	169°18'	N 178° W	3	0.1
December	18	0600	77°05.6	169°04'	N 176° W	2	
December	19	0600	77°08.3	168°37'	N 176° W	4	0.3
December	22	0100	77°13.7	168°03'	N 172° W	4	0.2
December	23	0400	77°17.2	168°25'	N 171° W	2	?

December	24	1300	77°15.8	168°32'	N 173° W	3	0.1
December	27	0600	77°21.8	167°46	N 172° W	4	0.3
December	28	0700	77°25.3	167°32'	N 172° W	4	1.0
December	28	1300	77°25.0	167°30'	N 173° W	4	0.1
December	29	1100	77°24.4	167°36'	N 174° W	4	0.8
December	31	0400	77°17.7	167°47'	N 174° W	4	0.2
January	2	0700	77°13.6	167°34'	N 173° W	5	0.2
January	3	0400	77°11.8	167°44'	N 173° W	4	0.1
January	4	0600	77°10.6	168°01	N 172° W	4	0.1
January	6	0400	77°04.9	168°38'	N 171° W	4	0.1

The radius of error is the radius in nautical miles of a circle inscribed within the polygon formed by the L.O.P.'s