Cruise Report

Site Surveys on Mississippi Submarine Fan

R/V ROBERT D. CONRAD CRUISE 2312

Prepared for
Joint Oceanographic Institutions, Inc.
(subcontract JOI 50-82)

by

Alexander Shor

Lamont-Doherty Geological Observatory

7 February 1983

Site Survey Objectives and Background

R/V ROBERT D. CONRAD Cruise 23-12 (RC23-12) was supported by JOI, Inc. (subcontract 50-82) to provide geophysical surveys on Mississippi Submarine Fan in anticipation of drilling in late 1983 by D/V GLOMAR CHALLENGER (DSDP Leg 95B). The site survey program included single channel seismic reflection profiling, medium-range side-scan sonar and near bottom subbottom profiling using the Sea MARC I system, surface-ship echosounding (12 kHz and 3.5 kHz), and gravity data acquisition. Ship navigation data was determined from LORAN C and transit satellites. LORAN C was logged separately from a second Northstar LORAN C receiver unit at a 30-second rate during Sea MARC deployments. Vehicle positions were determined through acoustic ranging from the ship to the towed vehicle. Gravity and navigation data were logged continuously (from Tampa to Tampa) on digital tape.

Three regions were surveyed in anticipation of drilling (Fig. 1), designated herein as 1) Mississippi Trough, 2) Middle Fan Meander, and 3) Lower Fan Channel Termination. Additional seismic reflection profiling was carried out during transits between the surveys. Thirteen sites for drilling were selected (including two alternate sites). These are summarized in Table 1. Seismic profile times are listed in Table 2.

The design and success of the site survey program which was carried out during RC23-12 was largely due to the availability of data from GLORIA MARK II long-range side-scan sonar surveys conducted by Neil Kenyon (IOS) and Lou Garrison (USGS, Corpus Christi) during February 1982. These GLORIA surveys provided us with regional maps of a meandering submarine channel extending from 2400 m depth, north of our middle fan survey, to nearly 3200 meters depth (at the start of our lower fan survey). With these data (plus interpretive sketches provided by Garrison) on board we were able to use our transit legs to convincingly demonstrate continuity of a single submarine channel more than 500 km long between 1400 meters and 3275 meters water depth. This allowed us to achieve a central goal of the survey: to locate well-surveyed drilling targets at various depths along a single flow pathway.

Drs. Arnold Bouma (Gulf Research and Development Company) and James Coleman (Louisiana State University) participated in the site survey cruise. Both have been designated as co-Chief Scientists for DSDP Leg 95B and much of the survey planning, both prior to the cruise and at sea, was in accordance with their wishes.

Cruise RC23-12 bagan from Tampa, Florida, on 29 November 1982 at approximately 2200Z. The ship crossed to Gulfport, Mississippi, to wind conducting cable onto the Sea MARC tow winch, arriving Gulfport 1615Z/1 Dec and departing 0100Z/2 Dec. The only operations during the transit to Gulfport were 1) continuous navigation and gravity measurement, 2) 3.5 kHz and 12 kHz echosounder profiling across de Soto Canyon and 3) a source signature test of the water gun. Underway geophysical watches began at 0300Z on 2 December following departure from Gulfport. Seismic reflection profiling began at 1600Z at the shelf-slope break off Southwest Passage of the Mississippi Delta.

MISSISSIPPI TROUGH SURVEYS

Objectives

The goal of surveys in Mississippi Trough was to identify one or more potential drill targets to define the sedimentary sequences and stratigraphy of a sediment-filled slope canyon. The specific survey requirements were proposed to us by Dr. Bouma. They were designed to examine an acoustic sedimentary sequence identified by himself in slope basins and possibly identified in Mississippi Trough in some medium-quality sparker records obtained by USGS. Lines were laid out by Bouma and Coleman with the following objectives:

1. Provide a series of sections across the Trough to examine acoustic facies and stratigraphy;

2. Provide tie lines crossing all "sections" for correlation;

3. Avoid salt diapirs, both for drilling safety and for seismic correlations;

4. Tie the Trough seismic grid to a set of stratigraphic borings in the shallow Mississippi Trough in which ^{14}C dating has established the age of various Trough fill seismic horizons; and

5. Identify appropriate drilling targets to establish the stratigraphy, of what appears to be cycles of deposition involved in the (presumed) extremely rapid fill of Mississippi Trough.

Operations

Because the Mississsippi Trough is underlain by an extensive field of salt diapirs, it was necessary to survey along a rather complex network of lines in order to provide reflector continuity for seismic stratigraphic correlation (Fig. 2). Dr. Bouma laid out the tracks for seismic reflection profiling. He also decided that it was not necessary to deploy the Sea MARC I vehicle in Mississippi Trough as we had initially proposed.

The seismic surveys consisted of 502 kilometers of water gun seismic reflection profiling (Figure 2). As in all subsequent surveys, data were digitally recorded on two channels at 2500 samples per second each, in a 5 second window. In the Mississippi Trough survey, one channel recorded data from a single 25-m section of hydrophones and the other channel recorded data from two 25-m sections. In the later surveys, these were doubled to two and four sections, respectively. The objective in recording two channels with different streamer sections was to provide records of either moderately better resolution or moderately better penetration. One 80 cubic inch water gun was towed, floated at 15 feet with a Norwegian float to maintain uniform source characteristics. Surveys were run at 5 knots with 18 second (nominally 50 meter) shot spacing. The survey consists of 21 lines from 8 to 52 kilometers long (lines numbered from 1 to 21; Figure 2, Table 1). Lines were laid out to complement a survey run simultaneously by Dr. Richard Buffler of University of Texas for Marathon Oil Company. Buffler's lines were tied to drill sites in the upper Mississippi Trough and adjacent shelf. With appropriate correlation, ties between proposed DSDP sites and industry wells may be possible through use of the combined data set.

Seismic profiling was begun at approximately 1600Z on 2 December 1982 near the shelf break off Southwest Passage of the Mississippi Delta. Profiling concluded at 1740Z on 4 December, and was followed by a Hydrophone-Pinger Experiment station (lowering 1) in the vicinity of one of the recommended drill sites (MF3). These results, and those of subsequent Hydrophone-pinger Experiments, are described in Appendix I.

Results

Seismic data is of excellent quality, and no time was lost due to equipment malfunction. Diapiric structures are common. We successfully navigated between them to provide reflector continuity from the sea bed to at least one second subbottom. The water guns provided sufficient energy to identify reflections to at least two seconds subbottom, although on monitor records most reflections this deep are obscured by the multiple.

Based on these lines, Dr. Bouma selected two drill sites and two alternate sites for rotary drilling (Table 1). The three sites deeper than 1600 meters water depth were selected during the survey, and cross lines were run to provide additional information for Safety Panel review. The shallow site was selected after the completion of the surveys and hence does not have a tie line.

TRANSIT TO MEANDER SURVEY AREA

Seismic profiling was completed over 269 kilometers on 10 lines (Lines 22 to 31) between the Mississippi Trough survey and the middle fan region (Fig. 3). Seismic lines include four profiles across the Mississippi Trough extension (23, 25, 27 and 29) to define the continuity of the sedimentary sequences between the Trough survey and the morphologically distinct leveed channel characterizing the middle fan region. These seismic profiles successfully delineated the path of the filled channel as the western of two troughs within the Mississippi Trough survey.

Seismic profiling during the transit began at 0536Z on 5 December 1982 (line 22) and concluded at 0620Z on 6 December 1982 (Line 31) when seismic profiling of the Middle Fan Meander Survey began.

Beginning with Line 22, seismic profiling was carried out at a nominal ship spread of 6.5 knots and 15 second shot spacing (to maintain 50-meter shot spacing).

MIDDLE FAN MEANDER SURVEY

Objectives

The primary goal of the site survey on the middle fan was to define the 3-dimensional geometry of a channel meander. The site was selected by Dr. Bouma based on the GLORIA profiles obtained by Kenyon and Garrison. Although the channel at this location is filled with acoustically transparent "debris flow," it was concluded that appropriate drilling targets were within reach of the Hydraulic Piston Corer to examine channel and levee facies beneath the fill. Surveys included:

1. Sea MARC I side-scan sonar tows at 5 kilometer swath for mapping surface morphology;

2. Sea MARC I side-scan sonar tows at 1 kilometer swath for detailed examination of surface structures within the meander; and

3. Closely-spaced seismic reflection profiles roughly normal to the channel (plus tie lines) to look for evidence of channel migration through time.

A second goal of surveys on the middle fan was to define an appropriate drilling target to sample a major slump complex centered to the northeast of the channel. Both 5-kilometer swath side-scan lines and seismic lines were extended NE from the channel to provide appropriate data on surface morphology and subbottom structure of the slumped sequence.

Operations

Seismic profiling was carried out in two phases. Five NE-SW lines were run beginning 0520Z on 6 December and concluding 1845Z the same day. These lines (1001, 1008, 1016, 1024 and 1025) are five of the 31 NE-SW lines planned for a closely-spaced seismic grid, of which 19 were actually shot (Fig. 4). The initial five lines were used to define the channel location in order to design an appropriate side-scan sonar survey which would include the entire channel meander. The 19 NE-SW seismic lines are numbered as shown in Figure 2, beginning with #1001 on the north. Together with four NW-SE tie lines, they will comprise the seismic network to be processed by Gulf Research and Development Company for 3-dimensional modelling of the submarine channel meander.

Following completion of the first five seismic lines, Sea MARC I was deployed, beginning at 0140Z on 7 December. Four NE-SW side-scan sonar lines and two NW-SE lines were run using the 5-kilometer side-scan swath (Fig. 5). Lines were spaced to provide overlapping coverage of a region roughly 500 km^2. At 0900Z on 9 December we concluded the 5-kilometer mapping and switched to 1-kilometer swath side-scan. Three 1-kilometer swath lines were run, roughly parallel to and within the channel to image the lineated channel floor and inner levee walls. At 0611Z on 10 December we began retrieval of Sea MARC I, and the vehicle was brought on deck at 1124Z on 10 December, concluding the side-scan sonar survey of the Middle Fan Meander.

Hydrophone-Pinger Experiment lowerings 2 and 3 followed the Sea MARC I survey, from 1254Z/10 Dec to 0100Z/11 Dec (Appendix 1).

Following conclusion of the Hydrophone-Pinger Experiment, seismic profiling was continued (starting 0400Z on 11 December) to complete the NE-SW grid pattern of 25-kilometer long, 500-meter spaced seismic lines. Dr. Bouma recommended that lines be shortened and outer lines be omitted to save time for operations on the lower fan, and this modification was adopted. Lines 1010-1013 and 1019-1022 are therefore only 16 kilometers long, and 500 meter line spacing is restricted to the 8.5 kilometers of channel between lines 1008 and 1025. The grid was completed at 0730Z/12 December on completion of line 1023, which was extended to the NE into the slump deposit, and four tie lines were run orthogonal to the primary survey lines (2001-2004). Short lines which did not form part of the Gulf 3-D survey were numbered consecutively through the cruise, and seismic profiling in the meander was completed with Line 41 at 2050Z on 12 December. Hydrophone-Pinger Experiment lowerings 4 and 5 were carried out, (Appendix 1). At 0729Z on 13 December we departed the middle fan region to begin the transit to the Lower Fan Channel Termination site.

Problems

Electronics problems with Sea MARC I caused ground faulting throughout much of the Meander survey, which resulted in spurious data recorded and mis-pinging. These problems are quite apparent on both side-scan and subbottom images, and although in almost all instances it is possible to map targets on the side-scan sonar records through the poor sections, they nonetheless detract significantly from record quality. Following completion of the survey, the cable between the depressor (towing weight) and the neutrally-buoyant vehicle was replaced, as resistance was unacceptably high. This corrected the problem and it was presumed that a crushed section of the cable was responsible for the ground faulting.

A power supply failure caused data loss from 0130 to 0330Z on 9 December. The failure occurred as we began a turn, and, therefore, resulted in minimal loss of data in the NW corner of the survey. Because we extended the turn during the power failure, we fortuitously discovered a major set of slump-front "pressure ridges" which otherwise would not have been mapped.

A significant data logging problem was discovered after completion of the meander survey. Two of eight data bits were not properly transferred by the interface between the side-scan sonars and the logging computer. Taped data is, therefore, highly limited in usefulness for subsequent processing, and analog side scan records are not likely to be significantly enhanced. Although the collection and processing of digital data was not contractually required, degredation of the digital tape records is a major disappointment. The tapes will be examined further, as low gain levels are properly recorded, and subbottom data are not affected. The problem was identified and repaired before the lower fan deployment.

The Sea MARC pressure sensor had a calibration error which we were not able to correct during the survey. The depth calibration has an error of approximately 3% which results in apparent slopes of the sea floor in some instances (particularly when the vehicle is changing altitude rapidly). Digital depth data have been corrected, but analog subbottom profiler records contain depth artifacts, and some care is necessary in interpreting them.

Results

Five-kilometer swath side-scan sonar lines clearly delineate a meander in the submarine channel. The channel lies immediately southwest of a highly reflective, meandering feature on the GLORIA records, which proved to be the NE channel levee. The channel is approximately 3 kilometers wide in the vicinity of the meander, and is filled with in excess of 100 meters of acoustically transparent fill, with a single reflector (on 3.5 and 4.5 kHz records) within the uppermost 20 to 40 meters. Three additional acoustic facies (at 3.5 and 4.5 kHz) outcrop locally within the channel region. These include (1) an acoustically laminated unit immediately underlying the transparent fill, (2) a thin basal sequence of variable thickness, and (3) an acoustically opaque unit which we interpret as the top of the levee sequence. Bathymetry in the vicinity of the meander was prepared from seismic line echosounder data and is shown in Figure 6.

The channel surface within the meander is lineated with "flow-line" striations which parallel the channel trend. No morphologic expression is evident on the subbottom profiler records, but hyperbolae are present, suggesting that the striations originate from shallow ridges or grooves in the sea bed. The truncation of reflectors of the underlying laminated sequence where it outcrops suggests relatively recent erosion (apparently post-dating deposition of the transparent unit, which is stratigraphically the youngest deposit). We do not observe truncation of reflectors in this unit where it is buried. The surface lineations in the transparent sequence support the hypothesis that erosion is caused by channelized turbidity currents.

The nature of the transparent fill will be examined during the drilling leg. We expect that it will be found to be similar to the "Walker-Massingill slump" immediately NE of the channel, which apparently overrides the levee in the NW corner of our survey. A pronounced pattern of arcuate reflectors on the sea bed in that region are interpreted as slump-front pressure ridges. The absence of similar features down-channel suggests a change from plastic to thixotropic flow as the slump mass entered the channel. We do not view the parallel lineations in the meander region to be the same as the arcuate features (also developed on the surface of the transparent unit) in the NW corner of the survey area.

As was observed in both the Mississippi Trough and in subsequent lines down the fan, the channel in the Middle Fan Meander survey is underlain by two sets of "high amplitude reflectors." These reflectors are easily recognized on watergun profiles, and may be sand bodies. The nature and geometry of these unusual deposits is of considerable interest to geologists interested in submarine fan growth processes, as we observe these reflectors beneath every channel crossing and they may represent a continuous coarse deposit extending from the slope canyon to the lower fan. It is hoped that the geometry of these features may be clarified through use of 3-dimensional analysis by Dr. Bouma at Gulf Research and Development Company. Analysis of these reflections should provide important data not only for evaluating the petroleum potential of deep-sea fans, but also the growth processes of deep-sea channel meanders and the nature of submarine channel sediment facies.

TRANSIT TO LOWER FAN

Seismic reflection profiling was carried out at 6.5 knots during the transit to the lower fan survey site. Profiling began at 0729Z on 13 December and concluded at 1700Z on 14 December. The objective was to examine the continuity of the leveed channel between the two surveys, particularly in the vicinity of 87°15'W, 26°30'N where previous work had indicated that the slump sequence terminates (Walker and Massingill, 1970). GLORIA images from this region show a marked change in channel character, and prior to our surveys it was not clear that channels east and west of this region were connected.

Fourteen seismic lines were run (Lines 43-55; Fig. 7) covering 370 kilometers (Fig. 7). Lines were laid out to stay generally south of and parallel to the channel (as indicated on GLORIA profiles). A trapezoidal survey across the slump front to examine channel continuity consisted of four lines (44-47). Lines 50 and 51 diverted to the north to tie with a UTMSI multi-channel line at the request of M. Feeley. In addition to providing interval velocity data for processing our single-channel lines for true depth determination, this line demonstrates that the channel deviates far to the NE and outside of the GLORIA swath. Lines 52 to 55 provided a clear definition of channel location and trend near its point of departure towards the south of the GLORIA profiles. At 1700Z (EOL 55) we secured the seismic profiling gear to prepare for Sea MARC I deployment.

LOWER FAN SURVEY

Objectives

The lower fan is predicted to receive channel-transported coarse-grained deposits, which may build a depositional lobe seaward of the end of the submarine channel. The survey objectives were:

1. Trace the path of the channel using side-scan sonar from the point at which it departs from the GLORIA swath;
2. Identify the termination of the leveed channel.
3. Describe the surface morphology in the vicinity of the channel terminus;
4. Identify appropriate drilling targets for sampling the depositional lobe (if it exists); and
5. Identify potential sites for drilling channel, levee and overbank deposits on the outermost lower fan.

The Sea MARC tow along the channel south from 26°N was originally proposed by Dr. Bouma at a meeting at L-DGO in November. At that time, we planned to run the surveys in reverse order, beginning the Lower Fan Channel Termination survey with surface ship reconnaissance of the region near 25°N; 86°W to locate the end of the channel before deploying the vehicle. The survey plan was changed because of the need to begin at Gulfport, and hence the lower fan survey was run last. As Dr. Bouma and L-DGO personnel believed that the side-scan tow connecting the channel termination to the GLORIA profile was still important (for the purpose of establishing channel morphology and continuity) we began the side-scan tow at 26°N with a long southward transit, although this required recognition of the channel terminus from side-scan sonar. We believe we successfully identified and mapped the terminus of the main channel. However, there is clear evidence of at least one extremely shallow (distributary?) channel which extends southward out of our survey. Considerable further examination of these data and comparison to other fan survey side-scan data will be necessary before we understand the channel termination geologic setting sufficiently for fan model evaluation.

Operations

Sea Marc I failed initial deck check, at 1730Z/14 Dec, and a short channel survey using the ship's 3.5 kHz echosounder was carried out while a section of conducting cable in the harness was removed and replaced. The vehicle was launched at 2220Z to begin a tow to the channel terminus approximately 80 kilometers to the south. Channel crossings from previous L-DGO and U. S. Navy cruises were used as way points to follow the channel. A major section of the channel was mapped during the long tow.

The overlapping side-scan survey began at 1100Z on 16 December. Tracks were run along courses 200° and 020°, as the Loop Current prevented other, more preferable headings.

Operations were difficult at the Lower Fan Channel Termination site (Fig. 8) because of persistent flow of the Loop Current toward the SW at 1.5 to 2 knots. Towing speed was limited to approximately 2 knots to prevent the cable from riding out of the snout sheave of the towing crane. Therefore, on downcurrent legs it was very difficult to maintain steerageway, and, when the wind blew from the north, we were occasionally thrusting forward with the bowthruster to slow our progress. Data quality suffered somewhat, as the vehicle pitch increased on southerly legs causing data dropout. On southward legs we also had to continuously pay out cable to keep the vehicle within 500 to 600 m of bottom. Northward legs were substantially better, and one kilometer swath lines were generally reserved for northerly legs after an initial attempt driving south (0000Z to 0215Z, 17 December).

Electronics problems encountered in the Meander survey were less severe on the Lower Fan, although periodic malfunction of the power supply occurred. One electronic connector had to be replaced which had caused some of the ground faulting and may have contributed to power supply problems. Data quality from 0230Z to 0400Z is therefore quite poor. In general, however, data quality is good, and we anticipate additional processing of digital tapes to improve feature resolution along lines of particular interest.

Side-scan operations were completed at 0000Z/19 December following a 1-kilometer swath side-scan transect across the channel near 25° 12.5'N for high-resolution imaging of proposed drill sites (MF 11, 12, and 13). Sea MARC I was brought on deck and secured at 0350Z on 19 December. We proceeded to the site for Hydrophone-Pinger Experiment lowering 6, beginning at 0700Z and ending at 1900Z/19 Dec (Appendix 1).

Following completion of the Hydrophone-Pinger Experiment, seismic gear was streamed for a series of East-West profiles covering the region of the channel termination (Fig. 9). As the area was too large for precise definition of a fine-scale grid (as originally proposed) we ran closely-spaced lines across two sections of interest for drilling and then filled in lines approximately 3 kilometers apart and 25 kms long between our long, bounding profiles (Line 57 in the north and 59 to the south). We, therefore, have a seismic grid covering approximately 750 km^2 with extensions both east and west which should provide sufficient coverage for defining the areal extent of depositional lobes. Bathymetry based on surface-ship echosounding is illustrated in Figure 10. Lines parallel to the Sea MARC transit down the channel followed. Ten lines (73-82) completed the tie between the Lower Fan Channel Termination seismic grid and the previous surveys (Fig. 11), providing continuous seismic lines from approximately 1200 meters water depth in Mississippi Trough to 3300 meters on the lower fan. In the event that data obtained by Buffler is available as well, this will tie continuously from borings on the shelf to the deepest section of Mississippi Fan along a single channel pathway.

Post-survey Operations

Following completion of the seismic lines connecting the Lower Fan Channel Termination Survey with the Lower Fan Transit, we deployed a hydrophone array for watergun source signature tests. The source signature should allow us to develop a deconvolution algorithm for the water-gun reflection data. The source signature test concluded at 0830Z and we steamed at full speed to Tampa, arriving 1200Z/23 December 1982 to conclude the voyage.

TABLE 1

Sites to be recommended for drilling (prepared 22 Dec. 82 by A. Bouma)

Site #	Latitude	Longitude	Water Depth	Seismic Line
(R) MF-1	28°03.4'N	89°25.2'W	1178 m	line 18 @ 0918 Z
(R) MF-2 (Altern.)	27°36.3'N	89°04.8'W	1688 m	Lines 8, 21
(R) MF-3	27°39.3'N	88°51.7'W	1615m	Lines 9, 15
(R) MF-4 (Altern.)	27°34.4'N	88°58.7'W	1760 m	Lines 10, 14
MF-5	26°41.75'N	88°31.95'W	2465 m	Lines 1017, 2004
MF-6	26°43.6'N	88°29.9'W	2477 m	Lines 1017, 2003
(R) MF-7	26°45.1'N	88°28.3'W	2465 m	Lines 1017, 2002
MF-8	26°53.5'N	88°21.5'W	2544 m	Line 37 @ 0820 Z
MF-9	25°46.4'N	86°13.6'W	3173 m	Line 79 @ 0307 Z
MF-10	25°25.1'N	86°03'W	3245 m	Line 76 @ 2323 Z
MF-11	25°12.9'N	86°59'W	3278 m	Line 75 @ 2130 Z
MF-12	25°12.64'N	85°56.5'W	3277 m	Line 57 @ 0050 Z
(R) MF-13	25°12.2'N	85°59'	3282 m	Line 75 @ 2124 Z Line 61 @ 1615 Z

(R) indicates Rotary drill site.
All others are Hydraulic piston core sites.

Table 2

Seismic Reflection Lines: RC 2312

Line #	Start	End	
1	1600Z	2053Z/2 Dec 82	MISSISSIPPI TROUGH SURVEY START
2	2053	0026Z/3 Dec 82	
3	0026	0207	
4	0207	0409	
5	0409	0639	
6	0639	0908	
7	0908	1008	
8	1008	1306	
9	1306	1408	
10	1408	1728	
11	1728	1813	
12	1813	2218	
13	2218	2305Z/3 Dec 82	
14	2305	0026Z/4 Dec 82	
15	0026	0118	
16	0118	0324	
17	0324	0752	
18	0752	1003	
19	1003	1135	
20	1135	1514	
21	1514	1740Z/4 Dec 82	MISSISSIPPI TROUGH SURVEY END
22	0542Z	0602Z/5 Dec 82	TRANSIT TO MIDDLE FAN START
23	0602	0917	
24	0917	0955	
25	0955	1615	(Latter half of line 25 reshot due to gun failure. Join points 1245Z = 1405Z)
26	1615	1649	
27	1649	2036	
28	2036	2134Z/5 Dec 82	
29	2134	0223Z/6 Dec 82	
30	0223	0418	
31	0418	0617Z/6 Dec 82	TRANSIT TO MIDDLE FAN END
1016	0617Z	0820Z/6 Dec 82	MIDDLE FAN MEANDER SURVEY START
32	0820	0858	
1001	0858	1114	
33	1114	1132	
1008	1132	1339	
34	1339	1422	
1024	1422	1624	
1025	1624	1846	
35	1846	1859Z/6 Dec 82	
1009	0400Z	0530Z/11 Dec 82	
1010	0530	0659	
1011	0902	1052	(Line 1011 reshot because of gun failure. Times given are for second run. Enter grid at 0918Z.)
1012	1052	1210	
1013	1210	1343	
1014	1343	1537	
1015	1537	1806	

Seismic Reflection Lines: RC 2312, cont'd.

Line #	Start	End	
1017	1812Z	2020Z/11 Dec 82	
1018	2020	2237Z/11 Dec 82	
1019	2237	0006Z/12 Dec 82	
1020	0006	0141	
1021	0141	0306	
1022	0306	0435	
1023	0435	0732	
36	0732	0813	
37	0813	0921	
2001	0921	1028	
38	1028	1133	
2002	1524	1653	(Lines 2002, 2003 reshot due to gun failure.
39	1653	1711	Times given are for second run.)
2003	1711	1832	
40	1832	1857	
2004	1857	2021	
41	2021	2050Z/12 Dec 82	MIDDLE FAN MEANDER SURVEY END
42	0729Z	1300Z/13 Dec 82	TRANSIT TO LOWER FAN START
43	1300	1526	
44	1526	1710	
45	1710	1819	
46	1819	2027	
47	2027	2221Z/13 Dec 82	
48	2221	0400Z/14 Dec 82	
49	0400	0743	
50	0743	0927	
51	0927	1119	
52	1119	1328	
53	1328	1503	
54	1503	1546	
55	1546	1700Z/14 Dec 82	TRANSIT TO LOWER FAN END
56	2000Z	2125Z/19 Dec 82	LOWER FAN SURVEY START
57	2125	0352Z/20 Dec 82	
58	0352	0546	
59	0546	1144	
60	1144	1424	
61	1424	1728	(1728-1738 turn to N)
62	1738	2017	(2017-2024 turn to S)
63	2024	2329Z/20 Dec 82	(2329-2335 turn to S)
64	2335	0226Z/21 Dec 82	(0226-0242 turn to S)
65	0242	0515	(0515-0526 turn to S)
66	0526	0716	(0716-0722 turn to S)

Seismic Reflection Lines: RC 2312, cont'd

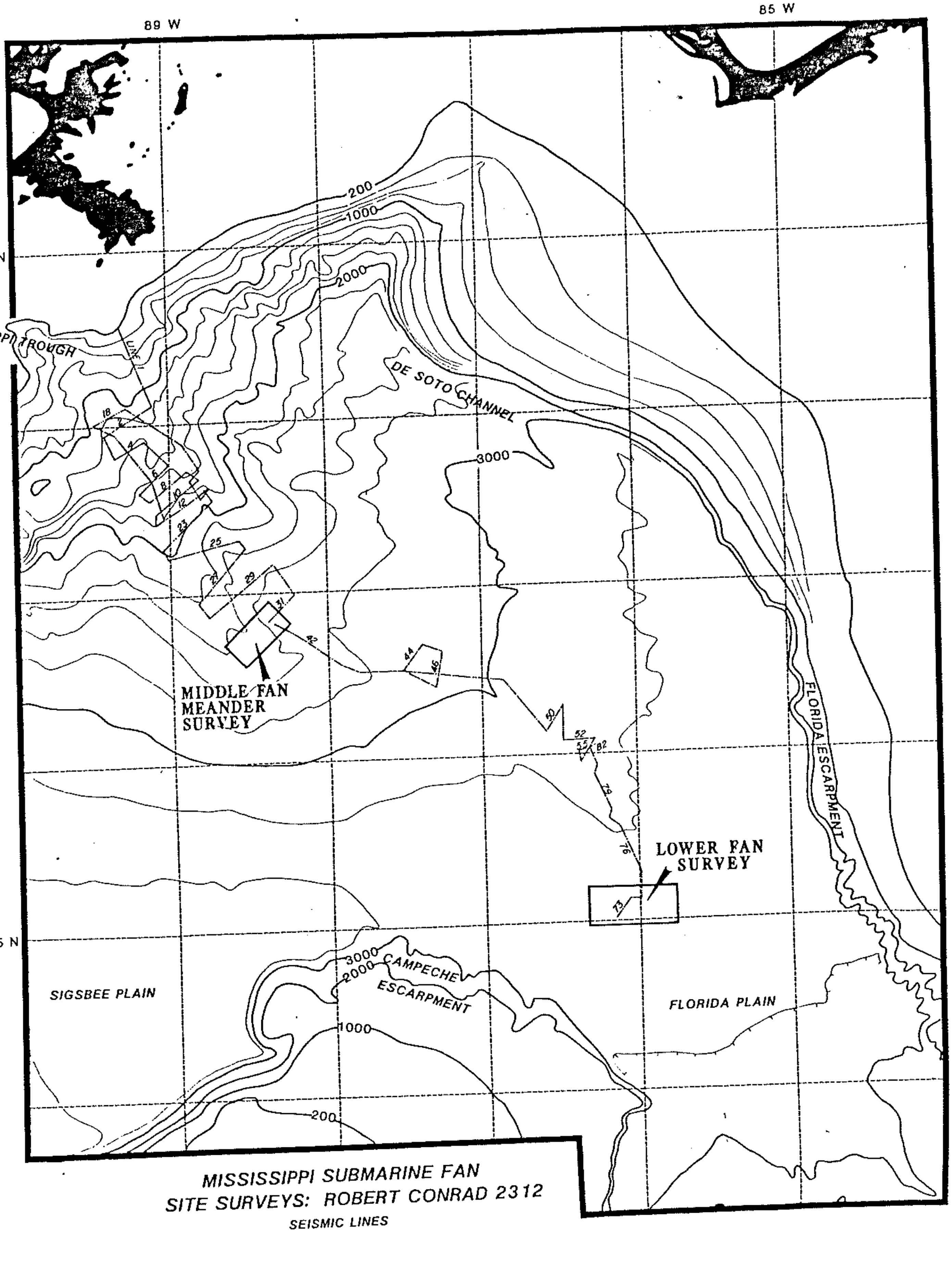
Line #	Start	End	
67	0722Z	0902Z/21 Dec 82	(0902-0907 turn to S)
68	0907	1050	(1050-1102 turn to S)
69	1102	1243	(1243-1254 turn to S)
70	1254	1438	(1438-1450 turn to S)
71	1450	1648	(1648-1659 turn to S)
72	1659	1841	
73	1841	2003	
74	2003	2050	
75	2050	2208Z/21 Dec 82	
76	2208	0040Z/22 Dec 82	
77	0040	0131	
78	0131	0208	
79	0208	0410	
80	0410	0444	
81	0444	0541	
82	0541	0554Z/22 Dec 82	LOWER FAN SURVEY END

TABLE 3

PERSONNEL LIST: CONRAD CRUISE 23-12

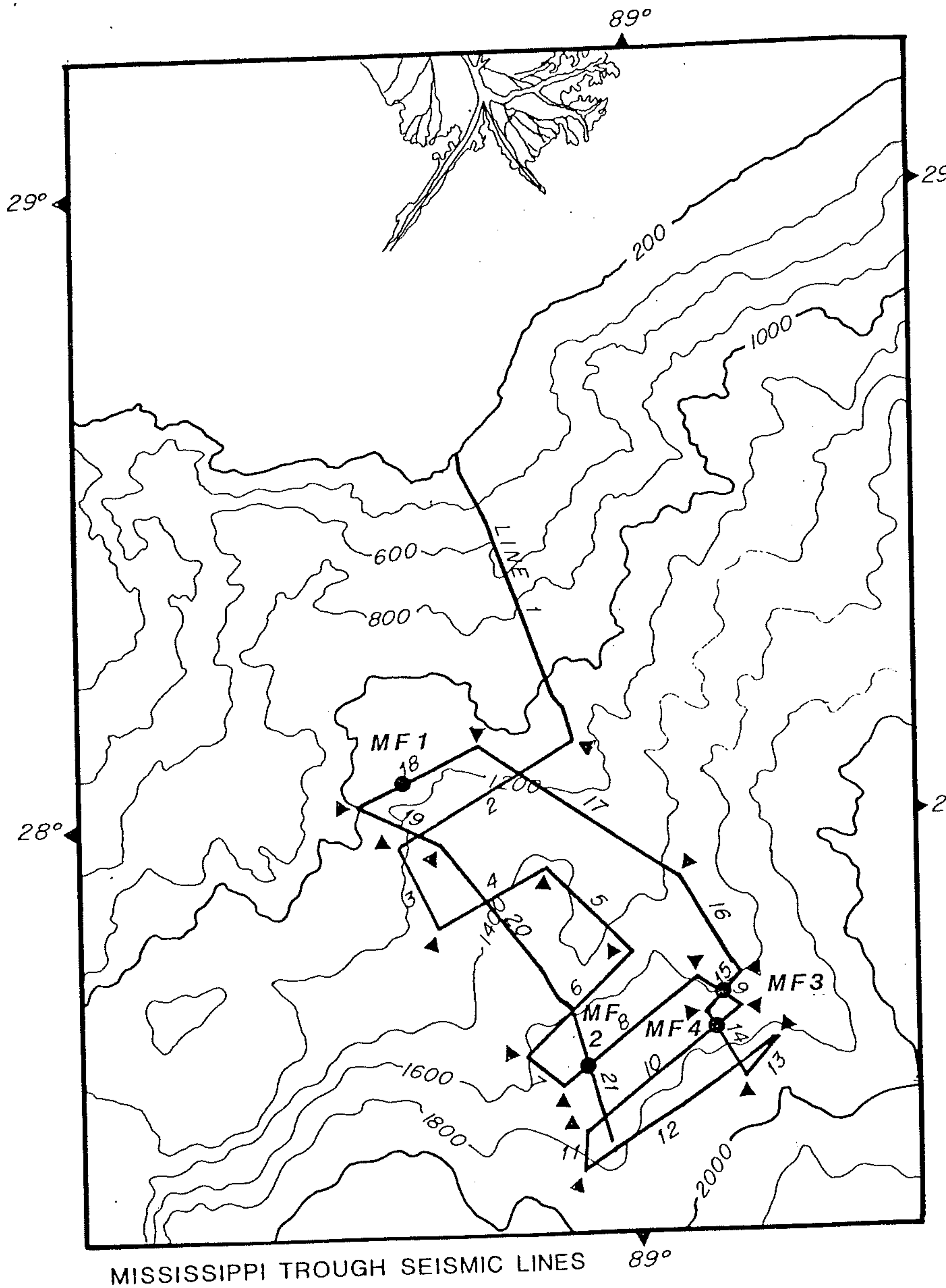
1.	Dr. Alexander Shor	LDGO	Chief Scientist
2.	Dr. Kim Kastens	LDGO	co-investigator, SeaMARC
3.	Dr. George Bryan	LDGO	co-investigator, hydrophone-pinger
4.	Dr. Roger Flood	LDGO	co-investigator, hydrophone-pinger
5.	Dr. Gregory Mountain	LDGO	co-investigator, seismics
6.	Mr. Dale Chayes	LDGO	project engineer, SeaMARC
7.	Mr. Bernard Gallagher	LDGO	technician, SeaMARC
8.	Mr. John DiBernardo	LDGO	technician, SeaMARC
9.	Mr. John Farre	LDGO	graduate student, SeaMARC
10.	Ms. Suzanne O'Connell	LDGO	graduate student, SeaMARC, seismics
11.	Dr. Arnold Bouma	Gulf S&T	observer
12.	Dr. James Coleman	LSU	observer
13.	Ms. Mary Feeley	TAMU	observer
14.	Mr. Joseph Stennett	LDGO	electronics technician
15.	Mr. Pablo Sosa	LDGO	elecyronics technician (jr.)
16.	Mr. Martin Iltzsche	LDGO	mechanical technician
17.	Mr. John Tauxe	LDGO	technician, SeaMARC
18.	Ms. Carolyn Keyes	LDGO	programmer, hydrophone-pinger, seismics

FIG. 1



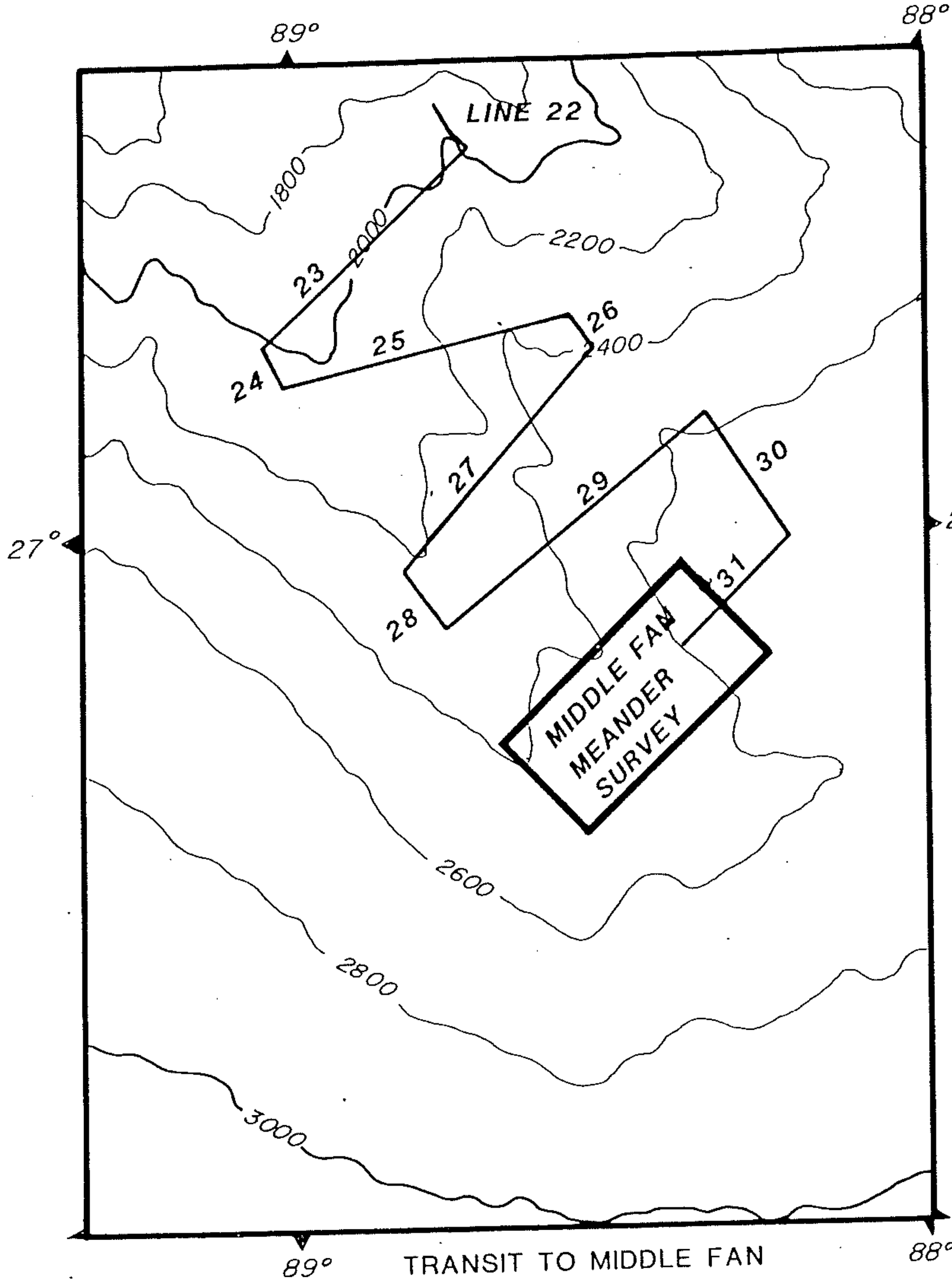
MISSISSIPPI SUBMARINE FAN
SITE SURVEYS: ROBERT CONRAD 2312
SEISMIC LINES

Figure 2



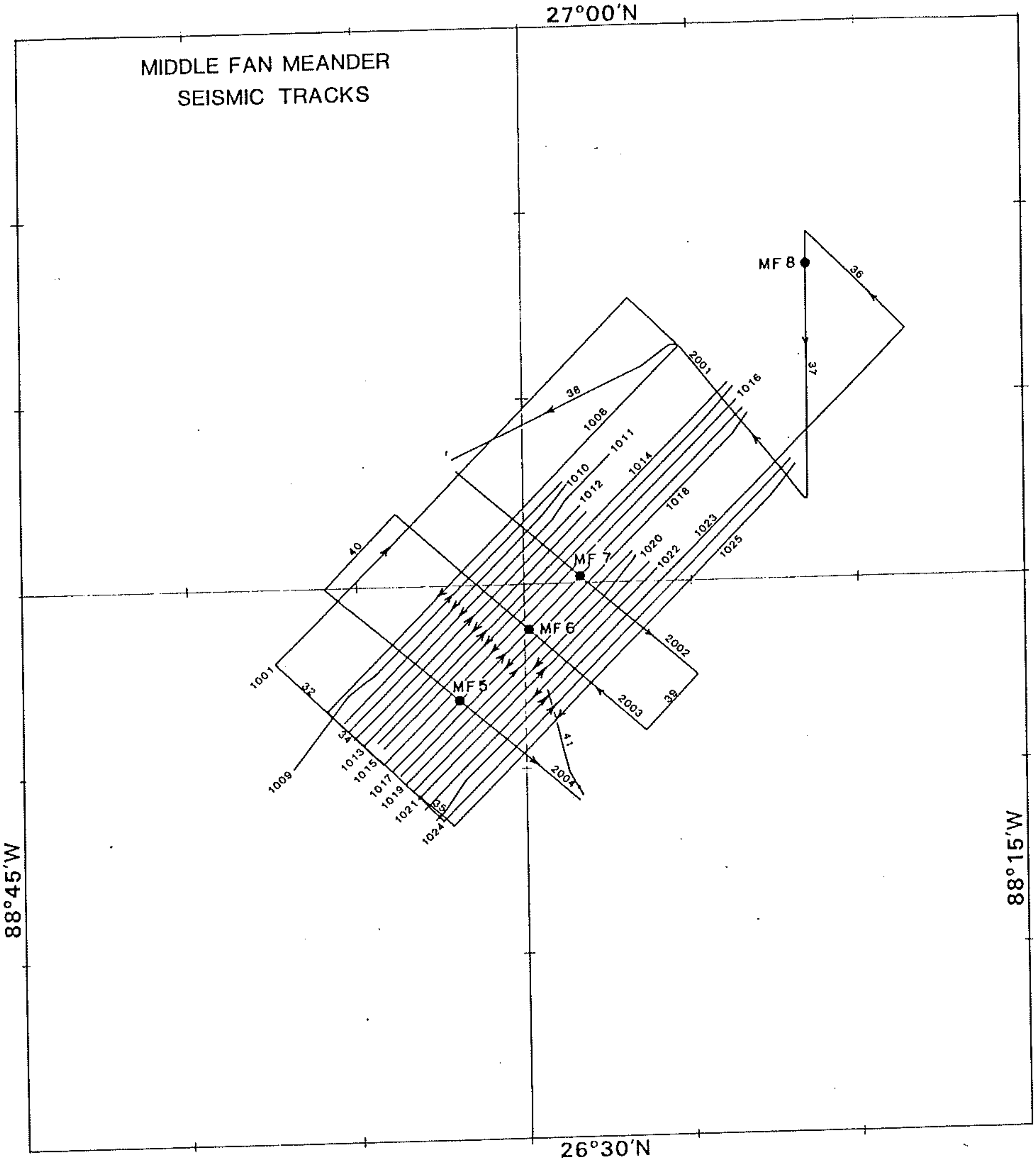
MISSISSIPPI TROUGH SEISMIC LINES

Figure 3



TRANSIT TO MIDDLE FAN
SEISMIC LINES

Figure 4



27°00'N
MIDDLE FAN MEANDER
SEISMIC TRACKS
MF 8
36
37
2001
1016
38
1008
1011
1010
1014
1012
1018
1023
40
MF 7
1020
1022
1025
MF 6
2002
1001
32
MF 5
2003
39
41
34
1009
1013
1015
1017
1019
1021
35
1024
2004
88°45'W
88°15'W
26°30'N

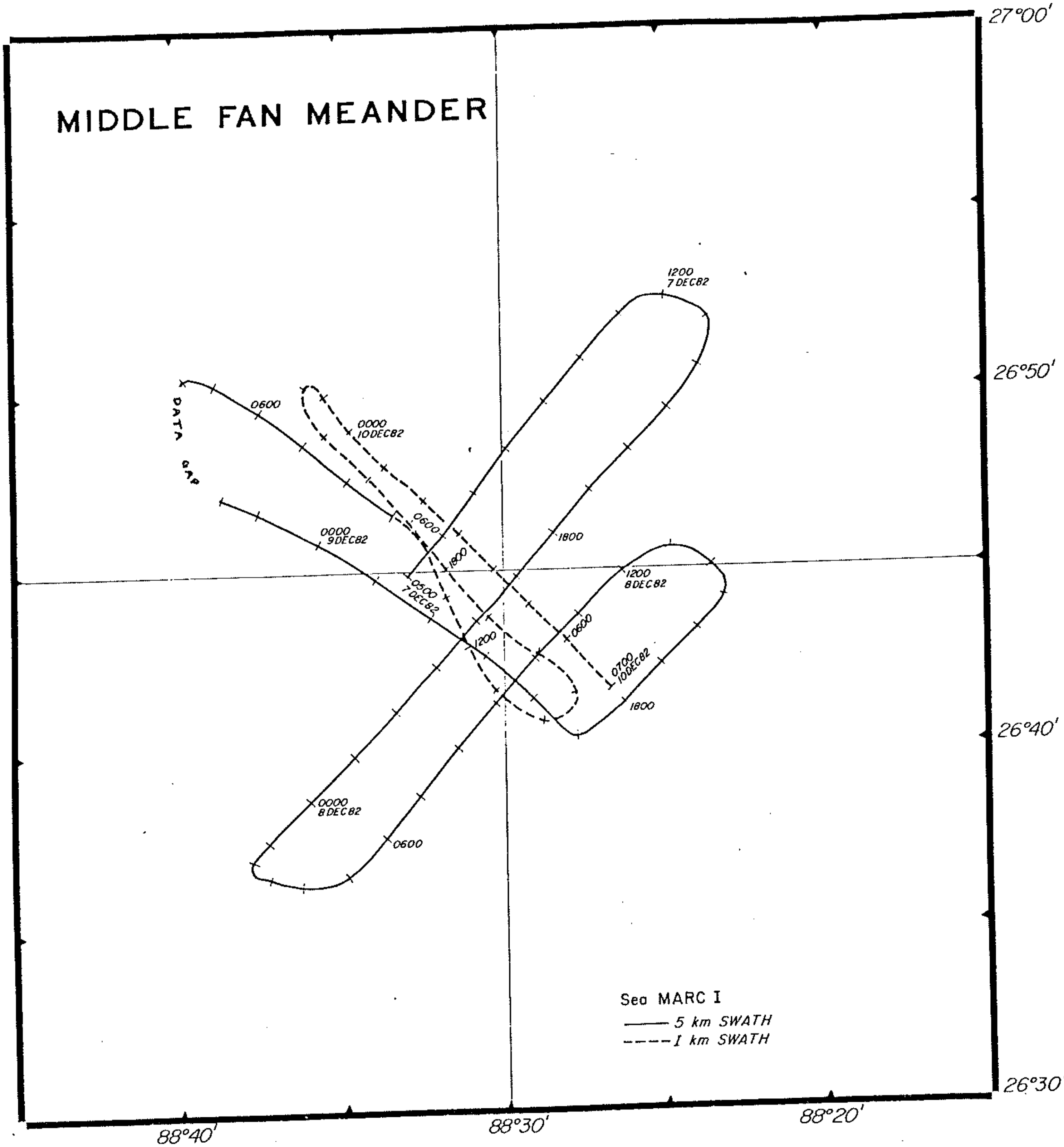

MIDDLE FAN MEANDER
27°00'
26°50'
26°40'
26°30'
88°40'
88°30'
88°20'
1200
7 DEC 82
0600
0000
10 DEC 82
DATA GAP
0000
9 DEC 82
0600
1800
1800
0500
7 DEC 82
1200
8 DEC 82
0600
1200
0700
10 DEC 82
1800
0000
8 DEC 82
0600
Sea MARC I
5 km SWATH
1 km SWATH

FIG. 6

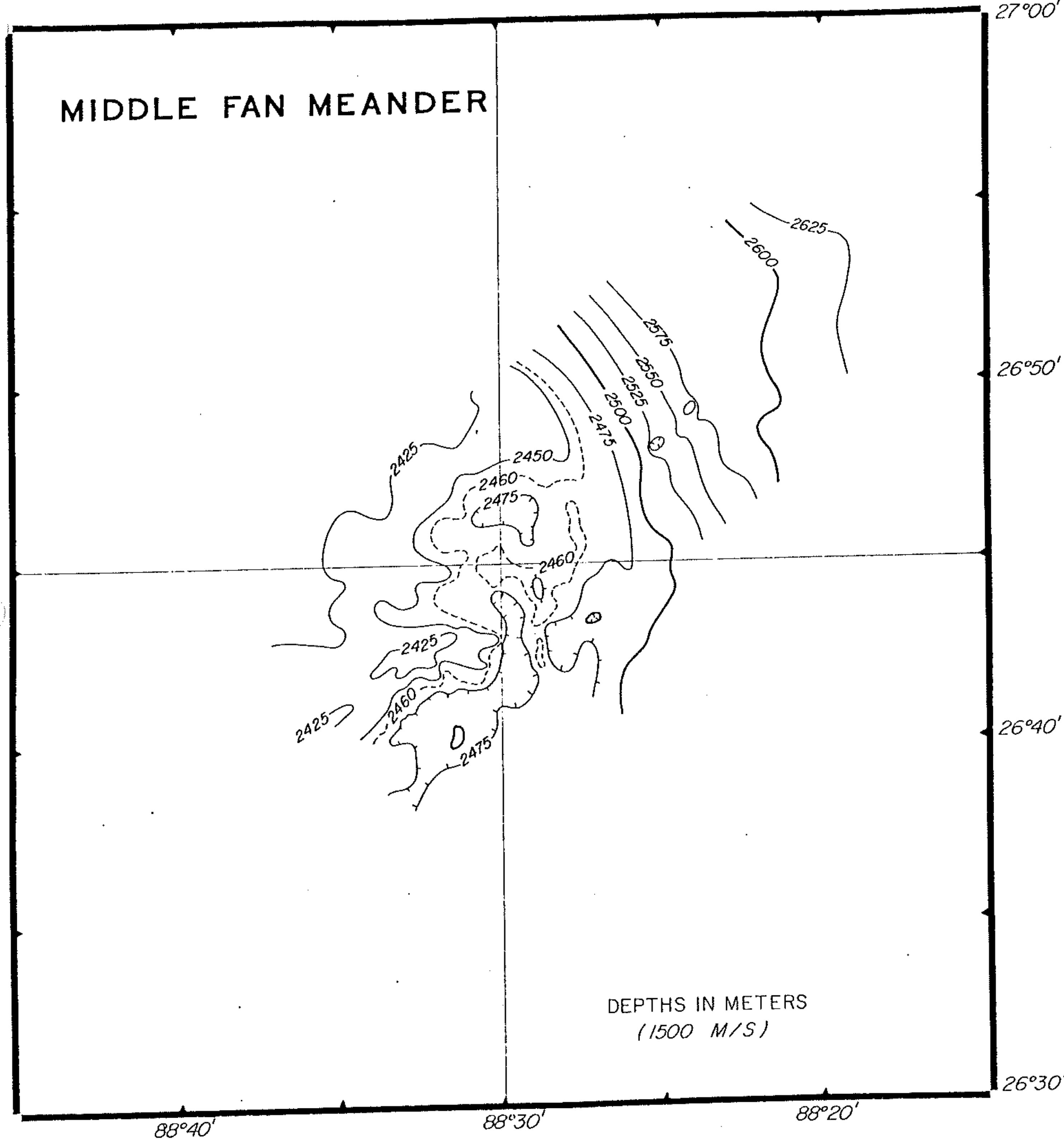

MIDDLE FAN MEANDER
27°00′
26°50′
26°40′
26°30′
88°40′
88°30′
88°20′
2625
2600
2575
2550
2525
2500
2475
2450
2460
2425
DEPTHS IN METERS
(1500 M/S)

Figure 7

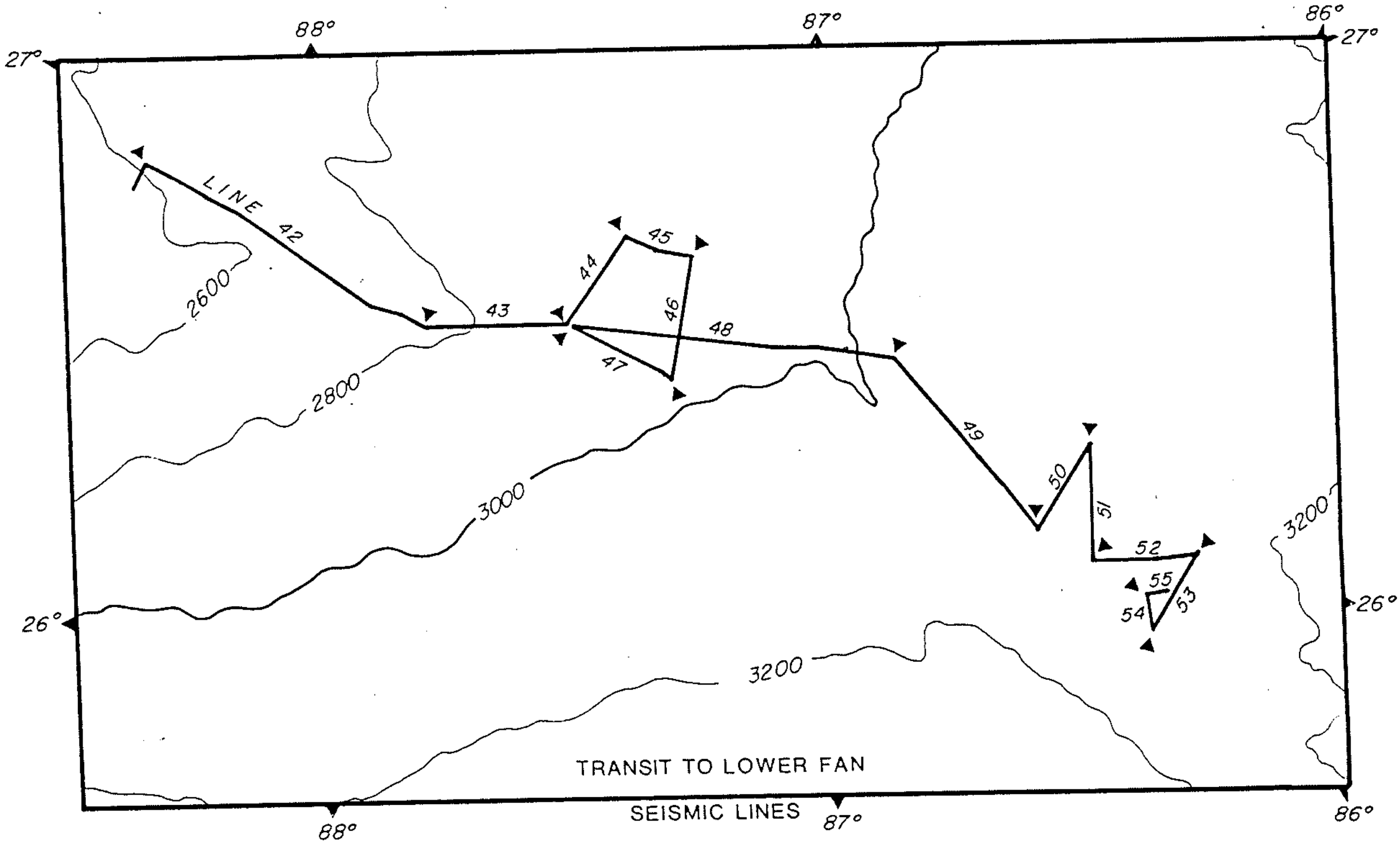
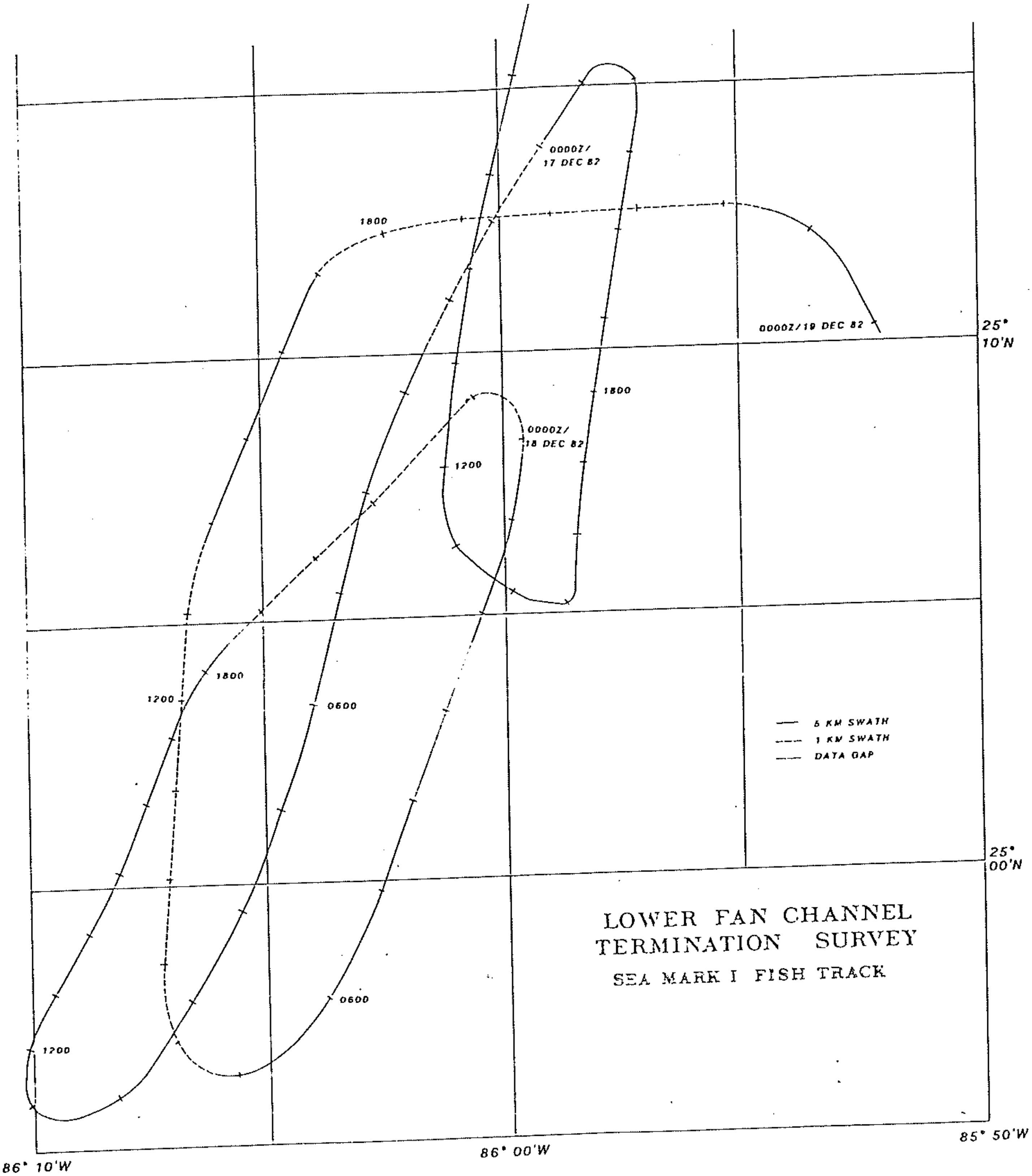
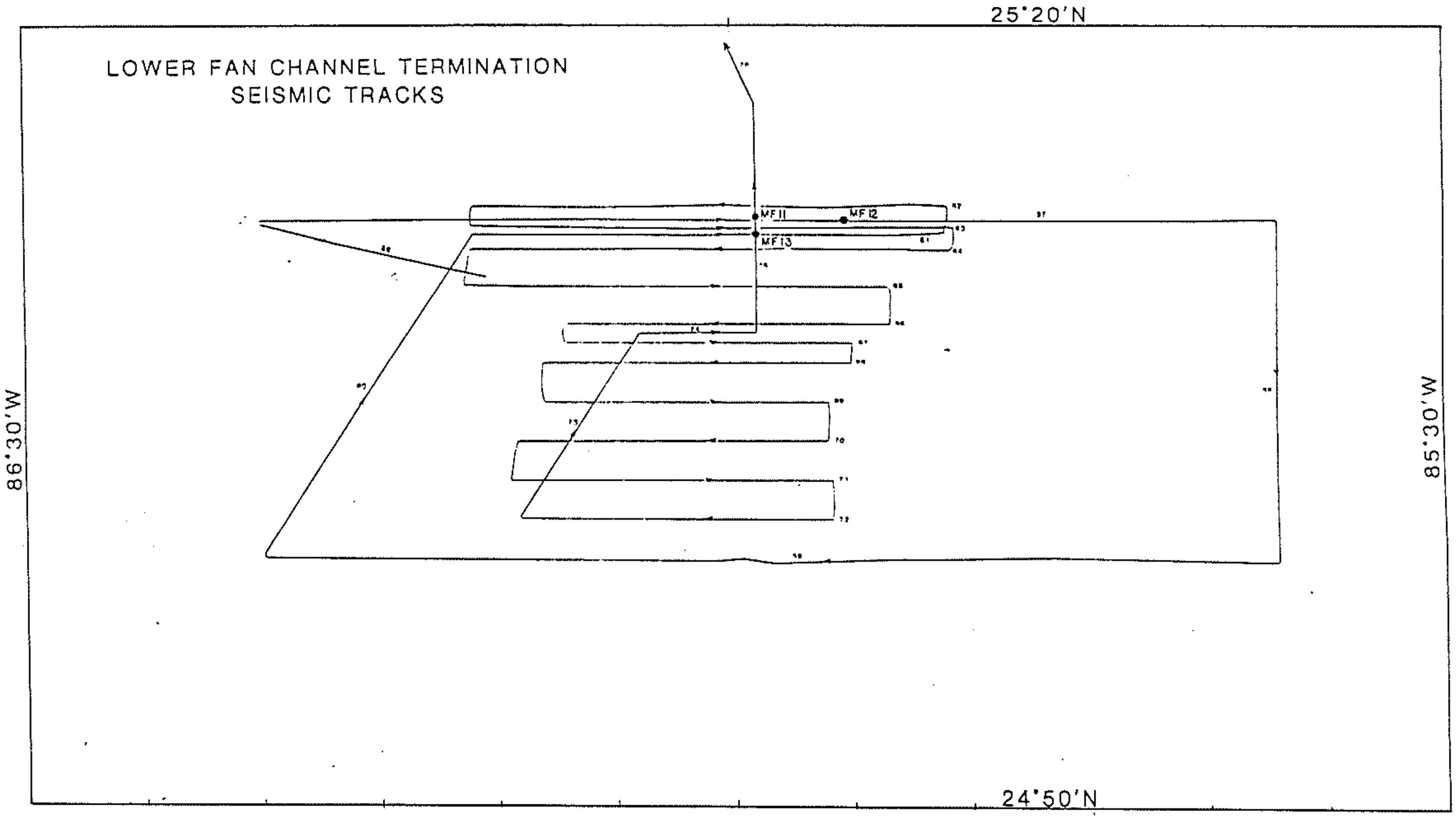

88°
87°
86°
27°
27°
26°
26°
88°
87°
86°
LINE 42
43
44
45
46
47
48
49
50
51
52
53
54
55
2600
2800
3000
3200
3200
TRANSIT TO LOWER FAN
SEISMIC LINES

Figure 8



00002/
17 DEC 82
1800
0000Z/19 DEC 82
25°
10'N
1800
0000Z/
18 DEC 82
1200
1800
1200
0600
5 KM SWATH
1 KM SWATH
DATA GAP
25°
00'N
LOWER FAN CHANNEL
TERMINATION SURVEY
SEA MARK I FISH TRACK
0600
1200
86° 10'W
86° 00'W
85° 50'W

Figure 9



LOWER FAN CHANNEL TERMINATION
SEISMIC TRACKS
25°20'N
24°50'N
86°30'W
85°30'W
MF11
MF12
MF13

Figure 10

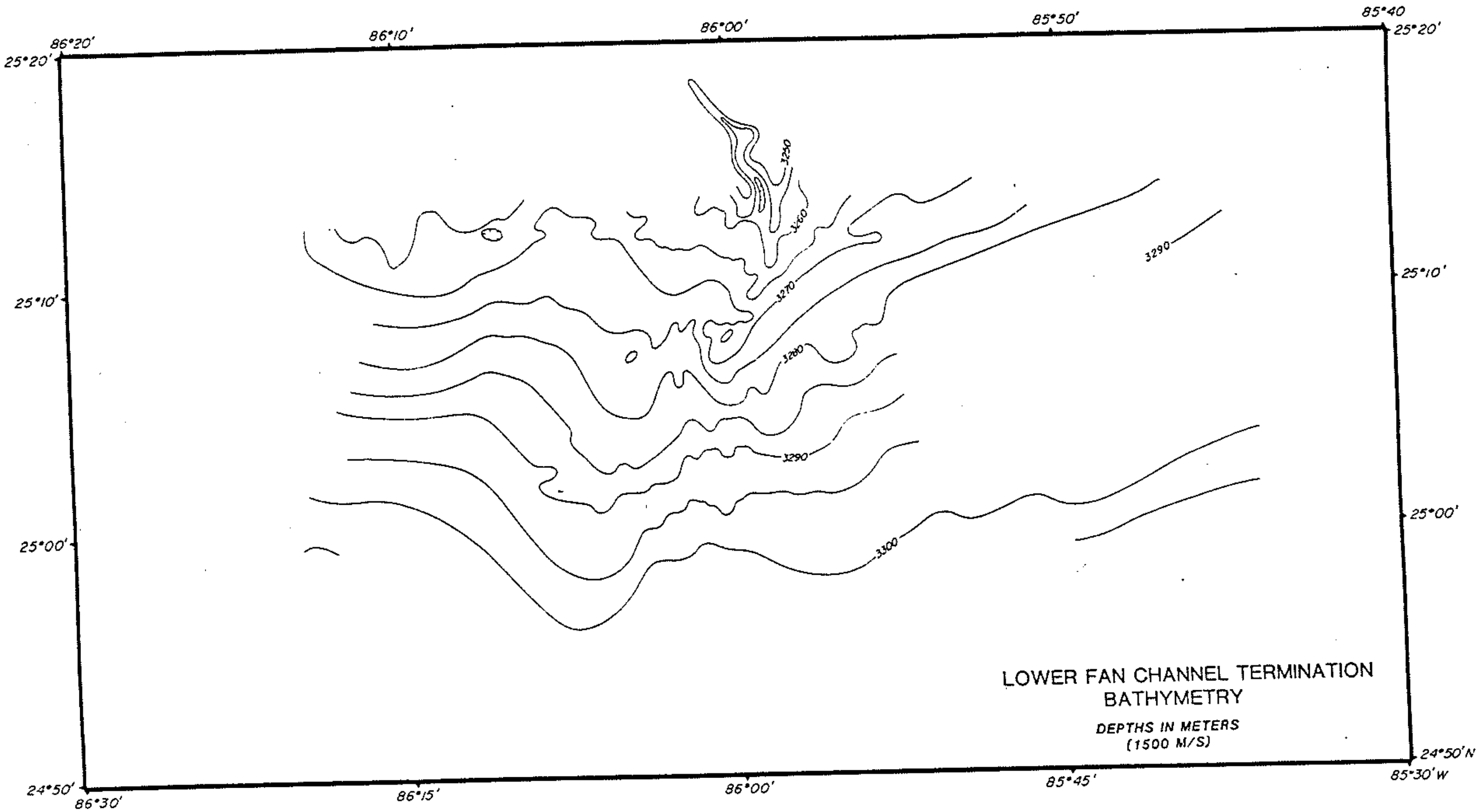
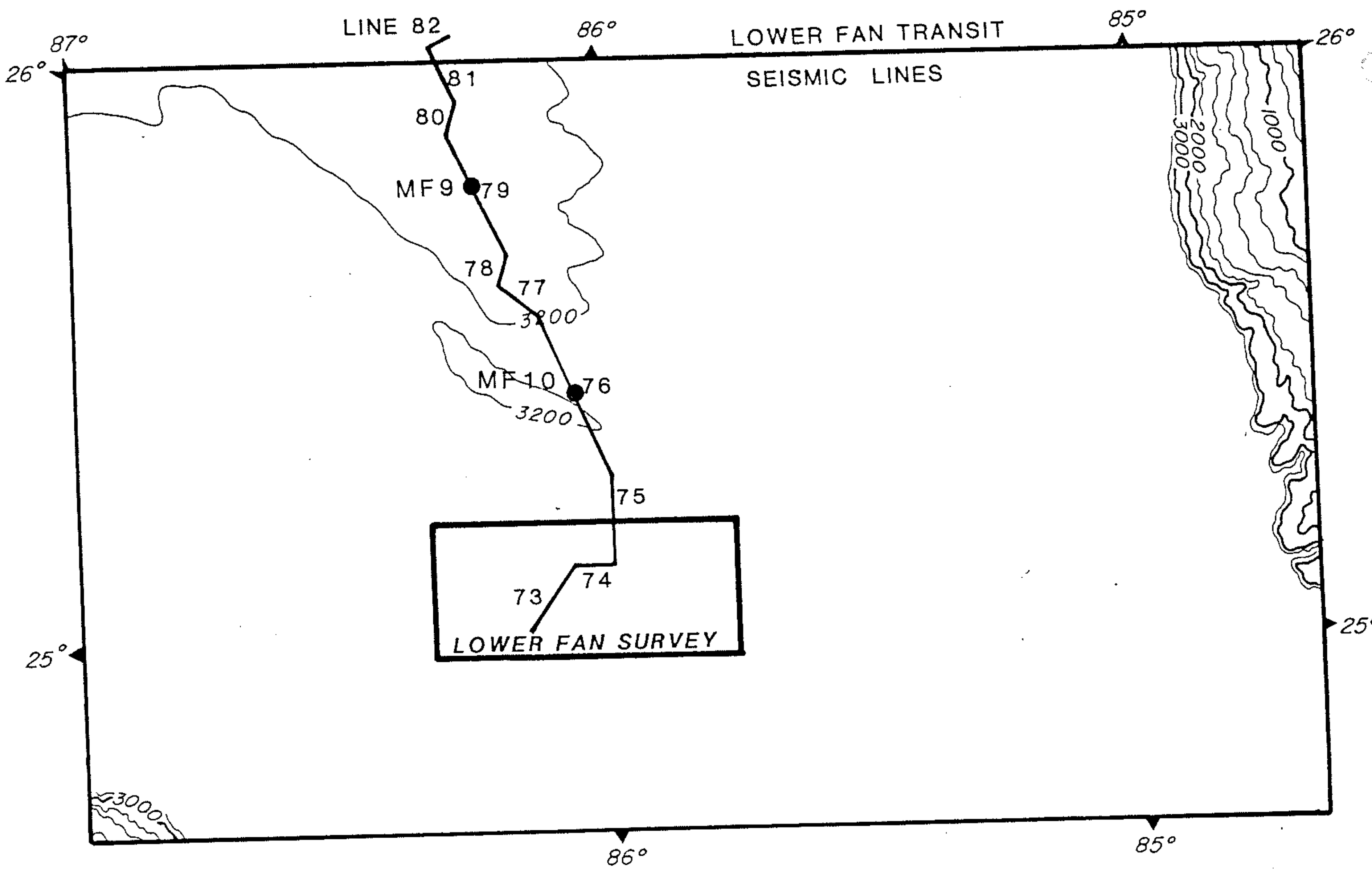

LOWER FAN CHANNEL TERMINATION
BATHYMETRY
DEPTHS IN METERS
(1500 M/S)
86°20'
86°10'
86°00'
85°50'
85°40
25°20'
25°10'
25°00'
24°50'
86°30'
86°15'
86°00'
85°45'
85°30'W
24°50'N
3250
3260
3270
3280
3290
3300

Figure 11


LOWER FAN TRANSIT
SEISMIC LINES
LINE 82
81
80
MF9
79
78
77
3200
MF10
76
3200
75
74
73
LOWER FAN SURVEY
1000
2000
3000
3000
87°
26°
86°
85°
26°
25°
25°
86°
85°