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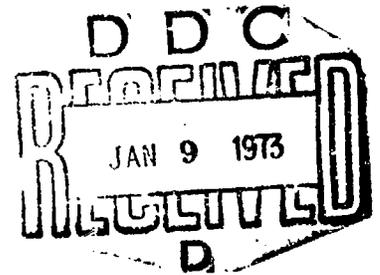
NRL Report 7516

Project NEAT I Environmental Data Report (USNS J. W. GIBBS)

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ABSTRACT

In September and October 1969, USNS *J. W. Gibbs* (T-AGOR 1) participated in the NEAT I (Northeast Atlantic Test I) acoustic experiment. Historical data were evaluated prior to the experiment and compared to the in-situ measurements made by *Gibbs*. Included in these measurements were bathymetry, camera, core and dredge stations, and water-column measurements including XBT's, Nansen casts, and velocimeter casts. The in-situ water-column measurements were used to confirm or deny the presence of the sound velocity double minimum that is present in much of the NEAT I study area. Measurements were made both while at anchor and in transit to and from the anchor sites.

PROBLEM STATUS

This is a final report on the environmental studies of Project NEAT I; work on the basic problem continues.

AUTHORIZATION

NRL Problem S01-37
Project No. R2408

Manuscript submitted October 31, 1972.

PROJECT NEAT I ENVIRONMENTAL DATA REPORT (USNS J. W. GIBBS)

INTRODUCTION

Project NEAT I (North East Atlantic) was a joint United States-United Kingdom experiment to evaluate acoustic characteristics in the West European, Iberian, and Canary Basins during September and October of 1969 (1). This report is a summary of environmental data taken by USNS *J. W. Gibbs* during her participation in Project NEAT I.

HISTORICAL ENVIRONMENTAL DATA REVIEW

Prior to USNS *Gibbs*' participation in Project NEAT I, an extensive review of historical environmental data for the NEAT I area was conducted by the Naval Research Laboratory (NRL). The following is a brief summary of this review.

PHYSIOGRAPHY

The NEAT I study area was bounded by 17° to 62° N. latitude and 08° to 28° W. longitude, including the West European, Iberian, and Canary Basins. In general, the north-east Atlantic is an elongated rectangle of interconnected basins (striking north northeast-south southwest), bounded on the west by the Mid-Atlantic Ridge, on the east by the continental margins of Africa and Europe, on the north by the Faeroe-Iceland Ridge, and on the south by Cape Verde Terrace. The area contains approximately 3.2 million square miles. Figure 1 shows the topographic setting of the NEAT I study area described above.

BATHYMETRIC AND OCEANOGRAPHIC DATA

In reviewing the historical bathymetric and oceanographic data for the NEAT I project, many sources of information were consulted. The primary source of information was the excellent series of Undersea Surveillance Oceanographic Center Requirement Documents for the Northeast Atlantic by Fenner (2-5).

Figures 2, 3, and 4 are Fenner's bathymetric track coverage charts, with each chart representing approximately one-third of the NEAT I area. With the exception of the upper one-third, Fig. 4, the bathymetric coverage of the NEAT I area consists of random track data.

The NEAT I area contains an unusual water column. Mediterranean Intermediate Water at depths of 900 to 1300 m mixes with North Atlantic Central Water. The resulting

sound speed profile* displays a double sound channel that occurs at the double minimum sound speed values. This phenomenon is primarily the result of the greater salinity found in the Mediterranean Intermediate Water (2-5).

Figure 5 shows the average depth of the upper sound channel for the winter months of January through March. The area of the permanent upper channel is confined to the Iberian Basin and to approximately 150 mi south of the Canary Islands. The transitory sound channel shows extremes based on all seasonal data examined.

Figure 6 shows a greatly expanded limit of the upper channel sound speed axis. The summer months (July through September) include the entire limit of the Northeast Atlantic, from the Faeroe-Iceland Ridge to the Reykjanes Ridge, southeast to Rockall Rise, and south again to an oceanographic front approximately 100 mi south of the Canary Islands. As in Fig. 5, the transitory limits are greater than the permanent limits of the upper sound channel.

The depths of the sound speed maximum axis are shown in Fig. 7. It should be noted that the geographic extent of this permanent sound speed maximum is quite similar to the geographic limits of the upper sound channel for the summer months. This annual presentation is given rather than a seasonal presentation because seasonal averages vary by less than 100 m in depth from annual figures in this area. As before, the transitory limits are well outside the permanent limits.

Figure 8 shows the annual average depth of the deep sound channel axis. Mediterranean Intermediate Water forces the deep sound channel, that is ubiquitous in North Atlantic Central Water, to its deepest depths when first interjected on the Atlantic side of the Straits of Gibraltar. Naturally, the further the Mediterranean Intermediate Water travels from its source, the greater the mixing with and dissipation into other water masses. Figure 8 illustrates this fact. Note that the gradient shoals greatest at the northern end, at the combined Faeroe-Iceland and Wyville-Thomson Ridges. Here, Arctic Intermediate Water flowing out of the Norwegian Sea forces a rapid shoaling of the deep sound channel to less than 400 m.

Figure 9 shows the generalized circulation patterns in the NEAT I study area. Mediterranean Intermediate Water, indicated by the heavy black arrows, enters the NEAT I study area via the Straits of Gibraltar and flows primarily to the north. It is this current, along with the effects of the annual heating and cooling cycle, that produces the area's unique double minimum sound velocity structure.

STATION ASSIGNMENTS OF USNS J. W. GIBBS

During NEAT I operations, USNS *J. W. Gibbs* was required by the operation plan to position herself (by deep sea anchorage) at the following sites for the purpose of acoustic measurements:

Phase I	43° 12.0' N.
	20° 36.0' W.

*See Fig. 39

Phase II	38°06.5' N. 21°08.0' W.
Phase III	30°00.0' N. 28°07.0' W.

Each site represented a full phase of the NEAT I operation. The selection of the actual anchorage position was determined by in-situ measurements because of possible errors on charts used to select these sites.

An illustration of the necessity of changing the site position based on inadequate bathymetric data was the determination of the site location for Phase II. Examination of Laugh'on's contour and United Kingdom sounding charts for the Phase II area raised doubts as to the existence of the seamount selected for the deep sea anchoring. The feature was contoured on the basis of one sounding of 1191 fathoms obtained by H.M.S. *Owen* in 1961 (7). An examination of NAVOCEANO's sounding data from the same location failed to locate this depth, or any shoal sounding in the area. Laughton also doubted the existence of the feature, and conducted a small survey on R/V *Discovery* in August 1969. He found that the minimum depth observed was 1965 fathoms (8). It was decided, therefore, to abandon this site, and two alternate sites were selected for Phase II. Field surveys would determine the final selection.

Examination of NAVOCEANO sounding sheets (9) indicated potential sites for acoustic evaluation at (a) 37°15' N., 20°05' W. and (b) 36°58' N., 21°51' W. Contingency plans for these two sites were drawn up and incorporated into the NEAT I Operation Plan.

OPERATIONAL PLANS FOR DATA GATHERING

A concept of the pre-NEAT I planning was that the acoustical and environmental properties of a basin would be measured within the same time frame. Thus, upon the completion of a given phase, a field evaluation of an acoustic measurement site could be made. Measurements would be made under two conditions: (a) Underway or in transit, or (b) On station.

On-station measurements consisted of the following:

- Bathymetric site surveys
- Bathymetric profiles along lines of bearing (LOB's)
- Bathymetric anchor charts
- Nansen casts (temperature profiles and sound speed)
- Cores
- Dredge hauls
- Bottom photographs

- Sound velocity casts and X-BT's on station
- Bottom currents (time permitting).

Transit measurements consisted of the following:

- Bathymetry along transit routes (time permitting)
- Magnetic data
- Sound velocity casts and X-BT's.



Fig. 1 — Physiographic diagram with Project NEAT I area outlined
(Copyright 1968, National Geographic Society; used by permission)

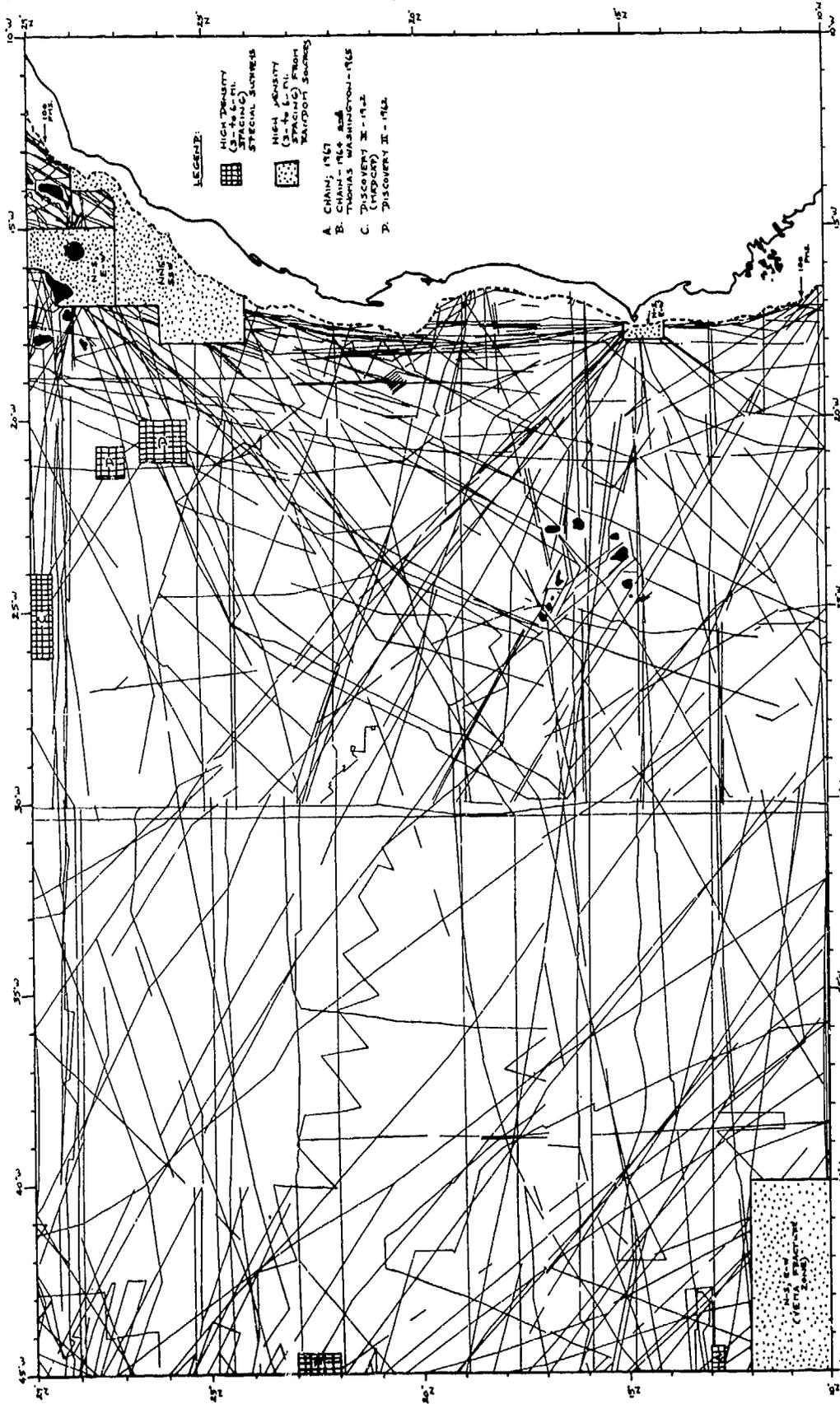


Fig. 2 -- Bathymetric track coverage chart, 10° N. to 29° N. (after Fenner (2))

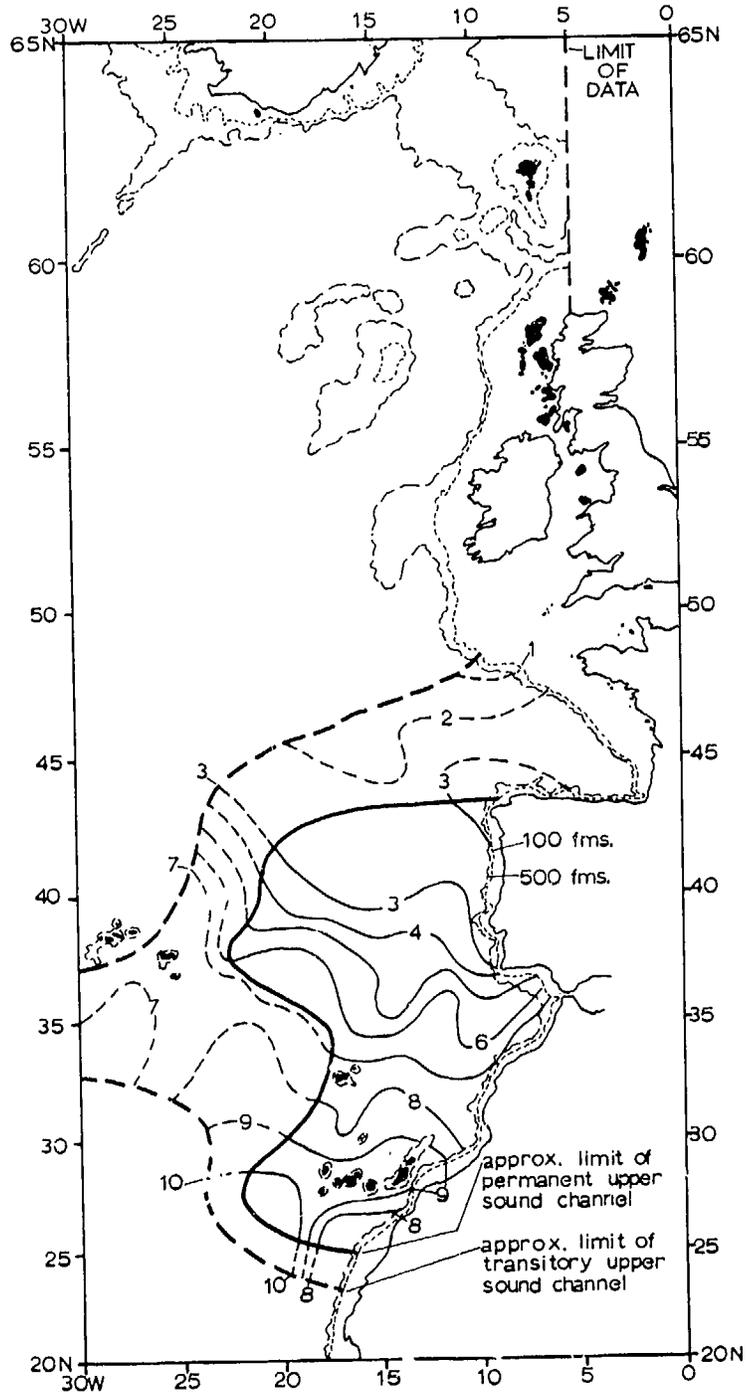


Fig. 5 — Average depth of upper sound channel axis (in meters x 100) for winter (Jan through Mar) (Ref. 6)

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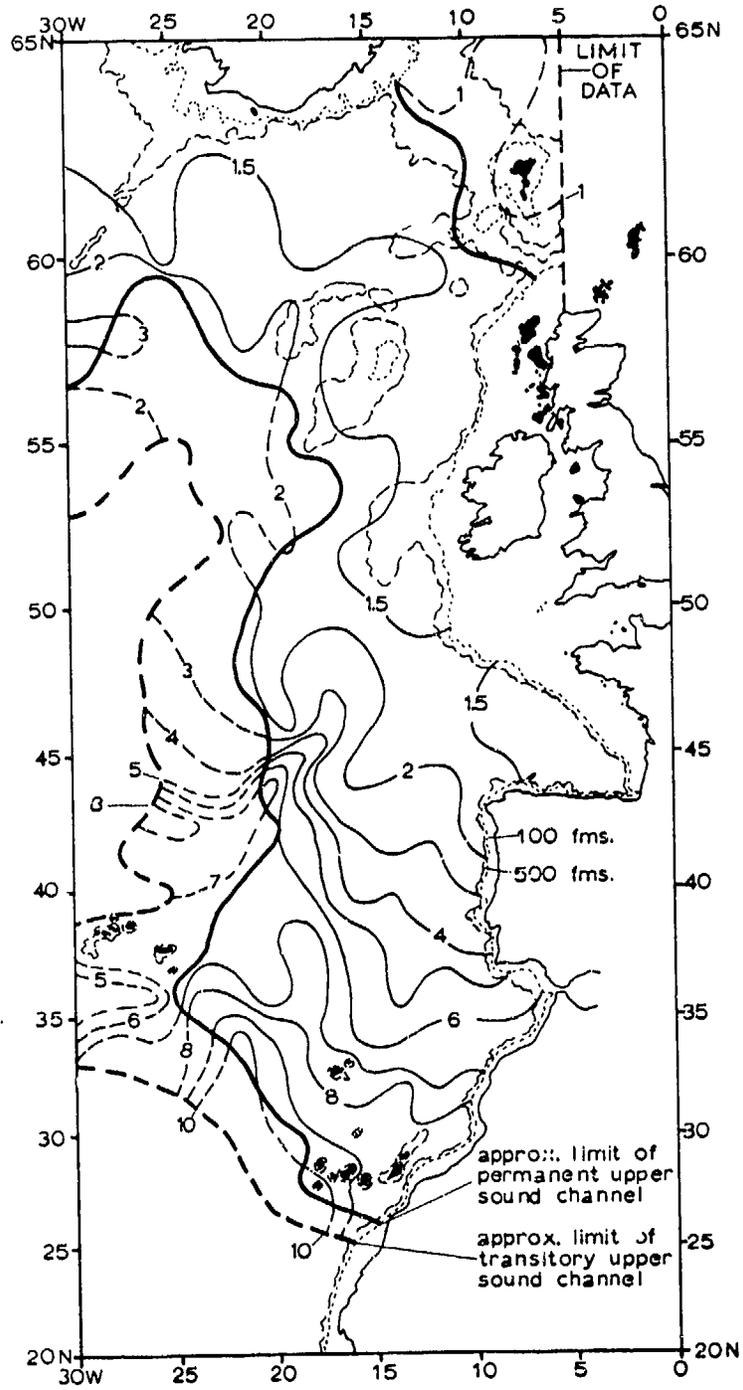


Fig. 6 — Average depth of upper sound channel axis
(in meters X 100) for summer (Jul through Sep) (Ref. 6)

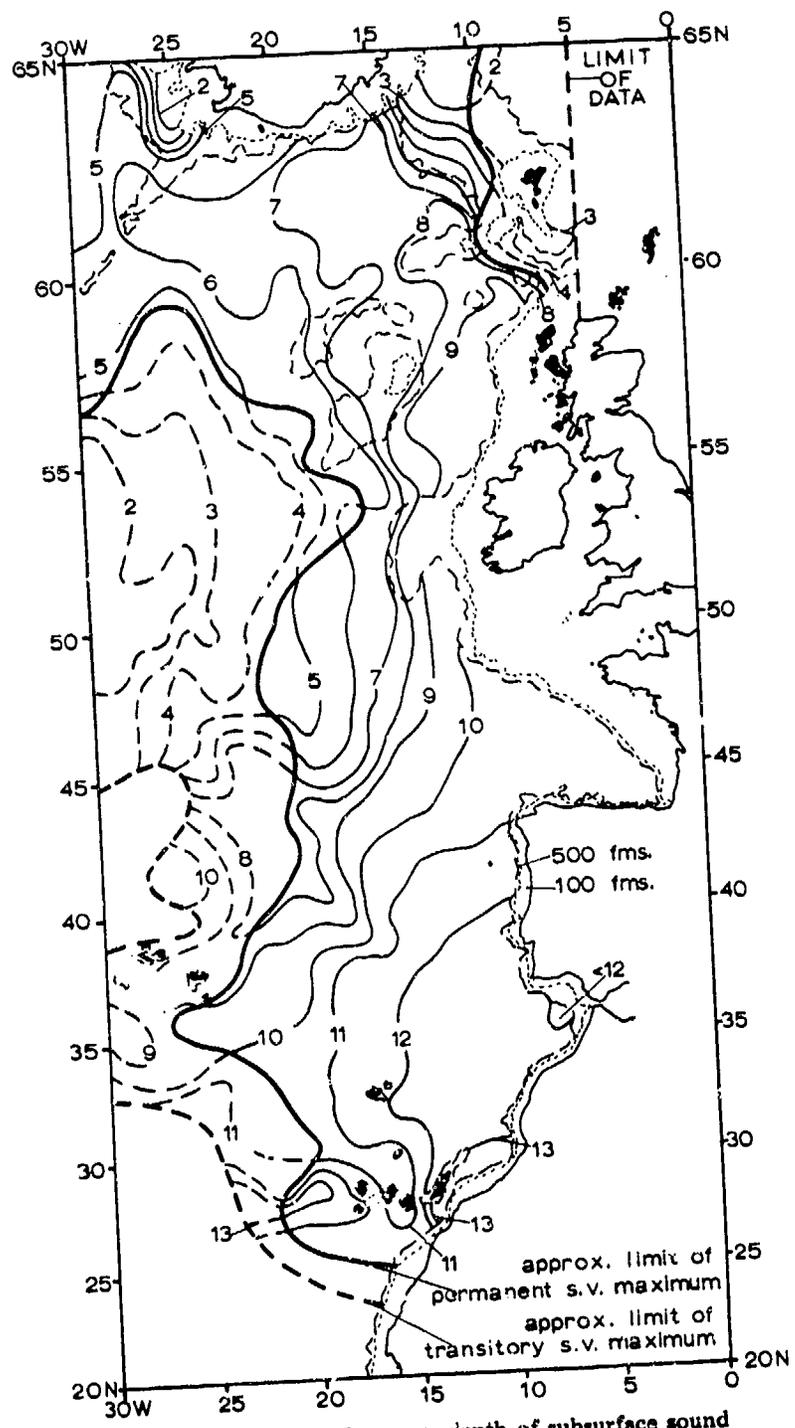


Fig. 7 - Annual average depth of subsurface sound speed maximum (in meters x 100) (Ref. 6)

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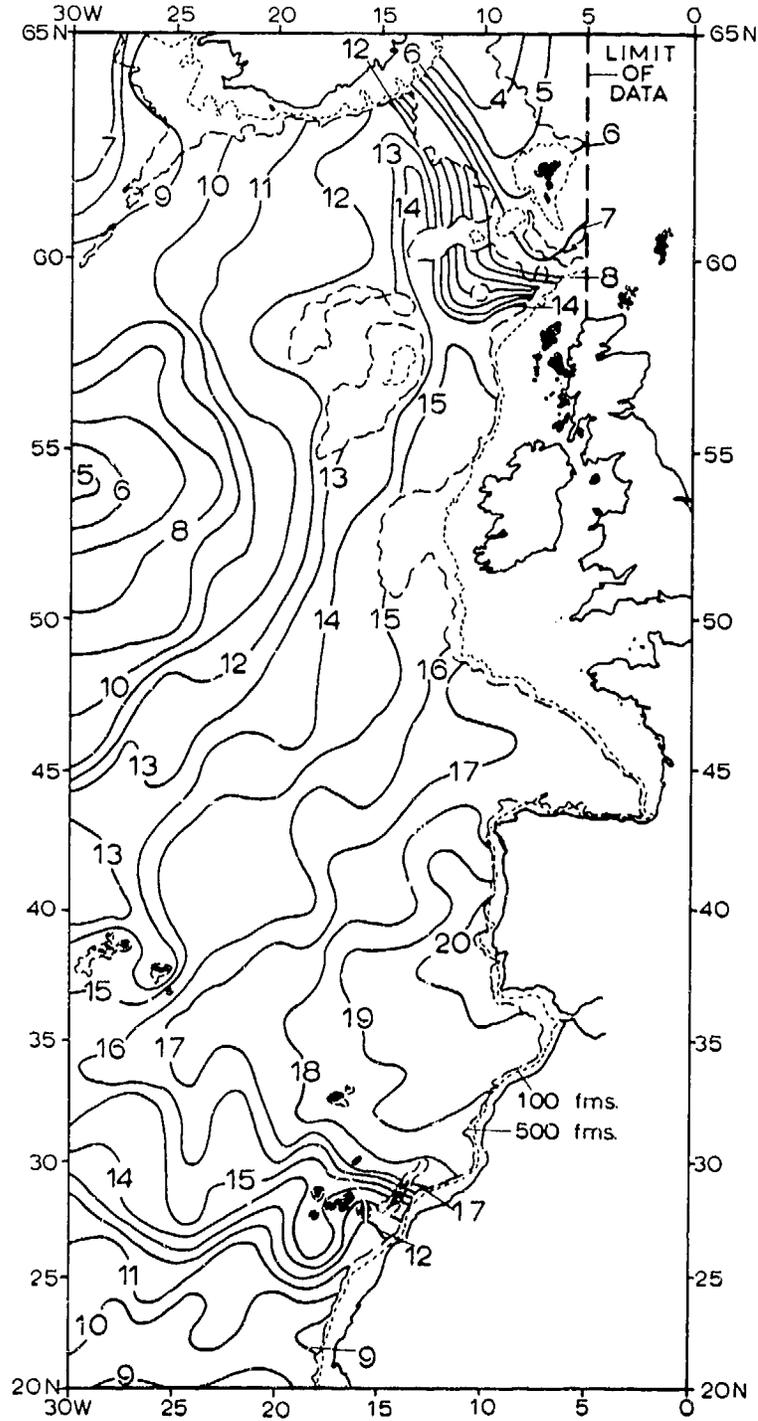


Fig. 8 — Annual average depth of deep sound channel axis (in meters \times 100) (Ref. 6)

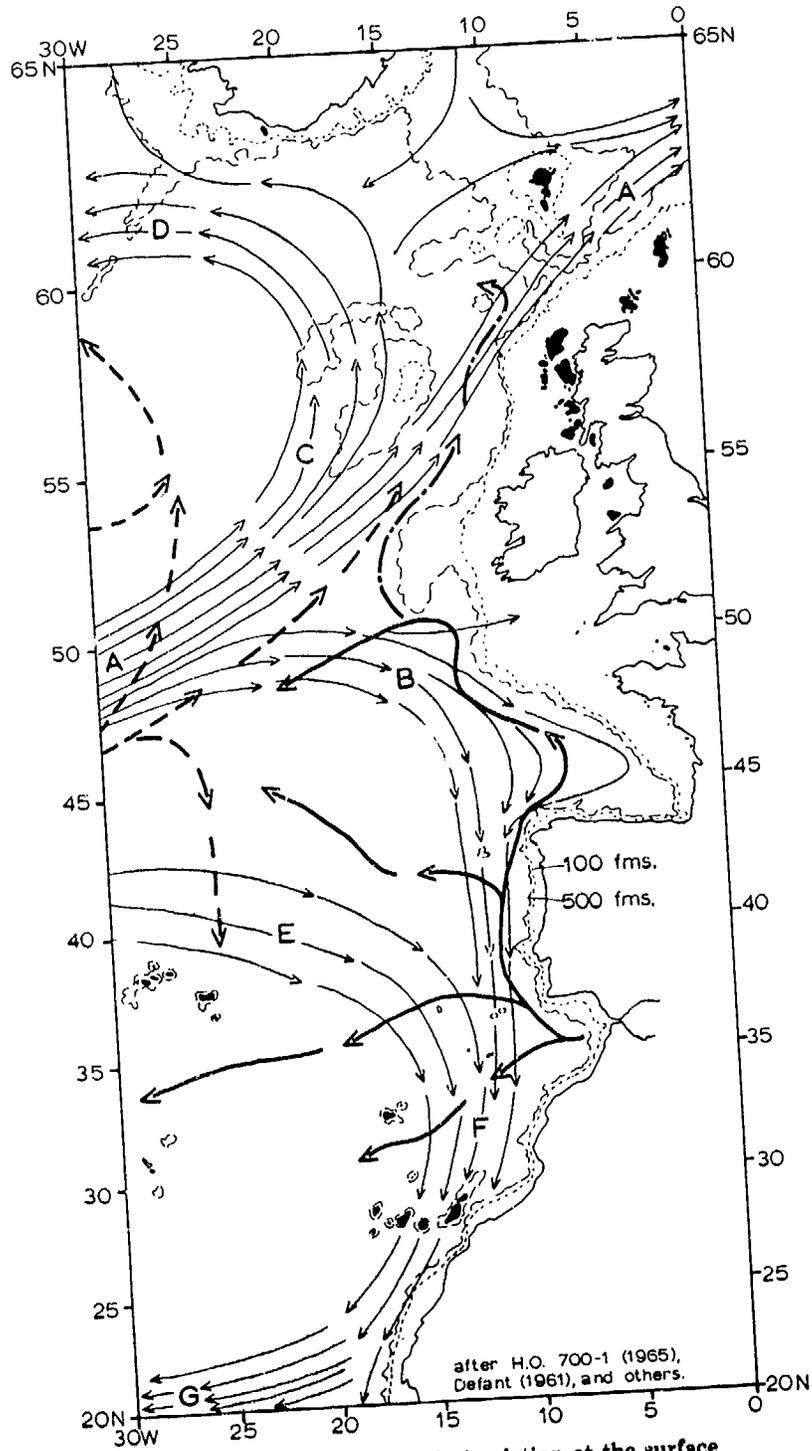


Fig. 9 - Generalized circulation at the surface and intermediate depths (Ref. 6)

PHASE I

Hydrophone Location

During Phase I (Sept. 19-27, 1969), USNS *J. W. Gibbs* was anchored in a depth of 1556 fathoms (uncorrected for sound speed and ship's draft) at $43^{\circ}12.88'$ N. latitude and $20^{\circ}39.08'$ W. longitude. This position was fixed by Naval Navigation Satellite System.

Gibbs' Phase I anchoring site was located on the northeastern slope of a seamount near the junction of the King's Trough and the Peake and Freen deeps (10). This seamount is at the southern termination of a range striking northwest-southeast, which in turn forms the northern boundary of the King's Trough.

Bathymetry

The bathymetric survey conducted by *Gibbs* at site I consisted of 14 east-west lines and three cross-checking lines. Figures 10, 11, and 12 show the contours and profiles constructed from data obtained on the survey.

This survey verified Laughton's interpretation that a linear ridge (striking northeast-southwest) separated the Peake Deep from an enclosed basin to the northwest. Because of intermittent periods of equipment failure and the uncertainty of published Omega diurnal corrections, the contours shown in Fig. 10 were adjusted to reflect the best bathymetric tie between sounding lines. Navigational repeatability is believed to be ± 2 n. mi.

The bathymetric profiles shown in Fig. 11 were constructed along aircraft lines of bearing from the anchorage to the edges of the survey. It should be noted that flights from the anchor site to the southwest cross an unsurveyed portion of the sheet. Soundings in that area indicated that a peak of less than 1000 fathoms exists, but operational time limits prevented further investigation in this area. For this reason, profiles 1-2 and 1-6 (220°) that are contained in Fig. 11 have been inferred by a dashed line where no real data exist.

A bathymetric anchorage chart was constructed to show bathymetry crossed while at anchor, as the ship swung on the scope of the anchor line (Fig. 13). The winds were predominantly westerly, as shown by ship's position (obtained by the satellite fixes). This chart gives a good picture of the true slope of the sea floor in the vicinity of the bottomed hydrophone. To construct this chart, only soundings coupled with navigation fixes were used, and contours were extrapolated between the points.

Bottom Photographs

During Phase I, two deep-sea camera lowerings were made and 254 pictures obtained. Figure 13 shows the location of camera drops relative to the acoustic measurement site.

Figures 14, 15, and 16 contain 12 frames which are representative of the Phase I bottom lithology. For a brief description of each frame, see Table 1.

Table 1*
Representative Bottom Photo Descriptions, Phase I

Frame No.	Depth (fm)	Description
1-22	1668	Level bottom of globigerina ooze reworked by benthic fauna which produced the mounds.
1-45	1671	Same as 1-22. Note small band of shingle near center of frame.
1-46	1670	Same as 1-22. Note large calcareous boulder above vane. Object under vane judged to be a sponge.
1-47	1670	Globigerina ooze with benthic mounds. Outcrop may be semiconsolidated calcareous rock. Note large sponge in upper right of frame.
1-48	1669	Same as 1-47.
1-49	1669	Same as 1-22.
1-52	1670	Same as 1-22.
1-69	1666	Same as 1-22. Note meandering benthic trails.
2-31	1478	Level bottom of globigerina ooze with benthic mounds and large amounts of shingle.
2-43	1478	Same as 2-31.
2-66	1478	Same as 2-31. Linear bands are probably ripple marks.
2-99	1474	Same as 2-66.

*Area of frame coverage is approximately 21 sq ft. Pictures were taken at 1/60 s at f/16 with "X" strobe synchronization. Film used was Eastman Kodak Type 2498RAR (ASA 320).

Cores

Three cores were taken during Phase I (Fig. 13) and were analyzed by the Naval Oceanographic Office. Table 2 is a listing of core locations, depth of water, and length of sample. Cores 1 and 2 were taken with a 500-lb gravity corer and Core 3 with a 1000-lb gravity corer. All core pipes were 5-ft lengths. A summary of sediment size, composition, chemistry, and engineering properties has been prepared by the Naval Oceanographic Office (11).

(U) Table 2
Core Stations, Phase I

Core No.	Location	Depth		Length of Sample	
		(Fathoms)	(m)	(in.)	(cm)
1	43°12.57' N. 20°36.00' W.	1500	2742	28	71.12
2	43°12.80' N. 20°38.0' W.	1539	2813	24	60.96
3	43°12.95' N. 20°38.45' W.	1458	2665	33	83.82

Sound Velocimeter Casts

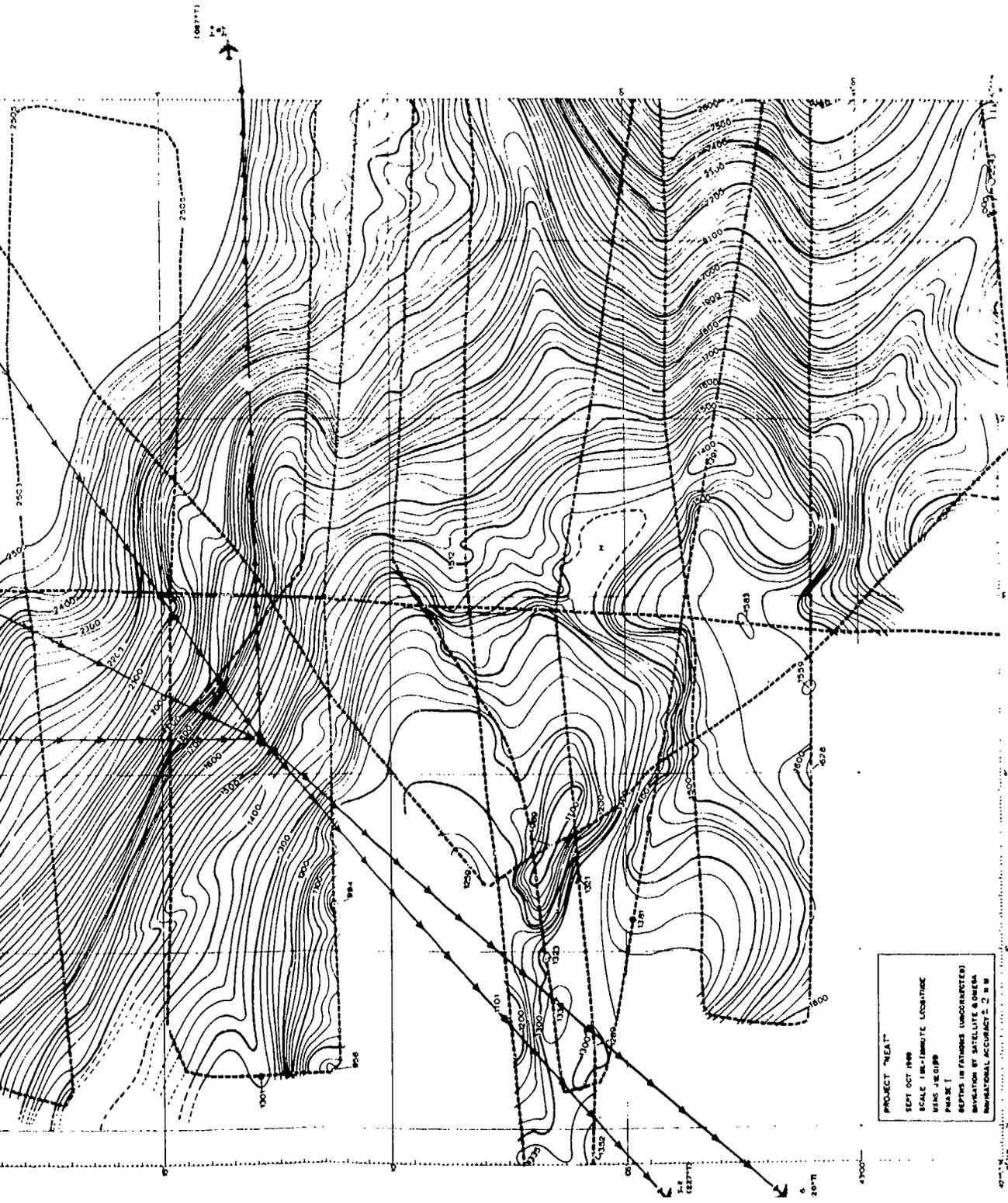
Three American Car and Foundry sound velocimeter casts were made during Phase I. Figure 17 displays computed plots of the data taken to construct sound speed profiles during the transit from the Azores to the Phase I anchorage site. Depths of the velocimeter readings were calculated from the amount of wire out and the wire angle. Figure 18 shows the geographic locations of sound velocimeter casts taken during Phase I.

Expendable Bathythermographs

A total of 63 Sippican expendable bathythermographs (X-BT's) were taken during Phase I; 40 were judged acceptable. Both T-5 (6000-ft) and T-7 (2500-ft) X-BT's were used. X-BT recordings with temperature variations in excess of 3°C above 300 ft and 1.5°C below 800 ft from the multiplot scale's mean value were rejected. Figure 19 is a digital multiplot printout of the data from X-BT casts 6 through 24 taken on or near the Phase I anchor site. The mean position for this group of X-BT's is 43°13' N., 20°38.5' W. Figure 20 is a composite digital multiplot printout of computed sound speed curves from X-BT's 6 through 24 shown in Fig. 19. Salinity values used in computing the sound speed curves were taken from historical data. Figure 21 shows the location of X-BT's used for this study during Phase I.

Nansen Casts

On Station 1, a single, intermediate-depth Nansen cast was taken between the depths of 240 and 1037 m. A malfunction of the salinometer resulted in erroneous salinity values, and sound speed calculations were of no value. The thermometric profile, however, is valid, and salinity data taken by R/V *Discovery II* in 1958 were used to construct the sound speed profile in Fig. 22.



PROJECT "HEAT"
 SEPT OCT 1969
 SCALE 1 INCH = 1 MILE, LOCATIONS
 WNS J.E.D.P.P.
 PHASE I
 HEIGHTS IN FATHOMS (UNCORRECTED)
 DERIVED BY SATELLITE & OTHER
 INFORMATION, ACCURACY ± 2 M

DETAILED INFORMATION UNCORRECTED
 HEIGHTS IN FATHOMS
 PHASE I
 SEPTEMBER 1969

Fig. 10 - Phase I contour chart

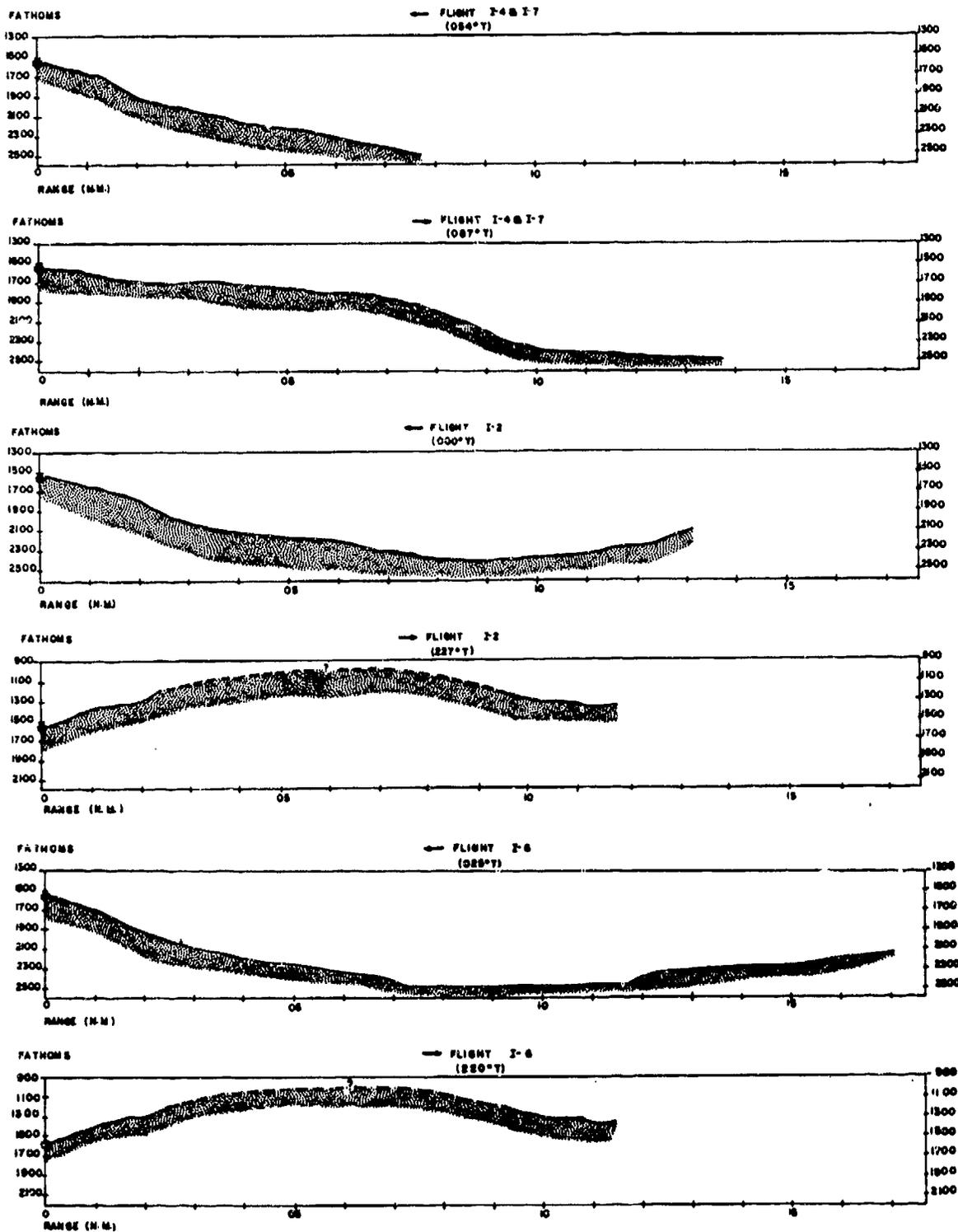
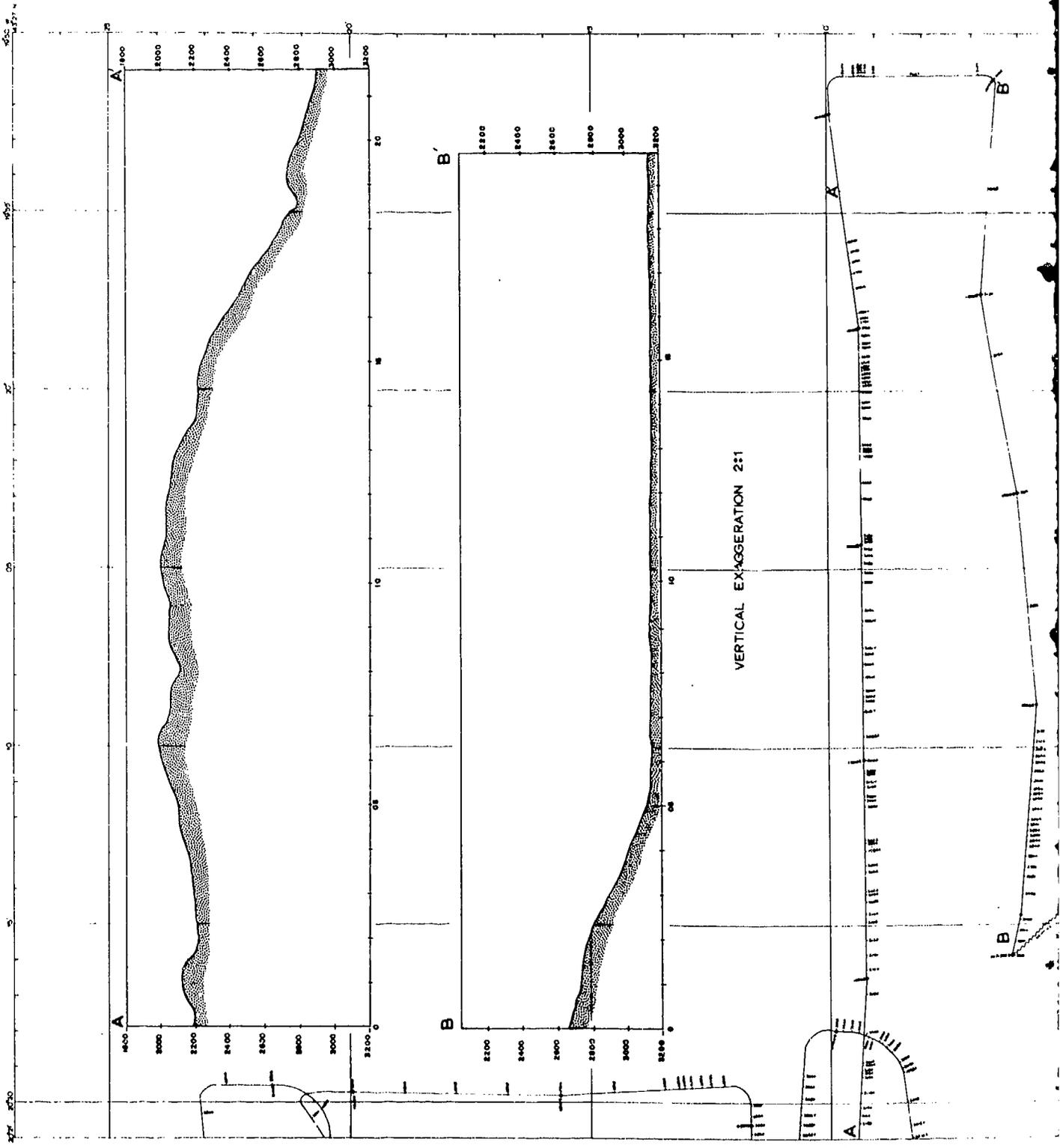


Fig. 11 -- Bathymetric profiles along transmission paths for Phase I; vertical exaggeration 2:1. The arrow indicates the direction of aircraft flight, and the asterisk gives the hydrophone depth.



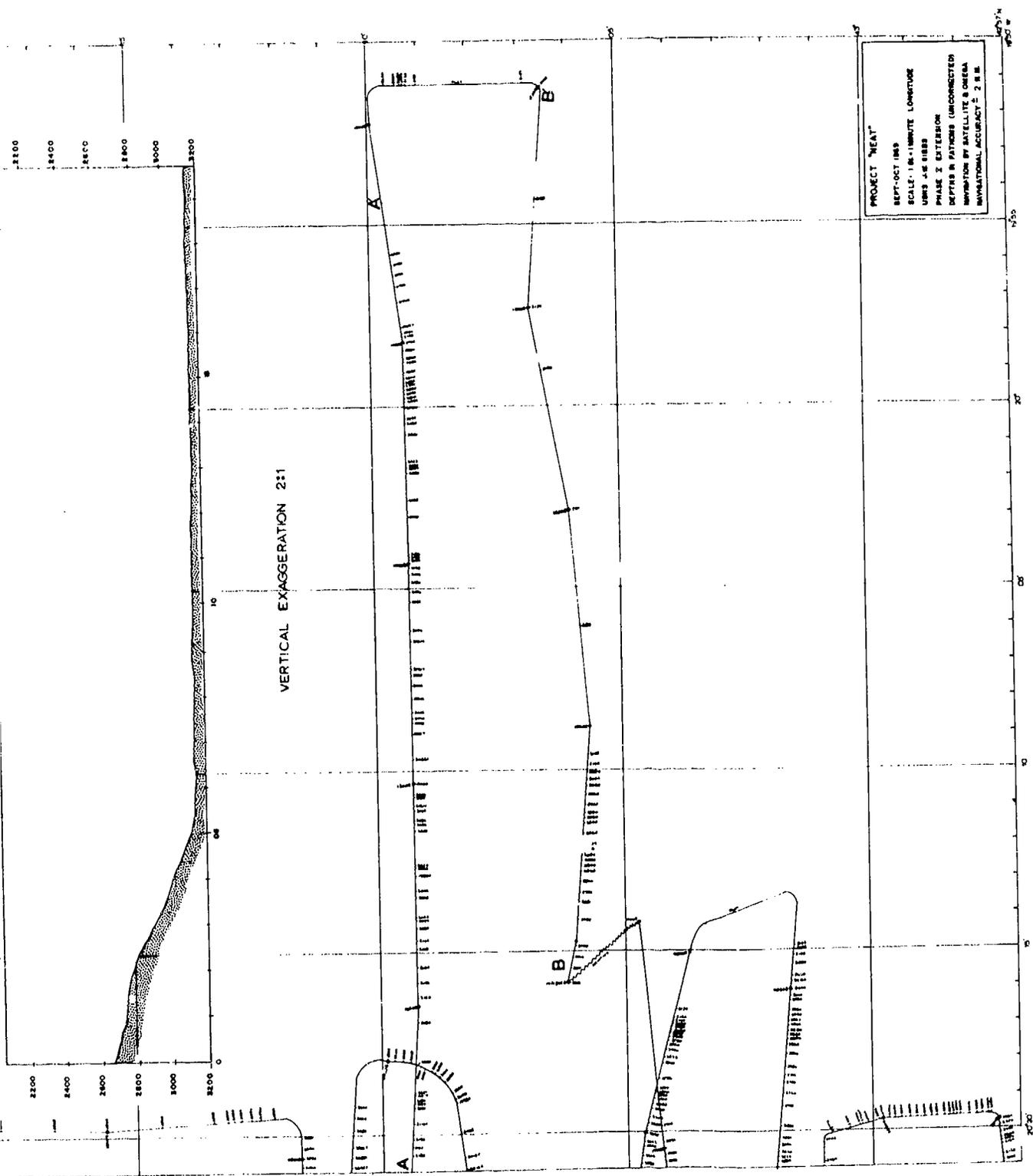


Fig. 12 — Profiles and sounding tracks for Phase I area extension

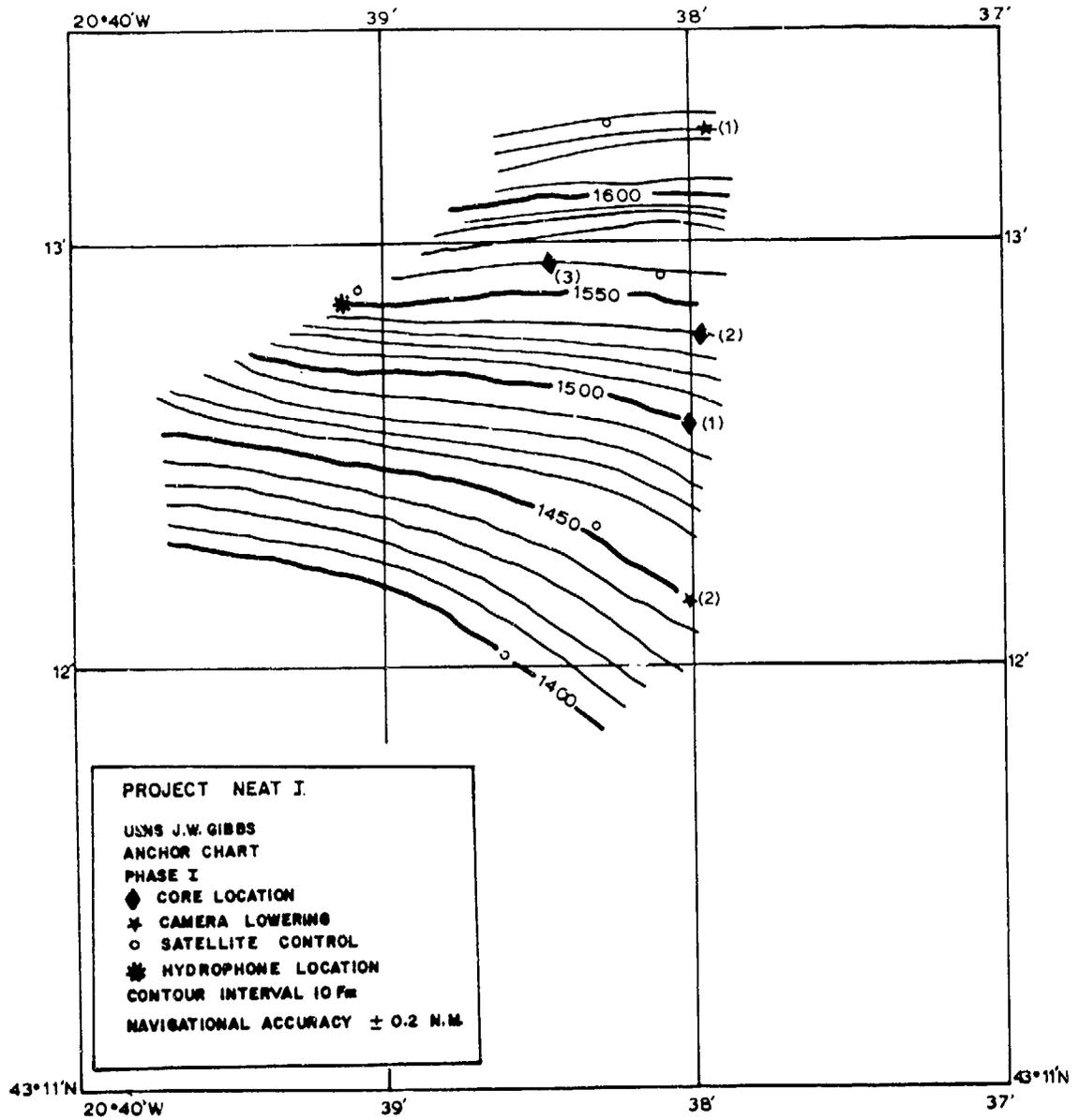


Fig. 13 — Phase I anchor chart

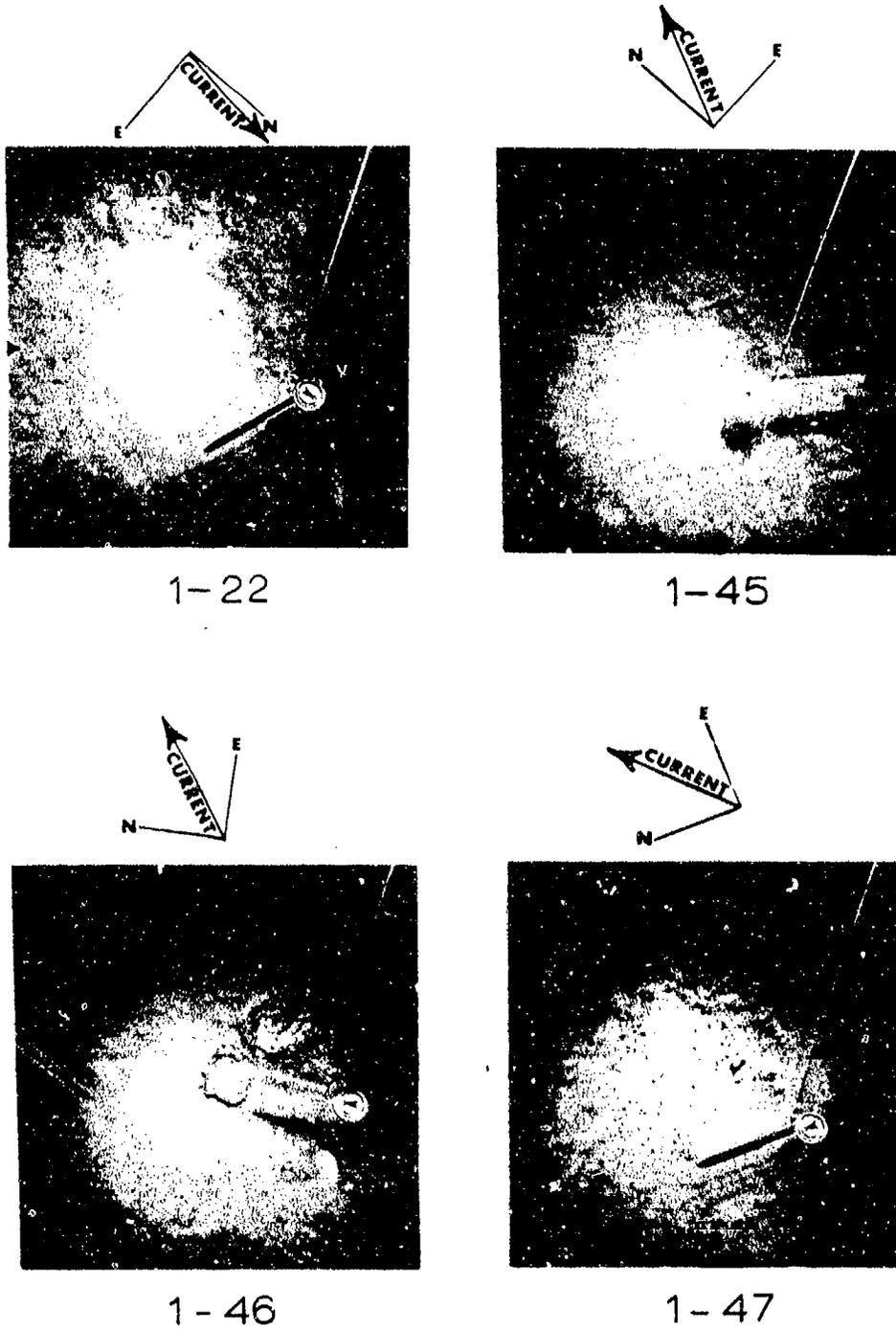
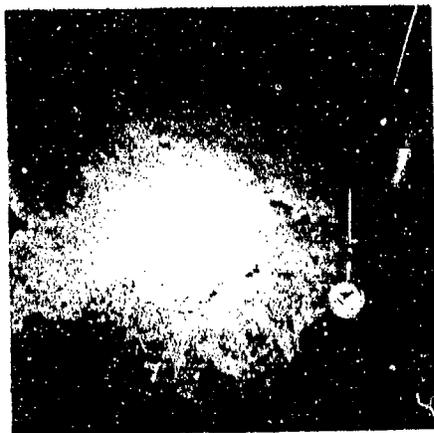
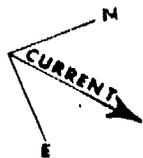
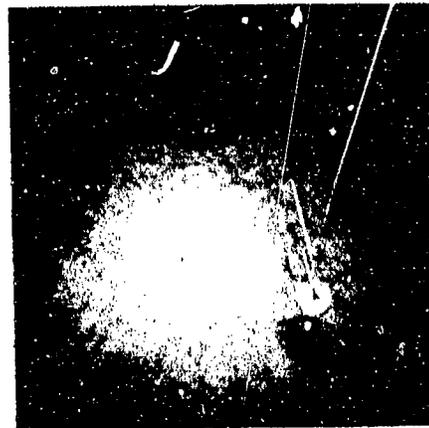
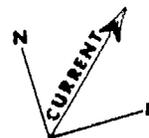


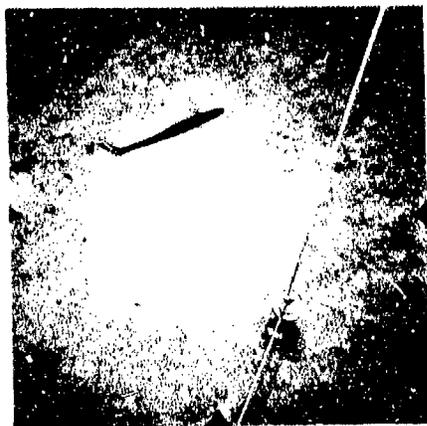
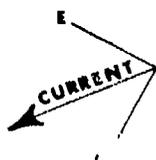
Fig. 14 - Phase I bottom photographs



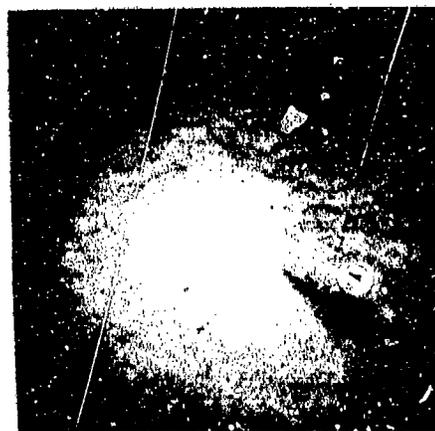
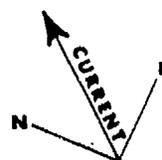
1-48



1-49

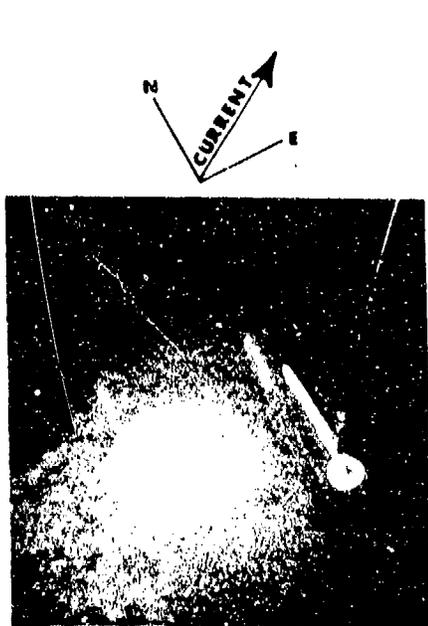


1-52

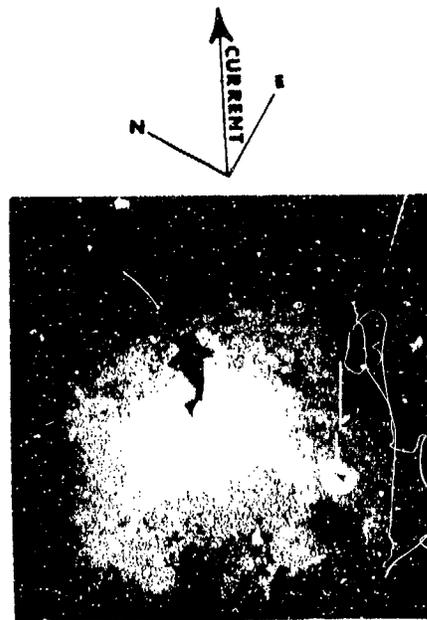


1-69

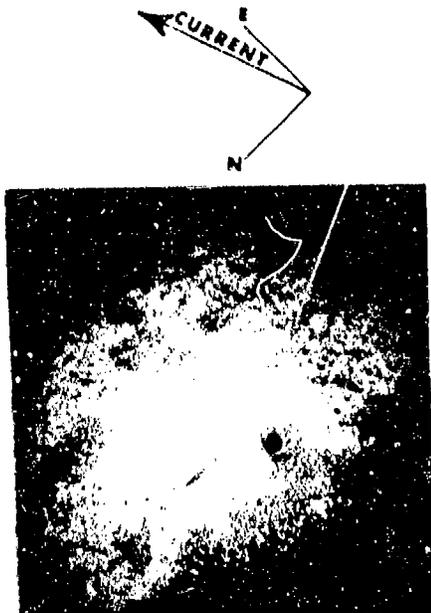
Fig. 15 — Phase I bottom photographs



2-31



2-43

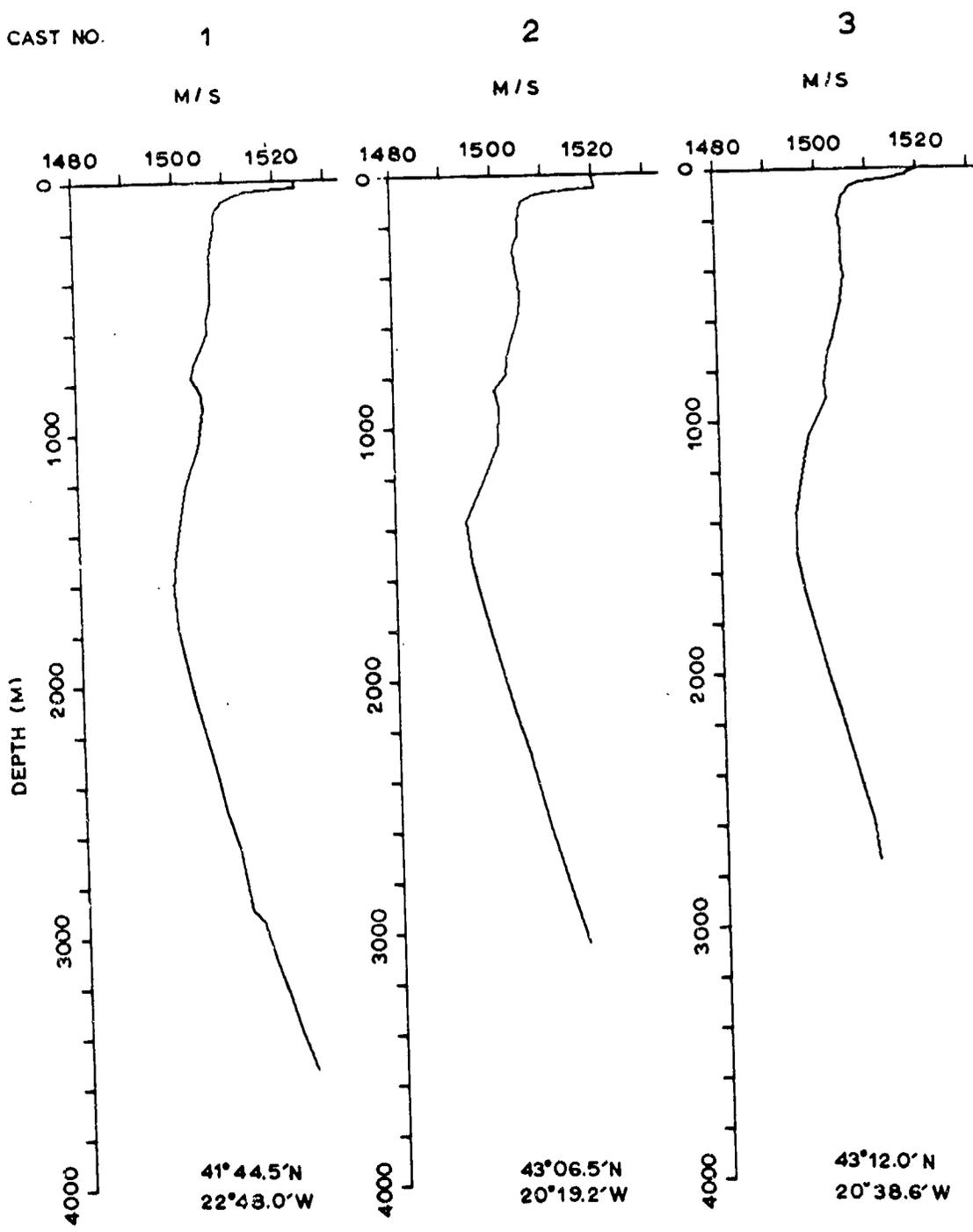


2-99



2-66

Fig. 16 - Phase I bottom photographs



SEPT. 1969

Fig. 17 — Phase I sound speed profiles from sound velocimeter: Cast 1, in transit to Station 1; Cast 2, in transit to Station 1; Cast 3, on station

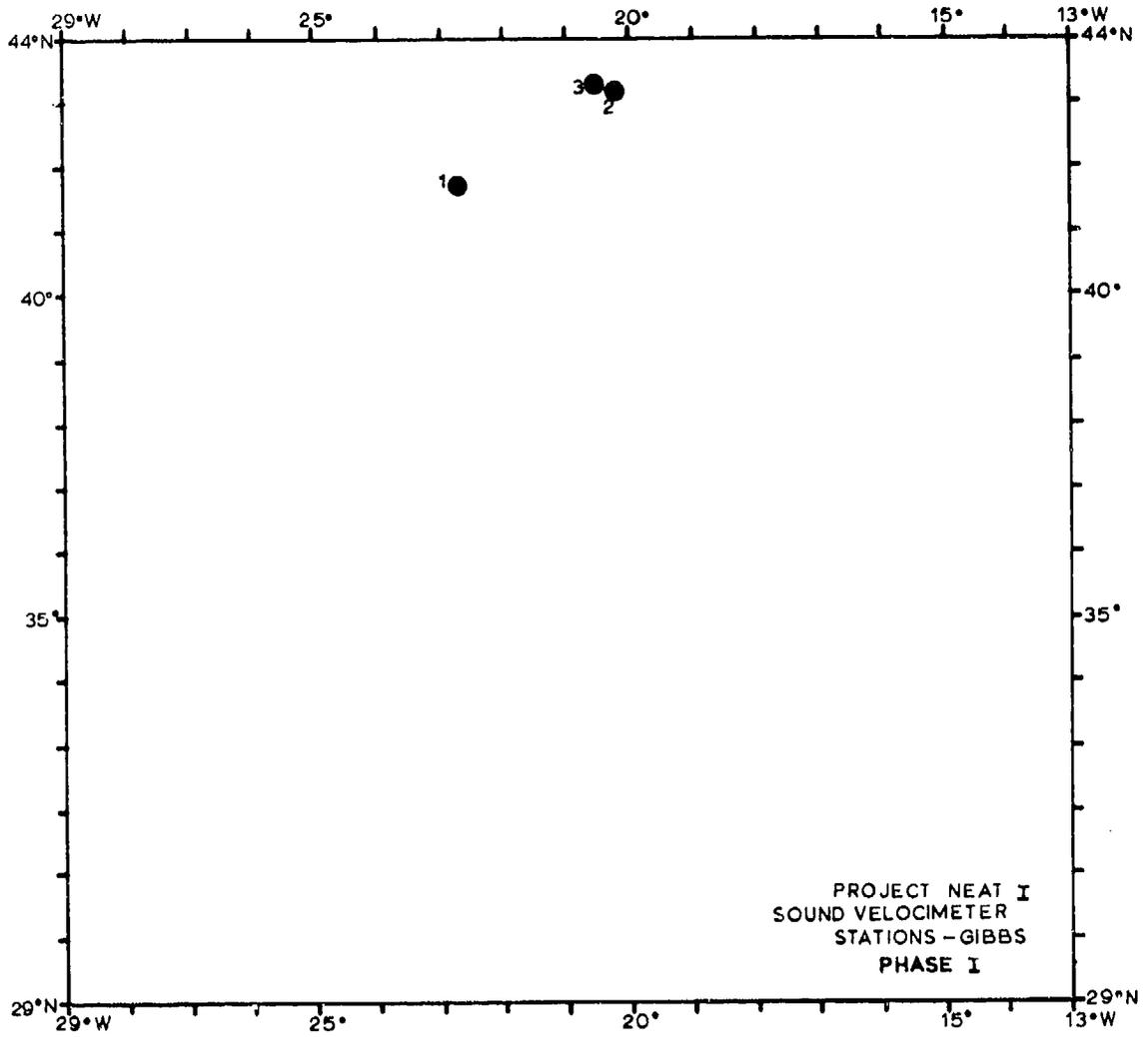
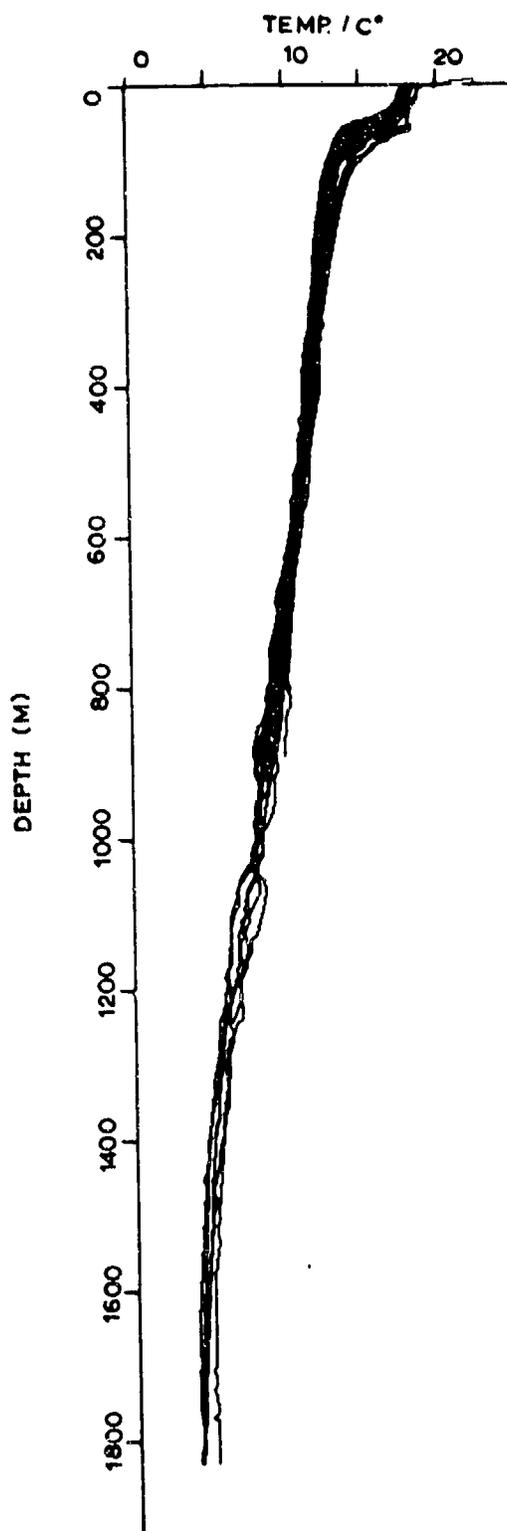


Fig. 18 - Phase I, distribution of sound velocimeter casts

Fig. 19 - Phase I, multiplot of on-station temperature profiles from X-BT's, Sept. 1969



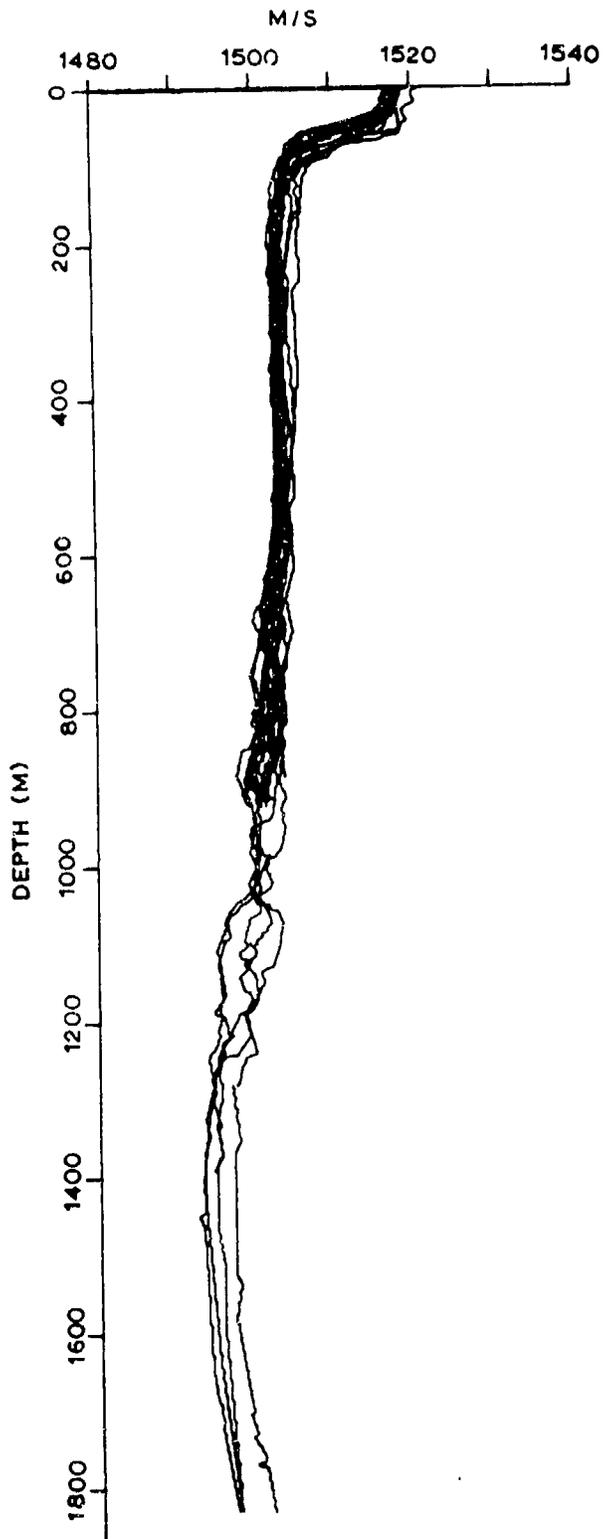


Fig. 20 - Phase I, on-station sound speed profiles from X-BT's, Sept. 1969

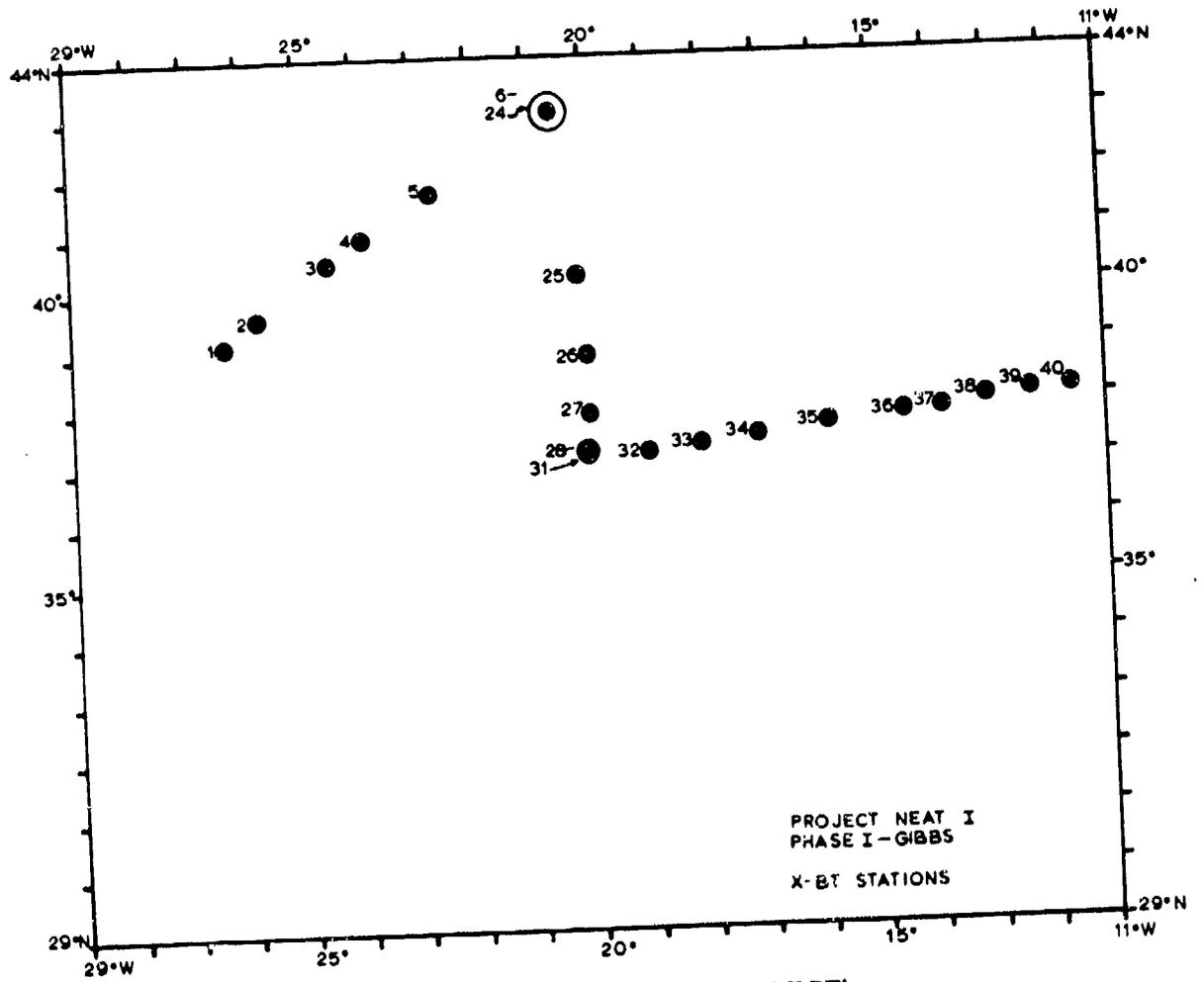


Fig. 21 - Phase I, distribution of X-BT's

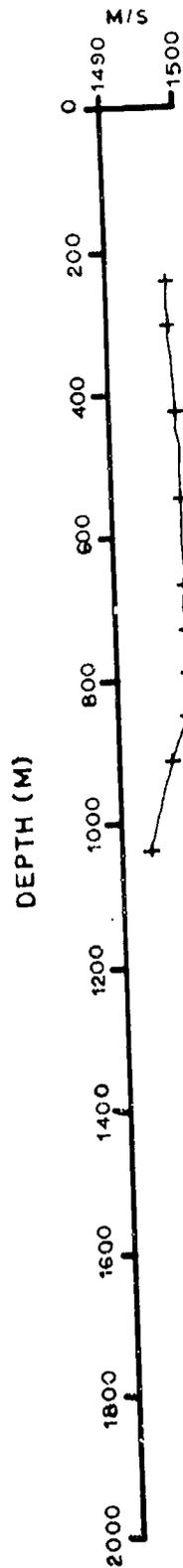


Fig. 22 - Phase I, sound speed profile
from Nansen cast

PHASE II

Hydrophone Location

As stated earlier in this report (see section on station assignments), reexamination of Laughton's contour and sounding charts raised doubts as to the existence of the seamount selected for the Phase II site. Thus Contingency Plans A and B were drawn up and incorporated in the NEAT I Operational Plan.

Upon completion of Phase I, and prior to transit to port, *Gibbs* initiated and conducted a preliminary survey of the Contingency Plan A area. Analysis of the data during the period *Gibbs* was in port indicated that the Contingency Plan A area was an acceptable anchoring site for Phase II.

At the start of Phase II (Oct. 6-12, 1969), *Gibbs* ran additional lines to complete development of the site survey and to locate a favorable anchoring point. The anchor hydrophone was placed in a depth of 1665 fathoms (uncorrected for sound velocity and ship's draft) at 37°08.7' N. latitude and 19°59.8' W. longitude.

Bathymetry

Gibbs' Phase II anchoring site was situated on the eastern crest of a seamount of the Azores Ridge. Prior to *Gibbs'* surveys, little was known about this seamount, since the only information available was random track data.

Gibbs' survey data indicated that the seamount is elongated (striking east-northeast) and shows two major peaks separated by a saddle (Fig. 23). Minimum depths observed were 1413, 1421, and 1445 fathoms. Profiles II-10 (357° T) and II-10 (288° T), shown in Fig. 23, indicate a steep fault scarp on the north flank of the seamount. Seismic activity in the immediate area is quite scarce, with only two epicenters having been recorded historically.*

Gibbs' survey data also indicated another seamount rising 7 mi to the south. Partial contouring of this seamount showed a minimum depth of 1687 fathoms, but shallower depth(s) may exist (Fig. 23).

As in Phase I, the local bathymetry of the hydrophone site was obtained by *Gibbs* while at anchor (Fig. 24). Slope gradient based on this chart is approximately 8°.

*Investigation of NOAA Hypocenter Data File gave the following information on two earthquake hypocenters (12):

May 29, 1942	05:32:03.0 GMT 38° N., 19° W. Magnitude 5.6 (PAS)
Feb. 4, 1953	10:53:06.0 GMT 37.5° N., 20.0° W.

Contours (Fig. 23) were adjusted to reflect the best bathymetric ties between sounding lines because the satellite receiver was not functioning properly and published Omega diurnal corrections were uncertain. Navigational accuracy is estimated at ± 2 n. mi.

Bottom Photographs

During Phase II, one camera lowering was made and 83 pictures were obtained. Figure 24 shows the location of this camera drop relative to the anchor hydrophone location. Figure 25 contains four frames representative of Phase II bottom lithology. For a brief description of each frame, see Table 3.

Table 3*
Representative Bottom Photo Descriptions, Phase II

Frame No.	Depth (Fathoms)	Description
3-01	1640	Level bottom of globigerina ooze, with crested, asymmetrical current ripples. Shingle deposited in troughs. Ophuroid present.
3-21	1630	Same as 3-01. Some gravel present.
3-22	1630	Localized patch of manganese-coated cobbles. This picture taken 44 s after 3-21.
3-55	1641	Similar to 3-01. Coarser sediments in ripple troughs.

*See note to Table 1.

Cores

Four cores were taken during Phase II (Fig. 24) and were analyzed by the Naval Oceanographic Office (11). Table 4 is a listing of core locations, depth of water, and length of sample. All cores were taken with a 1000-lb gravity corer. Cores 4 and 5 were taken with 5-ft core pipes, and cores 6 and 7 with 12-ft core pipes.

Sound Velocimeter Casts

Two sound velocimeter casts were made from *Gibbs* during the Phase II anchorage to a depth of 10,000 ft. Figure 26 is a computer printout of these casts. The double axial sound speed minima are visible as predicted (6). Depths of the velocimeter readings during each cast were calculated from the amount of wire out and the wire angle.

Table 4
Core Stations, Phase II

Core No.	Location	Depth		Length of Sample	
		(Fathoms)	(M)	(In.)	(Cm)
4	37°09.95' N. 19°59.03' W.	1740	3182	29	73.66
5	37°09.13' N. 19°58.55' W.	1800	3292	43	109.22
6	37°09.05' N. 19°58.64' W.	1800	3292	72	183.88
7	37°07.03' N. 19°58.27' W.	1830	3347	56	142.24

Figure 27 shows the geographical location of sound velocimeter casts 4 and 5 taken during Phase II.

Expendable Bathythermographs

A total of 38 Sippican X-BT's were taken during Phase II; 25 were judged acceptable. X-BT records with temperature variations in excess of 3°C above 800 ft and 1.5°C below 800 ft from the multiplot scale's mean value were rejected. Both T-5 (6000-ft) and T-7 (2500-ft) X-BT's were used.

Figure 28 is a digital multiplot printout of the data from X-BT casts 45 through 65 taken on or near the Phase II anchor site. The mean position for this group of X-BT's is 37°09' N., 19°58.5' W. Figure 29 is a digital multiplot printout composite of computed sound speed curves from X-BT's 45 through 65 shown in Fig. 28. Salinity values used in computing the sound speed curves were taken from a Nansen cast by Gibbs while at the Phase II anchor site.

Figure 30 shows the location of X-BT's used for this study during Phase II.

Nansen Casts

Nansen casts taken during Phase II consisted of one shallow cast (0 to 600 m) and one deep cast (700 to 2500 m). Water samples from both casts were stored aboard Gibbs, and salinity determinations were made at the Laboratory upon the ship's return. Figure 31 is a sound speed profile made from these casts.

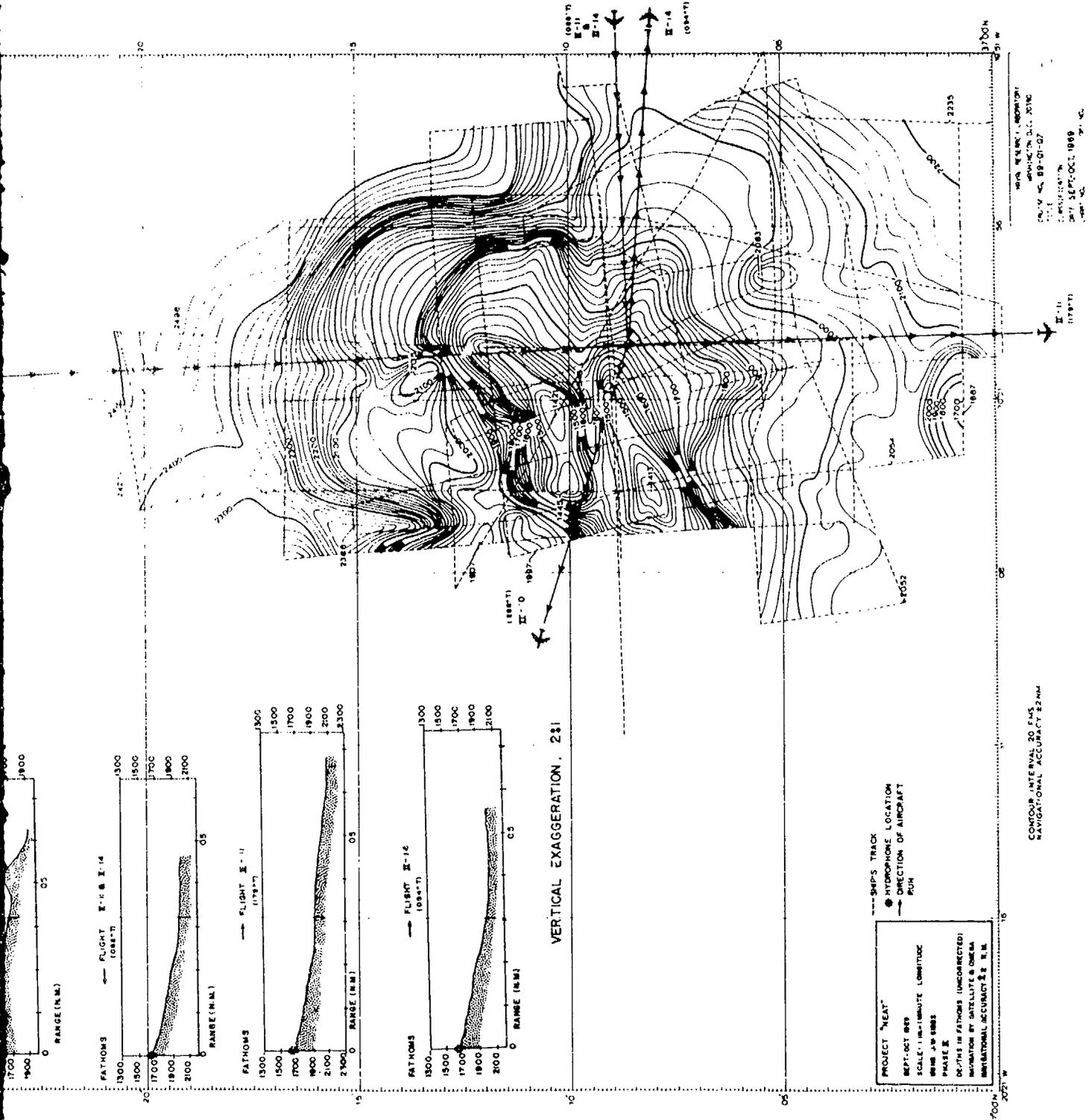


Fig. 23 — Phase II, contour and profile chart

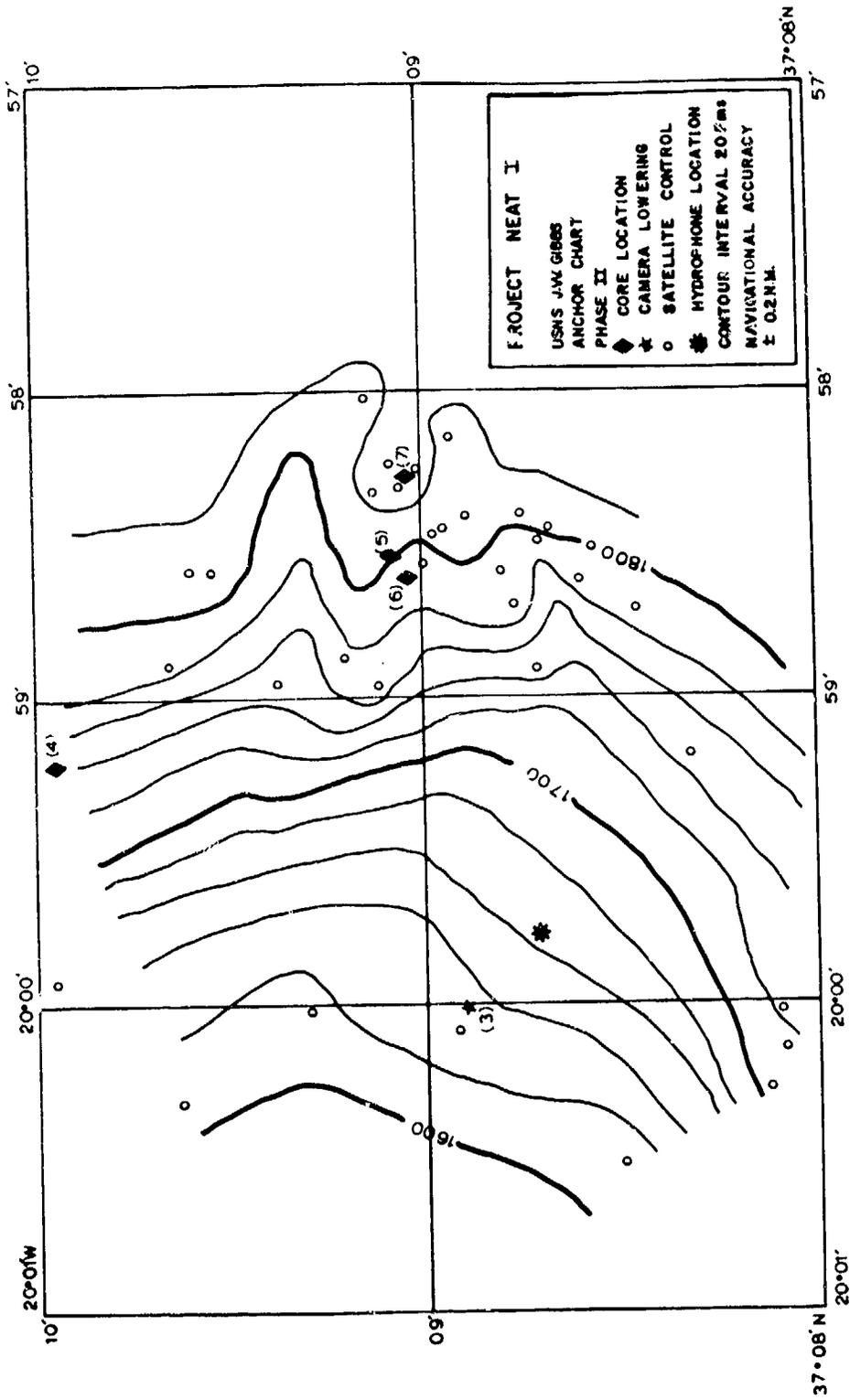
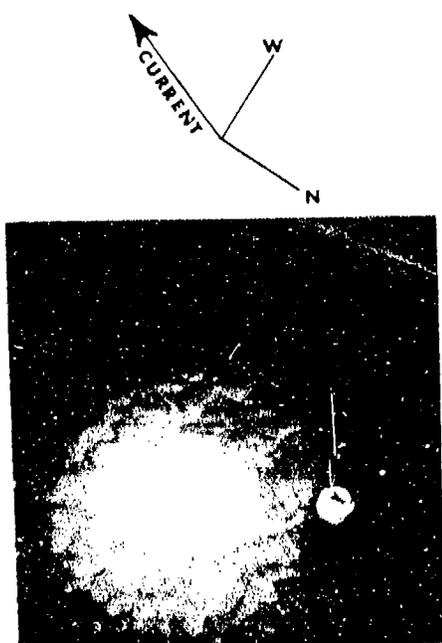
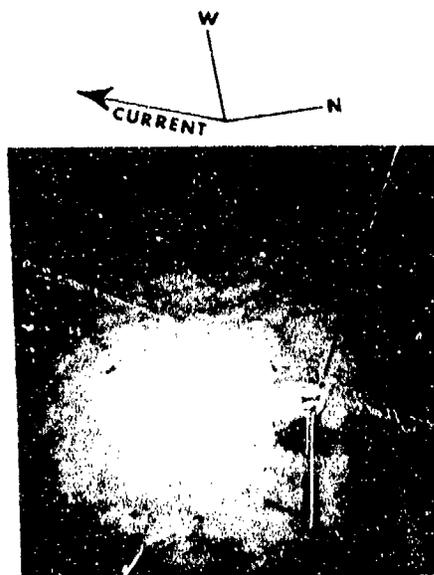


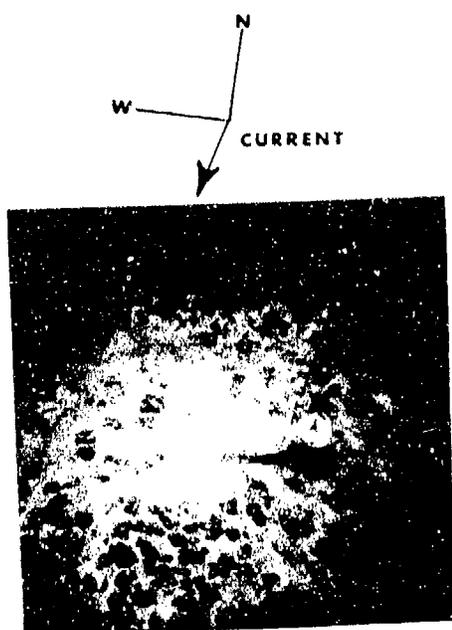
Fig. 24 — Phase II, anchor chart



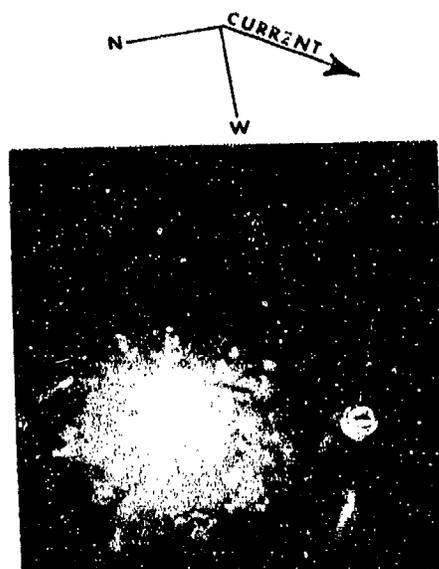
3-01



3-21



3-22



3-55

Fig. 25 - Phase II, bottom photographs

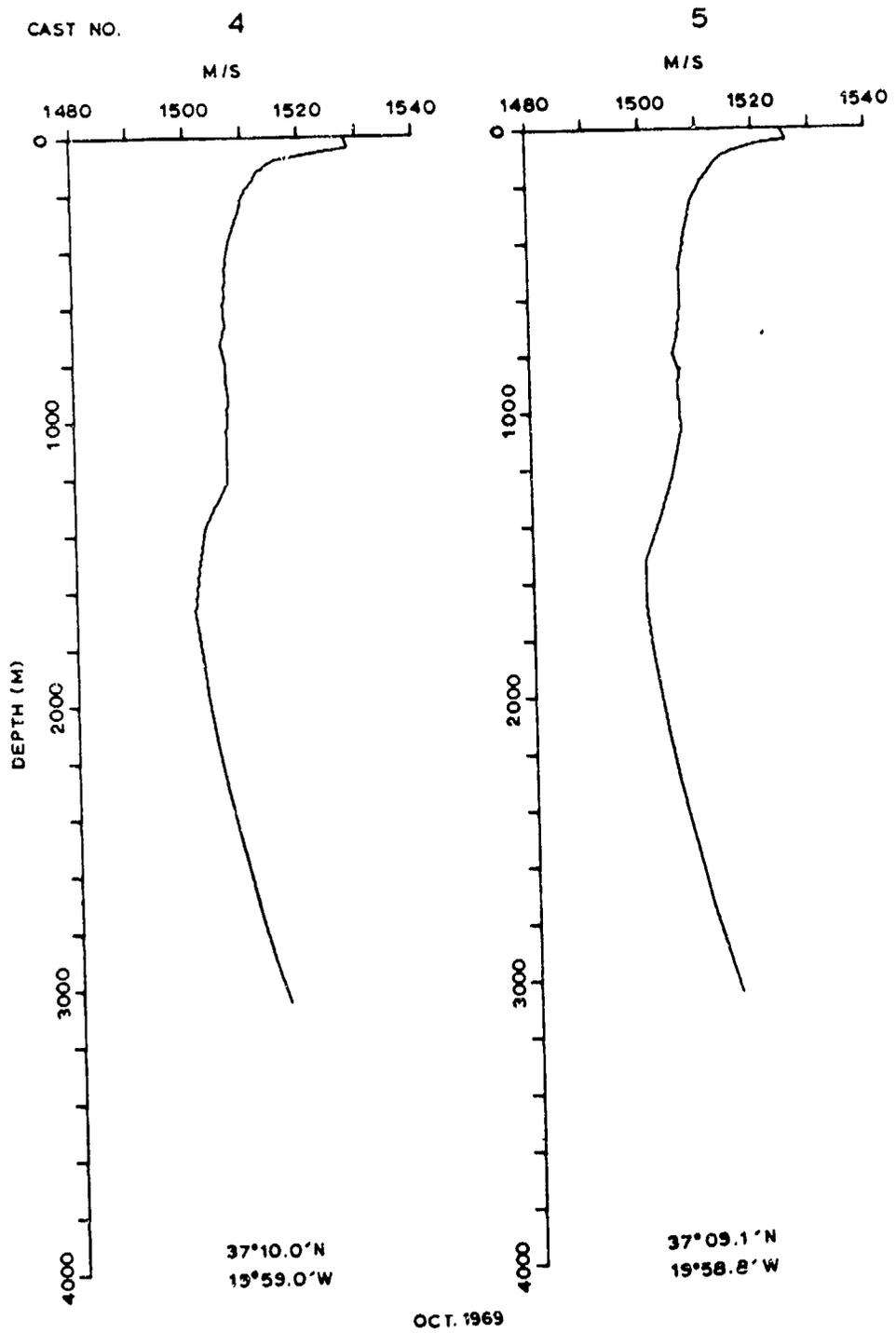


Fig. 26 — Phase II, sound speed profiles from on-station sound velocimeter casts 4 and 5

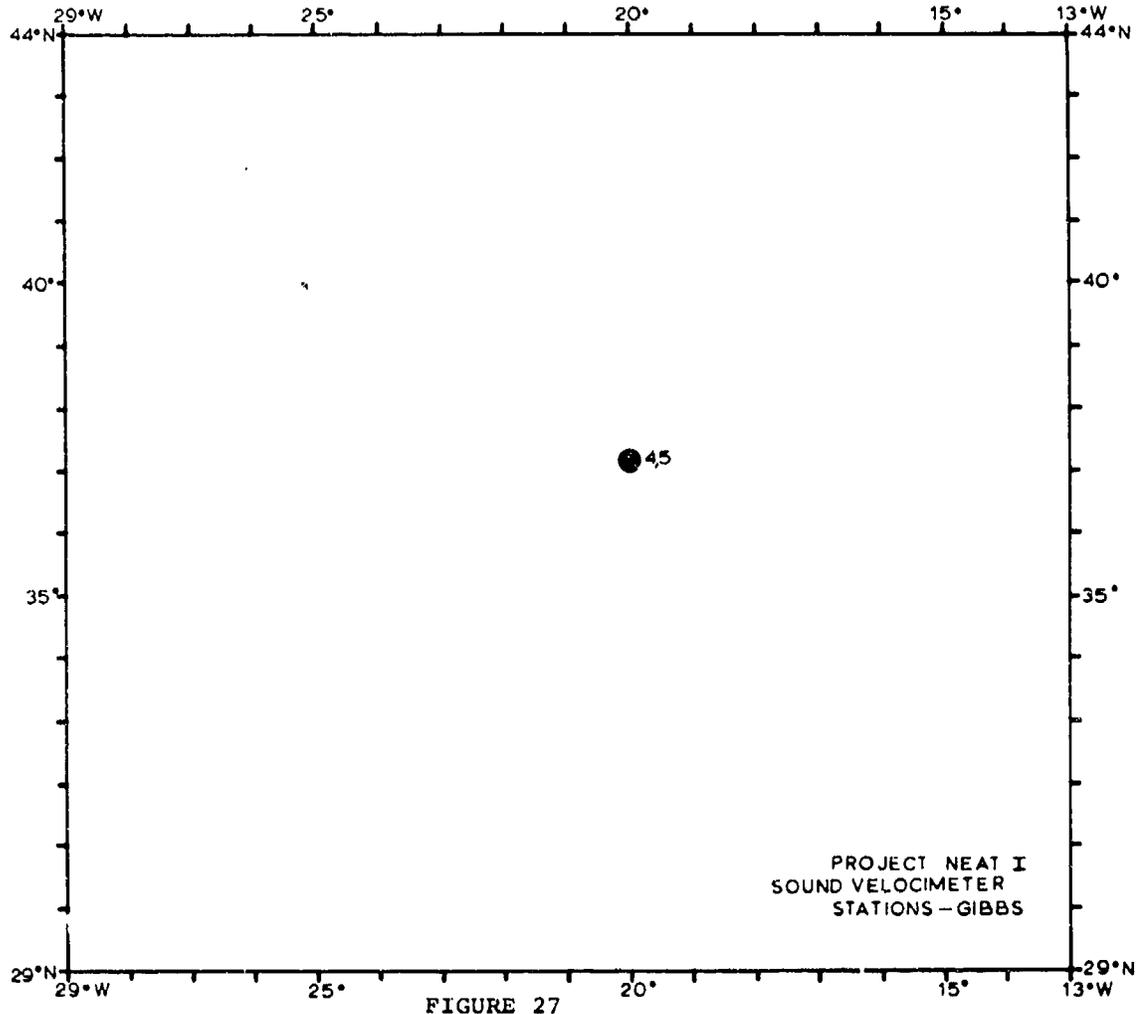


Fig. 27 — Phase II, distribution of sound
velocimeter casts

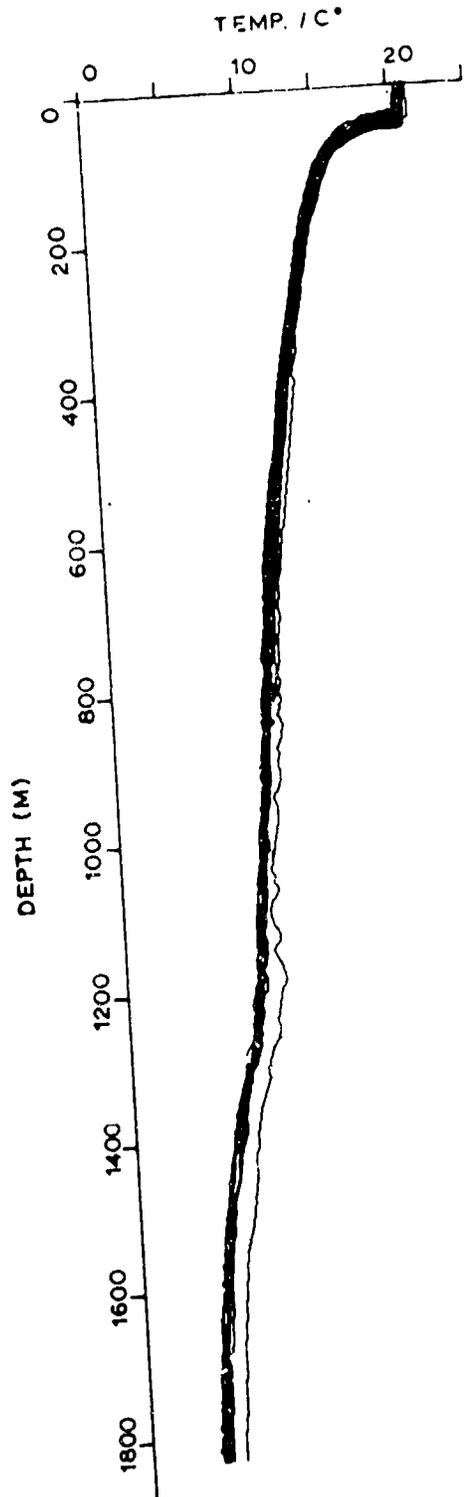


Fig. 28 - Phase II, multiplet of on-station temperature profiles from X-RT's, Oct. 1969

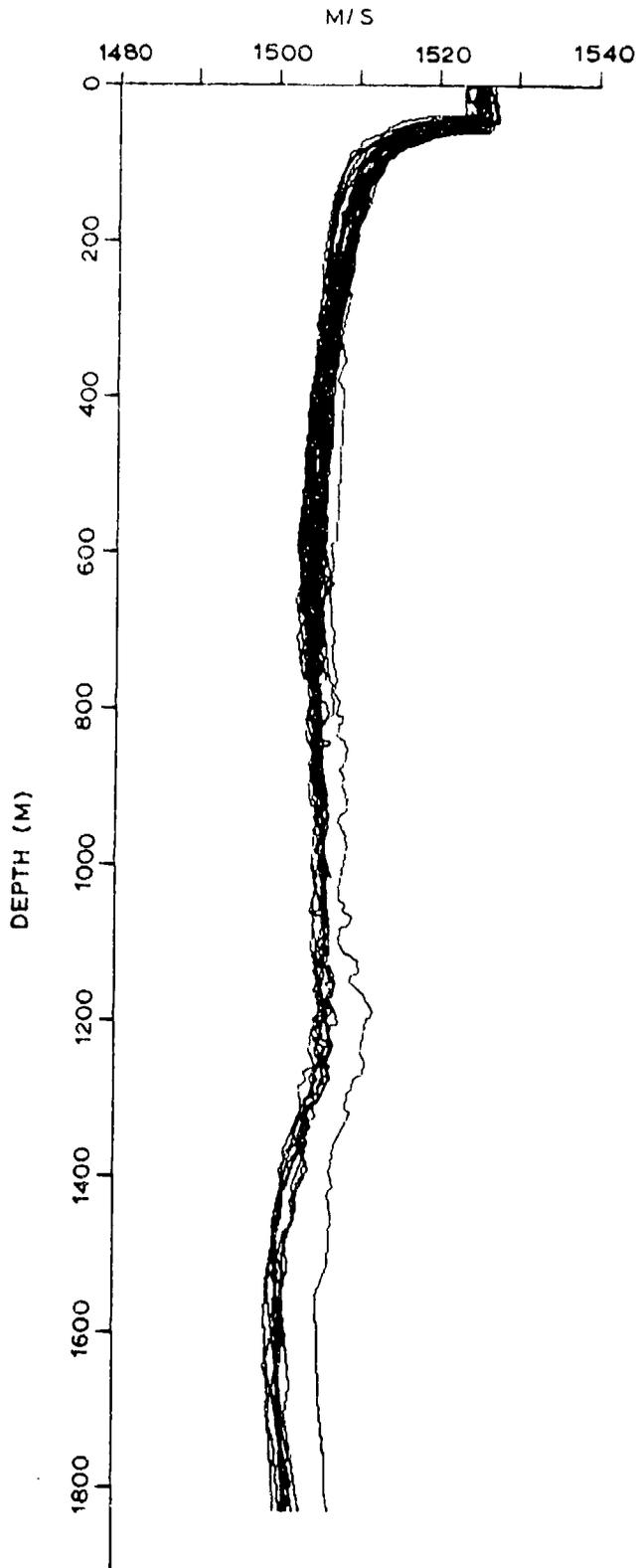


Fig. 29 — Phase II, on-station sound speed profiles from X-BT's, Oct. 1969

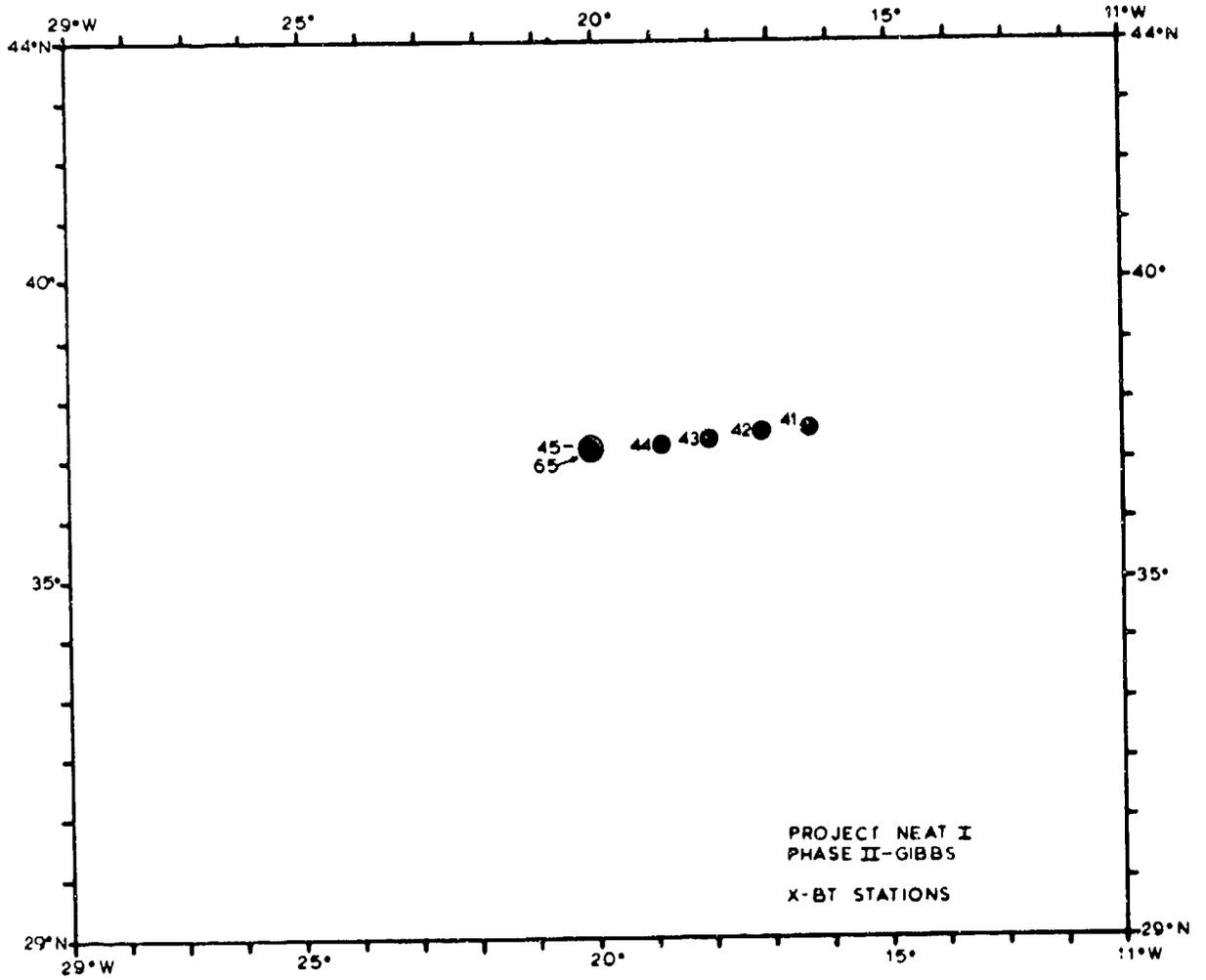


Fig. 30 - Phase II, distribution of X-BT's

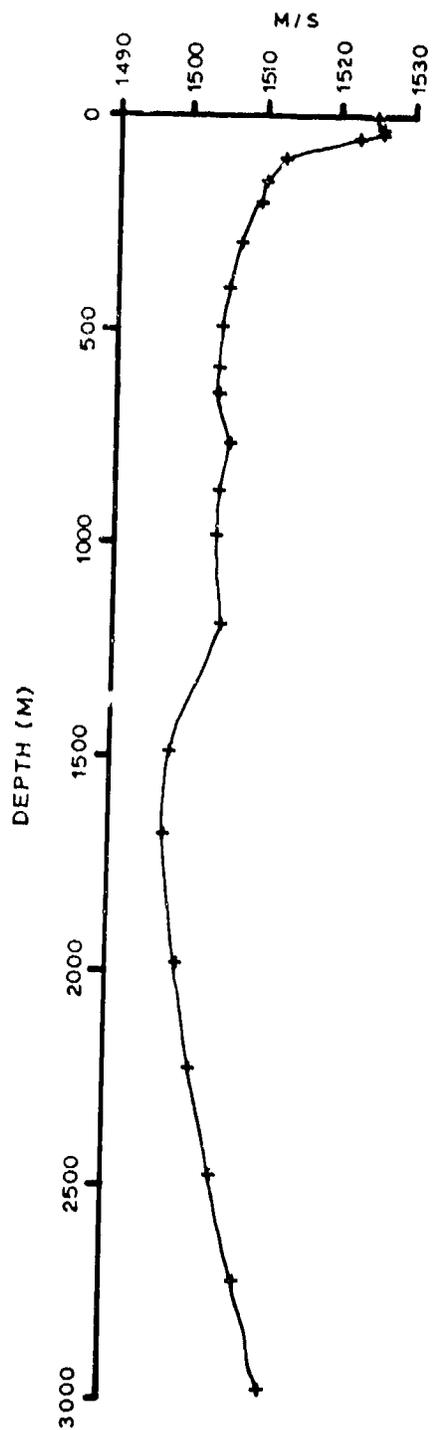


Fig. 31 — Phase II, sound speed profile from Nansen cast, Oct. 1969

Phase III

HYDROPHONE LOCATION

During Phase III (Oct. 21-27, 1969), *Gibbs'* hydrophone was anchored at 1557 fathoms (uncorrected for sound velocity and ship's draft) at $30^{\circ}07.45'$ N. latitude and $28^{\circ}11.34'$ W. longitude.

BATHYMETRY

Gibbs' Phase III anchoring site was situated on the lower slope of Great Meteor Seamount's eastern flank. This seamount, first discovered by the German research ship F.S. *Meteor* in 1937 (13), is the southernmost of a chain of large seamounts extending south from the Azores Plateau (14).

Excellent bathymetric surveys for this seamount were made by the Woods Hole Oceanographic Institution in 1959 (15) and the Deutsches Hydrographisches Institut in 1967 (16). The Naval Oceanographic Office has surveyed areas adjacent to and north of Great Meteor (17).

Figure 32 is Woods Hole's contour chart of the Great Meteor Seamount with an outline of *Gibbs'* survey areas (shaded). According to Pratt (18) the seamount has an elliptical base of about 60 mi in the north-south direction and is 50 mi wide. Maximum dimensions of the summit surface are approximately 36 by 20 mi and the minimum depth is 147 fathoms. The surface breaks abruptly at about 300 fathoms, with steep slopes running down to a depth of 2300 fathoms (18).

Bathymetric surveys by USNS *J.W. Gibbs*, like the findings of the German and Woods Hole Surveys, revealed that the seamount's summit was very smooth and highly reflective; that the break between the lower terrace and steep side slopes occurs consistently at 300 and 320 fathoms; and that the slopes are irregular and indicative of being cut by gullies of unknown origin (Figs. 33 and 34).

The Woods Hole contour chart of Great Meteor Seamount (Fig. 32) indicated the possible existence of a terrace at the 800-fathom depth on the eastern slope. Therefore, it was decided to survey this feature to determine its usability as a hydrophone anchoring site. A radar-reflector buoy was anchored on the summit shelf (275 fathoms) at $29^{\circ}55.9'$ N. latitude and $28^{\circ}17.7'$ W. longitude (Fig. 34). Control lines were spaced at 1 n. mi. and a survey was made of an area approximately 6 by 12 n. mi. A prominent gully was found in the general vicinity of the theorized terrace, but no terracelike feature was located by *Gibbs*.

As in Phases I and II, the local bathymetry of the hydrophone placement site was obtained by *Gibbs* while at anchor (see Fig. 35).

Bottom Photographs

During Phase III, a camera was lowered near the hydrophone site and 111 pictures were obtained. Figure 35 shows the location of this camera drop relative to the hydrophone site. Frames 4-33, 4-76, 4-81, and 4-83 of Fig. 36 are representative of the Phase III hydrophone bottom lithology.

Another camera drop was made on the summit of Great Meteor Seamount at $29^{\circ}56.2' N.$, $28^{\circ}24.0' W.$ One hundred pictures were obtained. Frames 5-10, 5-22, 5-59, and 5-78 of Fig. 37 are representative of the bottom at the latter site. For a brief description of all frames listed above, see Table 5.

Table 5*
Representative Bottom Photo Descriptions, Phase III

Frame No.	Depth (Fathoms)	Description
4-33	1489	Graded, sandy silt with pebbles. Sub-surface trails of benthic life present.
4-76	1491	Graded coarse sand to silt, with minor current ripples.
4-81	1492	Same as 4-76.
4-83	1492	Sediment disrupted by meandering faunal burrows. Holothurian in upper center.
5-10	173	Foraminiferal sand mixed with ooze with antipatharian coral (under compass). Current negligible.
5-22	174	Same as 5-10. Holothurian below compass vane.
5-59	174	Foraminiferal ooze with slight current scouring.
5-78	170	Same as 5-59. Ophuroid present.

*See note to Table 1.

Cores

Two cores were taken during Phase III (see Fig. 35) and were analyzed by the Naval Oceanographic Office. Table 6 is a listing of core location, depth of water, and length of sample. All cores were taken with a 1000-lb gravity corer and 12-ft core pipes. A summary of sediment size and composition, chemistry, and engineering properties is found in the NAVOCEANO Sediment Report (11).

In addition to the cores, a dredge sample was taken on top of Great Meteor Seamount. The analysis of this material will likewise be found in Ref. 11. This sample

Table 6
Core Stations, Phase III

Core No.	Location	Depth		Length of Sample	
		(Fathoms)	(M)	(In.)	(Cm)
8	30°06.80' N. 28°12.60' W.	1440	2633	67.5	171.45
9	30°06.82' N. 28°11.71' W.	1515	2771	94	238.76

produced a number of coelenterates probably of Pleistocene age and deposited prior to subsidence of the seamount. Also, living specimens of an antipatharian (Black Coral) were retrieved. Investigations are in progress at this time and will be reported at a later date.

Sound Velocimeter Casts

Two sound velocimeter casts were made from *Gibbs* during the Phase III anchorage to a depth of 9000 ft. Figure 38 is a computer printout of these casts. Depths of the velocimeter readings during each cast were calculated from the amount of wire out and the wire angle.

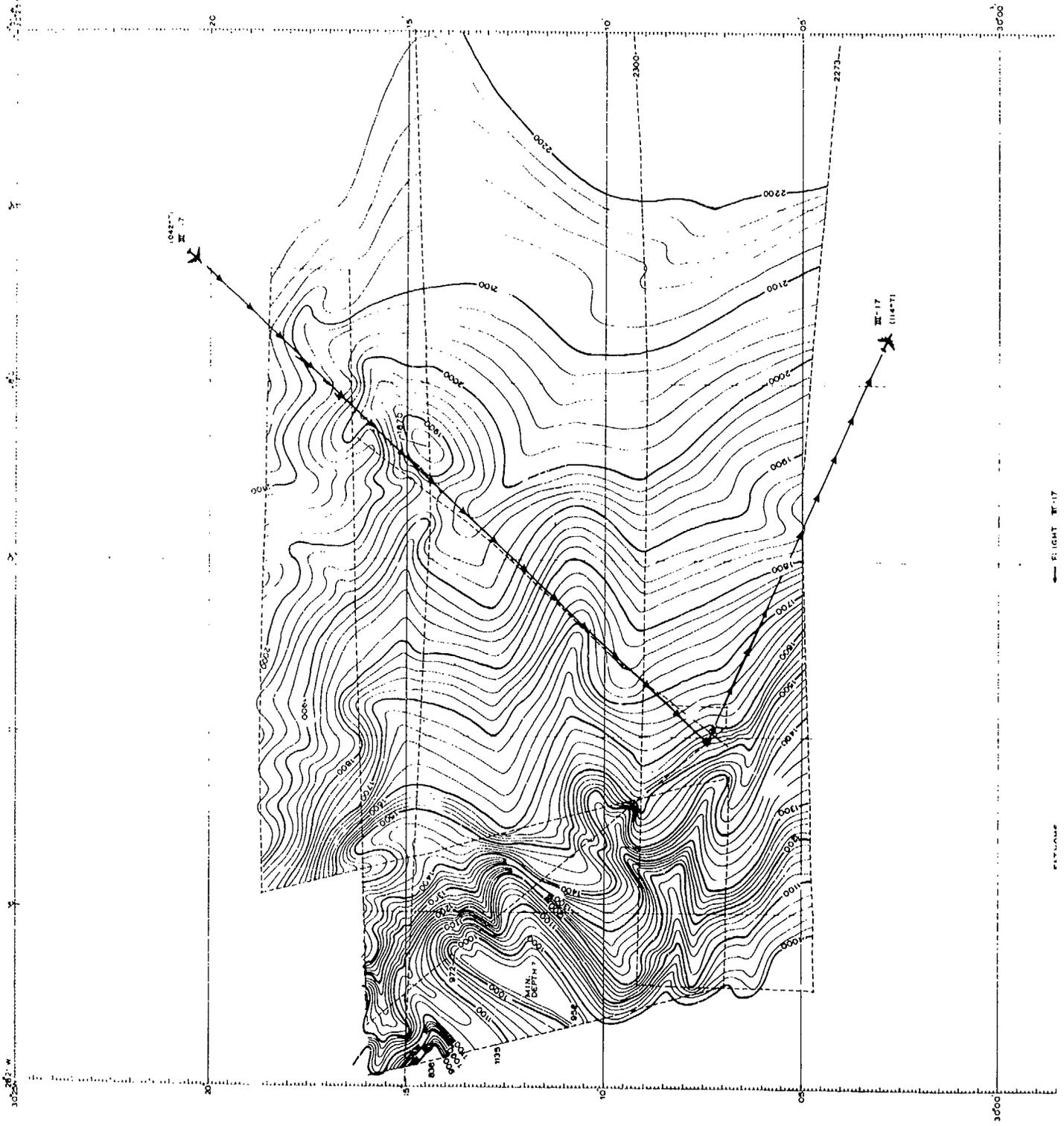
The same procedures were applied to velocimeter casts taken en route to and from the Phase III anchorage site. Figures 39, 40, 41, and 42 are computer printouts of these casts. It should be noted that although the double axial sound speed minima are weak or unrecorded at the anchorage site, the records made during casts taken in transit to and from the anchor site show the double sound speed axes in Cast 6 indicating that Casts 7, 8, and 11 were made in the seasonal transitory zone discussed in Fenner and Bucca (6). Figure 43 shows the geographical location of sound velocimeter casts taken during Phase III.

Expendable Bathythermographs

A total of 42 Sippican X-BT recordings was evaluated and accepted during Phase III. Both T-5 (6000-ft) and T-7 (2500-ft) X-BT's were used. Figure 44 is a digital multiplot printout of the data from X-BT casts 81 through 99 taken on or near the Phase III anchor site. The mean position for this group is 30°07' N., 28°12' W. Figure 45 is a digital multiplot printout composite of computed sound speed curves from the data recorded on X-BT's 81 through 99 and shown in Fig. 44. Salinity values used in computing the sound speed curves were taken from a Nansen cast by *Gibbs* while at the Phase III anchor site. Figure 46 shows the location of X-BT's taken during Phase III.

Nansen Casts

Nansen casts taken during Phase III consisted of one shallow cast (0 to 600 m) and one deep cast (700 to 2500 m). Water samples from both casts were stored aboard *Gibbs*, and salinity determinations were made at the Laboratory upon the ship's return. Figure 47 is a sound speed profile made from these casts.



FLIGHT 17 (11471)

FLIGHT 17 (11472)

2273

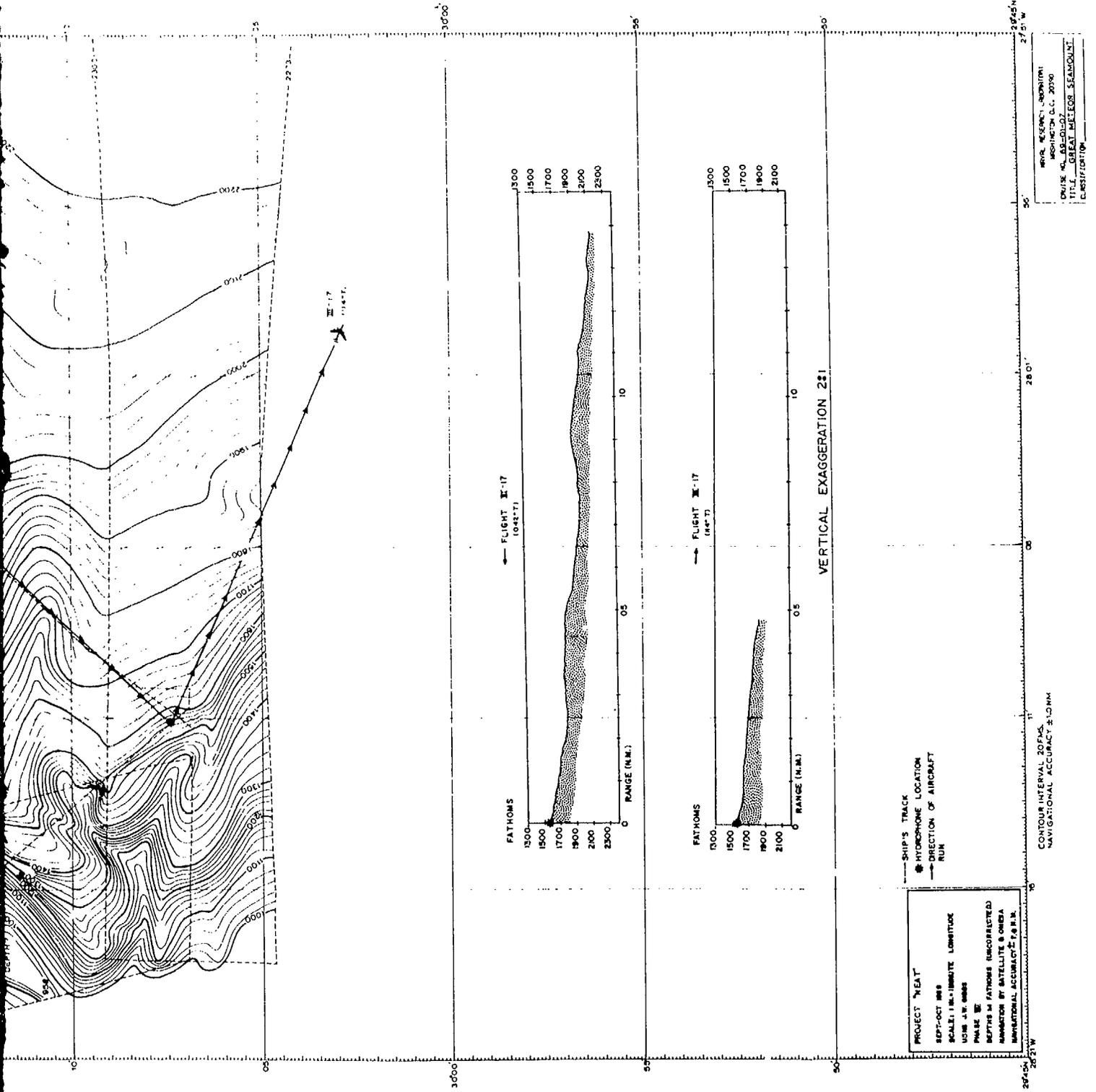
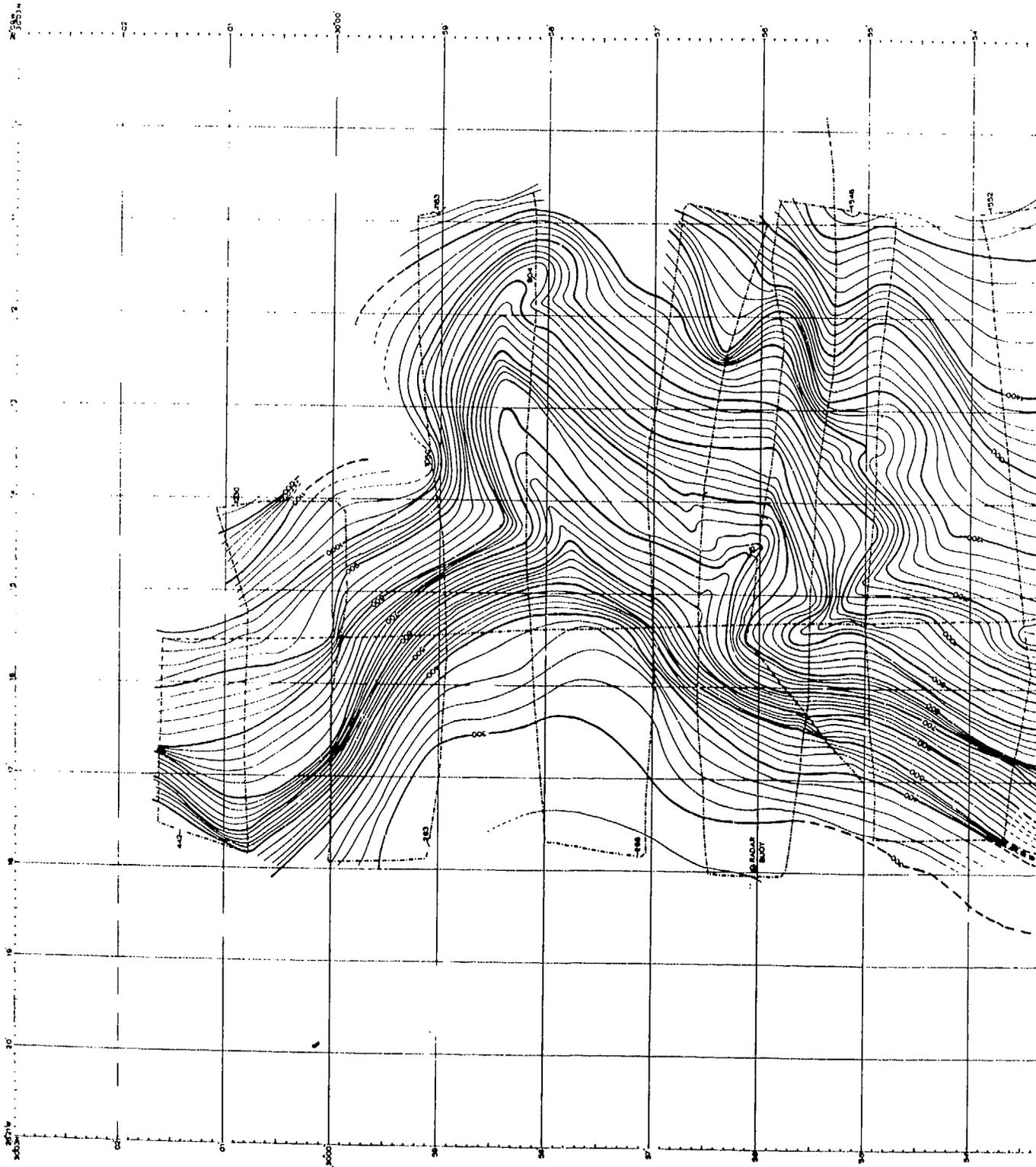


Fig. 33 - Phase III, contour profile chart



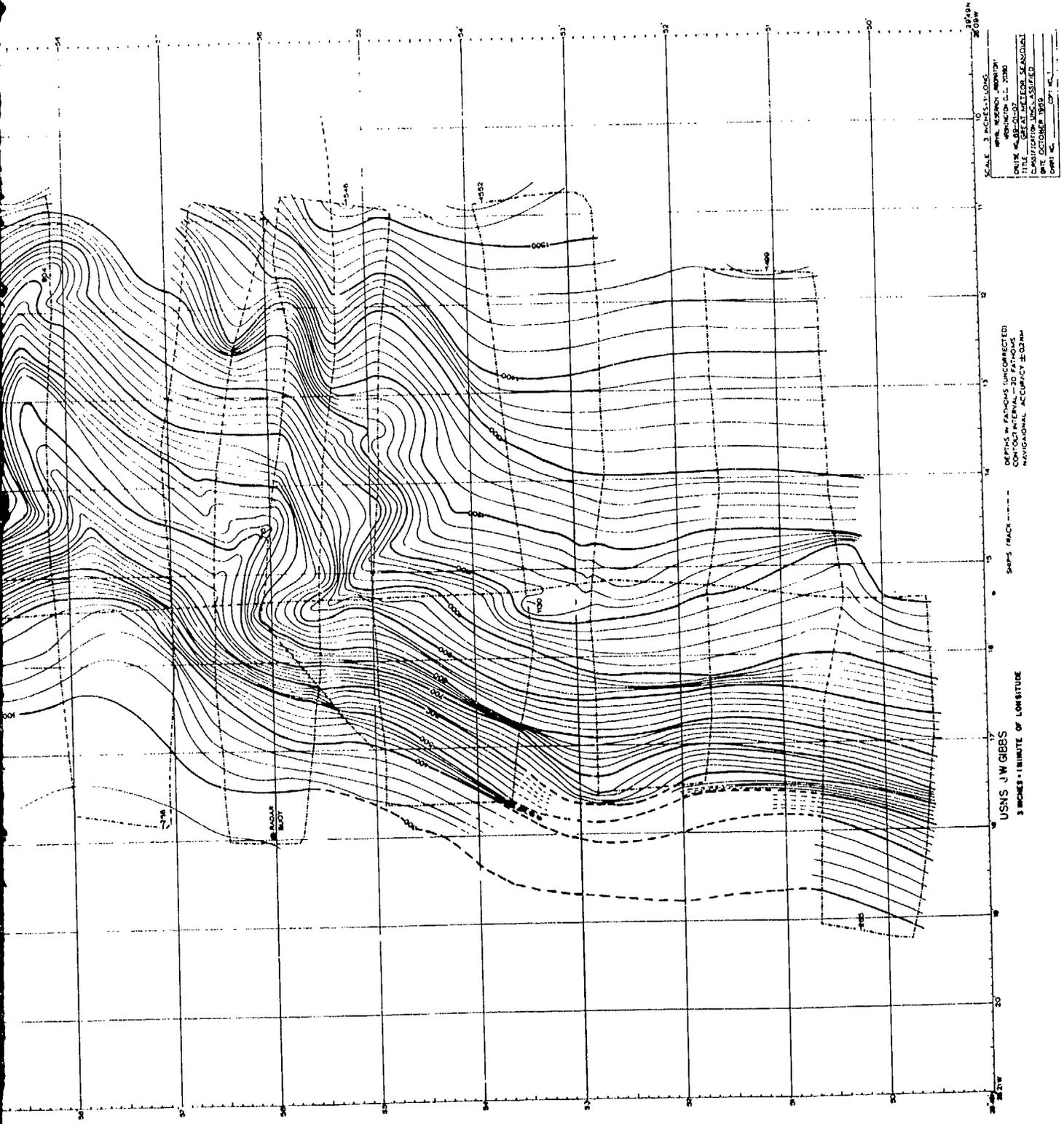


Fig. 34 - Phase II, contour chart (buoy survey)

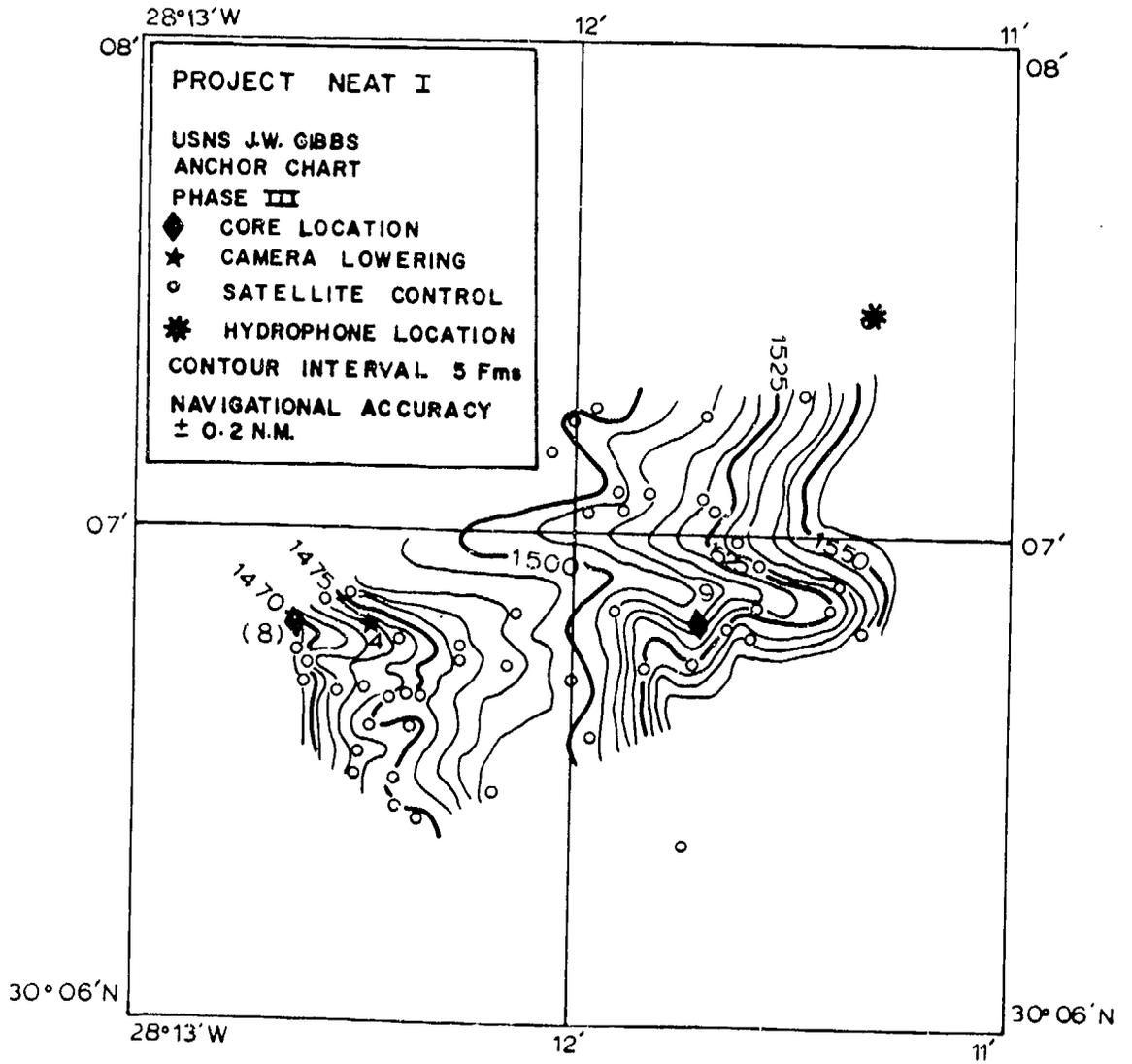
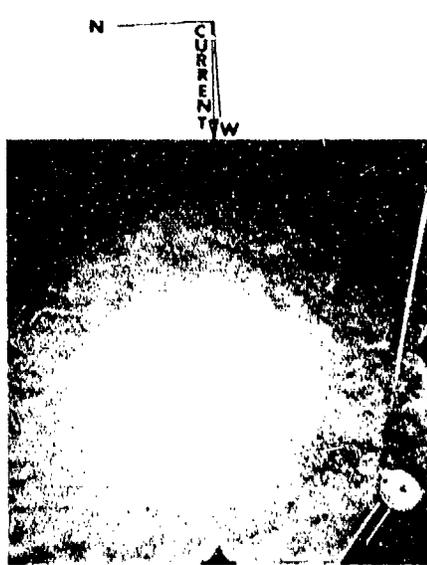


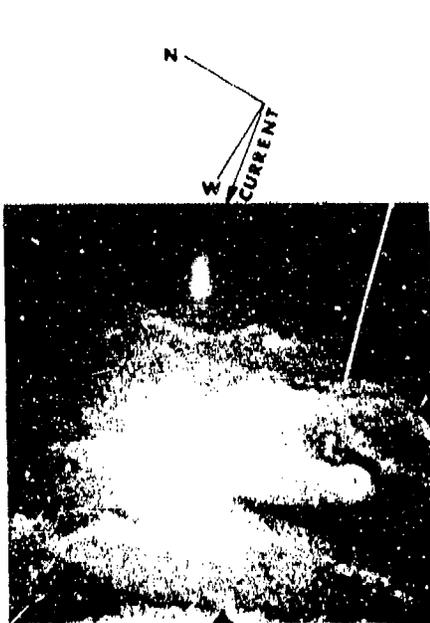
Fig. 35 - Phase III, anchor chart



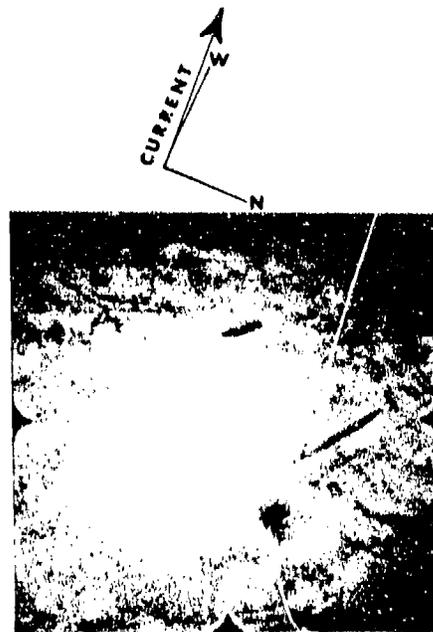
4-33



4-76



4-81



4-83

Fig. 36 -- Phase III, bottom photographs



5-10



5-22



5-59



5-78

Fig. 37 - Phase III, bottom photographs

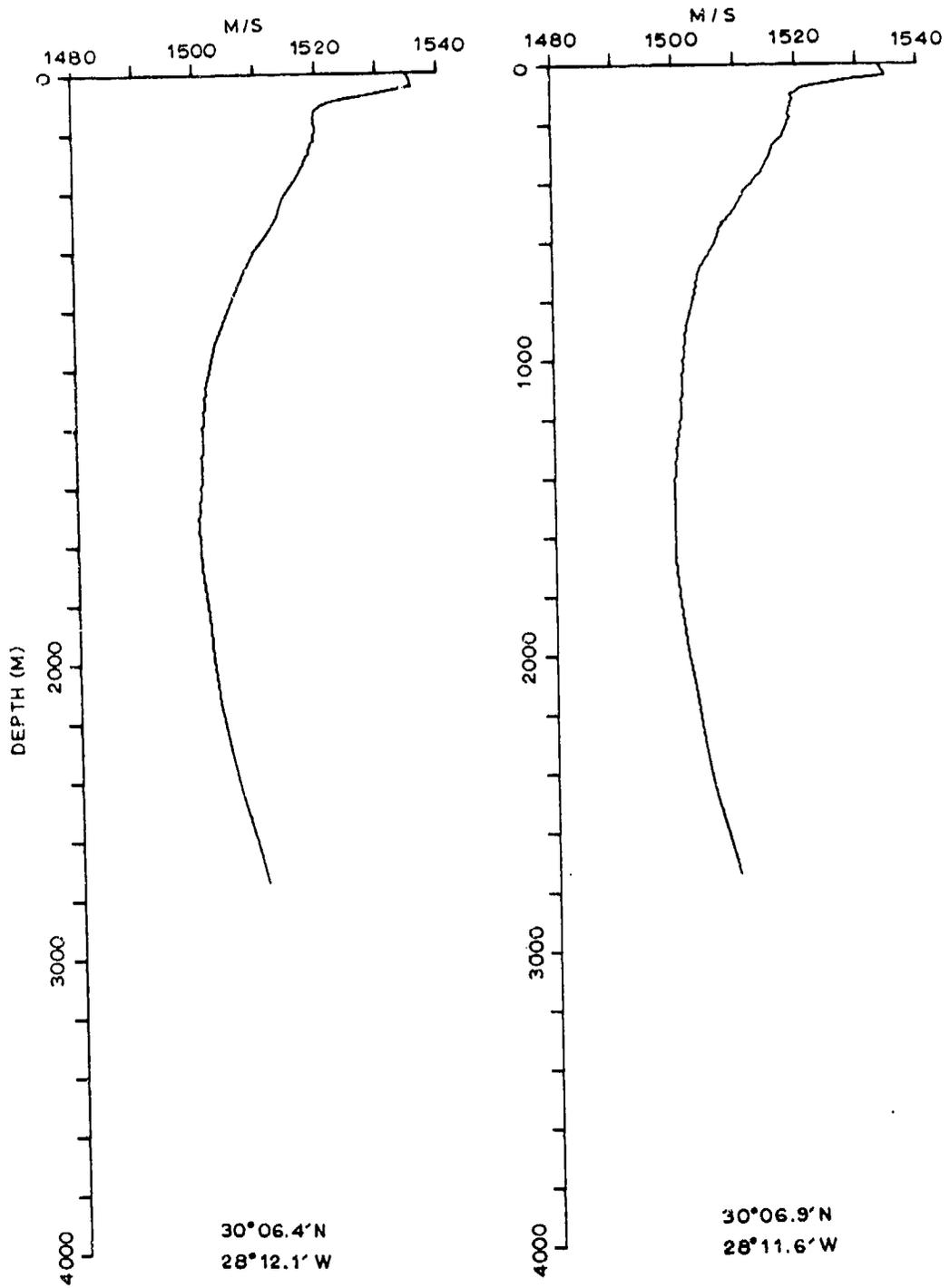


Fig. 38 — Phase III, sound speed profiles from sound velocimeter casts 9 and 10, Oct. 1969

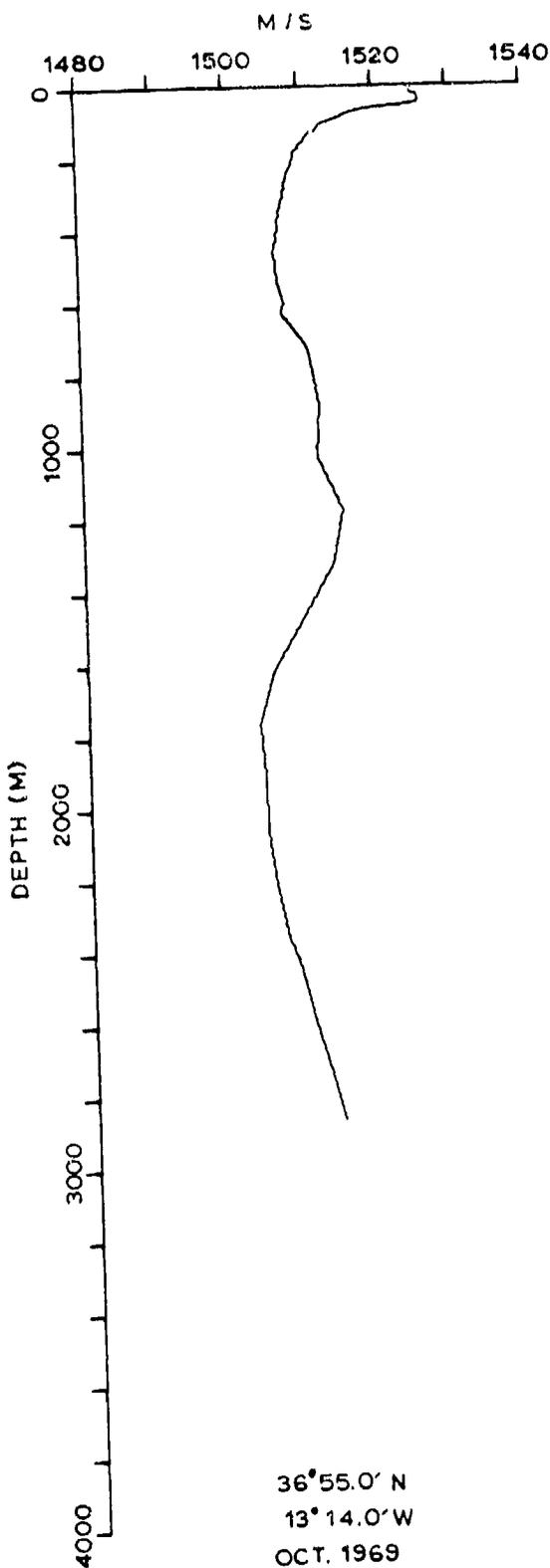


Fig. 39 -- Phase III, sound speed profile from in-transit sound velocimeter cast 6

36°55.0' N
13°14.0' W
OCT. 1969

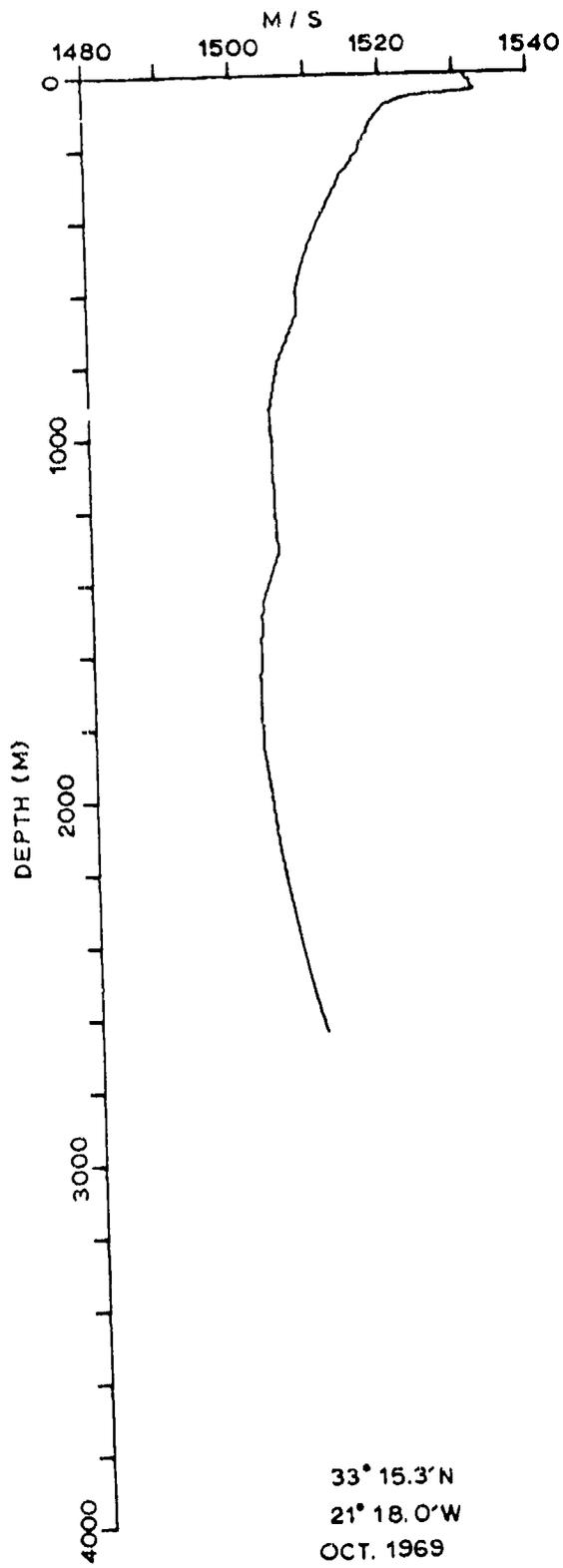


Fig. 40 — Phase III, sound speed profile from in-transit sound velocimeter cast 7

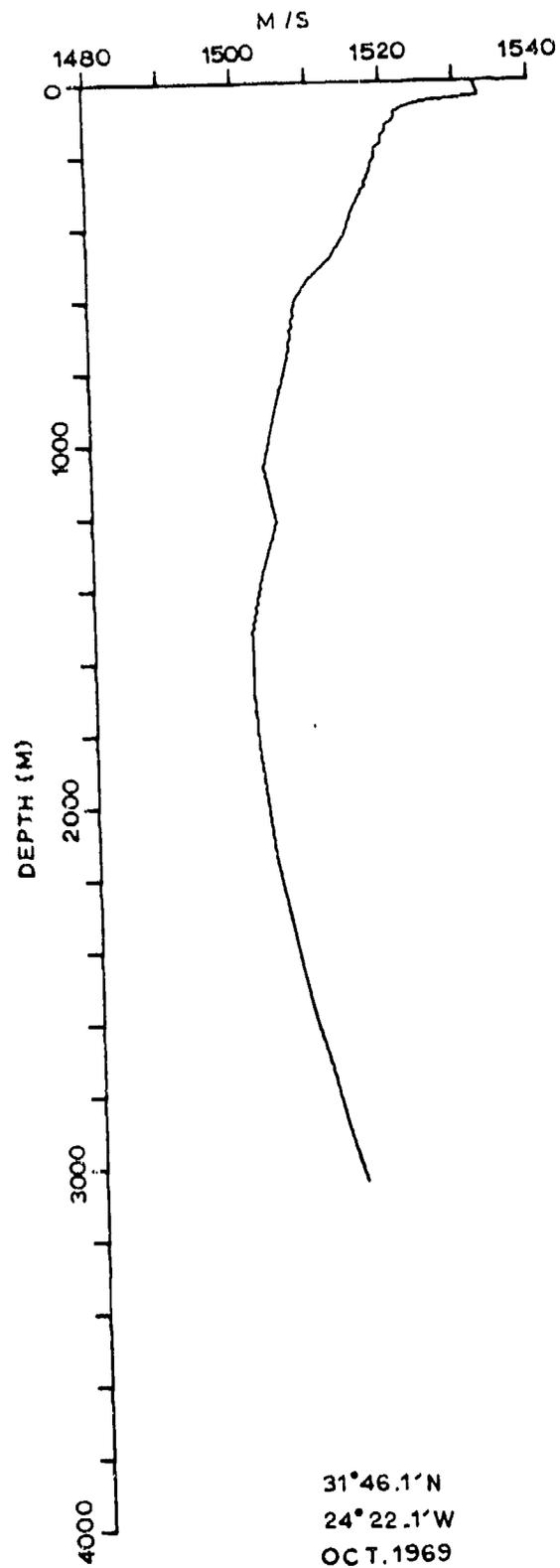


Fig. 41 -- Phase III, sound speed profile from in-transit sound speed velocimeter cast 8

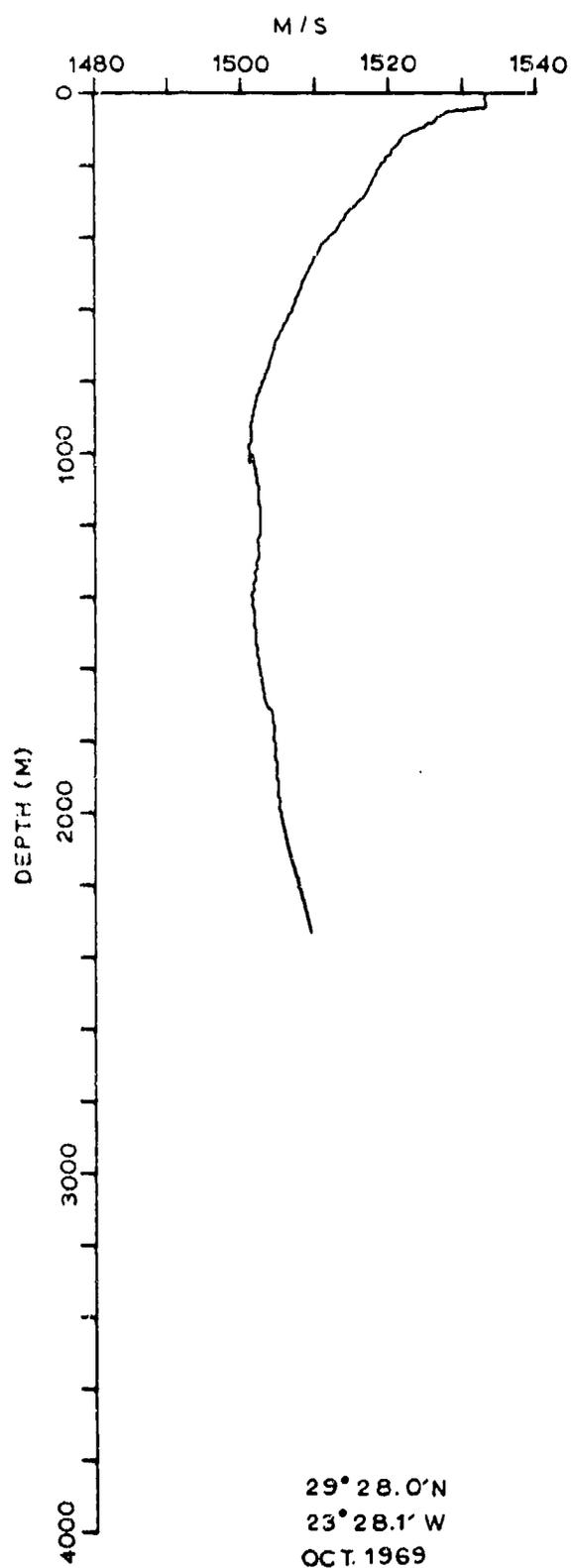


Fig. 42 — Phase III, sound speed profile from in-transit sound velocimeter cast 11

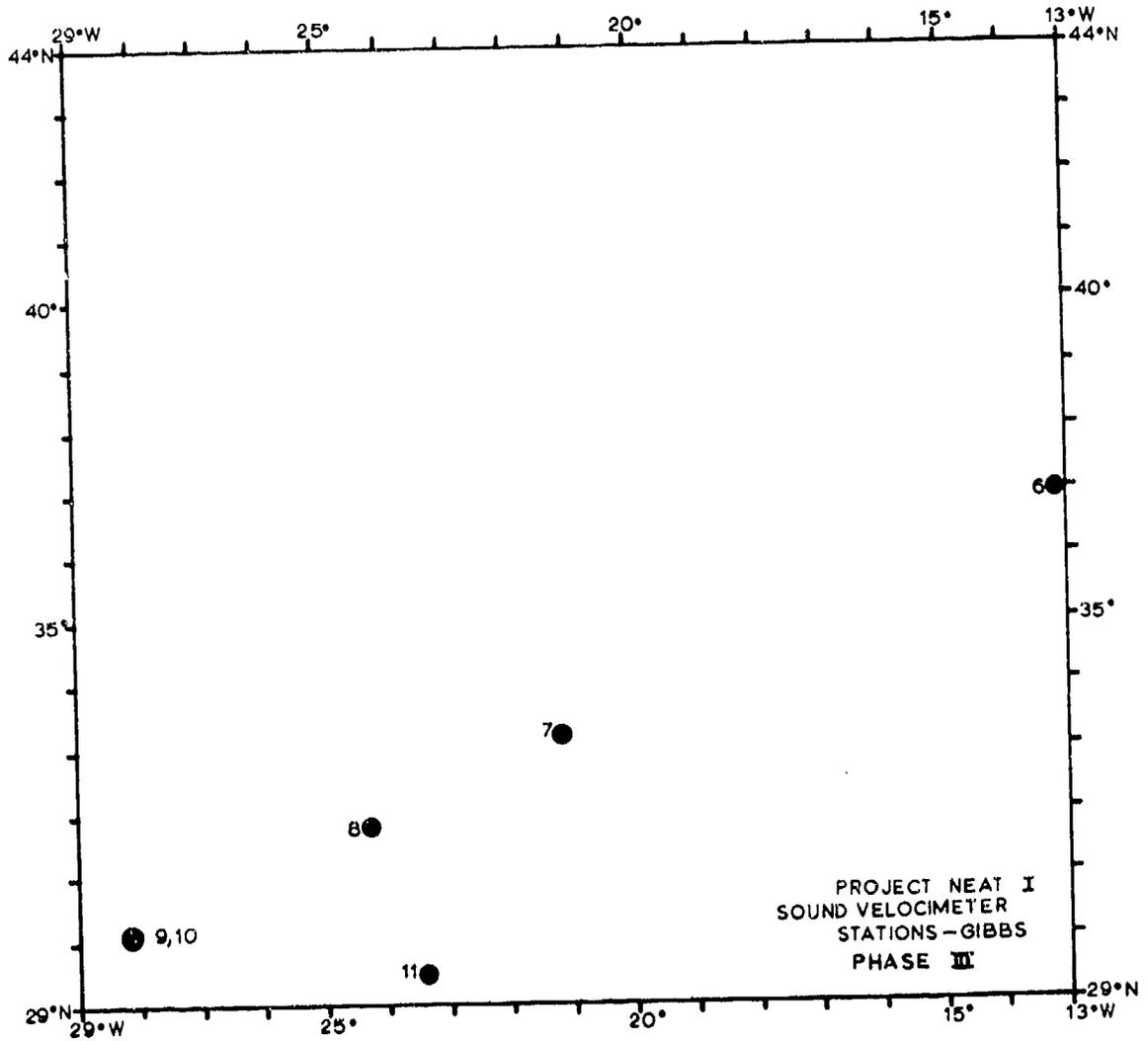


Fig. 43 - Phase III, distribution of sound velocimeter casts

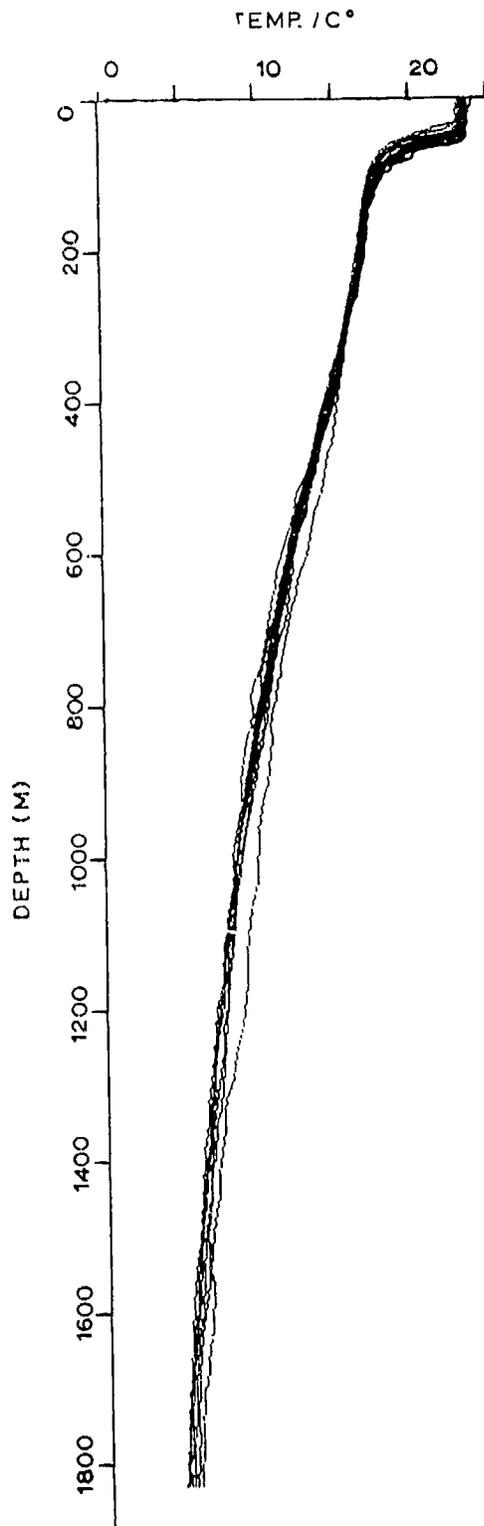


Fig. 44 — Phase III, multiplet of on-station temperature profiles from X-BT's, Oct. 1969

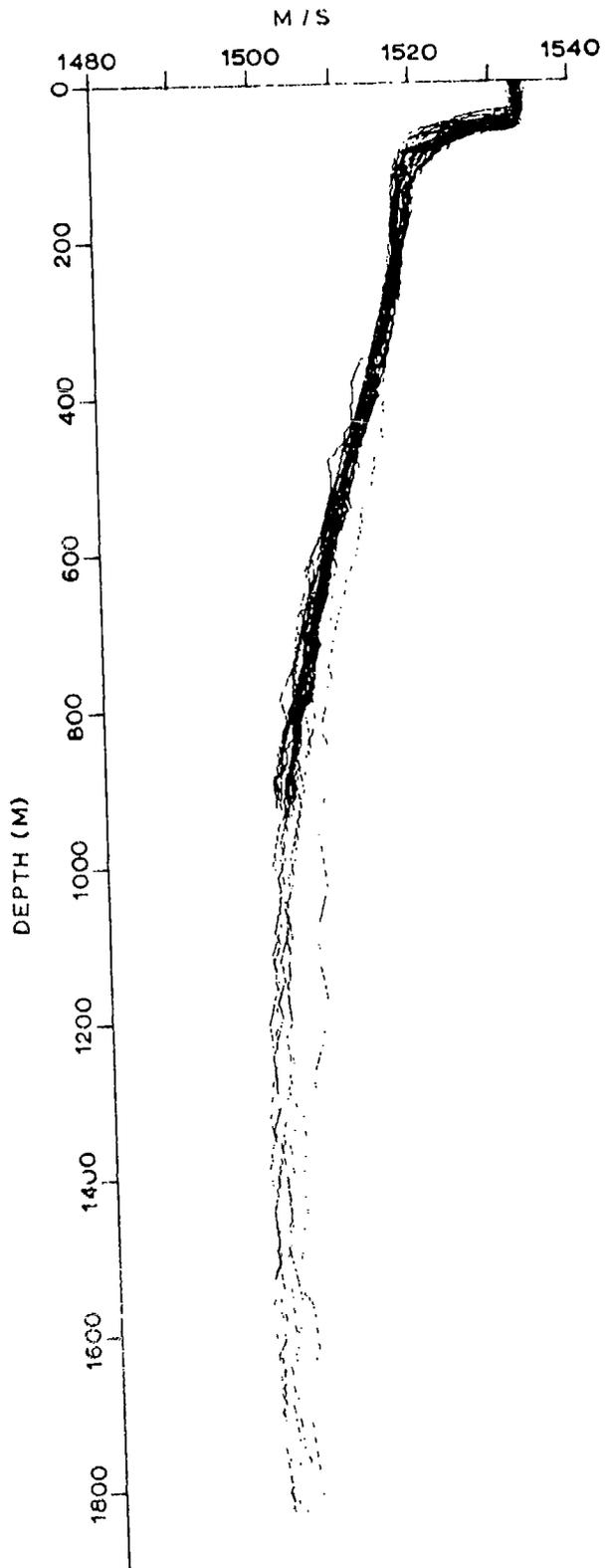


Fig. 45 -- Phase III, on-station sound speed profiles from X-BT's, Oct. 1969

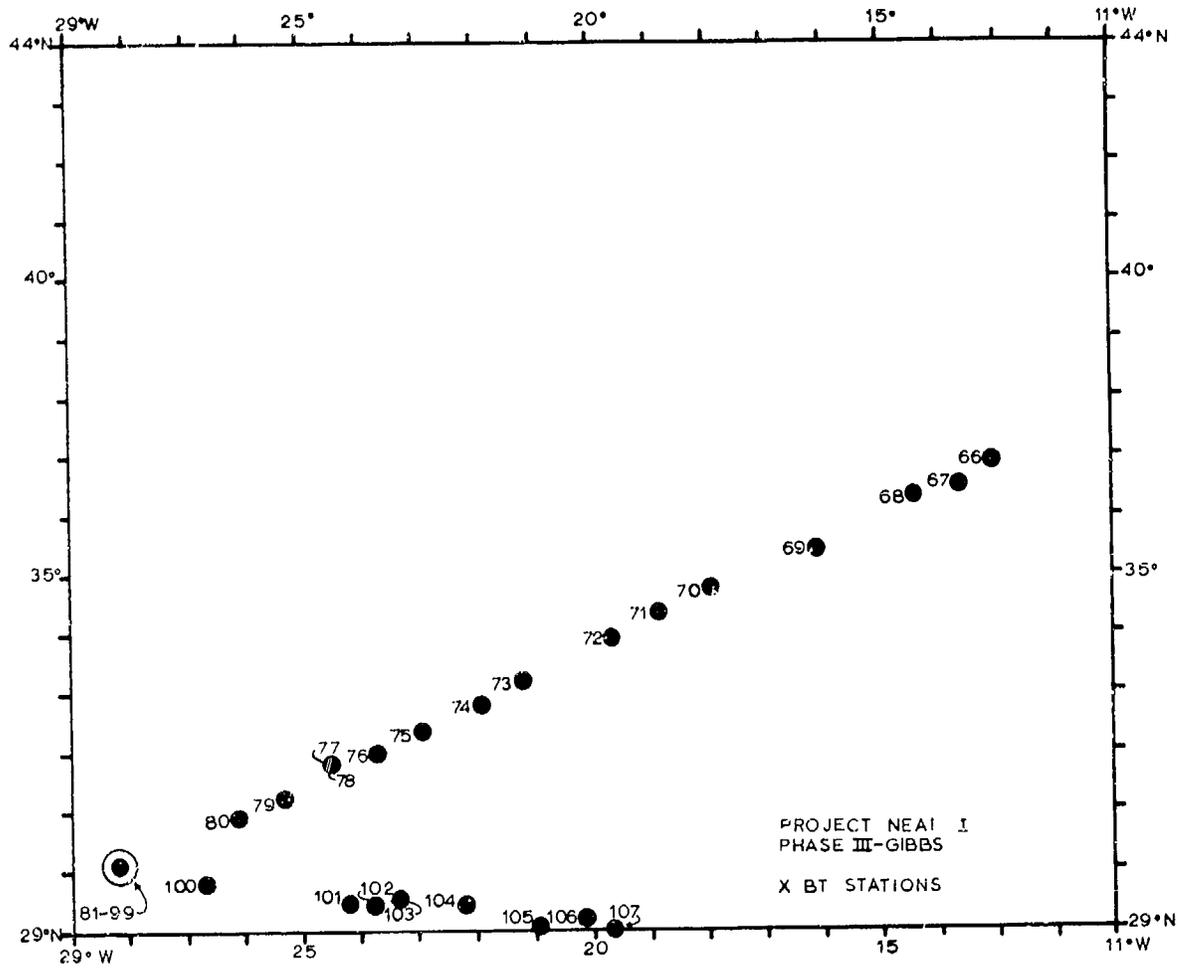


Fig. 46 — Phase III, distribution of X-BT's

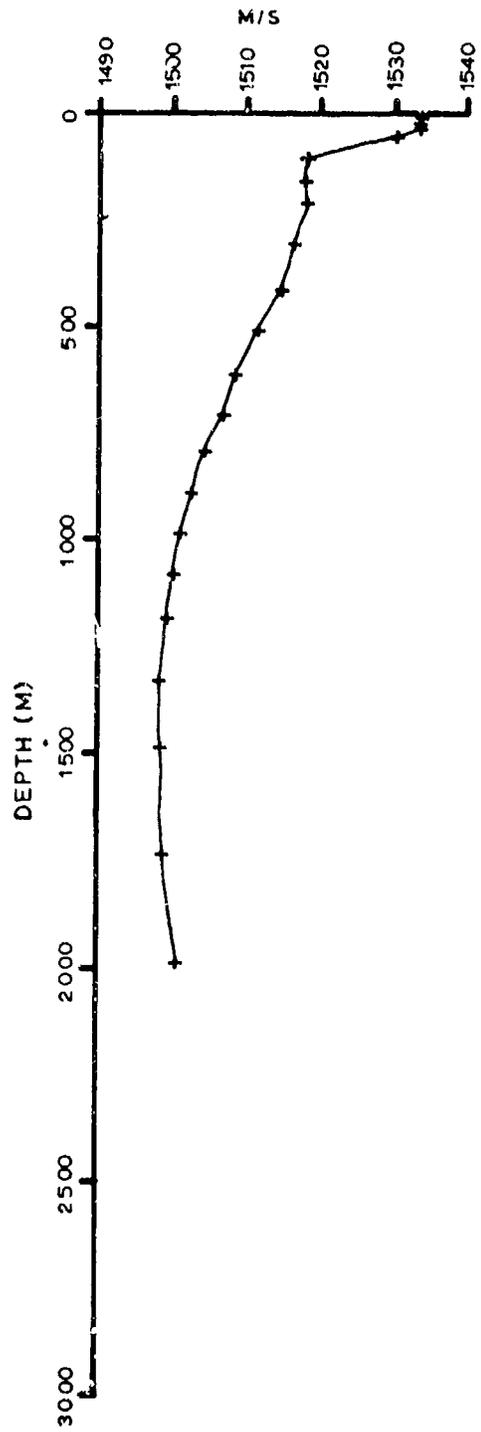


Fig. 47 — Phase III, sound speed profile from Nansen cast, Oct. 1969

SUMMARY

The analysis of environmental data from Project NEAT I demonstrated the advantages of total, simultaneous, in-situ evaluation given to each site with respect to acoustical and environmental properties. This evaluation consisted of (in addition to ambient noise and transmission loss studies), a bathymetric survey and a standard oceanographic station. Information was obtained through coring, bottom photography, Nansen casts, sound velocimeter casts, current meter casts, and X-BT casts. Wide-beam echo sounding, coupled with precision navigation by satellite (with a maximum error of 667 ft) made it possible for the construction of anchorage charts showing bottom topographic microstructure. The latter concept can be improved upon by the use of *narrow-beam* echo sounders. Further, the use of a seismic profiler in these areas could show the subbottom structure, which in turn could be of value in determining the positioning of permanent instrumentation with respect to near-field acoustic measurements through the subbottom media (e.g., sand, rock, silt, etc.).

Pre-NEAT I planning was an attempt to gain a broad look at the NEAT I area (an area of 3.2 million square miles) for acoustic *and* environmental properties from a historical standpoint, utilizing data from groups outside the Naval Research Laboratory, e.g., Undersea Surveillance Oceanographic Center, National Oceanographic Data Center, Naval Oceanographic Office, etc., in addition to data already on hand. Future experiments will likewise be planned in this manner.

This report is a summary or catalog of the environmental data taken by USNS *J. W. Gibbs* during her participation in Project NEAT I. No attempt is made to compare methods of obtaining oceanographic data, i.e. Nansen casts vs velocimeter casts.

The oceanographic data are available from the National Oceanographic Data Center. Other environmental data reported are available from Code 8174, Naval Research Laboratory.

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D.F. Fenner of the Naval Oceanographic Office (NAVOCEANO) prepared the NEAT requirements documents, and with P.J. Bucca supplied Figs. 5 through 9 for this publication from their informal report, "The Upper and Deep Sound Channel in the Northeast Atlantic," Naval Oceanographic Office, IR Number 69-94, December 1969. Messrs. D.F. Fenner, P.J. Bucca and R. Van Wyckhouse of NAVOCEANO gave support in planning the project, and later assisted in the final analysis of data collected on the experiment. W.A. Foster, Director, Bathymetric Division, and C.A. Justus, J.S. Sylvester, and G.E. Wilkes of NAVOCEANO lent support in freely supplying unpublished bathymetric manuscripts and sounding collection sheets of the NEAT I area. J.H. Kravitz, Head, Geology Laboratory, NAVOCEANO, assisted in the analysis of bottom photographs and analyzed NEAT cores and bottom sediments. A.S. Laughton of the National Institute of Oceanography, United Kingdom, supplied unpublished bathymetric manuscripts and further assisted by investigating the existence of the questionable sounding at the Phase II primary anchor site. W.W. Worsley, Naval Research Laboratory, helped prepare the illustrations.

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<p>(C) In September and October 1969, USNS J. W. Gibbs (T-AGOR 1) participated in the NEAT I (North-east Atlantic Test I) acoustic experiment. Historical data were evaluated prior to the experiment and compared to the in-situ measurements made by Gibbs. Included in these measurements were bathymetry, camera, core and dredge stations, and water-column measurements including XBT's, Nansen casts, and velocimeter casts. The in-situ water-column measurements were used to confirm or deny the presence of the sound velocity double minimum that is present in much of the NEAT I study area. Measurements were made both while at anchor and in transit to and from the anchor sites.</p>			

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Project NEAT I Acoustics Bathymetry Oceanography Northeast Atlantic						