Marine Habitat Atlas
Volume 2

Southwest Florida Shelf Ecosystems Study

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TABLE OF CONTENTS

MARINE HABITAT ATLAS, VOLUME 2

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Objectives

The primary goals of the Outer Continental Shelf Environmental Studies Program are to obtain environmental data on the impacts of petroleum exploration and production activities on the outer continental shelf (OCS), and to provide relevant information to decision makers in the Department of the Interior's Minerals Management Service.

The Department of the Interior is considering to offer for lease certain tracts on the southwest Florida shelf in the eastern Gulf of Mexico, an area where the distribution of bottom types and their significance in relation to the marine ecosystem over the shelf is not well known. Pursuant to these goals the Bureau of Land Management determined that a study should be conducted to describe the ecology of the southwest Florida continental shelf with emphasis on mapping the benthic environment utilizing bathymetric, geophysical, and ground-truth surveys. The basic program design was developed by the Bureau of Land Management and the study is being conducted by Woodward-Clyde Consultants, Continental Shelf Associates, Inc., and other consultants under contract numbers AA851-CT0-50 and AA851-CT1-45.

1.2 Methods of Investigation

The investigation was designed as a reconnaissance survey, regional in nature, extending over an area where the present knowledge of bottom types and conditions is either very limited or generally unknown. Five east-west and one north-south transects were surveyed over the southwest Florida shelf, covering an area from Charlotte Harbor in the north to the Dry Tortugas in the south (Figure 1-1).

Each transect was surveyed with a high-resolution, multi-system geophysical survey and an underwater television and still camera survey. In addition 39 areas (stations) were subjected to detailed ground-truthing (underwater

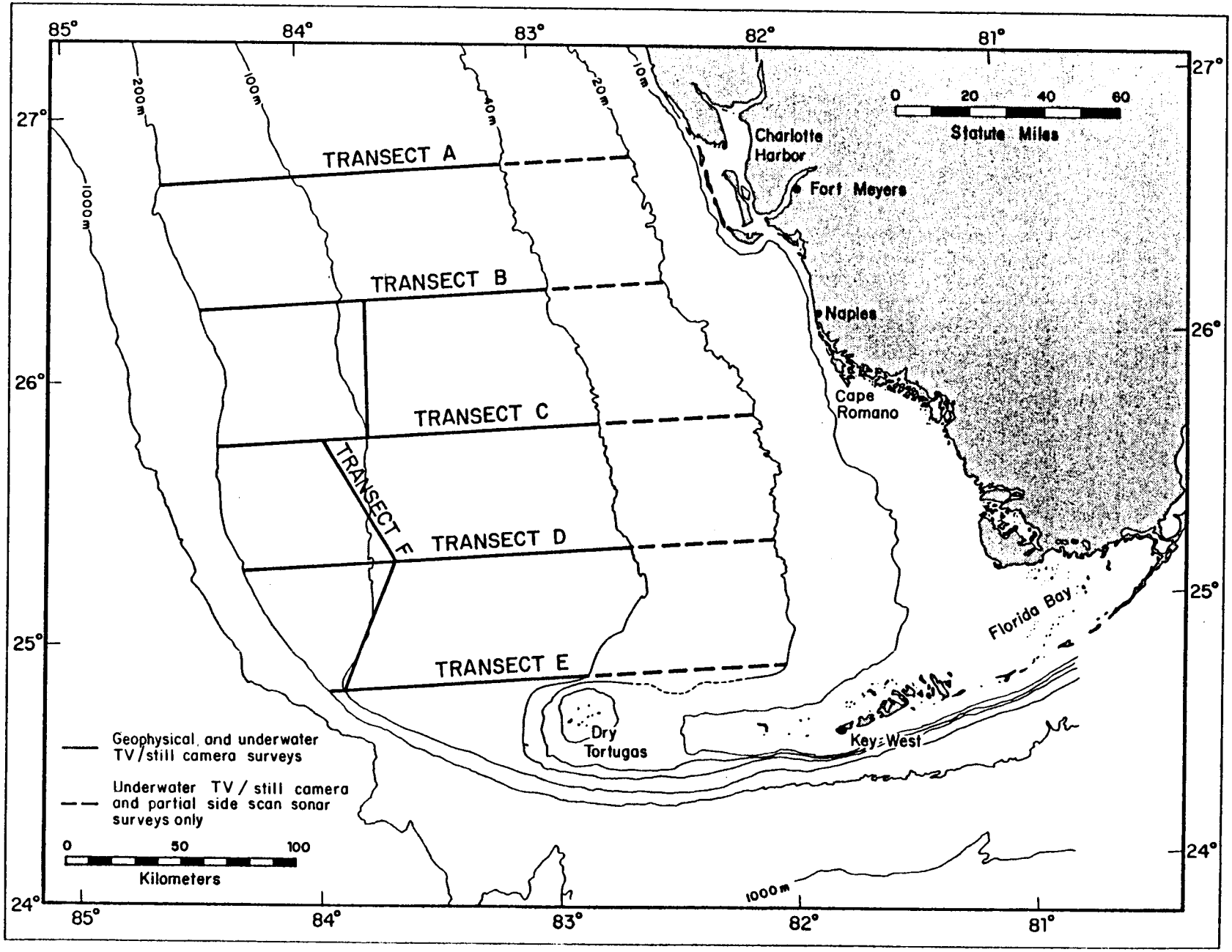

Figure 1-1. Southwest Florida survey transects.

television and still camera) and biological sampling surveys. The field investigations took place over a two-year period on the following cruises:

Cruise Number	Date	Investigation
I (Year 1)	9/10 - 10/8/80	High Resolution Geophysical Survey, Transects A-E, Water Depths 40-200 m.
II (Year 1)	10/10 - 10/21/80	Underwater Television and Still Camera Photography, Transects A-E, Water Depths 20-100 m.
III (Year 1)	10/25 - 11/23/80	Biological and Hydrographic Sampling, Fall Cruise.
IV (Year 1)	4/22 - 5/5/81	Biological and Hydrographic Sampling, Spring Cruise.
I (Year 2)	7/8 - 7/15/81	Underwater Television, Still Camera Photography and Geophysical Profiling, Transect F and Transects A-E, Water Depths 100-200 m.
II (Year 2)	7/16 - 8/5/81	Biological and Hydrographic Sampling, Summer Cruise.
III (Year 2)	1/28 - 2/15/82	Biological and Hydrographic Sampling, Winter Cruise.

Further information on the field programs, equipment, procedures, and data collected during these cruises is found in Section 2.0 and in the First Year Final Report (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1982).

1.3 Description of the Atlas

The Atlas is presented in two volumes. Volume 1, the Atlas itself, contains index and summary maps at a scale of 1:500,000 and the detailed maps and cross sections of the survey transects at a scale of 1:48,000. Volume 2 (this volume) is an interpretive report that discusses the field surveys and the data analyses and mapping procedures. Volume 2 also includes more complete descriptions of the habitat (substrate types, biological assemblages, and shallow geologic features) than can be presented in the legend for the maps.

The 1:48,000 scale maps are presented on a series of 43 sheets. Each sheet covers approximately six lease blocks in an east-west direction for Transects A to E and in a north-south direction for Transect F. Each sheet is divided into three sections. The top section shows the lease block boundaries, UTM and latitude/longitude coordinates, and the navigation data from the various cruises. The central section shows the marine habitat including bathymetry, substrate type, biological assemblage, and characteristic biota. At the bottom is a geological profile showing the subsurface strata and shallow geologic features as interpreted from the subbottom profile along the centerline of each transect. Further information on the construction of the Atlas is presented in Sections 4.0 through 7.0 of this volume.

2.0 FIELD SURVEYS

2.1 Navigation

Offshore positioning for the Geophysical Survey (Year 1, Cruise I) and Underwater Television and Still Camera Survey (Year 1, Cruise II) of Transects A to E was subcontracted to Racal/Decca of Houston, Texas. The primary navigation system consisted of a Decca Hi-Fix radio-positioning system and a Decca Autocarta onboard plotting system. A Decca Pulse-8, Loran C, medium-range positioning system was also provided as a backup navigation system.

The Decca Hi-Fix radio navigation system is a phase-comparison hyperbolic or range-range electronic positioning system, capable of operating out to a range of approximately 200 km, with an accuracy of about ± 3 m. The system consists of a master transmitting station, two slave transmitting stations, and a shipboard receiving system.

The Decca Autocarta system was used in conjunction with the basic navigation system. It is an onboard real-time navigational data recording and plotting system. In addition to recording all navigation data on magnetic tape and plotting a real-time ship track map, it provides navigational guidance along predetermined survey tracks in the form of a helmsman's left/right display. At the completion of the survey, the system was used off-line to provide final field post-plot maps at the desired mapping scale.

The Decca Pulse-8 navigation system is a hyperbolic electronic positioning system which utilizes the Loran C navigation net established and maintained by the United States Coast Guard. The system is capable of operating at ranges in excess of 800 km, with an established accuracy of approximately ± 50 m at 500 km. The Loran C system was less prone to operational difficulties arising from sky wave or thunderstorm interference than was the Hi-Fix system and was utilized for primary positioning whenever the Hi-Fix system was inoperable.

Primary calibration of the onboard navigation systems was accomplished by reference to presurveyed onshore control points. Calibration was then carried to the work areas where secondary control points (Lane-count buoys) were established. In the event of a navigation system failure, the equipment was recalibrated without returning to shore. The location of the secondary control points was established using both the Hi-Fix and Pulse-8 system values.

Offshore positioning for the four biological sampling cruises and the geophysical/underwater television and still camera survey of Transect F (Year 2, Cruise I) was conducted by Continental Shelf Associates, Inc. of Tequesta, Florida. Data for these cruises were collected with an Epsco C-Nav XL Loran C system. The operational characteristics are similar to the previously described Loran C system.

2.2 Geophysical Surveys

2.2.1 Equipment and Procedures

A high-resolution, multi-system geophysical survey was conducted along all six transects to aid in the identification of the substrate types, to extend the results of the ground-truthing investigations, and to identify shallow geologic features that could represent hazards or design constraints to sea floor oil and gas operations.

The geophysical survey patterns were specified by the Bureau of Land Management. During the Year 1, Cruise I survey, five east-west transects (Transects A to E, Figure 1-1) were surveyed. Each transect consisted of three parallel lines spaced at approximately 800 m (0.5 mi[1]). The survey lines were designed to run through the central area of the lease blocks as illustrated in Figure 2-1. Each survey line extended from the 40-m isobath, offshore to a water depth of approximately 200 m.

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[1] Throughout this report "mi" denotes statute mile and "nmi", nautical mile (1 statute mile = 0.869 nautical mile).

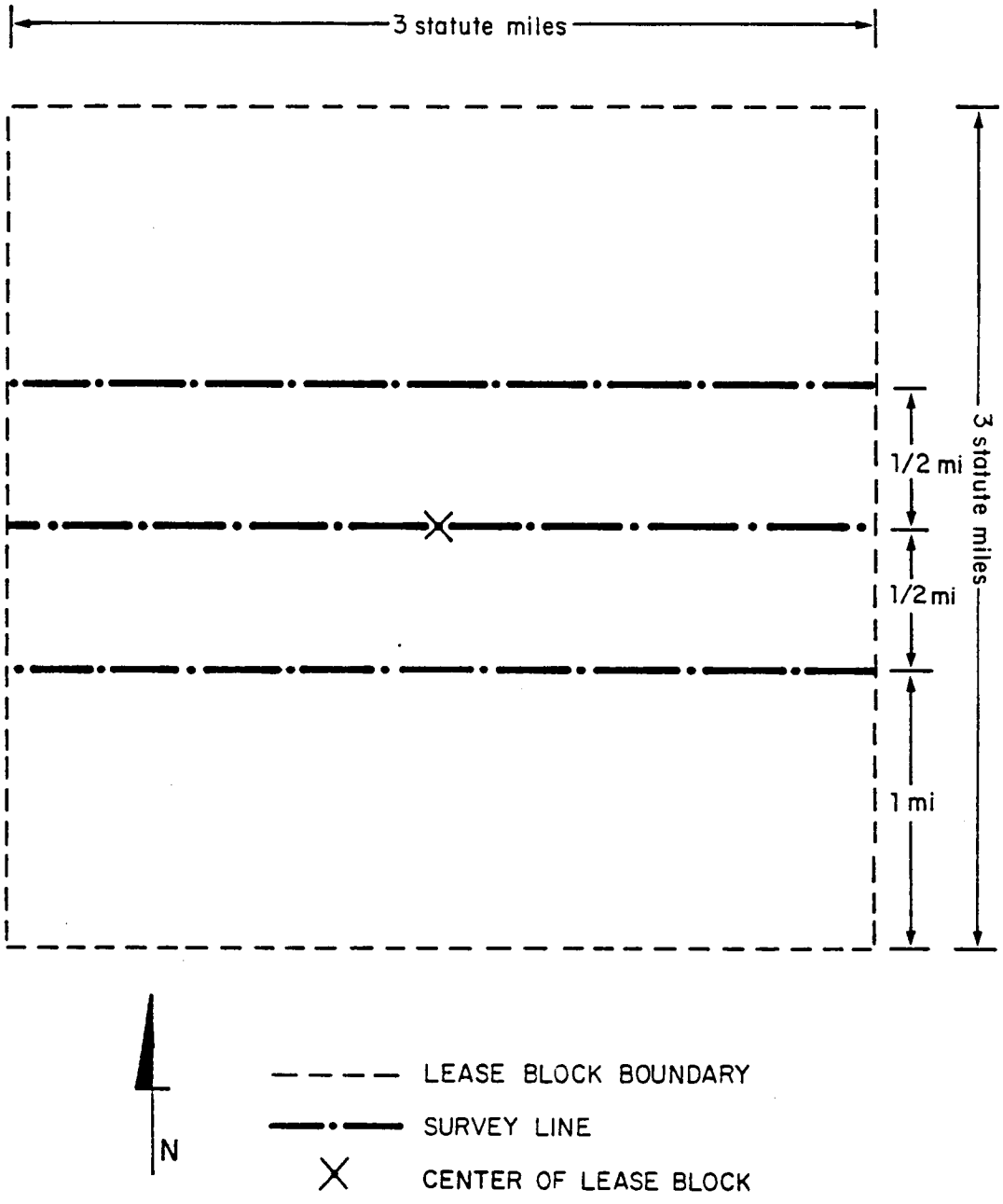


Figure 2-1. Geophysical survey pattern within lease blocks.

Transect F (Figure 1-1) was surveyed as part of Year 2, Cruise I. It consisted of a single line trending approximately north-south between Transects E and B in the approximate water depth range of 80 to 120 m. Additional geophysical data were also collected on Transects A through E over the 100 to 200-m water depth range during this cruise.

The geophysical surveys consisted of simultaneous data collection from the following systems:

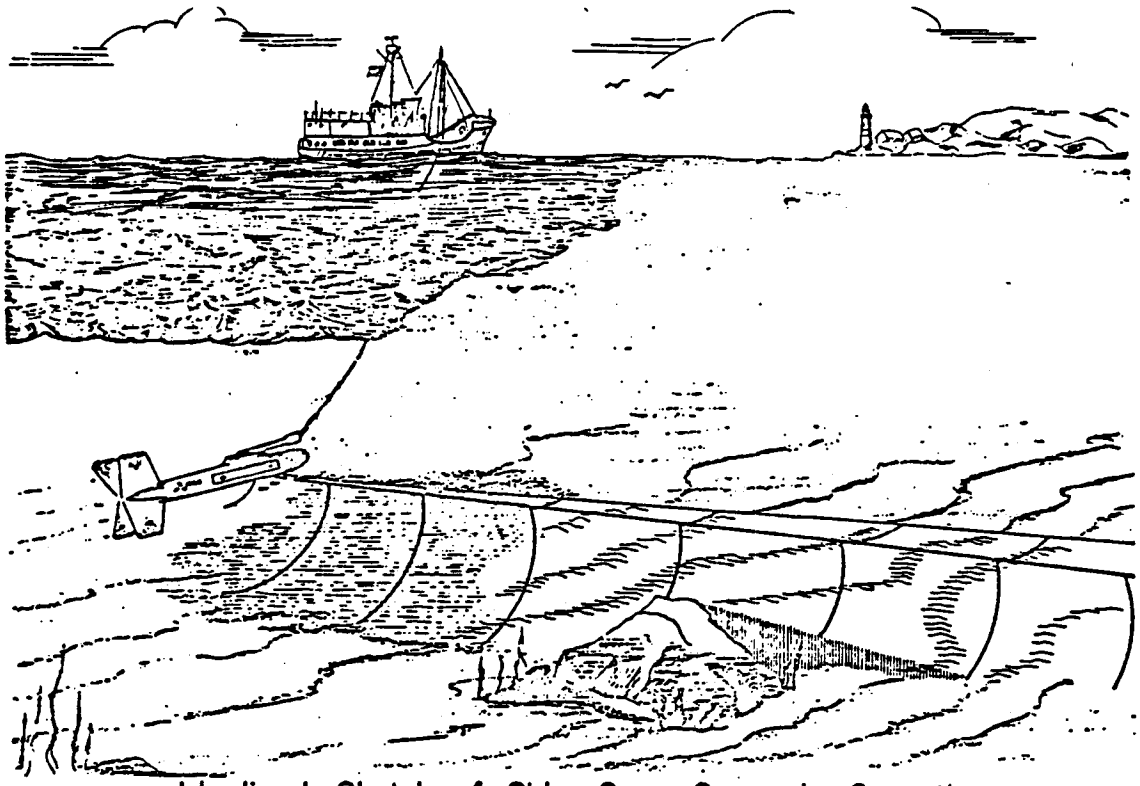
Depth Sounders:	Raytheon DFS-600 or Raytheon DE-719B.
Side Scan Sonar:	EG&G SMS 960 Sea Floor Mapping System, or Klein Model 400 Hydroscan System.
Subbottom Profiler:	EG&G UNIBOOM and Teac 4-Channel Tape Recorder.

A brief description of the geophysical systems is given in the following paragraphs.

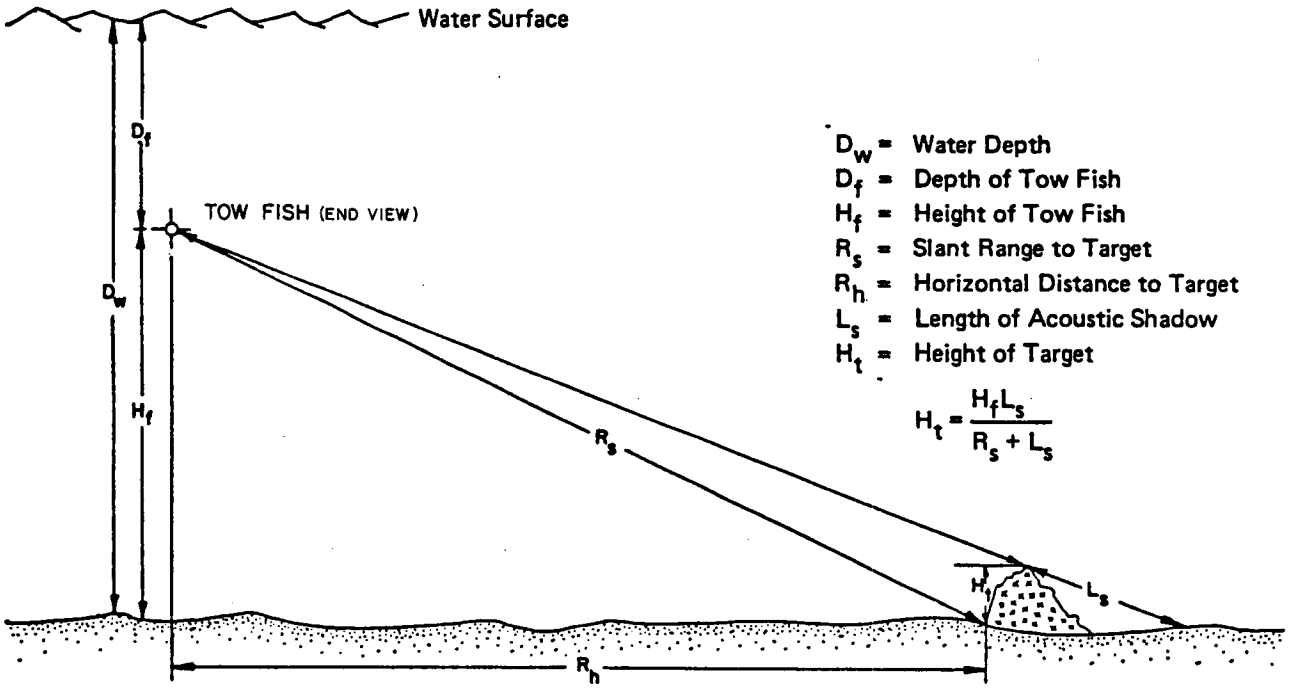
Depth Sounders: Two depth sounder systems were utilized on this survey to record water depth. The primary system consisted of a Raytheon DSF-600 digital survey fathometer. A Raytheon DE 719-B precision survey fathometer was onboard as a backup. The operating principle for both instruments is the same. They emit a high-frequency (200 kHz) signal from a transducer mounted on the side of the ship's hull. The return signal is graphically displayed on a continuous strip chart. Both instruments incorporate calibration adjustments to account for the depth of the transducer beneath the water surface and, since the fathometer converts travel time of the acoustic signal to water depths using a calibrated velocity, a provision for setting the observed velocity of sound in sea water. This value is established by conducting bar checks and from observed temperature profiles. Throughout this survey the calibration velocity was set for a speed of sound in sea water of 1,524 m/s.

A fix mark was placed on the depth sounder records each time a navigation fix was recorded so that the measured water depth could be correlated with the positioning data.

Side Scan Sonar: Two side scan sonar systems were utilized on this survey to continuously record sea floor features along transect lines. The primary system for Transects A to E was an EG&G SMS 960 seafloor mapping system. A Klein Model 400 hydroscan system was onboard as a backup and was used on Transect F. The side scan sonar record presents a continuous sonic "picture" of the sea floor and may be used for identifying changes in bottom sediment characteristics, or for locating and identifying natural and man-made objects lying on the seabed. The system consists of a towed, dual-beam transducer, a dual-channel recorder, and associated cables. The side scan sonar emits a narrow acoustic beam perpendicular to the direction of travel of the towfish along the survey line (Figure 2-2). The acoustic beam's primary concentration of energy is directed slightly below the horizontal plane. Echoes are obtained from the bottom directly beneath the transducers to several hundred metres to the side, depending on the range setting. The range setting is adjusted to maintain the desired target resolution and bottom coverage consistent with survey objectives. A range setting of 150 m was used throughout this survey. The combination of beam shape and short wavelength acoustic pulse (100 kHz) gives the side scan the ability to resolve small topographic irregularities and man-made objects on the sea floor. As the transducer is towed behind the ship, the reflected echoes are graphically recorded in a form which appears like a continuous "photograph" of a strip of sea floor. The SMS 960 system automatically removes the water column data from the plan view presentation and corrects for slant range, producing a single record of corrected data. Speed data input from the positioning system automatically corrects the data along the track line to give equal dimensional scales in both directions. This eliminates the distortion of observed objects and allows the size and range of targets to be measured directly from the side scan sonar record. Automatic water column and speed corrections are found on the SMS-960 records only. These corrections were made during the mapping process on records obtained from the Klein Model 400 system.



Idealized Sketch of Side Scan Sonar in Operation



Side Scan Sonar Geometry

Figure 2-2. Side scan sonar technique.

Subbottom Profiler: An EG&G UNIBOOM high-resolution seismic reflection profiling system was used to provide shallow-to-moderate penetration high-resolution subbottom data. The EG&G UNIBOOM system consists of an EG&G 231/232 power source, a UNIBOOM plate mounted on a towed catamaran, a receiving hydrophone and an EPC Model 3200 or 4100 seismic recorder. The UNIBOOM sound source is an electromechanical boomer plate which generates a broadband acoustic pressure pulse with a frequency spectrum from 400 Hz to 8 kHz.

The resulting seismic records generated by the subbottom profiling system are similar to a geologic cross section except that the vertical axis represents the two-way travel time of the reflected seismic signal rather than a true depth. Reflection times are converted to depths of the sedimentary layers using an assumed or measured value for the velocity of sound in the sediments. The system is towed behind the ship and mapping of the data requires a correction for the layback of the system from the positioning antenna. A fix mark is placed on the seismic records each time a navigation fix is recorded so that the data can be correlated with the positioning information.

2.2.2 Data Collected

Over 2,438 km (1,515 mi or 1,317 nmi) of geophysical data were collected during the two geophysical survey cruises. In addition to the analog records from the primary systems, a tape recording was made of all of the subbottom profile records. All analog records were subsequently microfilmed and will be available from the National Geophysical and Solar-Terrestrial Data Center (NOAA-Boulder, Colorado) at the conclusion of this project. The amount of survey data is summarized below.

Transect	Survey Lines	Lease Blocks	Total Survey Distance km
A	3	30	435
B	3	32	463
C	3	34	492
D	3	34	492
E	3	26	377
F	1	37	179
		Total	2,438

2.3 Underwater Television and Still Camera Surveys

2.3.1 Equipment and Procedures

Video footage of the sea floor and benthic biota was recorded using a Hydro Products Model TC-125 underwater television camera, Model LT-7 underwater light with a 250-w thallium iodide lamp, Model SC-303 television system control unit, an Elgar Model 121 power source (frequency stabilizer), and a Sony VO Model 1800 videocassette recorder. The camera had an f/1.4 lens with remotely controlled focusing. Navigation fixes and time of day were audio recorded on the videocassette tapes.

A Benthos Model 372, 35-mm deep-sea camera with data chamber, Model 382 deep-sea flash, and Ektachrome ASA 200, 35-mm color slide film were used to further verify substrate and benthic biotal types. Both the television camera and the still photo camera were mounted on a Model RP-3 pan and tilt unit which was attached to a Continental Shelf Associates, Inc. television/still-photo system sled (Figure 2-3).

The television/still camera system was towed at a height of one to three metres above the bottom at a speed of one to two knots. The still camera shutter was surface activated by scientific personnel viewing the television monitor. The television and still cameras were aligned such that the picture taken with the still camera was the same as the field of view of the television camera at the time of shutter activation.

The primary purpose of the still photographs was to provide greater resolution of the various biotic assemblages observed on the television monitor. Still photographs were taken on an average of one per minute with biological assemblages or substrates and any other specific items of interest photographed at the discretion of the scientist observing the television monitor.

2.3.2 Data Collected

Television videotapes were recorded and still camera photos taken along each of the five east-west transects (A through E) from 20 to 100-m depths during

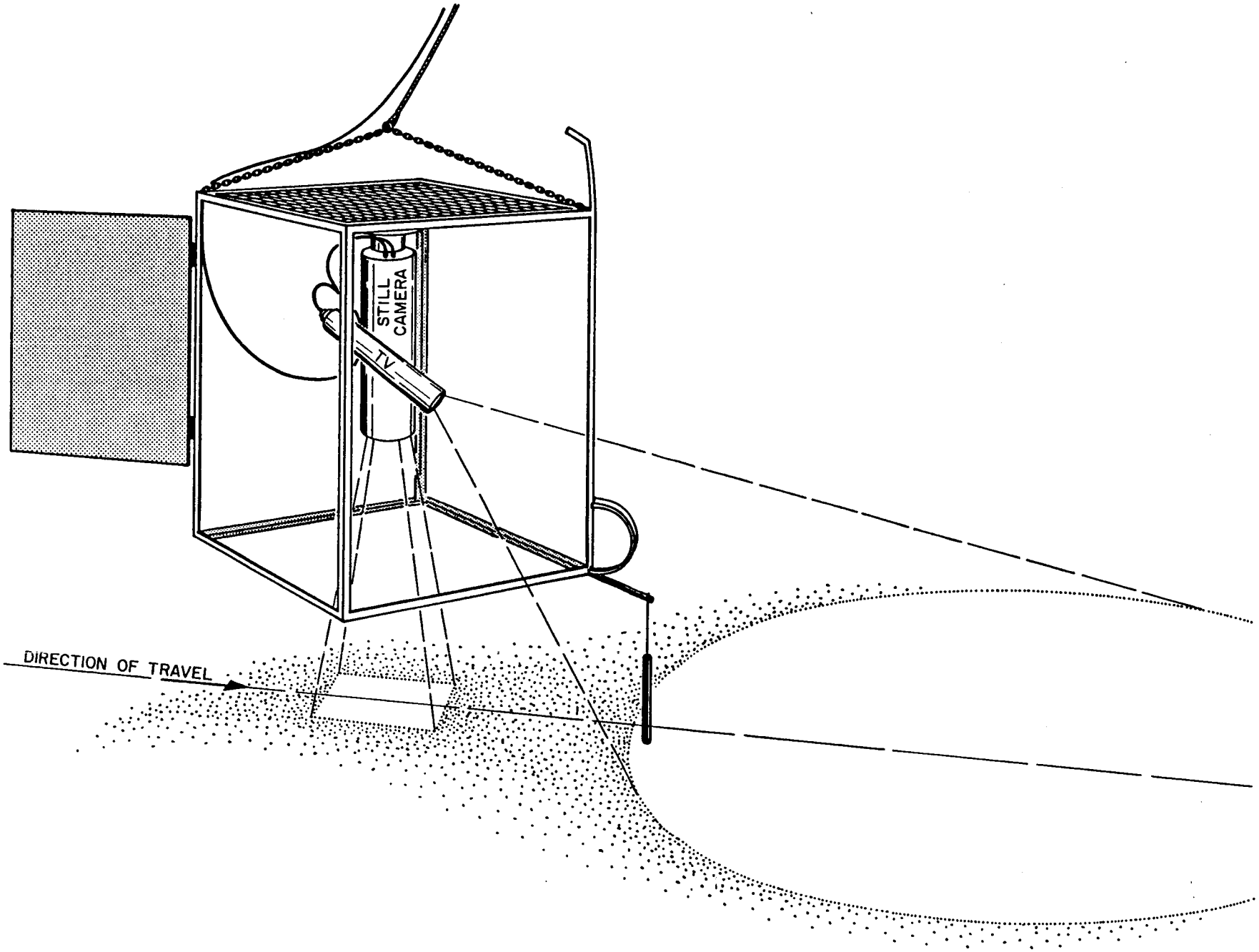


Figure 2-3. Schematic of television and still camera sled set-up.

Year 1 and from 100 to 200-m depths during Year 2. In addition, television/still camera data were obtained along north-south Transect F during Year 2. A total of 240 television videotapes (approximately 240 h of recording) were recorded and approximately 16,000 35-mm color photos were taken along these transects.

2.4 Biological Sampling Cruises

2.4.1 Equipment and Procedures

The television/still camera system used on the biological sampling cruises was the same system that was used during the television and still camera survey cruises. In addition to the television system, Kahlsico biological triangular dredges and Marinovich otter trawls were used to collect benthic epibiotal samples at designated sampling stations.

During the television and still camera survey cruises, both the television camera and the still camera were mounted on the pan and tilt unit so as to provide essentially identical fields of view. However, during the biological sampling cruises, the television camera was mounted in a position to view the sea floor ahead of the television/still camera sled while the still camera was mounted in an orientation that provided a field of view that was directly through the bottom of the sled. Approximately 200 still photographs were taken at each station and were used to quantitatively assess the percent coverage of various groups of biota at all biological sampling stations. The photographs also provided more detailed views of the individual species observed in photographs from the television and still camera survey cruises.

At each station, the television/still camera system was towed in a pattern similar to that shown in Figure 2-4. The sled was towed at a height of less than one metre above the bottom at a speed of one to two knots. Approximately three photographs were taken per minute at a set time interval with the scientist-observer also photographing other items of interest. The still photographic data were used for a quantitative assessment of the biota at each station, while the television data were used to determine the percent coverage

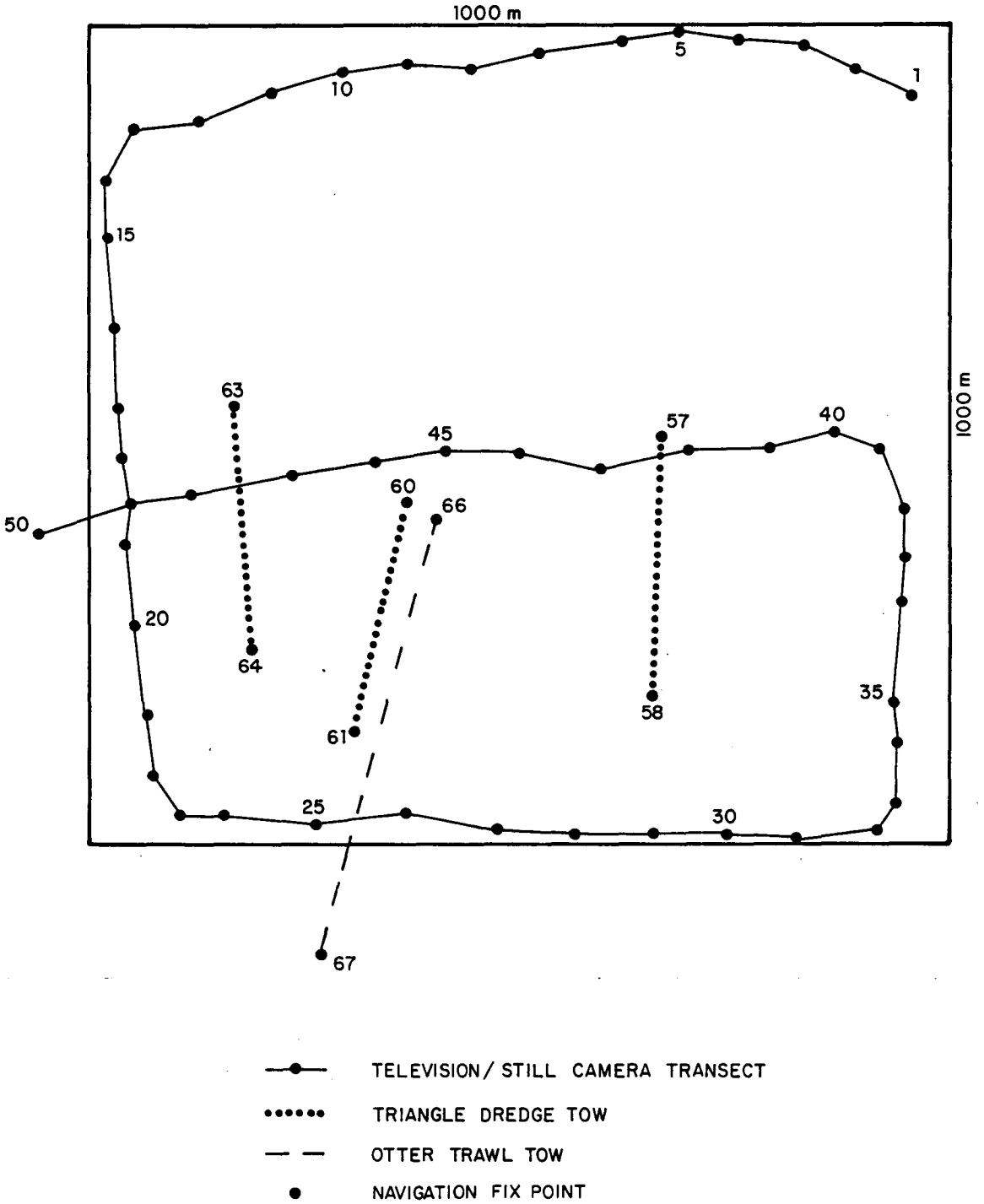


Figure 2-4. Typical hard bottom station (Station 9) showing an example of biological survey patterns.

of live bottom biota along the television tow track and to aid in the selection of areas of high biotal concentrations for sampling with the dredge and trawl.

The dredge and trawl samples were collected to aid in the identification of the biota in the quantitative photographs, to provide a qualitative assessment of the biota at each station, and to determine the species composition of the various biological assemblages observed during the television and still camera survey cruises.

2.4.2 Data Collected

One television videotape was recorded at each of 30 stations during the four biological sampling cruises of Years 1 and 2 for a total of 120 videotapes. Approximately 22,000 still photographs were taken on these four cruises. Tens of thousands of benthic specimens were collected with the biological sampling gear and more than 2,000 different taxa have been identified to date.

3.0 DATA BASE AND BATHYMETRIC MAPS

3.1 Map Projections

The base for the 1:48,000 scale habitat maps is a Universal Transverse Mercator Projection (UTM) using the Clarke 1866 spheroid. Coordinates for UTM Zones 16 and 17 were provided by Racal/Decca on the navigation post-plots for the initial geophysical cruise.

Lease block boundaries were taken from the OCS official protraction diagrams furnished by the Bureau of Land Management. Latitude-Longitude coordinates were calculated from tables published by the Department of the Army (1959).

3.2 Shiptrack Maps

Post-plot shiptrack data are plotted on the lease block base maps at the top of each sheet. Post-plot navigation data for lines 101 through 503 were provided by Racal/Decca. Post-plot data for line 602A and the biological sampling stations were provided by Continental Shelf Associates, Inc. The maps show the line number, direction of ship's travel, and the location of every fifth navigation fix point. Throughout all of the surveys navigation data were recorded at an interval of approximately 150 m.

3.3 Bathymetric Maps

Bathymetric data were recorded with Raytheon DSF-600 and DE-719B fathometers. Both systems contain provisions for automatic correction of the transducer depth and a calibrated velocity correction. The calibration velocity was set for a speed of sound in sea water of 1,524 m/s based on bar checks and temperature profiles.

The data are referenced to the Gulf Coast Low Water datum. Tidal corrections were minimal and were made only where they exceeded 0.5 m in the shallow water areas.

The corrected bathymetric data were plotted at every fifth navigation fix point or whenever the sea floor elevation changed by one metre. The data are contoured at a one-metre interval except in a few areas of steep gradient where a five-metre interval is used.

4.0 SUBSTRATE MAPPING

4.1 Technical Approach

Characterization of sea floor substrate types is one of the more important aspects of benthic surveys. Substrate plays an important role in determining the benthic biological assemblage present at a particular location. Since the type of substrate is a major factor in the settling and success of larvae of benthic organisms, the structure of the marine benthic community is strongly related to the structure and type of sea floor at a particular location. Classically, substrate type has been utilized as one of the principal physical parameters to delineate discrete benthic ecosystems.

The substrate is shown as specific patterns on the Marine Habitat Atlas maps. Five categories of substrate were defined and mapped using a combination of geophysical records (side scan sonar and UNIBOOM) and ground-truth data (underwater television videotapes and still camera photographs). The five substrate categories that were defined are:

- Rock Outcrops/Hard Bottom
- Thin Sand over Hard Substrate
- Sand Bottom/Soft Bottom
- Coralline Algal Nodule Layer over Sand
- Algal Nodule Pavement with Agaricia Accumulations.

Figure 4-1 illustrates the substrate classification scheme, which was established solely from the observations of the ground-truth data. Underwater television videotapes and still camera photographs were subsequently compared to side scan sonar and subbottom profile records to extend the mapping range of the ground-truth data and to develop the associations between the substrates and shallow geologic features.

The five substrate categories are described in the following paragraphs along with a description of their geophysical record characteristics. Sample

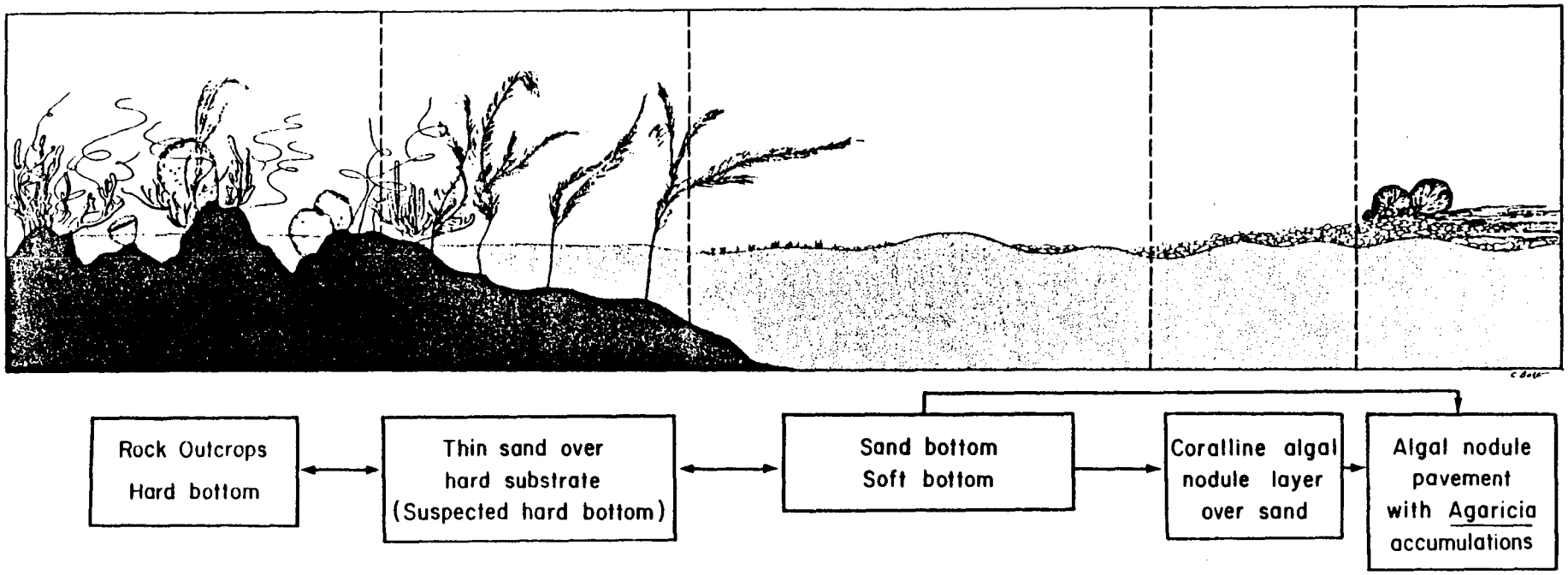


Figure 4-1. Generalized classification scheme for sea floor substrate types.

geophysical records are presented in Appendix A and photographs of biological assemblages associated with the various substrates are shown in Appendix B.

4.2 Substrate Categories and Identification Procedures

4.2.1 Rock Outcrops/Hard Bottom

This substrate includes hard bottoms in the form of emergent rock outcrops, rocky ledges, or exposed, low-relief (<1 m) rock areas. They are typically covered with distinctive indicator epibiotas (Appendix B; Figures B-2, B-3, and B-9). Where the exposed hard substrate was limited in extent to less than 300 m (two navigation fix points), the areas were mapped as part of the Thin Sand over Hard Substrate category.

Extensive areas of exposed substrate typically have a dark side scan sonar signature with varying reflecting patterns indicating minor irregularities in the hard surface. UNIBOOM records (Appendix A, Figure A-7) may also be indicative in identifying locations where subsurface strata crop out on the sea floor.

4.2.2 Thin Sand over Hard Substrate

This bottom type is transitional between the Rock Outcrops/Hard Bottom and Sand Bottom/Soft Bottom substrates. It is very common throughout the southwest Florida shelf and represents a thin veneer of mobile sand covering a rock substrate. On the underwater television and camera records, key biological organisms are used to indicate a bottom of this type. Large gorgonians and sponges, which attach to and are indicative of stable hard bottoms, can remain above the shifting sand veneer and survive the initial inundation.

Side scan sonar records from this substrate indicate a mottled pattern (Appendix A, Figure A-1) with the light areas indicating thicker patches of sand and the darker areas, thin sand and exposed substrate. On a short-range side scan record the darker areas are shown to be composed of numerous individual targets probably reflecting exposed substrate, attached epibiota, and coarse rubble. On the longer range records (such as Appendix A, Figure

A-1) the resolution of the system is insufficient to separate the individual targets and the entire area appears dark. Appendix Figure A-6 is a UNIBOOM record taken over this substrate. The gentle undulations of the sea floor reflect the thickening and thinning of the sand veneer and can be correlated with the side scan sonar patterns.

This substrate typically supports both sand bottom and live bottom biological communities. Appendix Figures B-1, B-2, and B-3 are photographs of sand bottom and live bottom assemblages taken from areas with this substrate.

4.2.3 Sand Bottom/Soft Bottom

This sand bottom category includes thick sand, silt, or mud bottoms that primarily support soft bottom communities. A variety of morphological forms are seen including open planar bottoms, areas of sand waves and ripples, bioturbated areas, and sandy bottoms covered with varying amounts of algae. Sediment grain size and chemical composition are also variable and often transitional, ranging from quartz to carbonate clastics.

Appendix Figures B-1 and B-6 (Appendix B) are still photographs of sand bottom assemblages. On the side scan sonar, the sand bottom appears as a light area generally devoid of identifiable reflecting targets (Appendix A, Figure A-1 shows a sonogram of patchy sand areas). Where the sand is thicker than 0.3 m (1 ft) the sand layer is also identifiable on the subbottom (UNIBOOM) profile records (Appendix A, Figures A-5 and A-6).

4.2.4 Coralline Algal Nodule Layer over Sand

This substrate represents soft (sand) bottom areas that are covered by varying thicknesses of coralline algal growths usually in the form of loose, uncemented nodules. The nodules are a few centimetres in diameter and may cover extensive areas. Appendix Figure B-4 is a photograph of this substrate and its associated biological assemblages.

The typical long-range (150 m) side scan sonar records obtained during Year 1 (Cruise I) were not diagnostic for this substrate and appeared similar to the

records obtained over an open sand bottom. A few short-range (35 m) records obtained during Year 2 (Cruise I) showed a more granular signature than the sand bottom but such a signature would not necessarily be interpreted as algal nodules without ground-truth data for confirmation.

The subbottom profile record (Appendix A, Figure A-8) from this substrate shows a thin, highly reflective bottom surface overlying a thin transparent (sand) layer. Occasional diffractions are noted immediately beneath the surface reflector.

4.2.5 Algal Nodule Pavement with Agaricia Accumulations

This substrate differs from the previous category in having a fused pavement of coralline algal growths, coralline debris, sponges, and corals overgrowing areas of soft substrate. Characteristically this bottom is covered by extensive beds of the encrusting coral, Agaricia spp. In many places the Agaricia plates accumulate and form a distinctive crust on top of the carbonate rubble pavement (Appendix B, Figure B-5).

Appendix Figure A-3 is a side scan record taken over this pavement. Typically the records are dark and contain scattered targets with small shadows perhaps reflecting surface rubble or the edges of encrusting plates.

Neurauter (1979), in a study at the Florida Middle Ground reef, suggested that records exhibiting a "granular" high reflectivity signature are related to a coral-algal pavement. Subbottom profile records from this substrate are identical to ones obtained over algal nodule areas (Appendix A, Figure A-8).

Side scan sonar and subbottom profiler systems are not sufficiently diagnostic to positively identify this substrate without ground-truth data.

4.3 Secondary Features

4.3.1 Depressions

Circular depressions (Appendix A, Figure A-4) were noted on the side scan sonar records throughout the middle and outer shelf. They appear to range in size from 5 to 30 m and are 2 to 3 m deep. They primarily occur in water depths of 70 to 160 m except on Transect E, where they are found in a depth range of 60 to 200 m. They are associated with both hard and soft substrates (see Section 7.3.4).

4.3.2 Pinnacles

Pinnacles or prominences that extend 0.5 to 5 m above the sea floor were seen on the side scan sonar records of Transect C in the water depth range of 135 to 170 m (Appendix A, Figure A-2). Underwater television showed the pinnacles to be dead coral heads supporting a live bottom assemblage. The coral heads are associated with a shallow buried reef complex that is now covered with only a thin sand veneer in this area (Appendix A, Figures A-2 and A-9).

5.0 BIOLOGICAL ASSEMBLAGE MAPPING

5.1 Technical Approach

The biological assemblages were described and plotted utilizing television data and still photographs that had been taken on each of five east-west transects (A through E) between depths of 20 and 100 m during Year 1 (Cruise II) and between depths of 100 and 200 m during Year 2 (Cruise I). A single north-south line (Transect F, depth 73 to 126 m) was also surveyed during Year 2 (Cruise I).

Due to the intergrading of various biological assemblages, the dominant assemblage occurring along a ten fix point interval was used to characterize that section of the transect. Where live bottom patches were distributed throughout a sand bottom assemblage, the area was categorized as a live bottom assemblage. In cases where abrupt breaks between assemblages were apparent, this change was recorded to the nearest fix point. Areas of exposed hard bottom or emergent rock containing live bottom assemblages that extended for distances of less than two fix points (300 m) were not separately mapped.

The biota chosen to characterize specific assemblages were collected at various stations along the transects during the biological sampling cruises and generally identified to at least the genus level. These taxa were selected due to their abundance and distinct physical characteristics, which made possible their positive identification in still camera slides. Fish were not used as characteristic species of assemblages due to both their mobility and avoidance of the television/still camera sled, and the difficulties in making positive visual identifications on a majority of the species.

5.2 Description of the Biological Assemblages

Sample photographs of each of the nine biological assemblages are presented in Appendix B.

5.2.1 Inner and Middle Shelf Sand Bottom Assemblage (Appendix B, Figure B-1)

This assemblage occurs on a predominantly sand-covered bottom with an attached macrofauna density that is generally less than one individual per m^2. Associated biota consist of algae (Caulerpa spp., Halimeda spp., Udotea spp., and coralline algae), asteroids (Astropecten spp., Goniaster tessellatus, Luidia spp., Narcissia trigonaria, Oreaster reticulatus), bryozoans (Celleporaria spp. and Stylopoma spongites), hard corals (Scolymia lacera), echinoids (Clypeaster spp., Diadema antillarum, and Lytechinus spp.), holothuroids, sea pens, and sponges (Geodia neptuni). Algae can cover up to 75% of the bottom in photos taken in this area, while epifauna are found in widely scattered patches. The sponges and solitary hard corals are generally attached to a hard substrate, but their occurrence is so limited that these areas are not differentiated as live bottom assemblages. Within this assemblage, occurrences of algae, asteroids, bryozoans, corals, echinoids, sea pens, and sponges were recorded. Bioturbation and sand waves may also be present. The assemblage is found at depths ranging from 20 m to the end of the apparent photic zone at a water depth of 70 to 90 m. The biota from this assemblage are also found interspersed in sandy areas among live bottom assemblages.

5.2.2 Inner Shelf Live Bottom Assemblage I (Appendix B, Figure B-2)

This assemblage consists of patches of various algae (Caulerpa spp., Halimeda spp., and Udotea spp.), ascidians, hard corals (Siderastrea spp.), large gorgonians (Eunicea spp., Muricea elongata, Pseudoplexaura spp., and Pseudopterogorgia spp.), hydrozoans, and sponges (Geodia neptuni, Haliclona spp., Ircinia campana, and Spheciospongia vesparia). Live bottom assemblages are defined as those in which average density of attached macrofauna is greater than approximately one individual per m^2. The fauna generally are larger and have a higher biomass per unit area than the Inner and Middle Shelf Live Bottom Assemblage II described below. This assemblage is found in water depths of 20 to 27 m.

5.2.3 Inner and Middle Shelf Live Bottom Assemblage II (Appendix B, Figure B-3)

This live bottom assemblage consists of algae (Halimeda spp. and Peyssonnelia spp.), ascidians (Clavelina gigantea), bryozoans (Celleporaria spp. and Stylopoma spongites), hard corals (Oculina spp. and Siderastrea spp.), small gorgonians, hydrozoans, and sponges (Cinachyra alloclada, Geodia neptuni, Ircinia spp., Placospongia melobesiodes, and Spheciospongia vesparia). This assemblage appears to have both a higher number of species of sponges than Live Bottom Assemblage I and a lower biomass per unit area. Live Bottom Assemblage II occurs in water depths of 25 to 71 m.

5.2.4 Middle Shelf Algal Nodule Assemblage (Appendix B, Figure B-4)

This live bottom assemblage consists of coralline algal nodules formed by the combination of at least two genera of algae, Lithophyllum spp. and Lithothamnium spp., together with sand, silt, and clay particles. Algae (Halimeda spp. and Udotea spp.), corals, and small sponges (Cinachyra alloclada and Ircinia spp.) are also present. The assemblage extends from water depths of 62 to 108 m.

5.2.5 Agaricia Coral Plate Assemblage (Appendix B, Figure B-5)

The biotal assemblage consists of a dead, hard coral-coralline algae substrate covered by green algae (Anadyomene menziesii), coralline algae (Peyssonnelia spp.), living hard corals (Agaricia spp. and Madracis spp.), gorgonians, and sponges. The assemblage is found in water depths of 64 to 81 m.

5.2.6 Outer Shelf Sand Bottom Assemblage (Appendix B, Figure B-6)

The deep water sand bottom assemblage is distinguished by a distinct lack of algae. Characteristically, the macrofauna consist of asteroids (Echinaster spp.), crinoids (Comactinia meridionalis, Leptonemaster venustus, and Neocomatella pulchella), echinoids (Clypeaster ravenelli, Echinolampas depressa, and Stylocidaris affinas), ophiuroids, sea pens, various anemones, crustaceans, and occasional hexactinellid sponges. The biota from this

assemblage are also found interspersed among the other outer shelf live bottom assemblages. Generally, assemblages of this type occur in water depths of 74 to 200 m.

5.2.7 Outer Shelf Crinoid Assemblage (Appendix B, Figure B-7)

The biotal assemblage consists of large numbers of crinoids of the species Comactinia meridionalis, Leptonemaster venustus, and Neocomatella pulchella, living on a coarse sand or rock rubble substrate. Small hexactinellid sponges may also be associated with this assemblage. The assemblage is found in water depths of 118 to 168 m.

5.2.8 Outer Shelf Prominences Live Bottom Assemblage (Appendix B, Figure B-8)

This assemblage consists of the soft coral Nicella guadalupensis; the hard corals Madrepora carolina and others in the families Caryophylliidae, Dendrophylliidae, and Flabellidae; crinoids; the hydrozoan Stylaster sp.; and medium to large hexactinellid sponges in the Order Dictyonina, all of which were attached to rock prominences. These prominences emerge from a sand covered bottom and have a vertical relief of up to five metres. The assemblage extends from water depths of 136 to 169 m on Transect C.

5.2.9 Outer Shelf Low-Relief Live Bottom Assemblage (Appendix B, Figure B-9)

This biotal assemblage consists of various soft corals (Nicella guadalupensis), occasional hard corals including Madrepora carolina, crinoids, the hydrozoan Stylaster sp., and small sponges in the Order Dictyonina. This assemblage is found on a low-relief rock surface with a thin sand veneer. Characteristically, this type of assemblage is found in water depths of 125 to 185 m on Transects C and D, and from 108 to 198 m on Transect E.

6.0 SUMMARY OF MARINE HABITATS

Two Regional Maps of Marine Habitats have been prepared at a scale of 1:500,000 and are included in Volume 1 of the Atlas. The relationships between water depth, substrate types, and biological assemblages along each transect are summarized in Table 6-1 and Figures 6-1 and 6-2.

The apparent limited occurrences of the Inner Shelf Live Bottom I, Agaricia Coral Plate, and Outer Shelf Prominences Live Bottom Assemblages are evident from Table 6-1 and Figures 6-1 and 6-2.

The Middle Shelf Algal Nodule and Outer Shelf Low-Relief Live Bottom Assemblages also have somewhat limited distribution based on the relatively sparce occurrence (within the areas surveyed) of the substrate types required for their existence.

Table 6-1. Relationships between water depth, substrate types, and biological assemblages.

Assemblage	Transect with Water Depth Range in Metres	Substrate Types[1]				
		Rock Outcrops/ Hard Bottom	Thin Sand over Hard Substrate	Sand Bottom/ Soft Bottom	Coralline Algal Nodule Layer over Sand	Algal Nodule Pavement with *Agaricia* Accumulations
Inner and Middle Shelf Sand Bottom	A (27-44)		X	X		
	B (20-81)		X	X		
	C (23-79)		X	X		
	D (20-88)		X	X		
	E (20-67)		X	X		
	F (77-98)		X	X		
Inner Shelf Live Bottom I	C (19-26)		X			
	D (22-26)		X			
Inner and Middle Shelf Live Bottom II	A (25-65)		X			
	B (31-33)	X	X			
	C (30-72)		X			
	D (43-53)		X			
	E (56-62)		X			
	F (78-93)	X	X			
Middle Shelf Algal Nodule	B (62-84)				X	
	D (76-93)				X	
	E (67-125)				X	
	F (73-89)				X	
Agaricia Coral Plate	E (69-90)					X
	F (79-85)					X
Outer Shelf Sand Bottom	A (74-212)		X	X		
	B (84-204)		X	X		
	C (79-200)		X	X		
	D (93-202)		X	X		
	E (180-205)		X			
	F (90-116)		X	X		
Outer Shelf Crinoid	B (98-167)		X			
	C (85-137)	X	X			
	D (117-142)		X			
	F (116-127)		X			
Outer Shelf Prominences	C (137-168)			X		
Outer Shelf Low-Relief	C (164-185)	X				
	D (127-178)	X				
	E (125-180)	X				
	F (91-115)	X				

[1] "X" indicates the occurrence of a given assemblage on a specified substrate. If a transect is not listed, it indicates the assemblage was not observed in that transect.

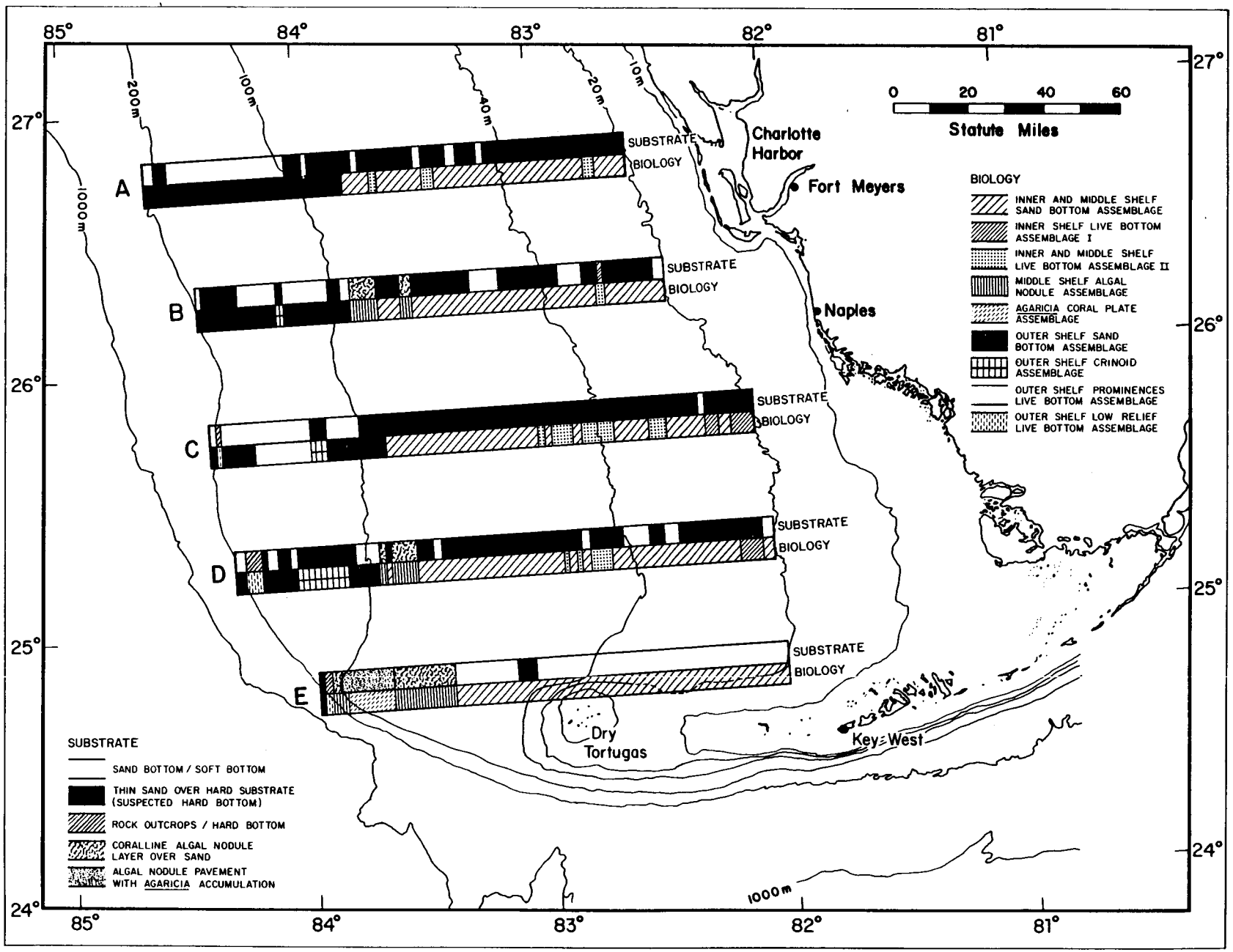


Figure 6-1. Generalized map of marine habitats along Transects A through E.

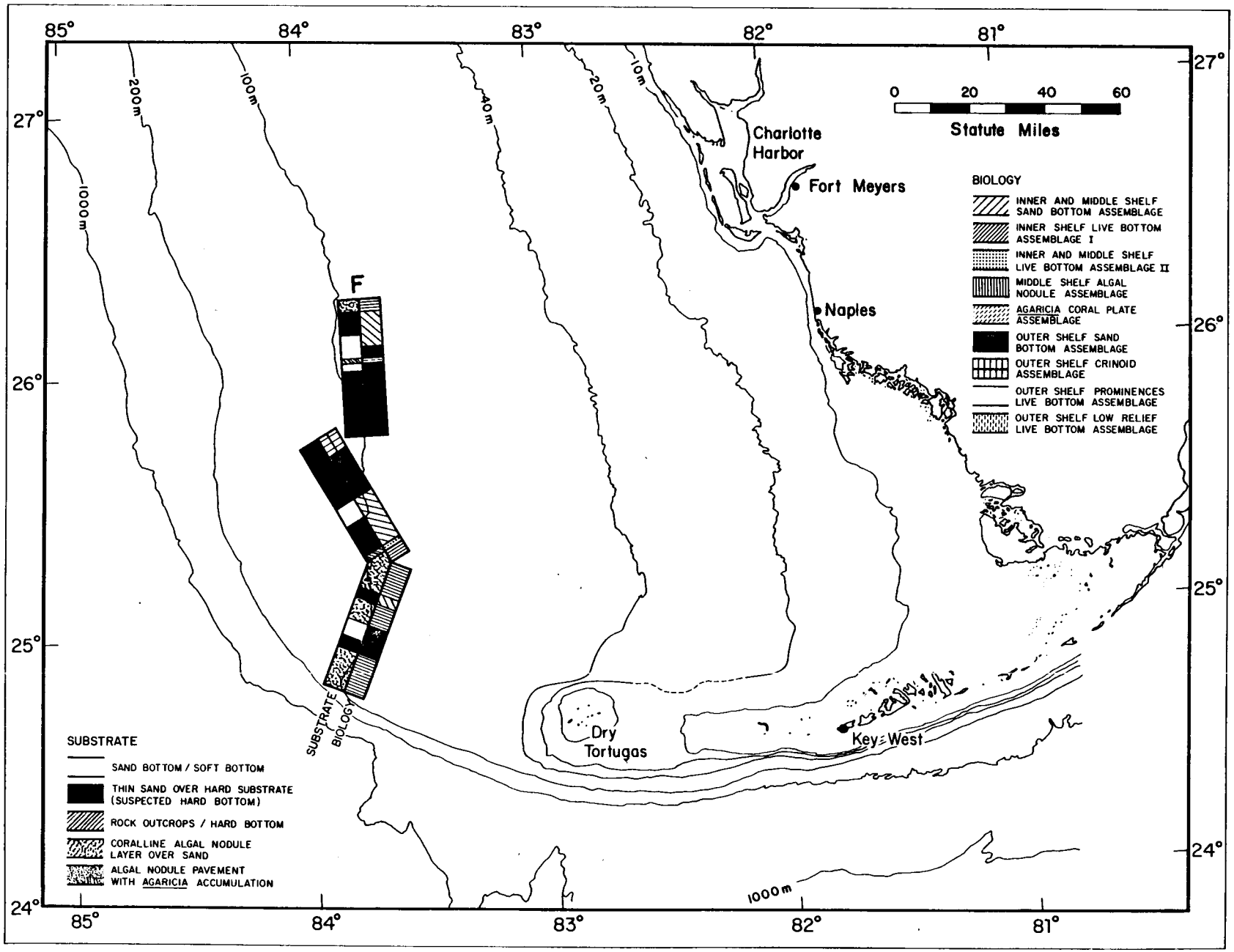


Figure 6-2. Generalized map of marine habitats along Transect F.

7.0 SHALLOW GEOLOGIC FEATURES

7.1 Geologic Cross Sections

A shallow geologic cross section (subbottom profile) was prepared for each transect. The cross sections were designed to illustrate the relationship between the shallow geology and sea floor habitats and to identify potential geologic hazards or design constraints for sea floor operations.

The cross sections were prepared for the centerline of each transect, except for Transect D where the northern line was used because of better data quality. The cross sections are based on the interpretation of the UNIBOOM records. A velocity of 1,677 m/s (5,500 ft/s) was used to determine the depth to the subbottom reflecting horizons. In order that the cross sections could be compared directly with the bathymetry/marine habitat maps they were also prepared at a scale of 1:48,000. This is a relatively large scale for mapping shallow subsurface geology and many minor features cannot be accurately illustrated at this scale. It was also necessary to use a 40X vertical exaggeration to emphasize the relatively gradual changes in the sea floor and subsurface geology.

7.2 Shallow Geology - Marine Habitat Relationships

7.2.1 Inner Shelf

The inner shelf extends from the coastline out to a water depth of approximately 40 m. No geophysical profiling was done in this zone for this project, but underwater television and still camera and partial side scan data were collected in the 20 to 40-m water depth range. The sea floor is generally smooth. However, bathymetric maps indicate it is pockmarked by circular depressions up to 2 km in diameter. These depressions are believed to be karst features carved into bedrock of Miocene age (Holmes, 1981).

Underwater television data indicate the bedrock is exposed or covered by a thin veneer of sand. The occurrences of both sand bottom and live bottom assemblages were noted in this region.

In the southernmost portion of the area (Transect E) the surficial sediment is finer grained silt, overlying Holocene and Pleistocene sediments. No live bottom assemblages were noted in this area. The surficial sediment layer is approximately 10 m thick at the 40-m water depth.

7.2.2 Middle Shelf

The middle shelf extends from the 40-m water depth out to 90 to 100-m depths. From 40 to 70 m the sea floor is smooth and consists of a thin sand veneer over late-Tertiary-Quaternary sediments. This wedge of younger sediments appears to increase in thickness seaward from 5 to approximately 20 m. The thickness of the younger sediments is estimated based on the depth to the first layer showing karst features. While this is an area of predominantly sand bottom assemblages, small areas of Live Bottom Assemblage II were noted on all transects.

The outer edge of the middle shelf is marked by a 10-km wide buried biohermal complex of unknown age. This series of carbonate reef-like structures occurs in water depths of 70 to 90 m and was designated the "Central Reef Complex" by Holmes (1981). The sea floor topography in this area is irregular and contains numerous depressions or pockmarks (see Appendix A, Figure A-4 and Section 7.3.4). The Middle Shelf Algal Nodule Assemblage is found (on Transects B, D, and E) interspersed with the sand bottom assemblages over the zone of this buried reef complex. The Agaricia Coral Plate Assemblage also extends across this zone on Transect E.

7.2.3 Outer Shelf

The outer shelf extends from water depths of 90 to 200 m. This zone is approximately 10 km wide on Transect E but rapidly widens to approximately 50 km on Transect D and 65 km on Transect A. The slope averages 0.2° and is broken by wave-cut terraces believed to have been formed during hiatuses in the

rise in sea level (Holmes, 1981). The sea floor depressions found over the Central Reef Complex are found throughout this area primarily in the water depth range of 100 to 150 m.

Holmes (1981) noted a double reef complex at the shelf break. The shallowest reef is described as a bioherm (see Appendix A, Figures A-2 and A-9) and appears to be partially exposed under a very thin sand cover and supports the Outer Shelf Prominences Live Bottom Assemblage mapped on Transect C in water depths of 137 to 170 m. Low-Relief Live Bottom Assemblages are associated with outcrops of Late-Tertiary and Quaternary sedimentary rocks in water depths of 150 to 185 m on Transects C, D, and E.

7.3 Geologic Hazards and Design Considerations

The basic shallow geologic and physiographic features of the southwest Florida shelf may be identified from the bathymetric/substrate maps and geologic cross sections. Several categories of potential geologic design constraints for sea floor facilities are also evident. However, the regional nature of the survey and the large mapping scale preclude accurate mapping of zones of occurrence of these features and limits the discussion to a description of the features and their observed locations on specific transects.

7.3.1 Sea Floor Topography

The sea floor slopes gently to the west throughout the southwest Florida shelf. Slopes are generally less than 0.25° (about 4 m per km) and only occasionally approach 1° (17 m per km) on the wave-cut terraces noted on the outer shelf. Local bathymetric irregularities are noted over the shallow Central Reef Complex and over the bioherm complex on Transect C. Numerous sea floor depressions, up to 30 m across and 2 to 3 m deep are seen over the Central Reef Complex (water depths of 70 to 90 m) and on the outer shelf in the water depth range of 90 to 200 m.

7.3.2 Sea Floor and Subbottom Sediment and Rock

The southwest Florida shelf surficial sediment layer is generally very thin (<1 m), although occasional sand accumulations of up to 10 to 12 m are noted (Appendix A, Figure A-5). Beneath the thin sediment cover is a hard substrate of Miocene(?) carbonate rock on the inner shelf, and late Tertiary to Quaternary rock on the middle and outer shelves.

7.3.3 Bioherms and Pinnacles

Shallow buried reef complexes were noted at the edge of the middle shelf (70 to 90 m) and on the outer shelf of Transect C. The latter complex is partially exposed and contains coral pinnacles extending one to five metres above the sea floor (Appendix A, Figures A-2 and A-9). The sea floor is generally irregular over these features and they provide the substrate for the Middle Shelf Algal Nodule Assemblage and the Outer Shelf Prominences Live Bottom Assemblage.

7.3.4 Sea Floor Depressions

Sea floor depressions ("pockmarks") (Appendix A, Figure A-4) are found throughout the southwest Florida shelf, generally in water depth ranges of 75 to 160 m. The depressions are up to 20 to 30 m across and 2 to 3 m in depth. The origin of the "pockmarks" is not known but they may be related to sea floor springs and/or the subsurface karst features. The karst features are generally buried 10 to 30 m and a one-to-one correspondence between a depression and karst feature has not been established.

7.3.5 Buried Karst Features

Buried karst features (Appendix A, Figure A-11) are evident on the UNIBOOM records from Transects A, B, C, and F (northern half). These may be solution sinks or collapse features. They occur in the water depth range of 55 to 200 m and are generally buried under 10 to 20 m of late Tertiary and Quaternary sediment.

7.3.6 Buried Channels

Near-surface buried channels were noted on the UNIBOOM records only on Transect E (Appendix A, Figure A-10) in the water depth range of 40 to 50 m. The base of the channels rests on a strong reflecting horizon at about 10 m beneath the sea floor.

7.3.7 Near-Surface Faulting

Near-surface faulting (Appendix A, Figure A-12) is found on Transects A, B, and F (northern half). The faults appear to be buried 15 to 30 m and have only minor vertical offset. Their depth extent cannot be determined from the UNIBOOM records nor can they be correlated laterally between the transects.

8.0 LITERATURE CITED

Holmes, C.W. 1981. Late Neogene and Quaternary geology of the southwestern Florida shelf and slope. U.S. Geological Survey Open File Report 81-1029. 27 pp.

Neurauter, T.W. 1979. Bed forms on the west Florida shelf as detected with side scan sonar. Master of Science thesis, University of South Florida. 144 pp.

United States Department of the Army. 1959. Universal transverse mercator grid table for latitudes 0° - 33°, Clarke 1866 spheroid (meters). Department of the Army Technical Manual TM5-241-12. 134 pp.

Woodward-Clyde Consultants and Continental Shelf Associates, Inc. 1982. Southwest Florida shelf ecosystems study-Year 1. Draft final report. Prepared for Minerals Management Service. 4 vols.

APPENDIX A

GEOPHYSICAL RECORD EXAMPLES

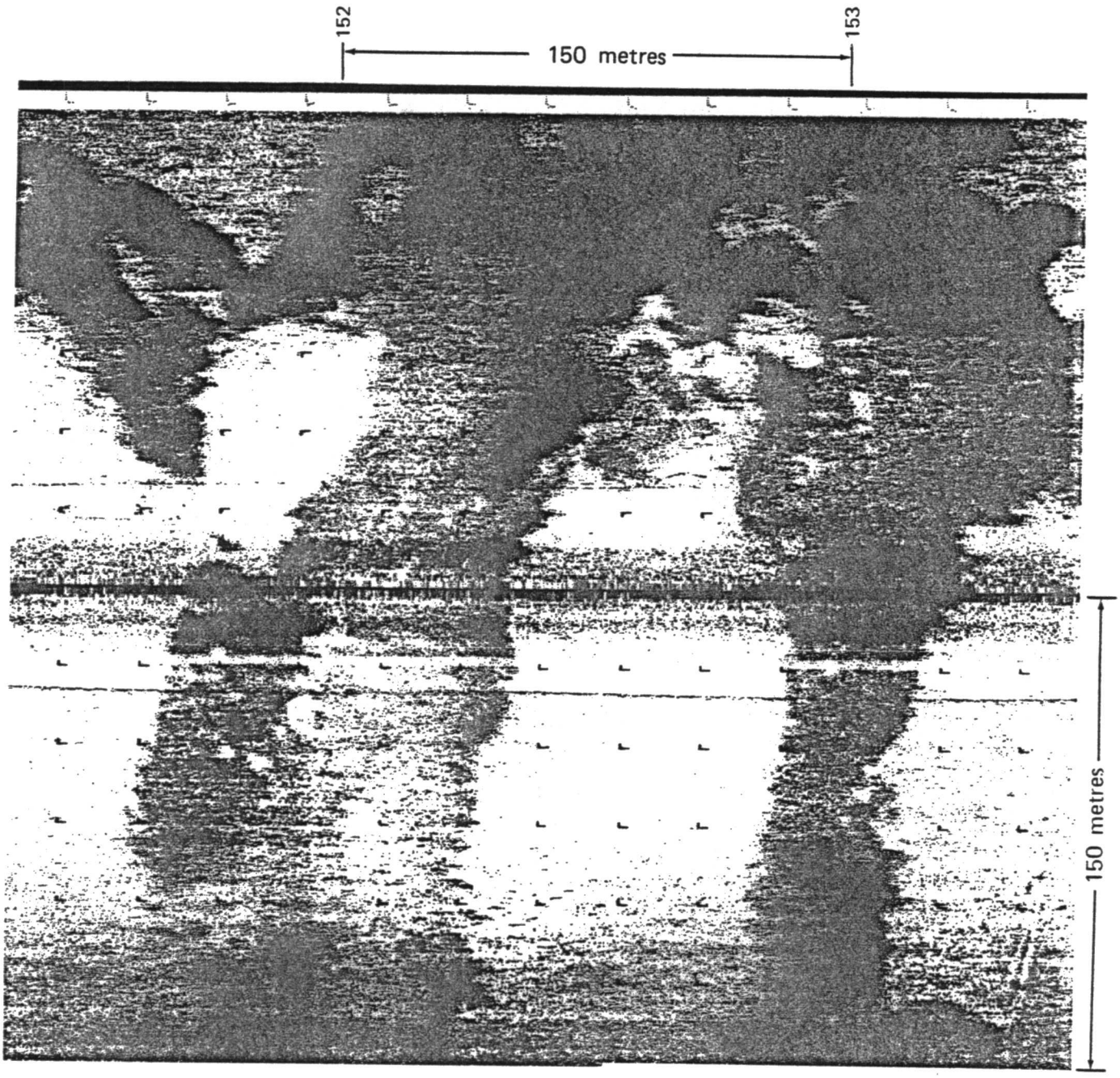
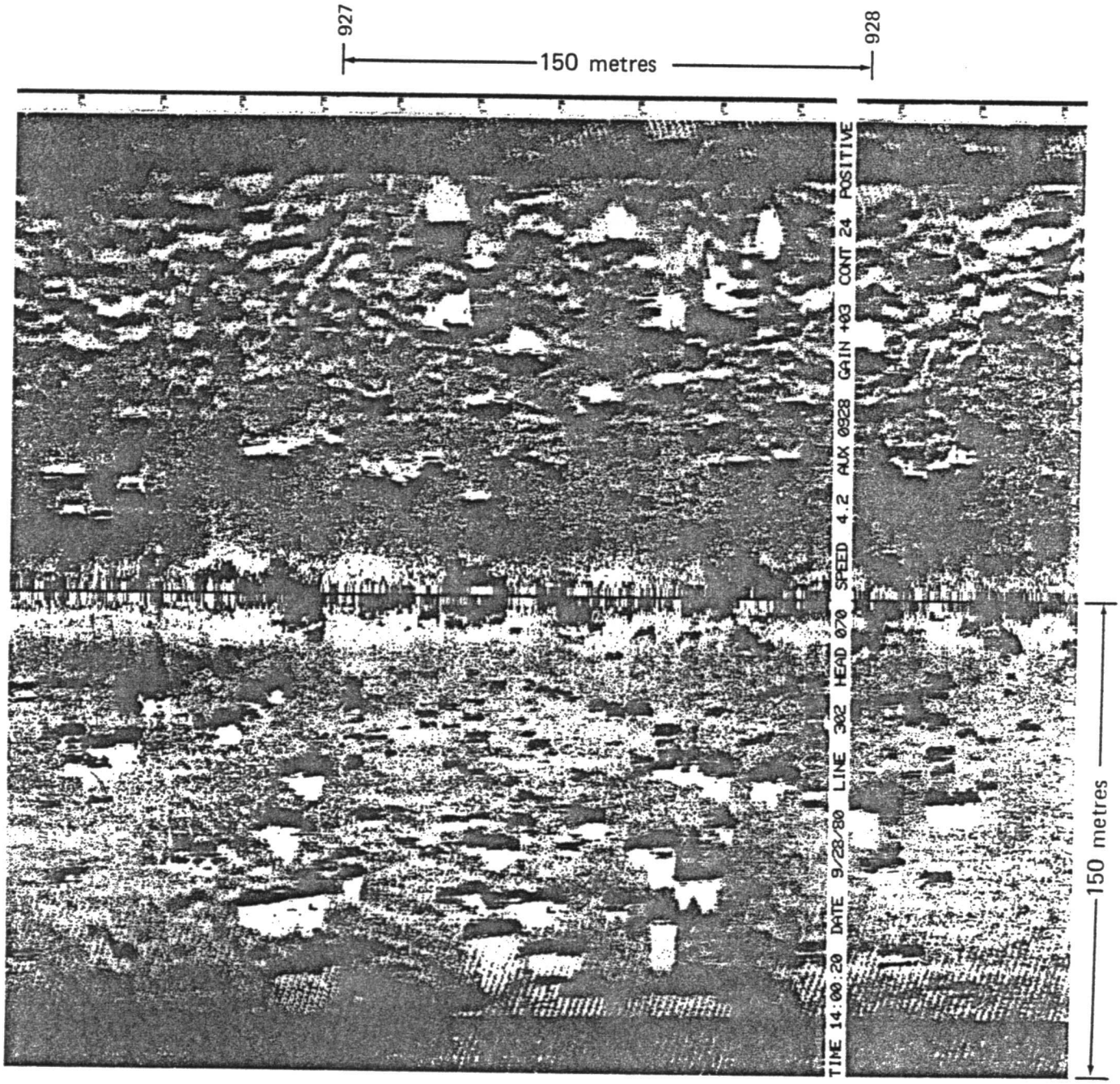
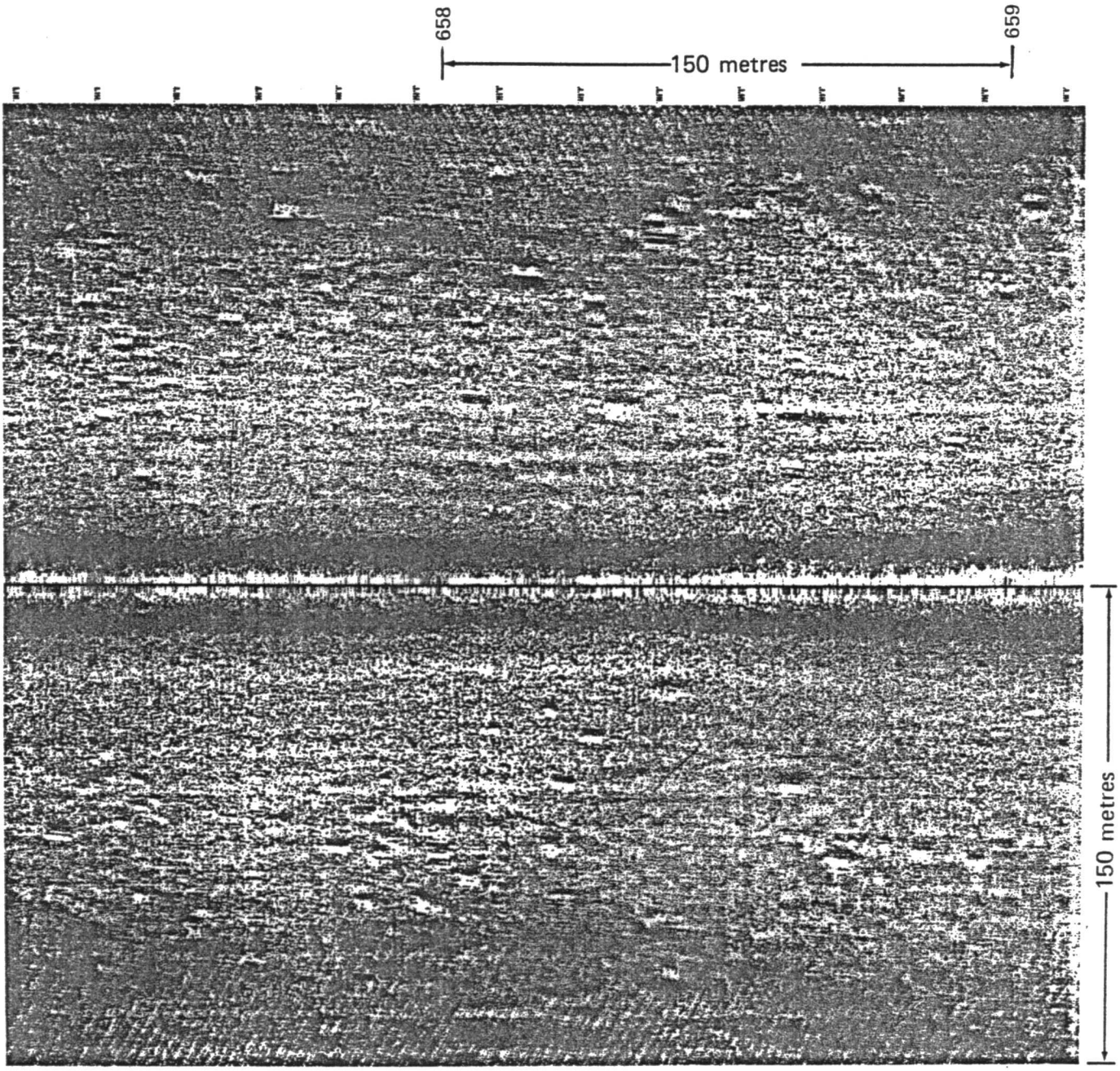


Figure A-1. Side scan sonar record showing the mottled pattern typical of areas on the inner and middle shelf where there is a thin sand cover over a hard substrate. On short-range records the dark areas appear as a large number of individual targets representing reflections from exposed hard substrate, coarse rubble, and epibiota. Location: map sheet 18, lease block 197, line 302, navigation fix points 152-154, water depth 51 m.



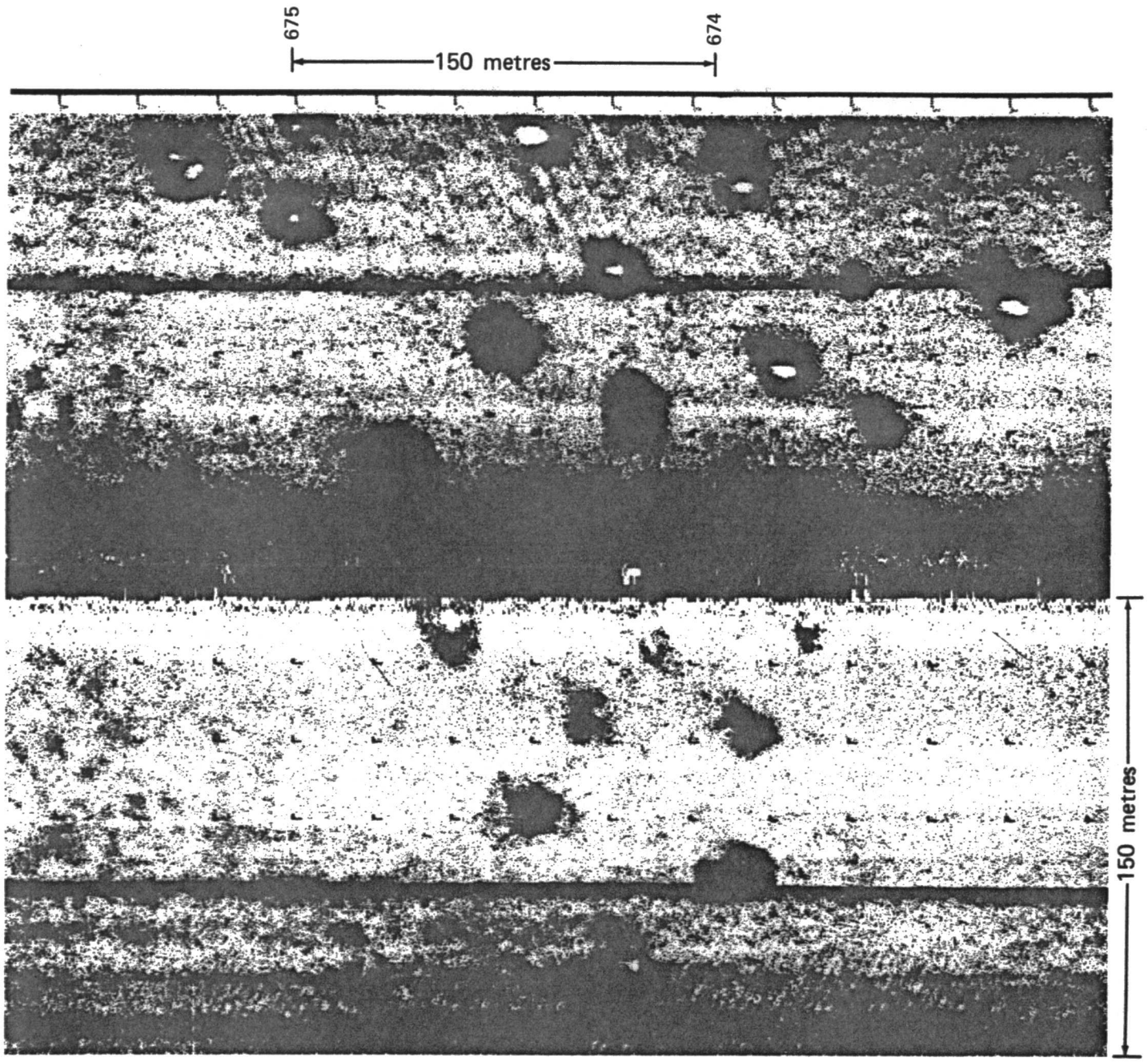
Sand Bottom with Pinnacles

Figure A-2. Side scan sonar record showing exposed pinnacles extending above a sand covered bottom. The pinnacles represent dead coral heads and extend 1/2 to 3 m above the sea floor. Location: map sheet 22, lease block 217, line 302, navigation fix points 926-928, water depth 158 m.



Algal Nodule Pavement

Figure A-3. Side scan sonar record typical of the areas mapped as algal nodule pavement by the underwater television system. Linear reflections may represent the edges of pavement plates or epibiota communities. Location: map sheet 37, lease block 134, line 502, navigation fix points 657-659, water depth 80 m.



Sand Bottom with Depressions

Figure A-4. Side scan sonar record showing depressions or "pockmarks" on a sand bottom. The depressions range from 5 to 30 m across and 2 to 3 m deep. The depressions also occur on hard substrate and algal pavement bottoms. They are probably related to subsurface karst features and/or springs. Location: map sheet 13, lease block 701, line 202, navigation fix points 673-675, water depth 131 m.

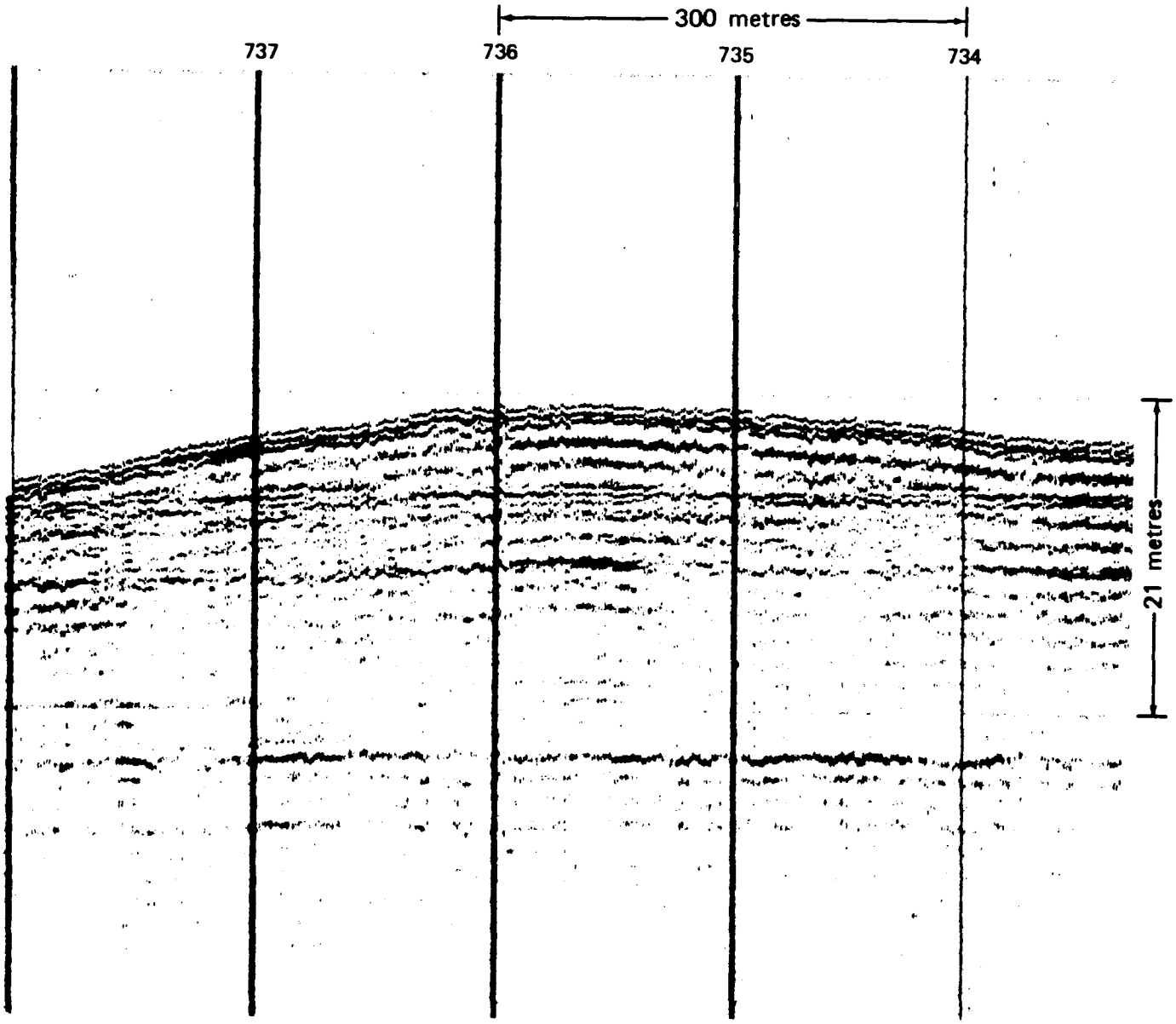
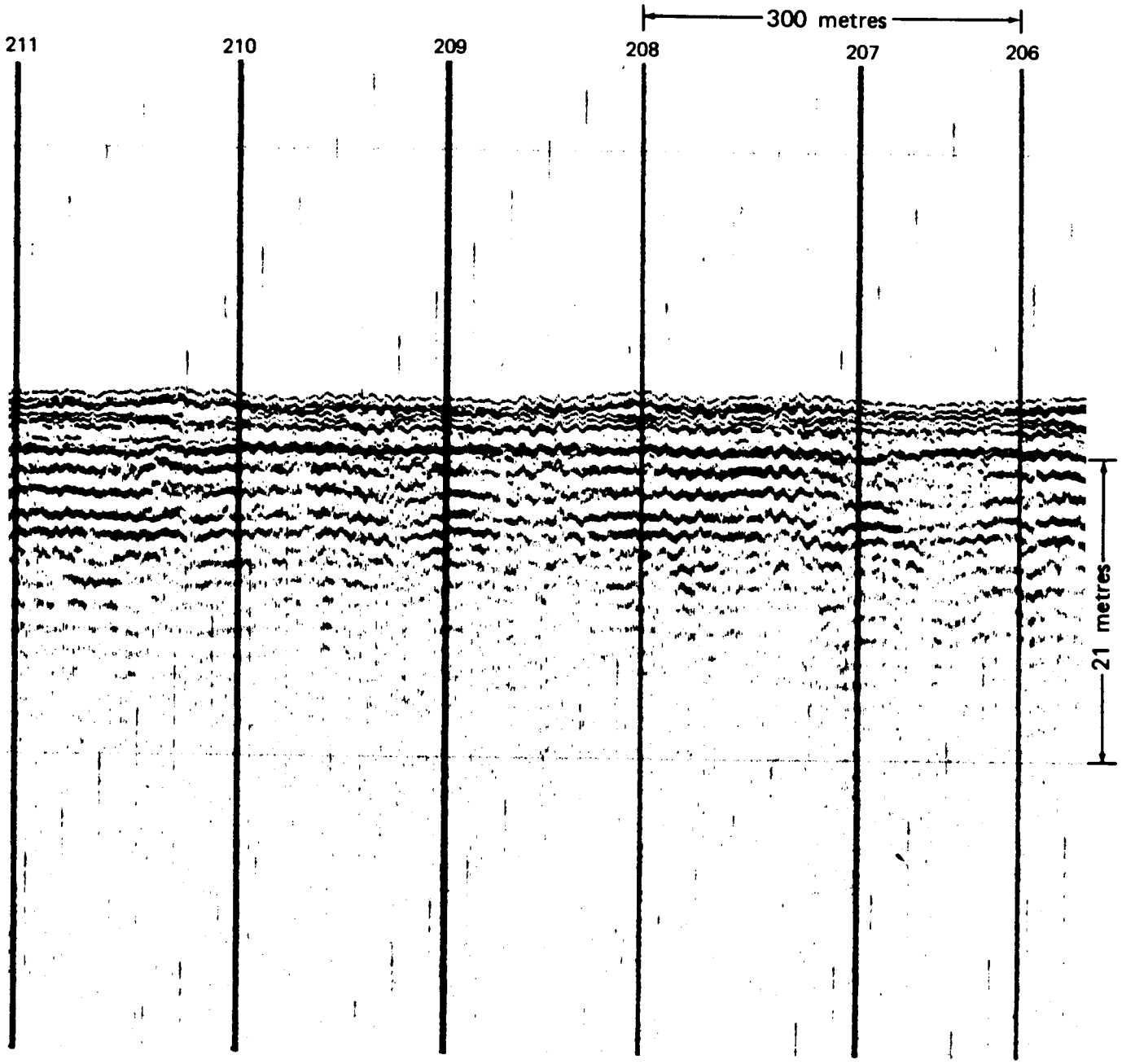
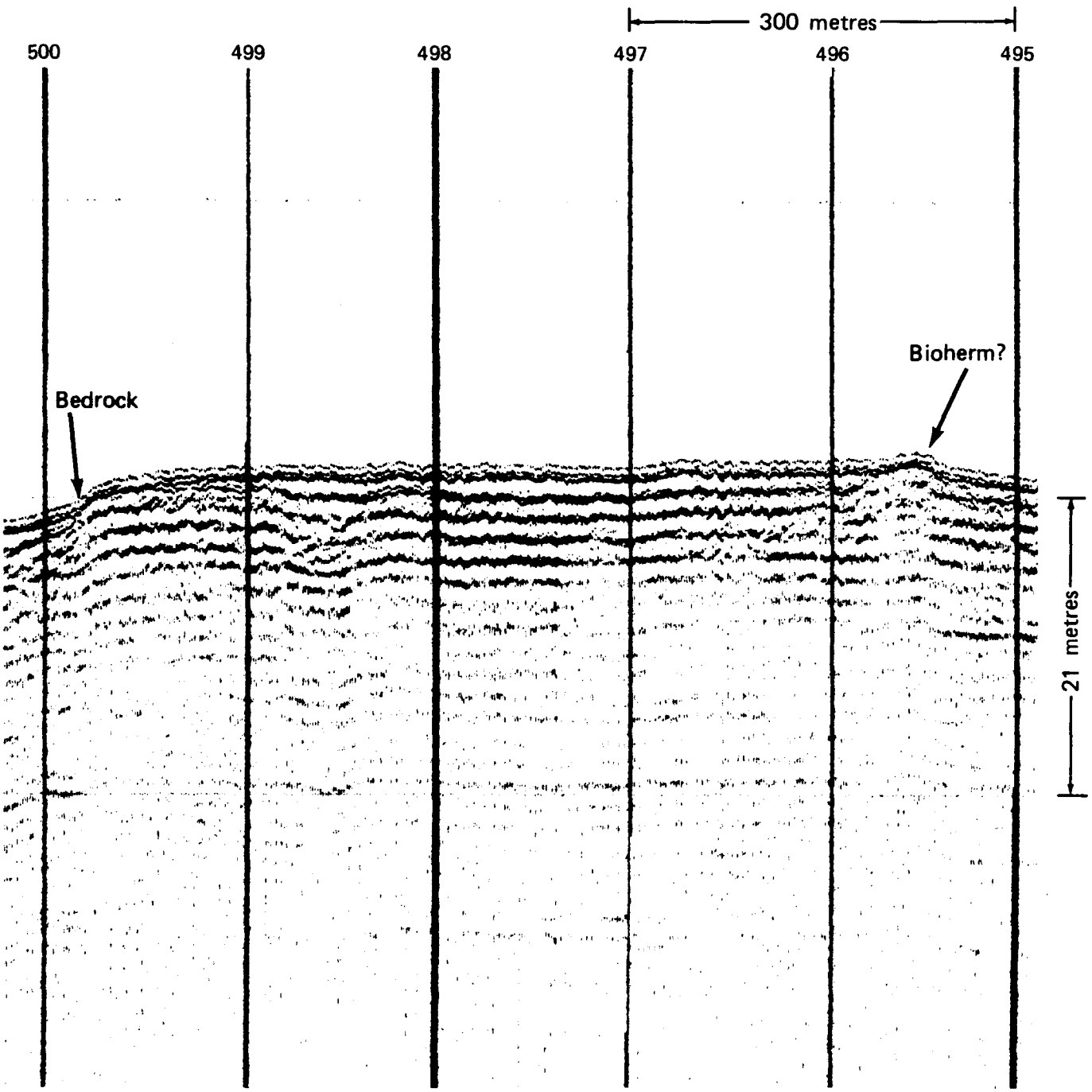


Figure A-5. UNIBOOM record showing thick sand deposit over hard substrate. Sand layers have an angular unconformity with relatively horizontal substrate. Sand is approximately five metres thick in the center of the bathymetric high. Location: map sheet 21, lease block 179, line 302, navigation fix points 734-737, water depth 118 m.



Thin Sand or Silt Layer over a Hard Substrate

Figure A-6. UNIBOOM record showing thin sand or silt layer over a hard substrate. Location: map sheet 10, lease block 675, line 202, navigation fix points 205-210, water depth 54 m.



Exposed Hard Substrate and Algal Nodule Surface

Figure A-7. UNIBOOM record showing local areas of exposed hard substrate (arrows). Area to the right of the scarp has a very thin sand layer covered with algal nodules. Location: map sheet 12, lease block 665, line 202, navigation fix points 495-500, water depth 75 m.

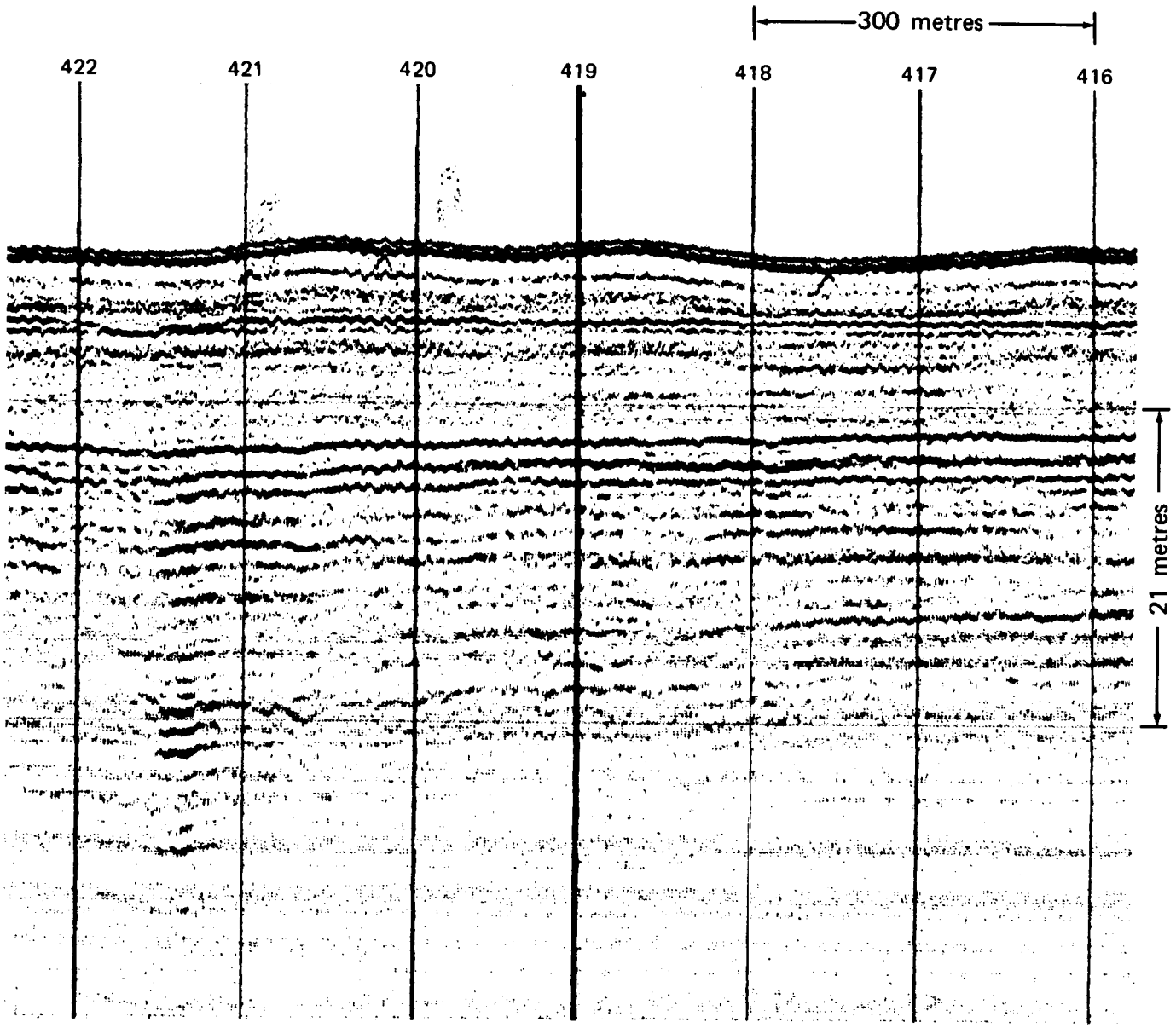


Figure A-8. UNIBOOM record over area of algal nodules over sand. This substrate is characterized by a strong, sharp water bottom reflection with occasional diffraction patterns immediately beneath the seafloor reflector. Location: map sheet 36, lease block 142, line 502, navigation fix points 415-420, water depth 66 m.

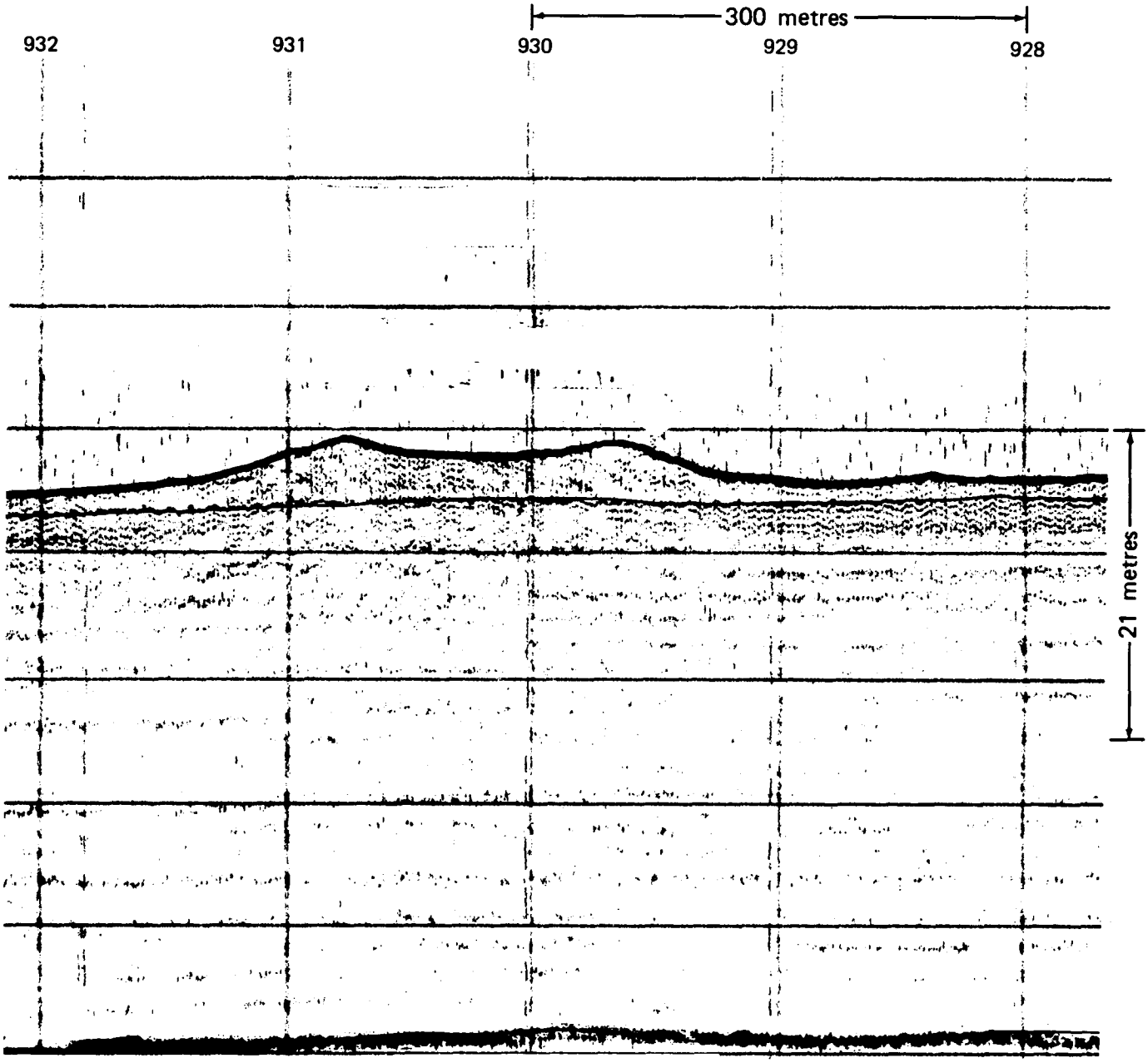


Figure A-9. UNIBOOM record over a bioherm. Side scan shows this feature to have a thin sand cover with exposed pinnacles of coral extending several metres above the sea floor. Location: map sheet 22, lease block 217, line 302, navigation fix points 929-931, water depth 159 m.

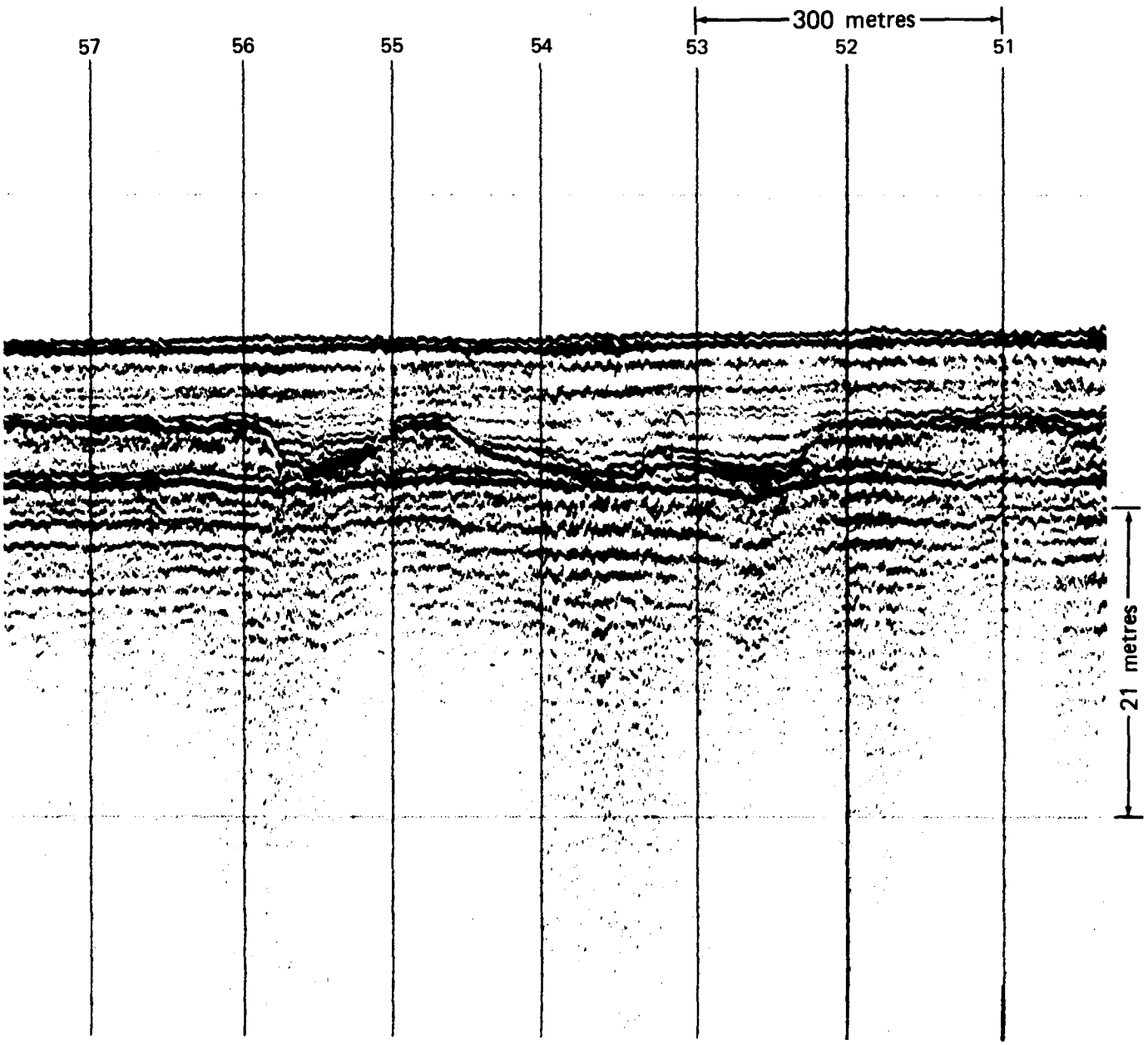


Figure A-10. UNIBOOM record showing buried channels with 5 to 10 m of sand or silt cover. These channels were found only on Transect E in water depths of 45 to 47 m. Location: map sheet 34, lease block 153, line 502, navigation fix points 52-56, water depth 46 m.

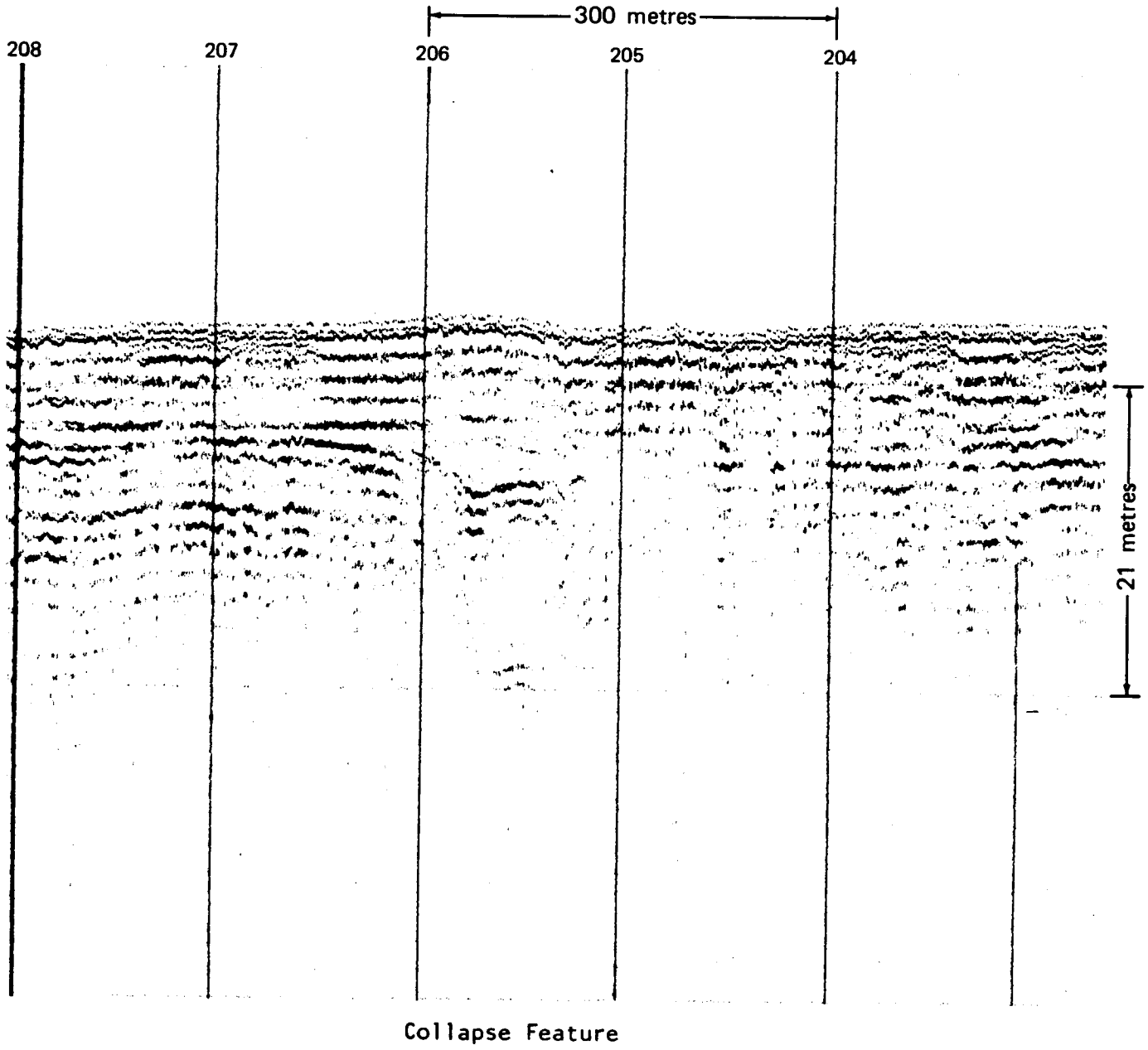
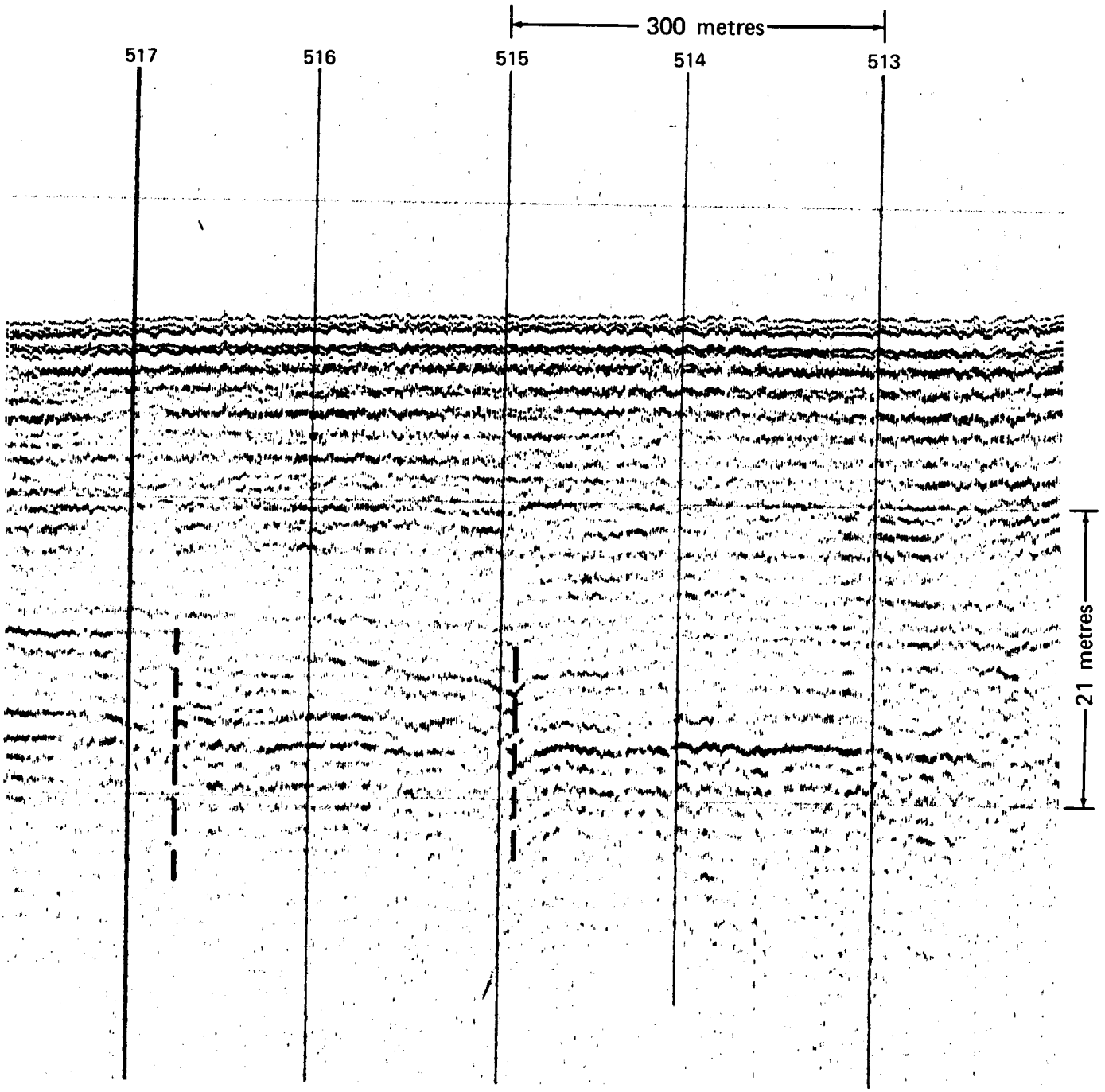


Figure A-11. UNIBOOM record showing sink or collapse features. The sink is approximately 150 m across and 8 to 10 m beneath the sea floor. Location: map sheet 3, lease block 188, line 102, navigation fix point 205, water depth 54 m.



Shallow Faulting

Figure A-12. UNIBOOM record showing shallow faulting. Top of faulting appears to be at least 20 to 25 m beneath the sea floor. Location: map sheet 5, lease block 178, line 102, navigation fix points 515-517, water depth 84 m.

APPENDIX B

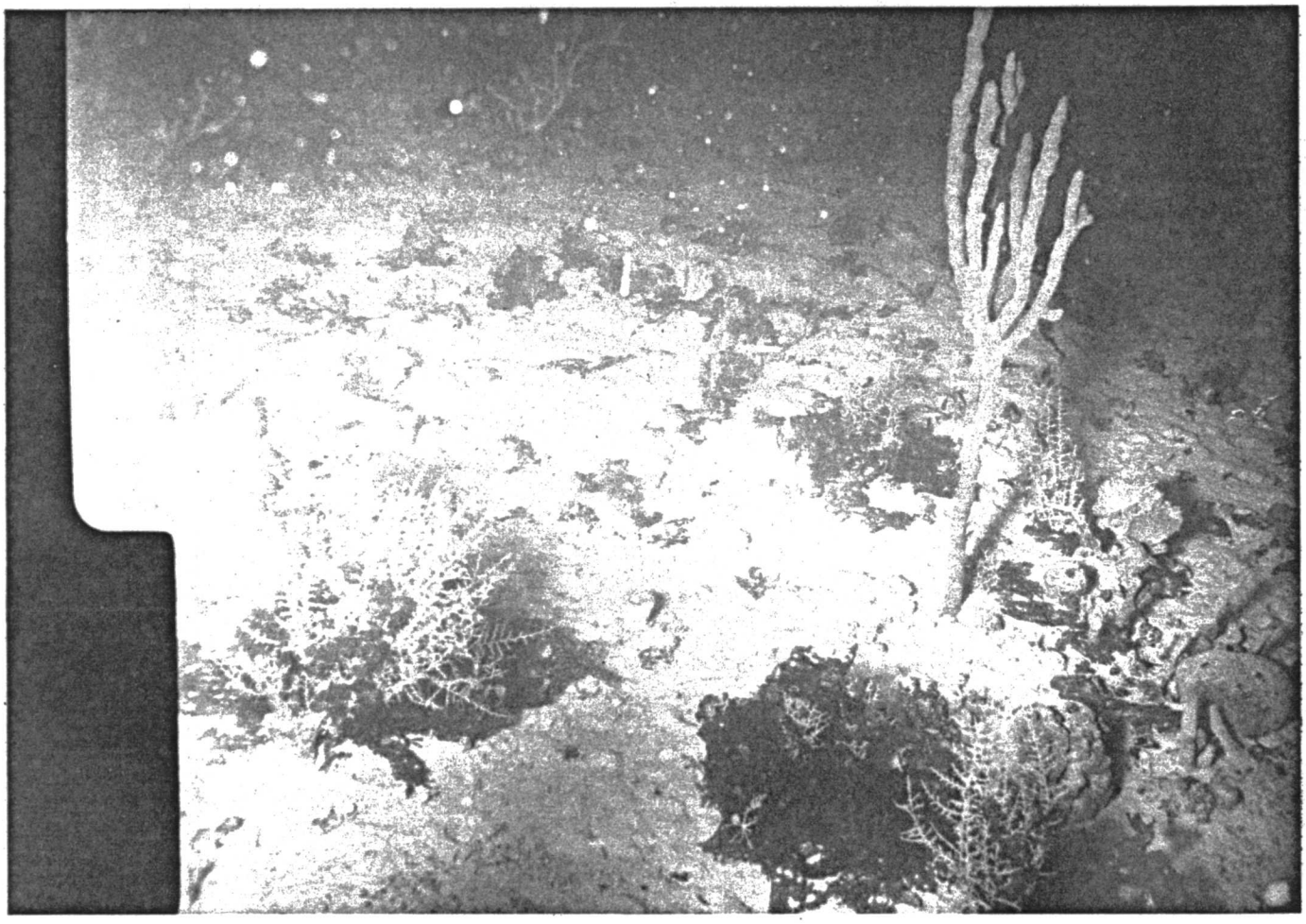
STILL PHOTOGRAPHS OF THE BIOLOGICAL ASSEMBLAGES

Inner and Middle Shelf Sand Bottom Assemblage

Figure B-1. Still photograph record of the Inner and Middle Shelf Sand Bottom Assemblage. A sand bottom area with the green algae Caulerpa sp. is shown. Location: map sheet 2, lease block 197, line 102A, navigation fix point -76, water depth 35 m.

Inner Shelf Live Bottom Assemblage I

Figure B-2. Still photograph record of the Inner Shelf Live Bottom Assemblage I. The vase sponge Ircinia campana and various soft corals including Pseudopterogorgia sp. and Pterogorgia sp. are shown. Location: map sheet 23, lease block 699, line 402A, navigation fix point -392, water depth 22 m.



Inner and Middle Shelf Live Bottom Assemblage II

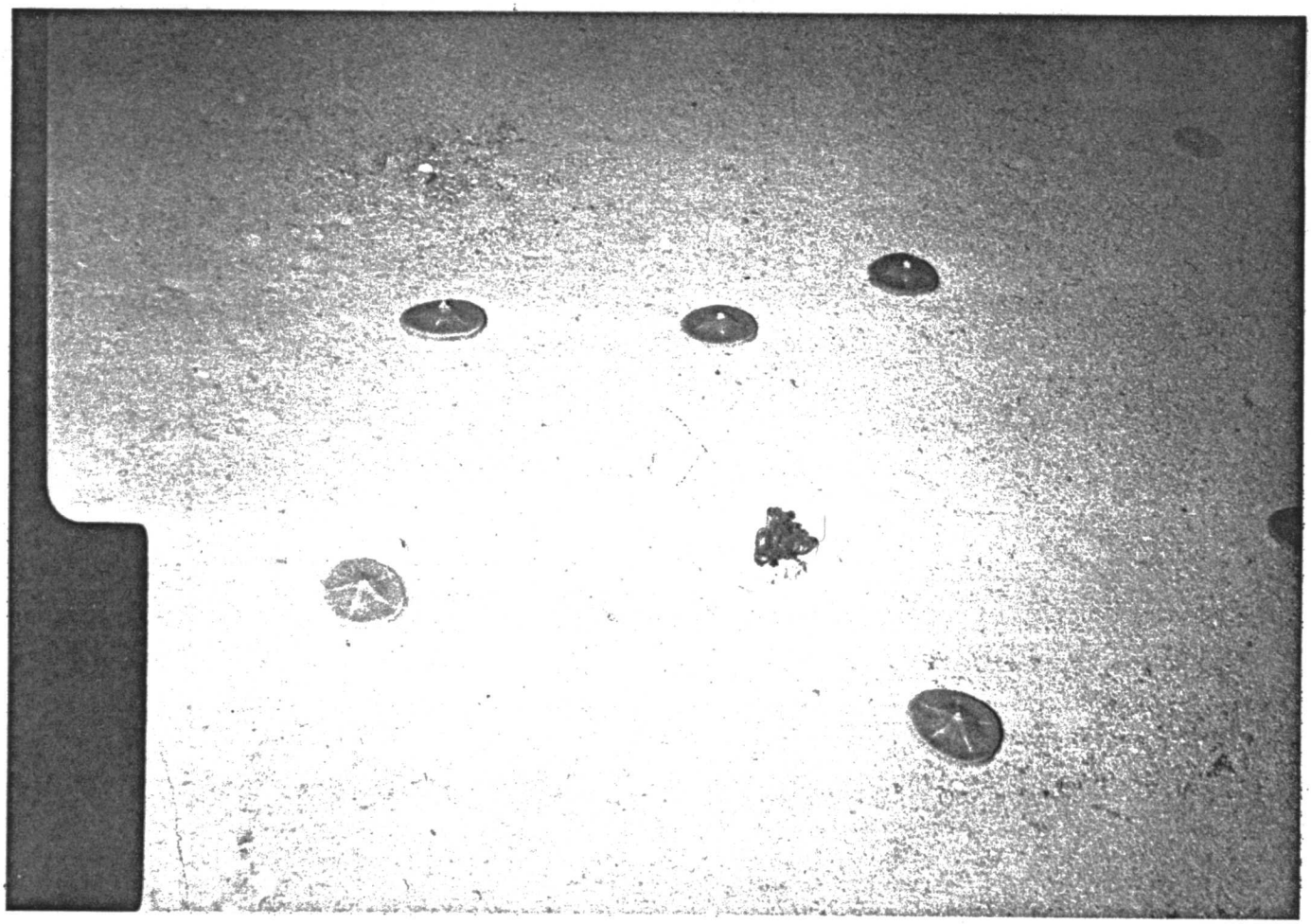
Figure B-3. Still photograph record of the Inner and Middle Shelf Live Bottom Assemblage II. Various sponges, including Axinella polycapella (tall branching sponge) and Cinachyra alloclada (round yellow sponges), unidentified hydrozoans (lower left), and algae are shown. Location: map sheet 16, lease block 206, line 302A, navigation fix point -153, water depth 34 m.

Middle Shelf Algal Nodule Assemblage

Figure B-4. Still photograph record of the Middle Shelf Algal Nodule Assemblage. A layer of coralline algal nodules, the green algae Anadyomene menziesii, and the starfish Narcissia trigonaria (lower center) are shown. Location: map sheet 12, lease block 667, line 202A, navigation fix point 473, water depth 68 m.

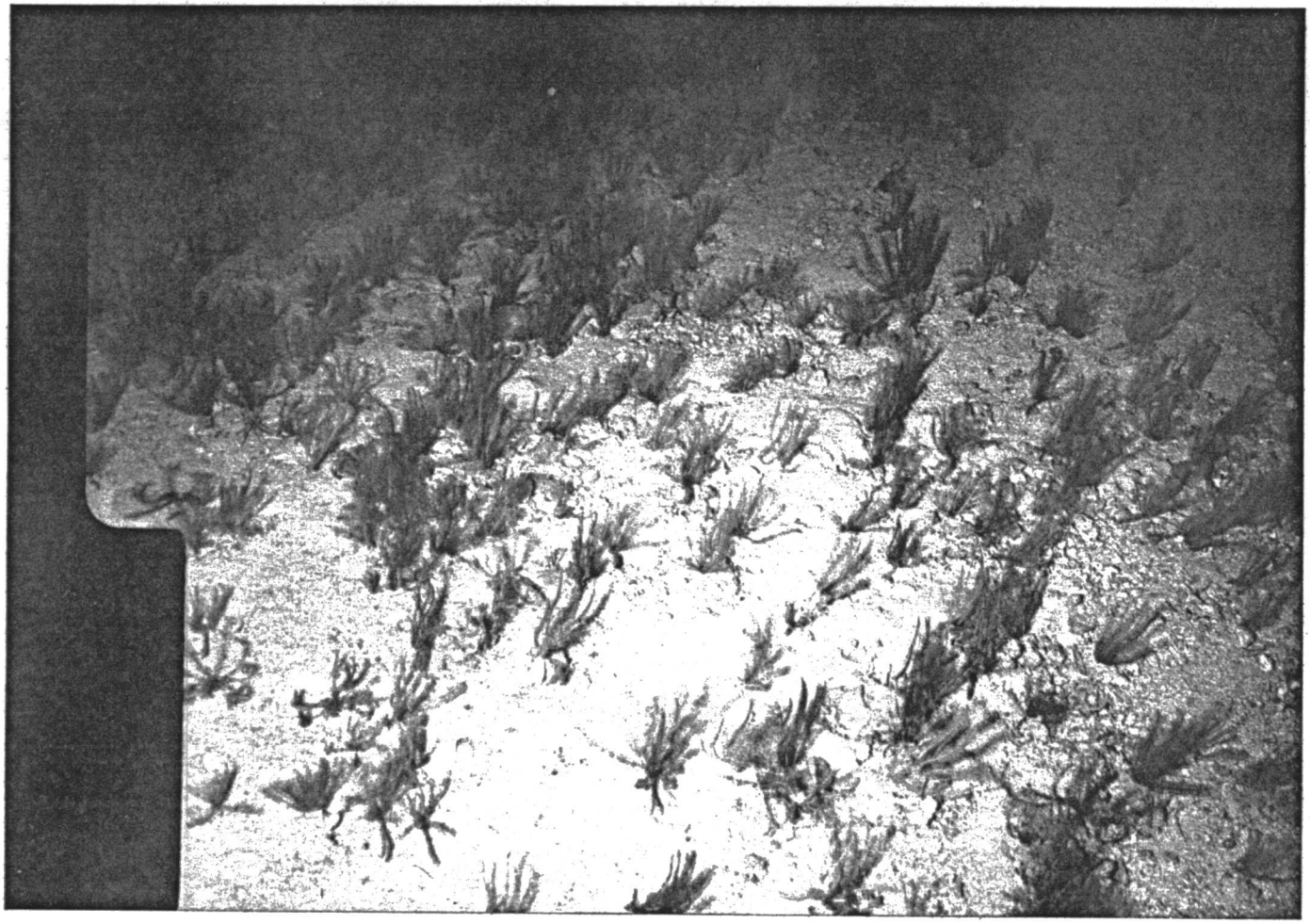
Agaricia Coral Plate Assemblage

Figure B-5. Still photograph record of the Agaricia Coral Plate Assemblage. The green algae Anadyomene menziesii, two species of coralline algae (Peyssonnelia simulans and P. rubra), the hard corals Agaricia spp., and the sponge Xestospongia sp. (lower right) are shown. Location: map sheet 36, lease block 138, line 502A, navigation fix point 541, water depth 66 m.



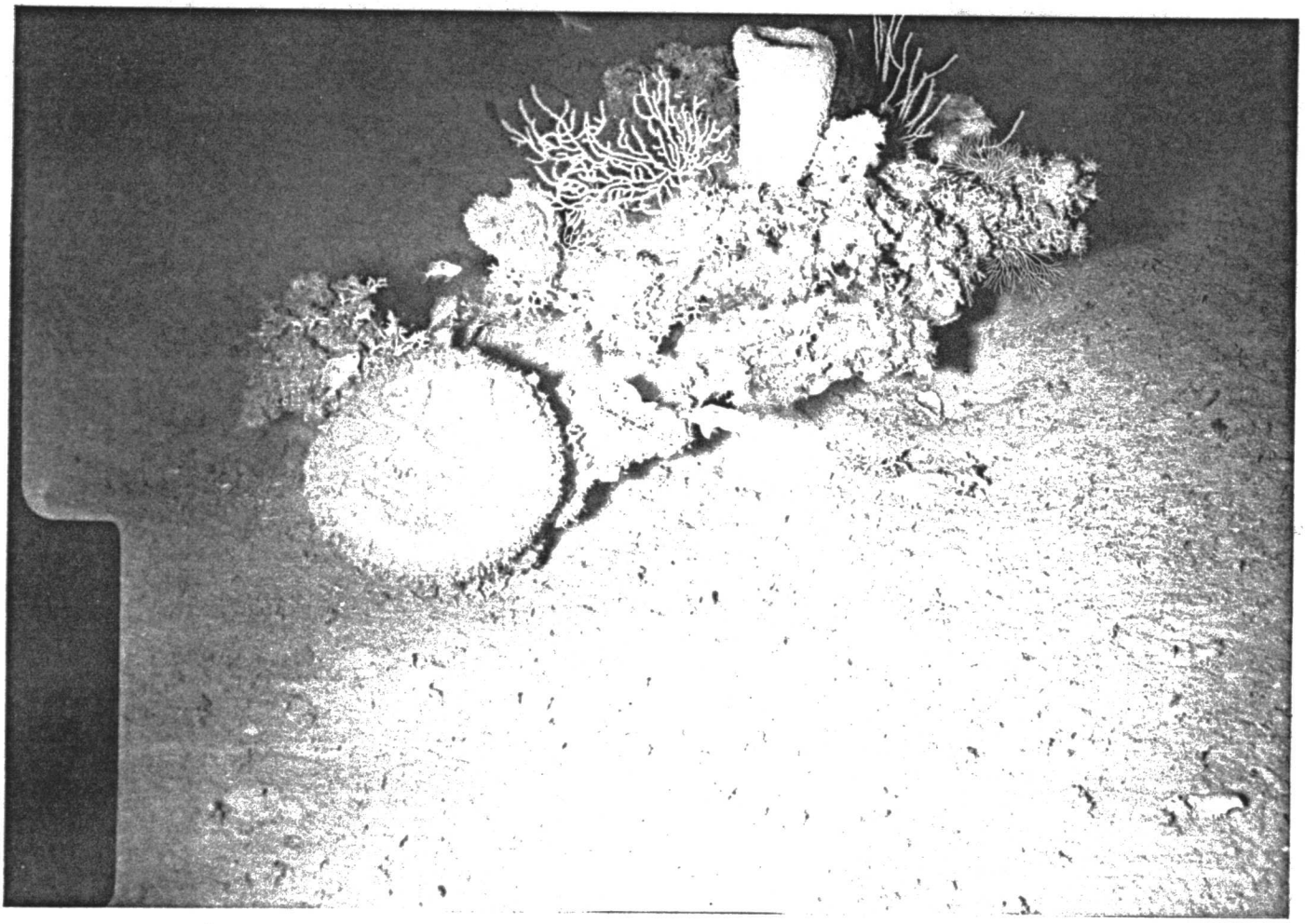
Outer Shelf Sand Bottom Assemblage

Figure B-6. Still photograph record of the Outer Shelf Sand Bottom Assemblage. The echinoid Clypeaster sp. and an unidentified crinoid (center) are shown. Location: map sheet 30, lease block 713, line 402A, navigation fix point 945, water depth 144 m.



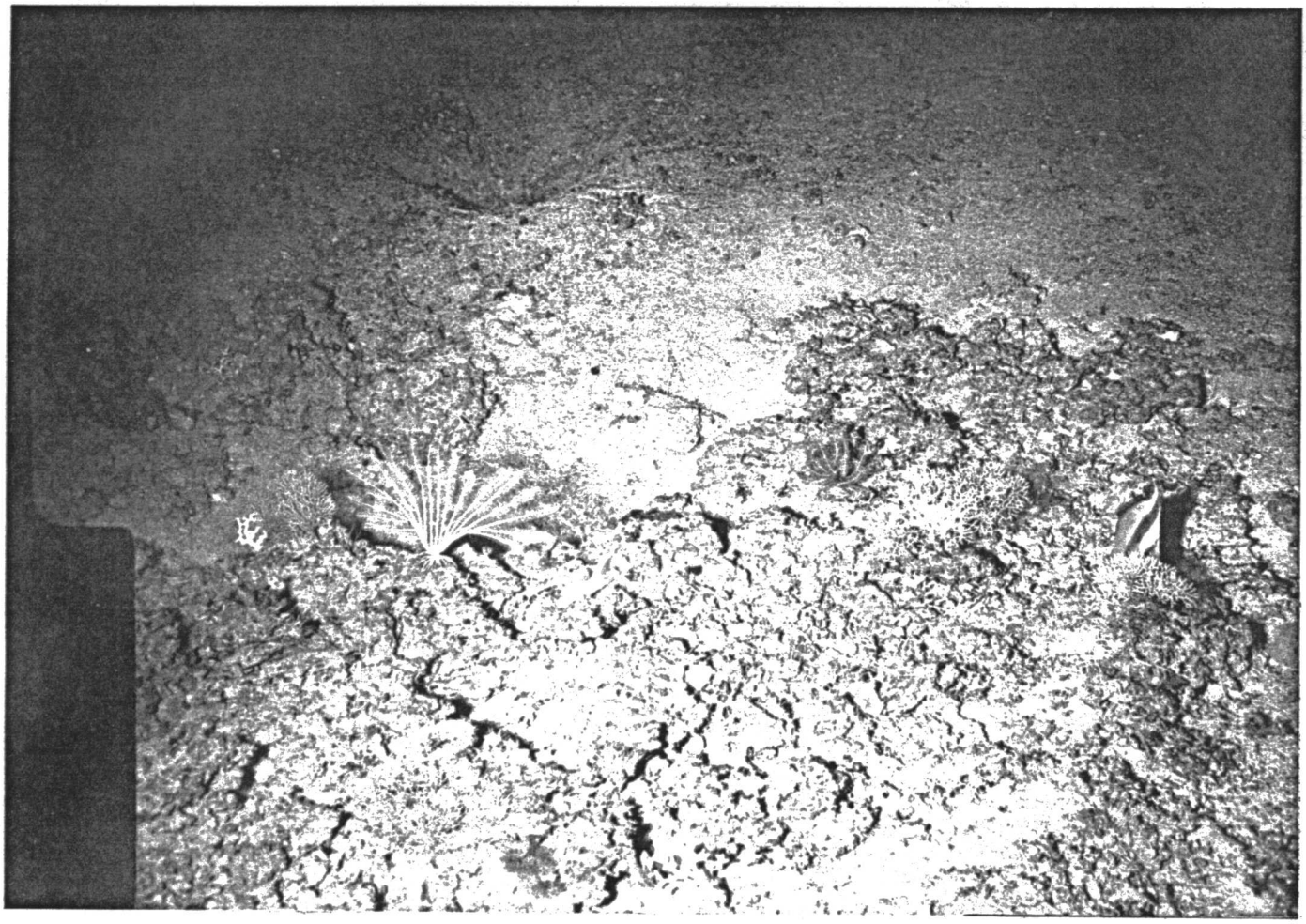
Outer Shelf Crinoid Assemblage

Figure B-7. Still photograph record of the Outer Shelf Crinoid Assemblage. The crinoid species Comactinia meridionalis, Leptonemaster venustus, and Neocomatella pulchella are shown. Location: map sheet 29, lease block 661, line 402A, navigation fix point 821, water depth 125 m.



Outer Shelf Prominences Live Bottom Assemblage

Figure B-8. Still photograph record of the Outer Shelf Prominences Live Bottom Assemblage. Various hexactinellid sponges in the Order Dictyonina, the roughtongue bass Holanthias martinicensis, the hard coral Madrepora carolina, soft corals, and crinoids are shown. Location: map sheet 22, lease block 218, line 302A, navigation fix point 898, water depth 153 m.



Outer Shelf Low-Relief Live Bottom Assemblage

Figure B-9. Still photograph record of the Outer Shelf Low-Relief Live Bottom Assemblage. The roughtongue bass Holanthias martinicensis (left), deepbody boarfish Antigonia capros (right), the hard coral Madrepora carolina (left), the soft coral Nicella guadalupensis (lower left and center), and crinoids are shown. Location: map sheet 22, lease block 213, line 302A, navigation fix point 1059, water depth 162 m.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.