Title
Site Surveys in the North Pacific and Bering Sea from ANTIPODE Expedition

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Site Surveys in the North Pacific and Bering Sea from ANTIPODE Expedition

Compiled by

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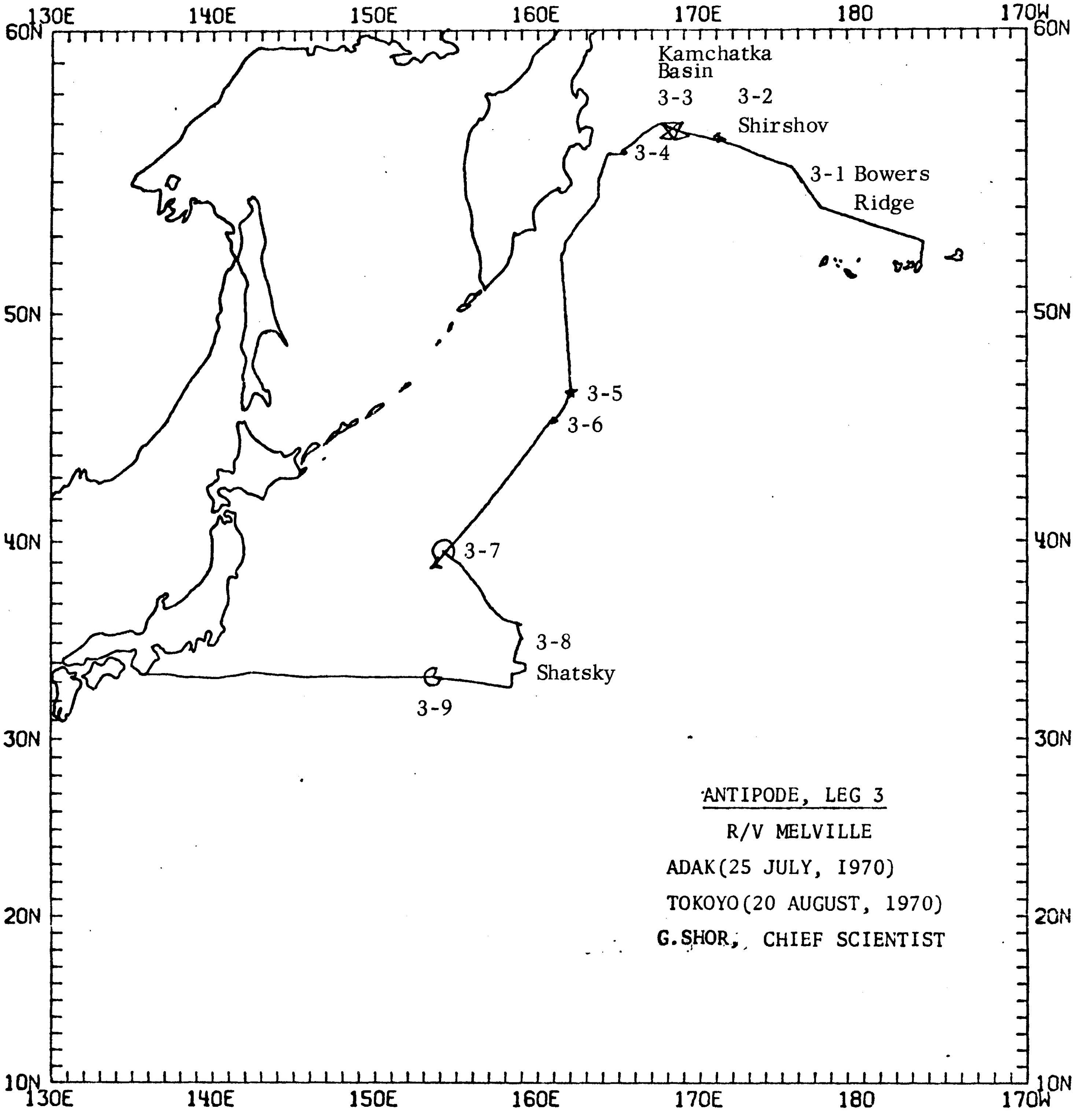


ANTIPODE, LEG 3

TABLE OF CONTENTS

INTRODUCTION

ANTIPODE Legs II and III, from San Francisco to Adak and Adak to Tokyo respectively were conducted by the R/V MELVILLE between 6 July and 19 August 1970. Deep Sea Drilling Project (DSDP) site surveys were conducted in conjunction with seismic refraction anisotropy surveys at most stations. This report will summarize just the site surveys while the refraction data will be published elsewhere. The chief scientist for both legs was George G. Shor, Jr. The following individuals assisted in the preparation of the site surveys at various stages: S. Einsohn, D. Fornari, J. Grow, R. Iuliucci, R. Kimes, L. Lawver, P. Liebertz, H. Poelchau, and F. van den Akker.

Most ANTIPODE site surveys consisted of an underway grid, usually determined by the refraction program, which obtained airgun reflection, 12 kHz and 3.5 kHz echo-sounder and magnetometer data. Satellite navigation was available on both legs. On site piston cores, heat probes, and bottom photographs were generally taken although the latter two suffered from intermittent mechanical problems. Bottom samples will be mentioned in the following site reports only where useful results were obtained.

Photographs of all airgun records are included in the Appendix and numbered ANT-1 to ANT-91. Regional track charts A1 - A6 are also included in the Appendix. References to specific airgun records will be made by citing the photograph number, e.g., (ANT-6). All airgun records and track charts are given in local ship time unless noted otherwiese in the figure caption.

These reports should be considered informal manuscript reports for use in selecting drilling sites, and do not constitute formal publications. The names of those who prepared each section are listed at the end of the portions for which they are responsible.

G. G. Shor, Jr.

SITE NUMBERING

A moderate degree of confusion exists in the numbering of the site surveys. Site numbers were assigned by the Drilling Project (of the form 18-8, 19-5, 19-8A etc.) to certain proposed survey locations before the R/V MELVILLE sailed. A number of these locations, plus others that had not been assigned site numbers, were surveyed by R/V MELVILLE on ANTIPODE Expedition. Each survey performed was given a consecutive number, of the form 2-1, 3-3, etc. Subsequent to the performance of the surveys, but before this report was complete, the sites to be drilled by the D/V GLOMAR CHALLENGER were renumbered by the drilling project; a new series of numbers was listed in the Scientific Prospectuses for Legs 18 and 19. Site numbers listed in this report are either the R/V MELVILLE survey numbers, or the original site numbers. Interrelationship is as follows:

R/V MELVILLE-ANTIPODE Site Numbers	Original JOIDES Site Numbers	Prospectus Site Numbers
2-1	18-8	18-11
2-2	19-1A	19-1D
2-3	NA	NA
2-4	NA	19-6A
3-1	NA	19-5B
3-2	19-7A	19-4E
3-3	19-7B	19-7E
3-4	NA	NA
3-5	19-8B	NA
3-6	19-8A	NA
NA	NA	19-8E
3-7	19-9	NA
3-8	NA	19-9B
3-9	20-1	NA

Survey 2-1

Site Survey Report

DSDP Site 18-8

REGIONAL SETTING: GULF OF ALASKA SITES

ANTIPODE Sites 2-1, 2-2, and 2-3 are located on abyssal plains in the Gulf of Alaska and are shown in a geomorphic sketch map (Figure 1; from Mammerickx, 1970). Site 2-1 is on the Tufts Plain which is presently being fed by turbidites from Moresby, Scott and Cascadia Channels. Sites 2-2 and 2-3 are on the Aleutian Abyssal Plain where turbidite deposition has ceased and the plain is blanketed by about 100 m of pelagic sediments (Hamilton, 1967). The age of the transition from turbidites to pelagic sediments and the source region of the Aleutian Plain turbidites are thought to have an important bearing on the tectonic history of the Eastern Aleutian Trench and Gulf of Alaska region.

The regional magnetic anomaly map for the northeast Pacific is shown in Figure 2 (from Atwater and Menard, 1970) along with Sites 2-1, 2-2, and 2-3.

SURVEY 2-1 (DEEP SEA DRILLING PROJECT SITE 18-8)

Deep Sea Drilling Project Site 18-8, on the Tufts Abyssal Plain, was surveyed by the R/V MELVILLE from 7 July to 10 July 1970. The site is located approximately 600 km west of the Juan de Fuca Ridge between the terminal ends of Moresby and Scott Channels (Figure 3). Regional magnetic studies suggest the site is near Anomaly 7 (Figure 2). The site was originally proposed in order to study the biostratigraphy of the plain. Airgun reflection profile and 3.5 kHz echosounder records were used for stratigraphic interpretation of the area.

Topographically, the bottom is essentially a flat plain dipping gently southwest with depths from 2260 fathoms in the northeast to 2295 fathoms in the southwest (Figure 5). Small nonlineated basement hills rise 50 - 150 fathoms above the bottom with a maximum relief of 350 fathoms. The reflection profiles show sediment troughs with an average thickness of 0.3 - 0.6 seconds (Figure 6). The records show distinct, continuous, flat-lying reflectors down to 0.3 second which are underlain by what appears to be transparent sediments down to basement. The transparent sediments are absent in areas where there is less than 0.3 seconds of penetration. The sediment troughs may have a north-south trend. However, the particular trough which was surveyed in detail trends approximately 30°W of north. Airgun photograph ANT-6 shows the airgun profile during the initial approach to Site 2-1.

A 30-foot piston corer (ANTIPODE2-34P) was lowered at 46°39.9'N, 138°14.15'W at 0200 - 0400 on 10 July where the records showed 0.4 seconds of penetration, but only 60 cm of sediment was recovered. The bottom barrel was bent at an angle of 5° and the plastic core liner cracked. The sediment was interspersed with water bubbles and little sedimentary structure preserved. The core catcher contained a gray sandy clay which was overlain by a gray-green silty clay. An analysis of the catcher sample follows:

angular quartz 95%
glauconite 1%
dark heavy minerals 2%
clay minerals 1%
organic matter 1%

Approximately 0.5% of the sample was composed of radiolarians and only five individual foraminifera were found. No age determination was made. The sediment is well compacted and should yield the desired columnar section.

The magnetic anomalies in the site area range from -200 to +400 gammas and were weakly aligned in a north-south direction. Local anomalies, not obviously related to basement topography, were more dominant than the north-south trends. The ship's track spacing was not sufficiently close to yield definitive magnetic patterns.

A trough, centered at 46°00'N and 137°51'W about 0.6 seconds, was surveyed in greatest detail and is recommended as the primary DSDP site. Two alternative sites could be considered. The first alternative site is at 45°51'N and 137°42'W and was crossed only once on the initial track into Site 2-1. Its major advantage is that the airgun record was clearer than the others (ANT-6). The second alternative was at 46°21'N, 138°04'W and is similar to the others but the airgun records were slightly poorer.

J. Grow
H. Poelchau
P. Liebertz
R. Iuliucci
S. Einsohn

REFERENCES

Atwater, T., and H. W. Menard, 1970, Magnetic lineations in the northeast Pacific: Earth and Planet. Sci. Letters, v. 7, p. 445-450.

Hamilton, E. L., 1967, Marine geology of abyssal plains in the Gulf of Alaska: J. Geophys. Res., v. 72, p. 4189-4214.

Mammerickx, J., 1970, Morphology of Aleutian Abyssal Plain: Geol. Soc. Amer. Bull., v. 81, p. 3457-3464.

FIGURE CAPTIONS

Figure 1 Regional morphology of Gulf of Alaska (from Mammerickx, 1970) with ANTIPODE Sites 2-1, 2-2, and 2-3.

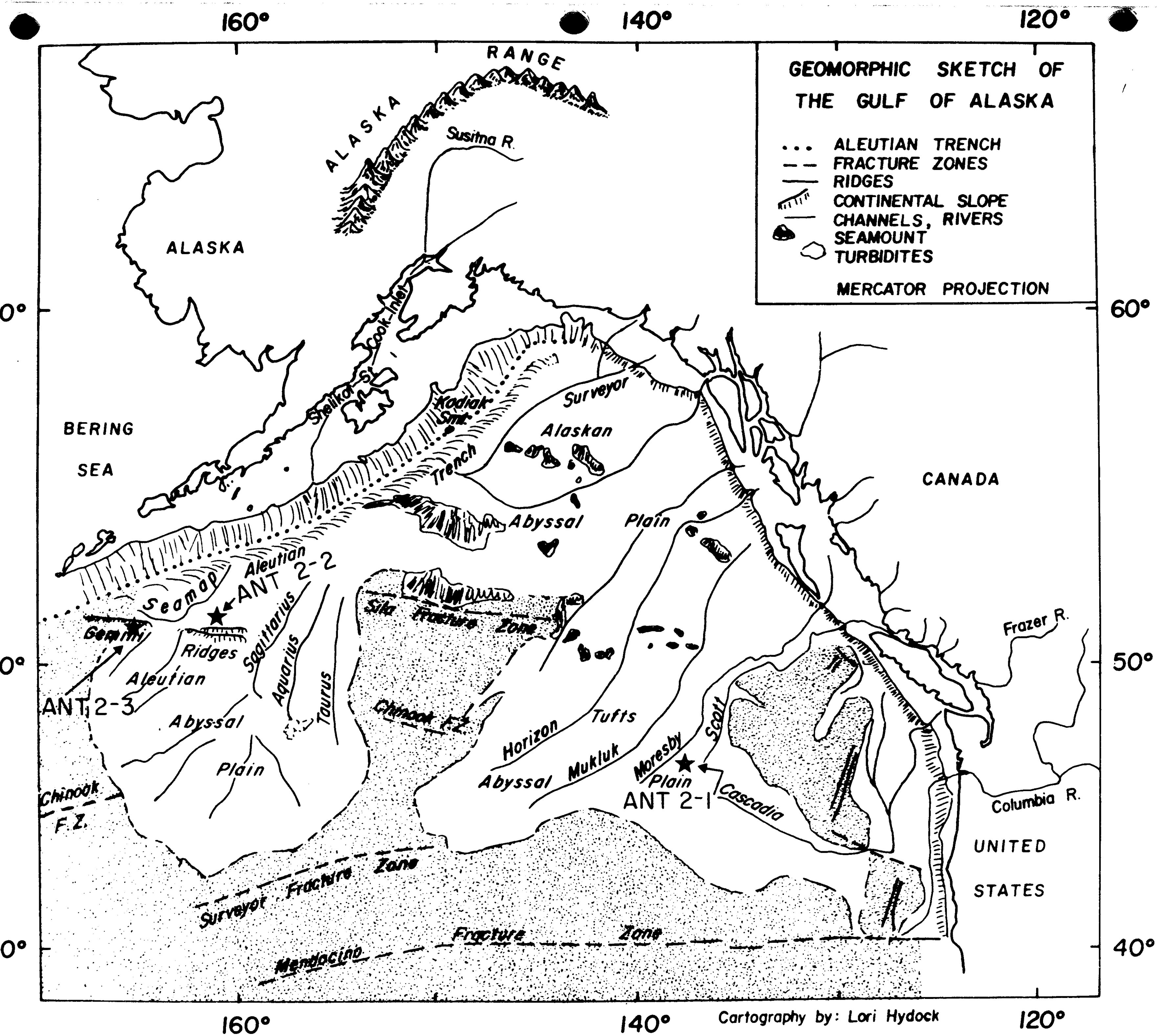
Figure 2 Regional magnetic anomalies of northeast Pacific (from Atwater and Menard, 1970) with ANTIPODE Sites 2-1, 2-2, and 2-3 .

Figure 3 Regional bathymetry and track chart for Site 2-1.

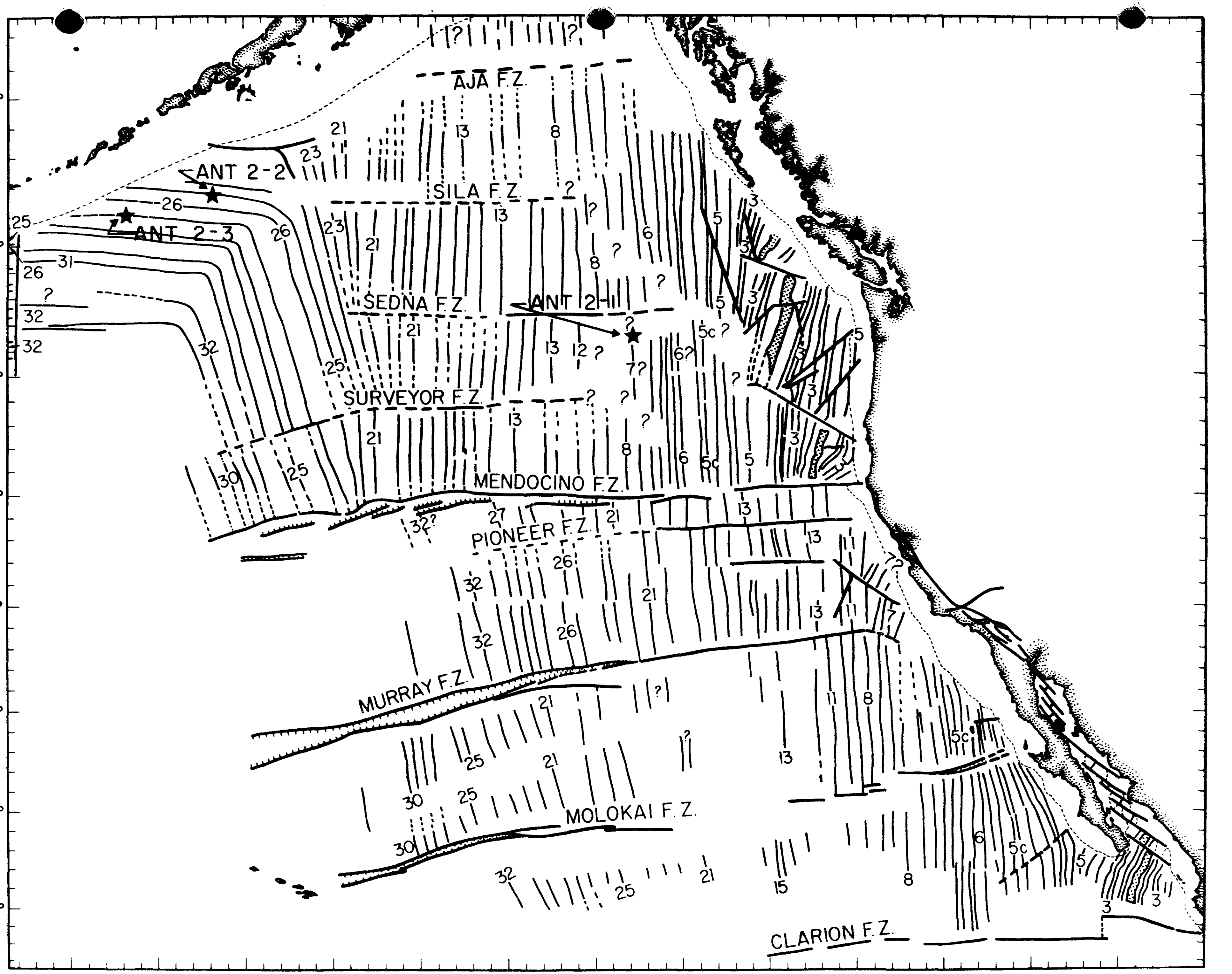
Figure 4 Detailed track chart for Site 2-1. Track times in this figure are in GMT. Airgun photographs ANT-6 through ANT-12 cover this chart and may be converted to GMT for comparison with Figure 4 by adding 10 hours.

Figure 5 Detailed bathymetric map for Site 2-1. Small abyssal hills which protrude above plain are shaded with only the maximum elevation indicated.

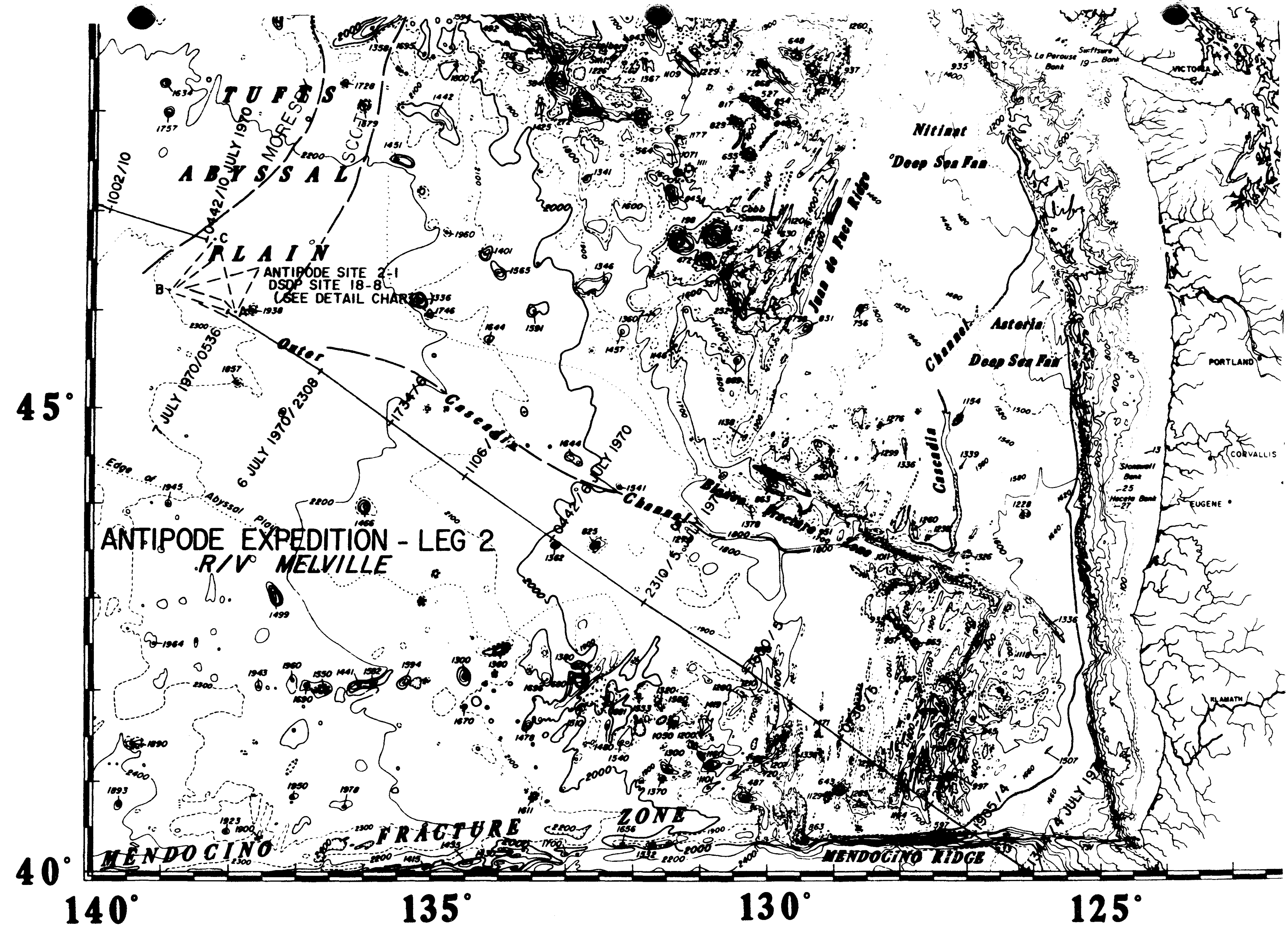
Figure 6 Detailed isopach map of sediment thickness for Site 2-1.

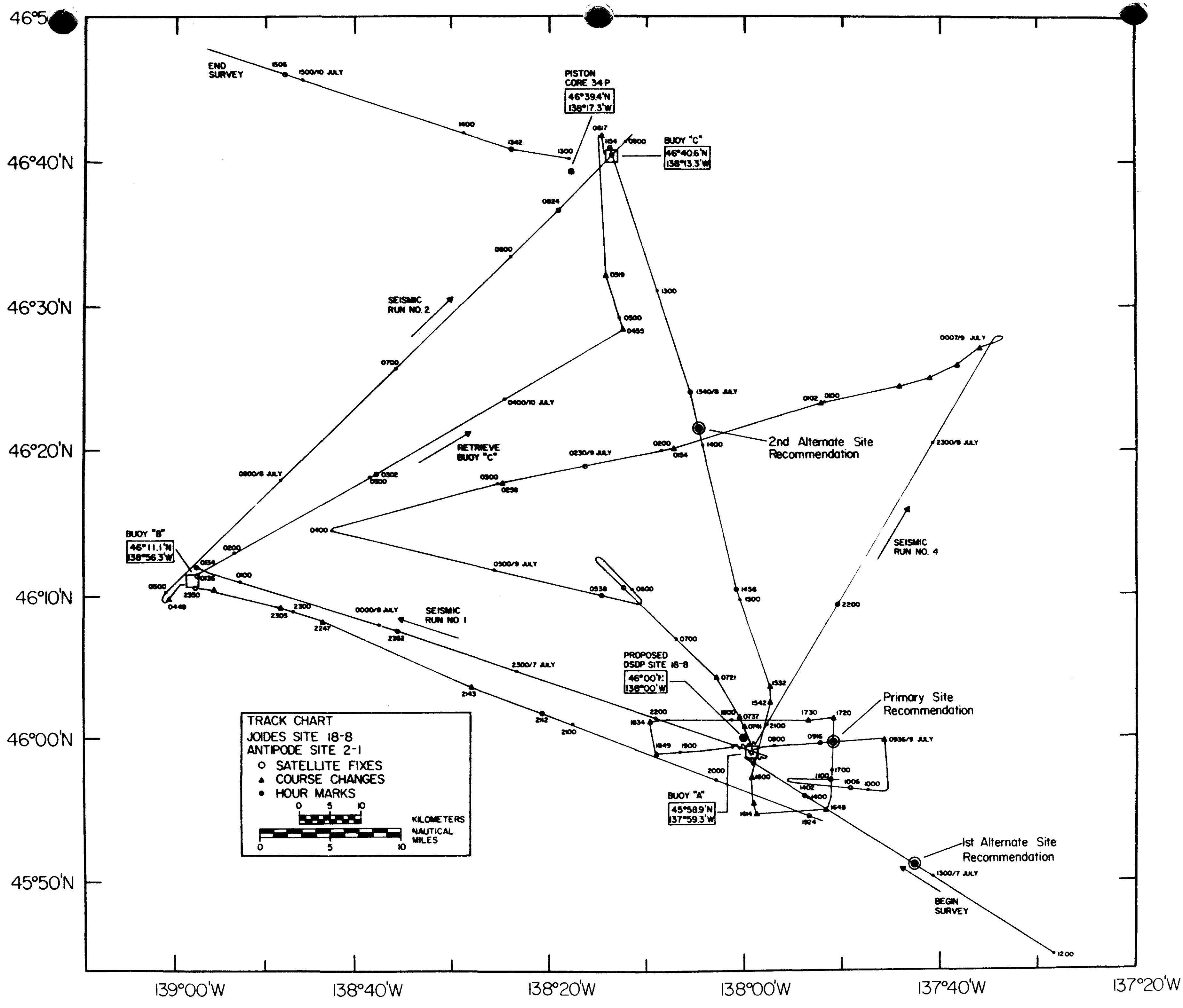


GEOMORPHIC SKETCH OF THE GULF OF ALASKA
ALEUTIAN TRENCH
FRACTURE ZONES
RIDGES
CONTINENTAL SLOPE
CHANNELS, RIVERS
SEAMOUNT
TURBIDITES
MERCATOR PROJECTION
160°
140°
120°
60°
50°
40°
ALASKA RANGE
Susitna R.
ALASKA
Cook Inlet
Shelikof St.
BERING SEA
Kodiak Smt.
Surveyor
Alaskan
Trench
Abyssal
Plain
CANADA
Aleutian
Seamap
ANT 2-2
Gemini
Ridges
Sagittarius
Aquarius
Taurus
Sila Fracture Zone
Aleutian
ANT 2-3
Abyssal
Plain
Chinook F.Z.
Chinook F.Z.
Horizon
Tufts
Abyssal
Mukluk
Moresby
Scott
Plain
ANT 2-1
Cascadia
Frazer R.
Columbia R.
UNITED STATES
Surveyor Fracture Zone
Mendocino Fracture Zone
Cartography by: Lori Hydock

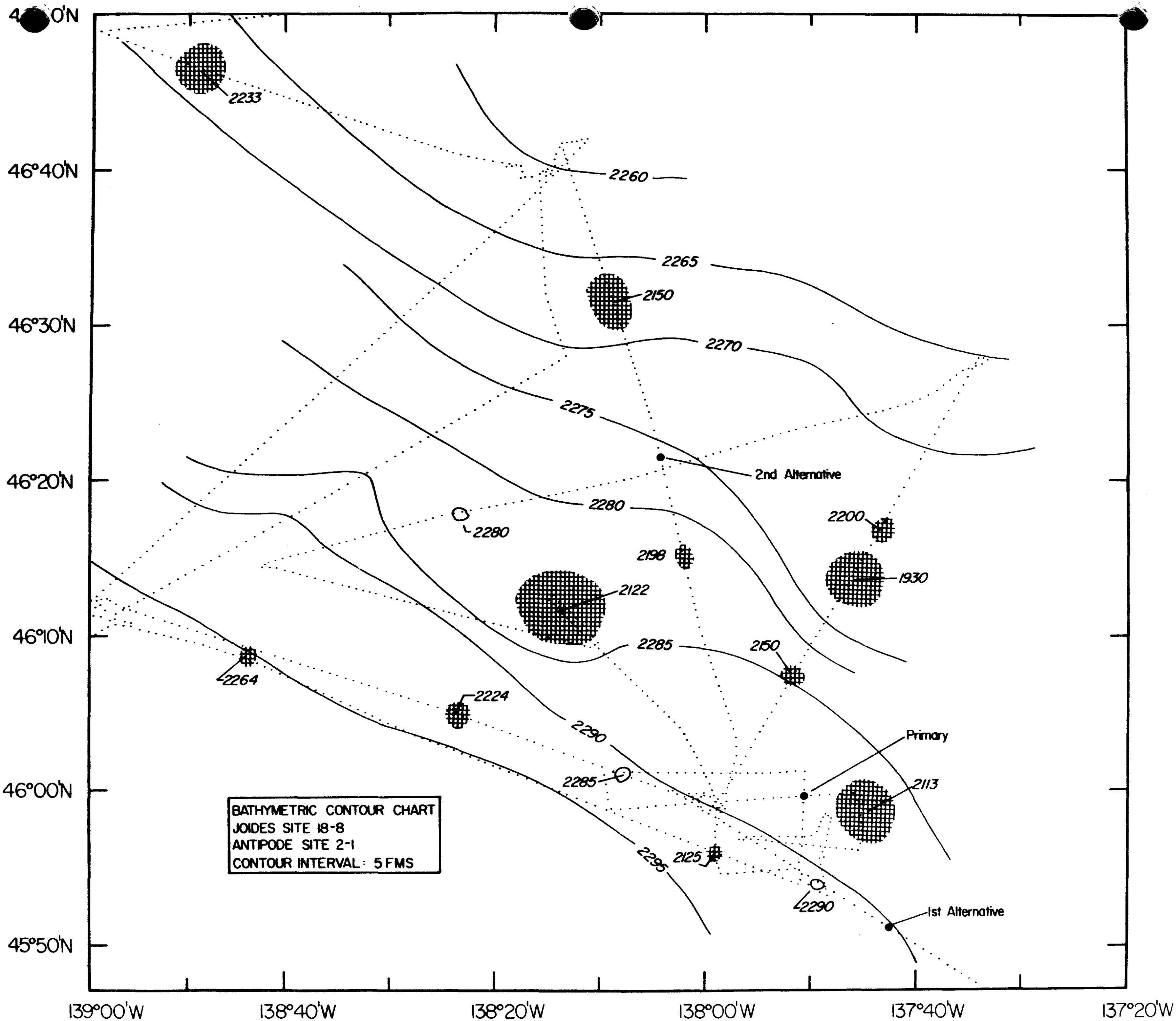

AJA F.Z.
SILA F.Z.
SEDNA F.Z.
SURVEYOR F.Z.
MENDOCINO F.Z.
PIONEER F.Z.
MURRAY F.Z.
MOLOKAI F.Z.
CLARION F.Z.
ANT 2-2
ANT 2-3
ANT 2H
55°
50°
45°
40°
35°
30°
25°
20°
170°
165°
160°
155°
150°
145°
140°
135°
130°
125°
120°
115°
110°
105°

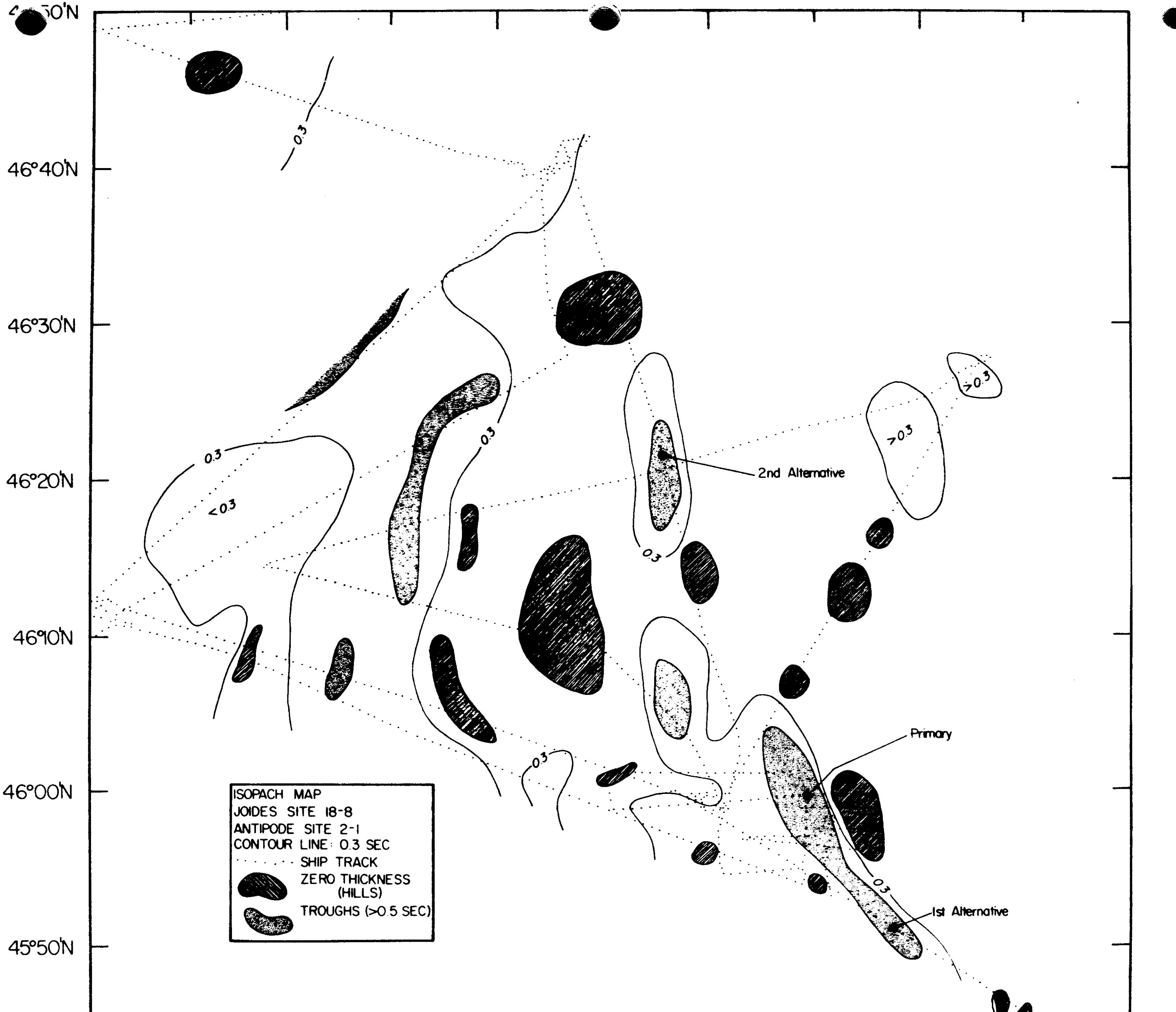
9.


ANTIPODE EXPEDITION - LEG 2
R/V MELVILLE
ANTIPODE SITE 2-1
DSDP SITE 18-8
(SEE DETAIL CHART)
TUFTS ABYSSAL PLAIN
Edge of Abyssal Plain
Outer Cascadia Channel
MENDOCINO FRACTURE ZONE
MENDOCINO RIDGE
Juan de Fuca Ridge
Blanco Fracture Zone
Cascadia Channel
Nitinat Deep Sea Fan
Astoria Deep Sea Fan
Astoria Channel
Cobb Seamount
MORESBY
SCOTT
7 JULY 1970/0536
6 JULY 1970/2308
10 JULY 1970
8 JULY 1970
4 JULY 1970
1002/10
0442/10
1734/6
1106/7
0442/8
2310/5
1905/4
VICTORIA
PORTLAND
CORVALLIS
EUGENE
KLAMATH
La Perouse Bank
Swiftsure Bank
Stonewall Bank
Heceta Bank
45°
40°
140°
135°
130°
125°



TRACK CHART
JOIDES SITE 18-8
ANTIPODE SITE 2-1
SATELLITE FIXES
COURSE CHANGES
HOUR MARKS
KILOMETERS
NAUTICAL MILES
END SURVEY
BEGIN SURVEY
PISTON CORE 34 P
46°39.4'N 138°17.3'W
BUOY "C"
46°40.6'N 138°13.3'W
BUOY "B"
46°11.1'N 138°56.3'W
BUOY "A"
45°58.9'N 137°59.3'W
PROPOSED DSDP SITE 18-8
46°00'N 138°00'W
SEISMIC RUN NO. 1
SEISMIC RUN NO. 2
SEISMIC RUN NO. 4
RETRIEVE BUOY "C"
2nd Alternate Site Recommendation
Primary Site Recommendation
1st Alternate Site Recommendation
46°40'N
46°30'N
46°20'N
46°10'N
46°00'N
45°50'N
139°00'W
138°40'W
138°20'W
138°00'W
137°40'W
137°20'W


BATHYMETRIC CONTOUR CHART
JOIDES SITE 18-8
ANTIPODE SITE 2-1
CONTOUR INTERVAL: 5 FMS
46°40'N
46°30'N
46°20'N
46°10'N
46°00'N
45°50'N
139°00'W
138°40'W
138°20'W
138°00'W
137°40'W
137°20'W
2233
2260
2265
2150
2270
2275
2nd Alternative
2280
2280
2200
2198
1930
2122
2285
2150
2264
2224
2290
Primary
2285
2113
2125
2295
2290
1st Alternative


46°50'N
46°40'N
46°30'N
46°20'N
46°10'N
46°00'N
45°50'N
139°00'W
138°40'W
138°20'W
138°00'W
137°40'W
137°20'W
0.3
<0.3
>0.3
2nd Alternative
Primary
1st Alternative
ISOPACH MAP
JOIDES SITE 18-8
ANTIPODE SITE 2-1
CONTOUR LINE: 0.3 SEC
SHIP TRACK
ZERO THICKNESS (HILLS)
TROUGHS (>0.5 SEC)

Survey 2-2

Site Survey Report

DSDP Site 19-1A

The magnetic anomaly patterns of the northwest Pacific have been well studied and indicate that the Aleutian abyssal plain lies to the west of the Great Magnetic Bight. Magnetic anomaly 25 has an east-west lineation and lies immediately south of the Aleutian Trench on the abyssal plain. Reflection profile records of Hamilton (1967) and the R/V CONRAD indicated that 0.1 second of pelagic sediment may overlie 0.2 second of turbidite deposits. It has been recently suggested that the turbidite deposites originate on the Alaskan mainland and exit through Cook Inlet (Hamilton, 1967). Presumably then after the formation of the trench these turbidites would be trapped in the trench and only pelagic sedimentation would occur out on the plain. It should then follow that the age of the pelagic-turbidite boundary would indicate the age of the trench. The age of the turbidites immediately overlying the basement may serve to date the age of the anomaly. However, if the fossil channels observed on the Aleutian Plain originally came from the east either through low parts of the seamount province or around its northern boundary, an alternative source region for the Aleutian Abyssal Plain turbidites could be southeastern Alaska. The Tertiary history of oceanic plate motions in the northeast Pacific can be constrained by the time distribution and provenance of these turbidites. Therefore, resolution of the "Aleutian Abyssal Plain problem" has major tectonic implications.

In conjunction with the Deep Sea Drilling Project site 19-1A the R/V MELVILLE site surveyed an area bounded by 51°15' - 51°50'N and 160°50' - 161°50'W (Figures 7 and 8) from 14 July to 16 July 1970 on the southern boundary of magnetic anomaly 25 (Figure 10). The purpose of this site is to determine the age of the pelagics, the age of the turbidites, and the source area of these turbidites. The site survey was shifted 25 miles to the west due to unfavorable topography for a refraction anisotropy run at the originally proposed site.

Topographically the area is essentially a flat plain leveled at a mean depth of 2490 fathoms and a very slight southerly dip (Figure 9). Small nonlineated hills rise 50-100 fathoms above the bottom with a maximum relief of 350 fathoms. The reflection profiles (ANT-23 - 28) show an average sediment thickness of 0.4 - 0.5 seconds with maximum thickness of 0.60 seconds. At a depth of 0.2 seconds there is a discontinuous reflecting horizon which is underlain by another nonreflecting unit at 0.4 seconds. The reflectivity of the units below 0.4 seconds of sediment seems to vary with the basement topography. The hard reflectors that are present at this depth are usually found in ponded troughs at the base of basement highs. Conversely the reflectors are absent in areas where the basement is essentially flat. The east-west and north-south airgun profiles are shown in ANT-26.

The 0.1 second of palagic sediments previously reported for this area were not clearly resolved on our reflection records. However, the discontinuous reflector at 0.2 seconds is probably equivalent to that reported by Hamilton (1967) and the R/V CONRAD. A small abyssal hill at the east end of the E-W profile (ANT-26) also has 0.2 seconds of pelagics on top of it. Therefore, the pelagic layer appears to be nearer 0.2 seconds in this area.

A 60-foot piston core was lowered at 51°43.1'N, 160°55.7'W where the records showed 0.5 seconds of penetration and the magnetics indicated that we were over anomaly 25. There appeared to be 50 feet of penetration but only 35 feet of sediment was recovered. Samples were taken every 150 cm of the core. As a general analysis the core is basically a gray-green silty clay composed mainly of diatoms with some quartz, dark heavy minerals and radiolarians. The radiolarians are too sparse for an age determination. The catcher sample however, was a gray sandy silt and contained:

quartz 70%	glauconite, phosphorite 3%
diatoms 25%	dark heavy minerals 1%
radiolarians 1%	

The sediment is well preserved and can be used for both stratigraphic and structural interpretation.

The recommended drilling location is at 51°41'N, 161°44'W where 0.60 seconds of sediment can be seen (at 0818/15 July course change on Figure 8 and ANT-26). The pelagic-turbidites contact is probably the discontinuous reflector at 0.2 seconds. The stronger reflector at 0.4 second can also be seen clearly here.

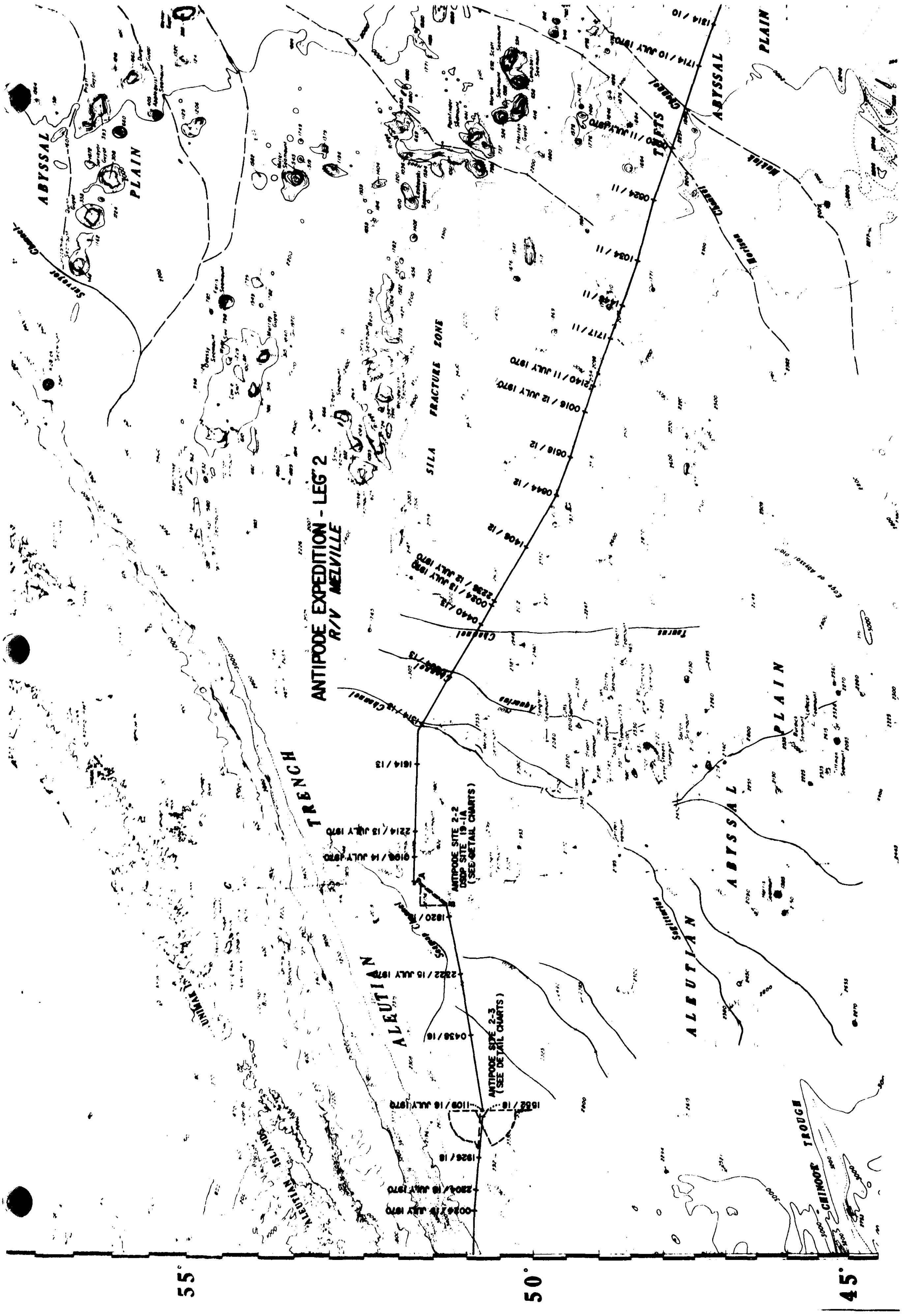
J. Grow
R. Iuliucci
S. Einsohn

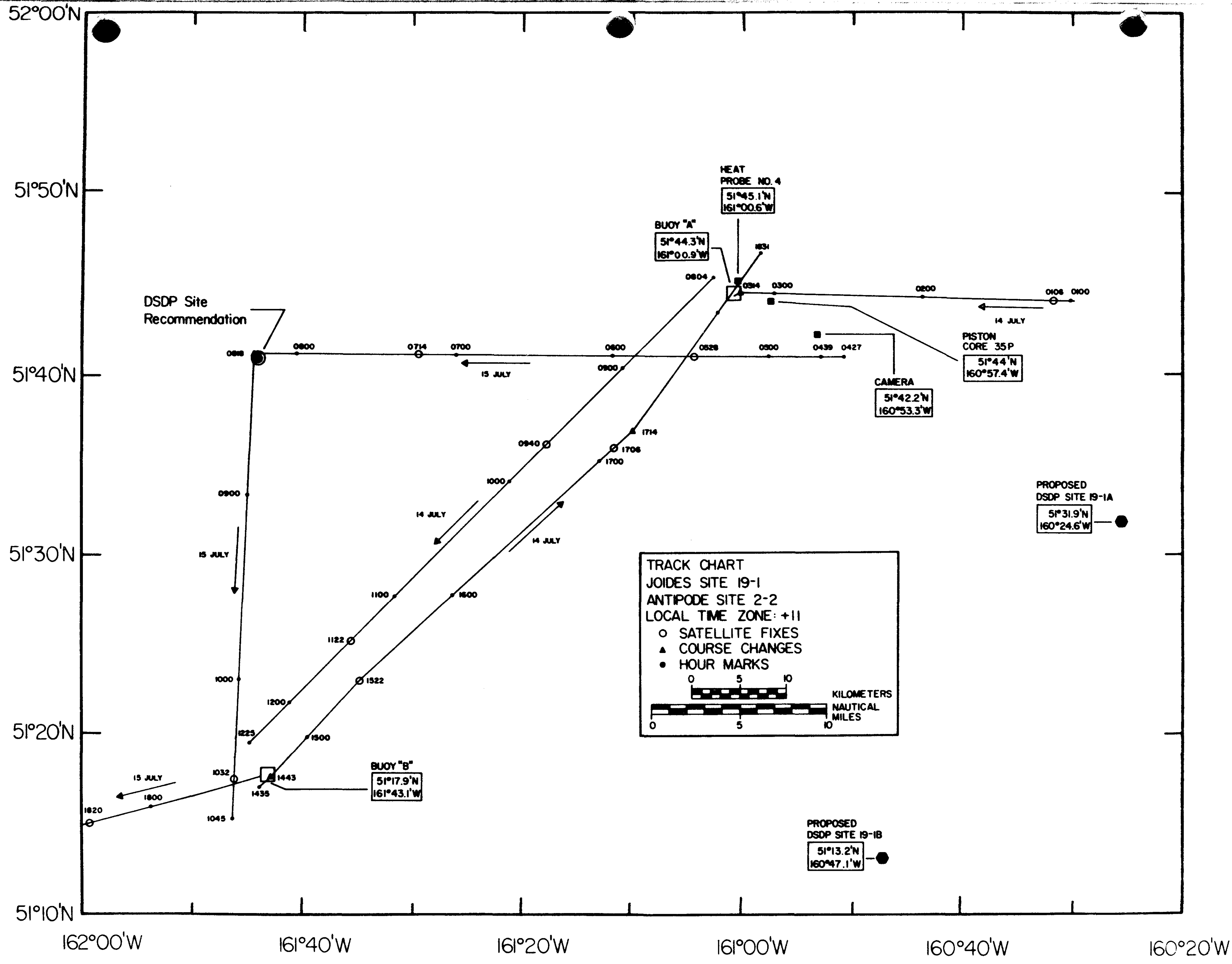
REFERENCES

Hamilton, E. L., 1967, Marine geology of abyssal plains in the Gulf of Alaska: J. Geophys. Res., v. 72, p. 4189-4214.

FIGURE CAPTIONS

Figure 7	Regional bathymetric chart for Sites 2-2 and 2-3.
Figure 8	Detailed track chart for Site 2-2.
Figure 9	Detailed bathymetric chart for Site 2-2.
Figure 10	Detailed magnetic anomaly chart for Site 2-2.


ANTIPODE EXPEDITION - LEG 2
R/V MELVILLE
ABYSSAL PLAIN
SILA FRACTURE ZONE
ALEUTIAN TRENCH
ALEUTIAN ABYSSAL PLAIN
CHINOOK TROUGH
ANTIPODE SITE 2-2
DSDP SITE 19-1A
(SEE DETAIL CHARTS)
ANTIPODE SITE 2-3
(SEE DETAIL CHARTS)
55°
50°
45°



TRACK CHART
JOIDES SITE 19-1
ANTIPODE SITE 2-2
LOCAL TIME ZONE: +11
SATELLITE FIXES
COURSE CHANGES
HOUR MARKS
KILOMETERS
NAUTICAL MILES
0
5
10
HEAT PROBE NO. 4
51°45.1'N
161°00.6'W
BUOY "A"
51°44.3'N
161°00.9'W
DSDP Site Recommendation
PISTON CORE 35P
51°44'N
160°57.4'W
CAMERA
51°42.2'N
160°53.3'W
PROPOSED DSDP SITE 19-1A
51°31.9'N
160°24.6'W
PROPOSED DSDP SITE 19-1B
51°13.2'N
160°47.1'W
BUOY "B"
51°17.9'N
161°43.1'W
14 JULY
15 JULY
0100
0106
0200
0300
0314
1831
0804
0816
0800
0714
0700
0600
0528
0500
0439
0427
0900
0940
1000
1100
1122
1200
1225
1714
1706
1700
1600
1522
1500
1443
1435
1032
1045
1800
1820
52°00'N
51°50'N
51°40'N
51°30'N
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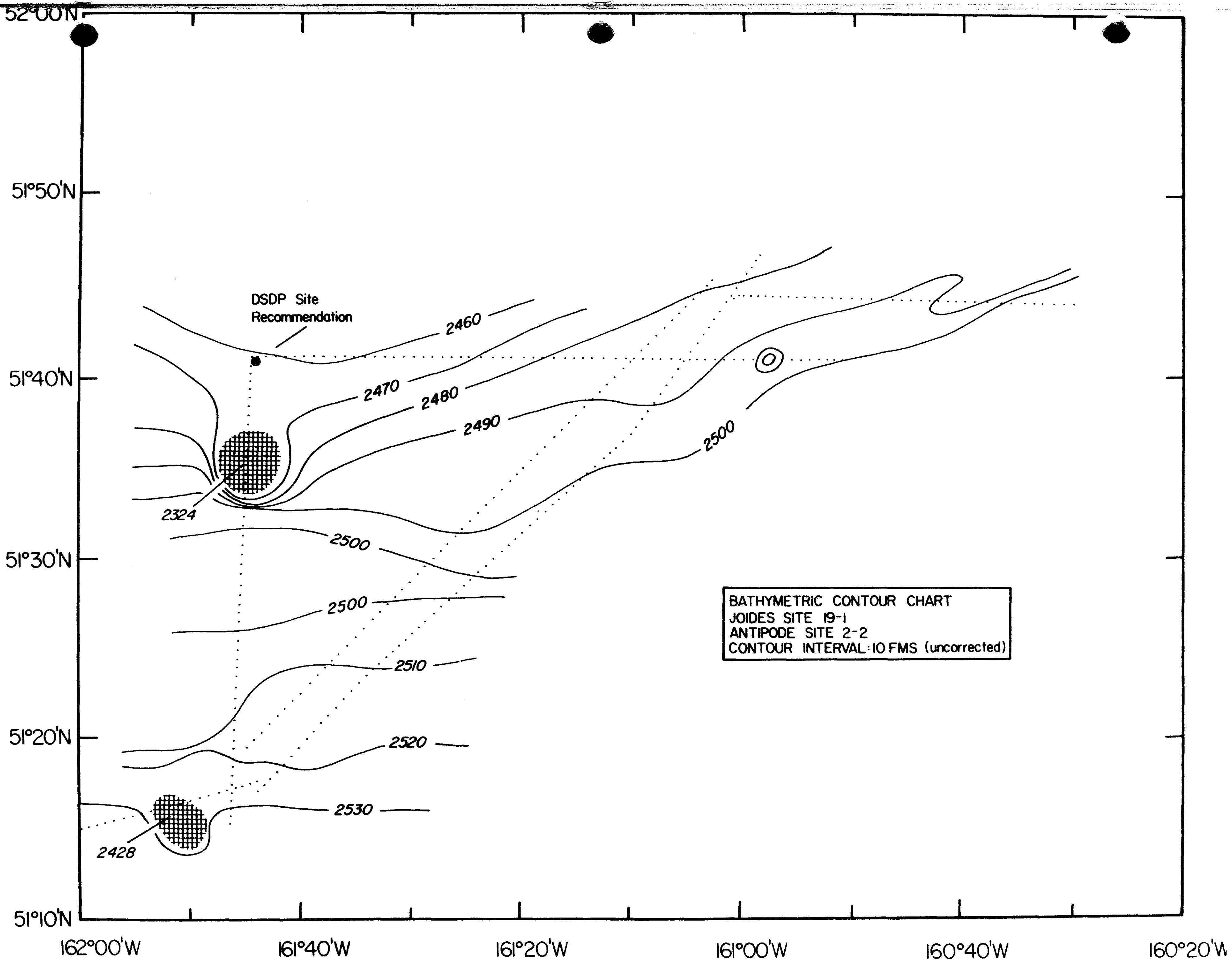
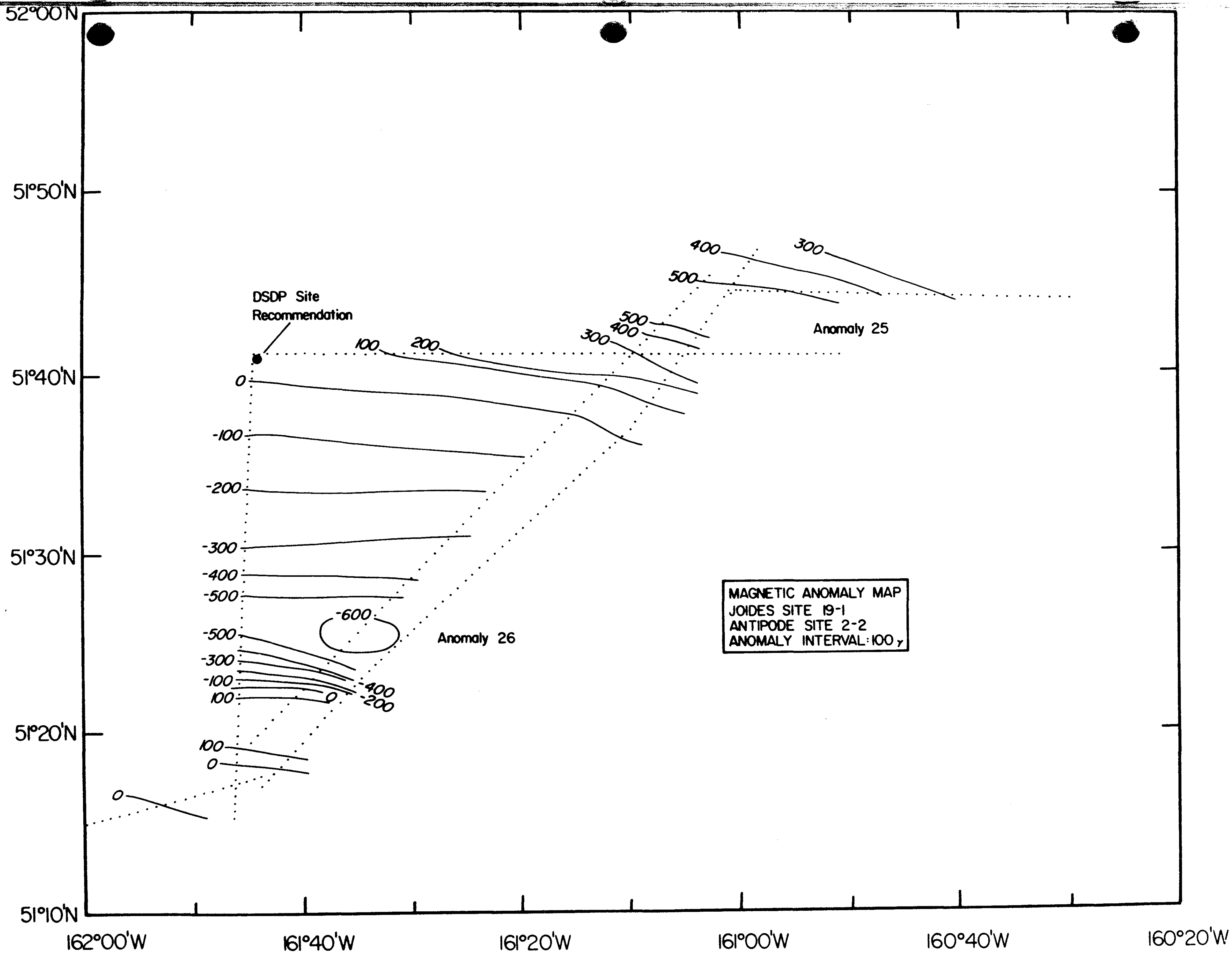
51°10'N
162°00'W
161°40'W
161°20'W
161°00'W
160°40'W
160°20'W


52°00'N
51°50'N
51°40'N
51°30'N
51°20'N
51°10'N
162°00'W
161°40'W
161°20'W
161°00'W
160°40'W
160°20'W
DSDP Site
Recommendation
2460
2470
2480
2490
2500
2500
2500
2510
2520
2530
2324
2428
BATHYMETRIC CONTOUR CHART
JOIDES SITE 19-1
ANTIPODE SITE 2-2
CONTOUR INTERVAL: 10 FMS (uncorrected)


MAGNETIC ANOMALY MAP
JOIDES SITE 19-1
ANTIPODE SITE 2-2
ANOMALY INTERVAL: 100 γ
DSDP Site Recommendation
Anomaly 25
Anomaly 26
52°00'N
51°50'N
51°40'N
51°30'N
51°20'N
51°10'N
162°00'W
161°40'W
161°20'W
161°00'W
160°40'W
160°20'W

Survey 2-3

Site Survey Report

An area south of the Aleutian Trench and at the western extremity of the Aleutian Abyssal Plain (Figures 1, 7) was surveyed by the R/V MELVILLE during 15-18 July 1970 in conjunction with a seismic refraction station. The survey area was bounded by 50°-52°N and 165°-168°W (Figure 11) and crossed the east-west trending magnetic anomalies 27, 28, and 29 (Figure 12).

The depths within the area ranged between 2650 and 2750 fathoms with the exception of a few hills which came up to 2500 fathoms. The bottom is irregular and not obviously lineated. The sediments have thinned from 0.4 - 0.5 seconds at Site 2-2 to an average of 0.30 seconds at Site 2-3 (ANT-27 - 31). The pelagic layer is again about 0.2 seconds thick and in some places the underlying turbidites are nearly absent. Maximum sediment thickness reached 0.5 seconds (ANT-31) at 50°13'N and 166°33'W (2200/17 July 1970 on Figure 11) near the positive maximum of magnetic anomaly number 29 (Figure 12).

A 60-foot piston corer was lowered between 1410/16 July and 1715/16 July at 50°47.4'N, 166°32.9'W. Only 762 cm of sediment were recovered. The cores were cut and sampled every 150 cm. The catcher sample revealed a dark gray silty clay which contained volcanic shards, quartz, glauconite, phosphorite, diatoms and radiolarians. At 150 cm, the base of section 2, there is a dark gray-black hard ash flow, which prompted further investigation. There are seven "ash falls" revealed in this section, varying in thicknesses and degrees of preservation. These volcanic layers can be found at 150 cm, 165 cm, 176 cm, 181 cm, 192 cm, 195 cm, and at 216 cm. At 159 cm is a cobble-sized clay coated nodule which is hard but was not cut. The sediment between the volcanics clearly grade upward from 75% to 25% volcanic fragments in a series of layers to the next volcanic layer, the color changes from a dark gray-black to a light gray. Perhaps the ash layers can be dated to give a more accurate age determination to the turbidites.

A camera was lowered at 50°50.4'N, 166°32.5'W on 1130/18 July to 1436/18 July there was no usable data obtained.

The heat probe was lowered at 50°47'N, 166°32.5'W on 1335/17 to 1710/17 July. A heat flow value of 1.30×10^{-6} cal/cm^2 sec was obtained.

This area was too far from the region of active turbidites during deposition of the Aleutian Plain for a DSDP hole here to be definitive in dating the sedimentation history of the plain. The 0.5 second sediment trough at 50°13'N and 166°33'W, however, is recommended as a possible site for dating magnetic anomaly 29 and might pick up some additional information about the turbidite-pelagic complex. Since the magnetic anomalies in this area have been very well defined with respect to the world wide anomaly sequence (Erickson and Grim, 1969), a date for anomaly 29 here could be correlated easily with numerous other regions.

R. Iuliucci
S. Einsohn
J. Grow

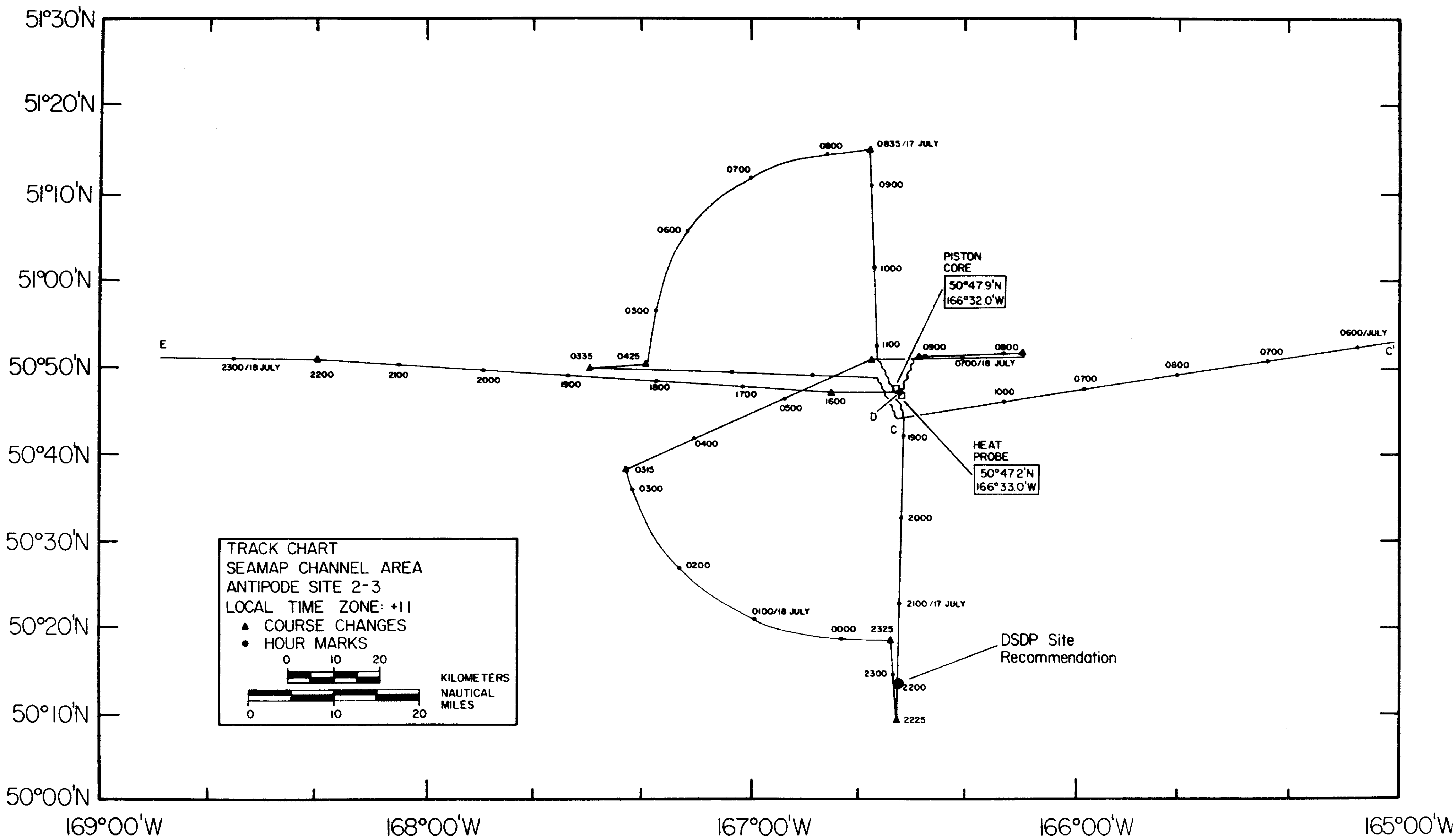
REFERENCES

Erickson, B. H., and P. J. Grim, 1969, Profiles of magnetic anomalies south of the Aleutian Arc: Bull. Geol. Soc. Amer., v. 80, p. 1387-1390.

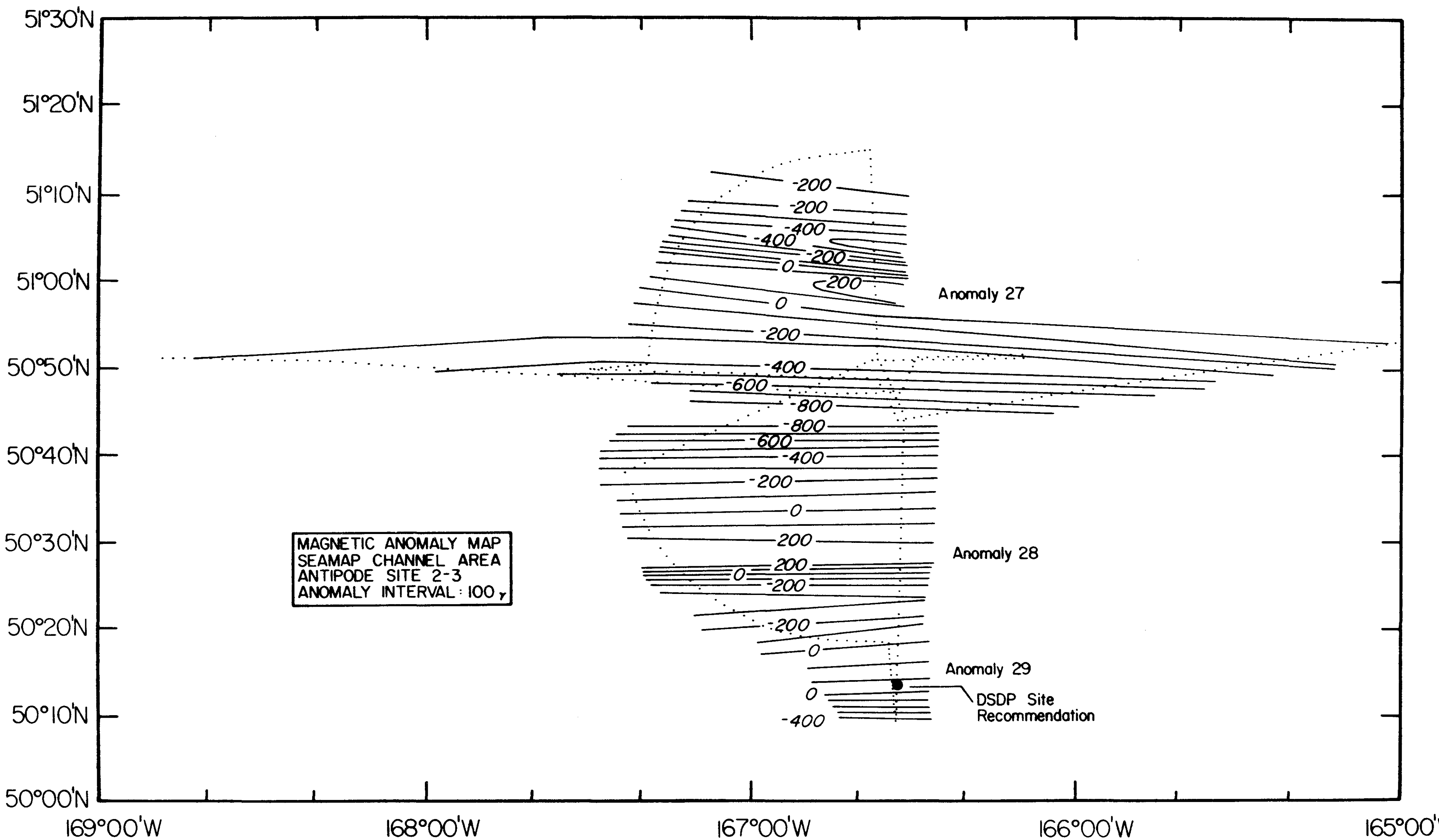
FIGURE CAPTIONS

Figure 11 — Detailed track chart for Site 2-3.

Figure 12 — Detailed magnetic anomaly chart for Site 2-3.



TRACK CHART
SEAMAP CHANNEL AREA
ANTIPODE SITE 2-3
LOCAL TIME ZONE: +11
▲ COURSE CHANGES
● HOUR MARKS
KILOMETERS
NAUTICAL MILES
PISTON CORE
50°47.9'N
166°32.0'W
HEAT PROBE
50°47.2'N
166°33.0'W
DSDP Site Recommendation
0835/17 JULY
2100/17 JULY
0100/18 JULY
2300/18 JULY
0700/18 JULY
0600/JULY
51°30'N
51°20'N
51°10'N
51°00'N
50°50'N
50°40'N
50°30'N
50°20'N
50°10'N
50°00'N
169°00'W
168°00'W
167°00'W
166°00'W
165°00'W


MAGNETIC ANOMALY MAP
SEAMAP CHANNEL AREA
ANTIPODE SITE 2-3
ANOMALY INTERVAL: 100 γ
Anomaly 27
Anomaly 28
Anomaly 29
DSDP Site Recommendation
51°30'N
51°20'N
51°10'N
51°00'N
50°50'N
50°40'N
50°30'N
50°20'N
50°10'N
50°00'N
169°00'W
168°00'W
167°00'W
166°00'W
165°00'W

Survey 2-4

Site Survey Report

Aleutian Terrace (Atka Basin)

Leg No. 19: Kodiak to Tokyo

Geographic Location: Southern Border of Aleutian Terrace

Coordinates: 51°08'N, 174°22'W

Water Depth: 15,240 ft. (corr) or 2480 fathoms (uncorr)

Sediment Penetration: Greater than 2500 ft. (0.8 seconds)

Basement Penetration: 20 - 50 feet

Total Drill String: Approx. 18,000 feet

TYPE OF FEATURE AND NATURE OF SUBBOTTOM

The north wall of the Central Aleutian Trench between 160° - 180°W is interrupted by a 40-60-km-wide terrace of intermediate depth, 2000 - 3000 fathoms (Figure 13). Reflection profiles indicate the Aleutian Terrace contains 1 - 2 km of very gently deformed sediments (Figure 14). The southern border of the terrace between 173° - 177°W is an anticlinal arch. The sediments thin from north to south onto the arch. A distinct acoustical basement is not clear on the best profile available. The purpose of the proposed drilling site on the Aleutian Terrace is to sample the sediments in the crest of the anticlinal arch and hopefully, the underlying basement material.

NATURE OF EXISTING DATA

The Atka Basin section of the Aleutian Terrace was surveyed by the R/V MELVILLE on 20-21 July 1970. Additional survey work was completed on the R/ V. THOMAS WASHINGTON between 27 July and 6 August 1970. Detailed bathymetric, magnetic, and gravity maps of the Aleutian Trench have previously been published by the U. S. Coast and Geodetic Survey. Figure 13 shows the positions of seven airgun profiles over the terrace between 170°-177°W. The profiles shown as lines A-G in Figure 13 are shown in Figure 14 A-G, respectively, with north side to the right. All are 10-second records.

Profile 14D shows the general structure of the Central Aleutian Terrace between 173°-177° W with the greatest clarity. The terrace has a broad anticlinal arch on the south with greater than 0.8 seconds of sediments. A broad synclinal trough lies to its north with sediments thickening to greater than 1.5 seconds. The anticlinal axis seen in profile D can be traced westward along strike to profiles C, B, and A where it forms Hawley Ridge. The arched sediments are still clearly visible on profile C, but profiles A and B also show subbottom layering on the north flank of Hawley Ridge and suggest the continuity and steepening of the anticlinal structure. In profile A, Hawley Ridge is uplifted nearly 700 fathoms higher than in profile D and a fault has developed on the north side. Continuing to the east of profile D to E, the acoustically opaque pinnacle on E is directly along strike with the anticlinal axis through profiles A-D. This suggests that a fault parallel to the axis has developed between D and E and split the anticline with the south limb having been downfaulted to form the next lower small terrace on profile E. The pinnacle is very probably a faulted and disturbed sedimentary block. The fold axes and faults discussed above are shown in Figure 13. Profiles F and G still show the thick sedimentary sequence, but the anticlinal trend appears to have died out. Of interest is the fact that the eastward and westward limits of the anticlinal structure appear to be aligned with the Adak and Amlia fracture zones of the Pacific plate.

PRIMARY SITE RECOMMENDATION

Because profile D shows the least complex structural character within this section of the Aleutian Terrace, and an undisturbed stratigraphic section appears possible, a drilling site near the axis of the anticline (see arrow on Figure 14D) where the sediments are thinnest is recommended.

OBJECTIVES

The primary objective of this site will be to obtain a stratigraphic section on the Aleutian Terrace. The oldest materials penetrated will thereby establish a minimum age for the terrace and the Aleutian Arc. A secondary objective will be to sample the acoustical basement underlying the anticlinal arc. The Central Aleutian trench-arch system with its well-developed terrace is structurally quite similar to most of the Pacific island arcs. Implications concerning the structure and evolution of the Aleutian Terrace which a successful hole in this location may permit should be broadly applicable to other Pacific trench-arch systems.

ALTERNATIVE SITE RECOMMENDATIONS

On profile C there appears to be an acoustically opaque ridge about 0.5 seconds below the bottom under the south flank of the anticlinal arch. The probability of obtaining basement in this area is better, but the chances of missing some of the stratigraphic record also are greater. Deeper reflectors just north of this opaque ridge appear to terminate abruptly against the ridge and the continuity of sediment layers into Atka Basin cannot be directly traced. An alternative site might be considered at the crest of the anticlinal arch on profile C where the deepest observed reflectors intersect the acoustically opaque ridge about 1.0 seconds below the bottom. The primary objective of this site would be to sample the basement ridge, but the about 1.0 km of relatively undisturbed terrace sediments could also be obtained. Critical data for this alternative site are:

Coordinates:	51°12'N, 174°48'W
Water Depth:	12,800 ft. (2090 fathoms, uncorr)
Sediment Penetration:	Approx. 3000 feet
Basement Penetration:	20 - 50 feet
Total Drill String:	Approx. 16,000 feet

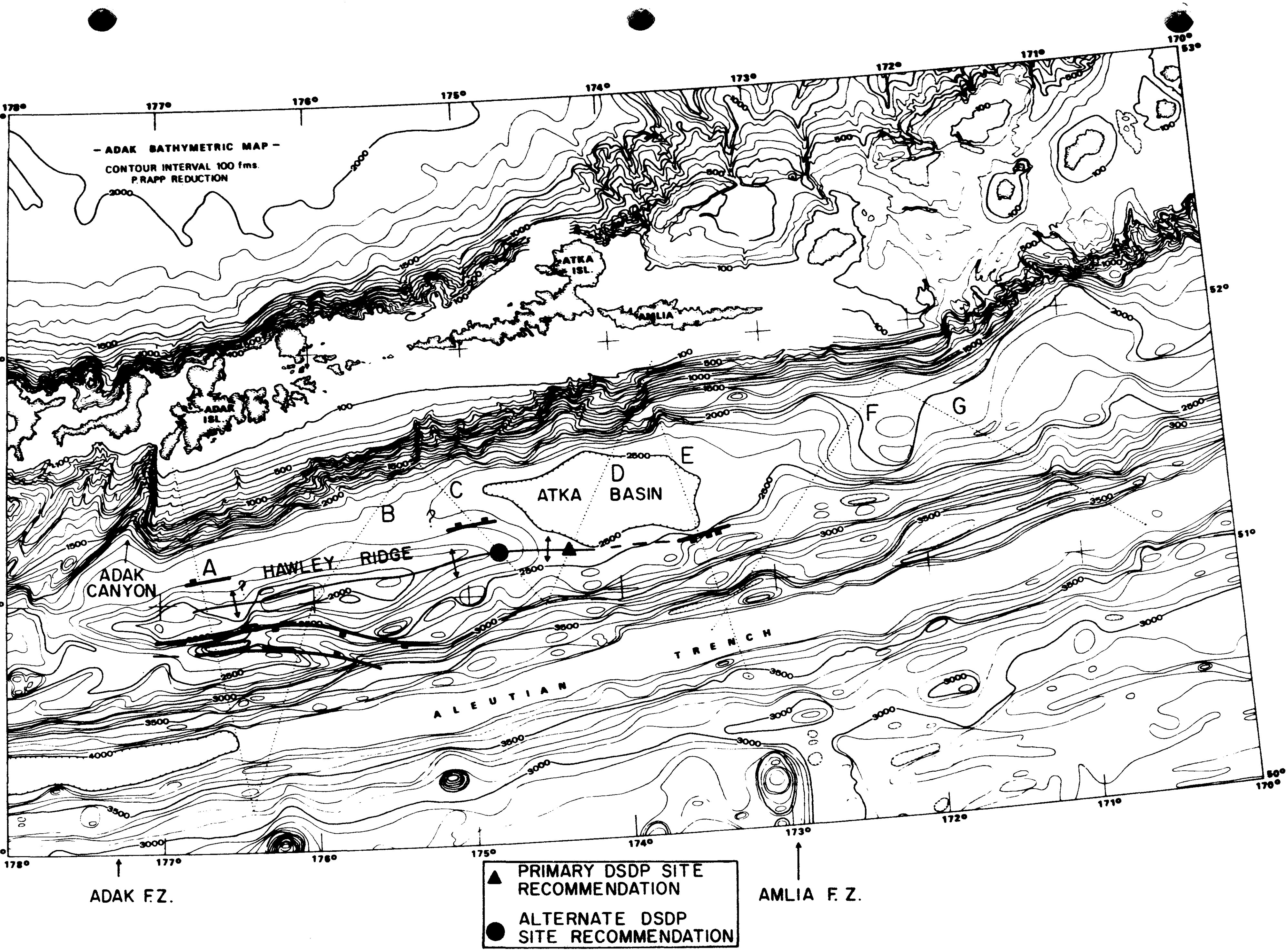
SPECIAL PROBLEMS

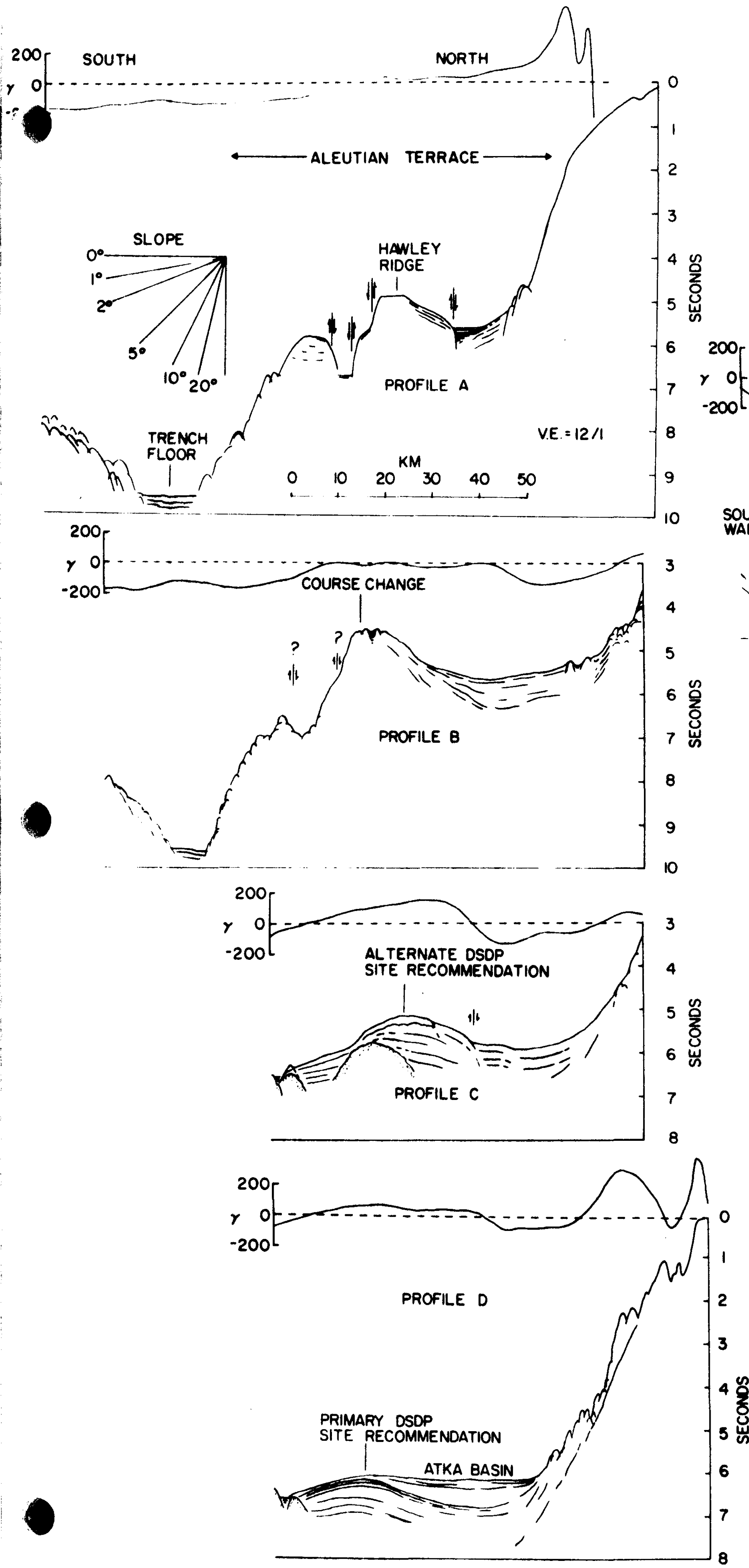
As can be seen from profiles A-E, there is no unequivocable indication of basement. At the primary site on profile D about 0.8 seconds of sediment (~2500 feet) can be observed. Precisely how much deeper the basement is remains problematic. At the alternative site a weakly defined opaque ridge appears to be present about 1.0 seconds below the surface. Therefore, the possibility of not reaching basement remains present even with a 3000-foot hole. In spite of this difficulty, the information provided by even a partial stratigraphic section would be very valuable. If basement materials of either deformed sediments, volcanics, or metamorphics can be sampled, very important insights could be gained. Therefore, although a hole in the order of 3000 feet may be time-consuming and difficult, the potential value of drill data in such a critical trench-arc setting justifies such on expenditure.

J. Grow

FIGURE CAPTIONS

Figure 13	Detailed track chart and bathymetry for Site 2-4. Tracks are dotted lines.
Figure 14	Line drawing of airgun profiles for Site 2-4.


- ADAK BATHYMETRIC MAP -
CONTOUR INTERVAL 100 fms.
P. RAPP REDUCTION
ATKA ISL.
AMLIA
ADAK ISL.
ATKA BASIN
A
B
C
D
E
F
G
HAWLEY RIDGE
ADAK CANYON
ALEUTIAN TRENCH
ADAK F.Z.
AMLIA F.Z.
PRIMARY DSDP SITE RECOMMENDATION
ALTERNATE DSDP SITE RECOMMENDATION



SOUTH
NORTH
ALEUTIAN TERRACE
SLOPE
HAWLEY RIDGE
PROFILE A
TRENCH FLOOR
V.E. = 12/1
KM
SECONDS
COURSE CHANGE
PROFILE B
ALTERNATE DSDP SITE RECOMMENDATION
PROFILE C
PROFILE D
PRIMARY DSDP SITE RECOMMENDATION
ATKA BASIN
EASTWARD EXTENSION OF HAWLEY RIDGE
SOUTH WALL
LINEAR RIDGE
6° SLOPE
TRENCH
PROFILE E
DATA GAP
PROFILE F
CHANNEL ?
PROFILE G

Survey 3-1

Site Survey Report

DSDP Site 19-5A, B, C, E

In the area north of the Aleutian Ridge in the Bering Sea there is an accumulation of over 1.0 seconds of layer sediment below the ocean floor. It has been suggested (Ewing et al., 1965) that the distinct and often continuous reflector "P" found at 1.0 second represents the same era of deposition in the Aleutian Basin, and Bowers Basin. Overlying this basal reflector is a series of continuous reflectors in the basins but on the Bowers Ridge there is an intervening opaque layer and only the top 0.35 seconds is composed of reflectors (ANT-43 & 44). These upper reflectors on the ridge are not continuous with those in the basins and are probably pelagic sediments rather than uplifted turbidites.

The R/V MELVILLE on 0130/26 July - 0500/27 July made two crossings of Bowers Ridge (Figure 15). A dredge was taken on the north facing scarp of the ridge at 54°55.1'N, 176°12.94'E between 400-600 fathoms. The dredge yielded live siliceous sponges, paleocorals with indurated mud, a boulder-size extrusive glass and ash conglomerate measuring two feet across and one foot high, and ice rafted angular cobbles of quartz, basalt, and granite.

STRUCTURE AND TOPOGRAPHY

Due to mechanical difficulties with the reflection profiler the Aleutian Basin immediately to the east of Bowers Ridge and most of the east face of the ridge were not recorded. The Aleutian Plain in this area is at a depth of 2100 fathoms (ANT-41 & 42). The records of Bowers Ridge begin at 1200 fathoms on a steep "basement" scarp which rises to 650 fathoms (ANT 43). Between this scarp and the basement peak of Bowers Ridge is eight miles of over 1.0 seconds of disturbed sediment. This area exhibits easterly tilted reflectors, whose maximum depths are at 0.20 seconds, 0.25 seconds, 0.35 seconds, and 1.25 seconds, which end abruptly against the "basement" material.

To the west of this sediment trough is a 16-mile long basement peak which rises to 325 fathoms (ANT-43). This outcrop has a thin veneer of sediment on the east flank and 0.10 - 0.15 seconds of sediment on the west flank. West of this peak, in a trough at a depth of 1600 fathoms there is an accummulation of 0.50 seconds of sediment. All the sediments in this basin are disturbed, as seen by noncontinuous reflectors, probably due to flow deposition off the basement high.

Further west on the ridge is a small channel preceeding a rise which comes to 1475 fathoms at this crossing. There are 0.75 seconds of sediment draping the rise in which 0.35 seconds of distinct continuous reflectors are present. The sediments below 0.35 seconds are disturbed as indicated by indistinct noncontinuous reflectors throughout the area. There are a number of faults present, one on the peak and three or four on the west flank of the knoll. There are several places on the west flank where there are over 150 fathoms of block relief. This is probably due to both the faulting and macroslumping.

From this knoll Bowers Ridge gently slopes down into Bowers Basin (ANT-44) to a depth of 2100 fathoms. In the basin there is at least 1.25 seconds of sediment with distinct reflectors at 0.10 seconds, 0.30 seconds, 0.50 seconds, 0.60 seconds, 0.75 seconds, and 0.80 seconds at 16 miles out into the basin west of the Ridge.

The south flank of the Ridge has 0.30 seconds of sediment on it which literally apears to have "rolled down" the flank. At the juncture of Bowers Basin and the south facing scarp of Bowers Ridge the basin sediments abut against the "rolled down" material. Below the basin floor there does not appear to be any mixing at the interface of the "rolled" flank material and the stratified basin sediments.

R. Iuliucci
S. Einsohn

A thin shallow layer of sediment overlies unconformably deeper stratified material 0.20 seconds below bottom. "White-outs" below these deeper stratified sediments indicate the presence of peaks of unstratified (volcanic?) material forming the main bulk of the ridge here (ANT-45). This is probably the material that was sampled in dredge haul 40D on the north slope.

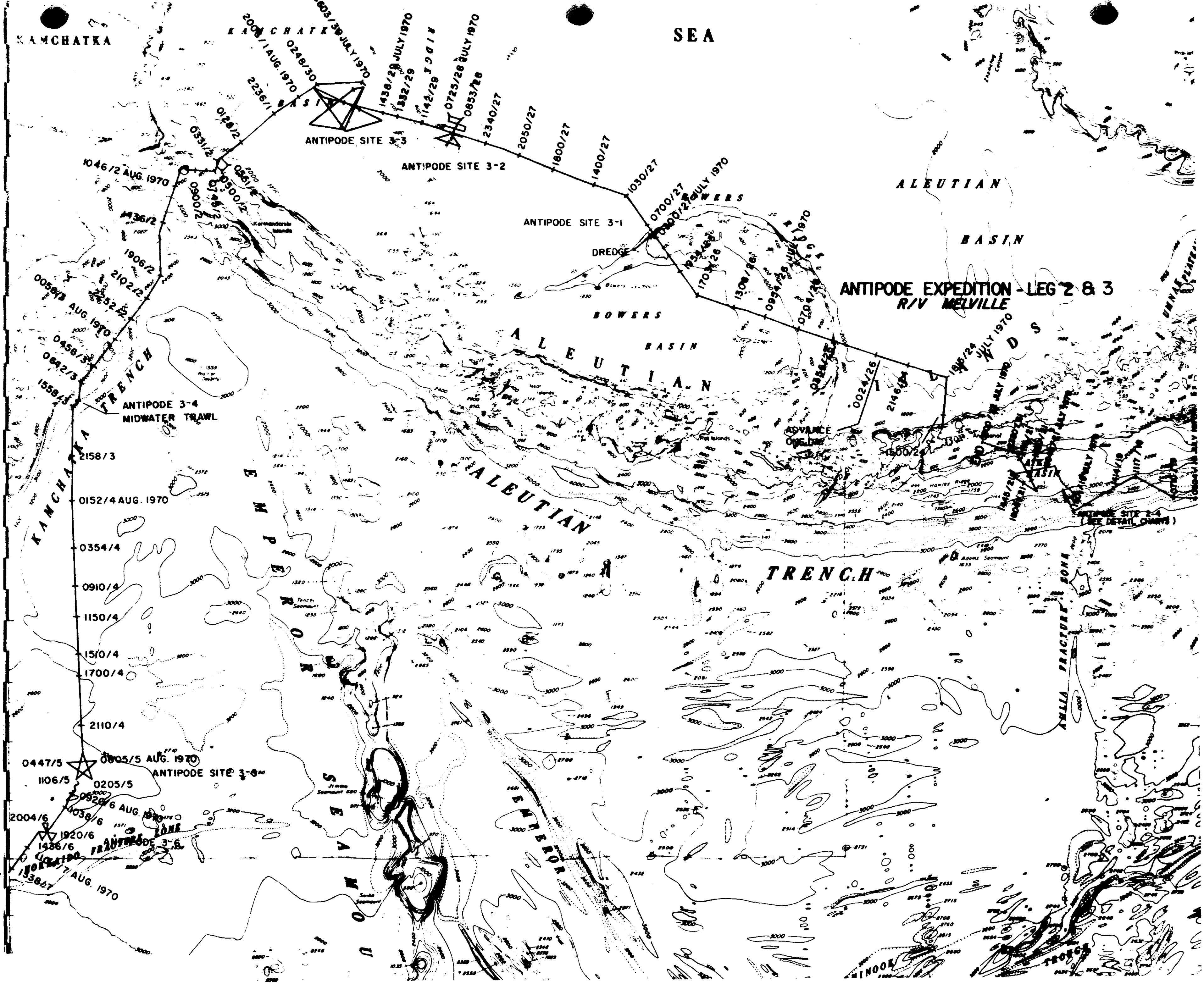
G. G. Shor, Jr.

REFERENCES

Ewing, M., W. J. Ludwig, and J. Ewing, 1965, Oceanic structural history of the Bering Sea: J. Geophys. Res., v. 70, pp. 4593-4600.

FIGURE CAPTIONS

Figure 15 Regional bathymetry chart for Sites 3-1 through 3-5.


ANTIPODE EXPEDITION - LEG 2 & 3
R/V MELVILLE
KAMCHATKA
SEA
ALEUTIAN BASIN
BOWERS BASIN
BOWERS RIDGE
ALEUTIAN ISLANDS
ALEUTIAN TRENCH
KAMCHATKA TRENCH
EMPEROR SEAMOUNTS
ANTIPODE SITE 3-1
ANTIPODE SITE 3-2
ANTIPODE SITE 3-3
ANTIPODE 3-4
MIDWATER TRAWL
ANTIPODE SITE 3-5
ANTIPODE 3-6
ANTIPODE SITE 2-4
(SEE DETAIL CHARTS)
DREDGE
ADVANCE
1046/2 AUG. 1970
0056/3 AUG. 1970
0152/4 AUG. 1970
0805/5 AUG. 1970
0926/6 AUG. 1970
1338/7 AUG. 1970
2158/3
0354/4
0910/4
1150/4
1510/4
1700/4
2110/4
0447/5
1106/5
0205/5
1038/6
2004/6
1920/6
1436/6
1030/27
1400/27
1800/27
2050/27
2340/27
0700/27 JULY 1970
2236/1
0128/2
0331/2
0500/2
1436/2
1906/2
2102/2
0456/3
0642/3
1558/3
0024/26
50°
45°

Survey 3-2

Site Survey Report

DSDP Site 19-7A

The Shirshov Ridge is a major topographic feature in the Bering Sea. It is 250 miles long and 100 miles wide, bounded on the east by the Aleutian Basin, on the west by the Kamchatka Basin and on the north by Cape Olyutorskiy of the USSR. A small area bounded by 56°10'N, 170°50'E and 56°40'N, 171°50'E was surveyed by the R/V MELVILLE from 0000/27 July - 1230/28 July for DSDP hole #19-7A (Figures 15, 16). The major objective of this drill hole is to sample bedrock on the ridge. It has been suggested that bedrock on the ridge is composed of Mesozoic rocks.

From the Aleutian Basin at 2000 fathoms the Shirshov Ridge rises to 850 fathoms (ANT-48). There are two major breaks in the slope of the Ridge, one where the sediment cover on top begins and another where the ascent to the peak begins. (See sections EF and GH, Figure 17.) A steep linear ridge of basement material, seven miles long trending northeast-southwest, rises from the Aleutian Basin on the east side of Shirshov Ridge. West of this on the ridge is a scoured current channel which was traced for 10 miles, extending south of the point where the basement high becomes covered by the sediments of the ridge top.

There is at least 1.0 seconds of sediment on top of the rise with distinct reflecting horizons at 0.20 seconds, 0.35 seconds, and at 1.0 seconds. The deepest strong reflector at 1.0 seconds still appears to be sedimentary. "Basement" (irregular) reflectors were not observed during any of our crossings.

In the Aleutian Basin there are reflecting horizons at 0.30 seconds, 0.50 seconds, and at 1.00 seconds (ANT-47) which end abruptly deflecting upward against the scarp. The reflecting horizons are not continuous from the basin onto the ridge across the scarp; without further data it would be difficult to correlate these horizons.

Dredge haul 41D was taken at 56° 19'N, 171°26'E, near the base of the eastern scarp of the ridge (ANT-50). The depth interval dredged was 1600-1800 fathoms where two reflectors were seen to outcrop 1845/28 July - 2121/28 July. The dredge haul contained a few fragments of coral which contained benthonic foraminifera.

A 40-foot piston corer (42P) was lowered at 56°23.2'N, 171°05'E, just west of the scour channel: 1116 cm of sediment were recovered. The catcher sample contained a green-gray siliceous ooze composed of diatoms and radiolarians. A tentative age of Oligocene - Miocene (?) has been assigned to this core.

Two heat probe lowerings 0255/28 - 0426/28 and 0630/28 - 0804/28 and a camera lowering 0434/28 - 0619/28 were made at the same station as the piston core. No usable data was obtained from any of these lowerings.

R. Iuliucci
S. Einsohn

RECOMMENDED DRILL SITE

It is quite possible that the proposed drill site would prove adequate in reaching basement rock near the pinnacle despite possible difficulty with the small knoll which outcrops just west of the pinnacle. The R/V MELVILLE survey, which made parallel tracks north of the proposed site, suggests that it would be better to avoid drilling on the small knoll and to shift the drilling site north onto the R/V MELVILLE track E-F (Figure 17).

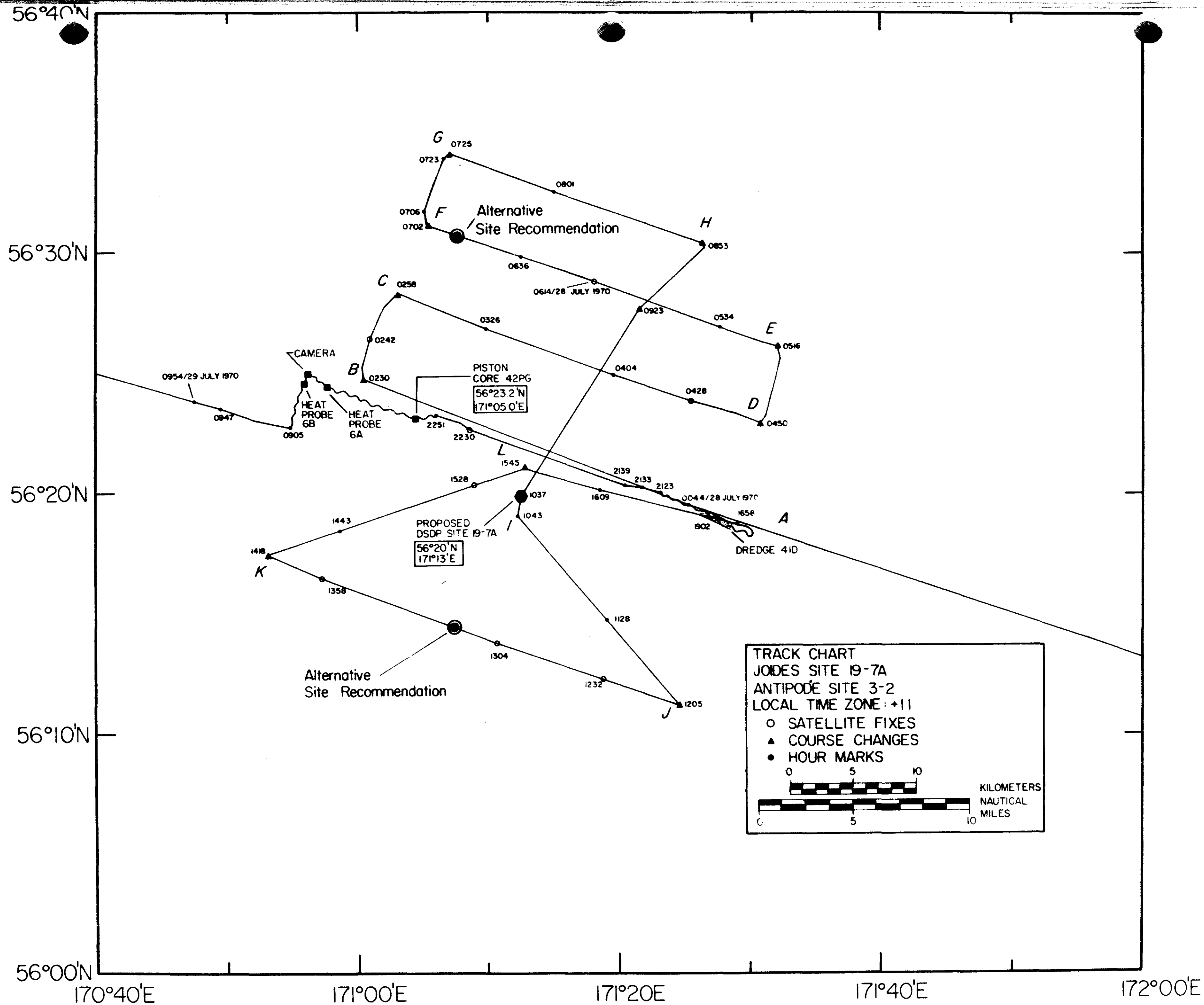
D. Fornari

It is not obvious that the "basement" in the "basement ridge" crossed on lines AB, CD, and EF, is sedimentary or in any way continuous with the horizon at 0.75 to 1.0 seconds on the main part of the ridge. It is more probably igneous, either a buried volcanic feature or an up-faulted slice of deeper basement material. If the

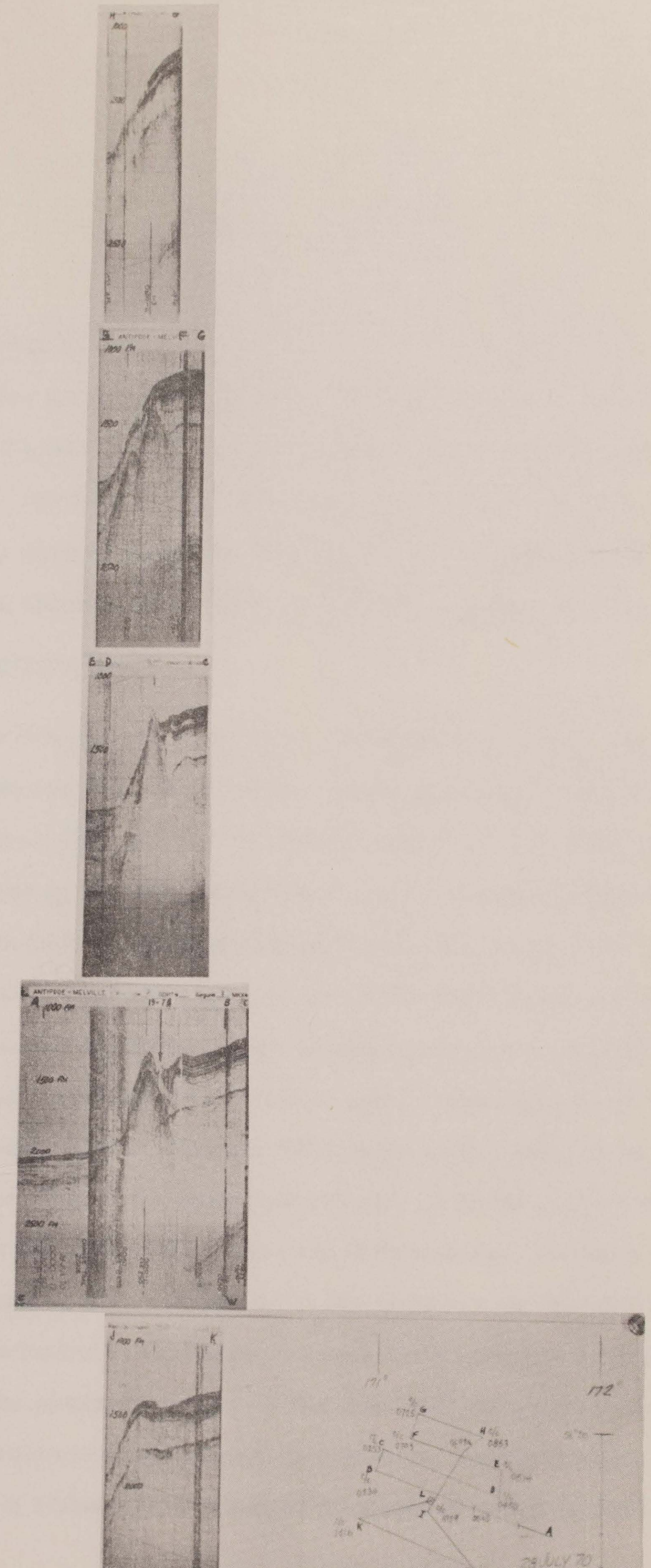
1.0 second reflector is the goal it would be more logical to drill for it where it is clearly sedimentary such as the channel just west of 1300-11 on line JK (Figure 17).

G. G. Shor, Jr.

FIGURE CAPTIONS



TRACK CHART
JOIDES SITE 19-7A
ANTIPODE SITE 3-2
LOCAL TIME ZONE: +11
SATELLITE FIXES
COURSE CHANGES
HOUR MARKS
KILOMETERS
NAUTICAL MILES
Alternative Site Recommendation
Alternative Site Recommendation
PROPOSED DSDP SITE 19-7A
56°20'N 171°13'E
PISTON CORE 42PG
56°23.2'N 171°05.0'E
CAMERA
HEAT PROBE 6B
HEAT PROBE 6A
DREDGE 41D
0954/29 JULY 1970
0614/28 JULY 1970
0044/28 JULY 1970
56°40'N
56°30'N
56°20'N
56°10'N
56°00'N
170°40'E
171°00'E
171°20'E
171°40'E
172°00'E


ANTIPODE - MELVILLE
29 JULY 70

Survey 3-3

Site Survey Report

DSDP Site 19-7B

From 1400/29 July to 2000/1 August 1970 the R/V MELVILLE surveyed the Kamchatka Basin in the area bounded by 56°23' - 57°00'N latitude, 167°30' - 169°00'E longitude (Figures 15, 18) for the Deep Sea Drilling Project proposed drill site 19-7B. The survey included 400 miles of underway profiling, two gravity cores, a piston core, camera lowering, heat probe, and a three-buoy anisotropy seismic station. The seismic station pattern controlled the layout of the survey.

TOPOGRAPHY AND STRUCTURE

The Kamchatka Basin in the area surveyed is flat floored with slightly increasing depth toward the south and few abyssal hills. Depth increases from 2070 to 2100 fathoms with a maximum hill relief of 200 fathoms (ANT-51 - 58). Subsurface structure indicates that at one time the basin was not receiving bottom transported detrital material from the surrounding source areas. The upper 0.6 - 0.7 seconds of subbottom penetration on the profiler record consistently shows numerous reflectors, which are undulating and confused in appearance and untraceable over long distances. The quantity and character of these upper reflectors, their flow around rather than over basement hills, their unconformable relationship to each other and the basement, and the flat floor of the basin, all indicate turbidity current deposition. Since the survey area is located 150 miles east of Kamchatka, 110 miles north of the Kormandorski Islands, and is bordered on the northeast by Shirshov Ridge, all of which contribute sediment to the basin, it is not surprising to find such thick deposition of turbidites. The piston core taken in the area (44P) is a gray-green silty clay with angular quartz fragments, glauconite, phosphorite, and dark heavy minerals. Underlying this zone of reflectors is transparent material which is present whenever basement can be identified. The thickness of the transparent material is directly related to the basement topography, thinning to as little as 0.05 seconds over basement rises and thickening to 0.5 seconds in the troughs. Maximum penetration to basement is 1.50 seconds (1505 on ANT-51) and in many places it appears at 1.25 seconds. Over most of the area basement is deeper and not seen.

RECOMMENDED DRILL SITE

A drilling site in this area should be placed so that the entire sedimentary section including the transparent material can be sampled, and basement can be reached. The R/V MELVILLE survey indicates that the most promising place for such an attempt, where basement is within 0.75 seconds of the bottom, is around Buoy A of the ANTIPODE Seismic Station 3-3, at 56°59'N, 167°38'E. Crossings of the area were made from 0200-0330/30 July (ANT-52), 0200-0700/31 July (ANT-54 - 55), and 1700-2000/1 August (ANT-57).

DATA SUMMARY

The following measurements were made in the survey area:

	Location	Results
Heat probe # 7	56°25.8'N 168°22.9'E	2.64 x 10^{-6} cal/cm^2 sec
Gravity Core 43G	56°28.87'N 168°16.5 'E	Hemipelagic
Piston Core 44P	56°32'N 168°09'E	916 cm recovery hemipelagic
Gravity Core 44PG	as above	88 cm recovery
Camera		no usable results
XBT # 9 to 17	various	
Anisotropy 3-3	56°33'N - 57°00'N 167°30'E - 169°00'E	

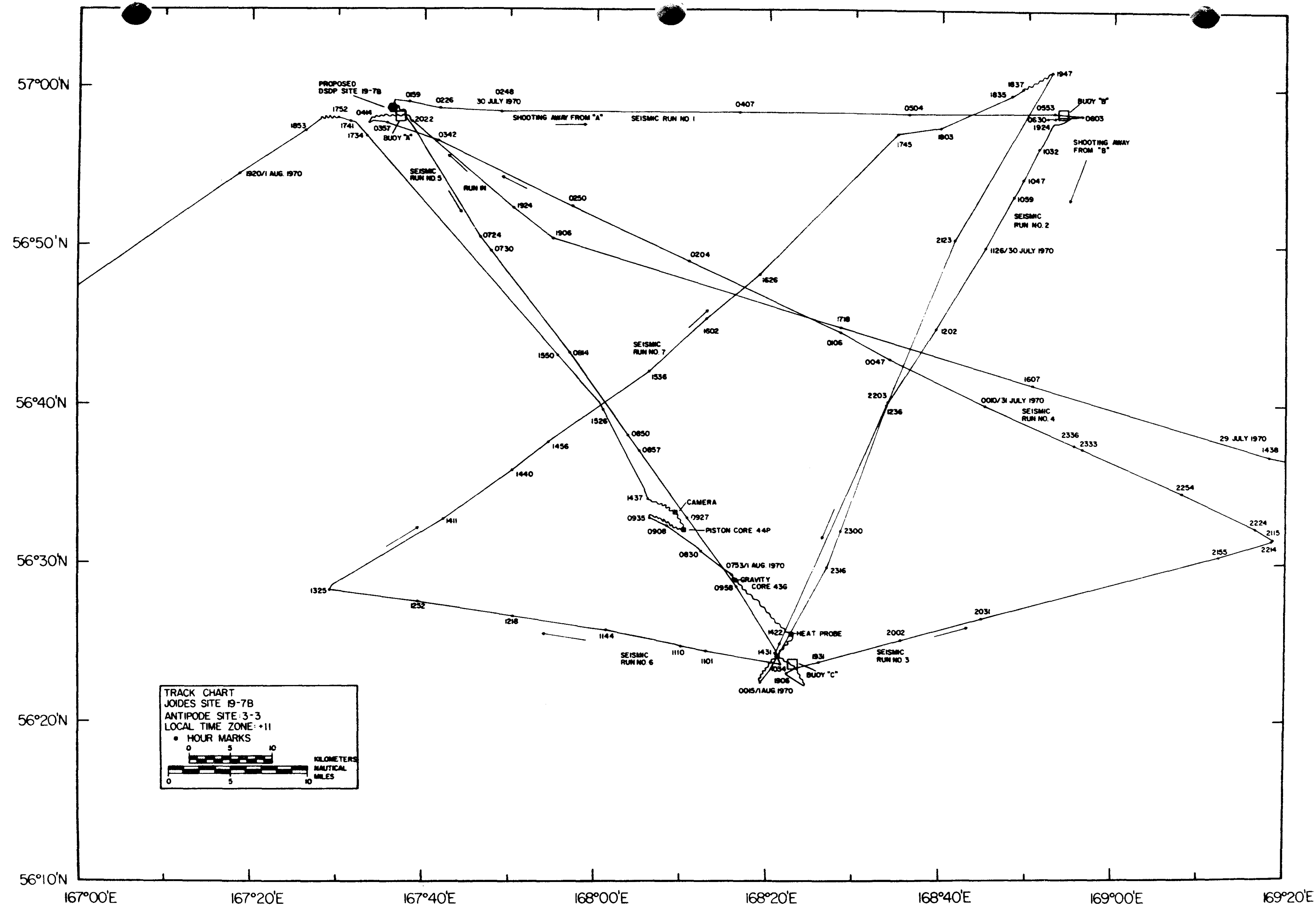
Continuous underway profiles of 3.5 kHz, airgun, and magnetics were made with 100% coverage.

S. Einsohn
R. Iuliucci

FIGURE CAPTIONS

Figure 18 Detailed track chart for Site 3-3.

Survey 3-4 was not a drilling site survey.


TRACK CHART
JOIDES SITE 19-7B
ANTIPODE SITE: 3-3
LOCAL TIME ZONE: +11
HOUR MARKS
KILOMETERS
NAUTICAL MILES
PROPOSED DSDP SITE 19-7B
BUOY "A"
BUOY "B"
BUOY "C"
SHOOTING AWAY FROM "A"
SHOOTING AWAY FROM "B"
SEISMIC RUN NO. 1
SEISMIC RUN NO. 2
SEISMIC RUN NO. 3
SEISMIC RUN NO. 4
SEISMIC RUN NO. 5
SEISMIC RUN NO. 6
SEISMIC RUN NO. 7
RUN IN
CAMERA
PISTON CORE 44P
GRAVITY CORE 43G
HEAT PROBE
30 JULY 1970
29 JULY 1970
1920/1 AUG. 1970
1126/30 JULY 1970
0010/31 JULY 1970
0753/1 AUG. 1970
0015/1 AUG. 1970
57°00'N
56°50'N
56°40'N
56°30'N
56°20'N
56°10'N
167°00'E
167°20'E
167°40'E
168°00'E
168°20'E
168°40'E
169°00'E
169°20'E

Survey 3-5 and 3-6

Site Survey Report

DSDP Site 19-8B and 19-8A

In an area west of the Emperor Seamounts and east of the Kuril Trench is a relatively smooth area, which would be called an abyssal plain if the term were not already preempted. This area is of interest due to:

1) The lack of magnetic anomalies

2) The presence of 0.40 seconds of nonreflecting sediment

3) The closeness of the basement to the surface.

The R/V MELVILLE surveyed ANTIPODE 3-5 from 2306/4 August to 0615/6 August 1970 in an area bounded by 46°35'N, 161°30'E to 47°00'N, 162°25'E. Air photographs ANT-65 to ANT-67 show the survey area, while Figure 19 shows the track chart. A five pointed star survey pattern was used to establish the magnetics of the area and any possible lineations in the bottom or subbottom topography. Neither the 3.5 kHz depth recorder nor the airgun reflection profiler showed any reflectors in the 0.40 seconds of sediments when traveling at 11 knots. However, just as the ship was positioned at slow speed for a piston core the depth recorder revealed a hard reflector at five fathoms.

A 60-foot (18 m) piston core (45P) was lowered at 46°39.8'N, 161°59.1'E (1548/5, ANT-67) where the depth is 3020 fathoms. Only 975 cm of sediment was recovered with a pullout tension of 23,000 pounds (10,500 kg) (cable and payload weighed 12,000 pounds (5500 kg)). The catcher sample was composed of a light gray dehydrated sandy clay. Upon analysis the sample contained only leached fragments of calcium carbonate. The overlying material, still within the catcher, contained ashlayers interbedded with this light gray sandy clay. At 824 cm depth, the base of section 2, volcanic glass shards and ash are intermixed with diatoms and radiolarians. At 673 cm, the base of section 3, diatoms and radiolarians are abundant with very few fragments of glass and ash. At 522 cm, the base of section 4, the sample is wet and is entirely composed of diatoms and radiolarians, in a gray-green silty clay.

There was no usable data obtained from the camera lowering at this station.

A heat probe was lowered at the same station yielding a value of 1.20×10^{-6} cal/cm^2 sec.

The magnetic data indicates a 150 gamma range of variation with no discernable orientation.

The subbottom topography is irregular with a maximum relief of 100 fathoms, revealing a shallow basement. In shallow basement troughs distinct reflectors can be seen which indicate sedimentary turbiditic deposition immediately overlying basement. As noted above the overlying sediments have no visible internal reflectors. A possible bottom current channel can be observed at 0500/4 August (ANT-63).

There appears to be some layering in the buried sedimentary reflector at the north point of the star pattern, at 46°55'N, 162°00'E, 2345/4 (ANT-64). This point appears to have been a channel that was filled and buried under the 0.40 second of transparent sediment. This might be an interesting drilling site.

Upon leaving site survey 3-5 the R/V MELVILLE proceeded south to survey a site 17 miles due east of the proposed site survey 3-6. The site survey for 3-6 was shortened and shifted eastward due to time considerations.

Site survey 3-6 was surveyed from 1030/6 August to 2121/6 August (ANT-68 & ANT-69) in a "clover leaf" pattern which was thought would best show the "confused" magnetic pattern which supposedly existed in the area. The short survey revealed the same type of topography and structure as at site survey 3-5 with 0.25 seconds to 0.40 seconds of transparent sediment conformably overlying an irregular basement with 50 to 100 fathoms of relief. However, it failed to reveal the expected magnetic variation. The only change in magnetics noted is the normal regional variation in magnetic field.

A 40-foot (12 m) piston core (46P) was lowered at 45°29.6'N, 160°56.9'E at a depth of 3020 fathoms (5655 m) on 0000/7 August to 0415/7 August (ANT-69).

The catcher sample was a gray-green sandy clay composed of calcium carbonate fragments, some diatoms and radiolarians, phosphorite, glauconite, quartz, and volcanic glass and ash.

No usable data was obtained from the camera lowering.

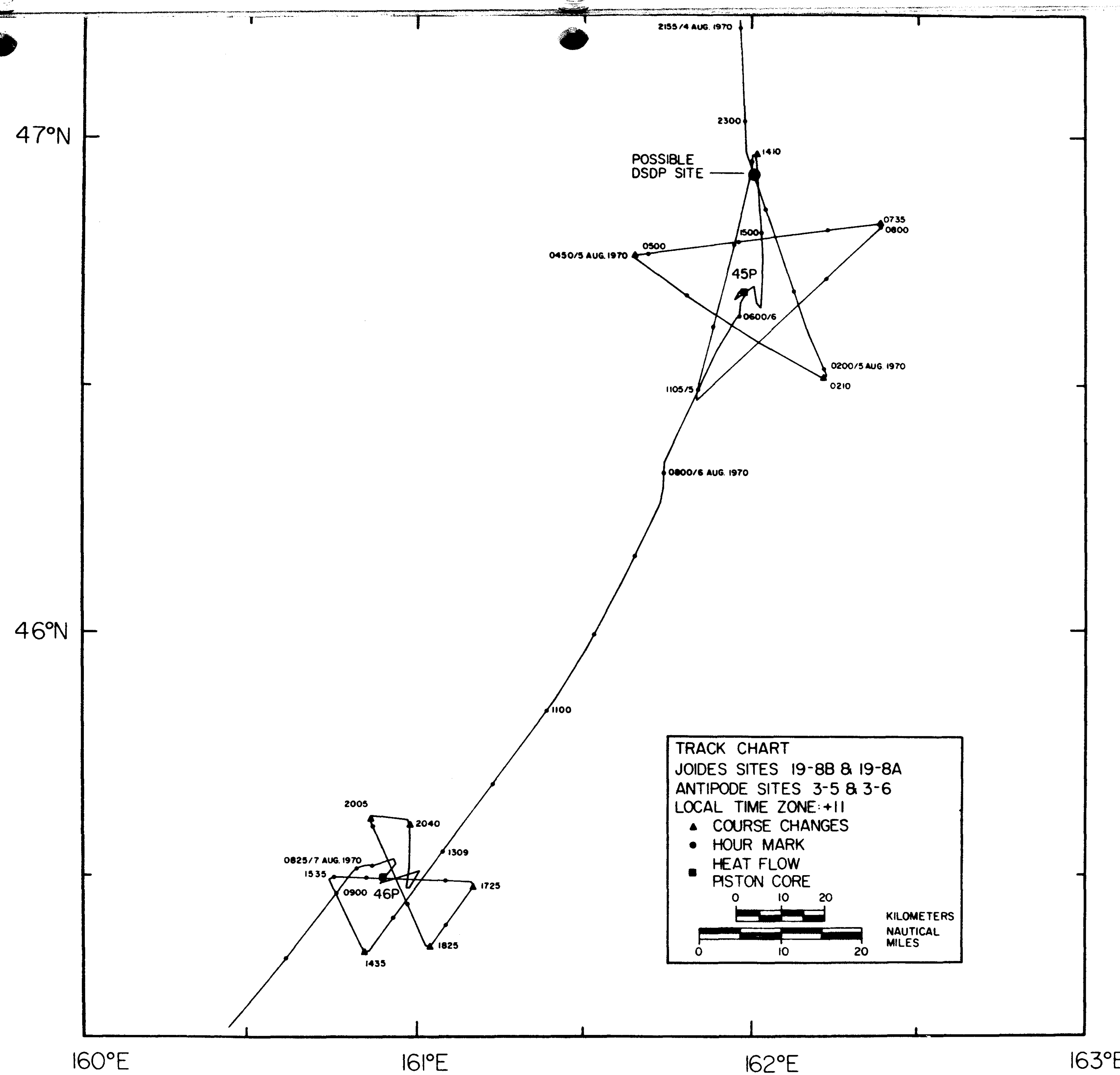
The heat probe lowering yielded a value of 1.15×10^{-6} cal/cm^2 sec.

Beginning approximately 50 miles (92 km) south of site survey 3-6 the R/V MELVILLE crossed an area of previously uncharted fracture zones. This area extended for 130 miles (240 km) and has associated with it anomalous magnetic values, and may be an interesting area for a drill site. (Refer to ANTIPODE 3-7 report and profiler records from 1330/7 August to 0230/8 August 1970.)

S. Einsohn
R. Iuliucci

FIGURE CAPTIONS

Figure 19 Detailed track chart for Sites 3-5 and 3-6.


TRACK CHART
JOIDES SITES 19-8B & 19-8A
ANTIPODE SITES 3-5 & 3-6
LOCAL TIME ZONE +11
COURSE CHANGES
HOUR MARK
HEAT FLOW
PISTON CORE
KILOMETERS
NAUTICAL MILES
0
10
20
POSSIBLE DSDP SITE
45P
46P
2155/4 AUG. 1970
2300
1410
0735
0800
1500
0500
0450/5 AUG. 1970
0600/6
0200/5 AUG. 1970
0210
1105/5
0800/6 AUG. 1970
1100
2005
2040
1309
0825/7 AUG. 1970
1535
0900
1725
1825
1435
47°N
46°N
160°E
161°E
162°E
163°E

Survey 3-7

Site Survey Report

DSDP Site 19-9

ANTIPODE Site Survey 3-7 was located in an area 12° east of the northern part of Honshu and about 3° south of the Hokkaido Rise, and to the north and west of the Shatsky Rise. The seismic survey area is bounded on the northeast by 40°05'N, 155°00'E and on the southwest by 38°30'N, 153°00'E. Figure 20 shows a track chart of site survey 3-7 and Figure 21 shows the lineated magnetic anomaly. In addition to a seismic station and the usual bathymetry, magnetics, and airgun profile along the ship's track, a 40-foot (12 m) piston core was taken as well as a successful camera lowering. Heat flow, although aborted at the site of the camera lowering, was taken in the area some 50 miles (90 km) to the north. Airgun 3.5 kHz and 12 kHz echo-sounder records were taken to detail the area.

THE COURSE

R/V MELVILLE arrived at site survey 3-7 from site survey 3-6 along course 218° to set seismic station Buoy A at latitude 39°30.6'N, longitude 154°20.0'E. Upon setting Buoy A, the ship's course was again set at 218° for approximately 50 miles (95 km) to set Buoy B at latitude 38°46.5'N, longitude 153°35.1'E, then running in a triangular course away from and back to Buoy B. Turning north along course 038° R/V MELVILLE came to course 312° about 30 miles (55 km) from Buoy A to start a 30-mile (55 km) radius three-quarter circle anisotropy shot run. Exit of the area was made upon course 130° at 1616/11 August. (Time/date group refers to notations on the airgun record).

The bottom and subbottom topography along course 218° prior to site survey 3-7 may be divided geologically and geomorphically into several distinct regions: Prefracture zone, fracture, which consists of a prefracture incline, first fracture (herein referred to as the Hokkaido Fracture), midfracture zone, second fracture, and postfracture decline, seamount (herein referred to as the Melville Seamount). Similarities between presite and site 3-7 topography facilitate their description as one unit. All areas, if blanketed by sediment at all, showed at least two good near-surface reflecting horizons upon airgun and 3.5 kHz records. Reflection from the sea floor was very weak on the airgun records. "Near-surface reflector" will refer to between 0.005 second and 0.04 second (two-way time) of sediment. "Intermediate reflectors" will be taken to mean those reflecting horizons found between near-surface reflectors and the generally strong subbottom reflecting horizons.

PREFRACTURE ZONE

This description starts at photograph ANT-69, immediately beyond site survey 3-6. The "prefracture zone" area is characterized by a nearly uniform thickness of sediment with an average thickness of 0.30 second (two-way time) and a maximum thickness of 0.41 second. In addition to the two good near-surface reflectors, there is a third uncontinuous medium-strength near-surface reflector, no intermediate reflectors, and strong basal reflectors which seem to be of sedimentary origin. There are no exposed basement outcrops in the area, but a basement high appears at 1938/6. Bottom topography is relatively flat, all relief within the 3020-3100 fathom (5525-5675 m) range, with maximum surface relief of 1 : 32 and maximum subbottom relief of about 1 : 19.

FRACTURE (0915/7 - 0515/8 August; ANT-69 to ANT-71)

Because of the difficulty in describing the entire fracture as one feature, arbitrary divisions were made with respect to the continuity of the singly discussed units:

Prefracture incline: The emergence of a third near-surface reflector in addition to the overall steady incline of the area (1 : 194 over a distance of 120 km) begins along the ship's track at about 0915/7 August (ANT-69). Weak intermediate uncontinuous reflectors may be observed within the 0.36 second thickness of sediment above the strong subbottom sedimentary (?) reflectors that fill basement depressions to a maximum thickness of 0.34 seconds. The continuity of the intermediate reflectors may be traced for a maximum of 10.8 miles (20 km). This region has a conspicuously larger sediment thickness than the previously described area with maximum sediment thickness greater than 0.54 seconds. Two basement highs appear in the area: 0947/7 below 0.27 second sediment, and at 1330/7 below 0.19 second sediment cover. A possible fault structure may be in evidence at 1150/7 as indicated by the surface topography and basement offset.

Hokkaido Fracture. The Hokkaido Fracture Zone (1526/7; ANT-70) at latitude 44°34.6'N, longitude 159°50.3'E, is the most striking feature of the entire run between stations in this portion of the northwestern Pacific. The north scarp, draped with a maximum of 0.12 second sediment, drops in steps a total of 900 m in 24 km, while the south scarp, without a sediment cover, rises 1050 m in less than 7.5 km (four miles) with no steps. (Note possible basement outcrop on north wall at 3120 fathoms.)

The trough between the two scarps, 14.4 km (7.75 miles) wide at a depth of 5980 m (3270 fathoms), is filled with 0.54 seconds of sediment with possible additional sedimentary structure below that level. Several strong near-surface reflectors are evident as well as strong but uncontinuous subbottom reflectors. Also, within the sediment fill and near the middle of the fracture area, is an unidentified highly reflective structure worth noting.

Midfracture zone (1630/7 - 0000/8 August; ANT-70 to ANT-71): The area between fractures is characterized by a thick veneer of sediment filling basement lows. The draped sediment tends to follow basement topography but being pinched at the extremities (0.15 seconds), and thickening toward the center of the zone masking the sharp basement relief. Maximum sediment thickness appears to be 0.69 seconds with a computed (30-minute interval) average thickness of 0.41 seconds.

Three continuous near-surface reflectors are evident on airgun and 3.5 kHz records for this region and a possible basement outcrop occurs at 1831/7. There are several uncontinuous intermediate reflectors, the longest being traceable for 41 km (22 miles), and strong, but uncontinuous subbottom reflectors.

Second fracture: The second outstanding fracture along course 218° is less spectacular than the first, but similar. The northern basement high, draped fully with sediment, drops with one step from a high of 2760 fathoms (5050 m) to about 2830 fathoms (5175 m) with a further drop to the 3050 fathom (5580 m) depth, the top of the fracture zone sediment fill which is 0.67 seconds thick. However, even with three good near-surface reflectors, there appears to be weak, uncontinuous intermediate reflectors and a maximum of 0.12 seconds subbottom reflectors.

The sediment-capped basement exposure provides the south scarp with a steep rise (computed 0.09/1) as opposed to the northerly scarp of the fracture with a 0.029/1 gradient.

Postfracture slope (0135/8 - 0600/8; ANT-71 to ANT-72): The postfracture zone slope begins as a 0.35 seconds sediment covered basement high buttressing the southerly basement exposure of the adjacent fracture. Sediment thickness increases to a maximum of 0.41 seconds in 9.3 miles (17.2 km), but then steadily decreases with slope to 0.15 seconds near a basement (?) exposure (seamount) in 48 miles (89 km), generally following subbottom topography.

The sediment blanket has weak near-surface reflectors, very scattered uncontinuous intermediate reflectors with no basement exposures through an average 0.16 seconds uncontinuous, generally weak subbottom sedimentary (?) reflecting horizons.

Melville Seamount (0600/8 - 0700/8; ANT-72): This previously uncharted seamount, impressive in its rise of 1440 m (787 fathoms in about 7 km (3.7 miles)), has no evidence of a sedimentary cap, and is very symmetric about a vertical axis. Base width, measured from the top of the northern sediment lap, is about 7.1 miles (13 km).

A sediment lap, 0.30 seconds thick, on the southerly side, falling off from an initial depth of 2830 fathoms (5175 m) to a maximum depth of 3015 fathoms (5515 m) in 7.7 miles (14.3 km), buries strong, "humped" subbottom reflectors adjacent to the buried base of the seamount. An interesting feature is the "notch" near the summit on the southward side at about 2250 fathom (4415 m) depth on an otherwise uncluttered flank.

Presite and Site Survey 3-7 (to 1616/11 August; ANT-73 to ANT-79): Site 3-7 as surveyed by R/V MELVILLE, is located in the area bounded on the northeast by latitude 40°05'N, longitude 155°00'E and on the southwest by 38°30'N, 153°00'E. Preliminary inspection shows a relatively flat topography with at least one traceable N-S ridge. General relief is 50 fathoms (90 m) or less; maximum relief is seen to be 110 fathoms (200 m) at 0745/11 August (ANT-78).

The sediment drape follows the topography of the subbottom with an average thickness of 0.42 seconds and a maximum of 0.55 seconds. Within the overlying sediment, uncontinuous intermediate reflectors are numerous with a weak but continuous intermediate reflector at about 0.23 seconds. Strength of the intermediate reflectors seems to increase toward the south and east corner of the area. Strong subbottom reflectors mask nearly all of the basement topography. Basement highs seem to be more numerous at site survey 3-7 than along the ship's track into the area. A basement exposure occurs at 0115/11 August (ANT-78) as a small hill with sediment lapping upon its flanks, and has a relief of about 50 fathoms (90 m). The basement high at 2000/11 (ANT-79), which may be traced across at least four points in the ship's track, may be part of a north-trending ridge system with a possible fault on its eastern flank. A basement high occurs at 0400/11 (ANT-78) under 0.18 second sediment and could be an extension of the 2000/11 high. Also, an isolated basement high may be seen at 1833/9 (ANT-76) under 0.20 second sediment. A piston core (47P) retrieved 40 feet (12 m) of sediment at latitude 38°42.1'N, longitude 153°24.3'E, at 0245/10 August. The catcher sample revealed a gray-green diatomaceous-radiolarian ooze with few fragments of glauconite and heavy dark minerals. A tentative age of Upper Miocene has been assigned to this core.

A heat flow value for the area has been given as 1.16×10^{-6} cal/cm^2 sec.

Bottom photographs obtained from the camera lowering at latitude 38°46.9'N, longitude 153°44.4'E show scattered manganese nodules (?) nearly buried by fine sediment reworked by benthic organisms. The depth at the camera location was 3056 fathoms (5589 m).

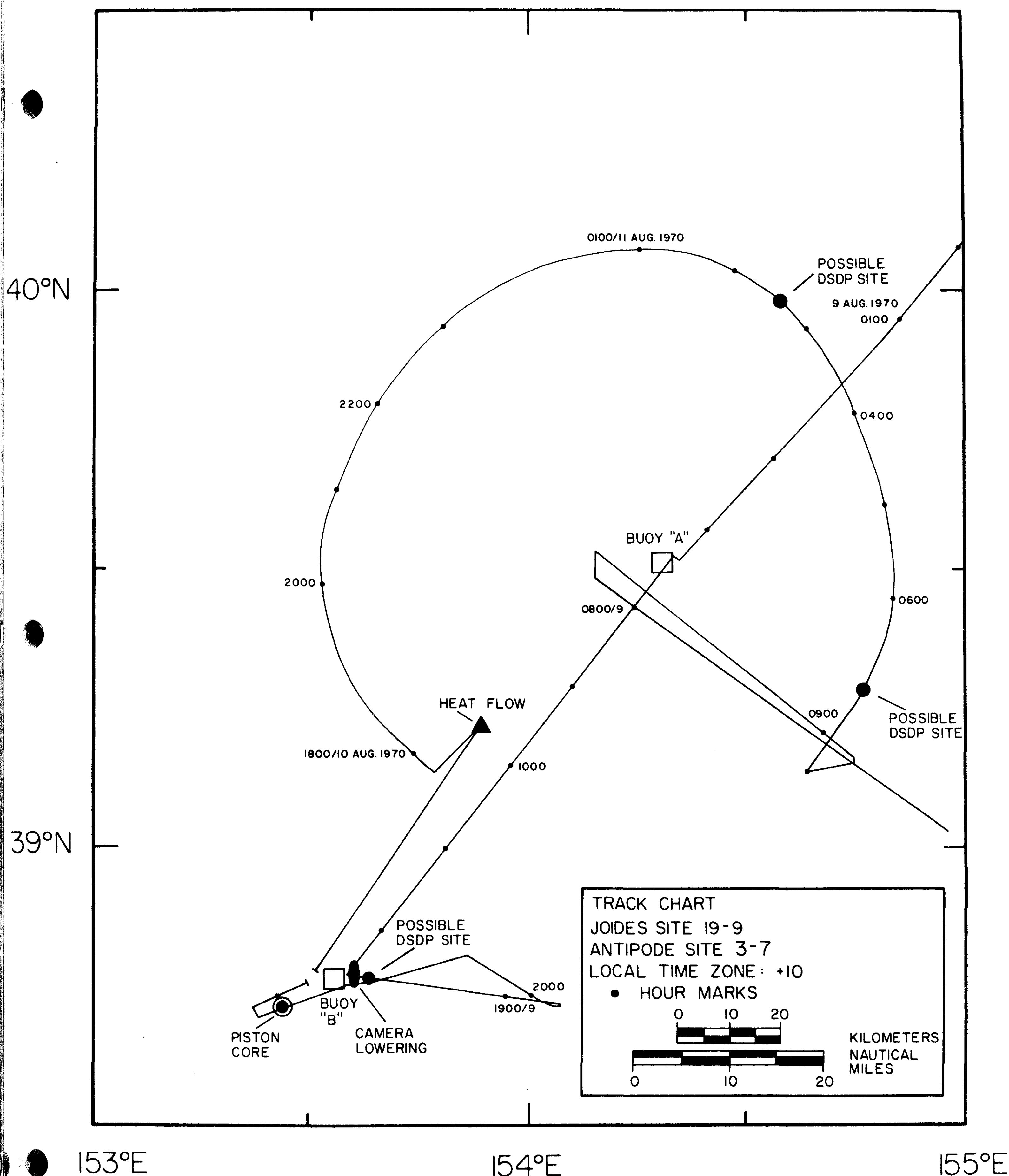
R. Kimes

There are three possible sites in the Site Survey 3-7 area, refer to Figure 20. The sediment covering is fairly uniform throughout the whole area but there appeared to be slightly more sediment on sites at (0235/11) 39°59'N, 154°35'E, at (0700/11) 39°17'N, 154°46'E, and finally in the vicinity of the camera lowering at 38°45'N, 153°37'E.

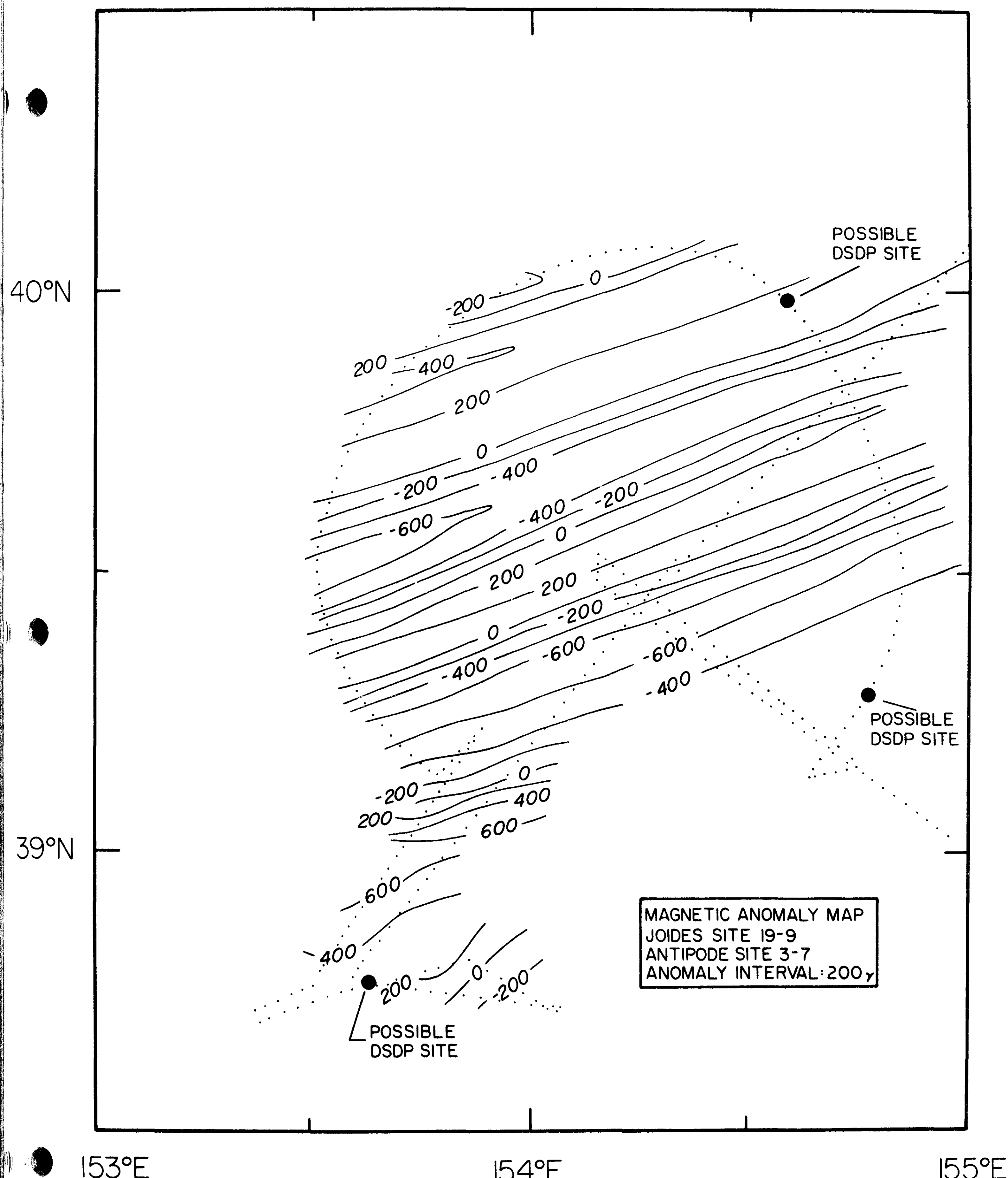
L. Lawver

FIGURE CAPTIONS

Figure 20	Detailed track chart for Site 3-7.
Figure 21	Magnetic anomaly map for Site 3-7.



40°N
39°N
153°E
154°E
155°E
0100/11 AUG. 1970
POSSIBLE
DSDP SITE
9 AUG. 1970
0100
2200
0400
BUOY "A"
2000
0800/9
0600
HEAT FLOW
0900
POSSIBLE
DSDP SITE
1800/10 AUG. 1970
1000
POSSIBLE
DSDP SITE
2000
BUOY
"B"
1900/9
PISTON
CORE
CAMERA
LOWERING
TRACK CHART
JOIDES SITE 19-9
ANTIPODE SITE 3-7
LOCAL TIME ZONE: +10
HOUR MARKS
0 10 20
KILOMETERS
NAUTICAL
MILES
0 10 20



POSSIBLE
DSDP SITE
40°N
39°N
153°E
154°E
155°E
POSSIBLE
DSDP SITE
POSSIBLE
DSDP SITE
MAGNETIC ANOMALY MAP
JOIDES SITE 19-9
ANTIPODE SITE 3-7
ANOMALY INTERVAL: 200γ

Survey 3-8

The Shatsky Rise

INTRODUCTION

The Shatsky Rise is a northeast-trending elongated elevation in the northwest Pacific, about the size and shape of Great Britain, near 33°N, 159°E (Figure 22). It rises 2000-3000 m above the surrounding ocean floor, and covers an area of about 5×10^5 km^2 (Figure 22). The rise actually consists of two topographically distinct structures; a major, linear feature, here called south Shatsky, and a smaller, more nearly circular feature (north Shatsky) northwest of the main rise and separated from it by a deep channel 10 miles wide and 1000 fathoms deep.

Recent investigations on and near the Rise (Ewing et al., 1966; Ewing et al., 1968; Den et al., 1969) have shown that the region has several characteristics which are markedly different from those of the midoceanic ridge system. The Shatsky Rise is not seismically active, has low heat flow, is covered by a considerably thicker accumulation of sediment (~ 1km), than the surrounding ocean basin (~0.3 km), and has no distinct magnetic lineations parallel to the axis of the Rise (Hayes and Pitman, 1969).

In May and June of 1969, the R/V ARGO of the Scripps Institution of Oceanography, on SCAN Expedition spent six days surveying the southern portion of the Shatsky Rise to locate drilling sites for the D/V GLOMAR CHALLENGER. Continuous bathymetric, magnetic, and seismic reflection profiles were obtained along more than 2000 km of track.

The D/V GLOMAR CHALLENGER attempted 10 cores on the southern portion of the Shatsky Rise in July 1969 (Heezen et al., 1969). Two cores from the southwest flank were reported to have age dates of Neocomian (Lower Cretaceous) or Tithonian (Upper Jurassic), the oldest known material from the ocean basins.

In August, 1970, the R/V MELVILLE of the Scripps Institution of Oceanography on the ANTIPODE Expedition, spent three days surveying north and south Shatsky. No cores were taken during these crossings; however, three dredge hauls were attempted. Continuous bathymetric, magnetic, and seismic reflection profiles were obtained along 1000 km of track.

REFLECTION PROFILES

In the ocean basins surrounding the Shatsky Rise the following sedimentary units have been described by other investigators (Ewing, 1966; Ewing, 1968), and can be identified in our own profiles (Figure 23):

(a) An upper layer of acoustically transparent sediment, generally about 0.10 second in thickness.

(b) An upper opaque layer, whose opacity may be due to pronounced stratification. The upper surface of this layer has been designated Horizon A' by Ewing et al. (1966).

(c) A lower transparent layer, 0.10 - 0.20 second in thickness.

(d) A lower opaque layer, ordinarily the deepest set of reflectors that can be observed by reflection profiling. The upper surface of this layer, designated Horizon B' by Ewing et al., 1966, is characteristically smooth, suggesting that B' may be a sedimentary horizon.

The total thickness of sediment above Horizon B' in the basins surrounding the Rise is 0.30 - 0.40 second, and is relatively uniform. The layers and reflectors appear to have lateral continuity over distances of hundreds to thousands of kilometers in the northwest Pacific (Ewing, 1968).

South Shatsky. Sediments on the Rise itself appear significantly different in character from those in the surrounding basins. The shallowest 0.10 - 0.30 second of sediment is relatively opaque: This surface opaque layer is thickest in the region near the prominent basement peak at the crest (Figure 24 - profile I). Toward the south (profiles II and III) this layer progressively thins and the reflectors become weaker.

Beneath the surface opaque layer is a relatively transparent layer, containing a few weak internal reflectors that are disconformable with the overlying layers (Figure 25). On profile I this upper transparent layer is bounded on the west by a prominent basement peak, and on the east by a broad basement arch. Near the southern end of the Rise (profile III) the upper transparent layer is thickest and most extensive. On all profiles the internal reflectors within this layer show many pinchouts and separations (Figure 25). Individual reflectors can be traced for only a few kilometers to tens of kilometers along individual profiles, and correlation of reflectors between profiles is difficult.

A set of relatively opaque reflectors underlies the upper transparent layer, at about 0.5 second beneath the sea floor at the crest of the Rise (Figure 25). The top of these reflectors has been labeled "Horizon A' " by Ewing et al., 1966, implying a correlation with Horizon A' in the surrounding basins. Even though the layer at 0.5 second is locally quite prominent, it cannot be traced extensively over the crest of the Rise nor connected to the adjoining basin. On profile I this layer appears strongest. However, it terminates against a basement peak on the west, while to the east it becomes indistinguishable in a series of reflectors near a basement arch. To the west of the peak is a sediment-capped basement mound which has been cut by a deep V-shaped channel. The internal reflectors in this section are weak and discontinuous, and cannot be satisfactorily correlated with the reflectors east of the peak. Farther south (profile II) a set of continuous reflectors is present at 0.5 second, and appears to outcrop at the sea floor on both the eastern and western flanks of the Rise where the upper transparent layer pinches out. On profile III, the only possible equivalent to this opaque layer is a single reflector at a depth of about 0.4 second in a section which is otherwise transparent down to about 0.6 second. On all profiles the thickness of the transparent sediment, and hence the total sediment thickness, increases sharply at depths shallower than about 3600 m (approximately 5.0 seconds). The greatest accumulation of sediment on the crest of the Rise occurs immediately east of the basement peak, where sediment thickness approaches 1 km at 2400 m (Figure 26; isopach map).

The profiles (profiles IV and V) northeast of the basement peak (profile I), do not appear to have any resemblance to the suggested horizons or stratification found south of the peak. The bottom of the surface opaques represent a distinct unconformity, below which the reflectors are discontinuous. Where a reflector is traceable it cannot be correlated with the profile south of it, and is usually conformable with the basement topography. Profile V appears to have a distinct horizon which cuts across the reflectors but it is not clear what the correlation is with the previously mentioned reflectors.

The relief of the "basement" reflector is highly variable, forming sharp peaks, low hummocky mounds, and broad, relatively smooth surfaces. The basement has greatest relief (up to 1.4 seconds) on profile I, and is present at or near the sea floor at several locations. In other regions on the Rise the basement reflector is remarkably smooth, and has been interpreted to be a set of highly stratified sediments (Ewing, 1966).

North and South Shatsky are separated by a channel 10 miles wide and about 1000 fathoms deep which appears to have received only pelagic sediment in the recent past (Figure 27). In the channel there are distinct reflectors from 0.07 second to 0.40 second. On the south side of the channel is a steep pinnacle.

North Shatsky. The reflection profiles of the northern portion of the Shatsky Rise (Figure 27) indicate a very different geologic and structural history for this northern knoll than for South Shatsky. On North Shatsky the reflectors are more irregular than on South Shatsky in terms of the number and variety of unconformities and the distinctness with which major unconformities occur. The number and locations of faults, the absence of peaks on the ridge, the paleochannel and a "bench" or linear feature which brings the first major reflector to the surface are a departure from the relief and structure found on South Shatsky.

There are a number of unconformities across the crest of North Shatsky. One at 0.05 second can only be clearly seen across the crest. A deeper, major and obvious reflector below changes depth rapidly across the crest exhibiting an unconformable relationship with the sediment above and below it. This strongly reflecting unconformity across the crest of North Shatsky behaves differently from the first reflecting horizon across South Shatsky (Ewing et al., 1966; Horizon A). In places on North Shatsky this reflector is vaguely conformable to the basement, though more often than not it does not follow anything obvious. It outcrops, or nearly does, in a number of places at 2160 fathoms (uncorrected) in what may be either a small linear feature or a bench encircling the Rise. Going off of the crest in a southerly direction this reflector comes within 0.024 second of the surface at 2160 fathoms. There was not enough time to either adequately survey or take cores to determine the age of the reflector or its topographic expression.

There are at least two more reflectors below this unconformity which vary greatly in character and depth making them difficult to define or describe. They seem to selectively follow basement topography, are noncontinuous, difficult to follow across intervening subbottom peaks and have been greatly affected by the tectonic movement on the Rise.

CORES AND DREDGES

In 1966, Lower Cretaceous (Albian) sediments were recovered from the southwest flank of the Rise by the R/V VEMA, indicating that the sediments on the Rise may be among the oldest sediments in the Pacific basin (Ewing et al., 1966).

In 1969, three piston cores were taken on the R/V ARGO in the areas on the Rise where deep reflectors appeared to outcrop at the sea floor. The two cores from the east flank failed to penetrate into sediments older than the Neogene. The third core, taken on the southwest flank near the site of the Albian core, penetrated 159 cm of Quaternary and Upper Tertiary sediment and bottomed in weathered basalt.

In June and July, 1969, the D/V GLOMAR CHALLENGER drilled 10 holes on the southern portion of Shatsky Rise (Figure 28; Table 1) (Heezen et al., 1969). Drilling sites were chosen on the basis of the R/V ARGO reflection profiles and the locations of the R/V ARGO basalt core and the R/V VEMA Albian core. The drilling results aided in interpreting the structure and history of the Rise as well as providing new information on the biostratigraphy of the northwest Pacific area.

At Hole 47 (Figure 29), the first drill site on the Rise, core 47.2 was taken on the crest of the Rise. Pleistocene to Maestrichtian (latest Cretaceous) chalk oozes were recovered. There is a distinct unconformity in the section in the Upper Miocene which here overlies the Middle Eocene (Table 2).

Hole 48, taken west of hole 47 on the crest of the Rise (Figure 29), contained Upper Miocene sediment overlying Maestrichtian (latest Cretaceous) cherty chalks. This was the first occurrence of the Middle Maestrichtian in the northwest Pacific.

Both of these holes, 47 and 48, are of major importance biostratigraphically to the northwest Pacific. The planktonic faunas will provide a new paleontologic standard for northwest Pacific sediments.

Hole 49 was drilled on the western flank of the Rise (Figure 30). A nanno-chalk ooze overlain by Pleistocene deposits was recovered. The chalk ooze contains coccoliths that are either Neocomian (Lower Cretaceous) or the Tithonian (Upper Jurassic). However, neither distinct Neocomian nor distinct Jurrasic fossils are present.

At Hole 50, core 50.0, taken on the southwest flank of the Rise, was a watery, white nannoplankton chalk ooze that was stored in buckets. It contained a mixed assemblage of Tertiary and Cretaceous (Campanian, Cenomania-Albian) foraminifera, planktonic lowermost Cretaceous (or uppermost Jurassic) benthonic forams and ostracods, and coccoliths which are either Neocomian (Lower Cretaceous) or Upper Jurassic. Pebbles of hematitic jasper and amygdaloidal basalt were found at the bottom of the core.

Core 50.1 contained a distinctly Pleistocene section (core 1) and a reworked assemblage of Plio-Pleistocene, Eocene, and the Lower Cretaceous or Upper Jurassic nannofossils, a Pleistocene assemblage (core 2) and the catcher (core 4) contained fossils of Mesozoic age, probably Cretaceous. The basement was not sampled at any time on the Rise.

Drilling has not been done on North Shatsky. However, considering the differences in behavior of the major reflectors, it is possible that the stratigraphy of this northern knoll is quite different from the southern portion of the Rise. A drilling site has been recommended for this knoll.

The pinnacle in the channel between North and South Shatsky, latitude 35°11'N, longitude 158°57.8'E, was dredged in August 1970. The dredge yielded a poor haul of only a few ash fragments. Since technical difficulties were encountered at the time it is probable that this was not a representative sample of the rock types present.

The basement peak on South Shatsky, latitude 32°43'N, longitude 158°15.8'E, was dredged from the R/V MELVILLE on 14 August 1970 (profile I and VI). Approximately 300 pounds of rocks were recovered at that time. The haul was composed of manganese-encrusted chalk; no fossils could be identified.

INTERPRETATION OF PROFILES

The opaque reflectors appear to be closely associated with nearby basement highs; these areas also have the thickest sedimentary sections. Near the prominent basement peak on the crest (profile I) is a thick accumulation of sediment containing numerous opaque reflectors. To the south (profileII and III), away from the peak, the section becomes increasingly transparent, the opaque reflectors become weak and discontinuous, and the total sediment thickness decreases. This association between strong reflectors and nearby topographic highs indicates that the opaque reflectors may consist largely of material derived from these highs. Alternatively, the opaque reflectors may contain lenses of chert, as has been demonstrated by deep drilling in other regions. However, the disturbed sediments found northeast of the peak (profiles IV and V) do not appear to be related to erosion off of the peak.

The transparent sediment on the Rise shows a marked increase in thickness at depths shallower than about 3600 m (approximately 5.0 seconds). Elsewhere in the north Pacific dissolution of calcium carbonate has been found to increase significantly below about 3700 m (Peterson, 1966; Berger, 1967). Although the depth of water over the Shatsky Rise during sediment deposition is unknown, and although dissolution levels may have varied during the past, the transparent sediment is pelagic carbonate, which must have been deposited above a level of rapid calcite dissolution, and has remained undissolved like similar deposits on guyots of the Mid-Pacific Mountains (Karig, Peterson, and Shor, 1970).

Faulting and erosion have been influential in modifying the sediment distribution pattern on the Rise. Major faults often occur in pairs, forming grabens (crest of Rise, profile III, IV, and V). On the east flank (profile II) the basement reflector is vertically offset at least 0.3 second by faulting, exposing deep layers at the sea floor. Some of the faults are relatively recent, since they cut the uppermost sediment layers. Step faulting which appears to trend ENE occurs on all profiles of the eastern flank of the Rise.

In other areas on the Rise the sea floor and subbottom reflectors are cut by deep depressions which are not accompanied by basement offsets, apparently erosional channels caused by local bottom currents. These depressions are commonly seen at the base of the exposed basement highs (profile III); others appear to cut through several hundreds of meters of sediment in regions where the sea floor is otherwise relatively smooth (profile I, Figure 26). The channels seen on the profiles do not show any in-fill of sediment. This evidence for faulting and erosion indicates that much sediment redeposition may have occurred as a result of tectonic and erosional processes on the Rise.

In the ocean basins surrounding the rise the basement is relatively smooth with little topographic expression. In contrast the basement on the rise exhibits extreme relief. On the rise reflectors drape over basement mounds but tend to pond between areas of subbottom peaks. This suggests that the basement relief on the rise is the result of subbottom erosion on the original basement surface prior to sedimentation. The lack of relief in the surrounding ocean basins implies that the acoustic basement may not be true basement but may be a later basalt flow. This would account for the lack of continuity in the basal horizon between the ocean basin and the rise.

SUMMARY

Based on the drilling results, the reflector at 0.06 second (Ewing et al., 1966; horizon α) proved to be an Upper Miocene unconformity. Bottom currents were probably the erosive force in the Upper Tertiary responsible for this hiatus. The sediment above this hiatus is a carbonate ooze containing a high latitude biota with some tropical species. The underlying section represents continuous deposition of carbonate oozes in the Middle Eocene, the Paleocene on down to the Maestrichtian (latest Cretaceous). Foraminifera and coccoliths are well preserved in the section as well as Inoceramus prisms in the Cretaceous. However, silicous fossils are absent. The chert in the chalk beds proved to be lenses rather than the postulated continuous beds.

The mesozoic sediments recovered from hole 49 are probably in place; however, there is no stratigraphic control on the data. Since these cores were taken on the flank it is not possible to determine which reflecting horizon on the crest yielded the material (Figure 30).

The water-saturated mixture as well as the unusual pebbles found in the core catcher from hole 50.0 are probably due to slope wash from subcrops further upslope. There is little evidence to suggest that the pebbles were in situ ("basal conglomerate") (Heezen et al., 1969, p. 199) when cored. The reworked sediments found in core 50.1 are probably also the result of slope wash since Pleistocene sediments lie directly above and below this layer.

The stratigraphy on the Rise below the cored middle Maestrichtian is still unknown (Table 1). At no time was the basement cored on the rise nor was there sufficient data control to assume that near-basement sediments were recovered.

CONCLUSIONS

The data clearly indicate that the bulk of sediment on the rise is pelagic carbonates. From the few cores taken on the rise by the D/V GLOMAR CHALLENGER it seems that a large portion of the sedimentary section is composed of Cretaceous cherty chalks. Inoceramus prisms have been found on the rise in Lower Cretaceous sediment (Albian), and they have also been found in deep water sediments of the same age exposed on land in the northern hemisphere. Therefore, a shallow water environment or source for these sediments is not necessary.

A reasonable reconstruction of plate movements suggests that the Shatsky Rise would have been equatorial 100 m.y. ago, during Cretaceous times, at its present subbottom depth. In time it moved northwestward traveling through the highly productive equatorial biotic zone during the Cretaceous into the less productive north latitude biotic zone during the Tertiary. This would yield the great thickness of Cretaceous sediment and a relatively thin veneer of Tertiary, Quaternary, and Recent sediments found on the crest of the rise. Faulting on the rise may be the result of local adjustments on the rise to gross tectonic movement. Taking into account the movement of the Rise from equatorial to midlatitude neither downwarping nor upwarping of this segment of oceanic crust is necessary to explain (1) the great quantity of sediment on the rise (3) the faunas within the sediment, or (3) the undulating basement topography.

S. Einsohn
D. Johnson
G. G. Shor, Jr.

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TABLE 1. Descriptions of cores and dredges on the Shatsky Rise.

-- Description of ARGO piston cores, June 1969

Core No.	Location	Water Depth (m)	Length of Core (cm)	Age of Core
22-P	32°20.4'N 159°14.9'E	3509	959	Pliocene
23-P	32°18.8'N 159°13.1'E	3471	1134	Quaternary
24-P	31°54.3'N 157°08.2'E	3582	159	Upper Miocene Basalt

--Description of CHALLENGER Drilling cores, July 1969

Site	Location	Water Depth (m)	No. of Cores	Length of Core (m)	Age of Core
47	Crest of Shatsky Plateau 32°26.9'N, 157°42.7'E	2689	3	129	Maestrichtian Cherty Chalk
48	Crest of Shatsky Plateau 32°24.5'N, 158°01.3'E	2619	3	49-72	Maestrichtian Cherty Chalk
49	West flank of Shatsky 32°24.1'N, 156°36.0'E	4282	2	18-20	Neocomian or Tithonian Cherty Chalk
50	West flank of Shatsky 32°24.2'N, 156°34.3'E	4487	2	45	Neocomian or Tithonian Cherty Chalk

--Description of MELVILLE Dredge hauls, August 1970

Dredge No.	Location	Description
48-D	35°11.0'N, 158"57.8'E pinnacle in channel	Volcanic ash (pumice) and manganese blocks
50-D	32°43.0'N, 158°15.8'E pinnacle on South Shatsky	Manganese encrusted chalk deposits nonfossiliferous

TABLE 2. Percentage compositional estimates for cores recovered at Hole 47.2 on site 47 (after DSDP Site Rpt. [illegible], p. 73).

Core No.	Age	Predominant Color	Nanno-fossils	Foraminifera (mainly planktonics)	Siliceous microfossils[a]	Clay minerals	Shell[c] fragments	Volcanic glass
1	Pleistocene	White to light brown	70	5	10	10*	5	0
2	Pleistocene	White to light gray	40	15	15	10*	5-20	10-20
3	Pliocene	White to light gray	55	10	15	5*	5-10	5-10
4	Pliocene	White to gray	60	6	12	5*	12	5
5	Pliocene-Miocene	White to dark gray	60	10	11	5*	11	3
6	Miocene	Yellow-brown to yellow-white	55	7	10	5*	18	5
7	Eocene	Yellow to brown	65	5	5	5	10	0-10
8	Eocene-Paleocene	White to brown	80	13	0	5	2	0
9	Paleocene	Light brown	70-90	5-20	0	5	0	0
10	Paleocene	White to light brown	60-80	10	0-5	5	5-30	0
11	Paleocene-Upper Cretaceous	White	40-80	5-35[b]	0	5	10-20	0
12	Upper Cretaceous	White	70-80	5[b]	0	2	15	0
13	Upper Cretaceous	White	65	10	0	5	10-20	0
14	Upper Cretaceous	White	50	10-25	0	5	30	0

[a]Diatoms, Radiolaria, sponge spicules.

[b]Contains abundant benthonic foraminifers.

[c]Mainly mollusks and foraminifera.

*These cores also contain 2 to 10 per cent quartz and feldspar according to X-ray studies by Rex.

TABLE 3. Location and description of cores and dredges taken on the Shatsky Rise in conjunction with the Deep Sea Drilling Program.

-- Age Determinations of the Cores from the GLOMAR CHALLENGER taken on the Shatsky Rise.

				47	48	49	50
CRETACEOUS	Maestrichtian		UPPER				
	Campanian						
	Santonian						
	Coniacian						
	Turonian						
	Cenomanian						
	Albian		LOWER				
	Aptian						
	Barremian						
	Hauterivian	Neocomian					
	Valanginian						
	Berriasian					?	?
JURASSIC	Tithonian		UPPER				
	Kimmeridigian						
	Oxfordian						

FIGURE CAPTIONS

Figure 22 Bathymetric map of the Shatsky Rise. Contours are based on the 1969 Bathymetric Atlas of the north western Pacific. Black lines indicate the location of reflection profiles shown in Figure 23.

Figure 23 Reflection profile showing the typical sedimentary section in the ocean basins surrounding the Shatsky Rise. The prominent reflectors A' and B' can be traced extensively across the northwest Pacific.

Figure 24A Seismic reflection profiles across the Shatsky Rise. Vertical scale is two-way reflection time in seconds. Profiles I, II, III were taken from the R/V ARGO, SCAN Expedition, 1969.

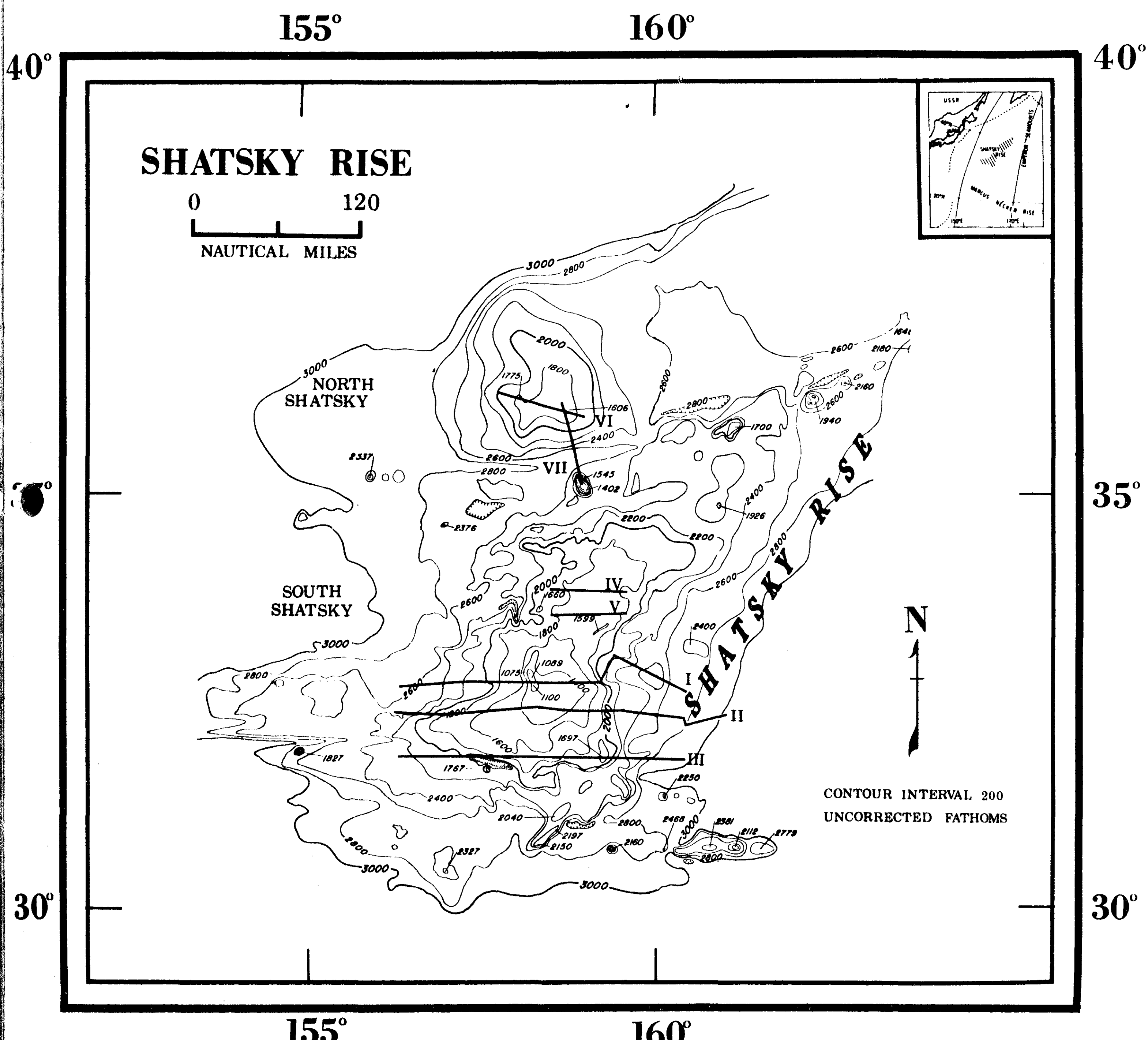
Figure 24B Profiles IV, V were taken from the R/V MELVILLE, ANTIPODE Expedition, 1970.

Figure 25 Reflection profile from the crest of the Shatsky Rise. Most of the reflectors can be traced for a few kilometers up to a few tens of kilometers. Numerous deep opaque layers are associated with the basement highs at the left side of the profile.

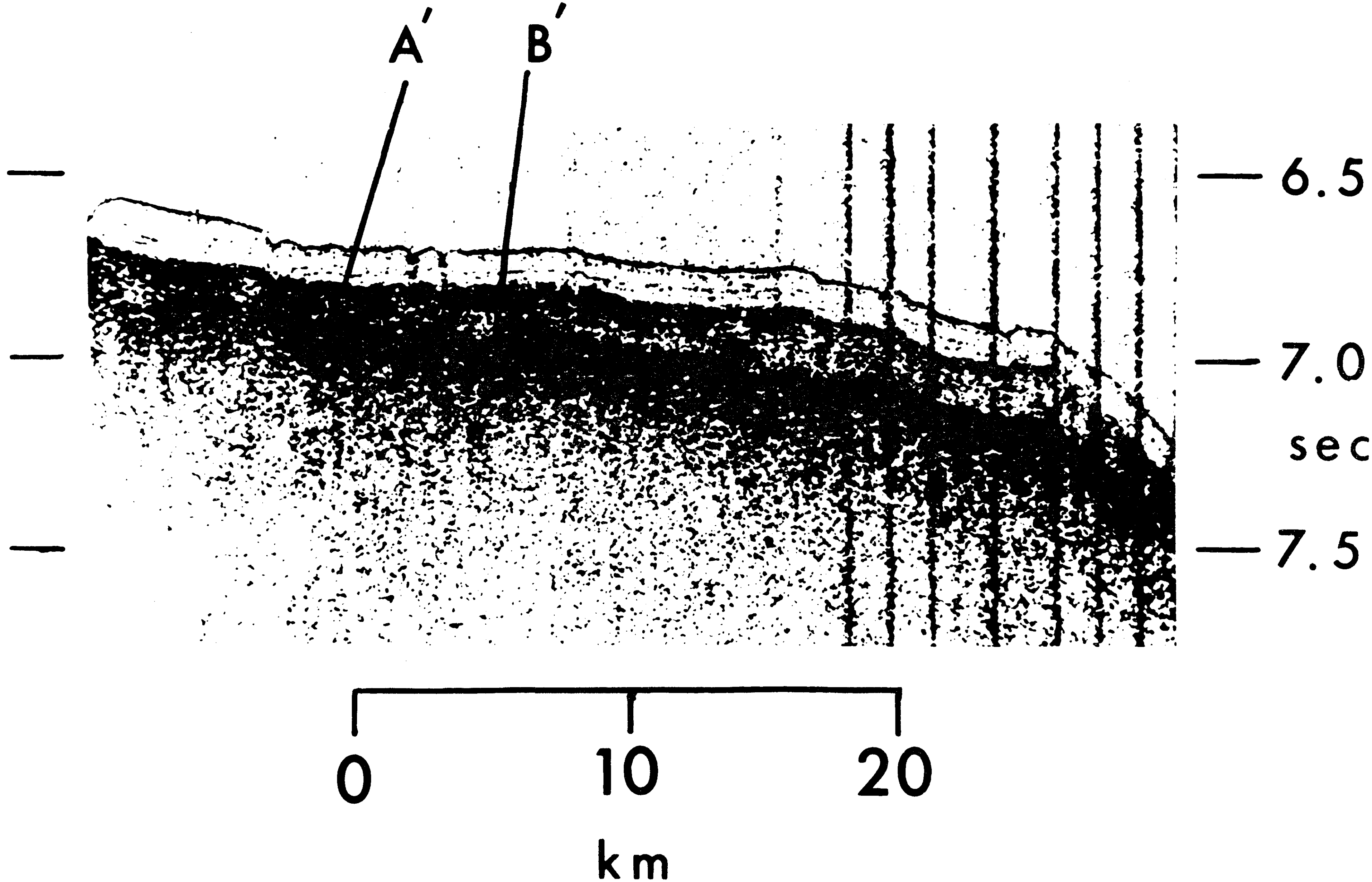
Figure 26 Isopach map indicating the total thickness of sediment on the south Shatsky Rise.

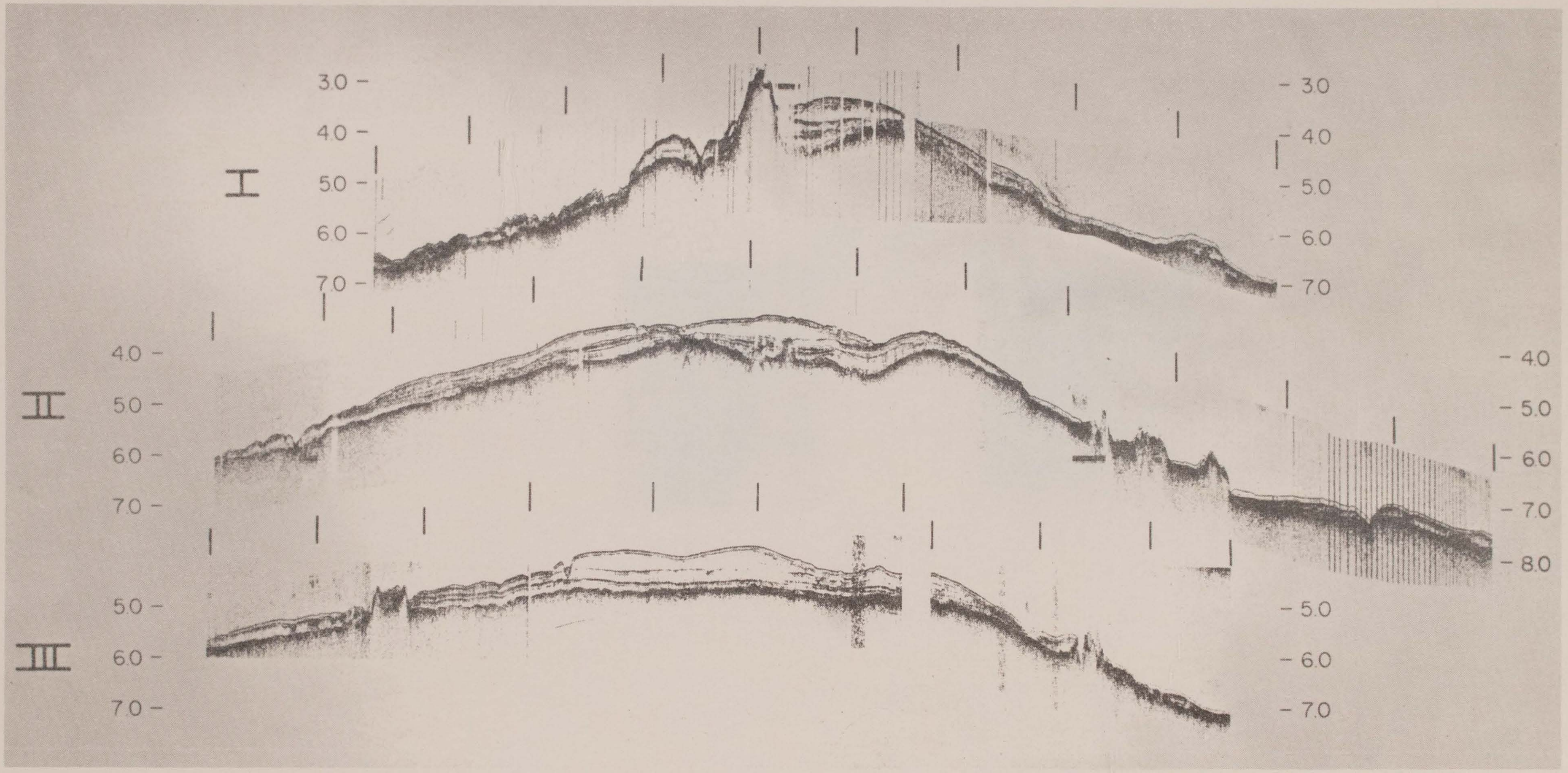
Figure 27 Seismic reflection profiles across the northern portion of the Shatsky Rise. Profiles VI, VII were taken on the R/V MELVILLE, ANTIPODE Expedition.

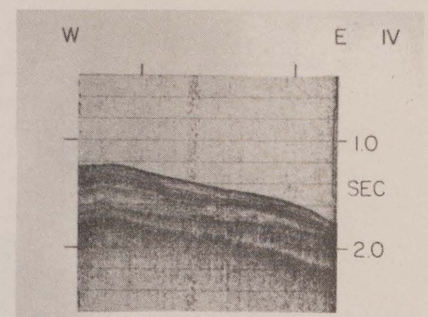
Figure 28	Bathymetric contour map of South Shatsky showing the drilling sites of the D/V GLOMAR CHALLENGER, 1969 (Leg VI). Sites 47, 48, 49, and 50 are clearly marked. (After DSDP Site Report 48, p. 146.)
Figure 29	Drawing of R/V ARGO four-second profile across Shatsky Rise. Profile C-D is found on profile II of this report. (After DSDP Site Report 47, p. 68.)
Figure 30	Drawing of D/V GLOMAR CHALLENGER profile at sites 49 and 50. (After DSDP Site Report 50, p. 196.)

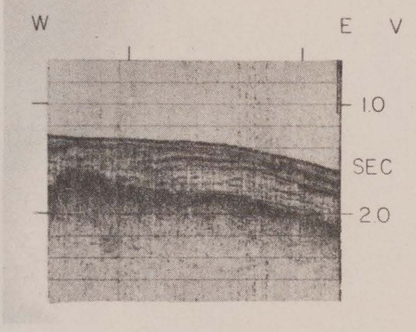


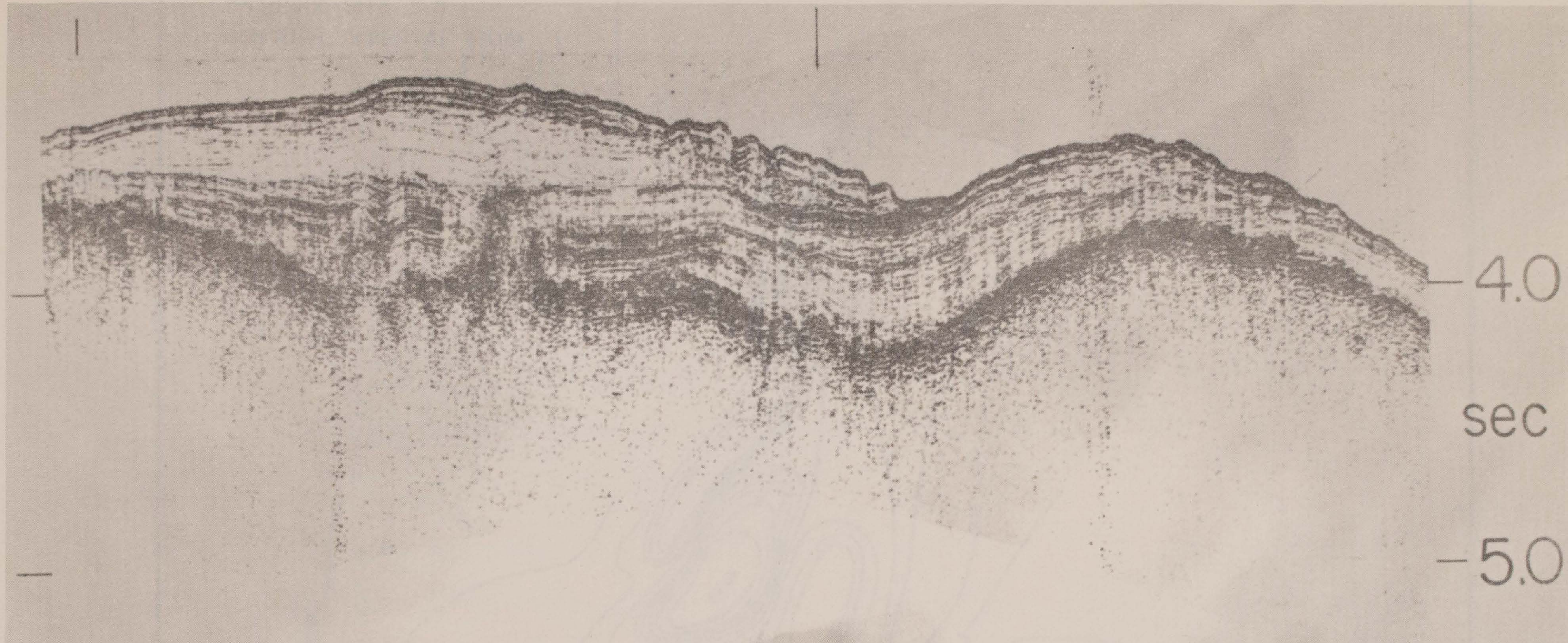
155°
160°
40°
35°
30°
SHATSKY RISE
0
120
NAUTICAL MILES
NORTH SHATSKY
SOUTH SHATSKY
SHATSKY RISE
N
I
II
III
IV
V
VI
VII
CONTOUR INTERVAL 200
UNCORRECTED FATHOMS

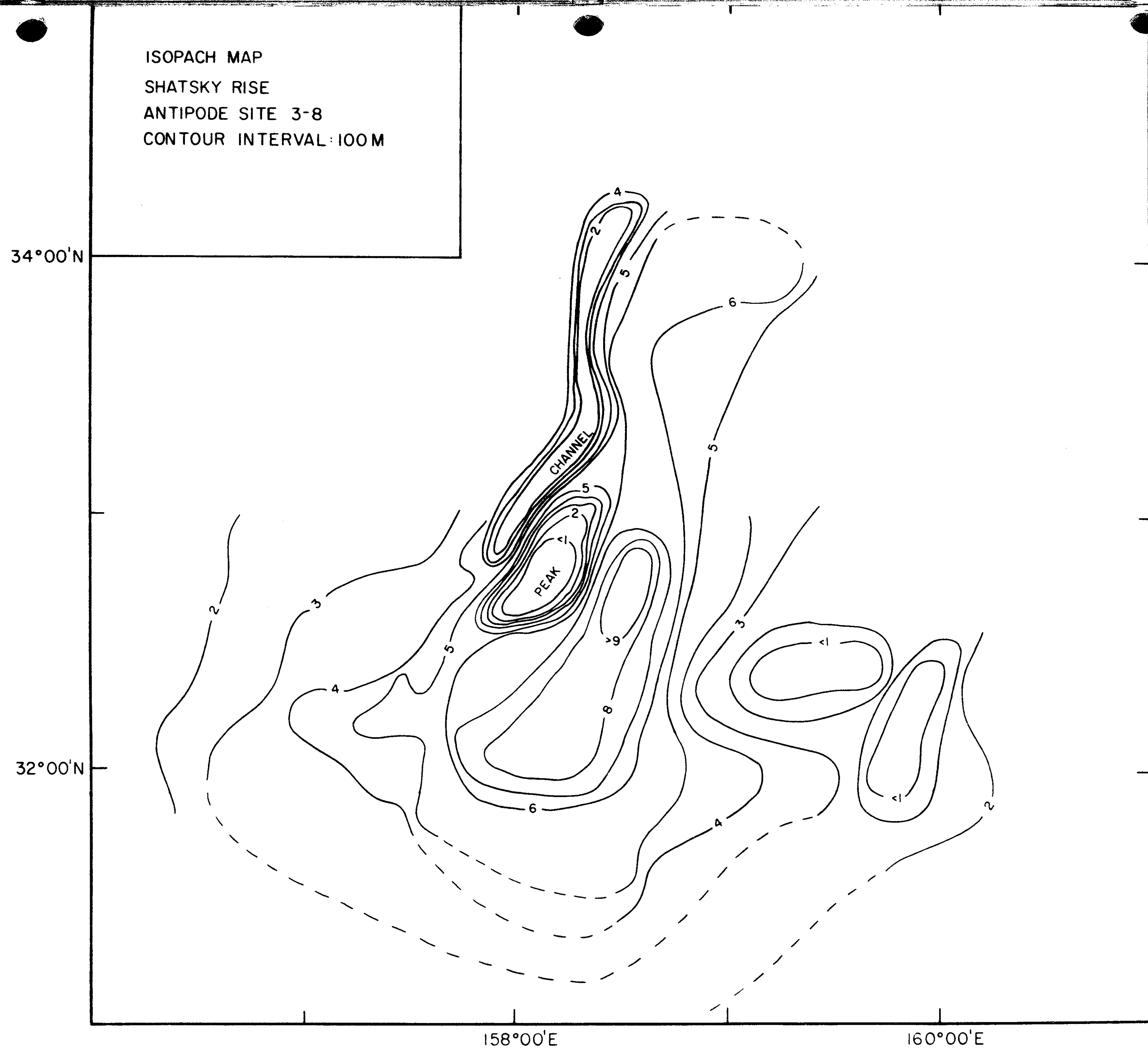

A'
B'
6.5
7.0
sec
7.5
0
10
20
km

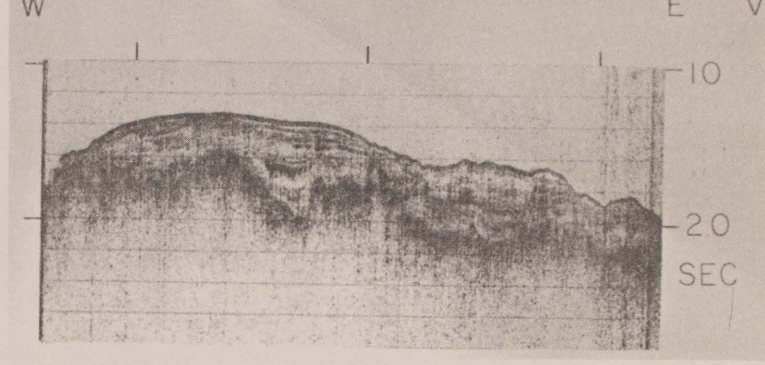

I
II
III
3.0
4.0
5.0
6.0
7.0
8.0

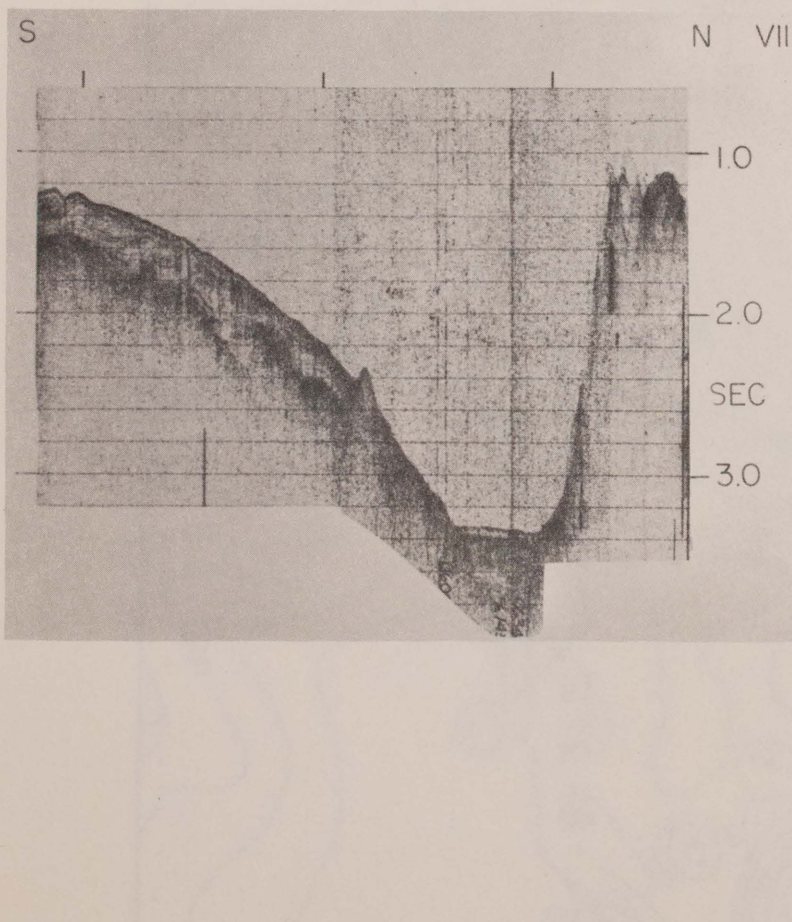

W
E IV
1.0
SEC
2.0

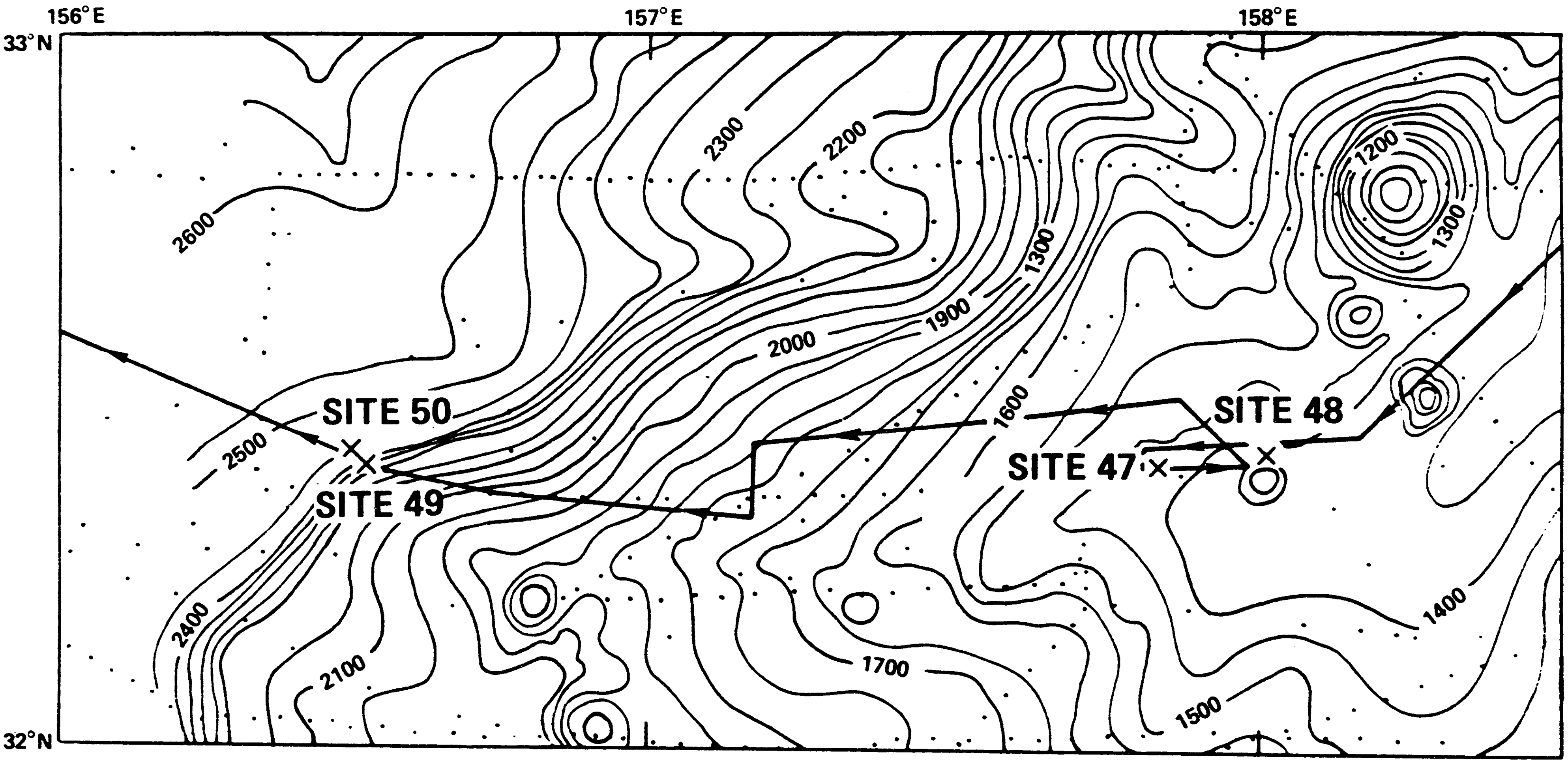

W
E V
1.0
SEC
2.0

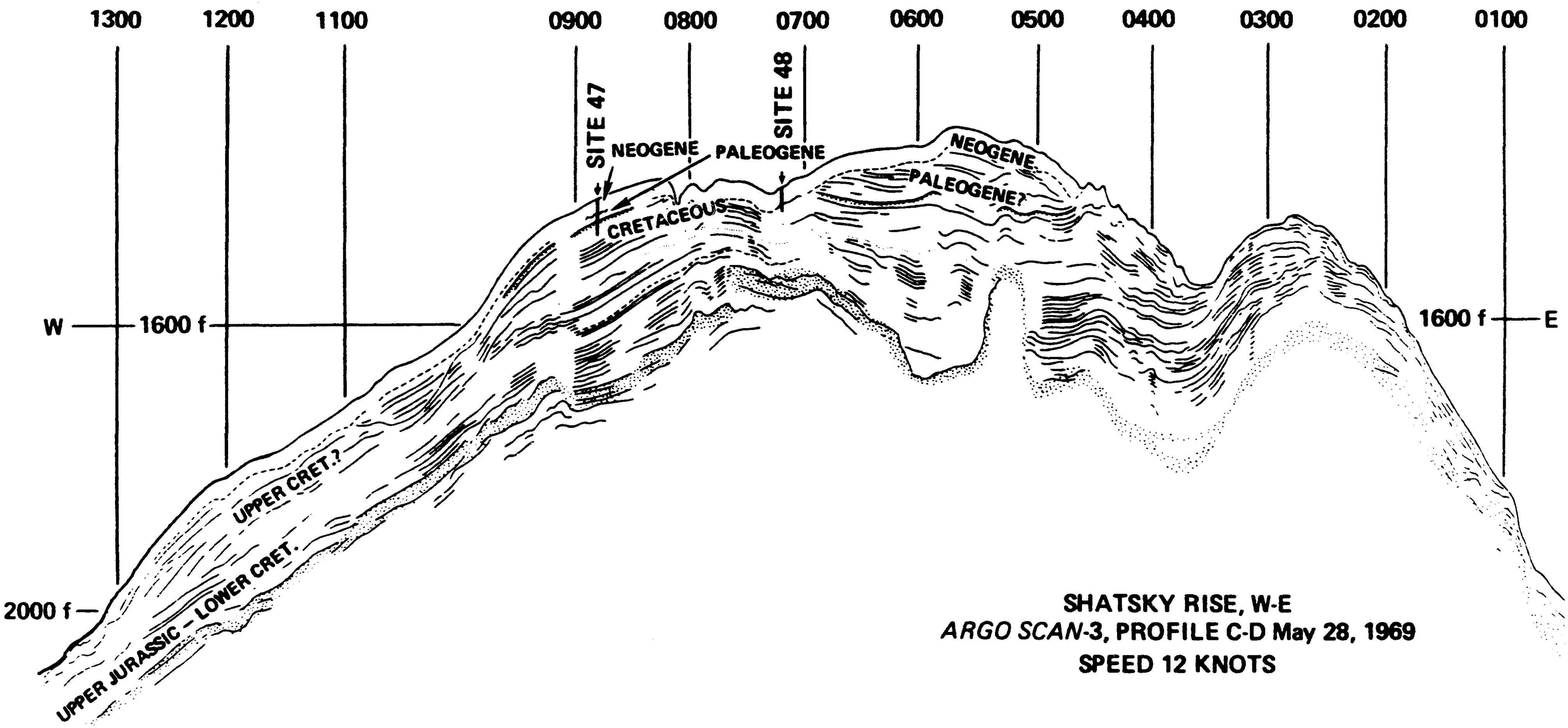

4.0
sec
5.0


ISOPACH MAP
SHATSKY RISE
ANTIPODE SITE 3-8
CONTOUR INTERVAL: 100 M
34°00'N
32°00'N
158°00'E
160°00'E
CHANNEL
PEAK
>9
<1

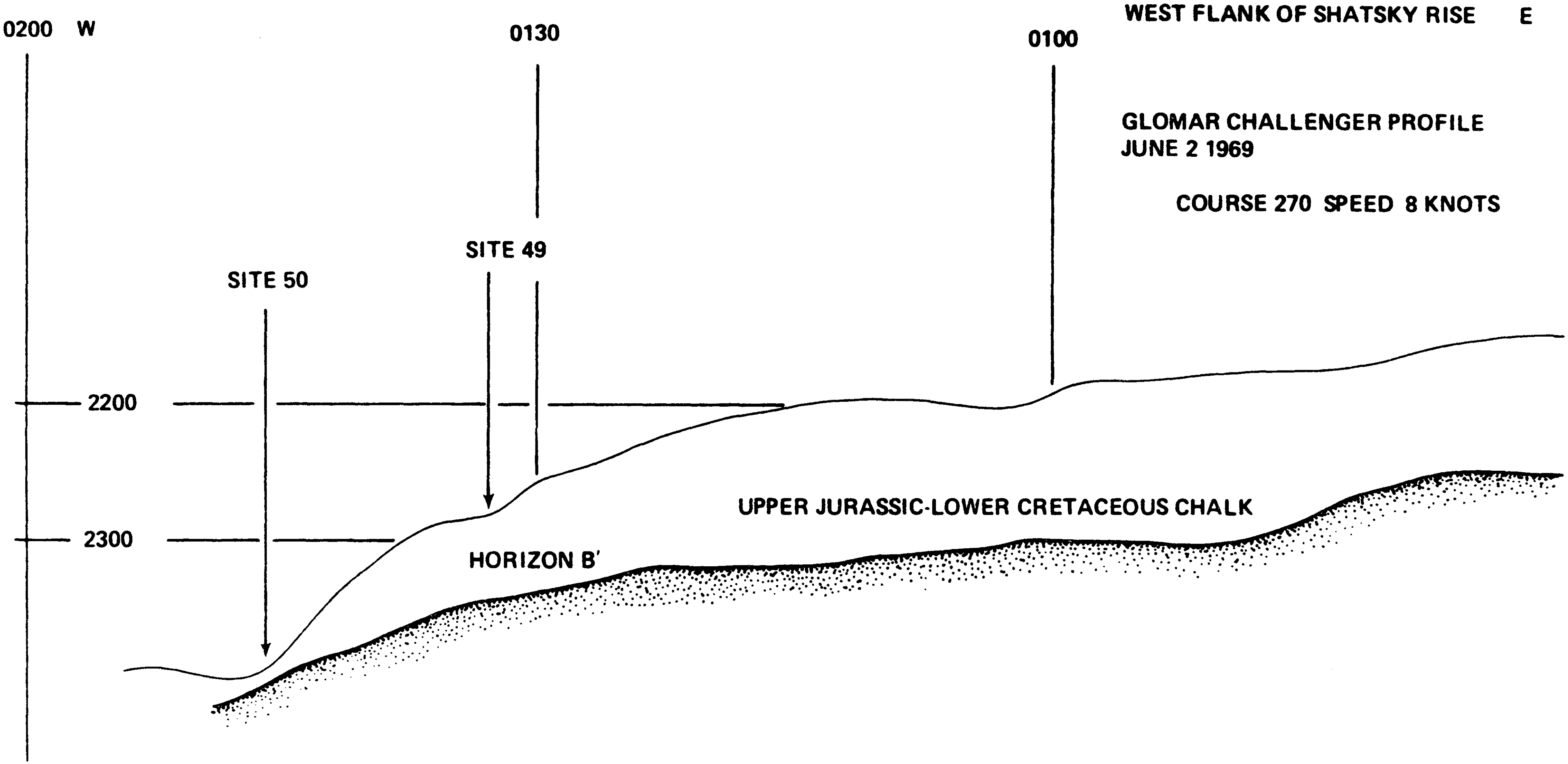

W
E
VI
1.0
2.0
SEC


S
N
VII
1.0
2.0
SEC
3.0


156° E
157° E
158° E
33° N
32° N
SITE 50
SITE 49
SITE 48
SITE 47
2600
2500
2400
2300
2200
2100
2000
1900
1700
1600
1500
1400
1300
1300
1200



SHATSKY RISE, W-E
ARGO SCAN-3, PROFILE C-D May 28, 1969
SPEED 12 KNOTS


WEST FLANK OF SHATSKY RISE
0200 W
E
0130
0100
GLOMAR CHALLENGER PROFILE
JUNE 2 1969
COURSE 270 SPEED 8 KNOTS
SITE 49
SITE 50
2200
2300
UPPER JURASSIC-LOWER CRETACEOUS CHALK
HORIZON B'

Survey 3-9

Site Survey Report

DSDP Site 20-1

A survey was made west of the Shatsky Rise and east of the Bonin Trench in an area bounded on the northeast by 33°50'N, 154°10'E, and on the southwest by 32°45'N, 153°00'E, refer to Figure 31 for site survey 3-9 track chart. The survey lasted from 2100/15 August 1970 to 0300/17 August 1970 (from 1100/15 to 1700/16 GMT, airgun photographs end 2120/16). This is the same location as site survey 15, site 51 (3-6 June 1969) published in Volume VI of Initial Report of the Deep Sea Drilling Project, February 1971. The area has moderate topography ranging from 3218 fathoms (5885 m) (uncorrected) in the northwest to 2886 fathoms (5278m) on the southeast, in a distance of roughly 100 km (approximately 1 : 160). The airgun photographs covering this site are ANT-88 to ANT-91.

The ANTIPODE survey was run in a three-quarters circle anisotropy study centered at 33°15'N and 153°35'E. The incoming run from the east shows (1500/15 to 0030/16; ANT-88 and ANT-89) two buried reflecting layers. The initial surface layer is up to 0.03 seconds thick and occassionally shows layering. The surface is underlain by a conformable transparent layer of 0.06 to 0.10 seconds thickness. The first reflecting horizon is between 0.12 to 0.15 seconds thick and shows distinct layering in places. The first reflector is underlain by another transparent layer that varies from 0.01 to 0.12 seconds thick. The bottom reflecting layer is generally greater than 0.15 seconds thick and up to 0.35 seconds thick. The whole sedimentary covering varies from 0.35 seconds to 0.65 seconds.

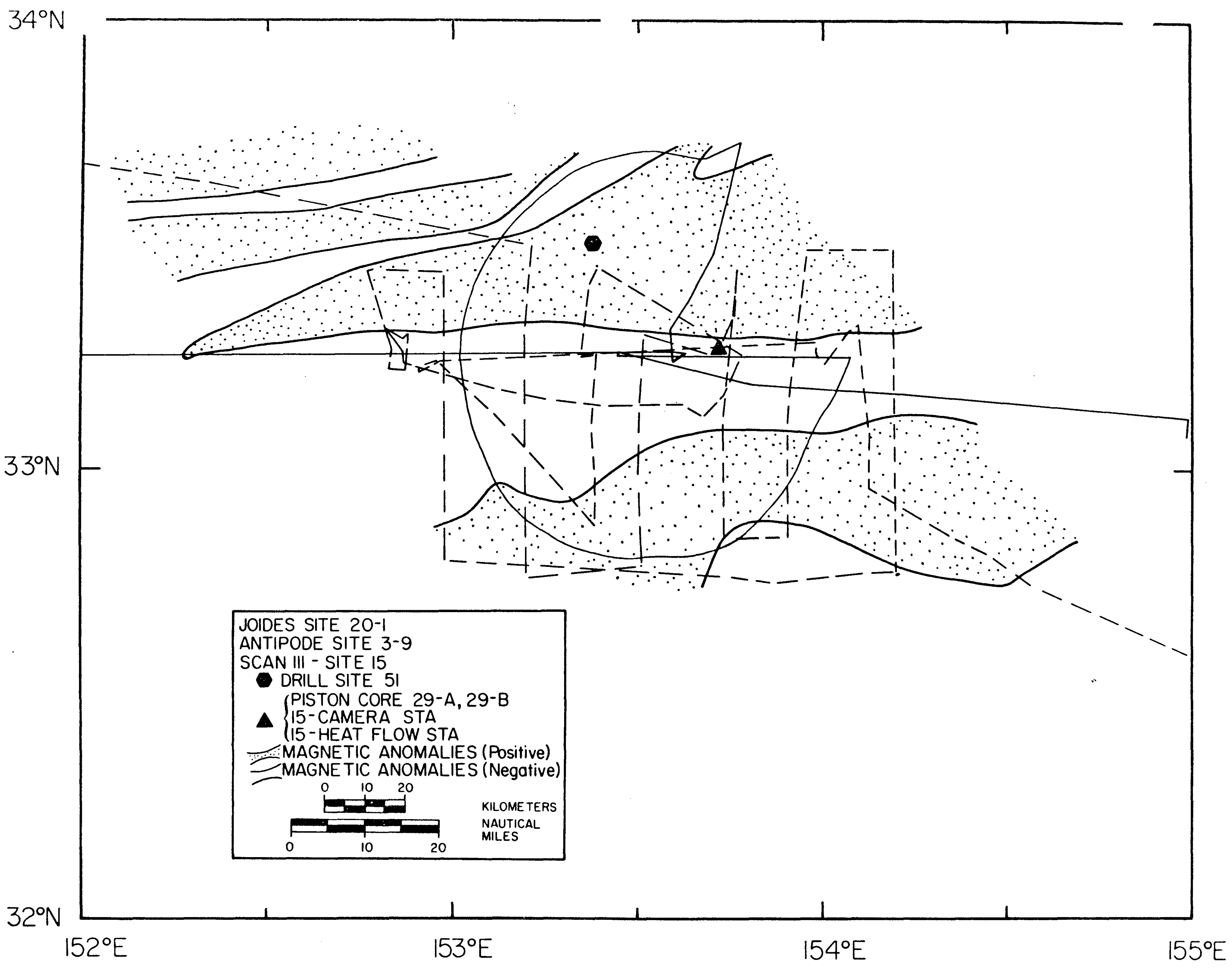
The bottom reflecting layer shows a few minor channels that are generally accentuated by the overlying layers and at 2010/15 (ANT-89) there appears to be a 50 fathom (90 m) deep channel. Other than minor channels there seems to be no crustal features perturbing the sediment structure. The uniform conformable sediment blanket continues until 0715/16 (ANT-90). South of 33°N (0715/16), there are at least two major basement structures penetrating the sedimentary blanket — one at 32°57.4'N, 153°54.3'E (0725/16) and a major one at 32°48.6'N, 153°39.5'E (0900/16). West of the major hill the bottom seems relatively rough until the 33°N line is recrossed at approximately 1200/16.

After 1200/16 the basement is again its typical structure described earlier until 1416/16, where the layers seem to be thickened until they intersect a major basement feature at 33°22.0'N, 153°02.2'E (ANT-91). After 1430/16 the lower reflector is at 0.70 seconds and overlain by a very thick upper buried reflector. The surface reflector is almost transparent at this point. The sediments seem thickest at 33°35.0'N, 153°12.0'E (1540/16), where they may be up to 0.80 seconds, and might be a good drilling site. Between 1640 and 1730/16 there is the largest feature in the entire area and it appears to have only a thin sedimentary covering on a 160 fathom (290 m) high basement protrusion. After the last major feature the sediments are similar to the original description. Although thicker than to the south, recommended site positions are not felt necessary since the sediments are so uniform. The only places that would not be suggested are those where the basement protrudes through the main sediment blanket, and these positions have been mentioned above.

L. Lawver

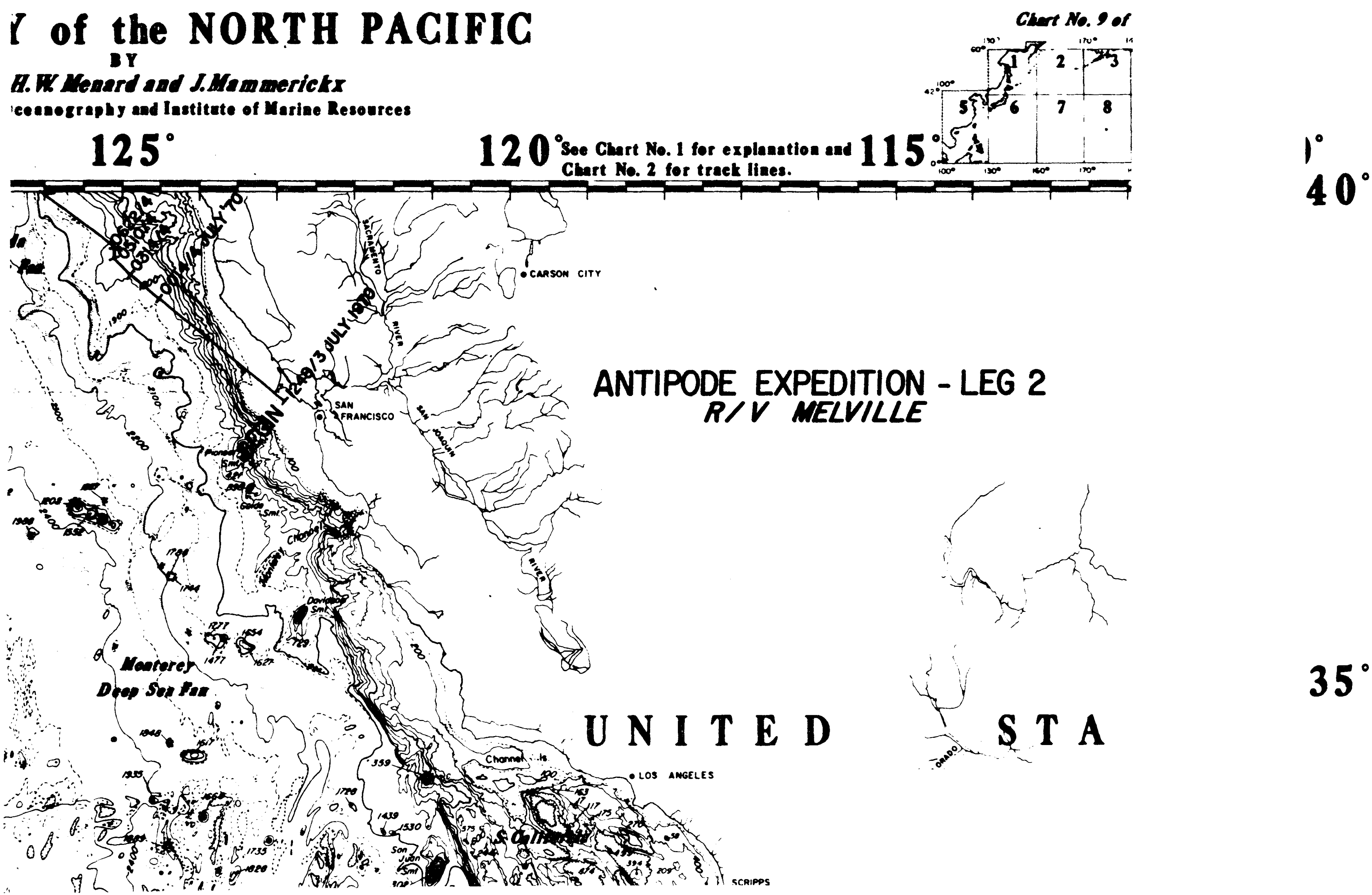
FIGURE CAPTIONS

Figure 31 Magnetic anomaly map of Site 3-9 and SCAN III, Site 15.

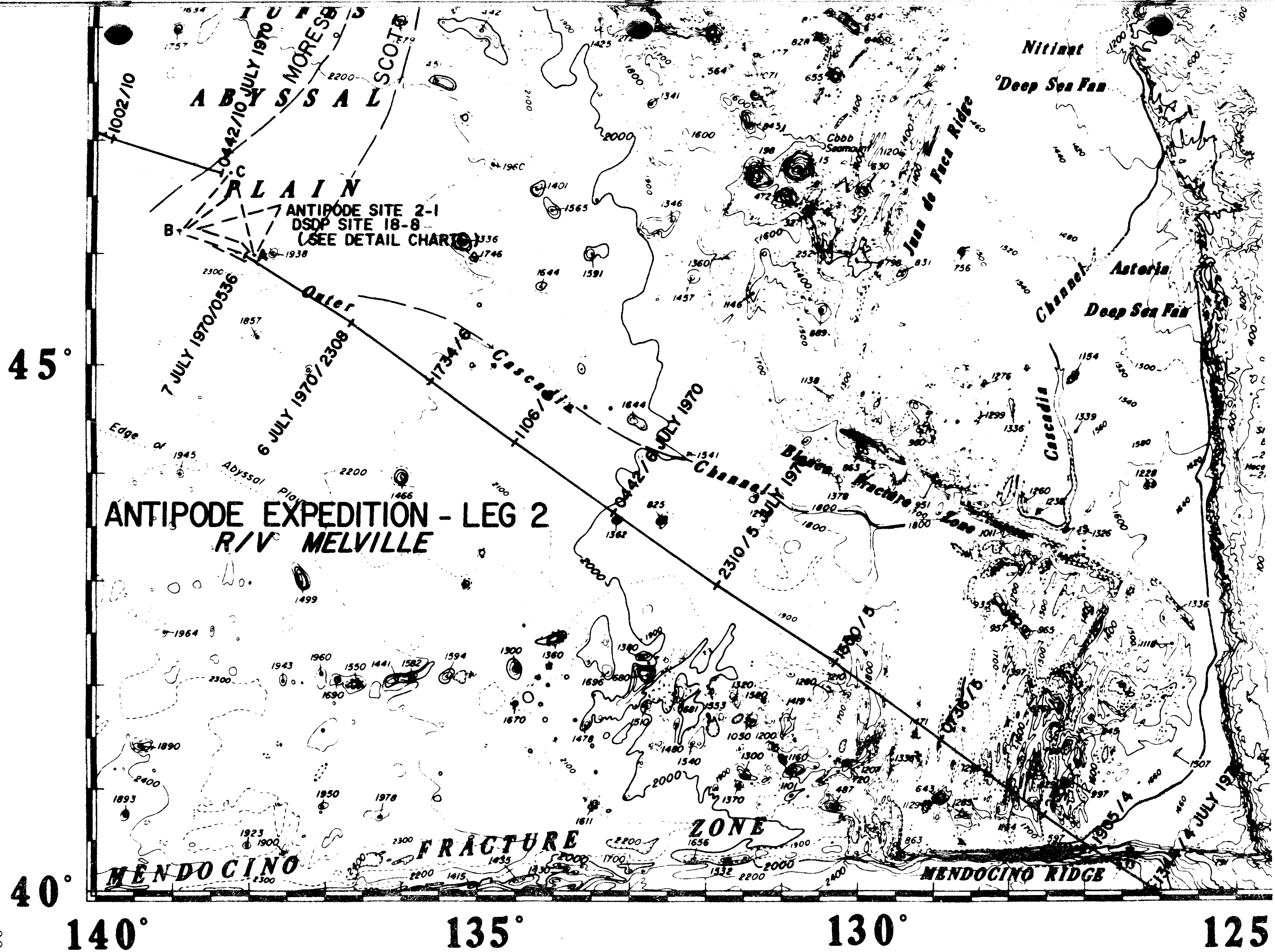

34°N
33°N
32°N
152°E
153°E
154°E
155°E
JOIDES SITE 20-1
ANTIPODE SITE 3-9
SCAN III - SITE 15
DRILL SITE 51
PISTON CORE 29-A, 29-B
15-CAMERA STA
15-HEAT FLOW STA
MAGNETIC ANOMALIES (Positive)
MAGNETIC ANOMALIES (Negative)
0 10 20
KILOMETERS
NAUTICAL MILES
0 10 20

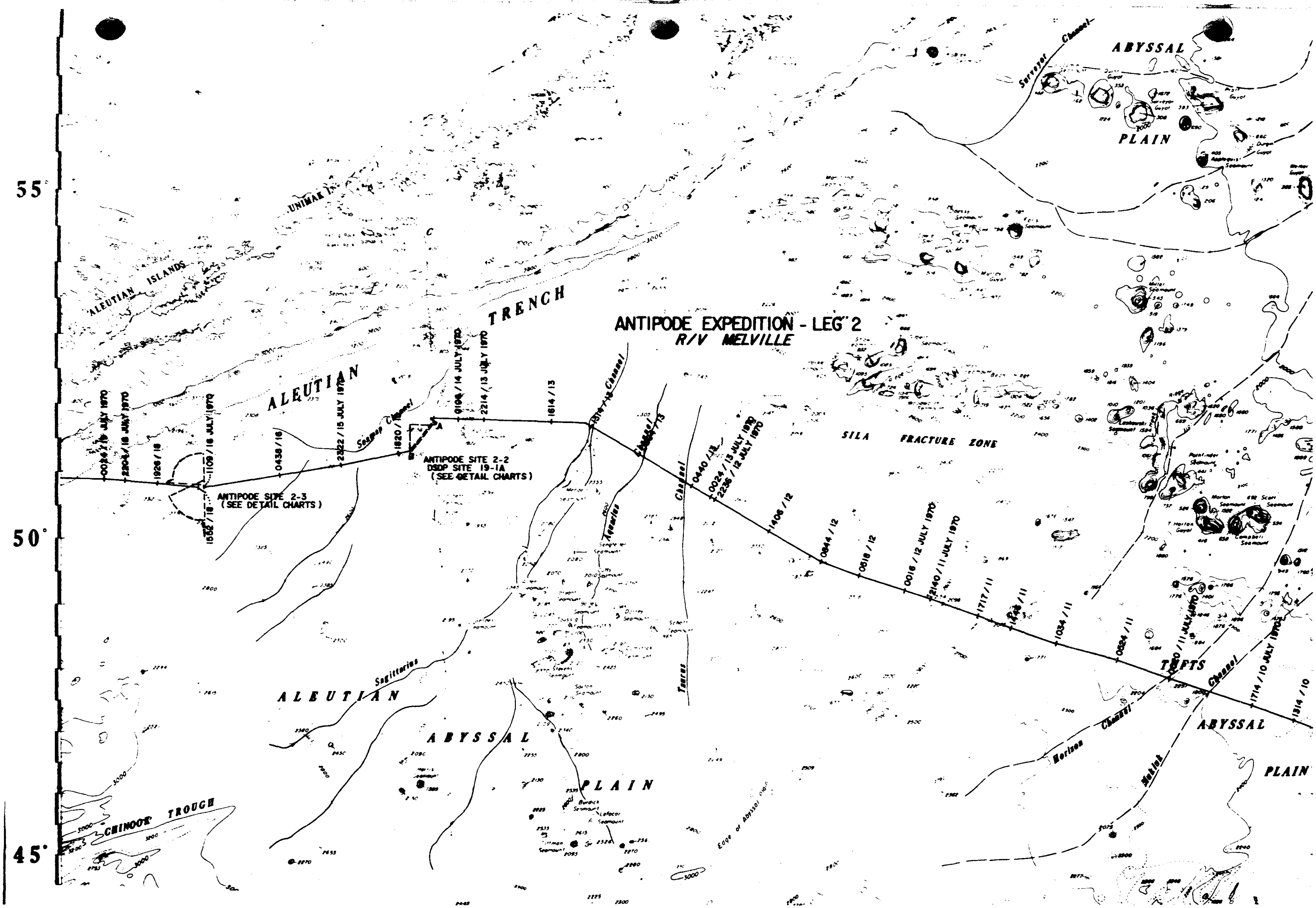
95

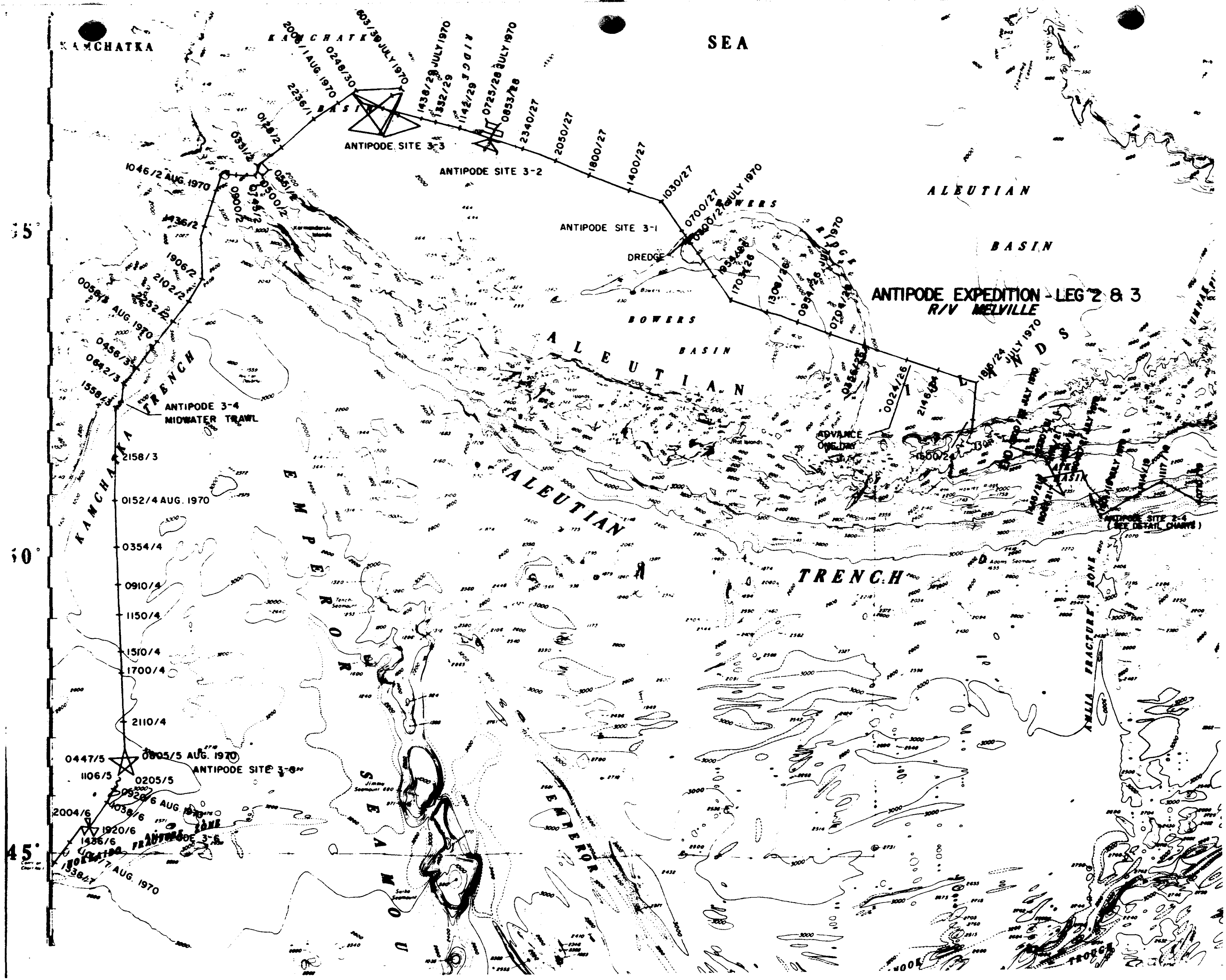
APPENDIX



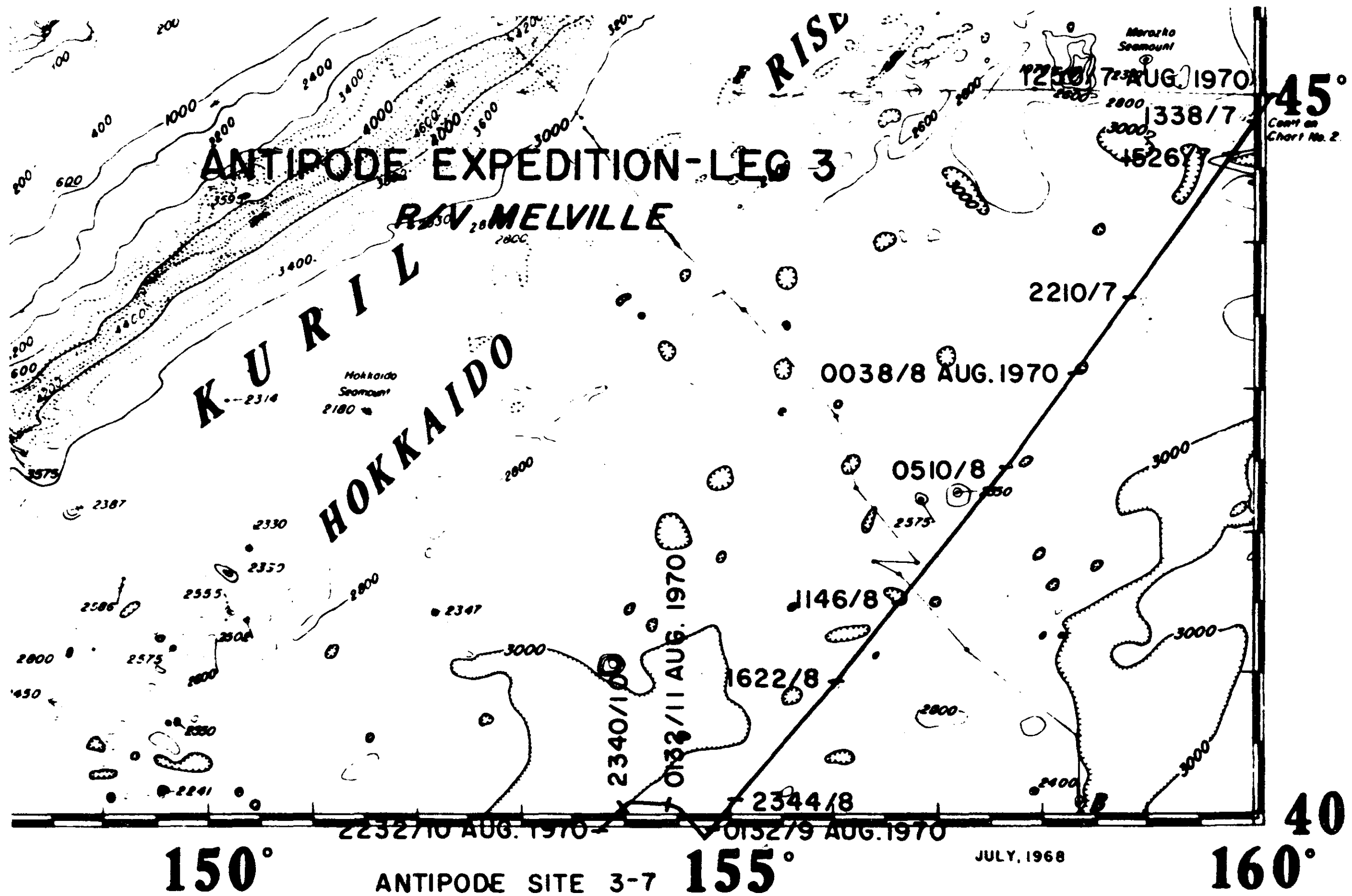
Y of the NORTH PACIFIC
BY
H. W. Menard and J. Mammerickx
ceanography and Institute of Marine Resources
Chart No. 9 of
125°
120°
115°
See Chart No. 1 for explanation and Chart No. 2 for track lines.
40°
35°
ANTIPODE EXPEDITION - LEG 2
R/V MELVILLE
CARSON CITY
SACRAMENTO
RIVER
SAN FRANCISCO
SAN JOAQUIN
RIVER
Monterey
Deep Sea Fan
UNITED
STA
LOS ANGELES
Channel Is
SCRIPPS


ANTIPODE EXPEDITION - LEG 2
R/V MELVILLE
ANTIPODE SITE 2-1
DSDP SITE 18-8
(SEE DETAIL CHART)
ABYSSAL
PLAIN
Outer
Cascadia
Channel
Edge of Abyssal Plain
MENDOCINO
FRACTURE
ZONE
MENDOCINO RIDGE
Blanco Fracture Zone
Juan de Fuca Ridge
Cobb Seamount
Nitinat Deep Sea Fan
Astoria Deep Sea Fan
Astoria Channel
Cascadia Channel
MORESBY
SCOTT
1002/10
0442/10 JULY 1970
7 JULY 1970/0536
6 JULY 1970/2308
1734/6
1106/6
0442/6 JULY 1970
2310/5 JULY 1970
1500/5
0736/5
1905/4
4 JULY 1970
45°
40°
140°
135°
130°
125


ANTIPODE EXPEDITION - LEG 2
R/V MELVILLE
55°
50°
45°
ALEUTIAN ISLANDS
UNIMAK I.
ALEUTIAN TRENCH
ALEUTIAN ABYSSAL PLAIN
TUFTS ABYSSAL PLAIN
ABYSSAL PLAIN
SILA FRACTURE ZONE
CHINOOK TROUGH
Seamap Channel
Surveyor Channel
Aquarius Channel
Taurus Channel
Sagittarius Channel
Horizon Channel
Tufts Channel
ANTIPODE SITE 2-2
DSDP SITE 19-1A
(SEE DETAIL CHARTS)
ANTIPODE SITE 2-3
(SEE DETAIL CHARTS)
0024 / 17 JULY 1970
2204 / 16 JULY 1970
1926 / 16
1109 / 16 JULY 1970
1532 / 16
0438 / 16
2322 / 15 JULY 1970
1820 / 15
0108 / 14 JULY 1970
2214 / 13 JULY 1970
1614 / 13
0440 / 13
0024 / 13 JULY 1970
2236 / 12 JULY 1970
1406 / 12
0844 / 12
0618 / 12
0016 / 12 JULY 1970
2140 / 11 JULY 1970
1717 / 11
1034 / 11
0524 / 11
1714 / 10 JULY 1970
1314 / 10
Edge of Abyssal Plain
3000


ANTIPODE EXPEDITION - LEG 2 & 3
R/V MELVILLE
SEA
KAMCHATKA
ALEUTIAN
BASIN
BOWERS
BASIN
BOWERS RIDGE
ALEUTIAN
ALEUTIAN ISLANDS
ALEUTIAN TRENCH
KAMCHATKA TRENCH
EMPEROR SEAMOUNTS
EMPEROR
ANTIPODE SITE 3-3
ANTIPODE SITE 3-2
ANTIPODE SITE 3-1
DREDGE
ANTIPODE 3-4
MIDWATER TRAWL
ANTIPODE SITE 3-5
ADVANCE
ONE DAY
ANTIPODE SITE 2-4
(SEE DETAIL CHARTS)
1046/2 AUG. 1970
0056/3 AUG. 1970
0152/4 AUG. 1970
0805/5 AUG. 1970
0920/6 AUG. 1970
1538/7 AUG. 1970
2004/6
1920/6
0447/5
1106/5
0205/5
2158/3
0354/4
0910/4
1150/4
1510/4
1700/4
2110/4
0700/27 JULY 1970
1030/27
1400/27
1800/27
2050/27
2340/27
2236/1
0248/30
55°
50°
45°


HOKKAIDO
AKKESHI
Erimo Seamount
145°


ANTIPODE EXPEDITION-LEG 3
R/V MELVILLE
KURIL
HOKKAIDO
RISE
Hokkaido Seamount
Morozko Seamount
1250/7 AUG. 1970
1338/7
1526/7
2210/7
0038/8 AUG. 1970
0510/8
1146/8
1622/8
2340/10
0132/11 AUG. 1970
2344/8
2232/10 AUG. 1970
0132/9 AUG. 1970
45°
40°
150°
155°
160°
ANTIPODE SITE 3-7
JULY, 1968

BATHYMETRY of the NORTH PACIFIC

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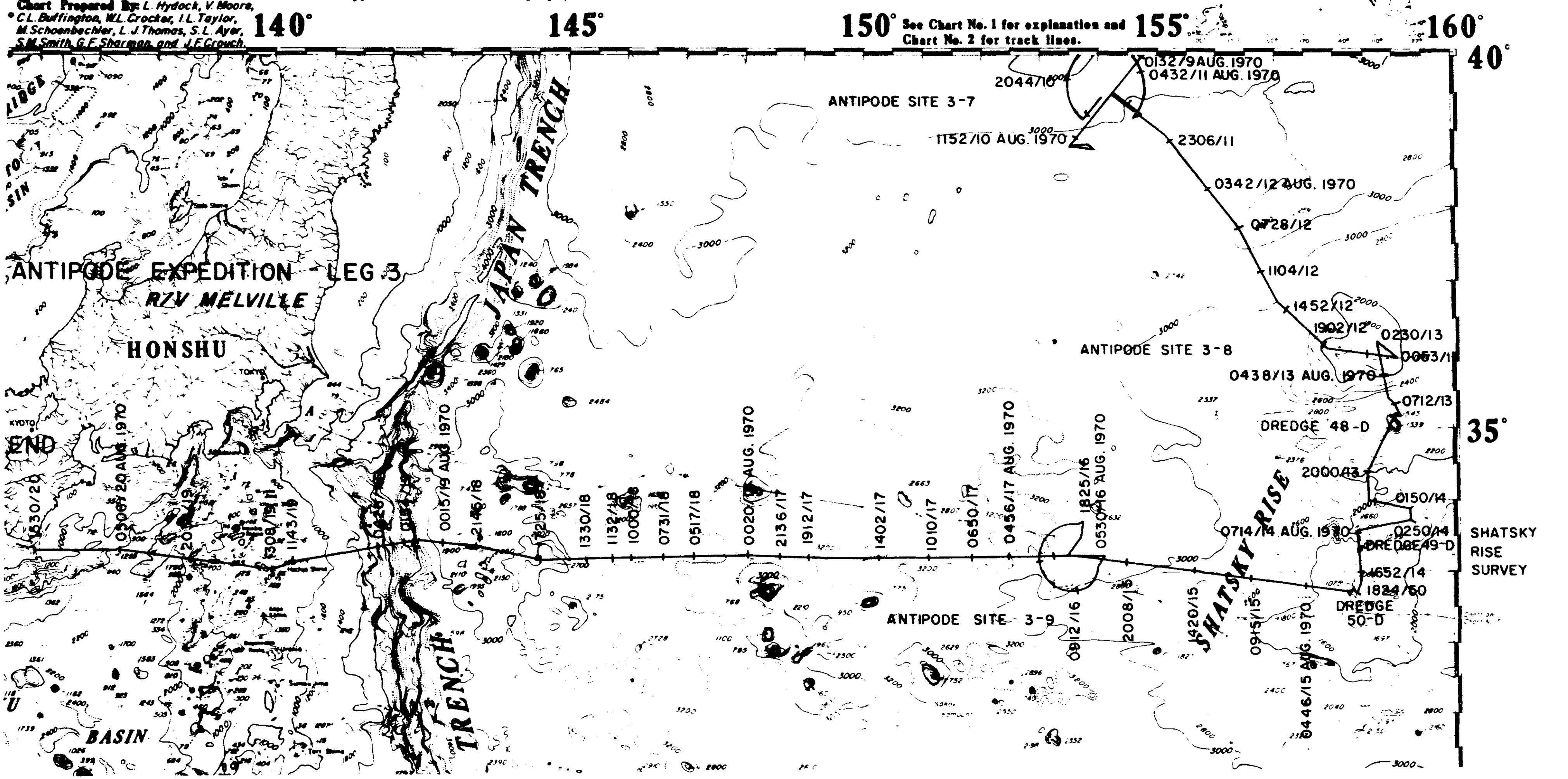
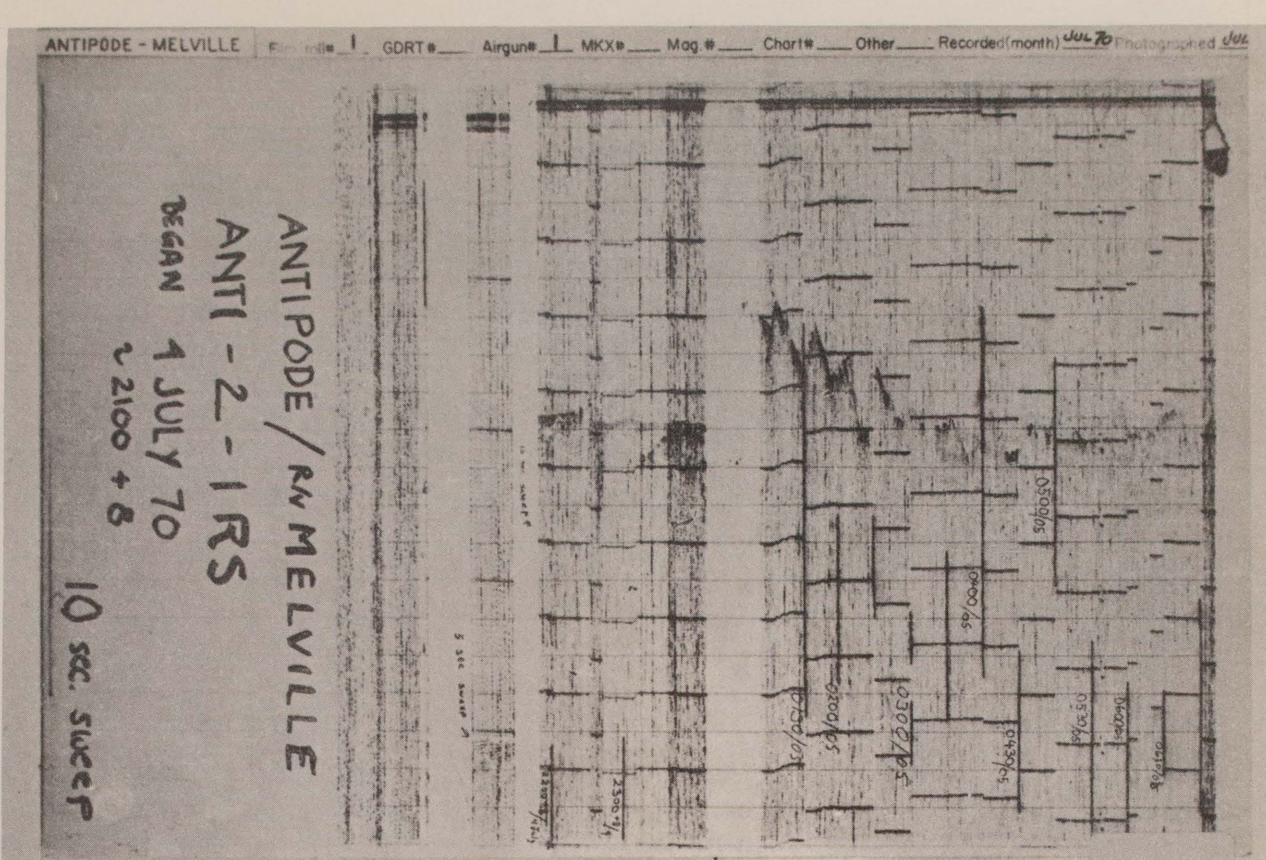
Scripps Institution of Oceanography and Institute of Marine Resources

Chart No. 6 of 10

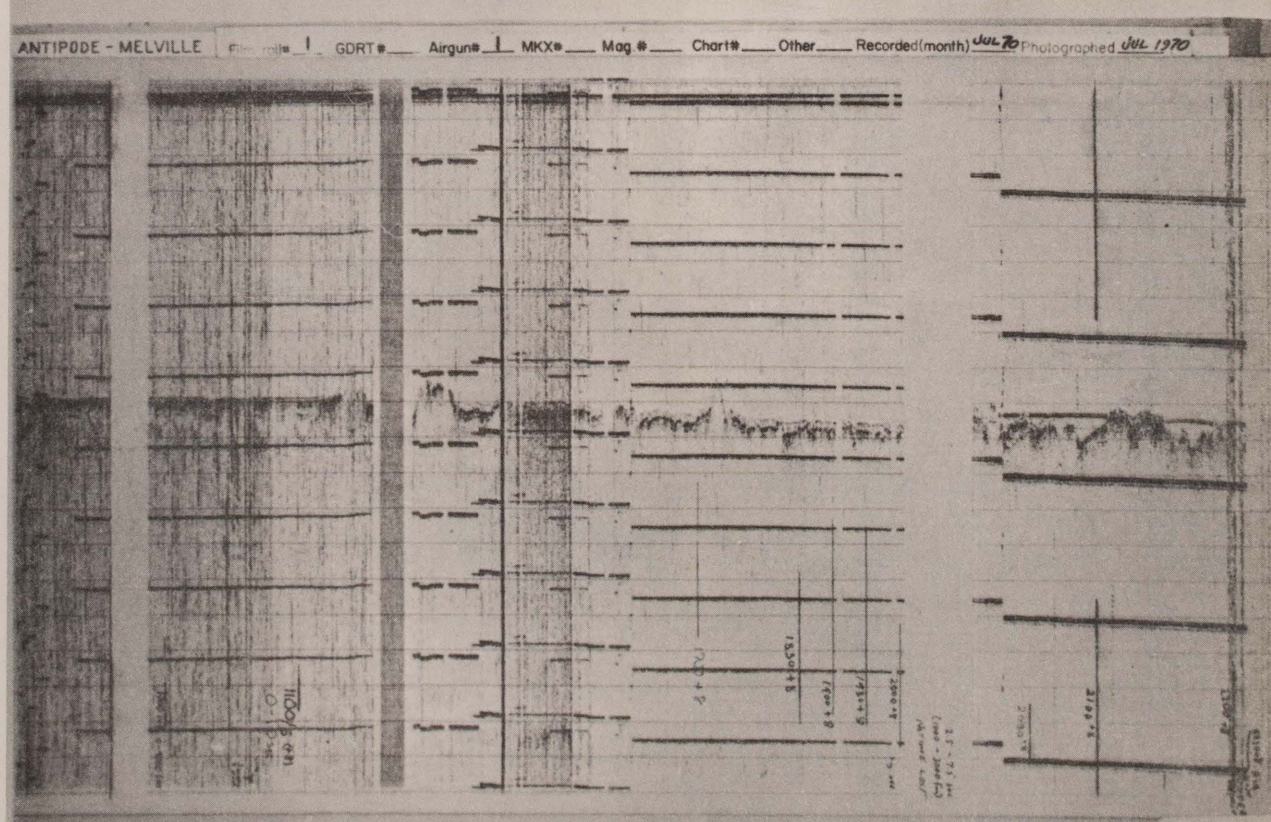
Chart Prepared By: L. Hydock, V. Moore, C.L. Buffington, W.L. Crocker, I.L. Taylor, M. Schoenbechler, L.J. Thomas, S.L. Ayer, S.M. Smith, G.F. Sharman, and J.F. Crouch.

See Chart No. 1 for explanation and Chart No. 2 for track lines.




ANTIPODE - MELVILLE
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL
ANTIPODE/RN MELVILLE
ANTI - 2 - 1RS
BEGAN 1 JULY 70
~2100 + 8
10 SEC. SWEEP

ANT-1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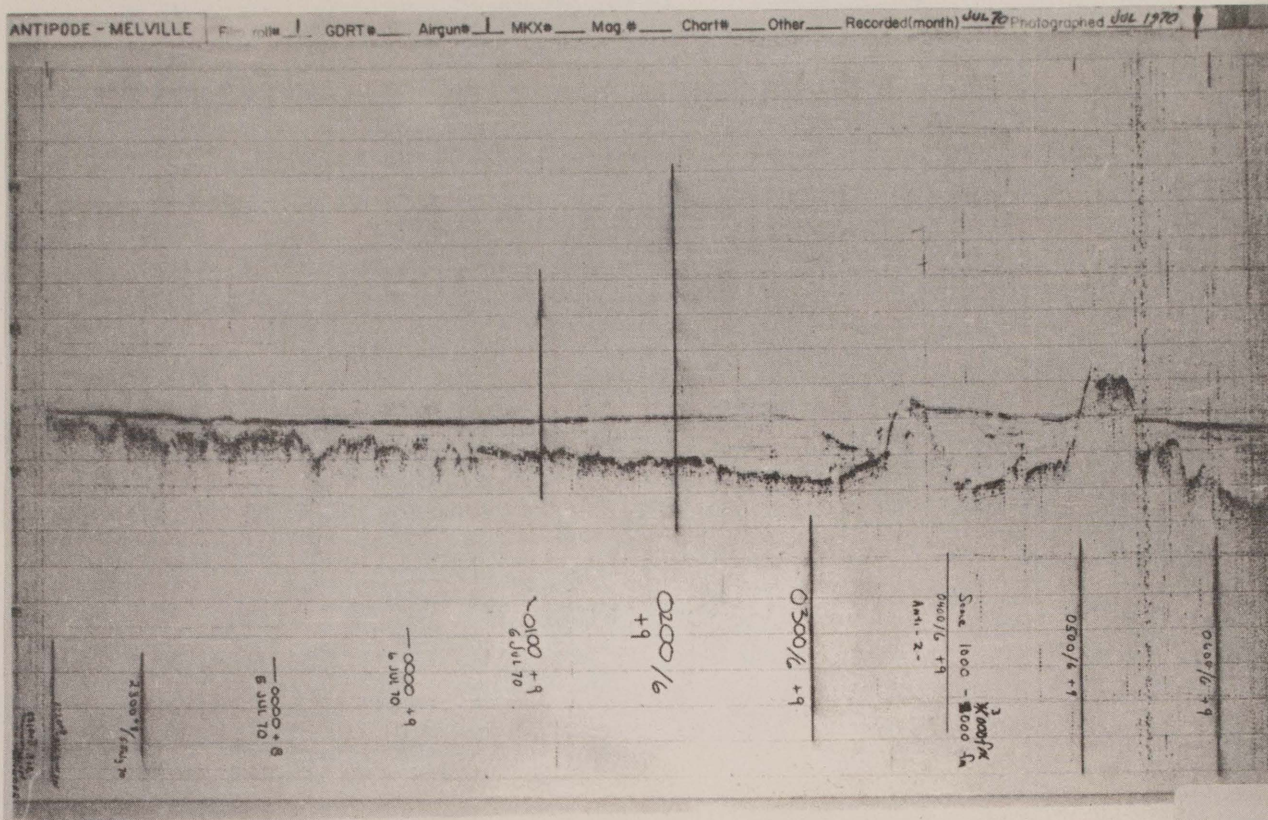
ANT-2



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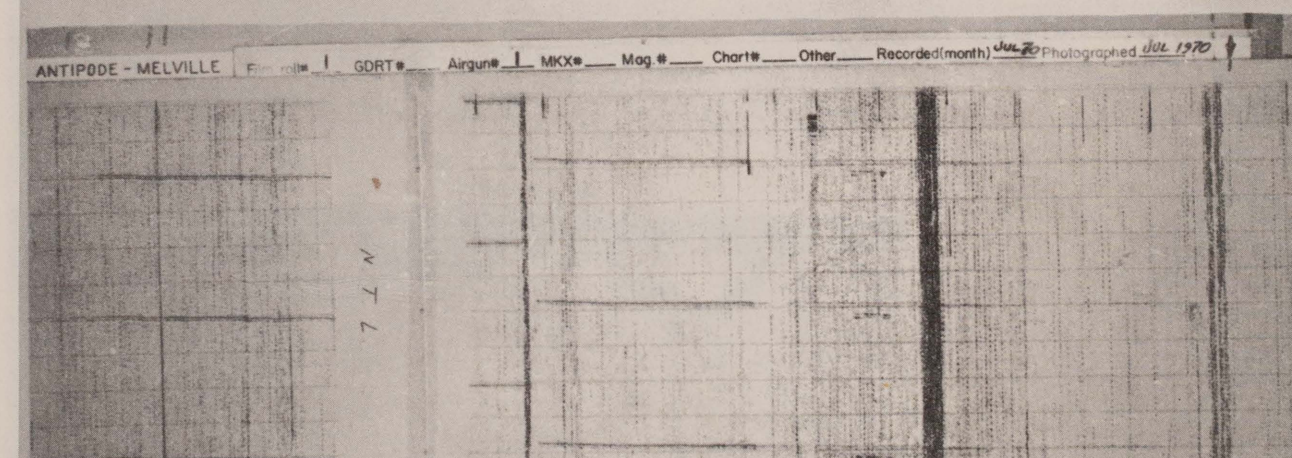
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-3



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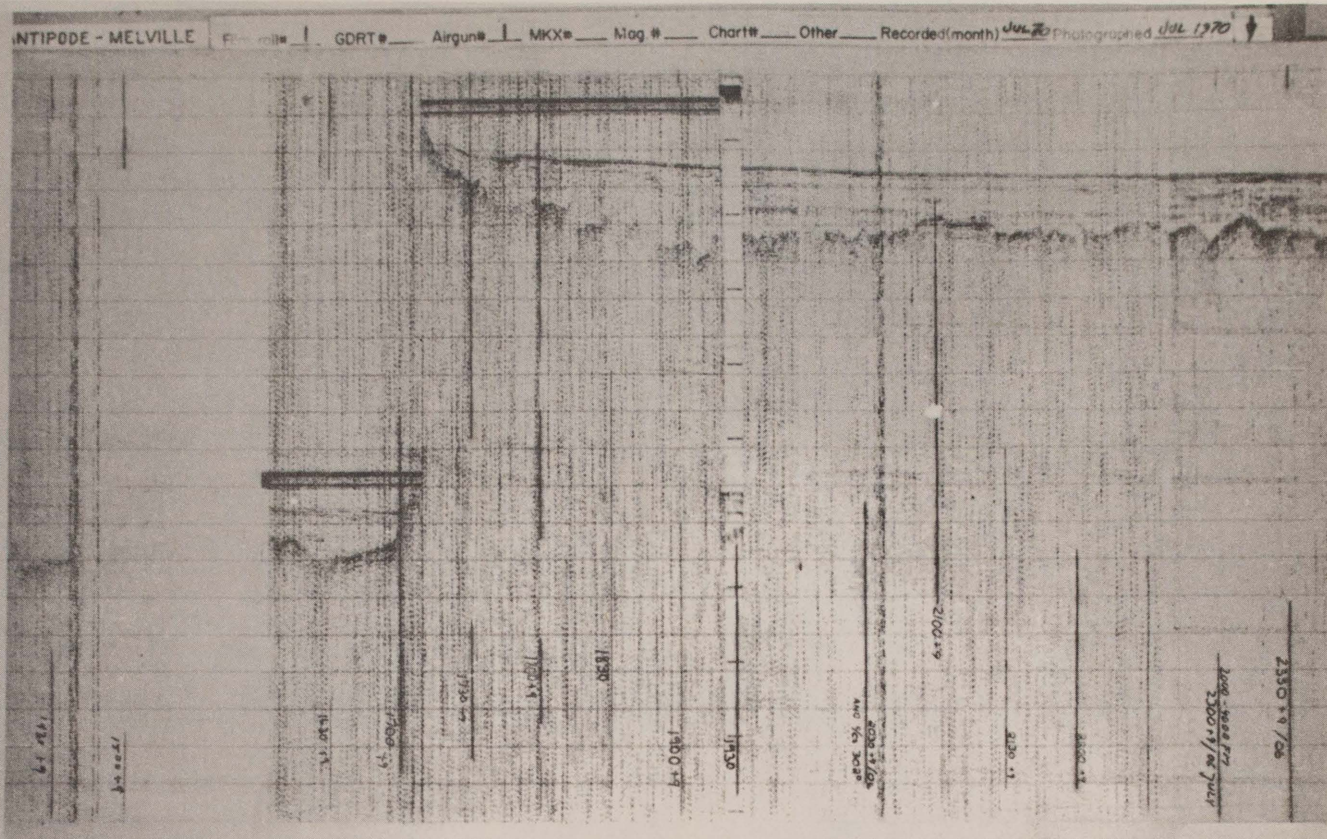
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-4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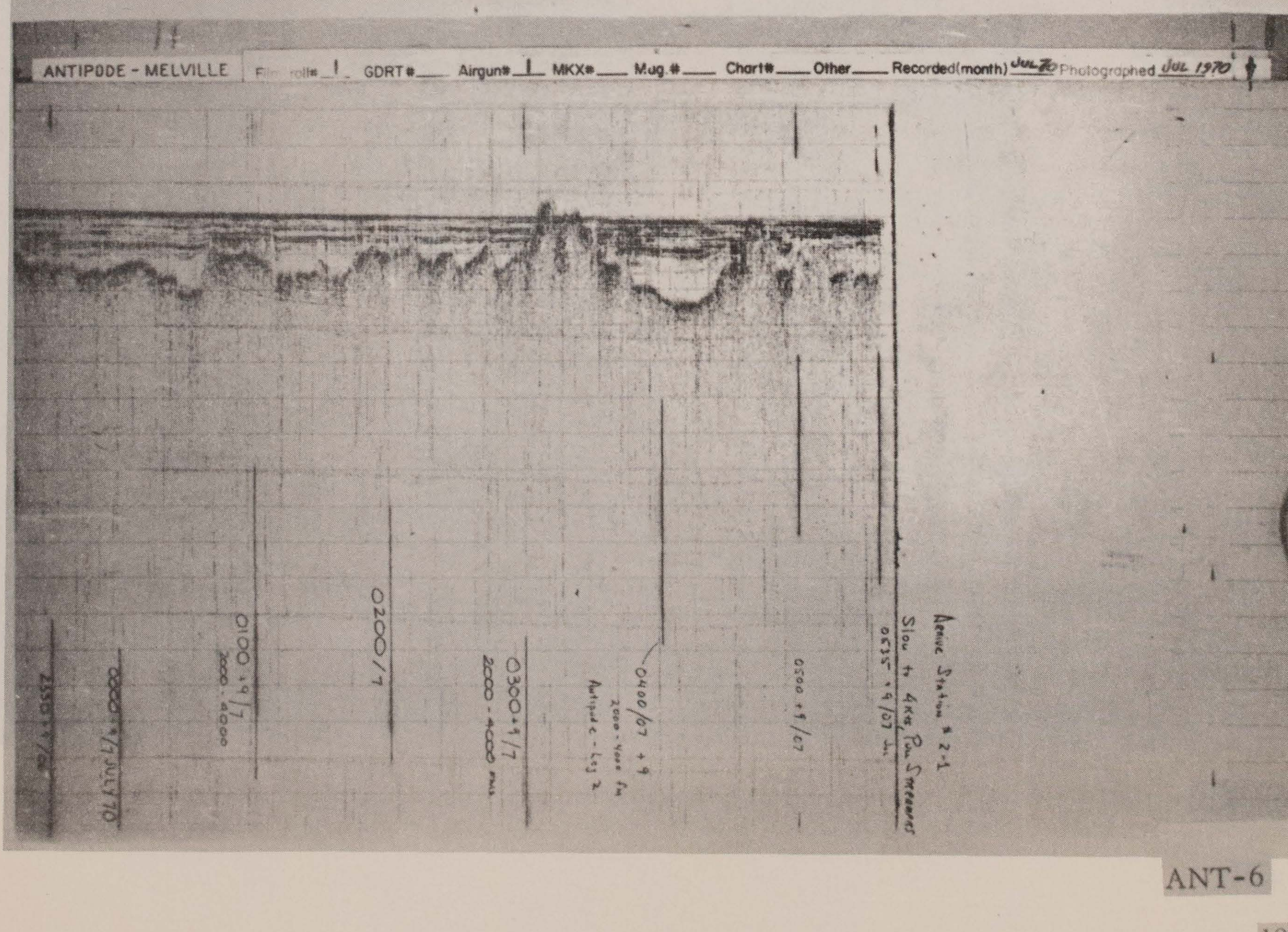
GDRT#
Airgun#
MKX#
Mag #
Chart#
Other
Recorded(month)
Photographed

ANT-5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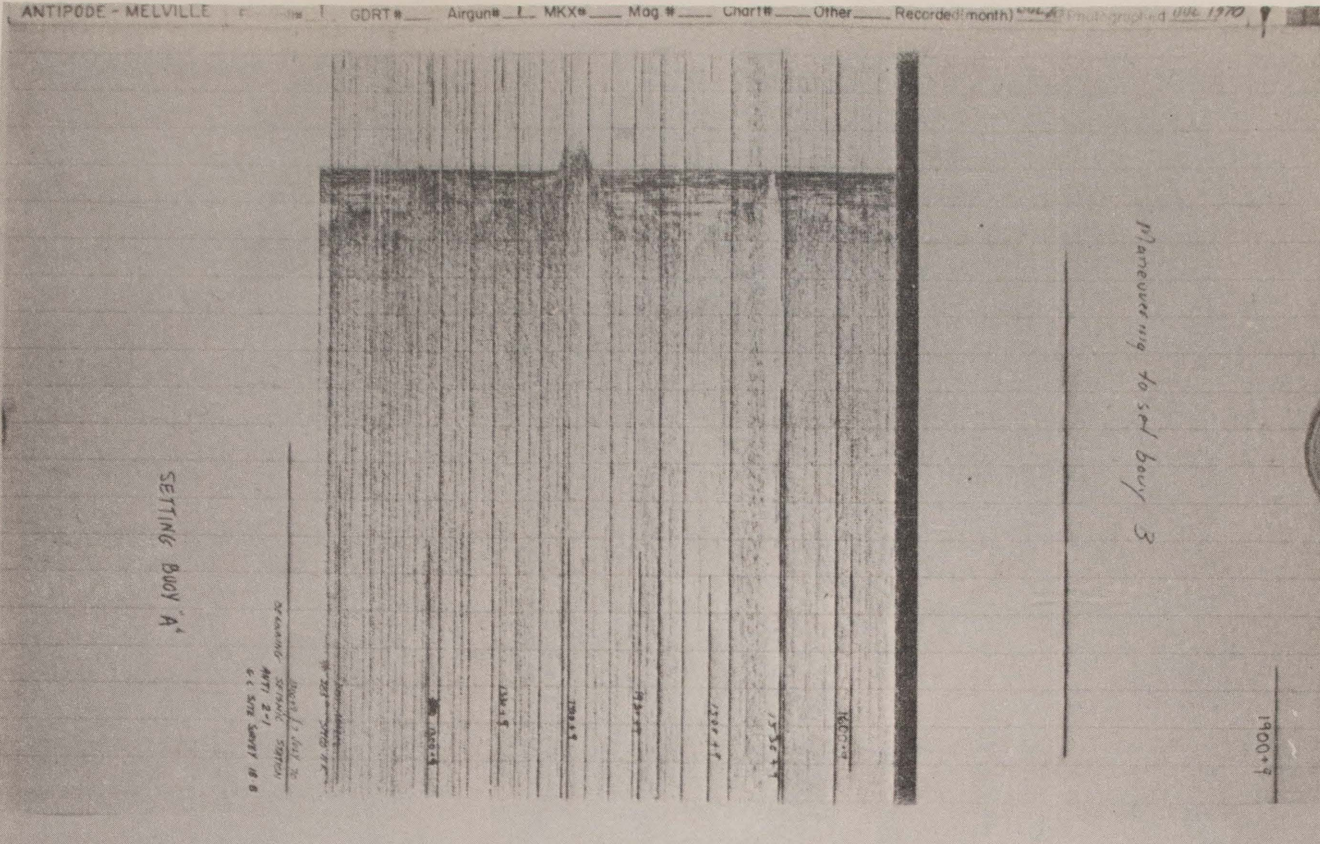
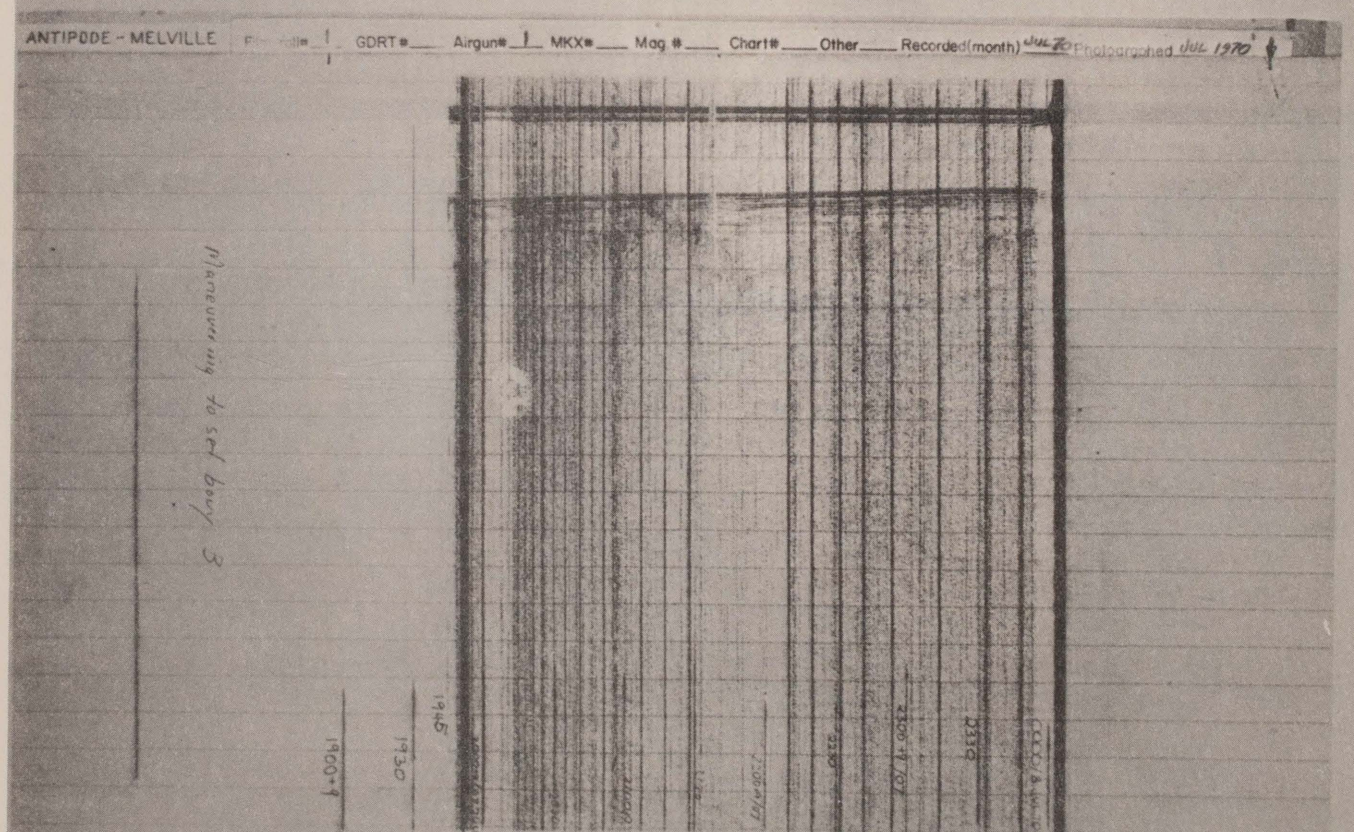
GDRT#
Airgun#
MKX#
Mag #
Chart#
Other
Recorded(month)
Photographed

ANT-6


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag #
Chart#
Other
Recorded(month)
Photographed JUL 1970
SETTING BUOY 'A'
Maneuvering to set buoy 3
1900+9

ANT-7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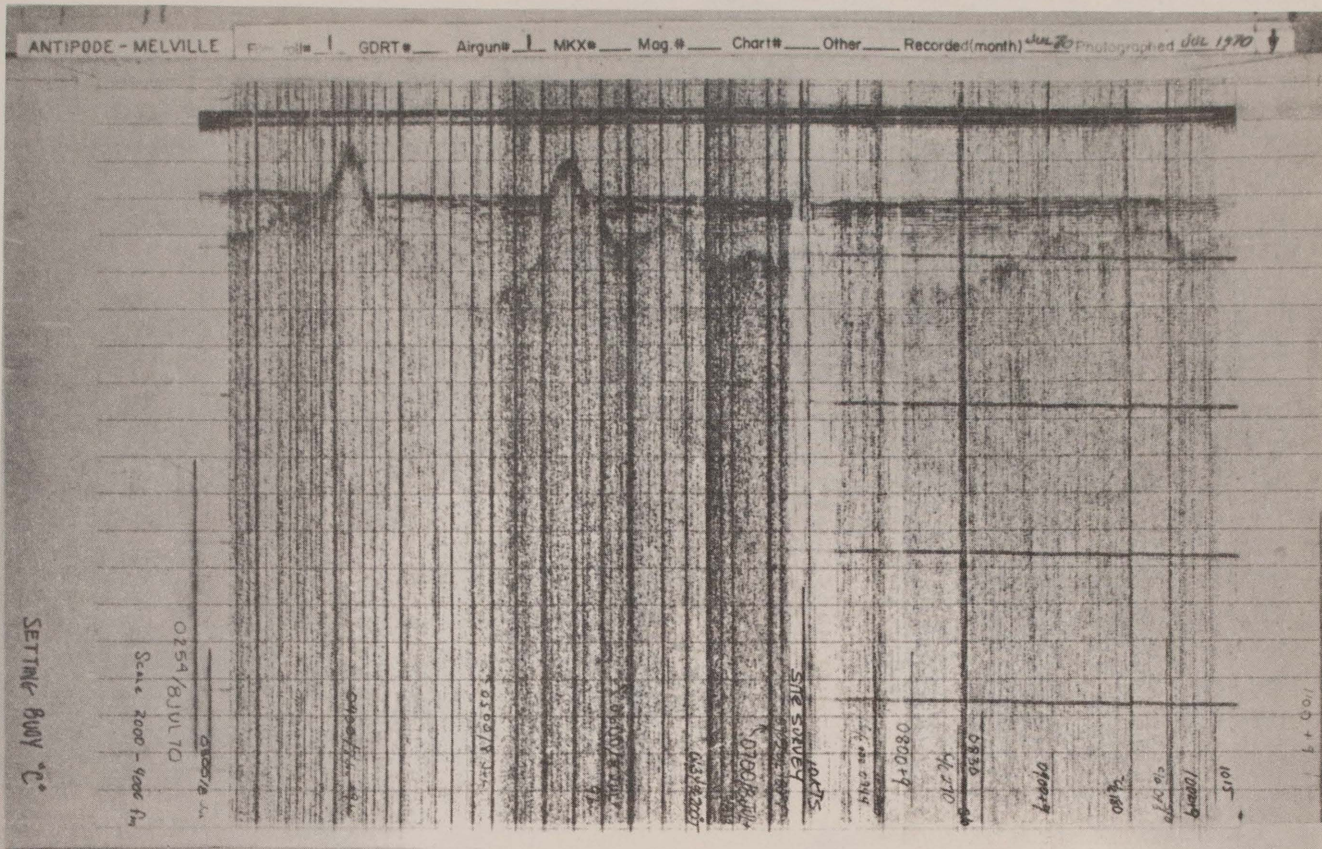
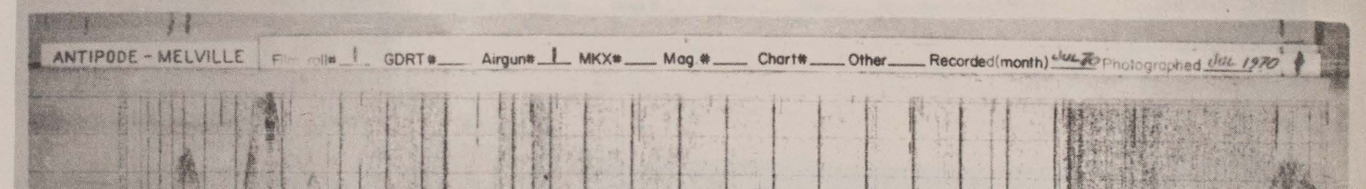
GDRT#
Airgun# 1
MKX#
Mag #
Chart#
Other
Recorded(month) JUL 70
Photographed JUL 1970
Maneuvering to set buoy 3
1900+9
1930
1945

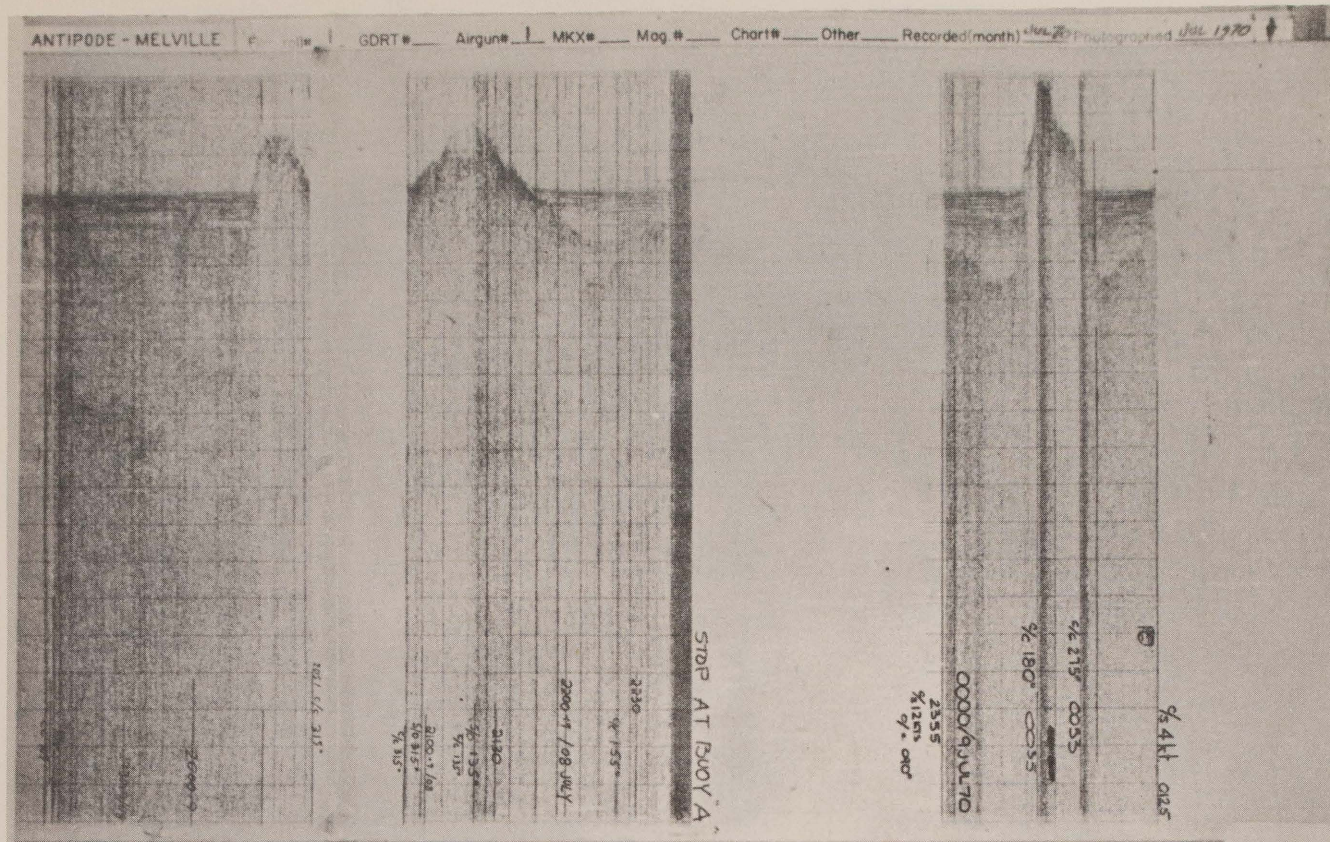
ANT-8


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed JUL 1970
SETTING BUOY "C"
0254/8JUL70
Scale 2000-4000 fm
SITE SURVEY
10 KTS

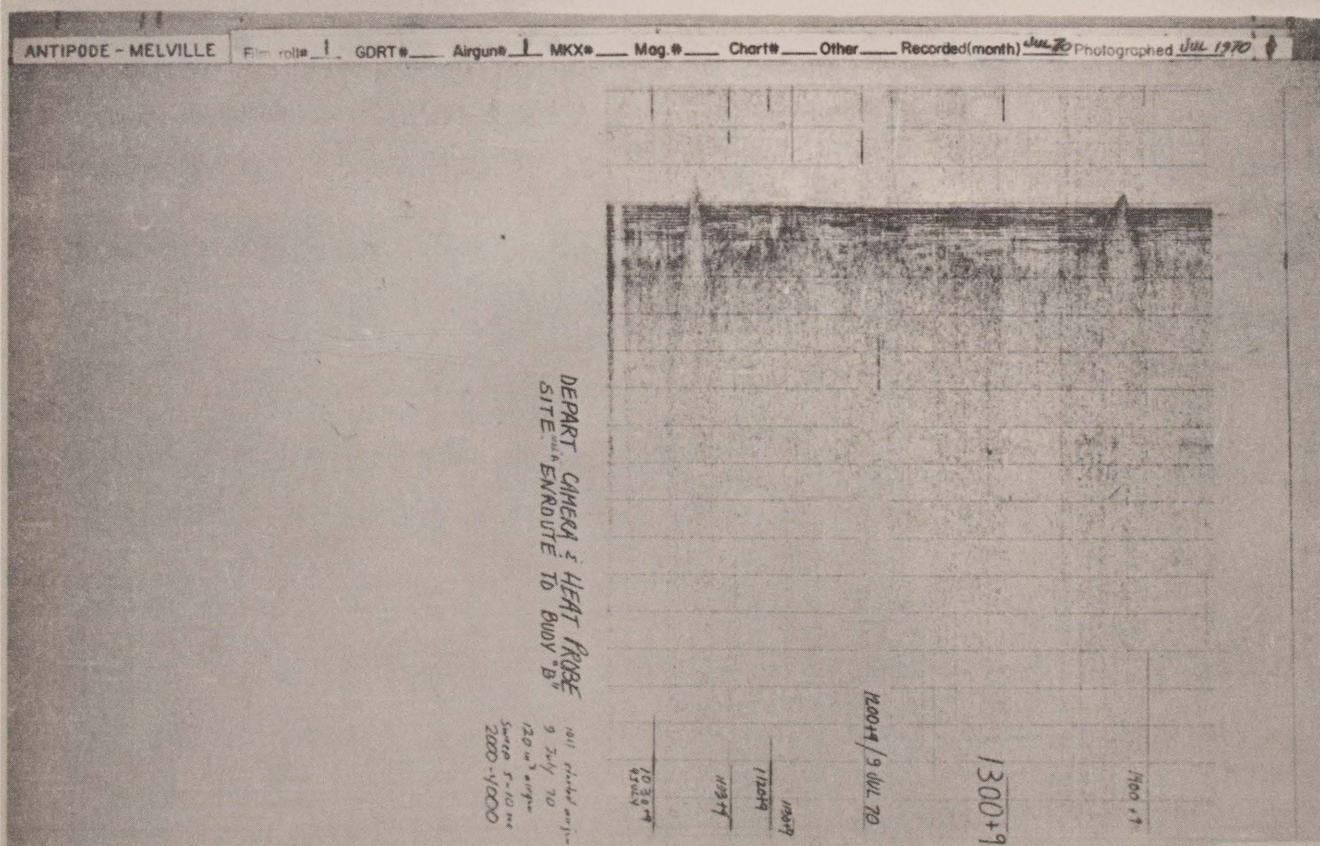
ANT-9


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed JUL 1970
1500+9
INCREASE TO FULL SPEED
S/O 255°
SLOW TO 4 KNOTS
C/C TO 255
1800+9
1730+9
1630+9

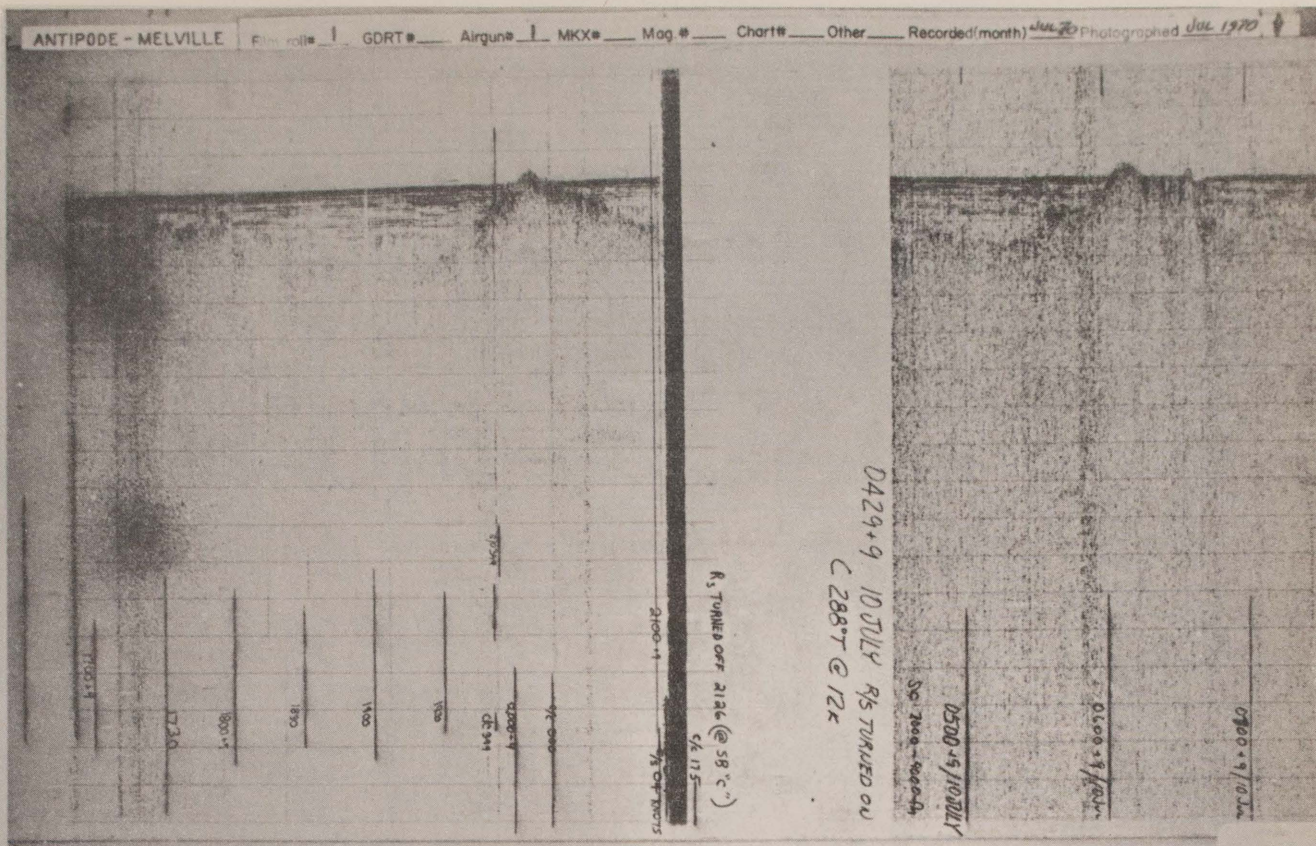
ANT-10


ANTIPODE - MELVILLE
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970
STOP AT BUOY 'A'
0000/9 JUL 70
2355
0053
0055

ANT-11


ANTIPODE - MELVILLE
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970
DEPART CAMERA & HEAT PROBE
SITE: ENROUTE TO BUOY "B"
1200+9/9 JUL 70
1300+9

ANT-12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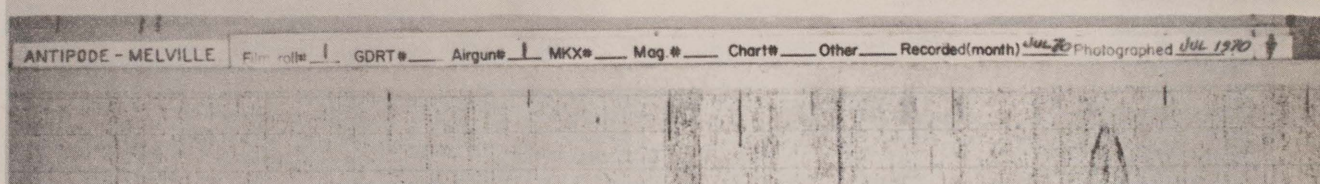
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-13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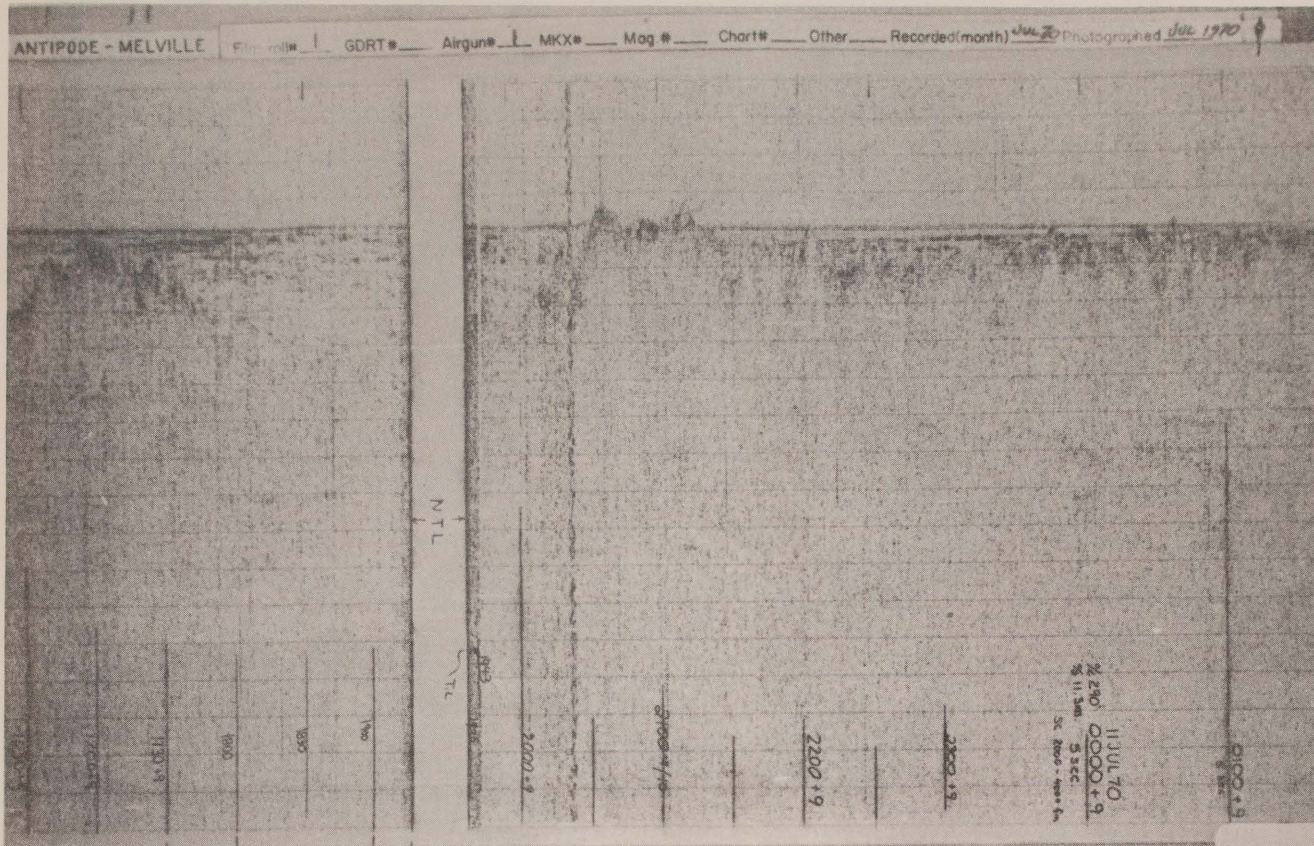
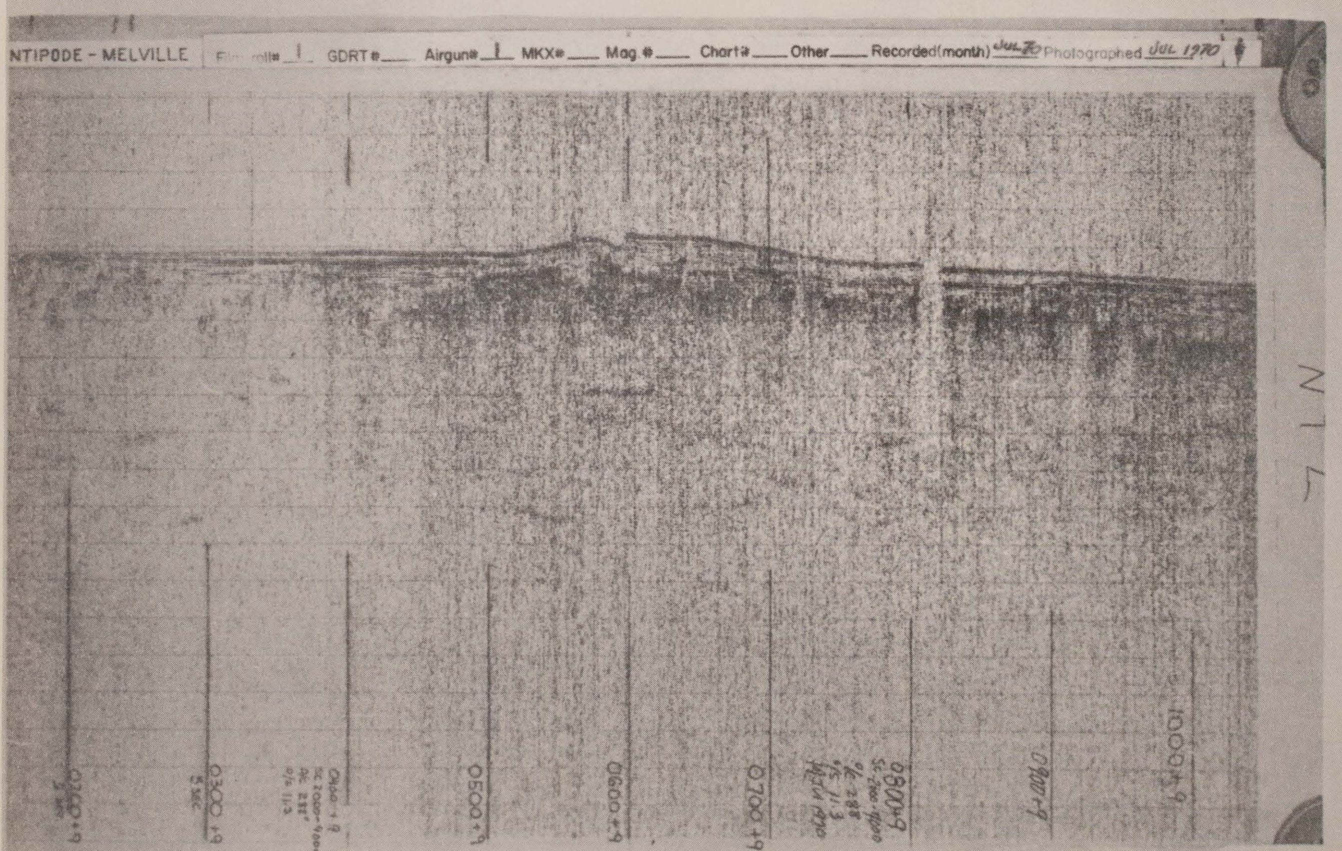
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-14



ANT-15



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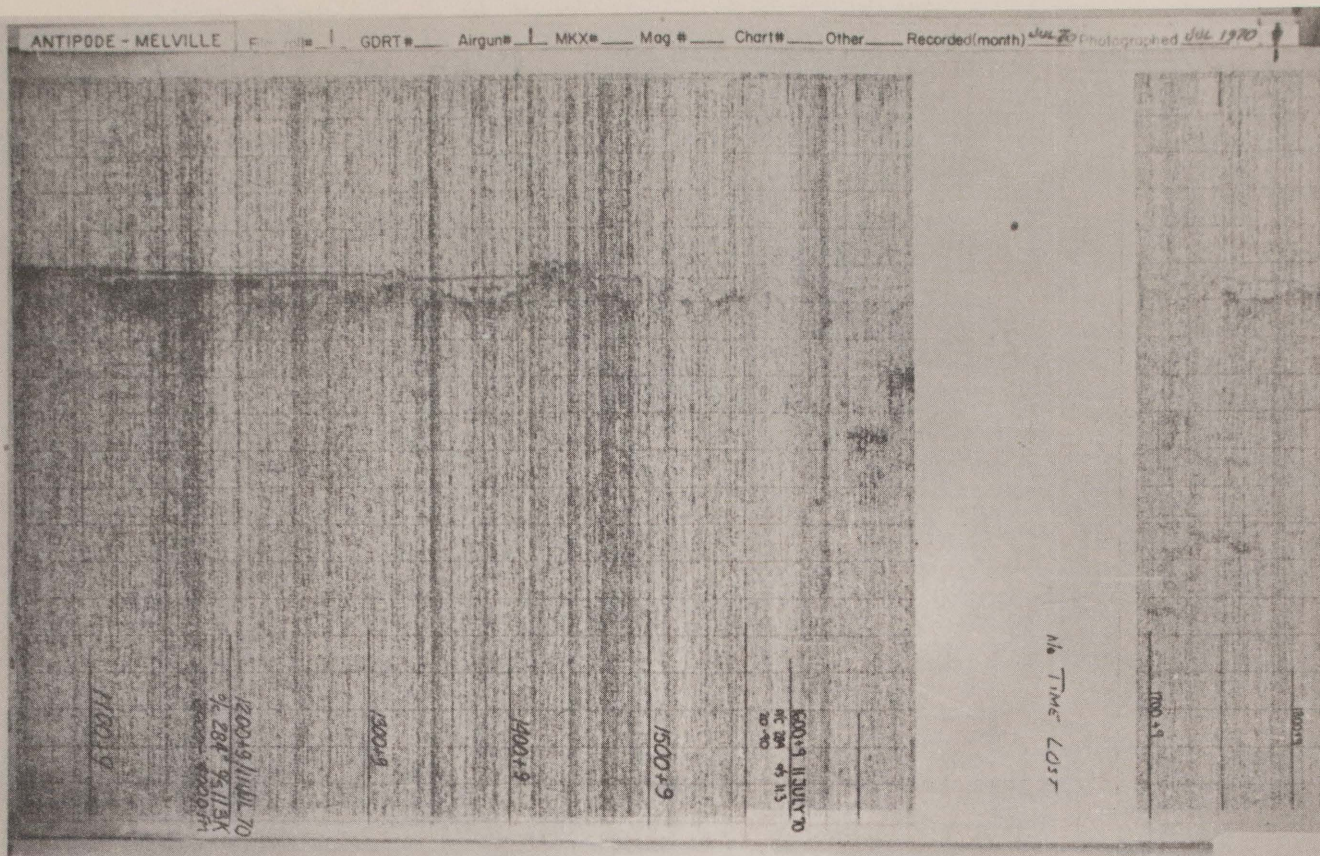
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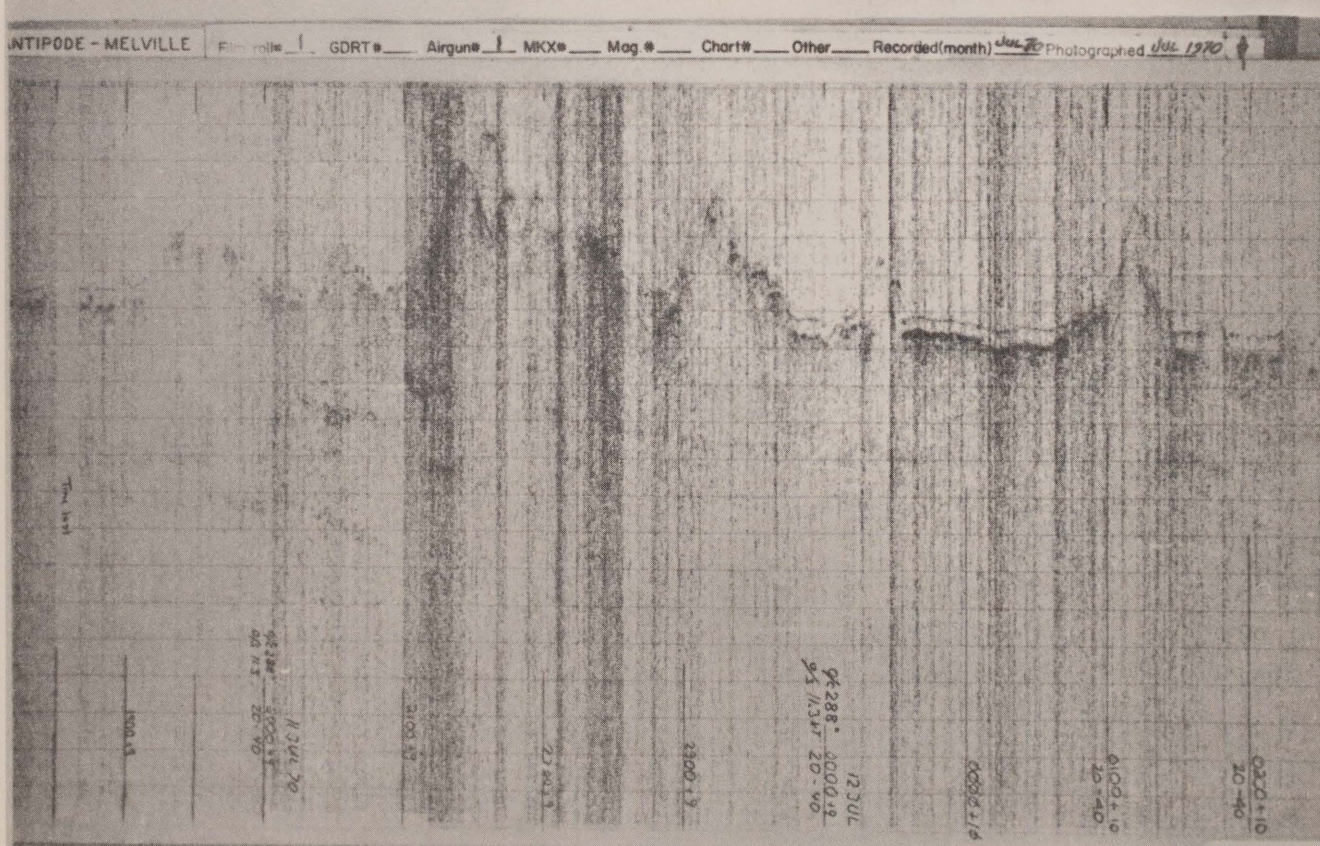
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-17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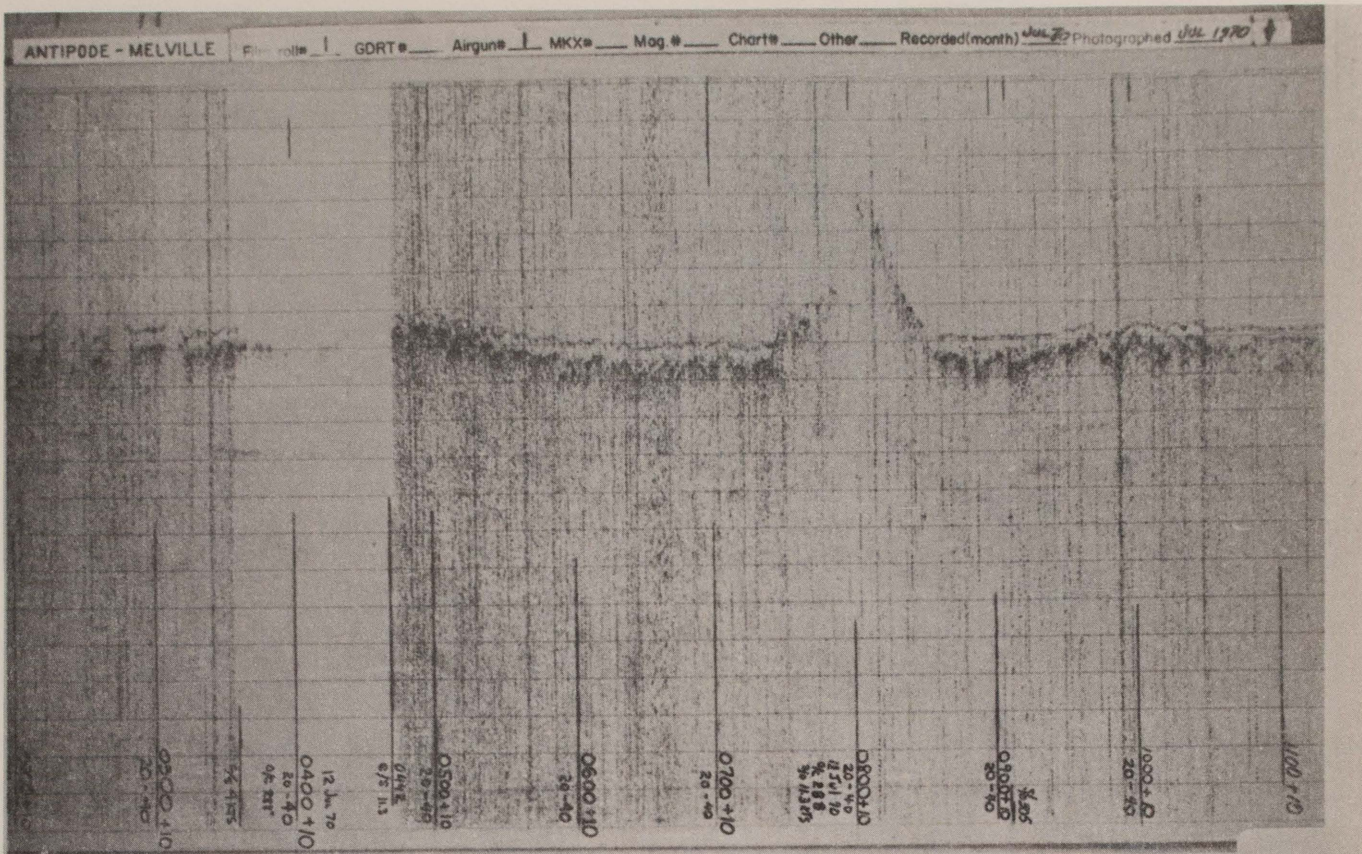
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-18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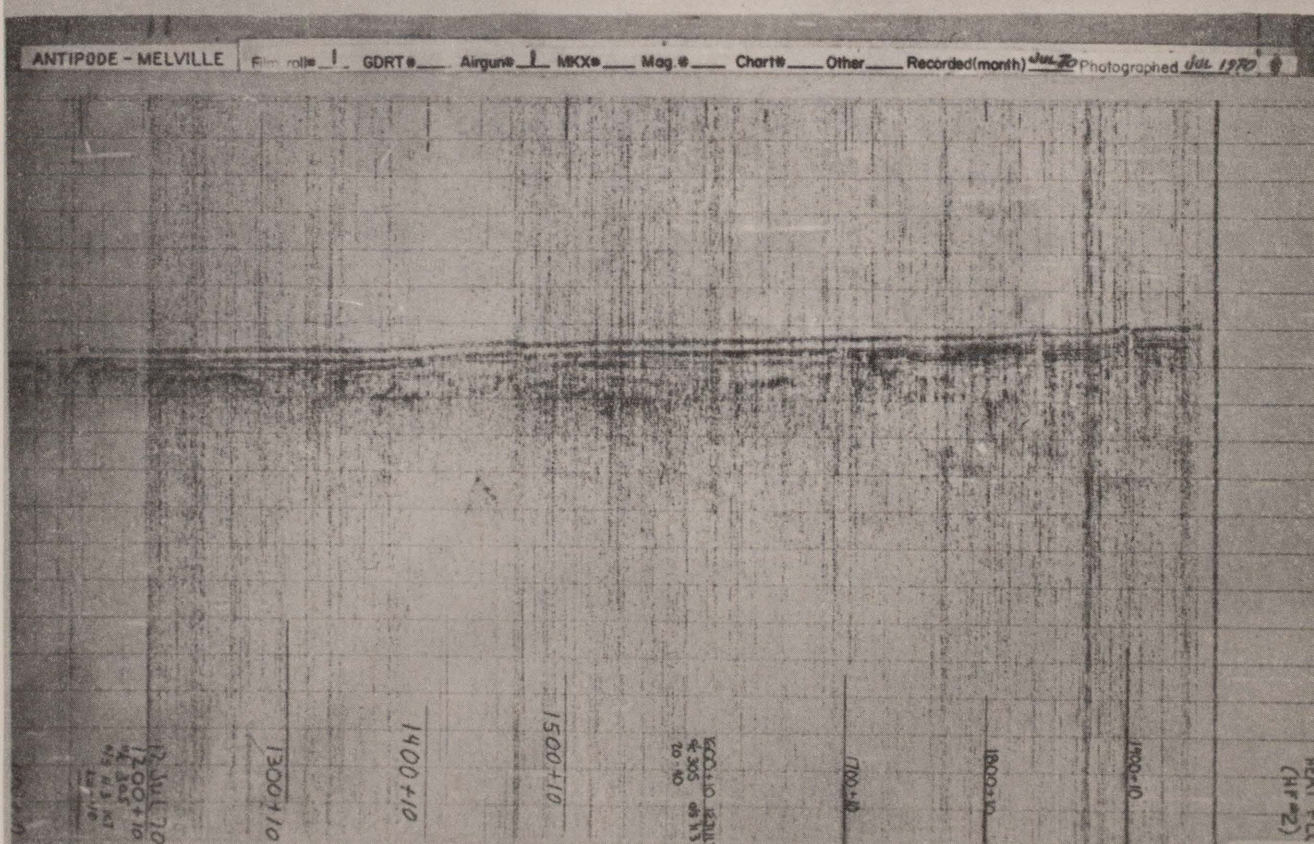
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

ANT-19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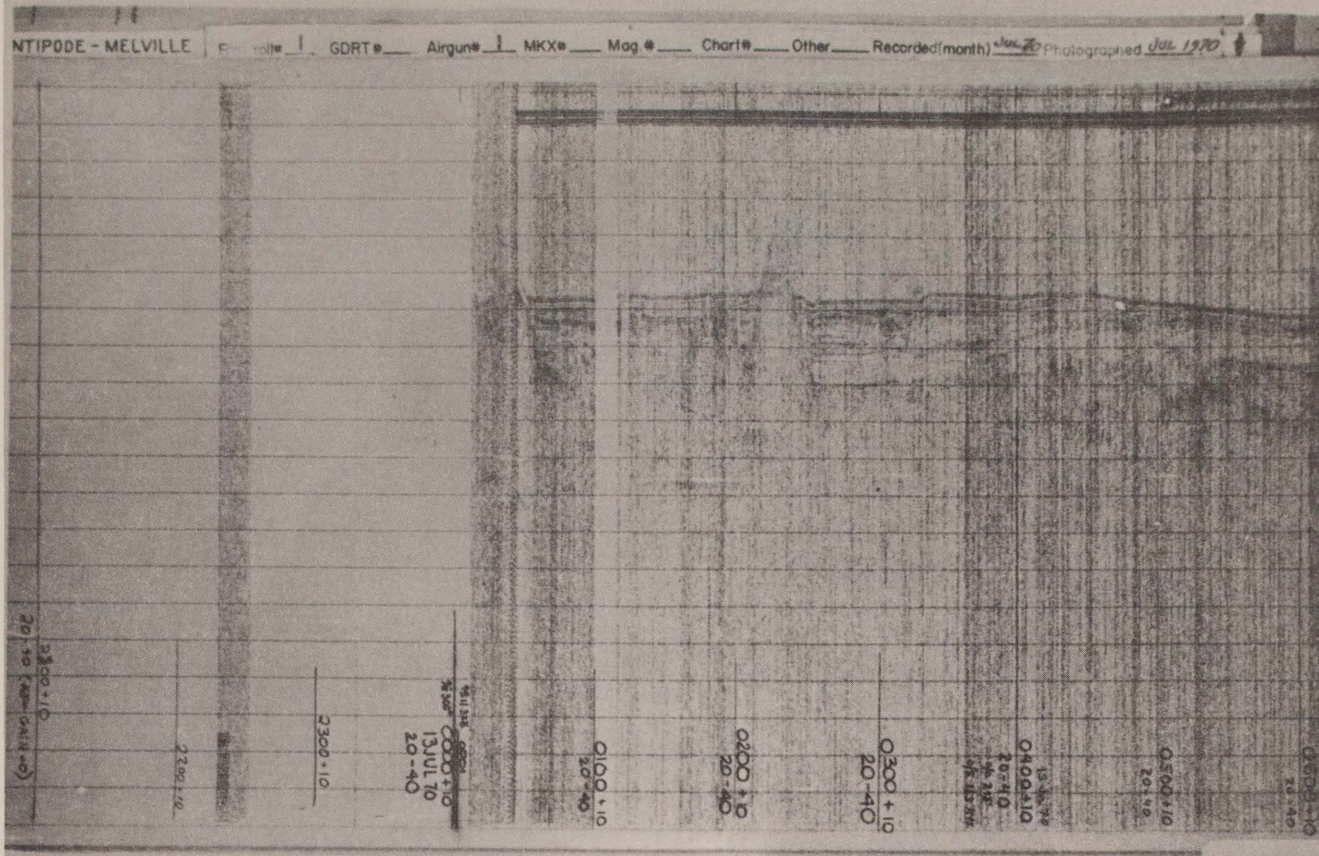
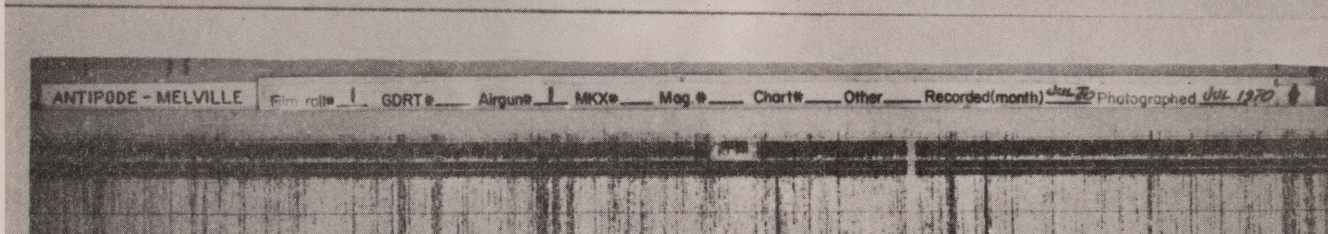
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970

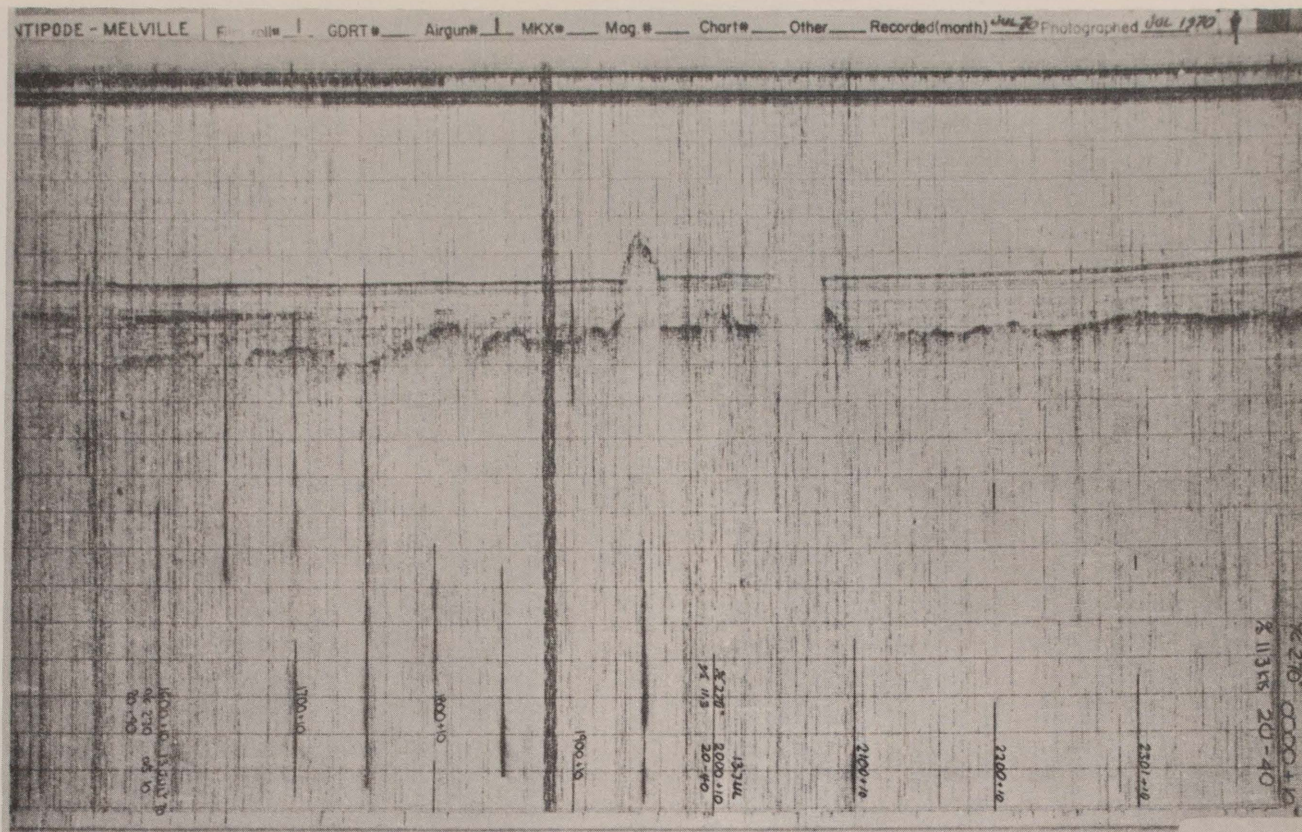
ANT-20


NTIPODE - MELVILLE
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970
0100+10
20-40
0200+10
20-40
0300+10
20-40

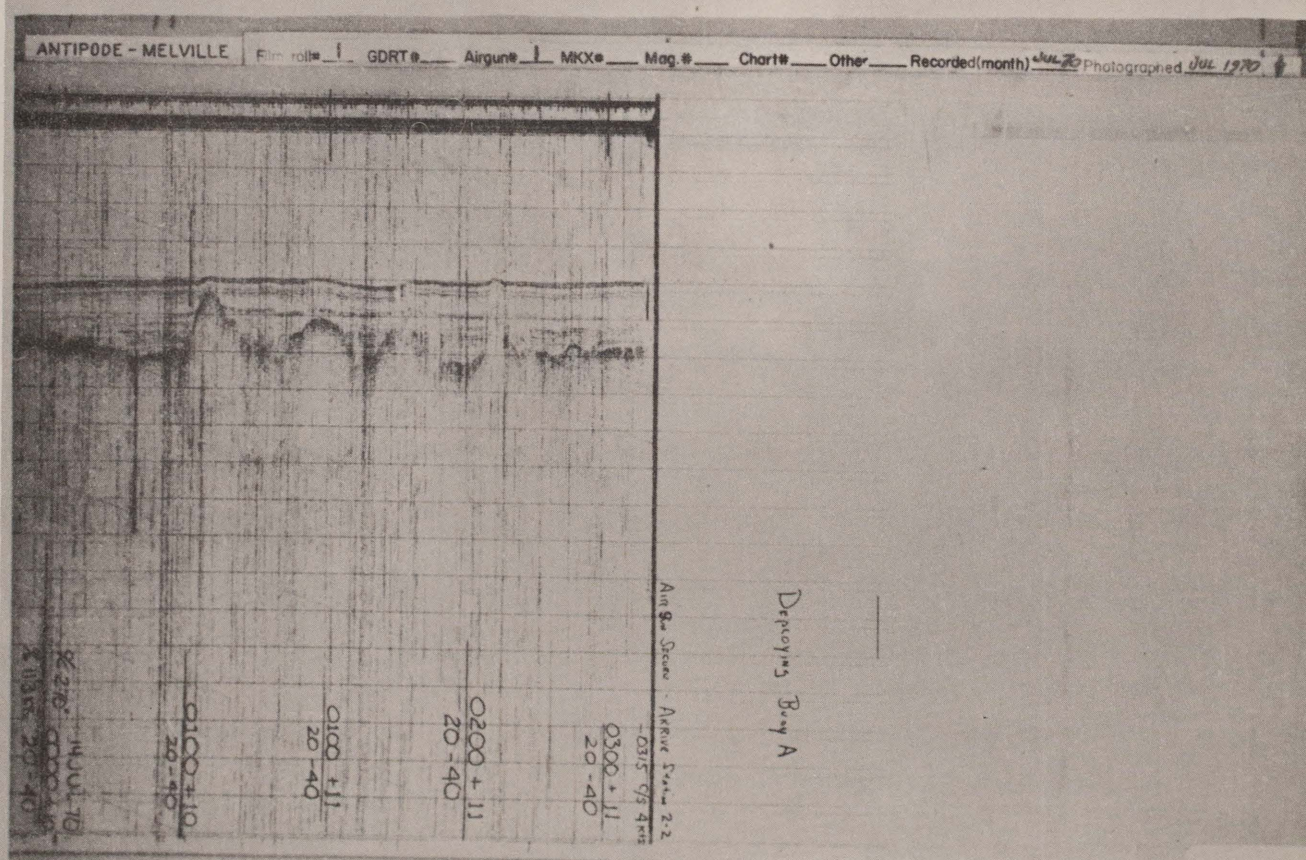
ANT-21


ANTIPODE - MELVILLE
Film roll# 1 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) JUL 70 Photographed JUL 1970
1000+10
1100+10
1200+10
13 JULY 70
1300+10
1400+10
C/C 270

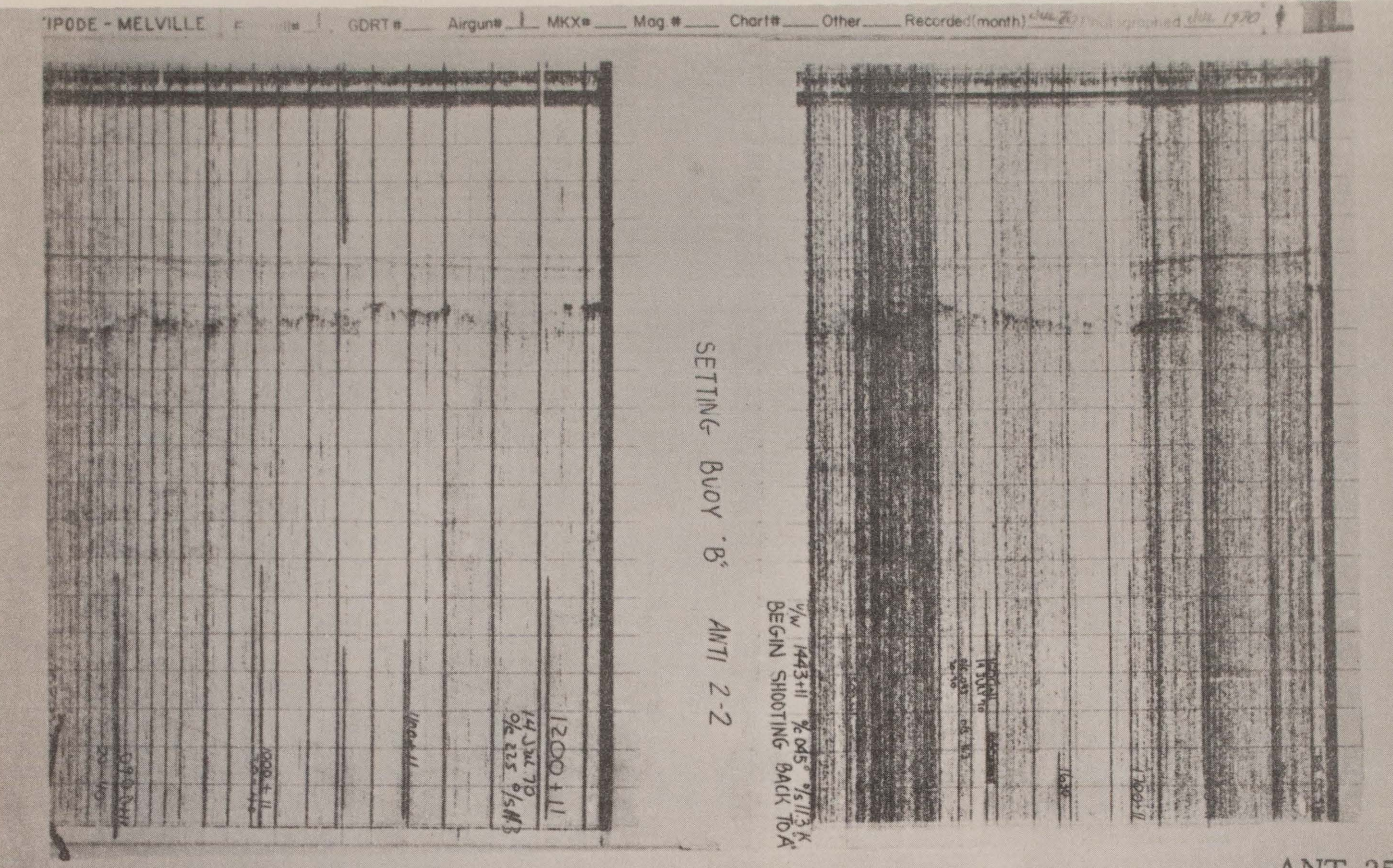
ANT-22


ANTIPODE - MELVILLE
Film roll# 1
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed JUL 1970

ANT-23


ANTIPODE - MELVILLE
Film roll# 1
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed JUL 1970
0100 + 10
20 - 40
0100 + 11
20 - 40
0200 + 11
20 - 40
0300 + 11
20 - 40
Deploying Buoy A

ANT-24



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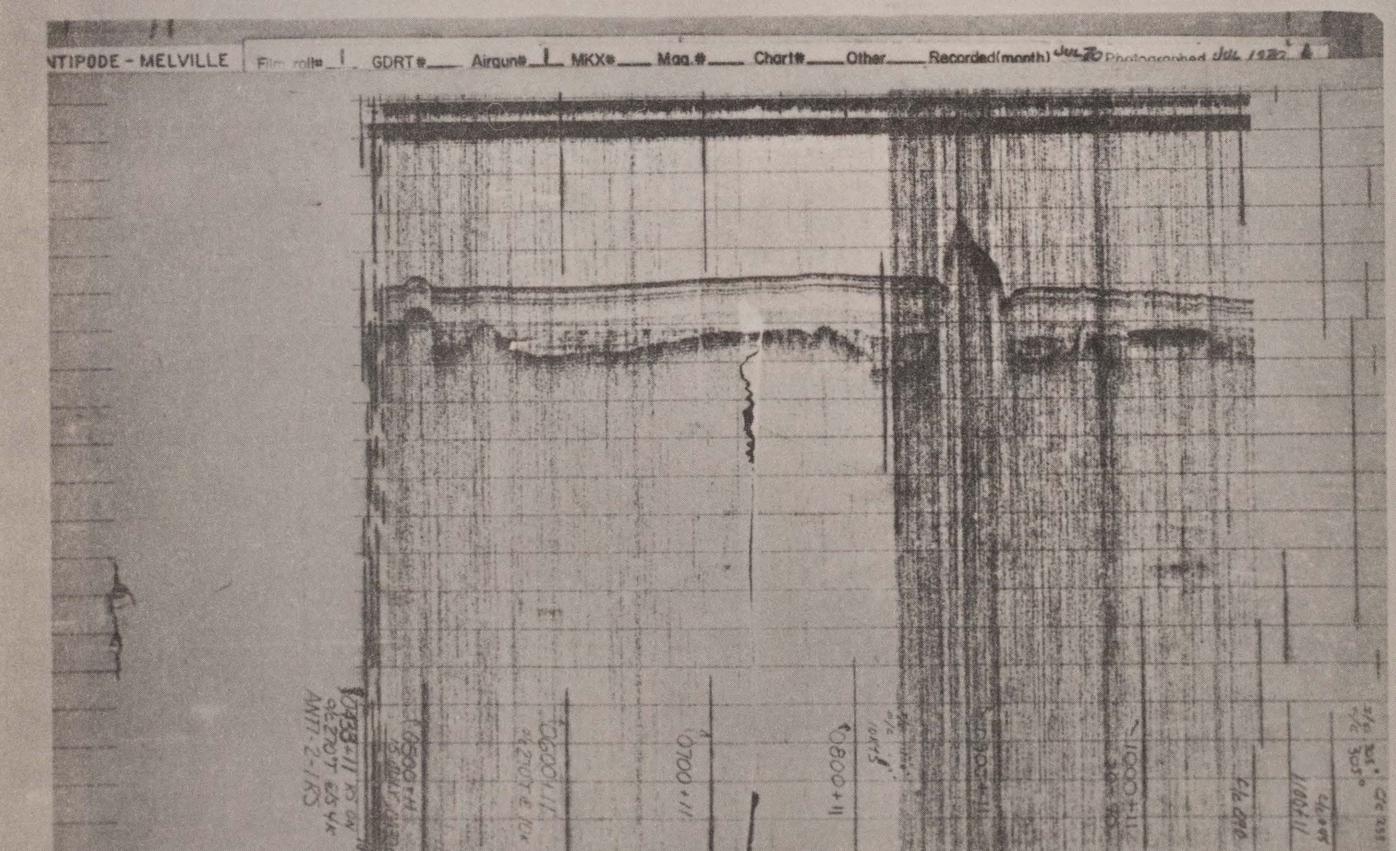

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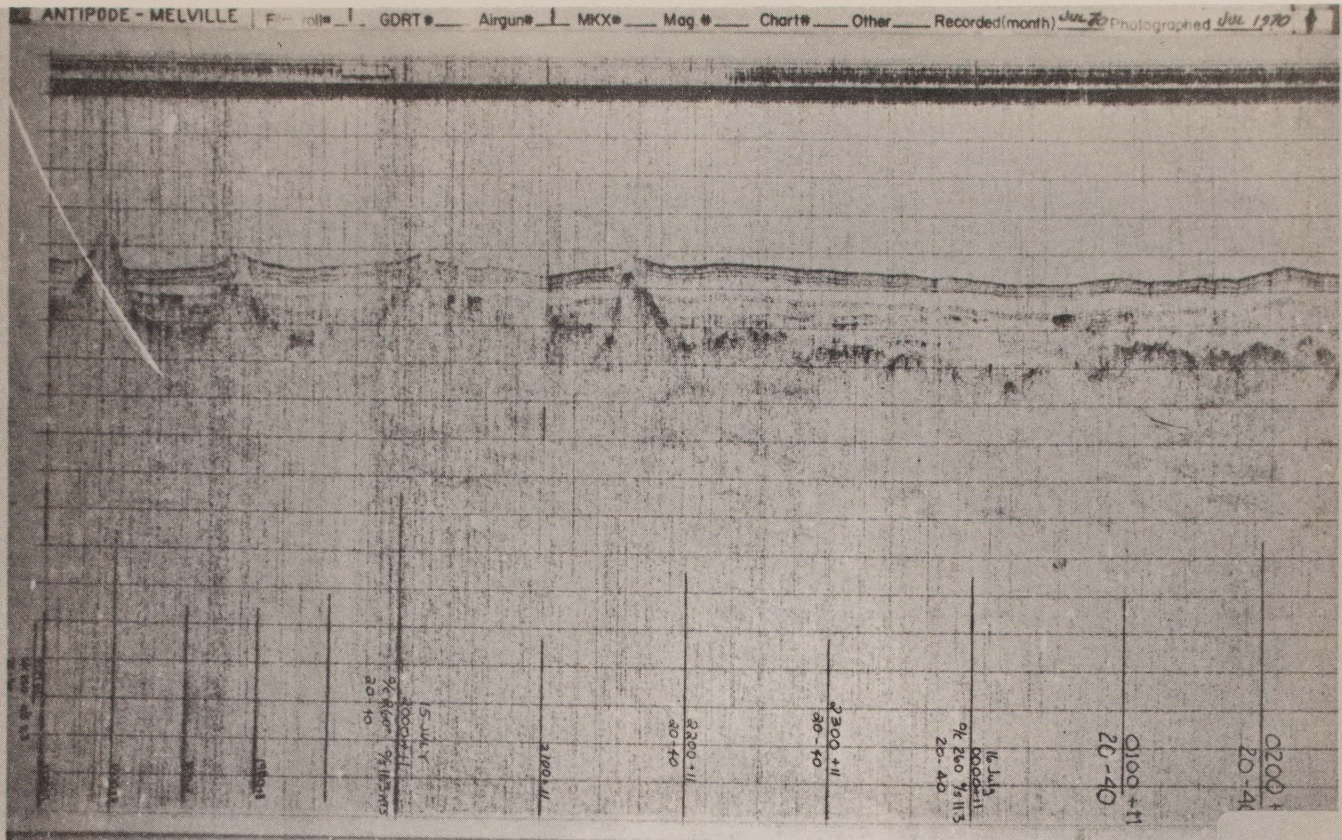
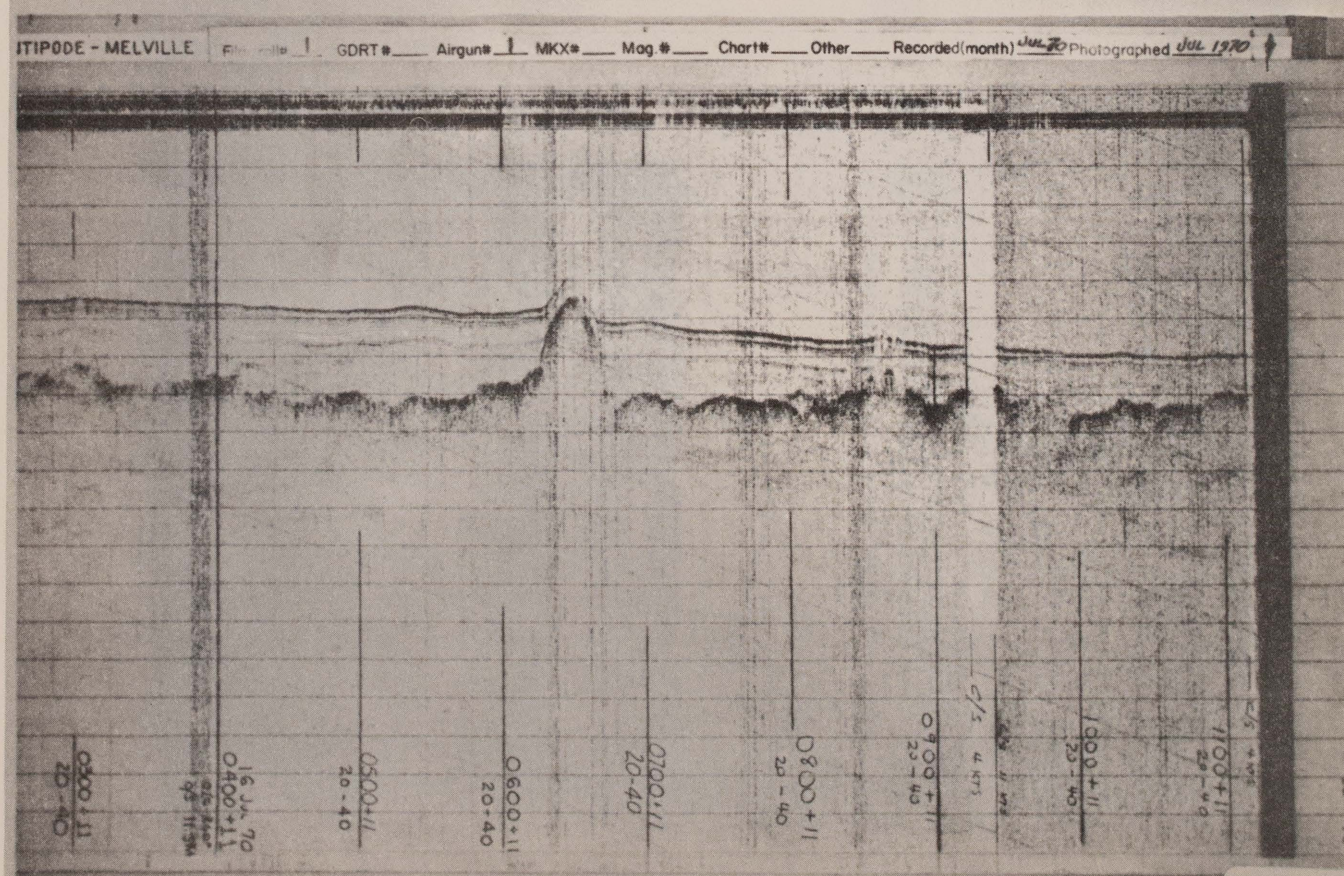

ANTIPODE - MELVILLE
Airgun# 1
Recorded(month) JUL 70
Photographed JUL 1970

ANT-27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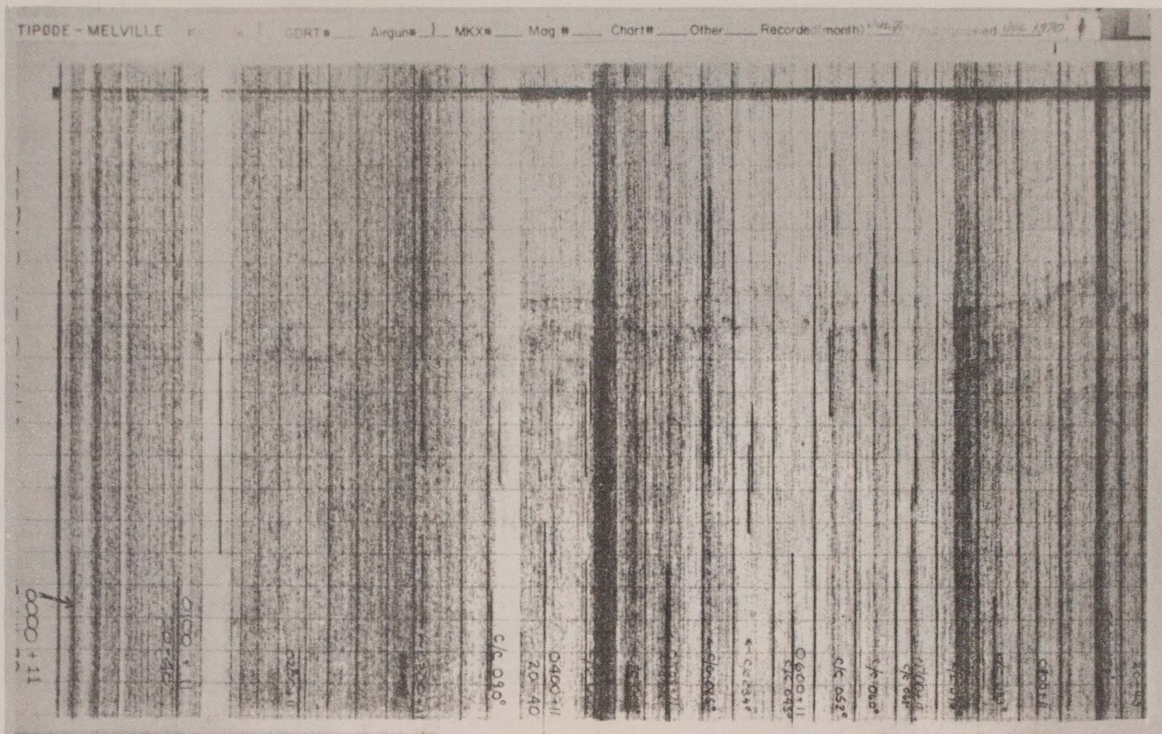
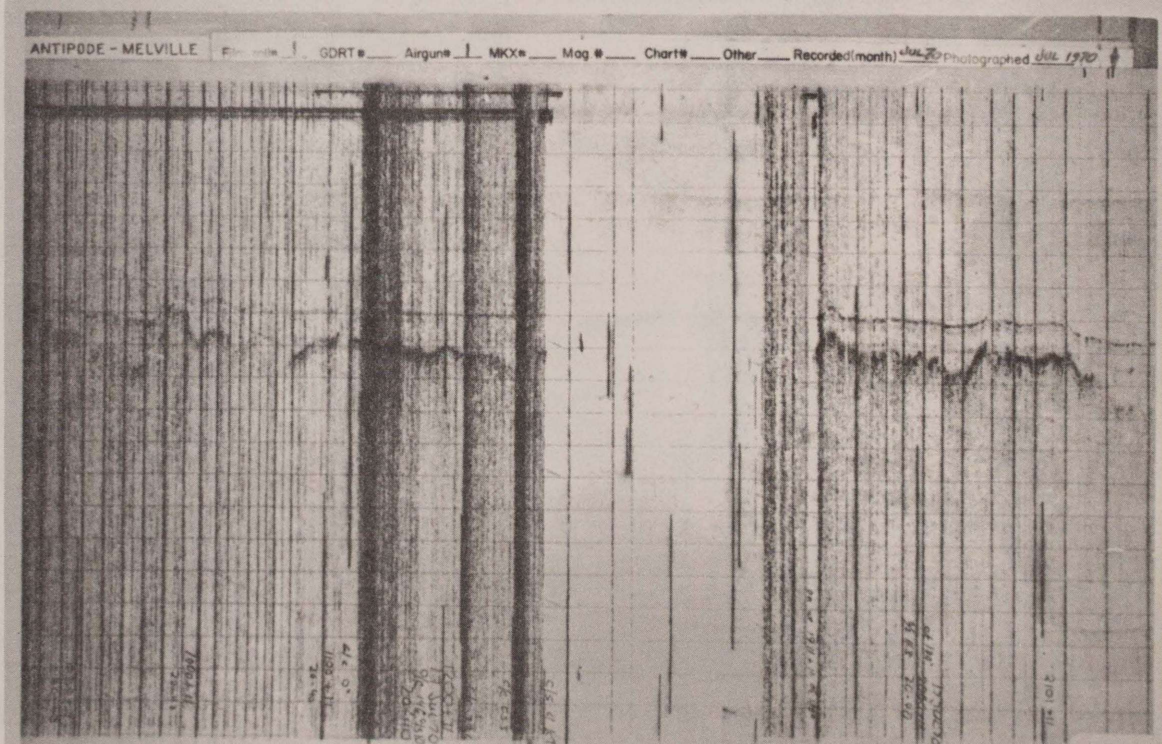
Airgun# 1
Recorded(month) JUL 70
Photographed JUL 1970

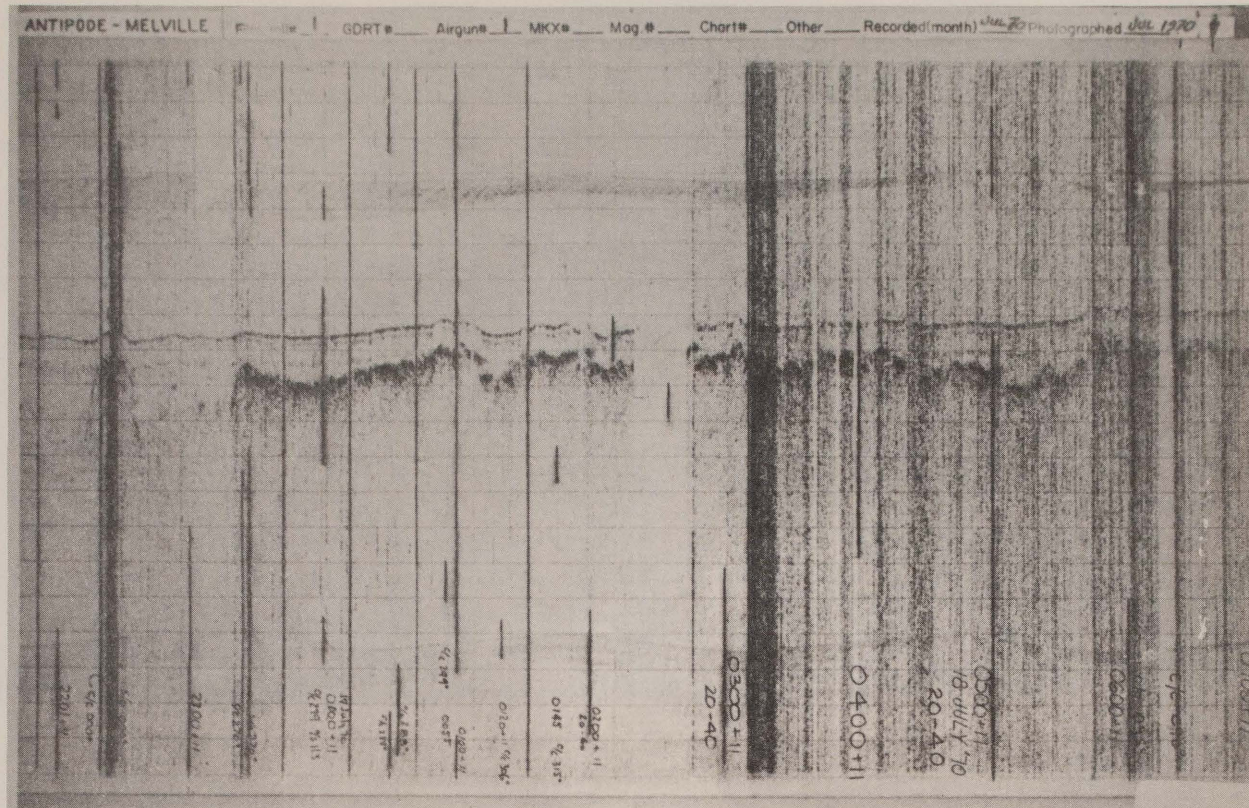
ANT-28


TIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag #
Chart#
Other
Recorded(month)

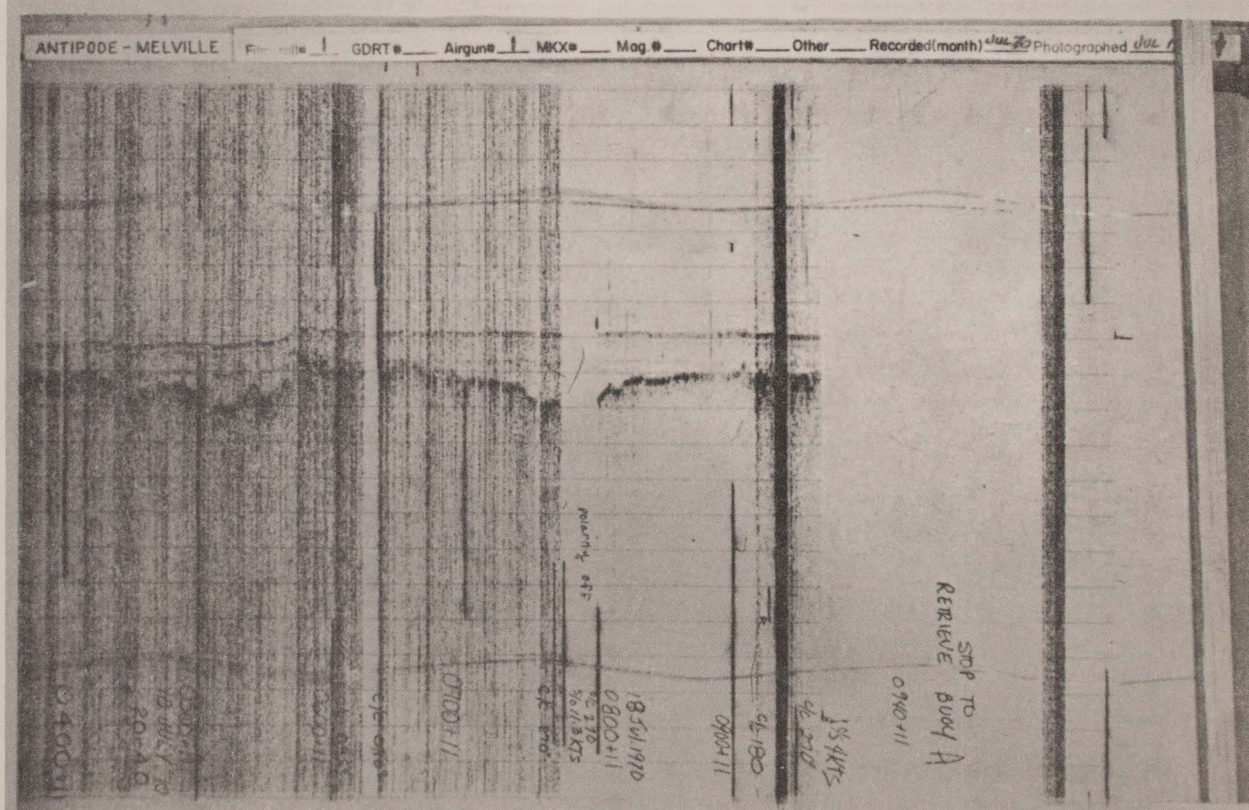
ANT-29


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag #
Chart#
Other
Recorded(month)
Photographed

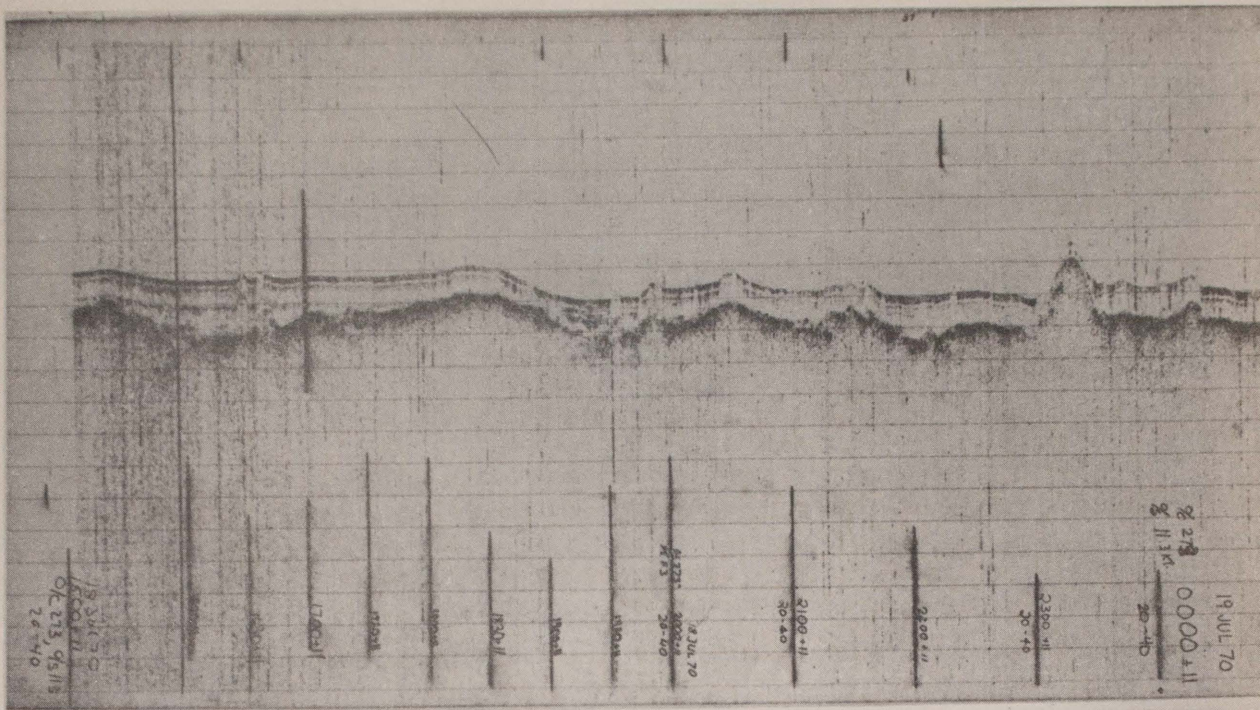
ANT-30


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month) JUL 70
Photographed JUL 1970
0300+11
20-40
0400+11
0500+11
18 JULY 70
20-40
0600+11

ANT-31


ANTIPODE - MELVILLE
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month) JUL 70
Photographed JUL
0400+11
18 JULY 70
20-40
0700+11
18 JUL 1970
0800+11
0900+11
STOP TO
RETRIEVE BUOY A
0940+11

ANT-32



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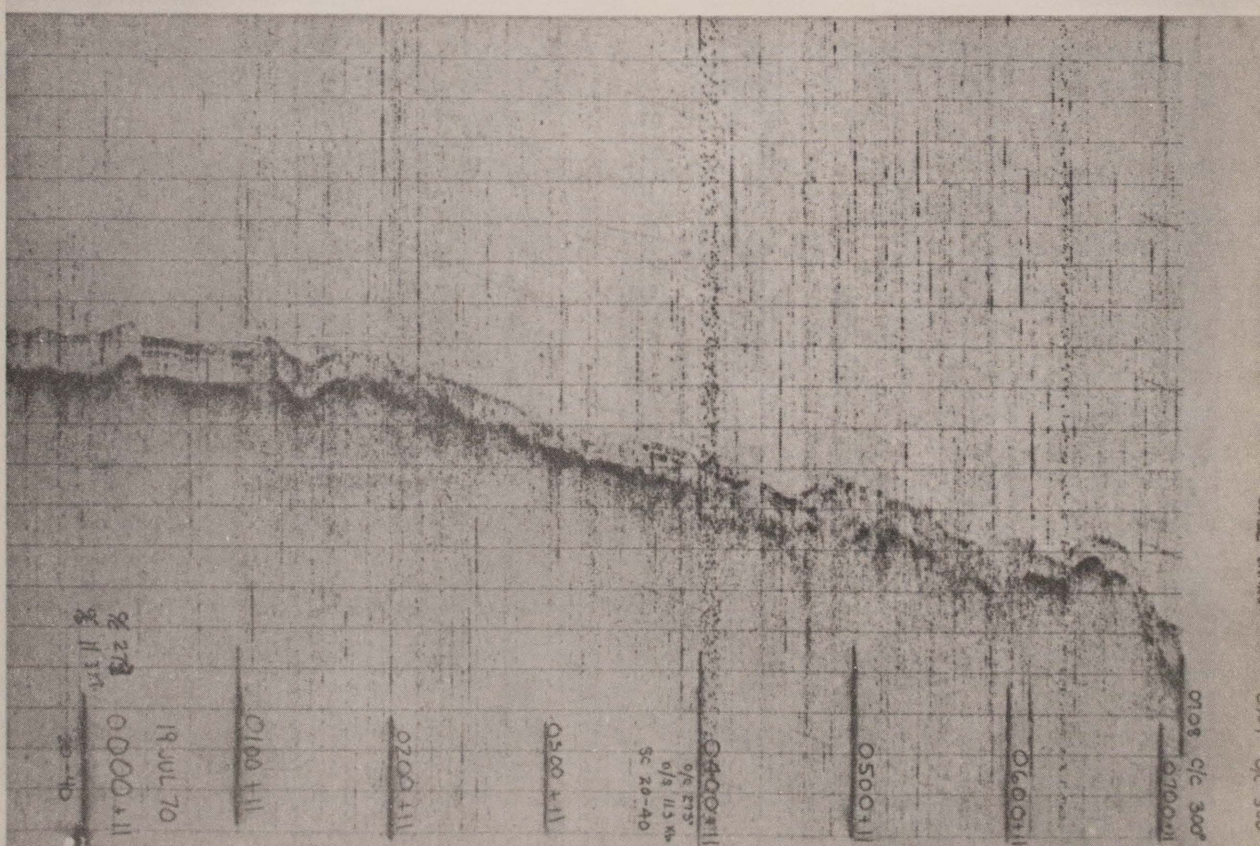

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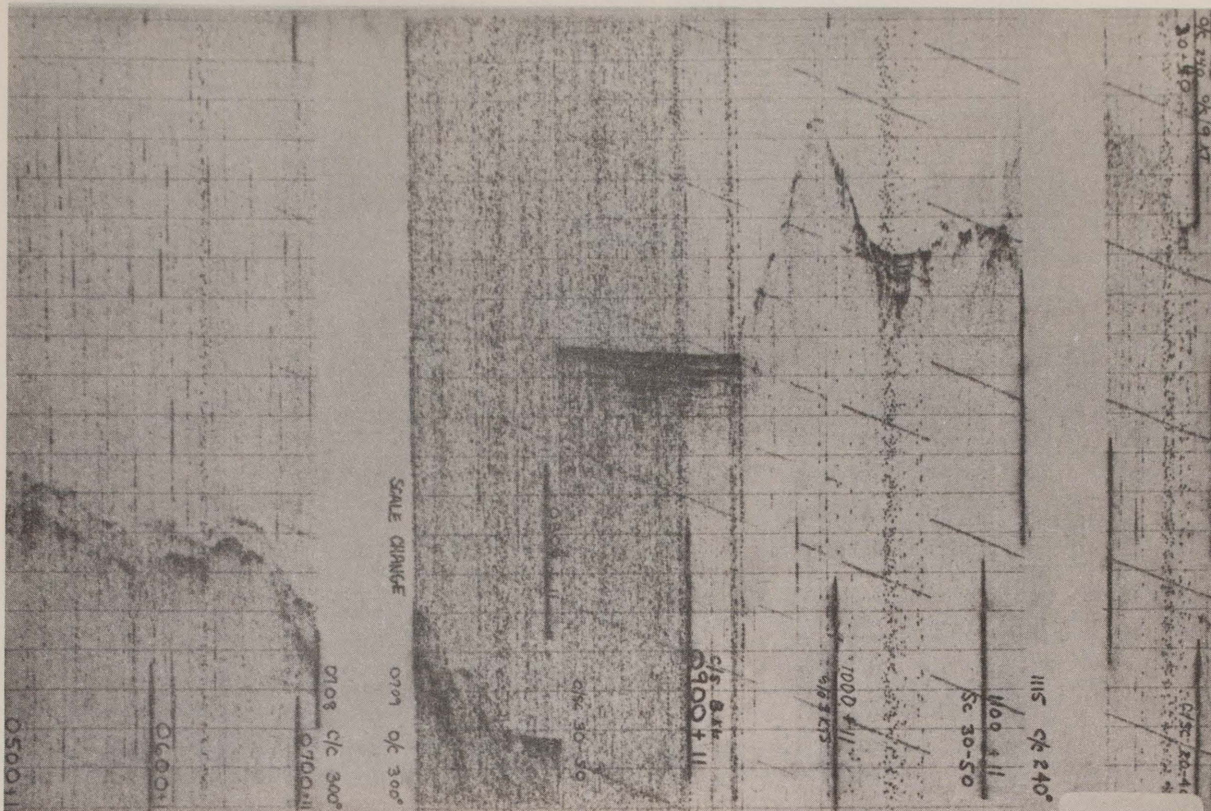
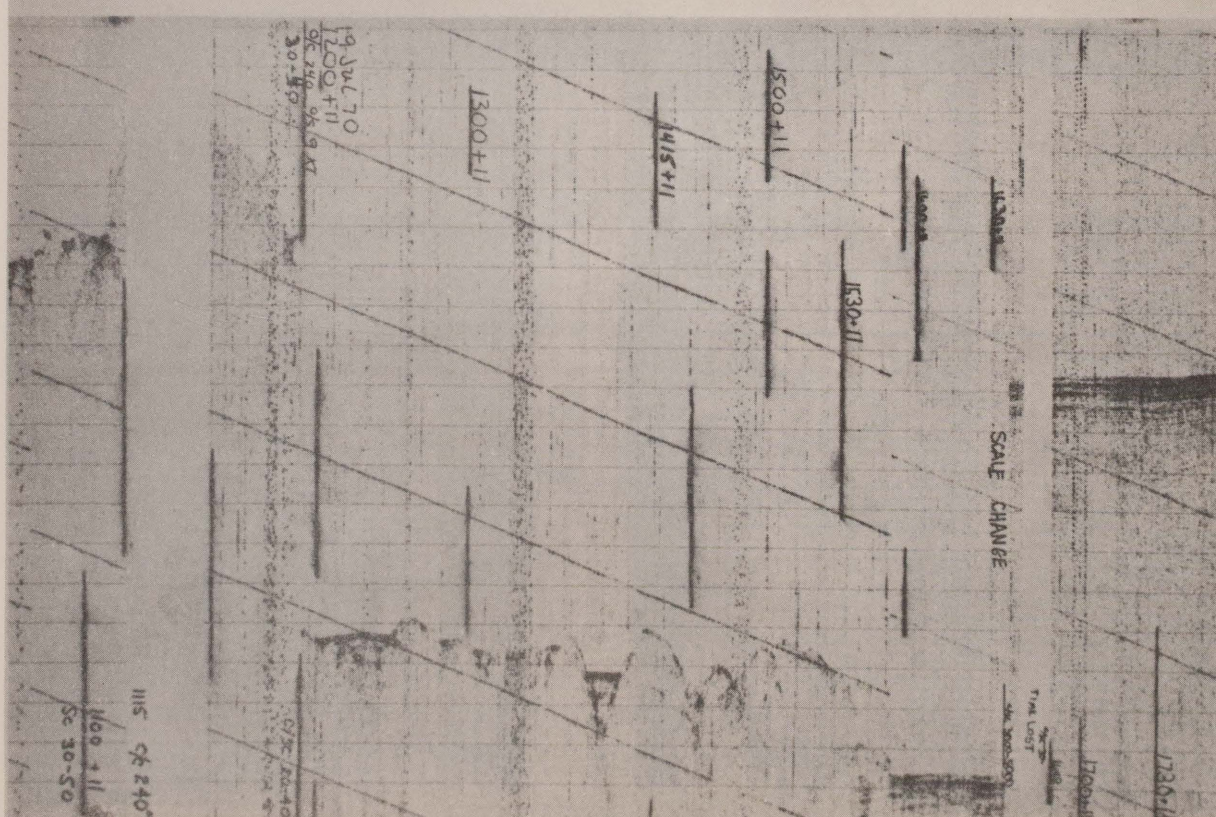
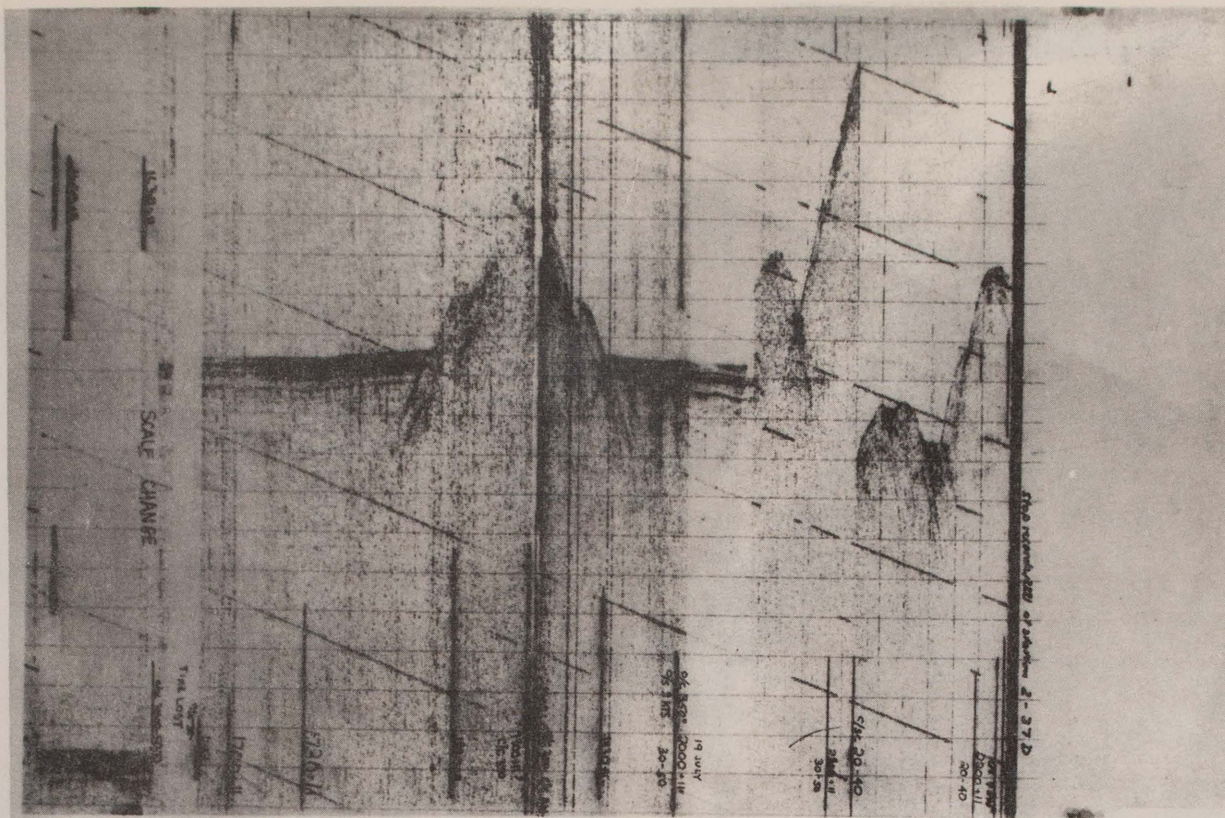

SCALE CHANGE
0500+11
0600+11
0700+11
0900+11
1000+11
1100+11
Sc 30-50
1115 c/c 240°

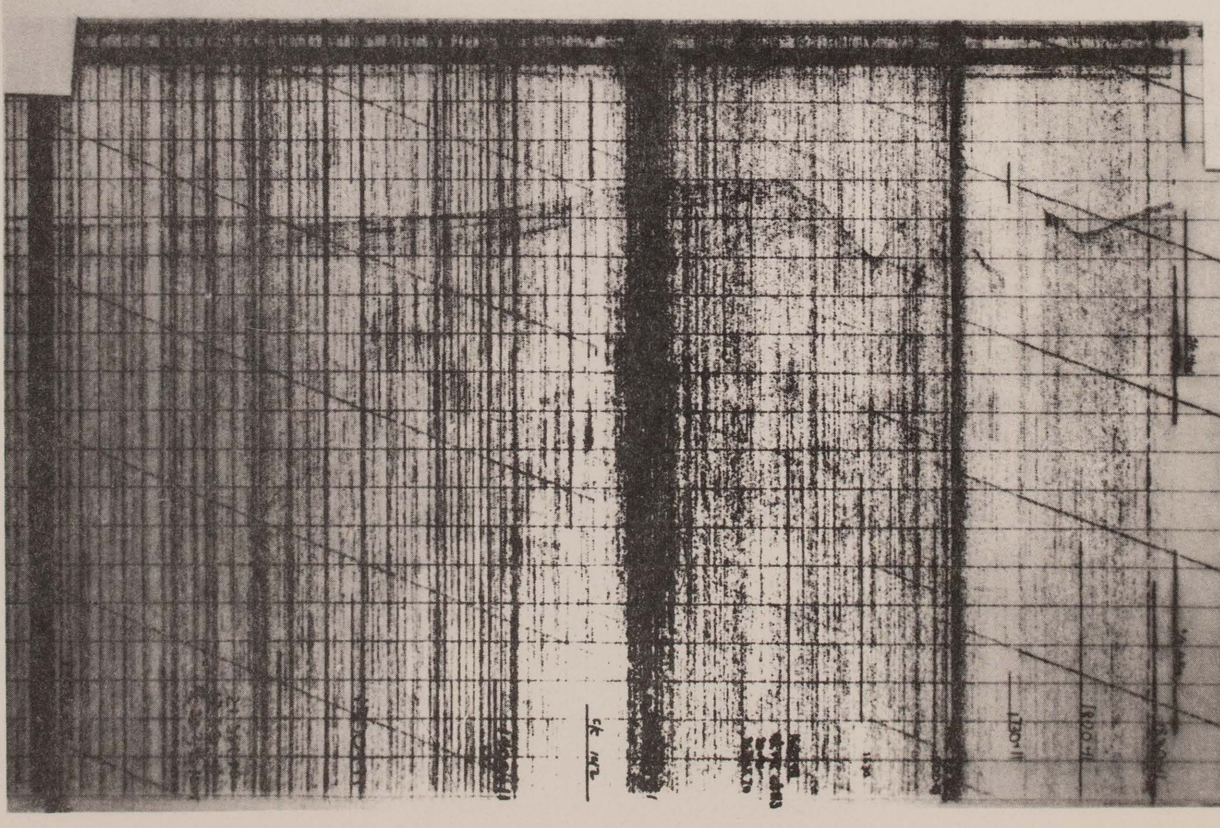
ANT-35


19 Jul 70
1200+11
1300+11
1415+11
1500+11
1530+11
SCALE CHANGE
1115 c/c 240°
1100+11
Sc 30-50

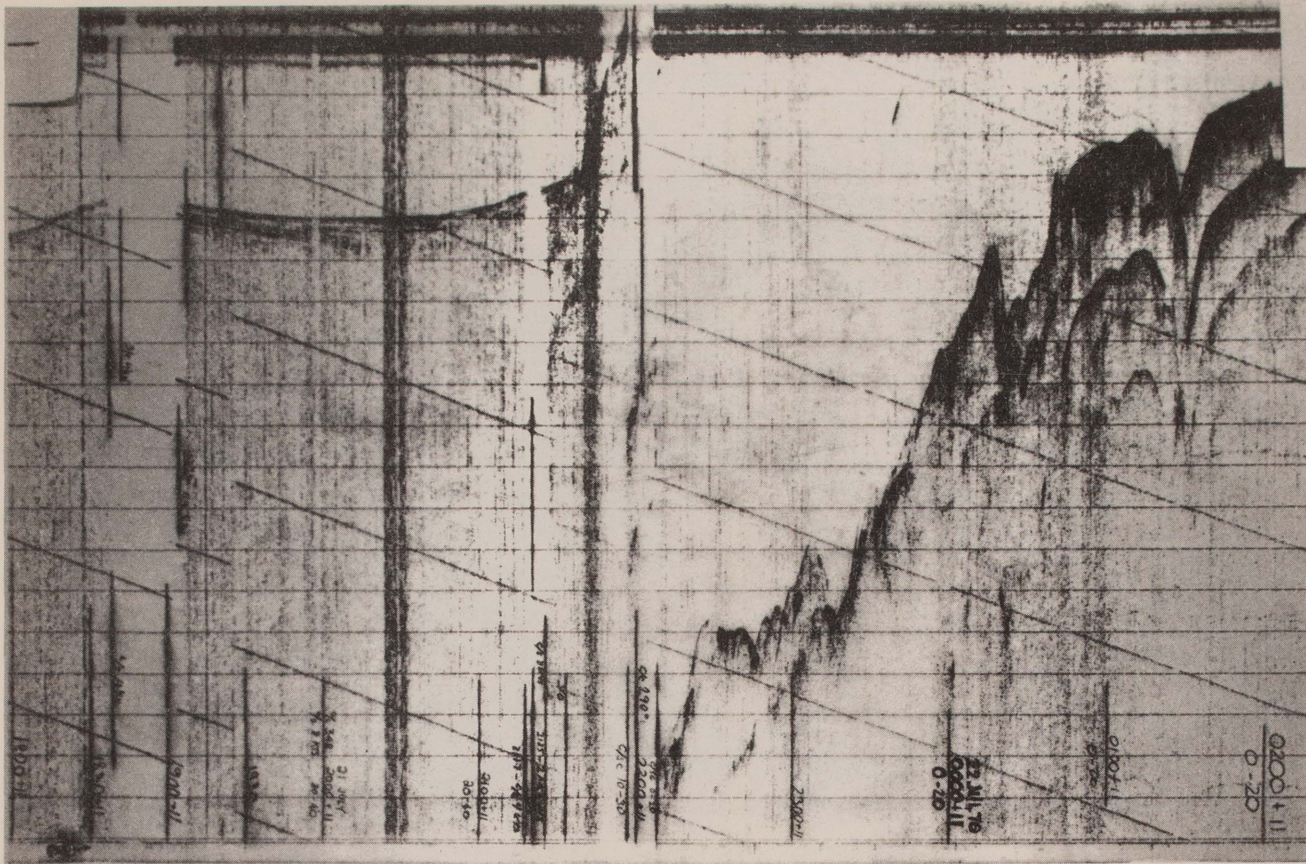
ANT-36



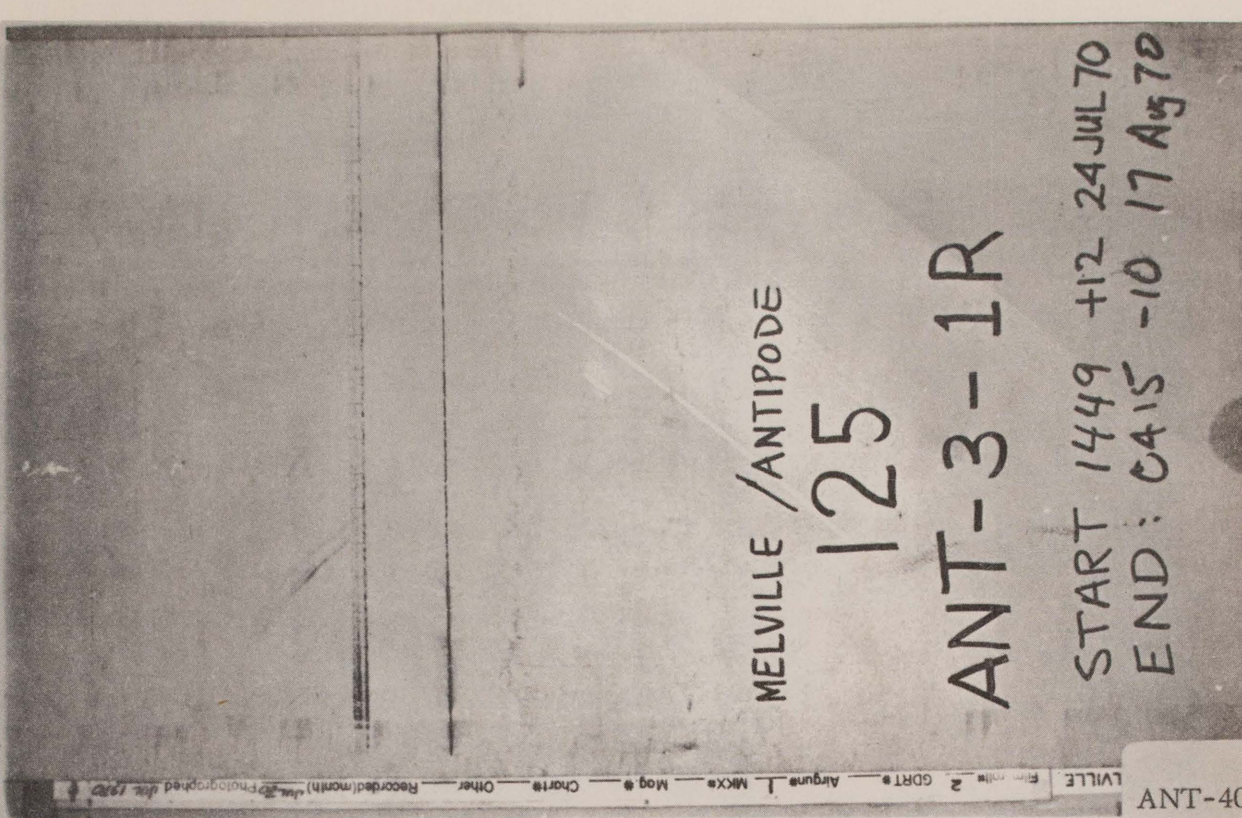
ANT-37



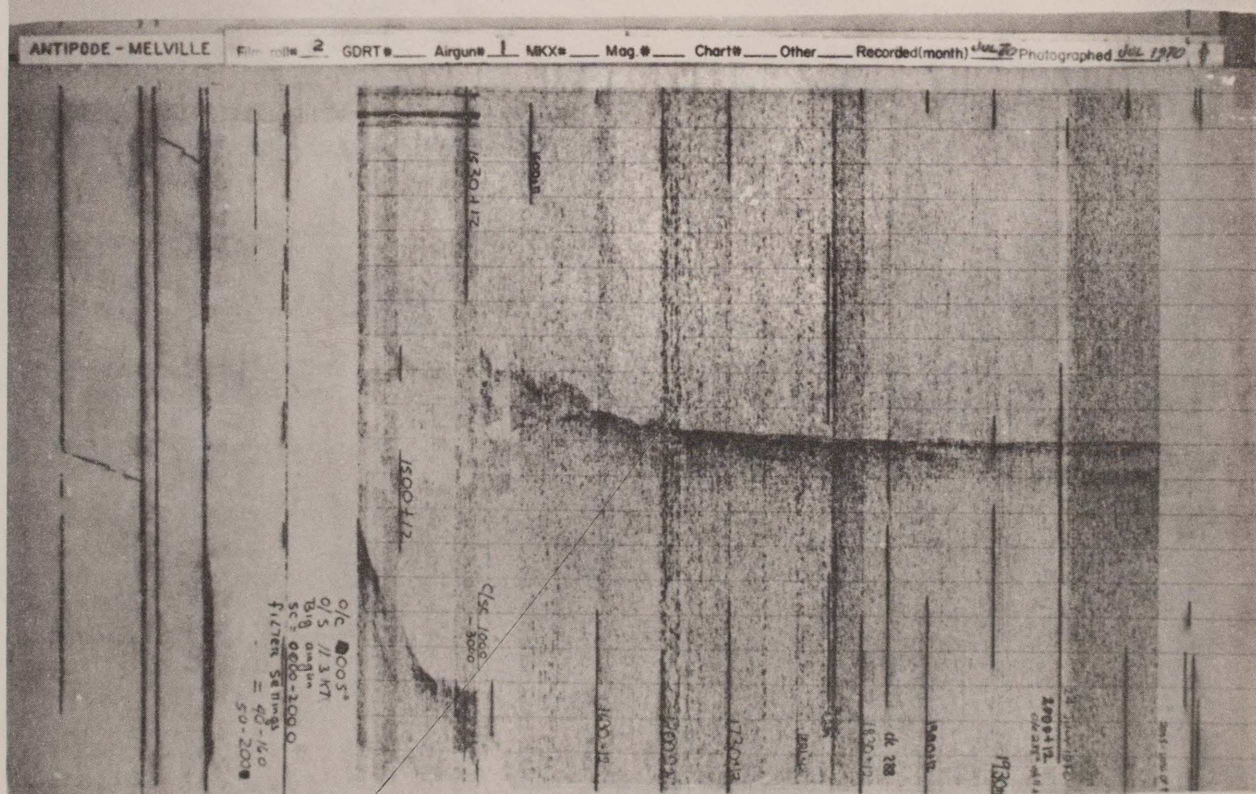
ANT-38



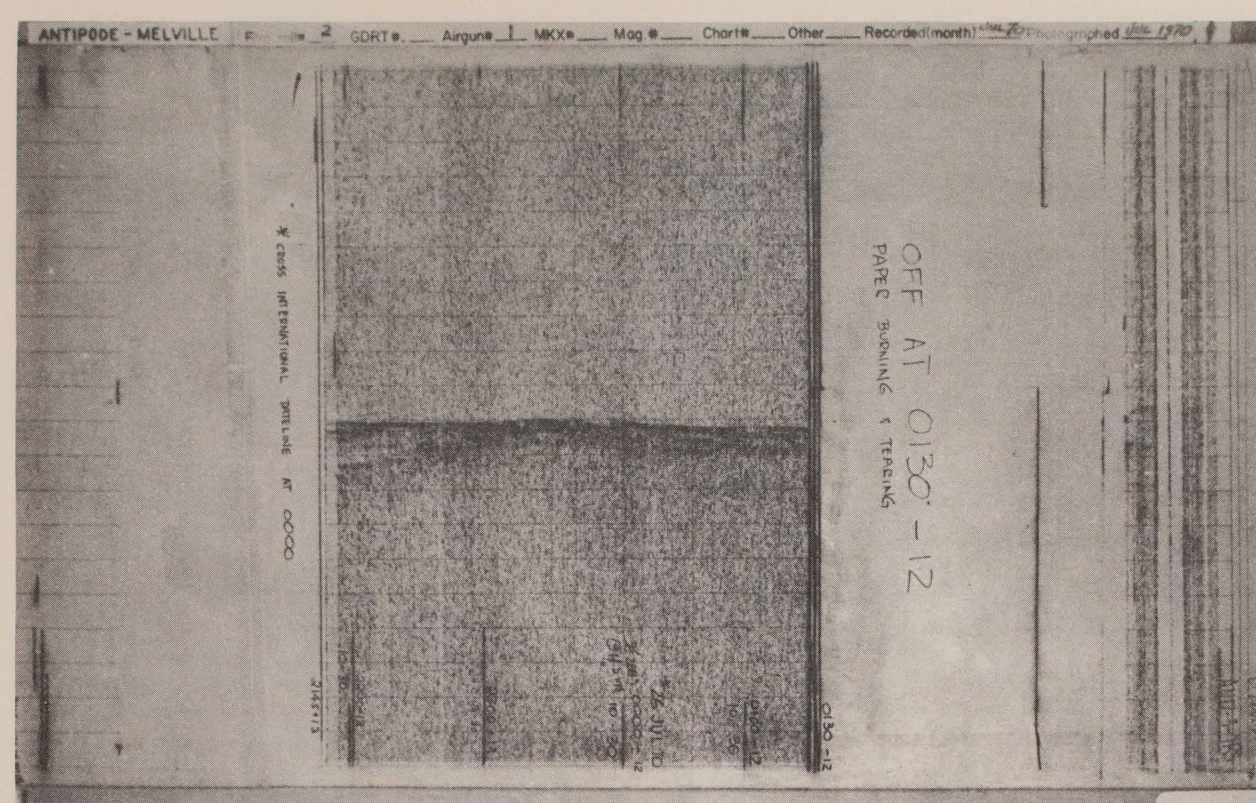
ANT-39


MELVILLE /ANTIPODE
125
ANT-3-1R
START 1449 +12 24 JUL 70
END: 0415 -10 17 Ag 70

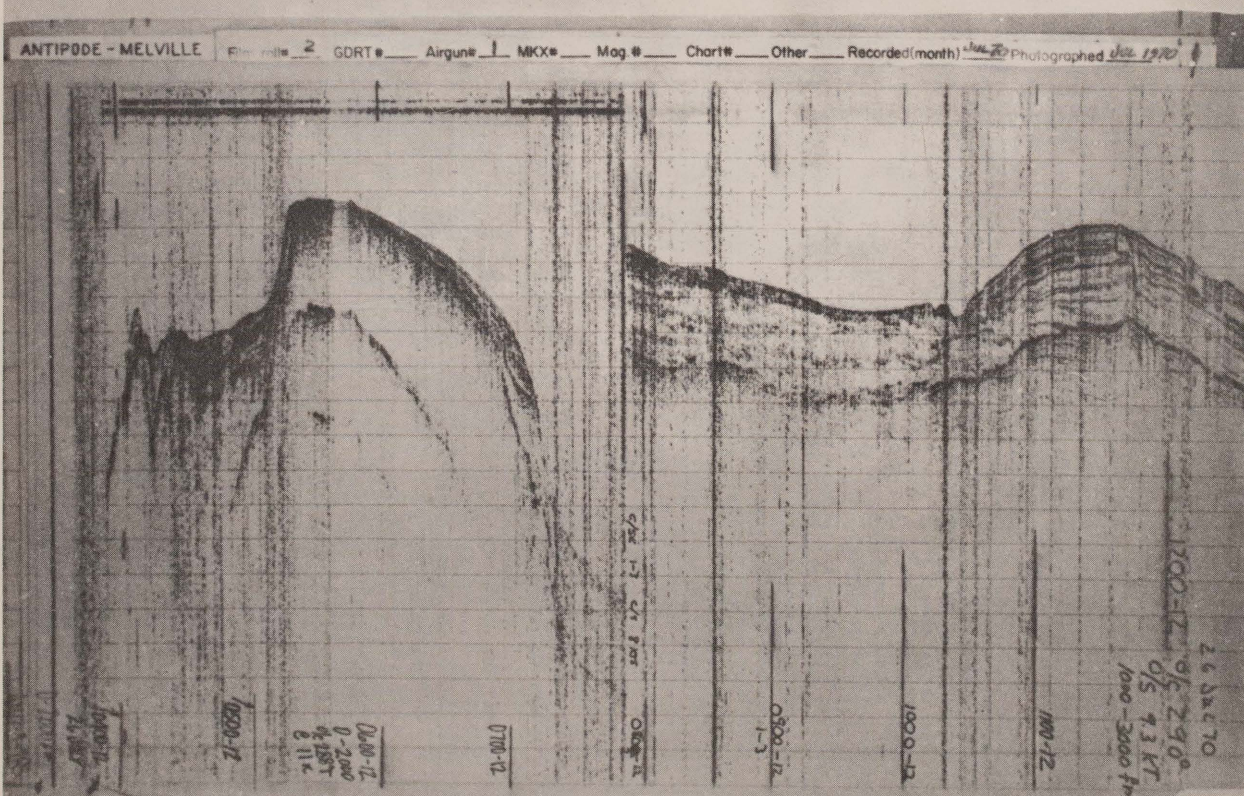
ANT-40


ANTIPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Jul 70 Photographed Jul 1970

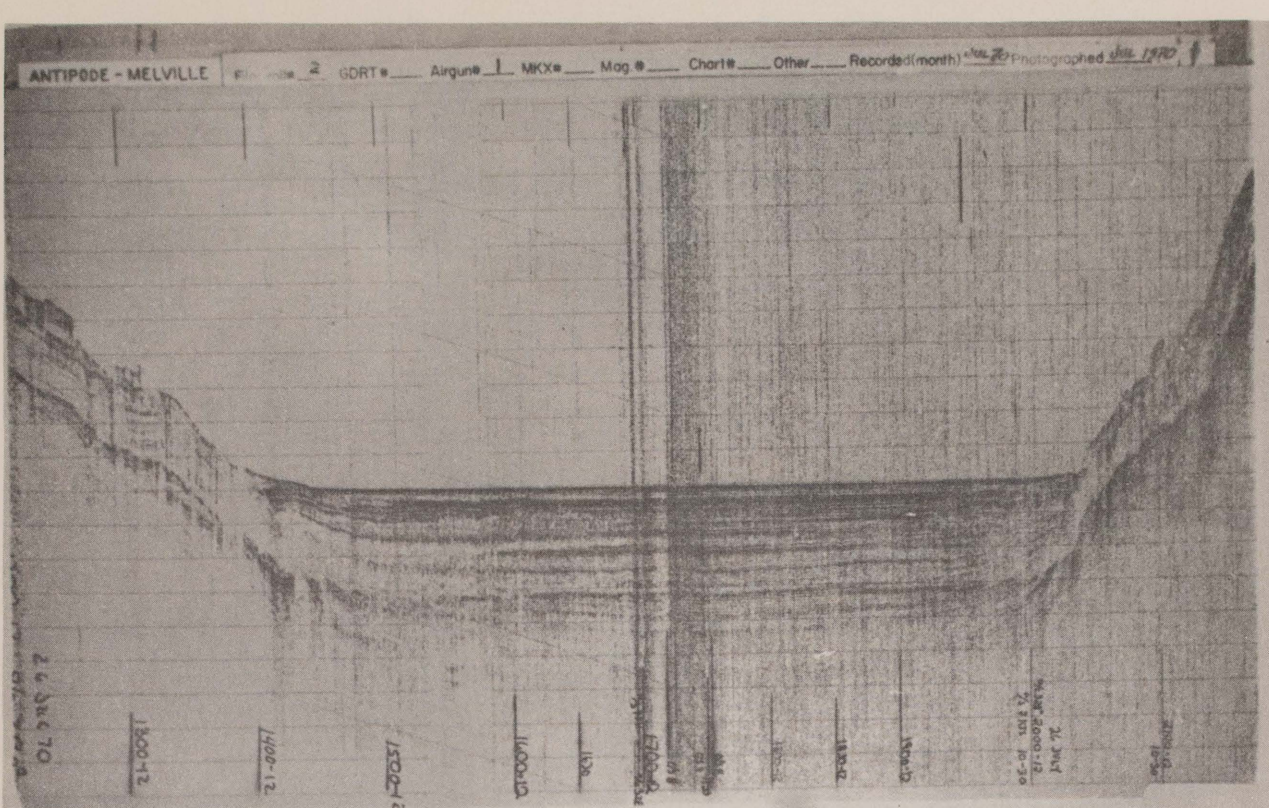
ANT-41


ANTIPODE - MELVILLE
GDRT # Airgun # 1 MKX # Mag. # Chart # Other Recorded(month) Photographed

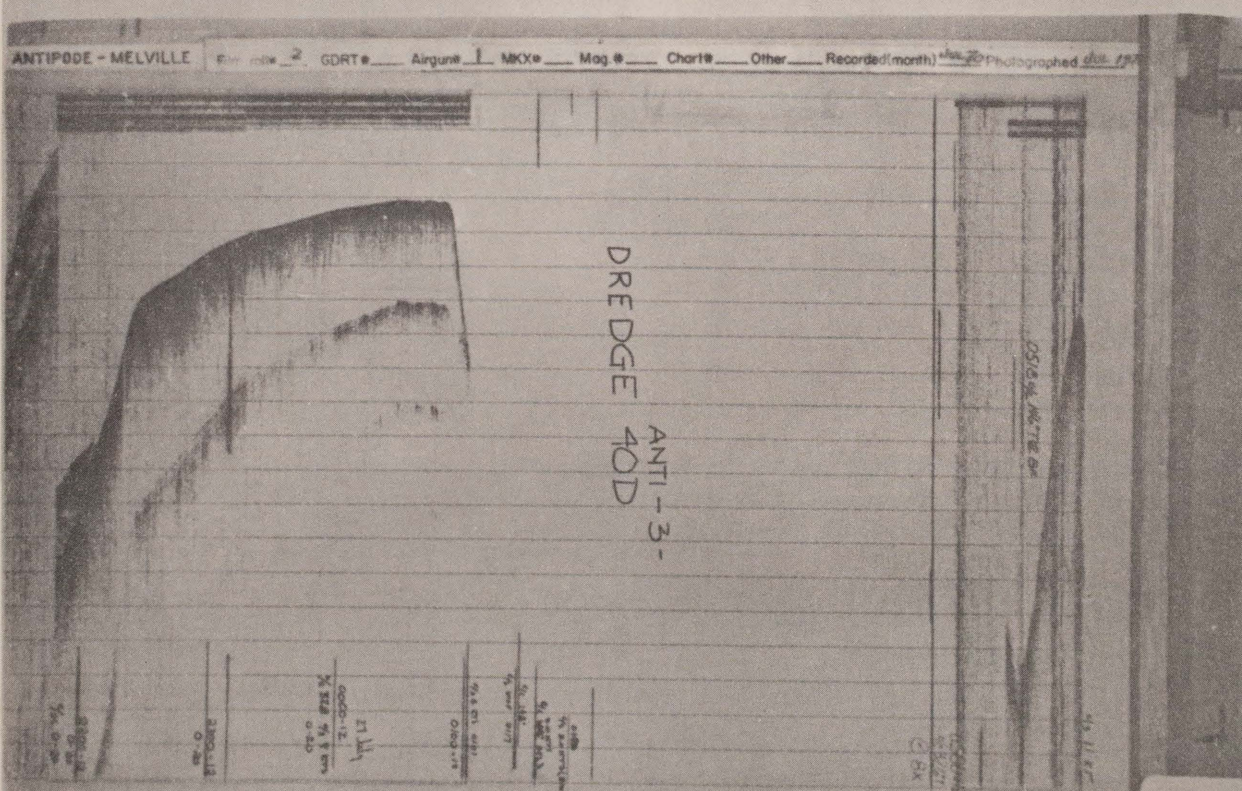
ANT-42


ANTIPODE - MELVILLE
GDRT # Airgun # 1 MKX # Mag. # Chart # Other Recorded(month) Photographed

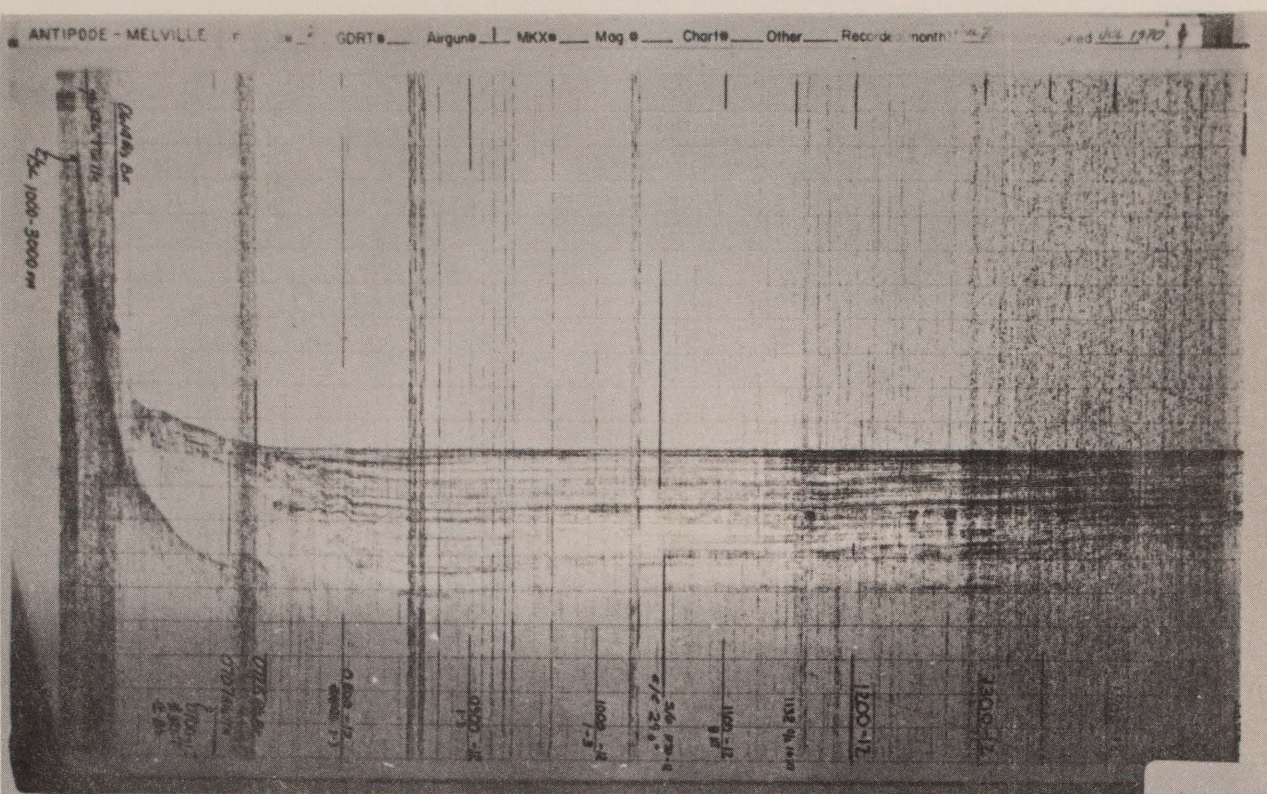
ANT-43



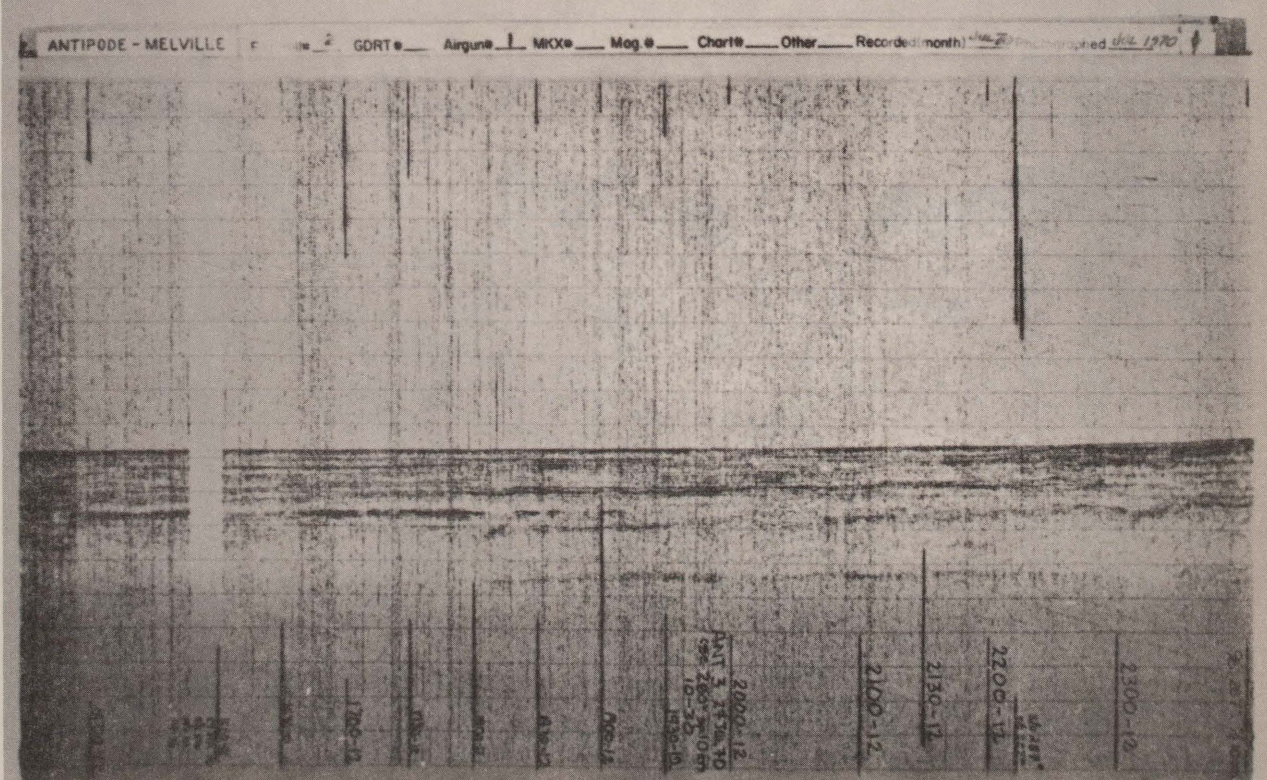
ANT-44



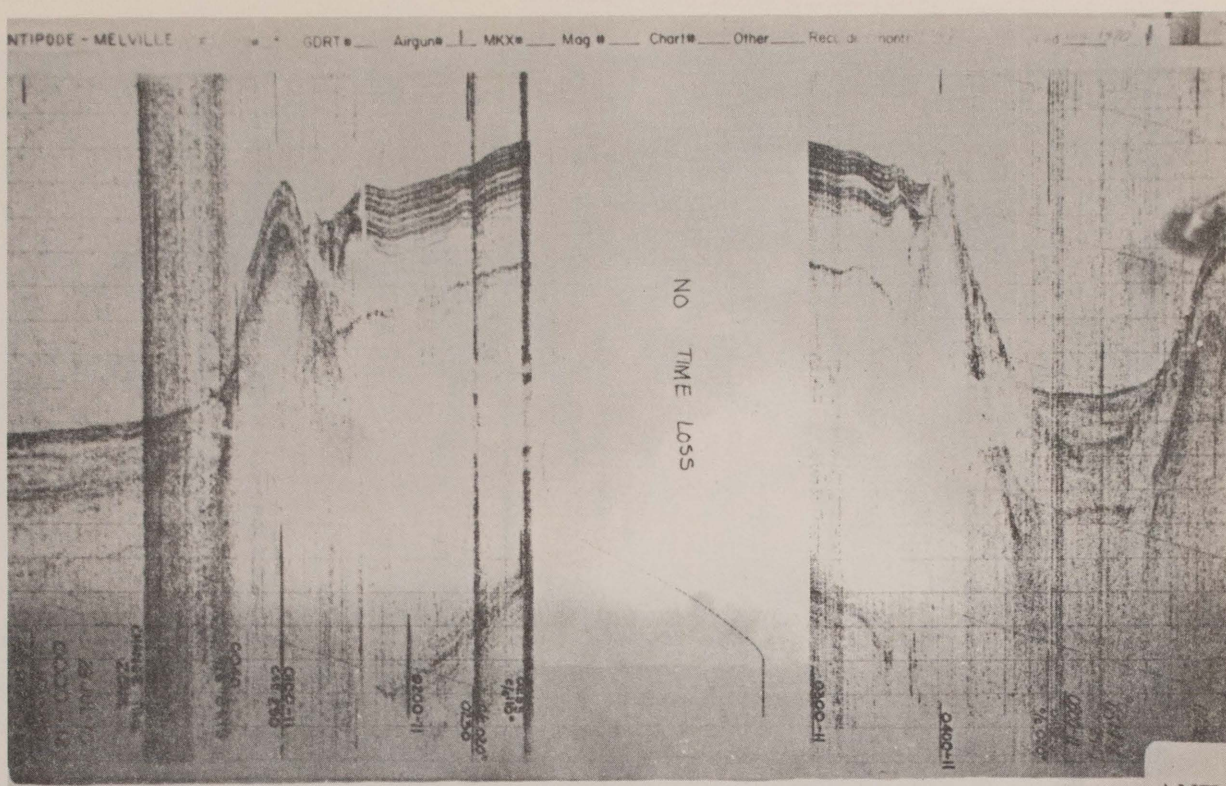
ANT-45


ANTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag
Chart
Other
Recorded (month)
1200-12
2300-12

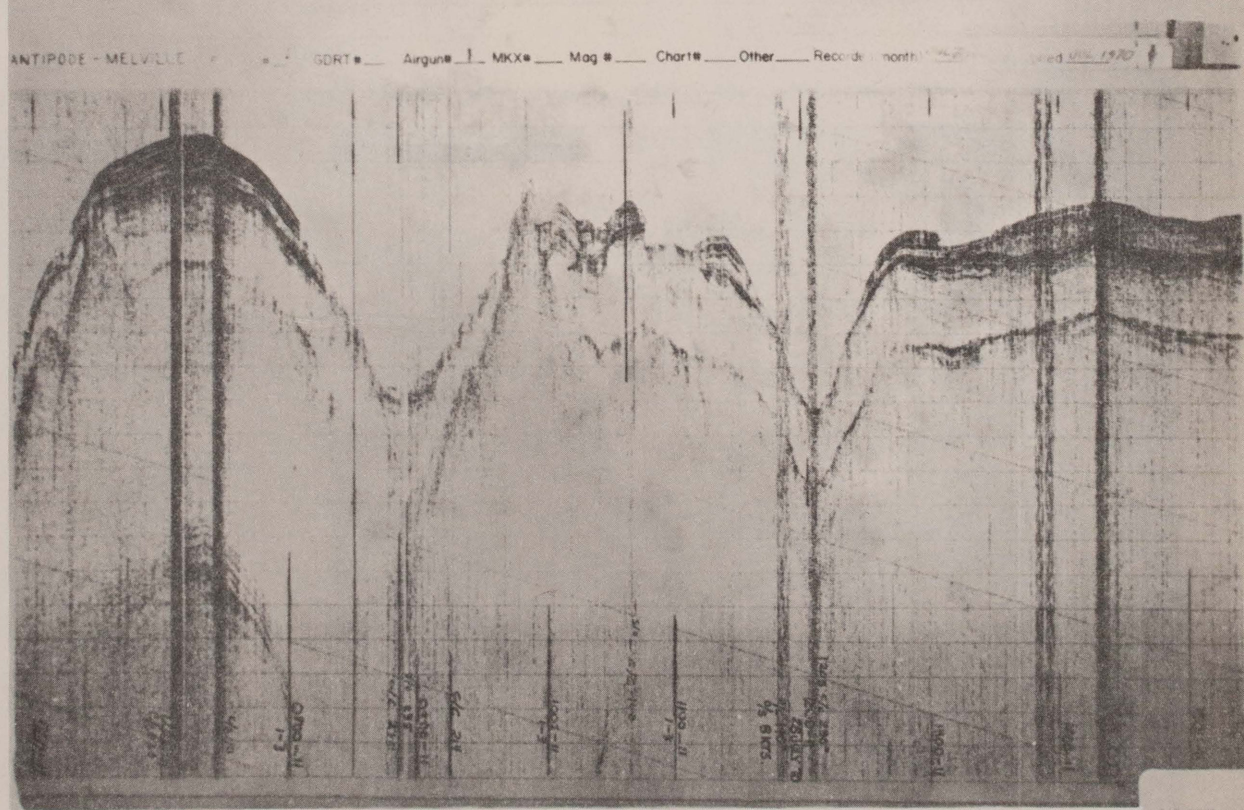
ANT-46


ANTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag
Chart
Other
Recorded (month)
Photographed
1700-12
2000-12
2100-12
2130-12
2200-12
2300-12

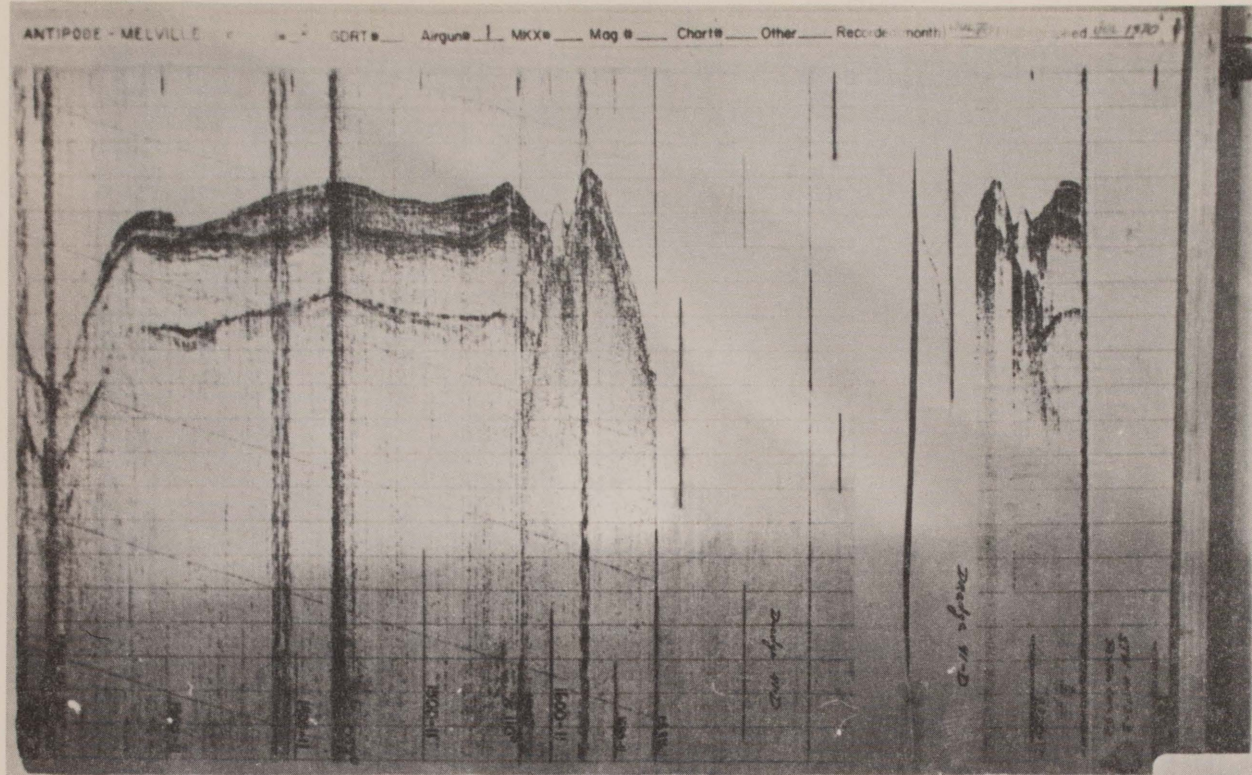
ANT-47


NTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag
Chart
Other
NO TIME LOSS

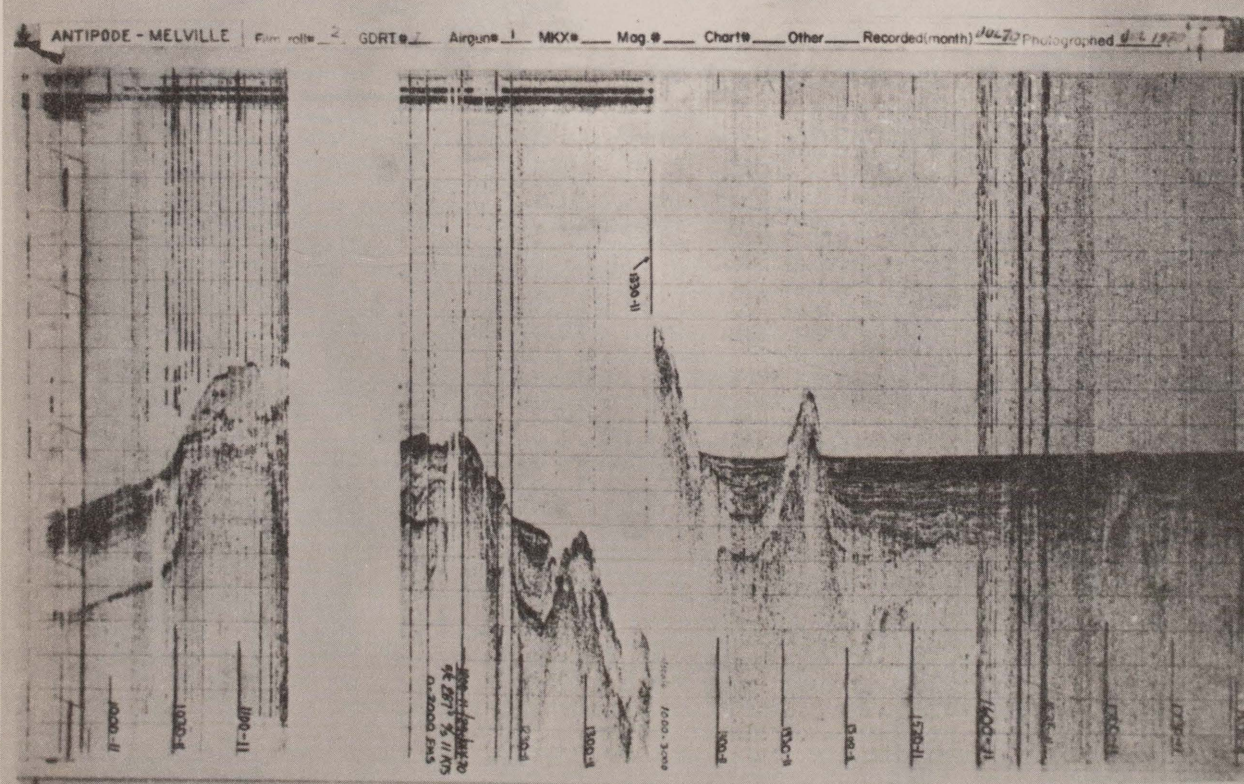
ANT-48


ANTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag
Chart
Other

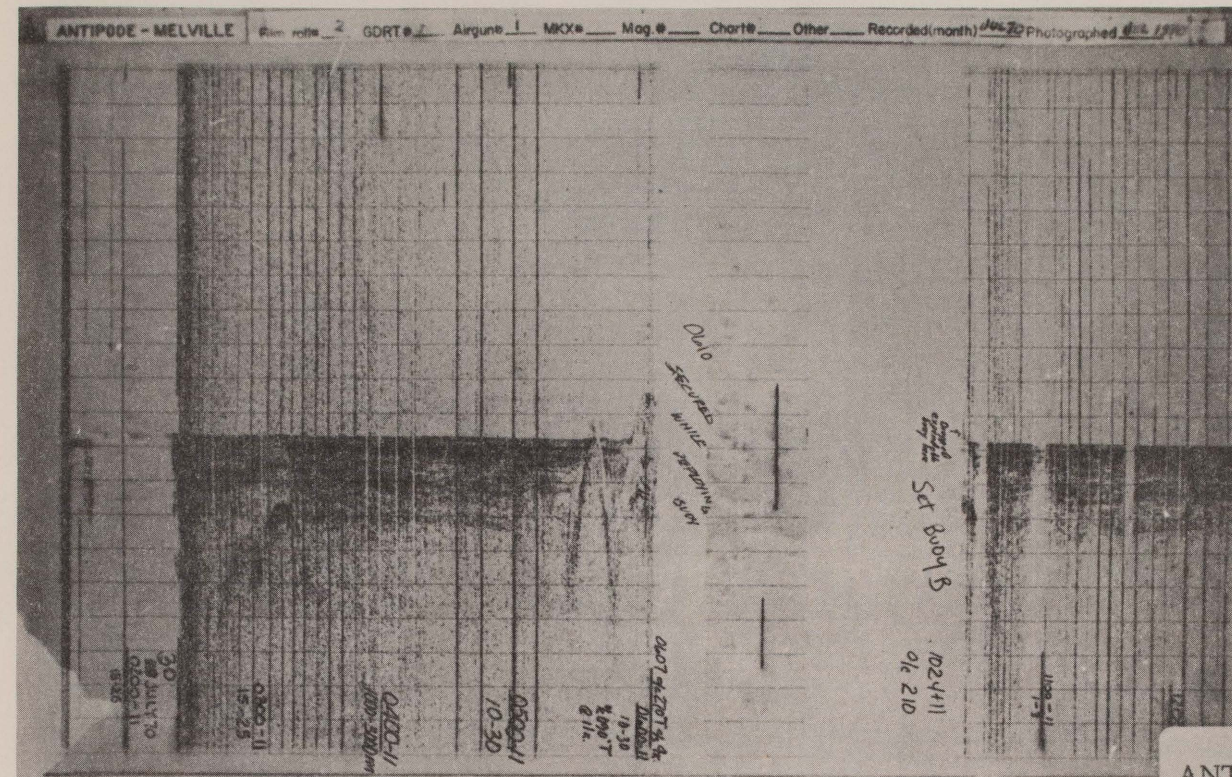
ANT-49


ANTIPODE - MELVILLE
GDRT #
Airgun # 1
MKX #
Mag #
Chart #
Other

ANT-50

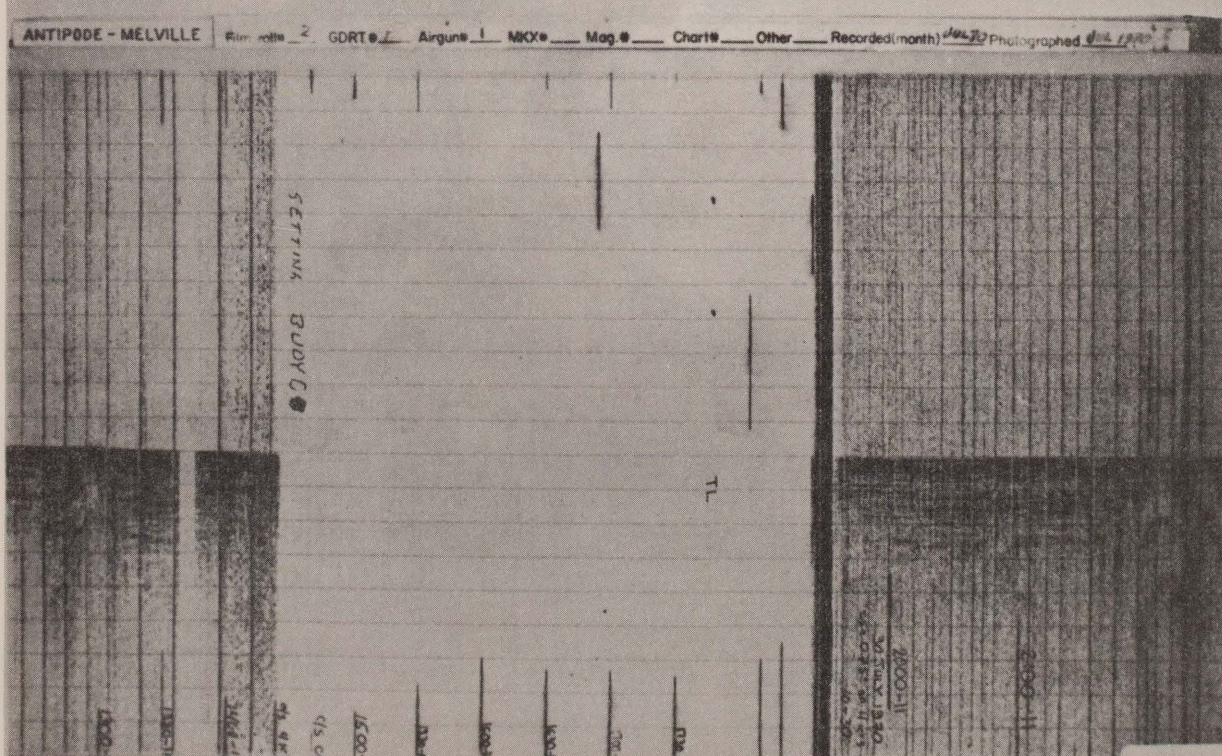

ANTIPODE - MELVILLE
GDRT #
Airgun # 1
MKX #
Mag #
Chart #
Other
Recorded(month)
Photographed

ANT-51



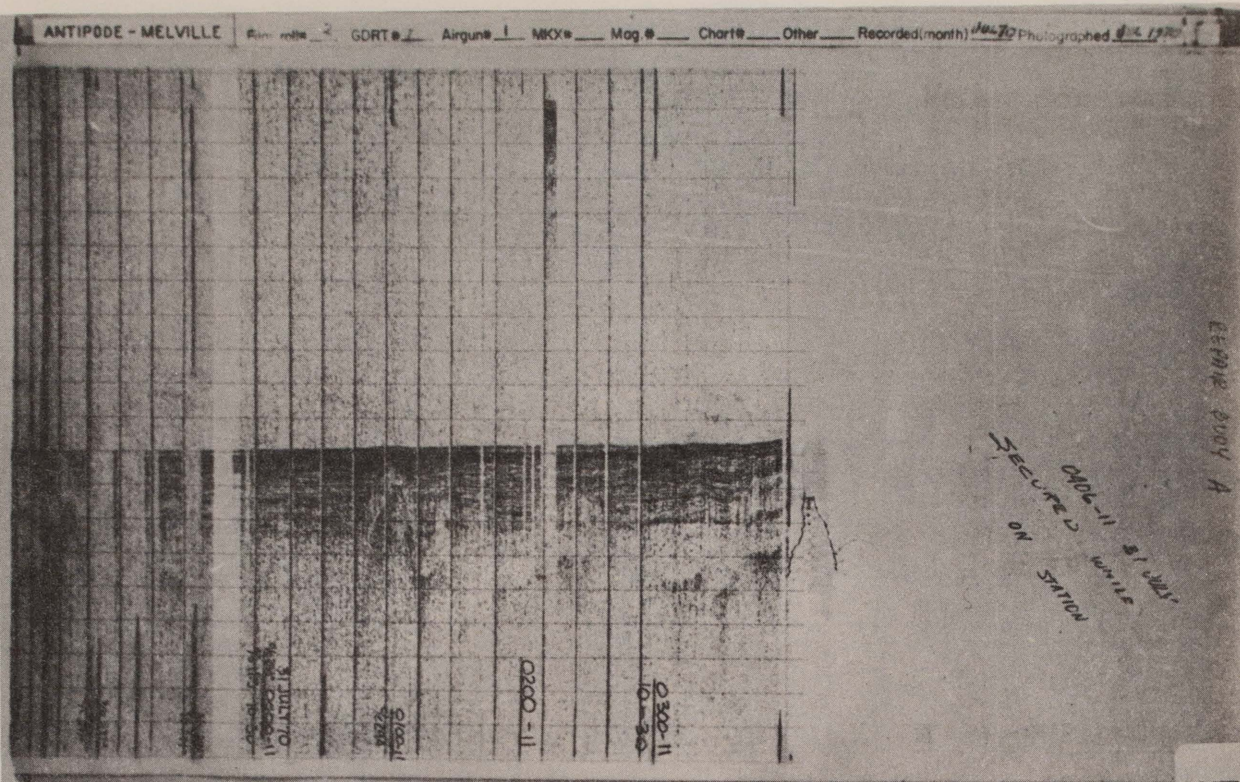
ANTIPODE - MELVILLE
Set Buoy B

ANT-52

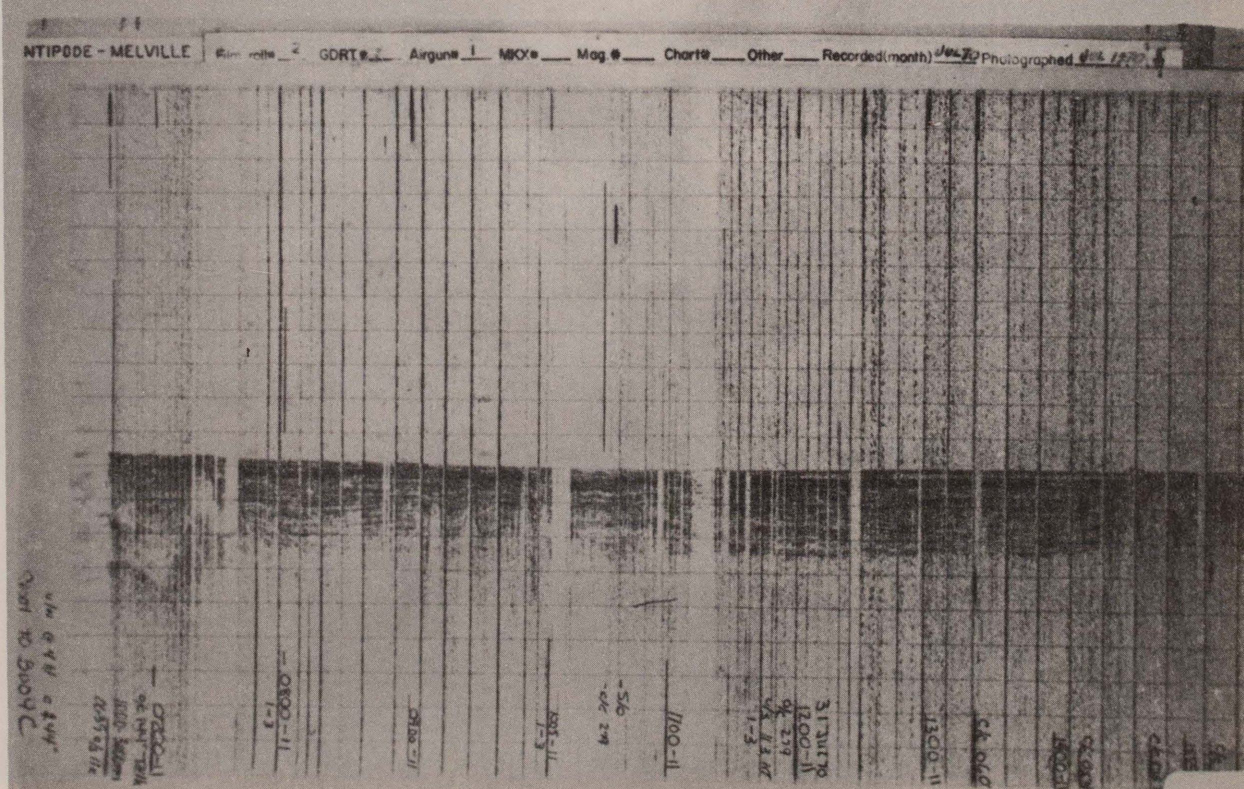


ANTIPODE - MELVILLE
SETTING BUOY C

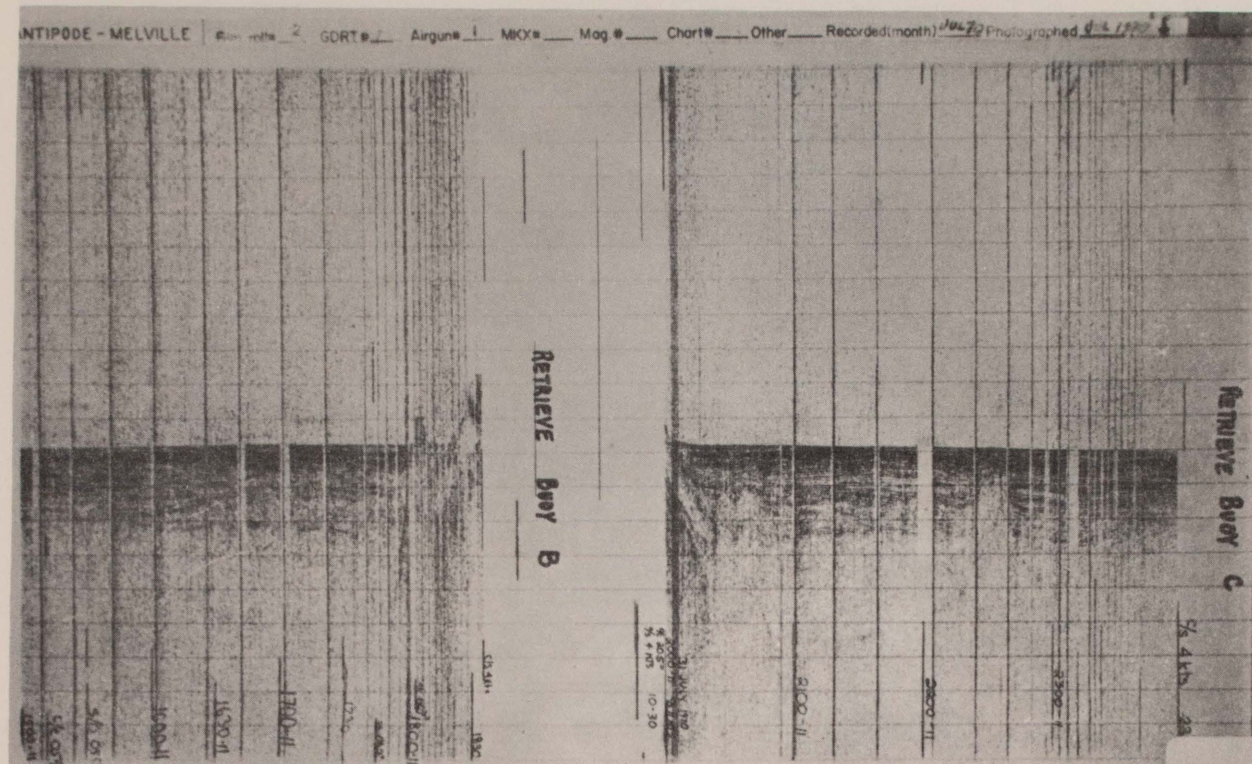
ANT-53


ANTIPODE - MELVILLE
GDRT #
Airgun #
MKX #
Mag. #
Chart #
Other
Recorded(month)
Photographed

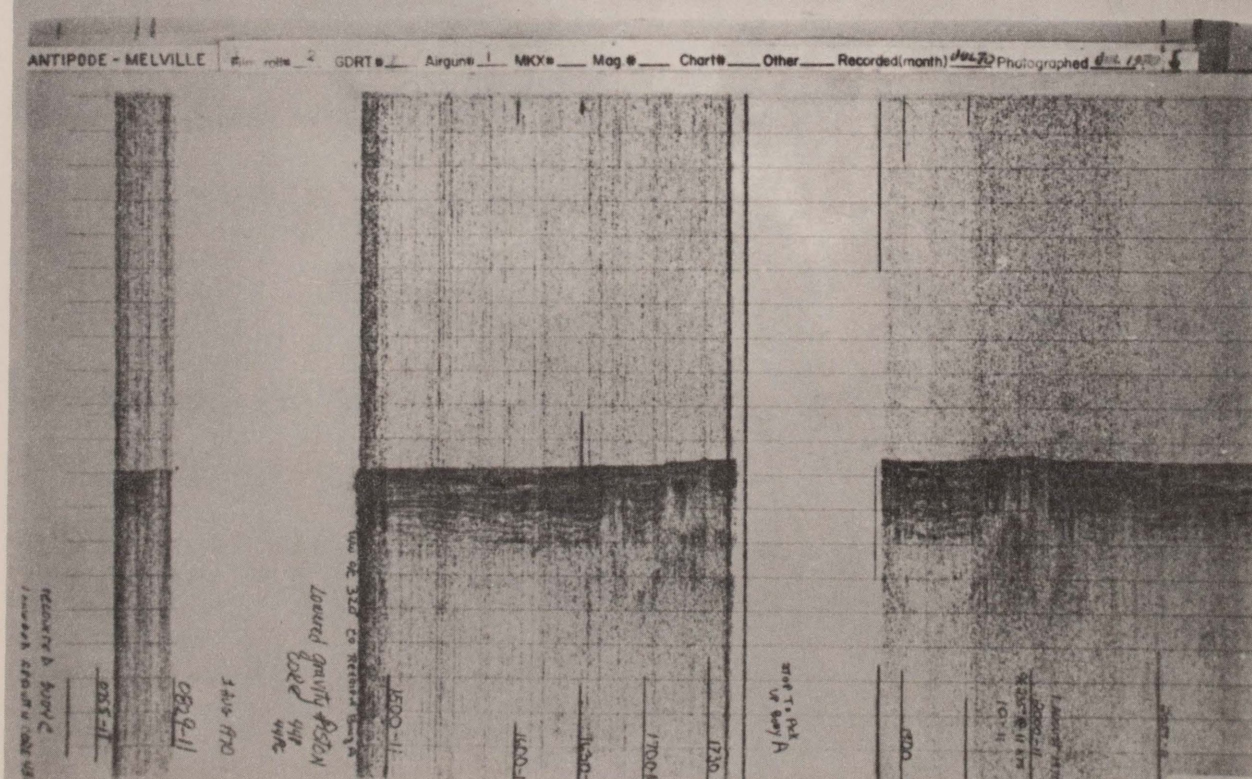
ANT-54


NTIPODE - MELVILLE
GDRT #
Airgun #
MKX #
Mag. #
Chart #
Other
Recorded(month)
Photographed

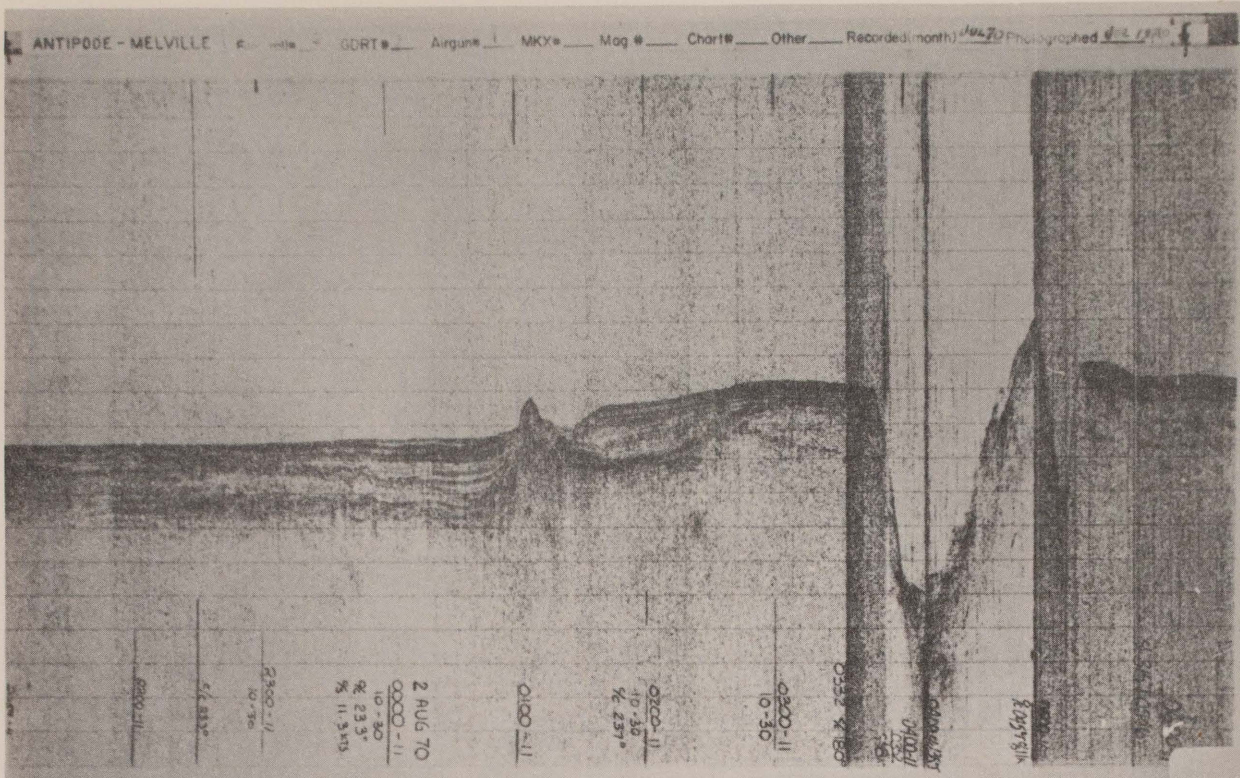
ANT-55


ANTIPODE - MELVILLE
RETRIEVE BUOY B
RETRIEVE BUOY C

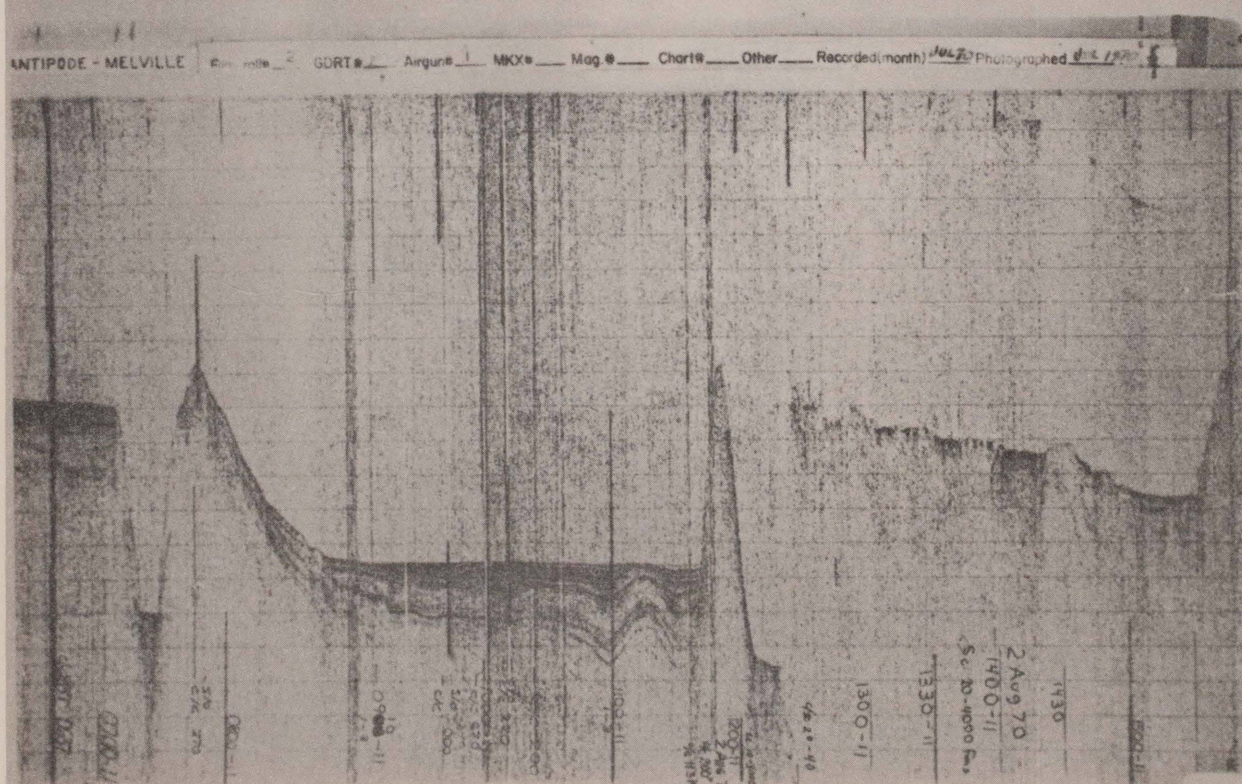
ANT-56


ANTIPODE - MELVILLE

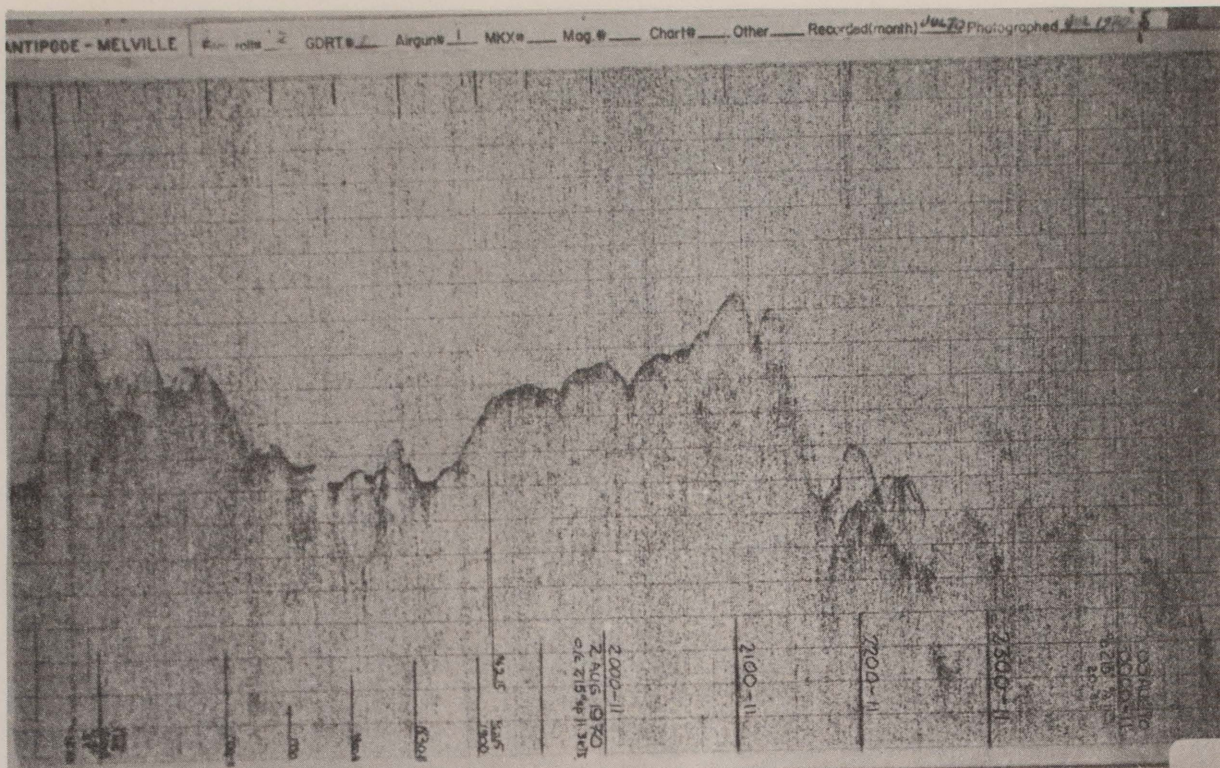
ANT-57


ANTIPODE - MELVILLE
GDRT#
Airgun#
MKX#
Mag #
Chart#
Other
Recorded(month)
Photographed

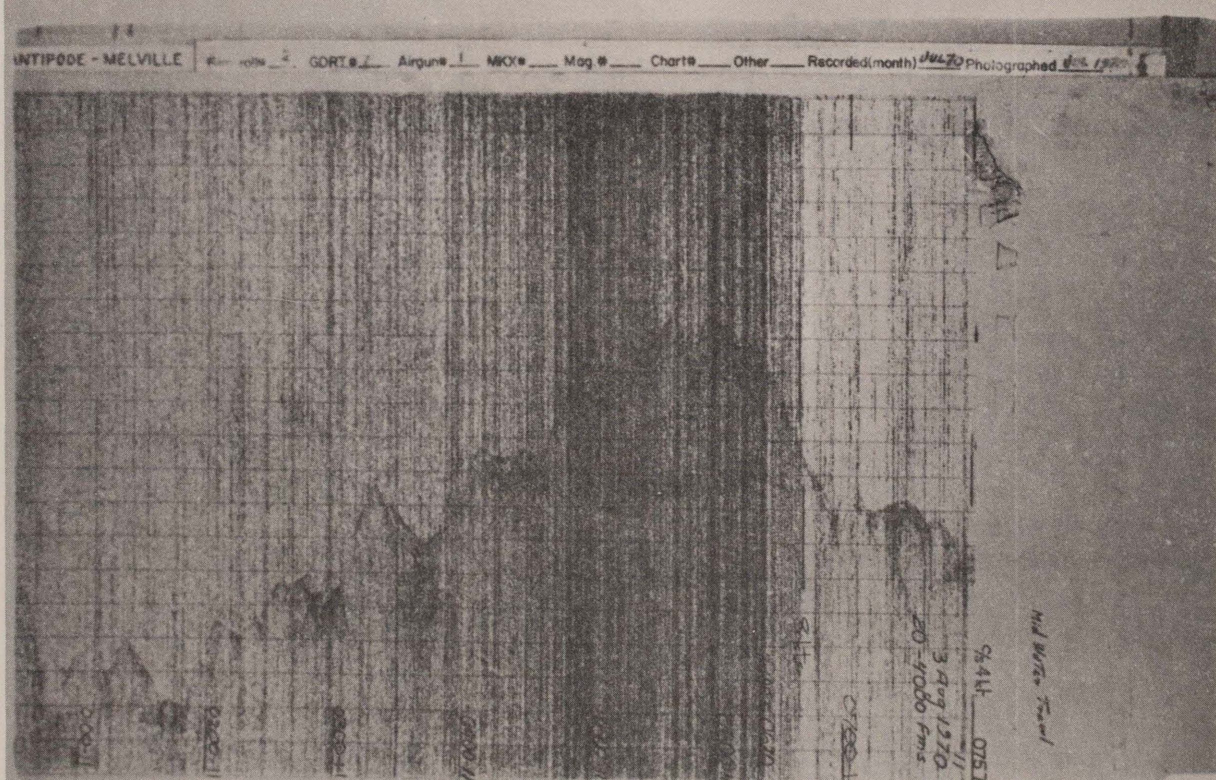
ANT-58


ANTIPODE - MELVILLE
GDRT#
Airgun#
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed

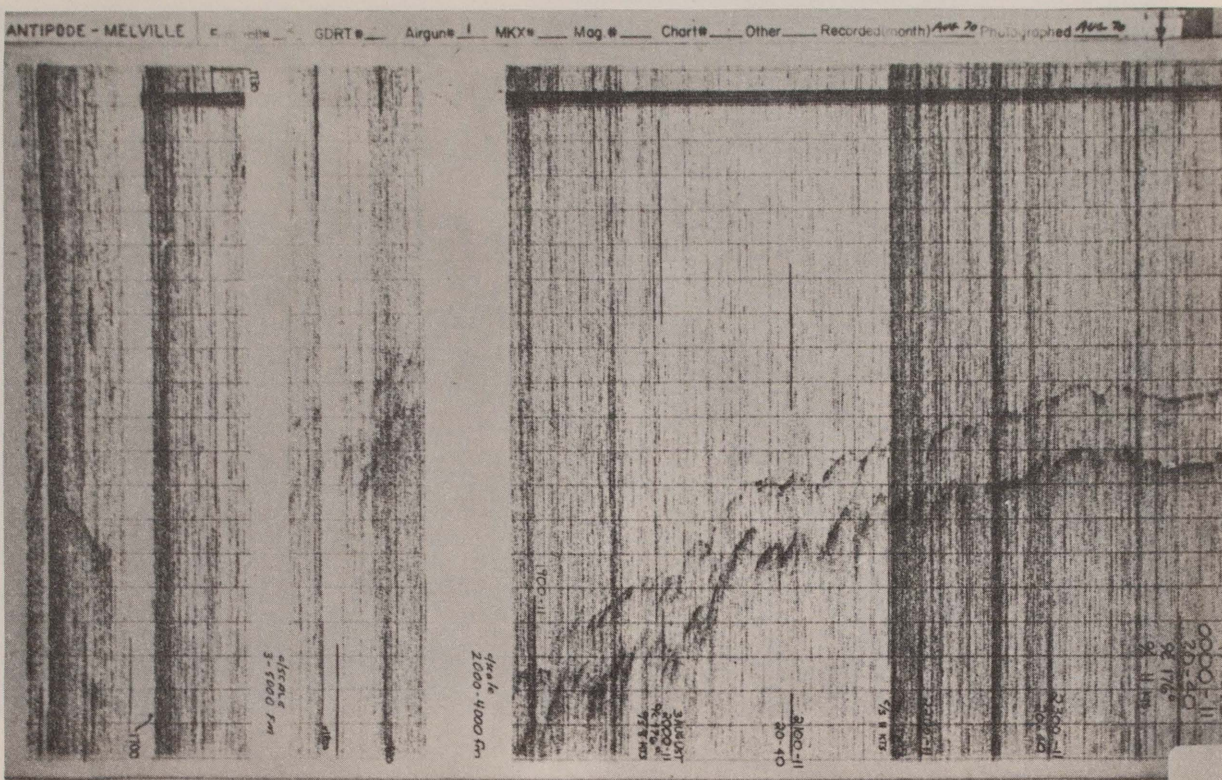
ANT-59


ANTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag.
Chart
Other
Recorded(month)
Photographed
2000-11
2 AUG 1970
2100-11
2200-11
2300-11

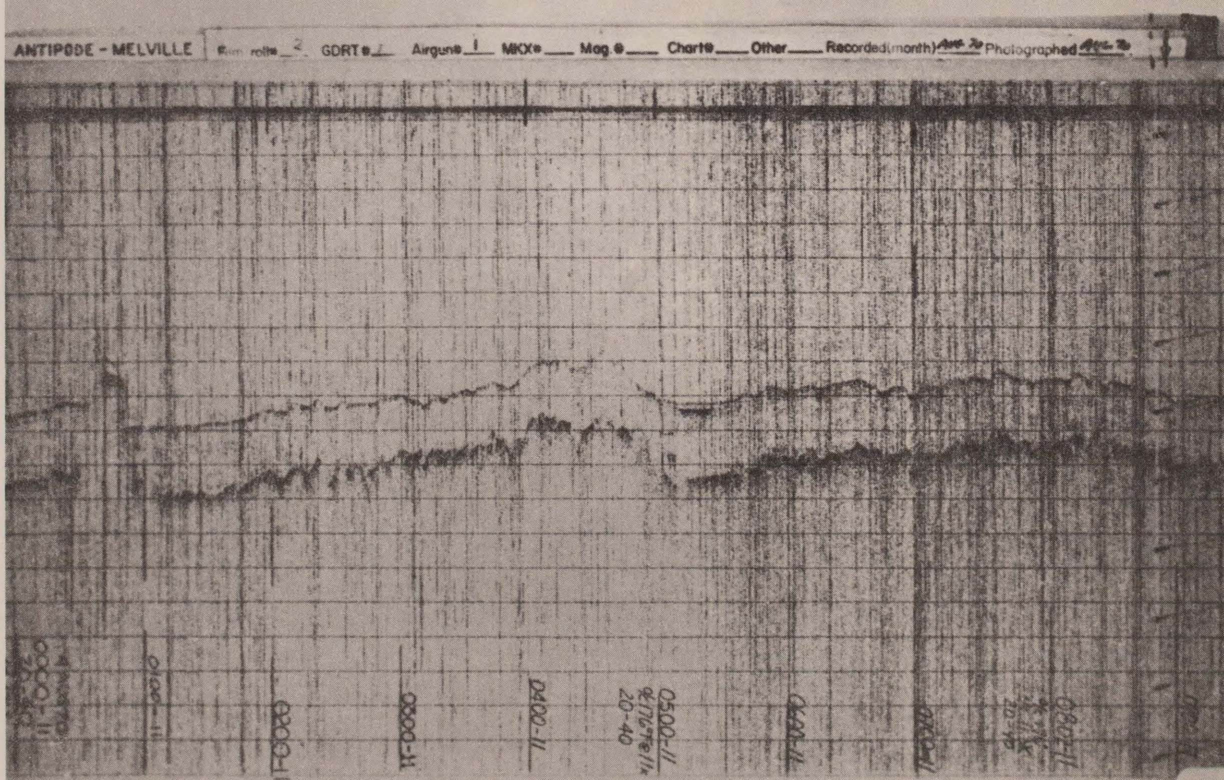
ANT-60


ANTIPODE - MELVILLE
GDRT
Airgun
MKX
Mag.
Chart
Other
Recorded(month)
Photographed
3 Aug 1970
20-4000 fms

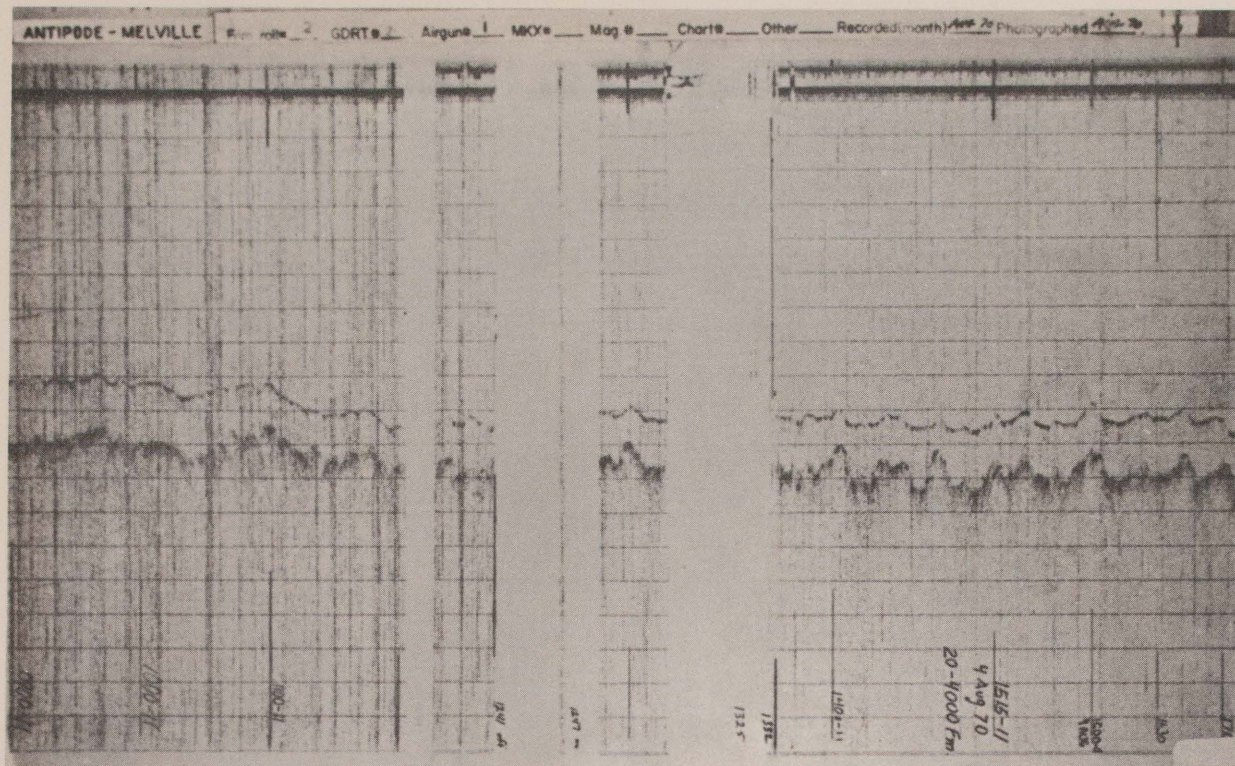
ANT-61


ANTIPODE - MELVILLE
GDRT #
Airgun # 1
MKX #
Mag. #
Chart #
Other
Recorded (month)
Photographed

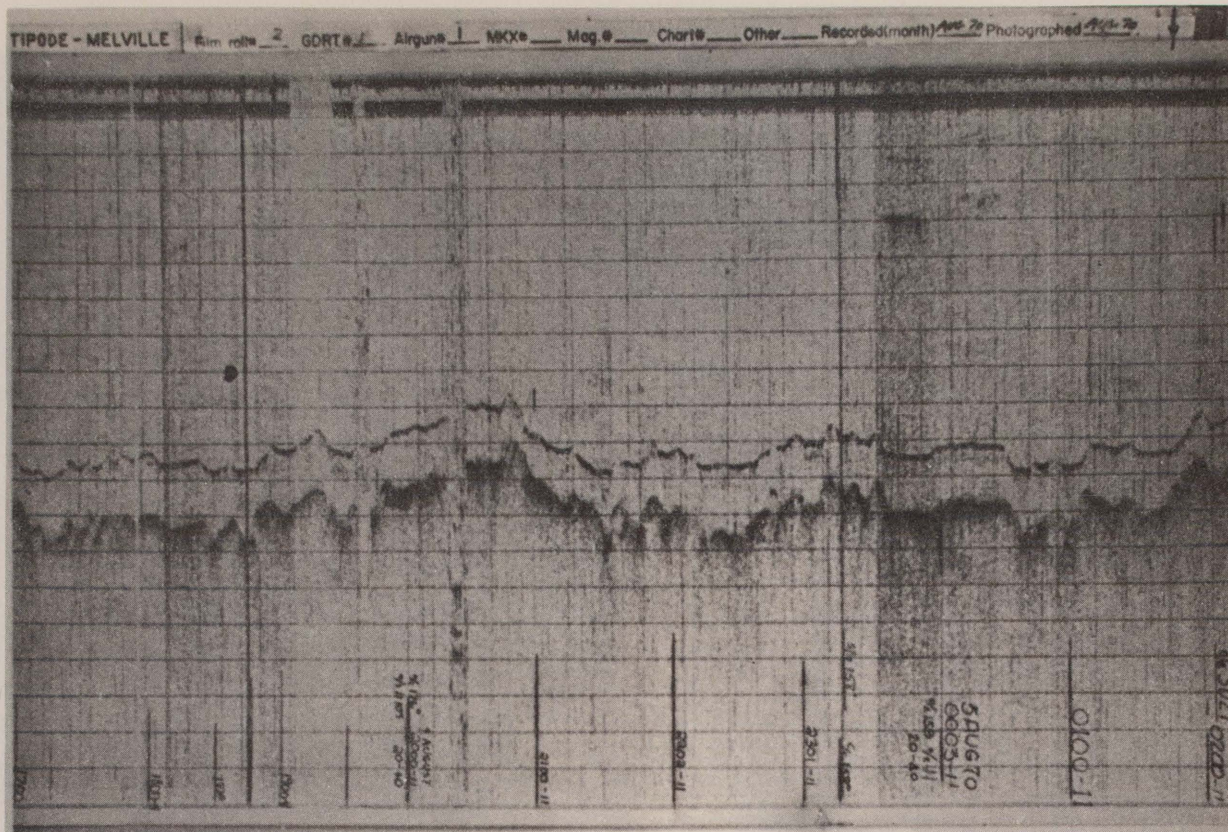
ANT-62


ANTIPODE - MELVILLE
GDRT #
Airgun # 1
MKX #
Mag. #
Chart #
Other
Recorded (month)
Photographed

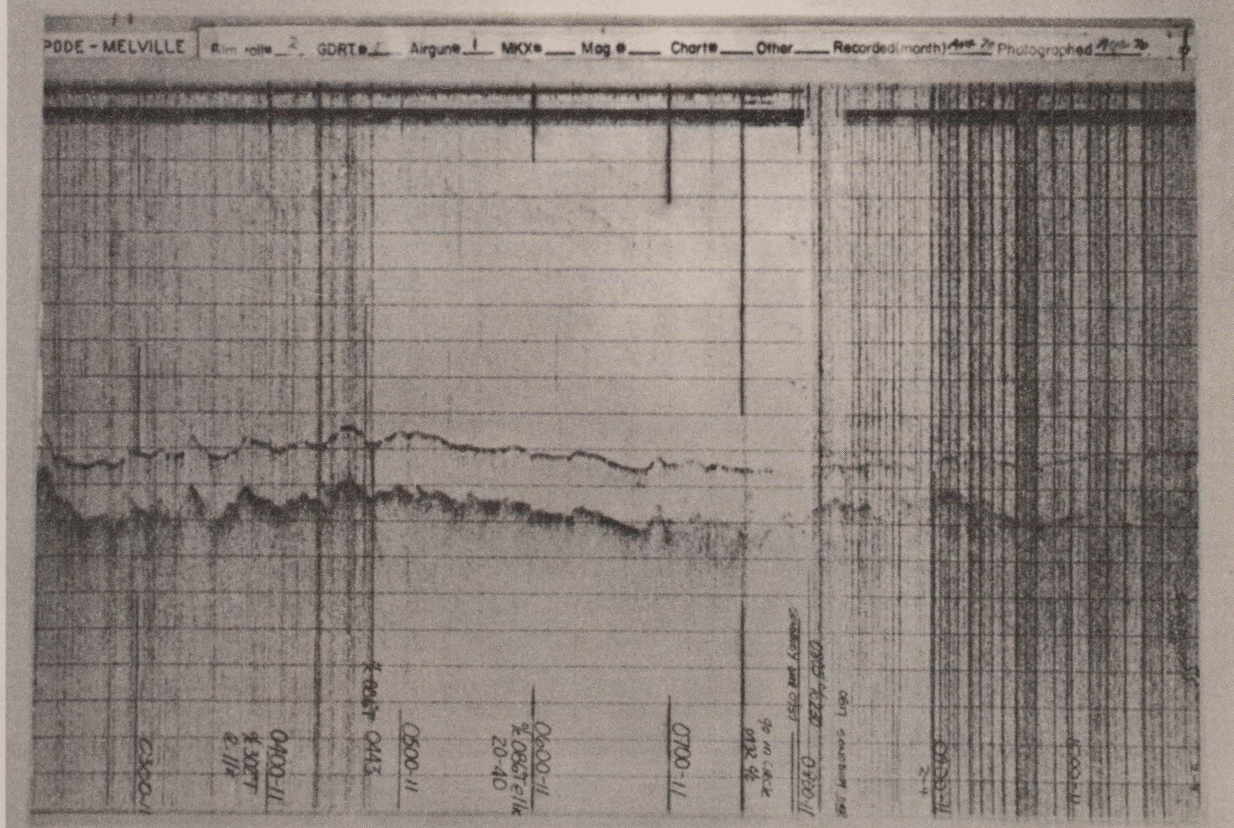
ANT-63



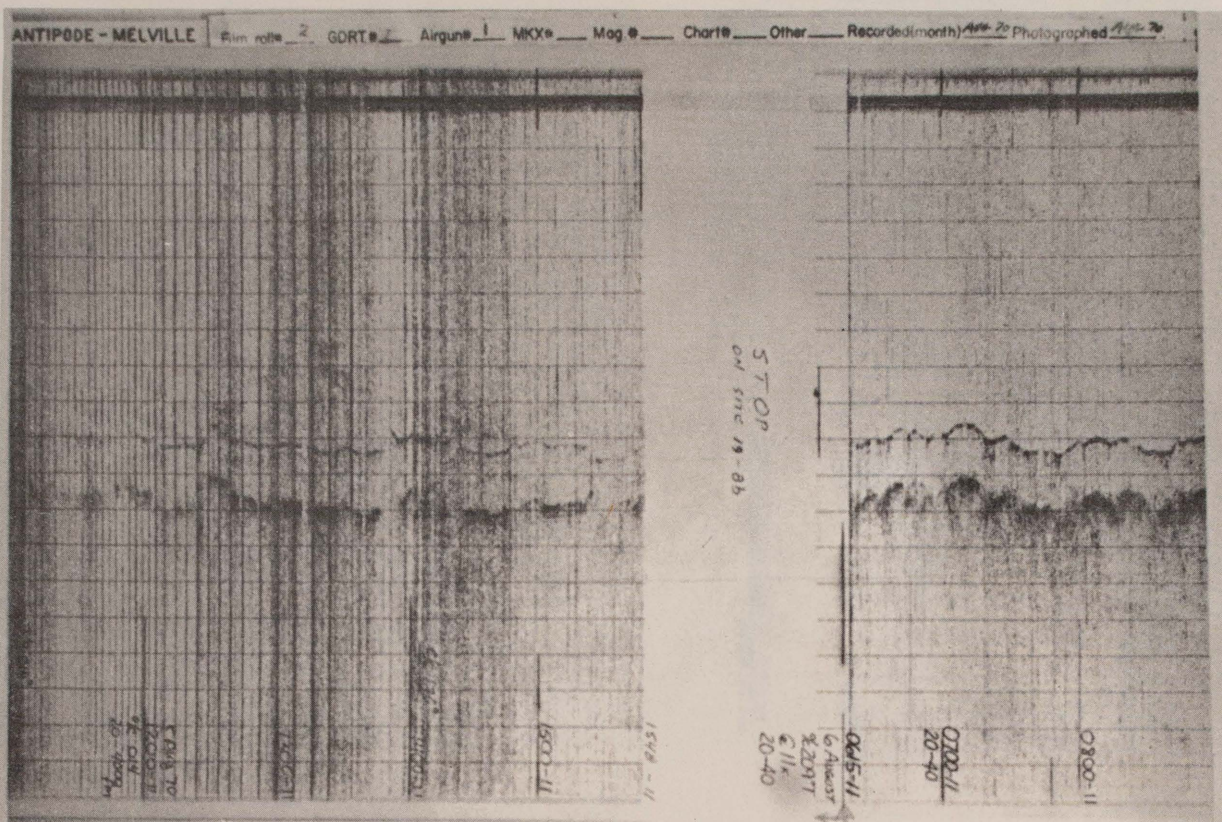
ANT-64


TIPODE - MELVILLE
Film roll# 2 GDRT# Airguns 1 MKX# Mag.# Chart# Other Recorded(month) Photographed

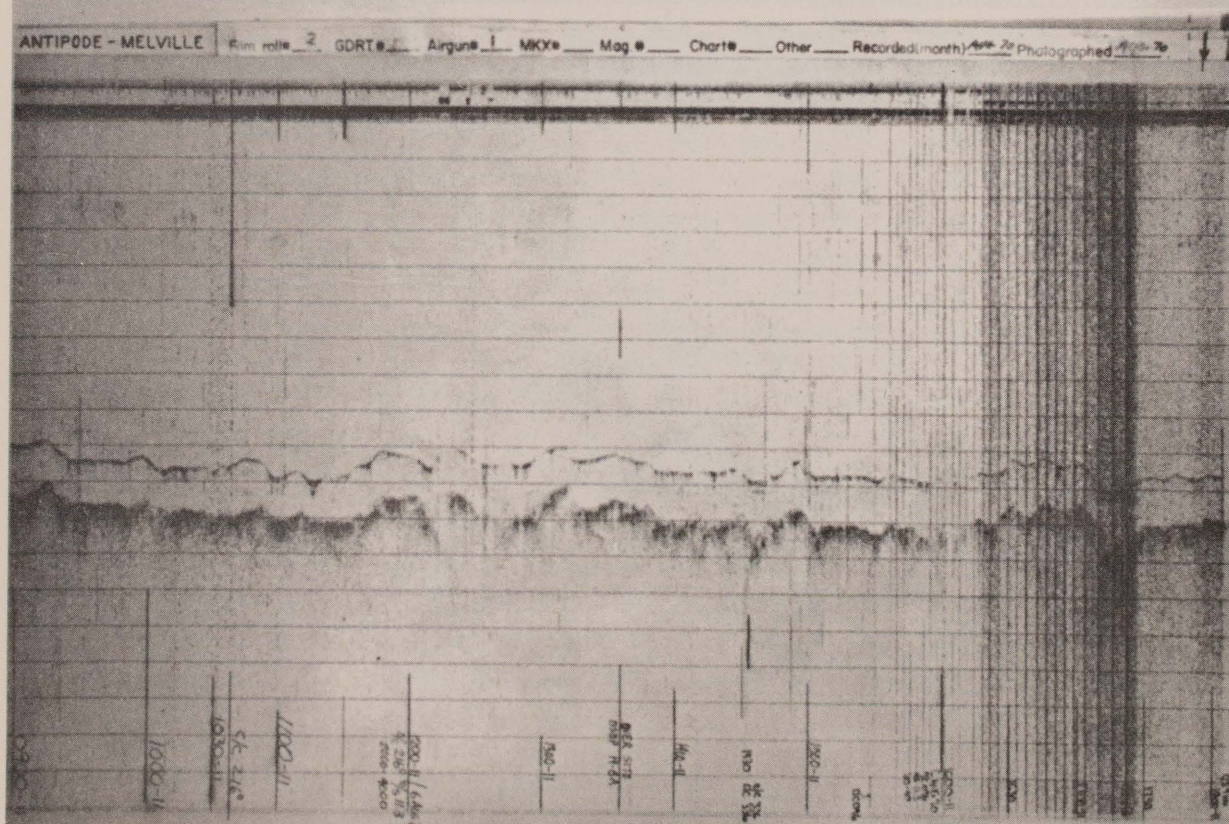
ANT-65


PODE - MELVILLE
Film roll# 2 GDRT# Airguns 1 MKX# Mag.# Chart# Other Recorded(month) Photographed

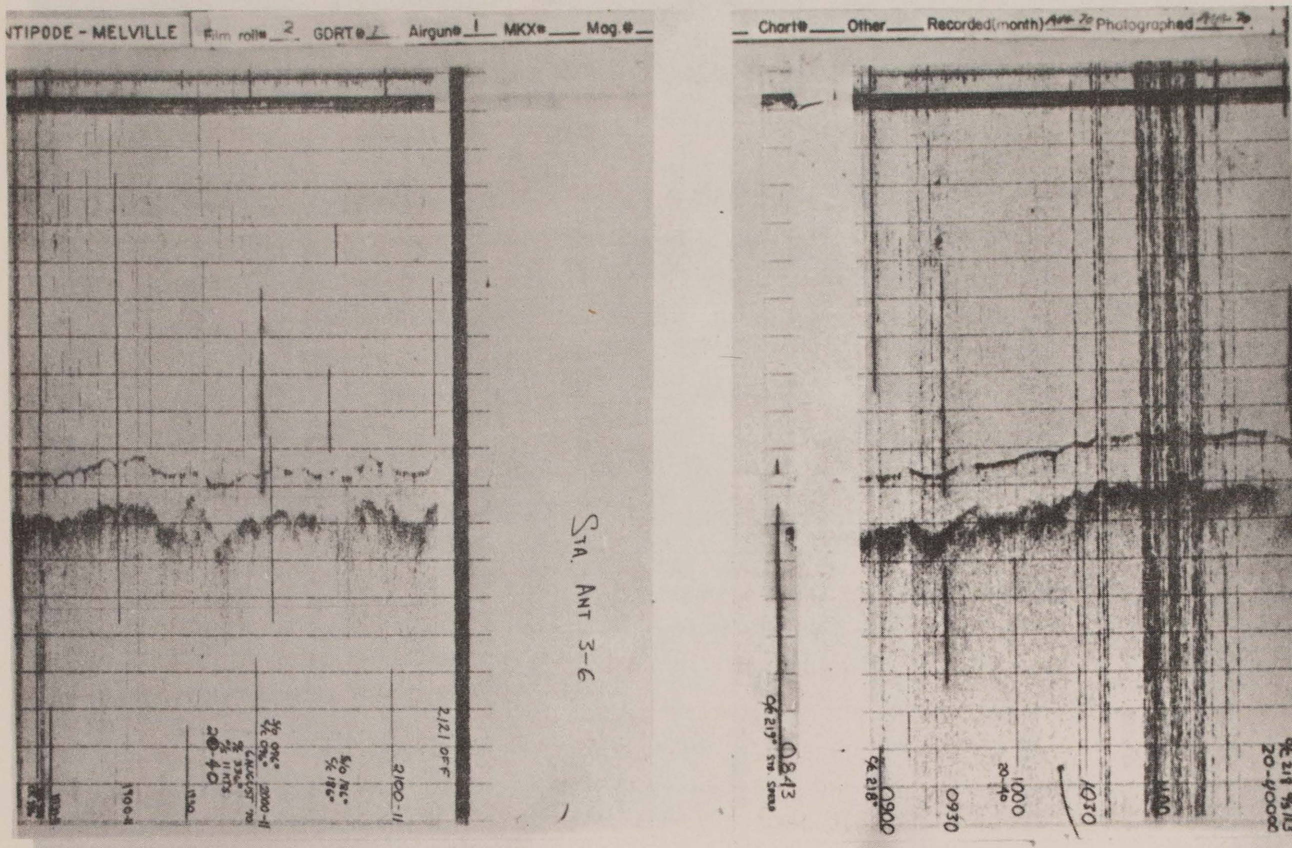
ANT-66



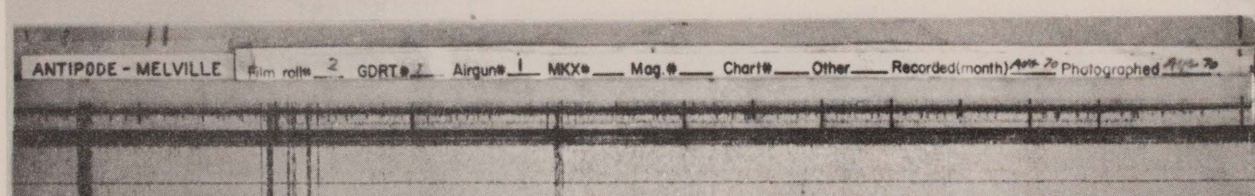
ANT-67



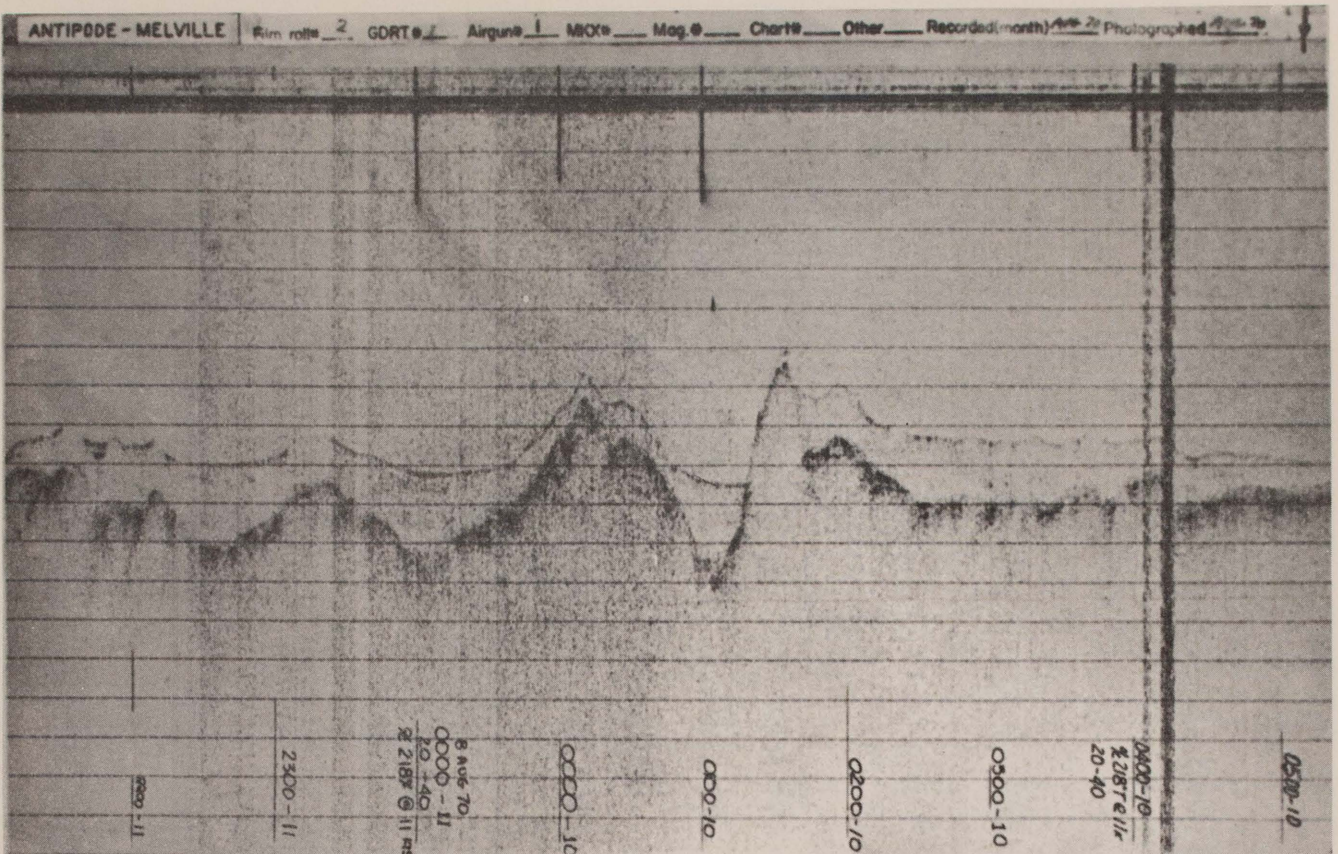
ANT-68


ANTIPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.#
Chart# Other Recorded(month) Photographed
STA. ANT 3-6

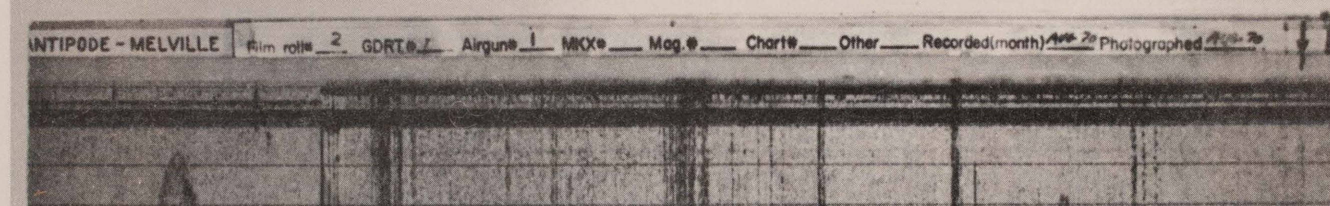
ANT-69


ANTIPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed
1300-11
1400-11
1500-11
2100-11

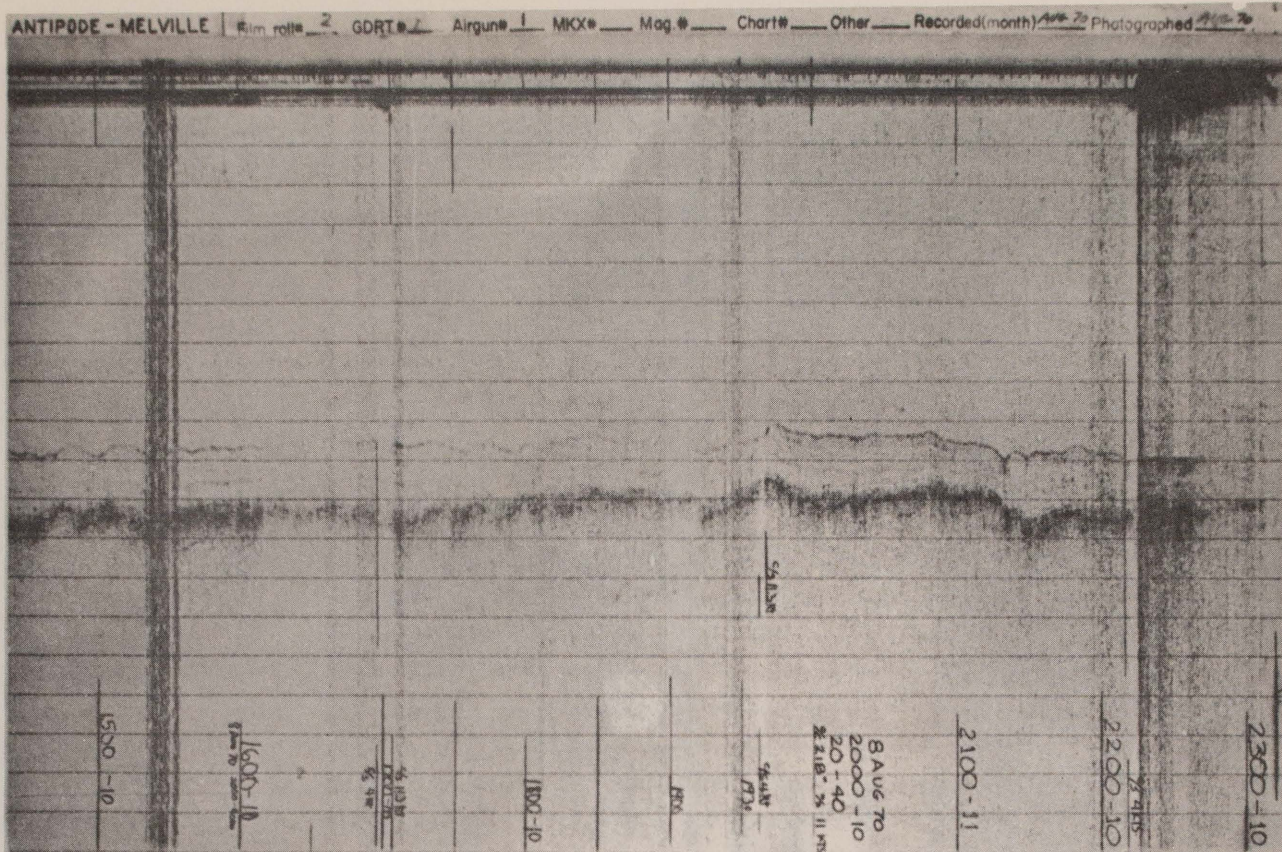
ANT-70


ANTIPODE - MELVILLE
2300 - 11
0000 - 10
0100-10
0200-10
0300 - 10
0500-10

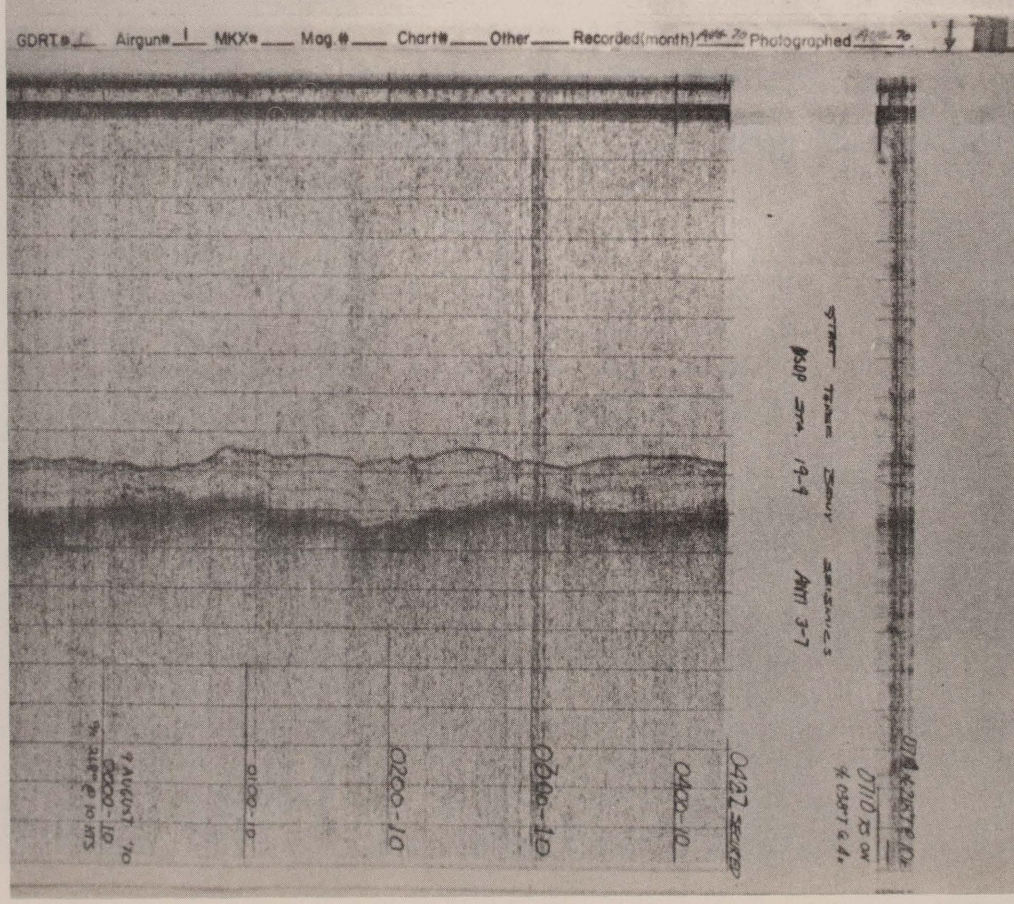
ANT-71


ANTIPODE - MELVILLE
0900 - 10
1000-10
1100 - 10
1300 - 10
1400-10

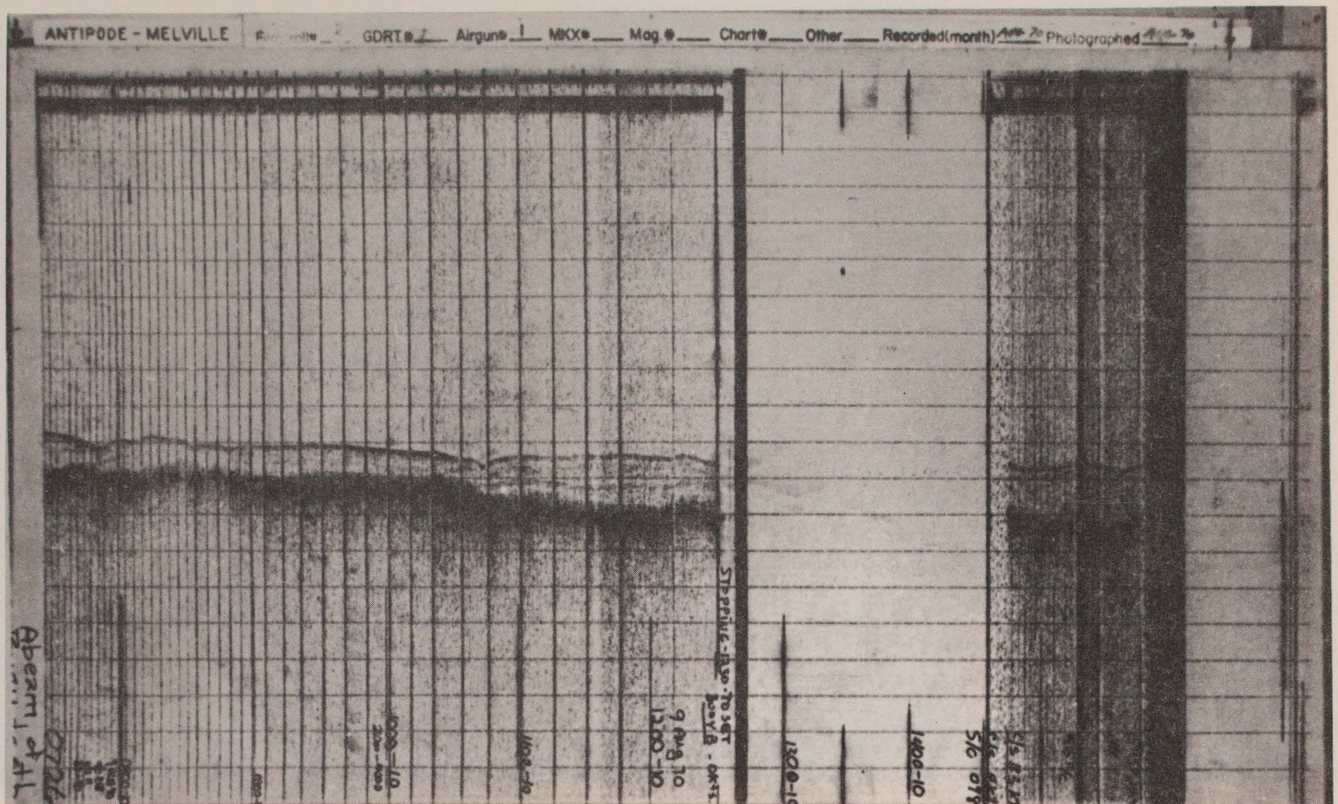
ANT-72


ANTIPODE - MELVILLE Film roll# 2 GDRT# 1 Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed
8 AUG 70
2000-10
2100-11
2200-10
2300-10

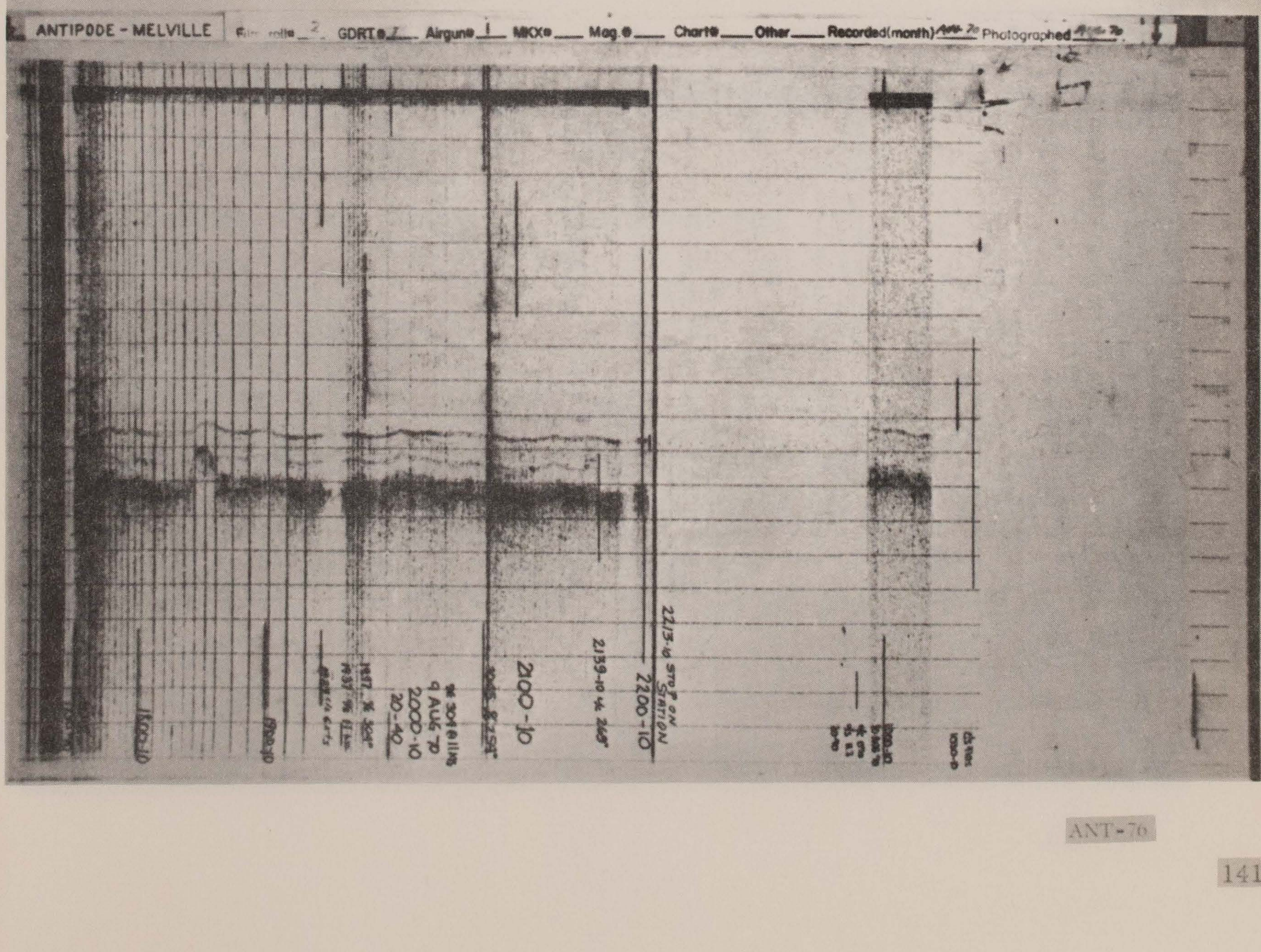
ANT-73


GDRT# 1 Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed
9 AUGUST 70
0000-10
0100-10
0200-10
0300-10
0400-10
0402 SECURED

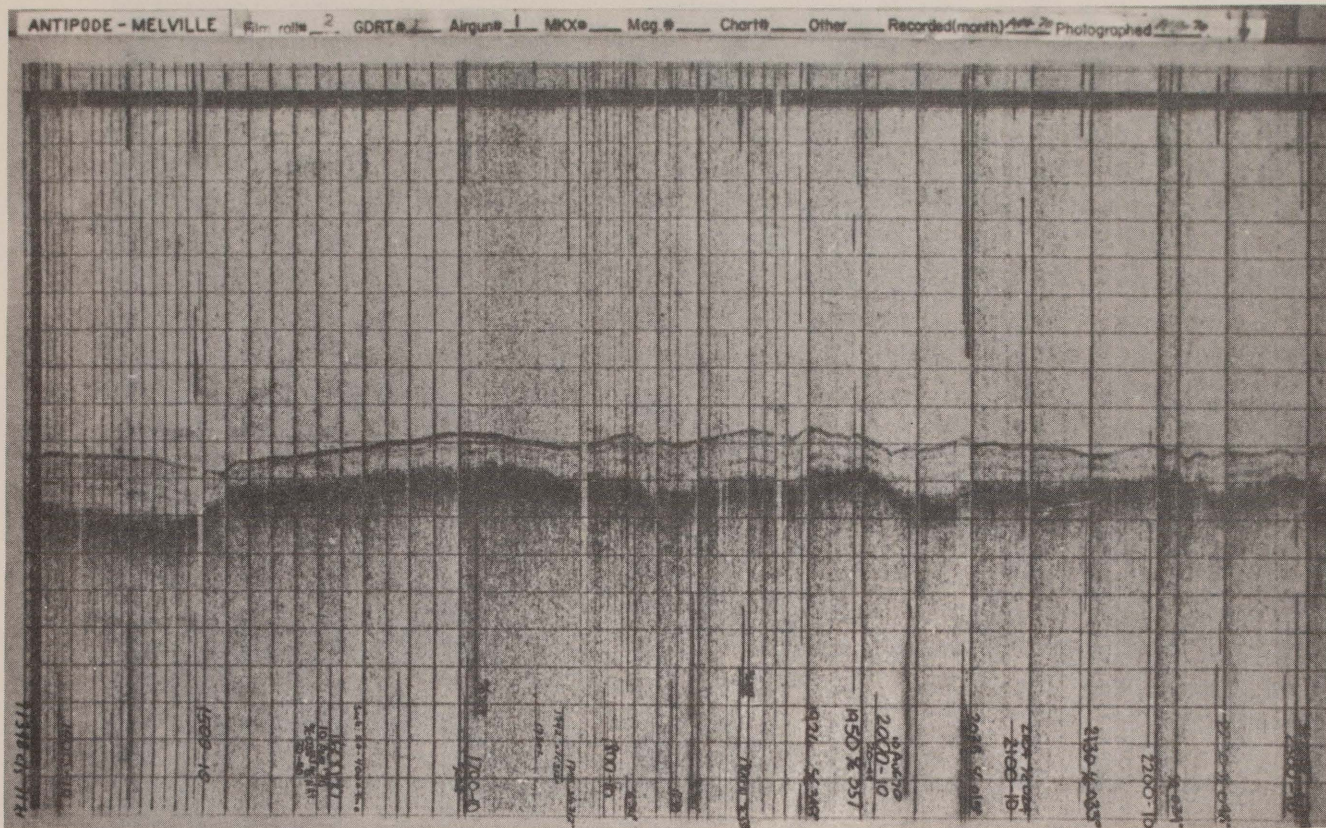
ANT-74



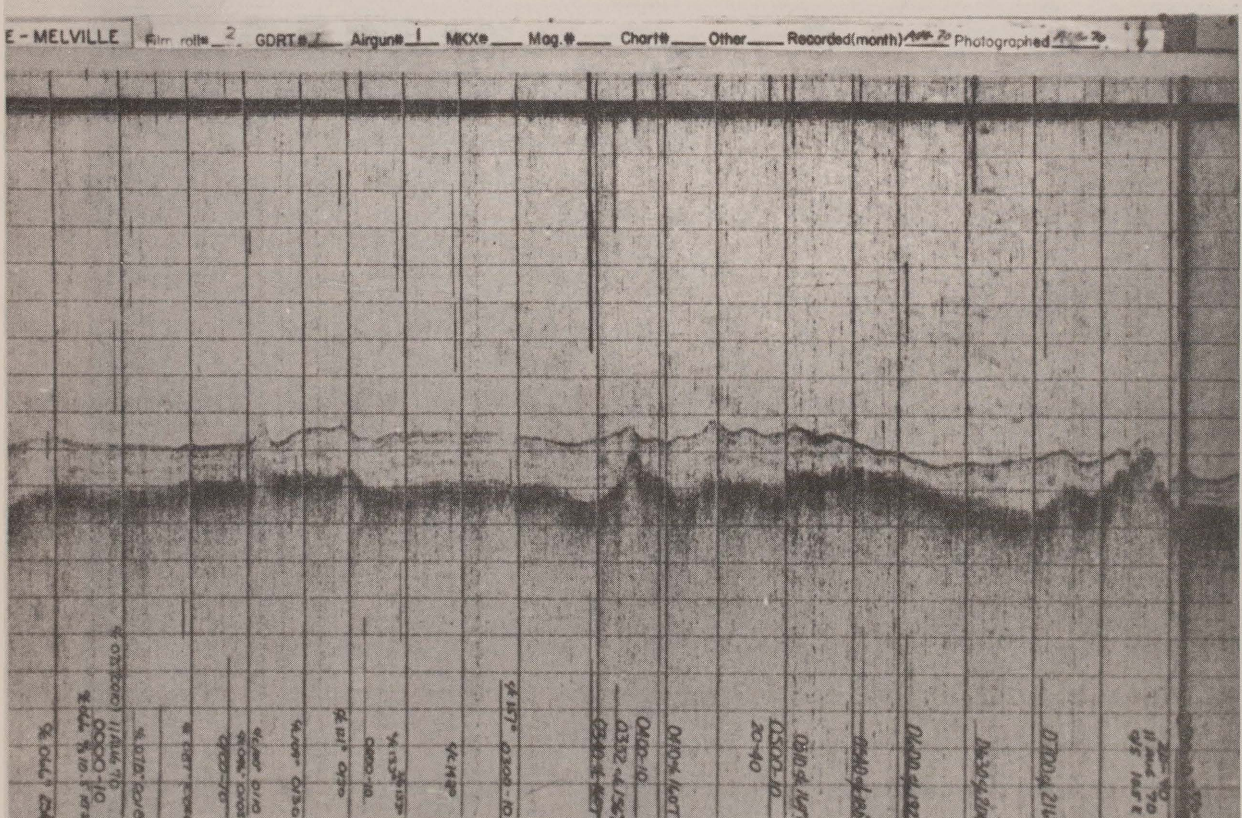
ANT-75



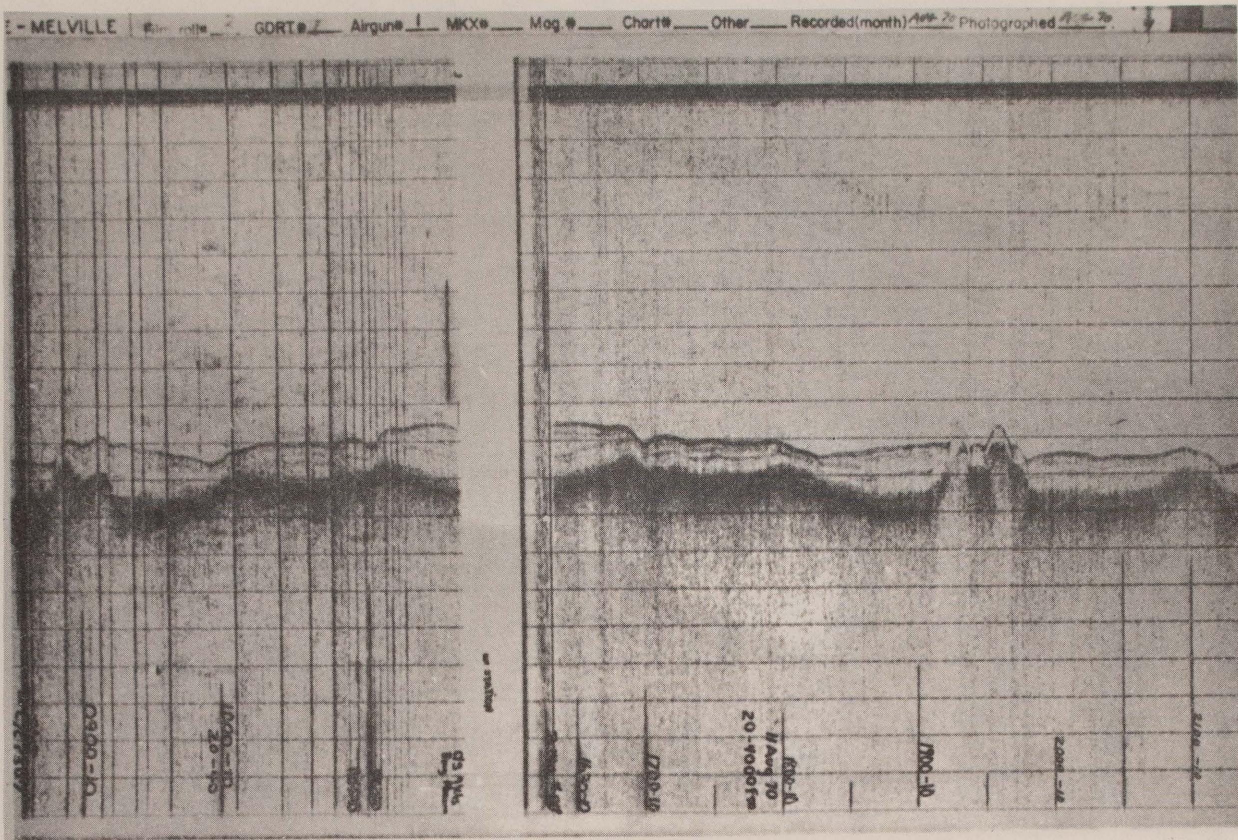
ANT-76



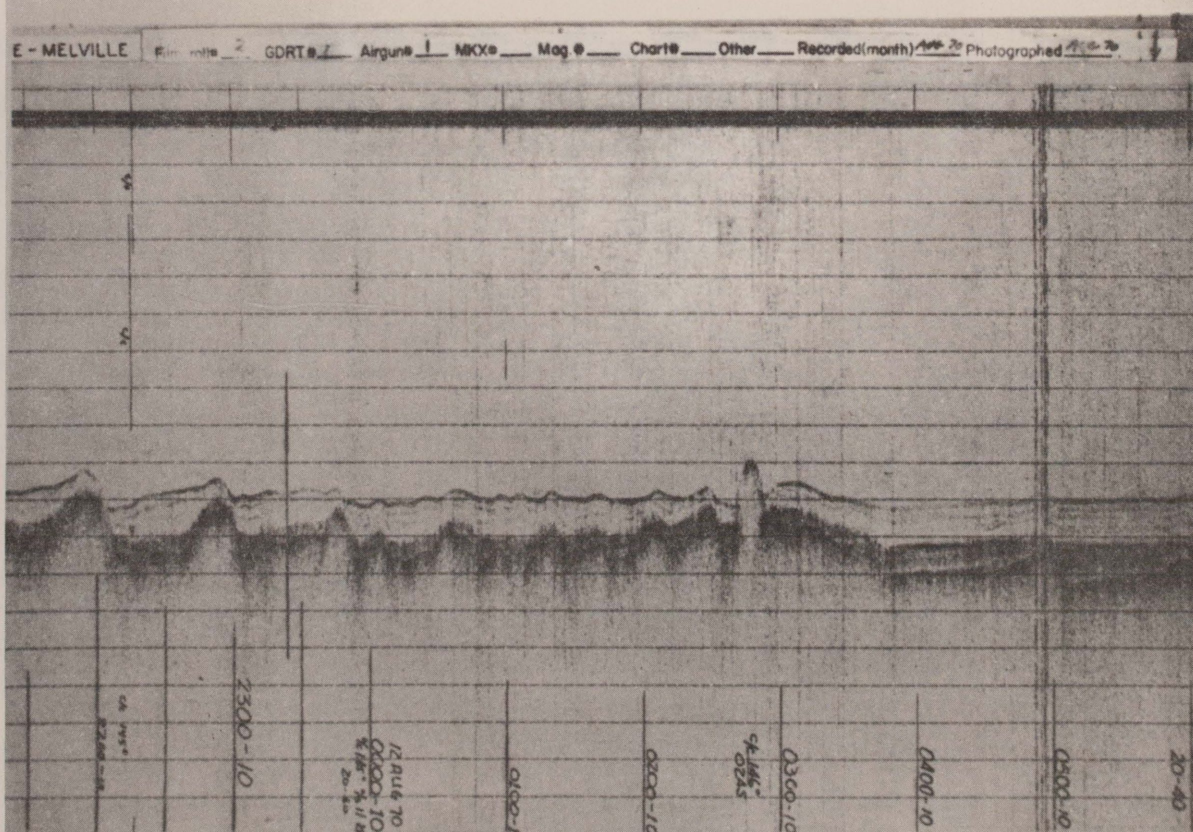
ANT-77



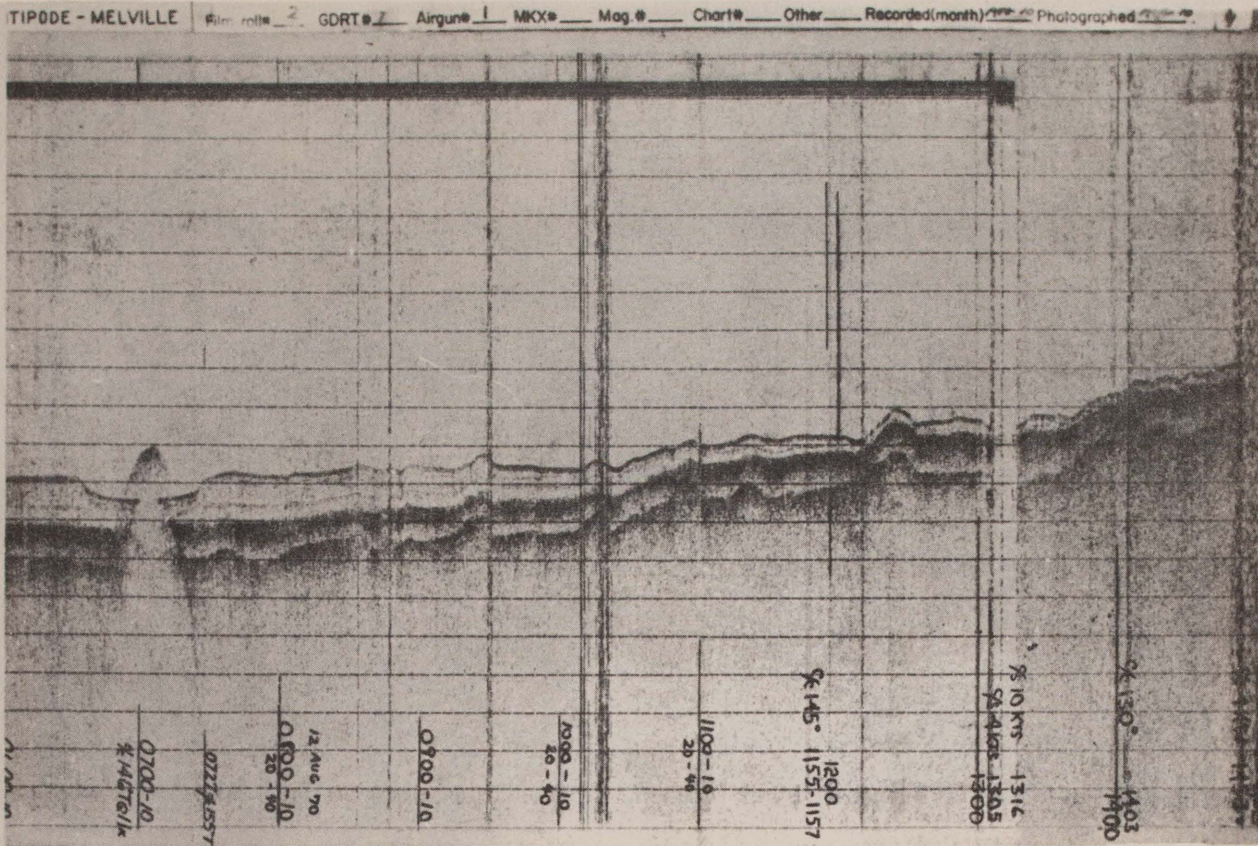
ANT-78


E - MELVILLE
GDRT
Airgun
MKX
Mag.
Chart
Other
Recorded(month)
Photographed
0900-10
1000-10
20-40
11 Aug 70
20-4000 fm
1700-10
2000-10

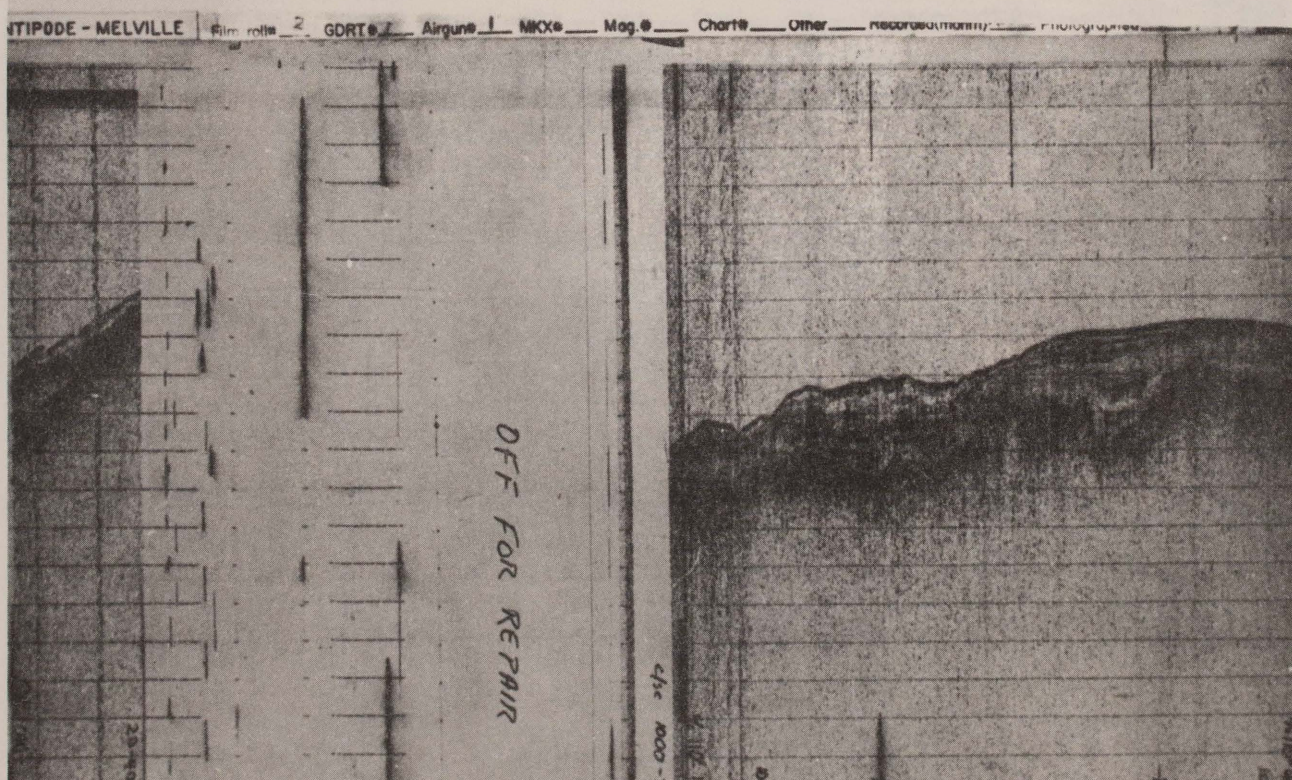
ANT-79


E - MELVILLE
GDRT
Airgun
MKX
Mag.
Chart
Other
Recorded(month)
Photographed
2300-10
12 AUG 70
0000-10
0100-10
0200-10
0245
0300-10
0400-10
0500-10
20-40

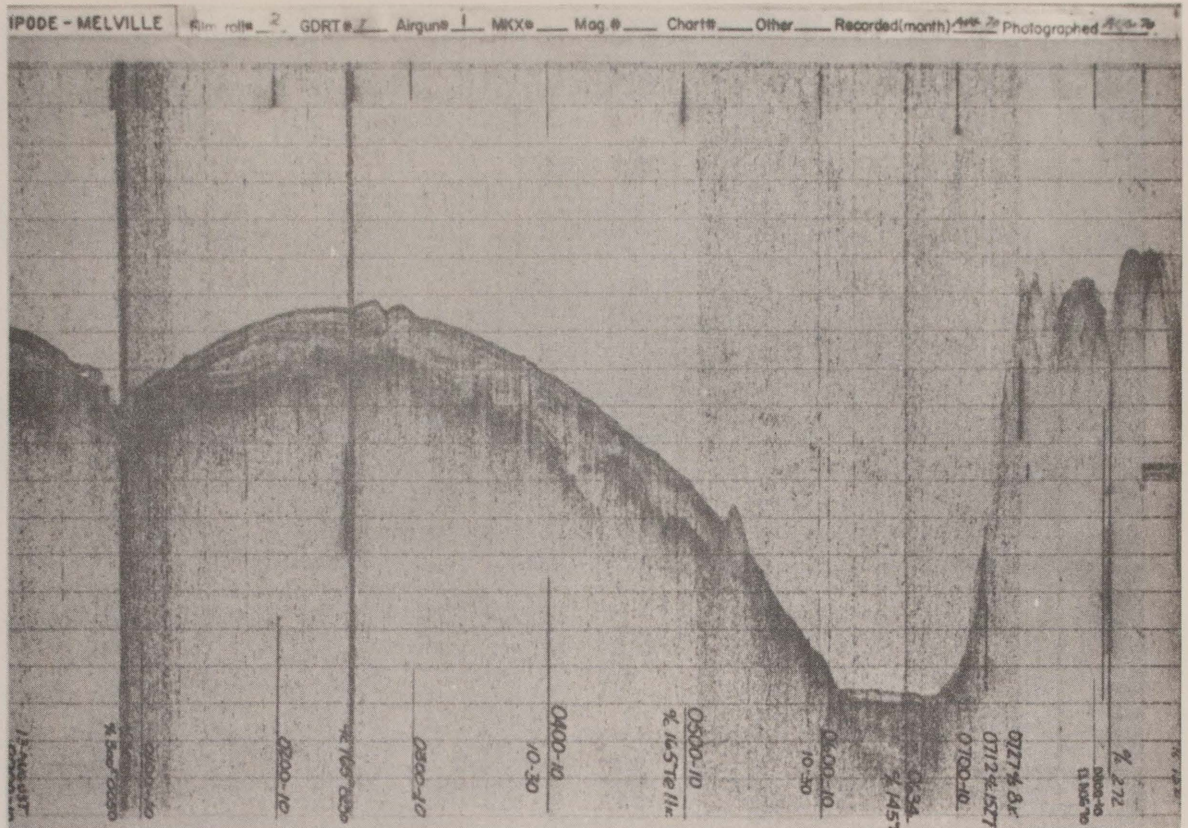
ANT-80


TIPODE - MELVILLE
Film roll# 2
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
Recorded(month)
Photographed

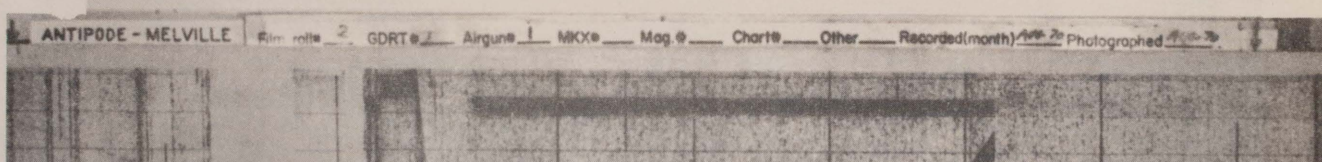
ANT-81


TIPODE - MELVILLE
Film roll# 2
GDRT#
Airgun# 1
MKX#
Mag.#
Chart#
Other
OFF FOR REPAIR

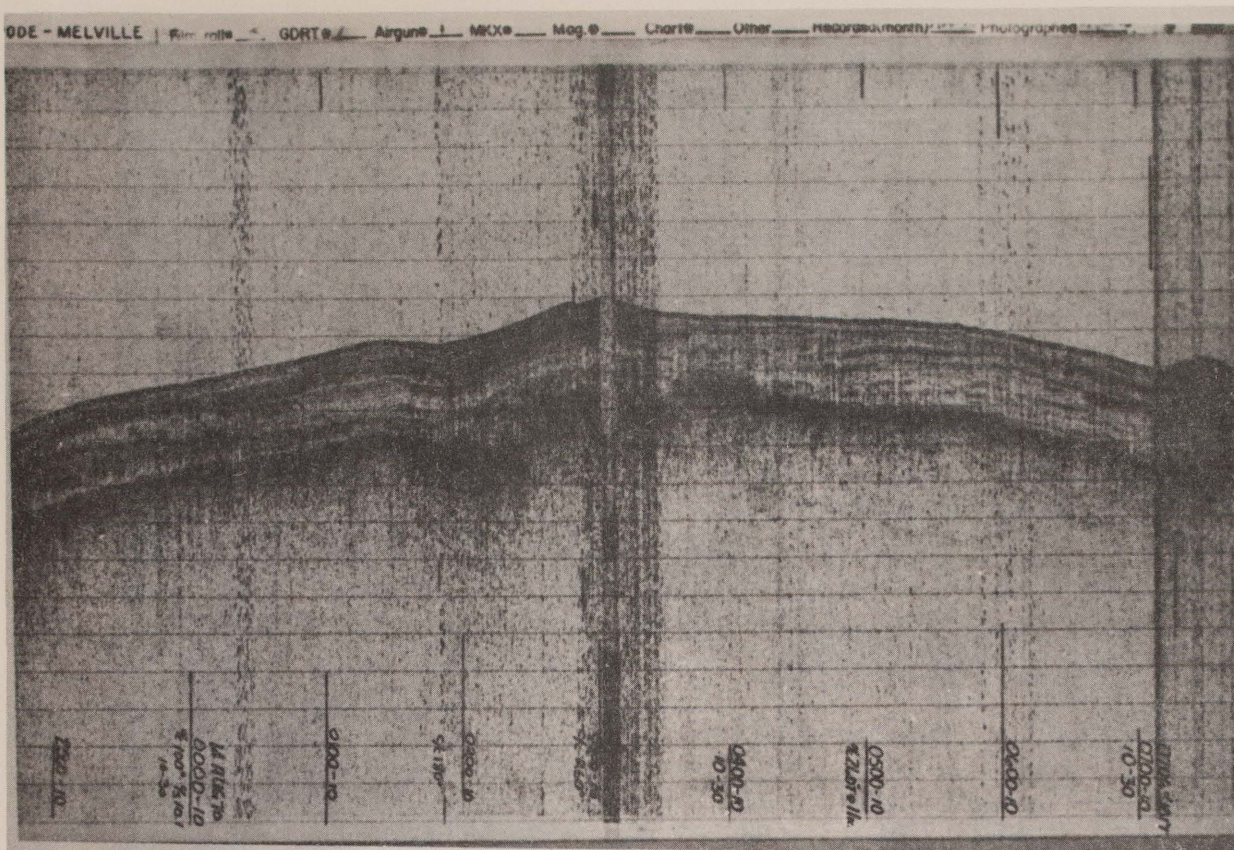
ANT-82


IPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed

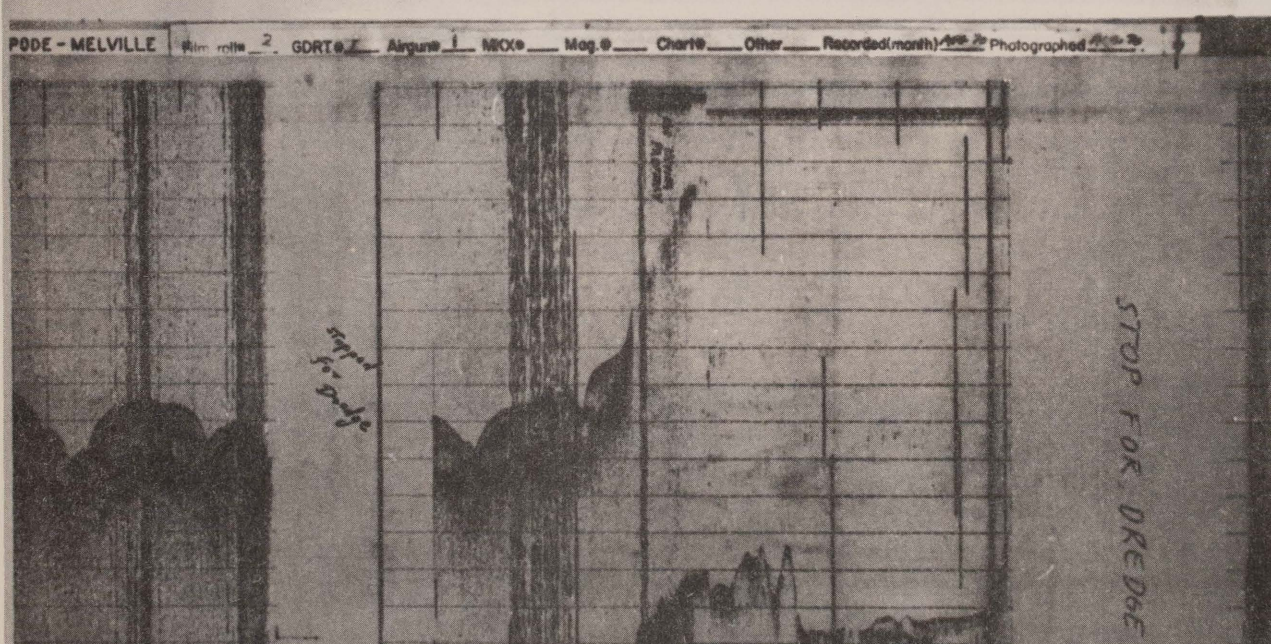
ANT-83


ANTIPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed
Dredge 48D
c/s 4kts TO
RETRIEVE GEAR

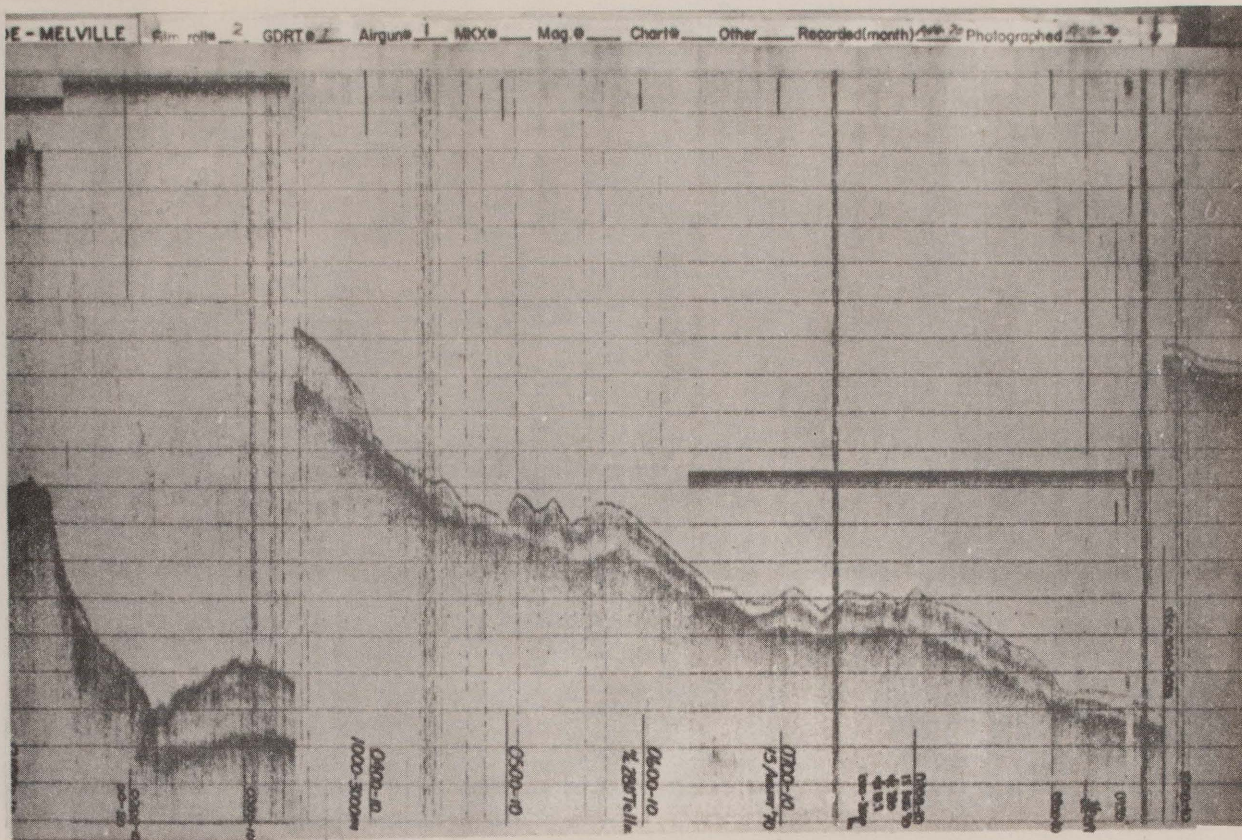
ANT-84



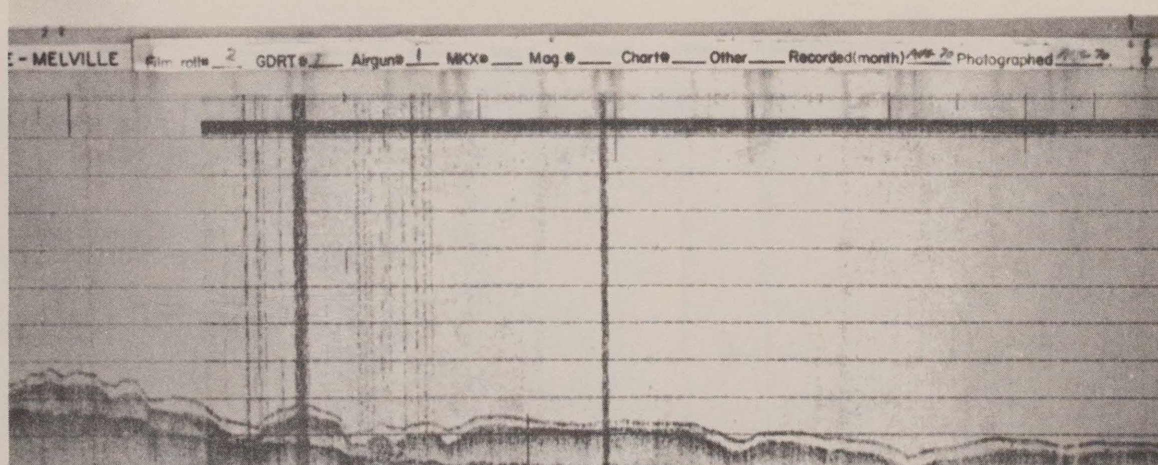
ANT-85



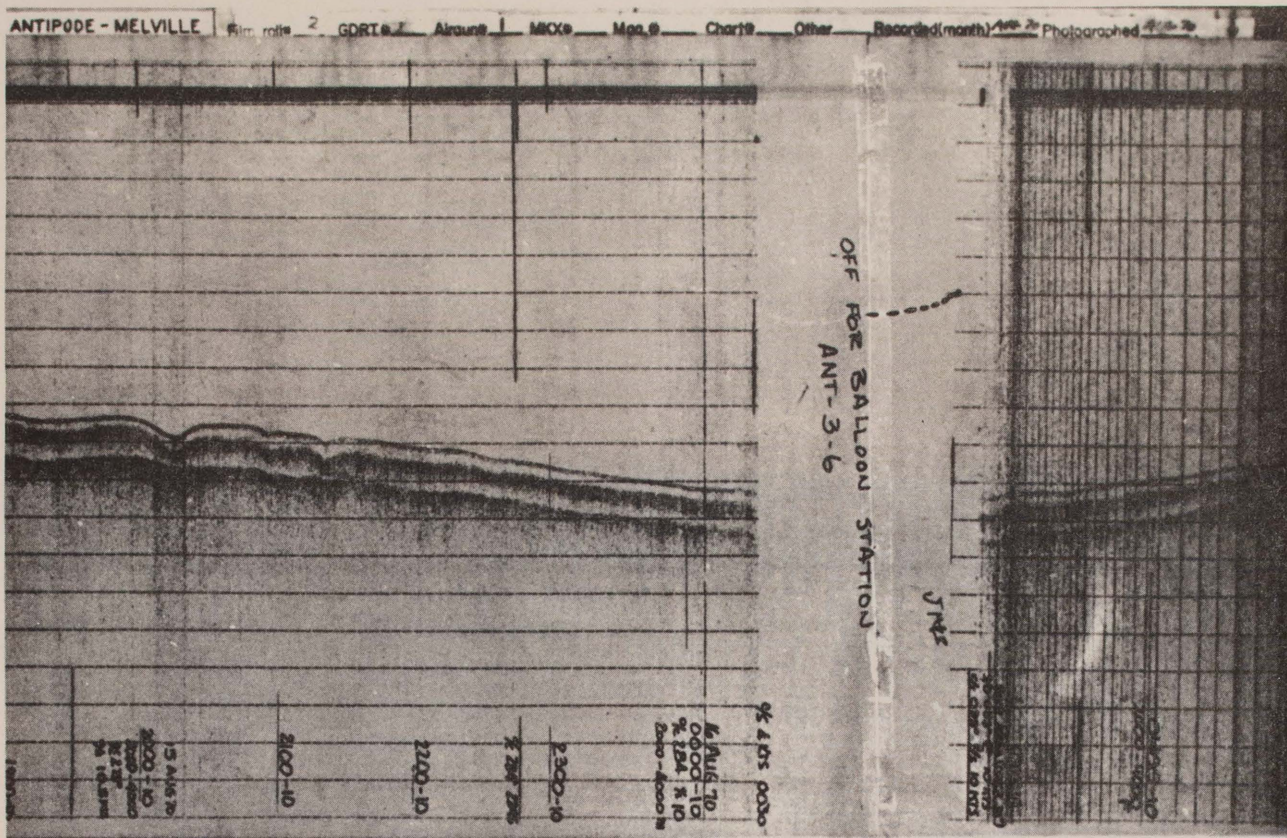
ANT-86



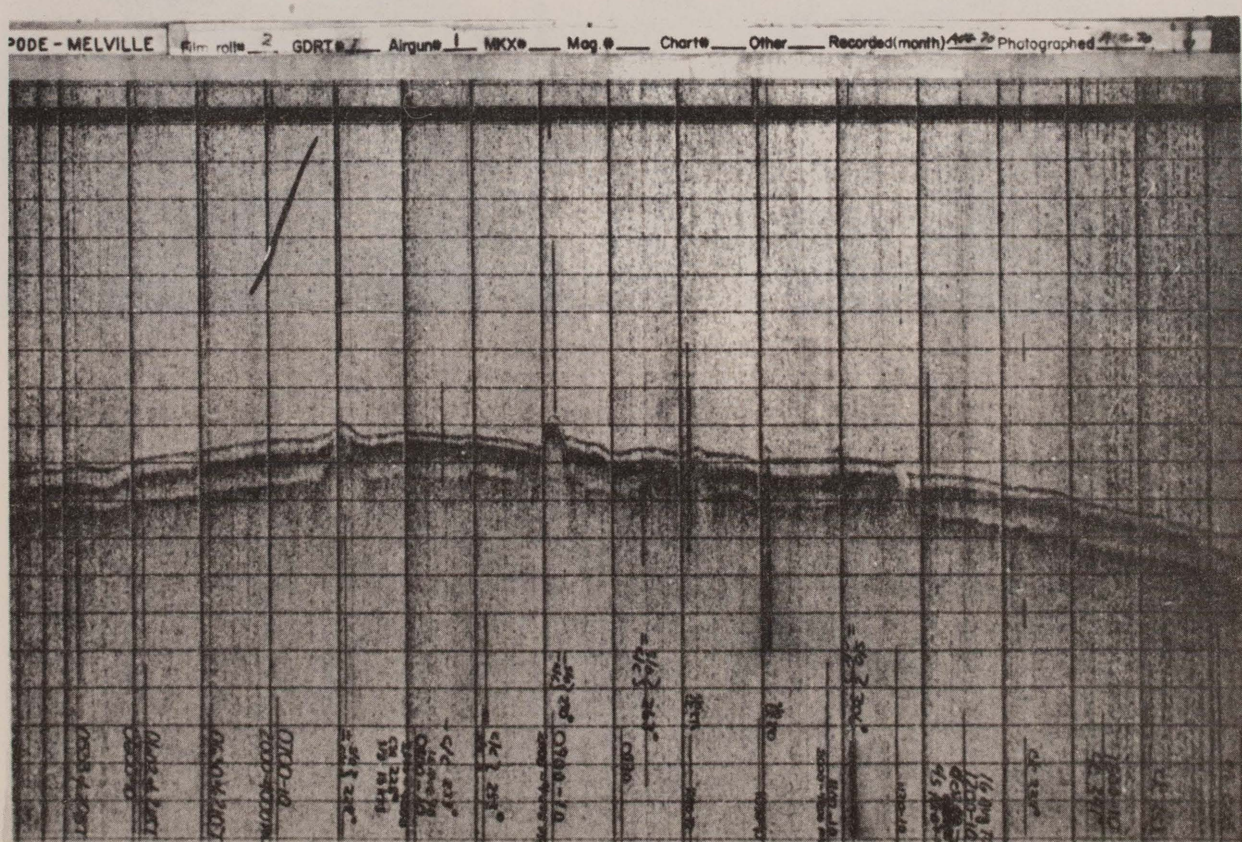
ANT-87



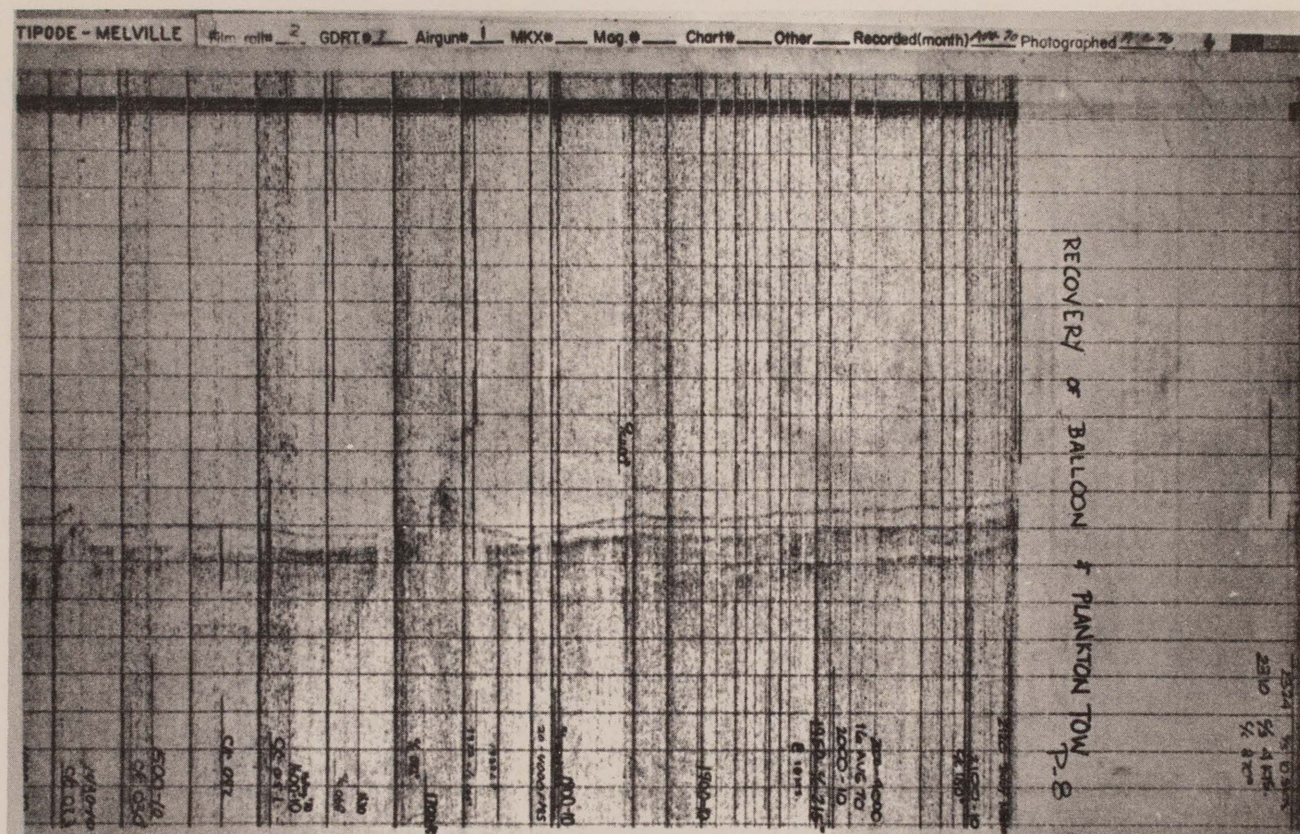
ANT-88


ANTIPODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed
OFF FOR BALLOON STATION
ANT-3-6
2100-10
2200-10
2300-10

ANT-89


PODE - MELVILLE
Film roll# 2 GDRT# Airgun# 1 MKX# Mag.# Chart# Other Recorded(month) Photographed

ANT-90



ANT-91