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W. E. SWEET

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NORTHERN GULF OF MEXICO TOPOGRAPHIC FEATURES STUDY

FINAL REPORT

VOLUME FOUR

Submitted to the
U.S. Department of the Interior
Bureau of Land Management
Outer Continental Shelf Office
New Orleans, Louisiana

Contract No. AA551-CT8-35

Department of Oceanography
Texas A&M University
College Station, Texas

Technical Report No. 81-2-T

Research Conducted Through
the Texas A&M Research Foundation

MARCH 1981

TEXAS A&M UNIVERSITY COLLEGE OF GEOSCIENCES

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VOLUME FOUR
TABLE OF CONTENTS

LIST OF FIGURES IN VOLUME FOUR

Figure | Page

CHAPTER XI (Continued)

LIST OF TABLES IN VOLUME FOUR

LIST OF TABLES IN APPENDIX D

CHAPTER XI

COFFEE LUMP

R. Rezak, T. Bright, D. McGrail, T. Hilde, G. Sharman,
P. Parker, K. Winters, R. Scalan, L. Pequegnat,
D. Boatwright, D. Horne, D. Huff

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Coffee Lump Bank included mapping and sub-bottom profiling, hydrographic sampling, and chemical analysis of sediment samples for high molecular weight hydrocarbons, Delta C-13, and total organic carbon. Results of these studies are presented in this chapter under the headings Structure and Physiography, Hazards, Sedimentology, Chemistry, Water and Sediment Dynamics, and Biology.

GENERAL DESCRIPTION

Coffee Lump is located at 28°04'33"N latitude and 93°55'01"W longitude (Volume One, Figure III-1). Most of the bank lies in the High Island Area, East Addition, South Extension in Blocks 340, 341, 358, 359, 360, and 361. The western margin of the bank lies in the High Island Area, South Addition, Blocks 521 and 546 (Figure XI-1).

The bank is a low, broad swell on the seafloor elongated in a north-northwest south-southeast direction and covering an area of about 75 km^2. Off-bank depths to the south are 76 m and to the north about 68 m. The maximum topographic relief is approximately 14 m; however, local relief is rarely greater than 3 m (Figure XI-2). The shallowest depths on the bank are located on two peaks in Block A-359 and one peak in Block A-340, both peaks rising to depths of 62 m (Figure XI-1). An elongate, shallow depression with a relief of less than two metres lies in the center of the bank.

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Although the bank is elevated very little, it exhibits extensive local relief in the range of 1-3 m, especially on the southern margin of the bank and along its west flank (Figure XI-2). As illustrated on the structure map (Figure XI-3) and the boomer and 3.5 kHz profiles (Figures XI-4 and 5), both the local seafloor relief and the broader morphology of the bank are clearly related to the subsurface structure.*

*For the sections of seismic reflection profiles shown in Figures XI-4 and 5, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

Coffee Lump is an erosionally truncated anticline with its axis plunging to the northwest in the northern part of the survey area and more steeply to the south-southeast in the southern part of the survey area (Figure XI-3). Bedding dips steeply away from the center of the bank on all sides. The local roughness is largely due to steeply dipping beds that crop out on the seafloor, as is shown on the seismic reflection profiles (Figures XI-4 and 5). Differential erosion of strata having variable resistance to erosion contribute to this roughness. The less resistant beds have been more deeply eroded, leaving the more resistant beds standing slightly above the general seafloor depths. On the flanks, the beds dip uniformly away from the bank, with the dip decreasing with increasing distance away from the bank (Figure XI-4a and b).

The central depression is the surface expression of a complex graben system caused by the removal of solid salt at the crest of the diapir due to dissolution by marine phreatic (interstitial) water. Figure XI-4a clearly illustrates the relationship between the graben complex and the central depression. The graben complex contains a series of highly folded and faulted sedimentary rocks (Figures XI-4a and b; and XI-5b and c). These are extremely complex structures; the axes of the internal folds strike in various directions but are predominantly aligned with the major structure of the bank. One intermediate-size fold is superimposed upon the southeastern flank of the bank and plunges to the northeast (Figure XI-3).

Faulting is very common in the core of the anticline. The faults are normal faults that generally parallel the axis of the major fold (Figure XI-3). A set of radial, normal faults, however, extends eastward from the southern end of the bank where it is more domal. Most of the faults do not appear to offset the seafloor (Figure XI-4a). Most of the displacement, therefore, must have occurred before the anticline was eroded. The central depression of the bank, however, is most probably due to recent movement on its boundary faults (Figure XI-4a and b).

Although the shallow structure of the bank, as observed in the boomer and 3.5 kHz records, is too steeply dipping to allow the mapping of specific horizons, a major unconformity is revealed within the stratigraphic section (Figure XI-5a). The unconformity was observed on several profiles. The upper, more gently dipping sequence clearly onlaps the more steeply dipping beds to the north. Both sequences crop out on the seafloor, but a greater seafloor roughness is associated with the outcrops of the sequence that underlie the unconformity (Figure XI-2). On the basis of its roughness and the observed unconformity, the lower sequence has been mapped where it intersects the seafloor (Figure XI-3). It is difficult to estimate the age of this unconformity without deeper seismic data and/or well data. However, it seems to be too deep to be the Pleistocene-Holocene unconformity, and it most likely represents the Late Pliocene regression and transgression. The Late Pliocene and Early Pleistocene transgressive sediments are primarily clays which represent the distal deposits of nearshore deltaic complexes.

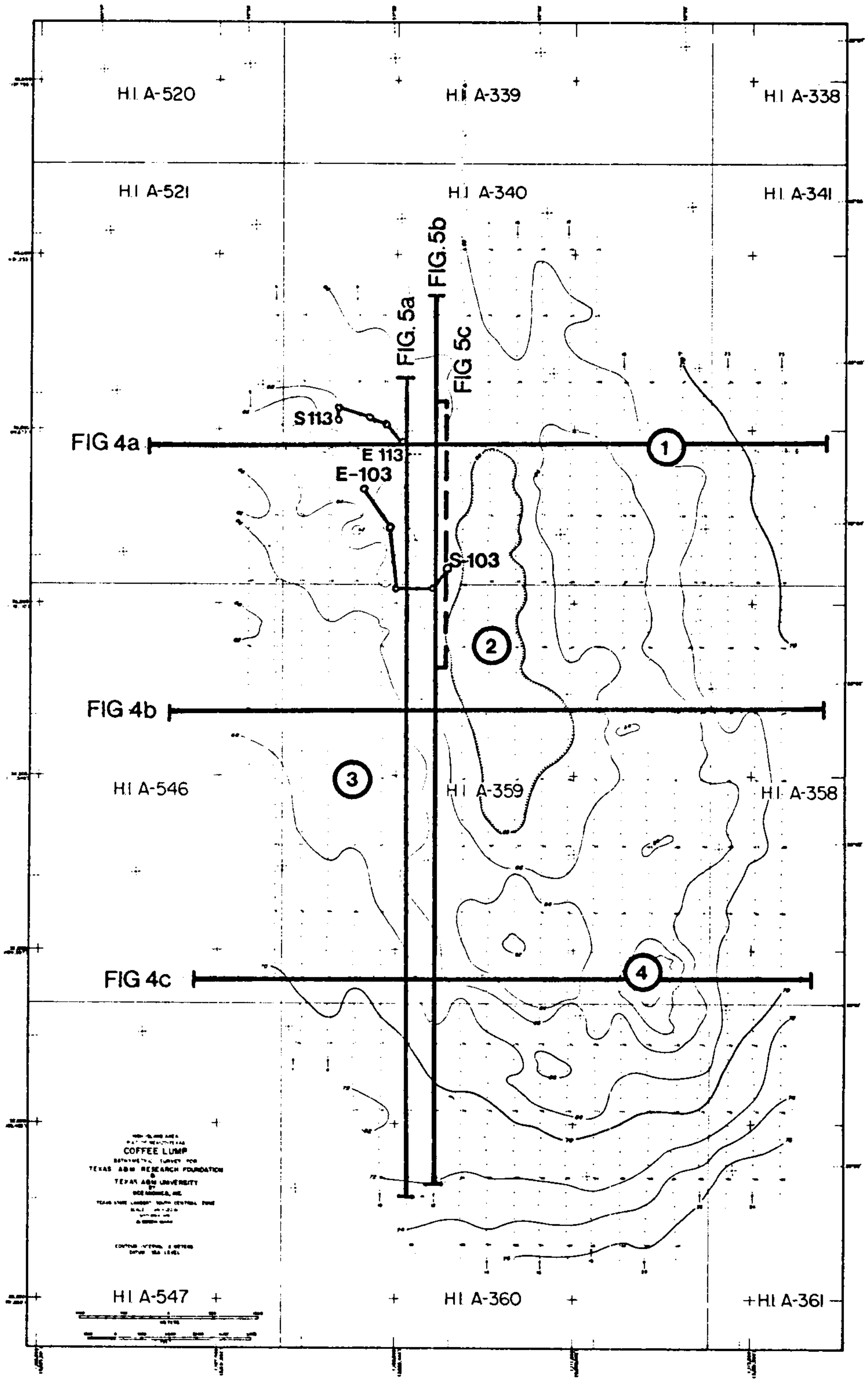

Figure XI-1. Bathymetry of Coffee Lump Bank. Solid lines and numbers indicate boomer and 3.5 kHz seismic reflection profiles shown in Figures XI-4 and 5. Submersible transects, dives 103 and 113: S = Start, E = End. Sample locations, 1-4.

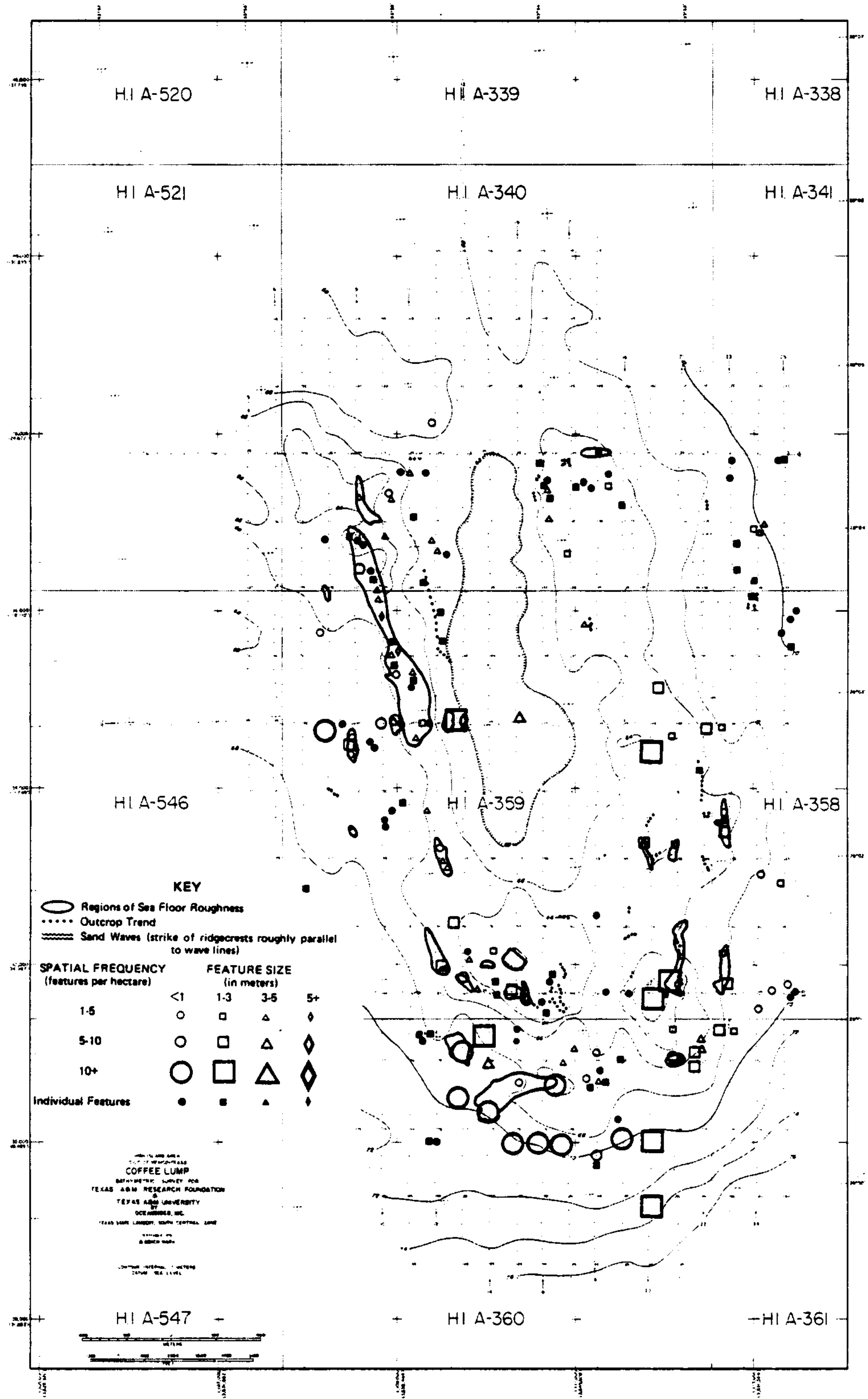

Figure XI-2. Seafloor roughness of Coffee Lump Bank, mapped from side-scan sonar records.

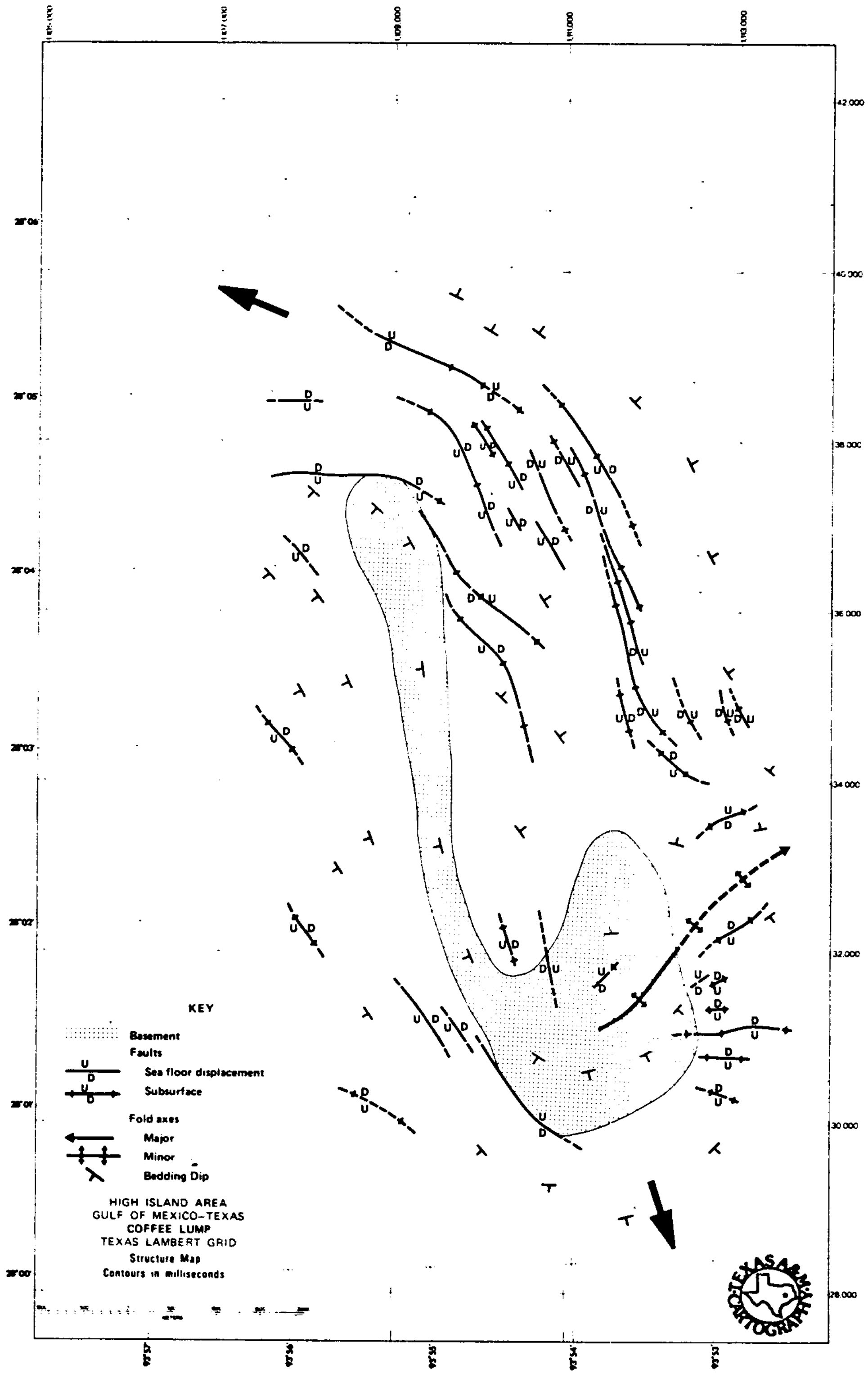

Figure XI-3. Structure map of Coffee Lump Bank.

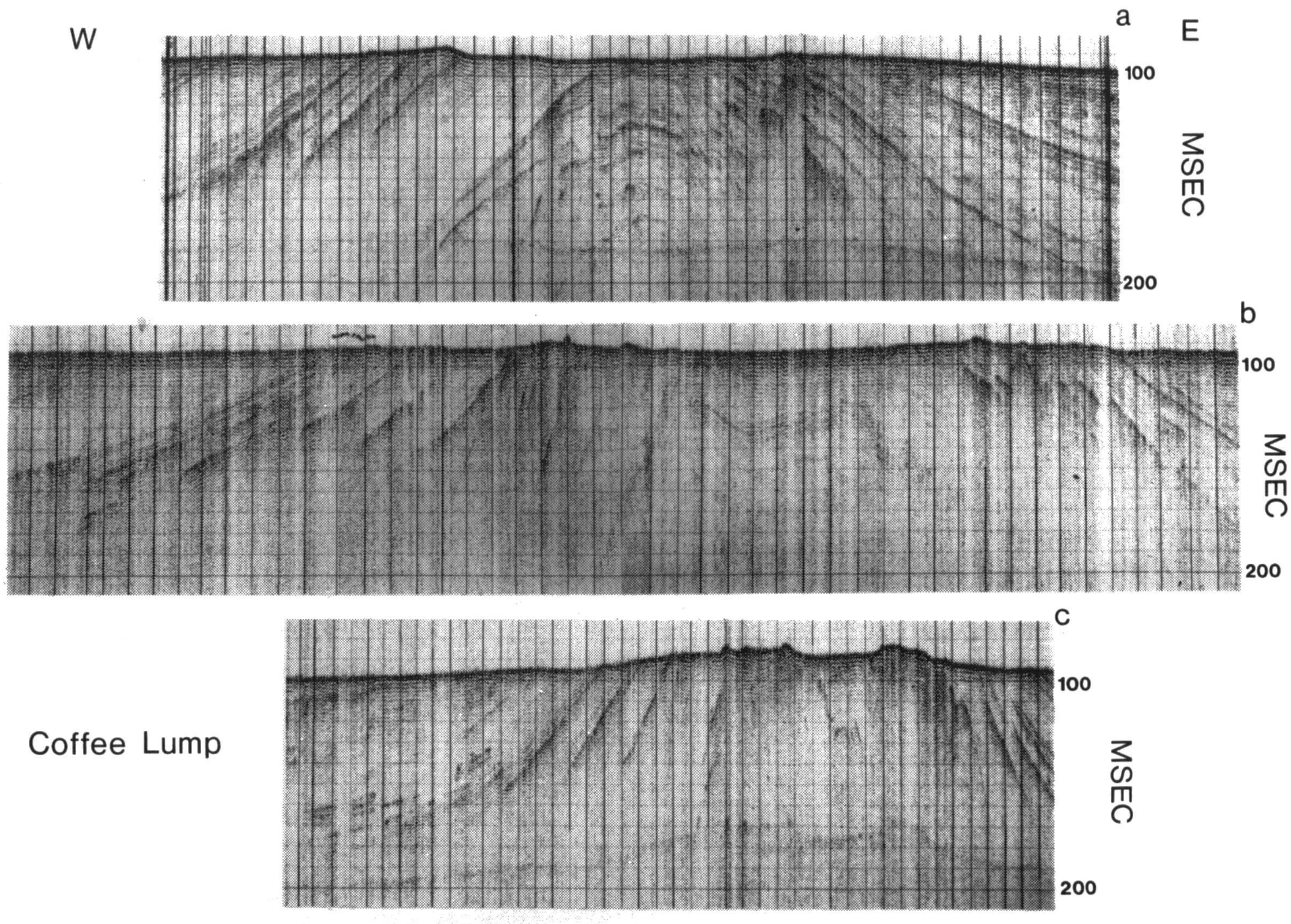

Figure XI-4. E-W boomer seismic reflection profiles across Coffee Lump Bank. See Figure XI-1 for locations. Vertical lines are shot points, spaced every 500 ft. Spacing of shot points on records varies due to constant recorder speed and variation in ship speed due to wind currents, wind, and seas.

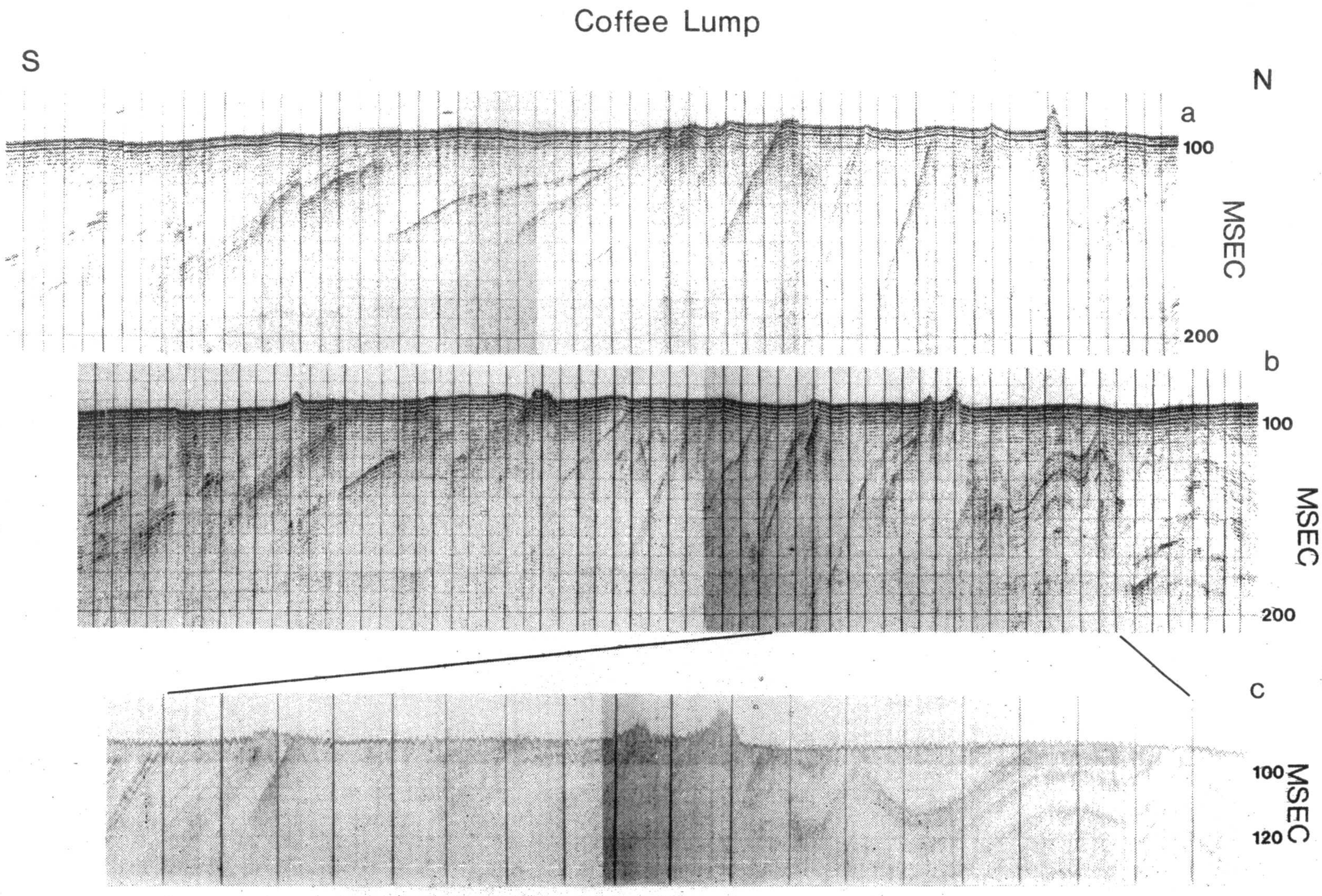

Figure XI-5. N-S boomer (a and b) and 3.5 kHz (c) seismic reflection profiles of Coffee Lump Bank. Profile c is a high resolution 3.5 kHz expanded scale recording of the indicated portion of profile b. Vertical lines are shot points (see Figure XI-4 for explanation).

Truncation of the anticline has resulted from several periods of subaerial exposure during the Late Tertiary and Pleistocene. The present configuration of the bank, except for the central depression, is due to erosion in a thalweg in which the bank was located during an Early Holocene regression. The stream flowing through the thalweg dumped its load into the Gulf of Mexico just to the west of the West Flower Garden Bank, creating a large delta in that area (Henry Berryhill, personal communication).

HAZARDS
(PI: R. Rezak)

Most of the faults on Coffee Lump do not intersect the sea-bottom, except for some of those associated with the central graben and along the margin of the exposed lower seismic sequence (Figure XI-3). Renewed movement on the faults that border the central graben is evidence for continuing dissolution of salt at the crest of the diapir. However, due to the extremely low relief on the bank and the depth to the crest of the salt (100 m or greater), the collapse process should be extremely slow.

Internal reflections on the seismic records are locally "brightened" (Figures XI-4 and 5), possibly indicating the presence of gas within the section, particularly where deeper reflectors appear to be "wiped out." Narrow areas of diffuse reflection patterns within the water column, observed mostly over areas where the lower seismic unit is exposed on the seafloor, could also represent very diffuse gas seepage. The diffuse water column reflections, however, are not well developed, and the apparent bright reflections within the section could be due to lateral facies changes related to discontinuous sand layers.

SEDIMENTOLOGY
(PI: R. Rezak)

It can be clearly seen on the 3.5 kHz profiles (Figure XI-5c) that this region of the seafloor has remained barren of any significant sediment accumulation since erosion of the anticline. Recent deposits are insignificant, except possibly in the depressions and farther out on the flanks of the bank. Direct observations of the bottom during submersible dives 103 and 113 (Figure XI-1), together with four grab samples (Figure XI-1), give some idea of the sediment distribution on the bank. The beginning of dive 113 was at the pipeline intersection on the northwest flank of the bank at a depth of 65 m. At that site, a 76 cm pipeline lay in a trench that had been jetted into the bottom about six months prior to our observations. The walls of the trench were still vertical, and only rare occurrences of caving of the walls were observed. The sediment is a very firm clay except for a thin veneer of very fine sediment lying on the surface. Patterned burrows are extremely abundant on the surface and are present right up to the edge of the trench. The jetting of the trench seems to have had no effect upon the biota. A living sabellid worm was observed in one of the burrows within a foot of the trench. The depth of the trench was about 0.9 m, and the sediment appeared uniform to the base of the trench.

During the transect to the small peak located at the end of dive 113, the sediments became sandy muds and sandy, gravelly muds in the vicinity of rock outcrops. The peak is a drowned patch reef with crusts of coralline algae, sponges, and a few clusters of Madracis. This reef is most probably a veneer that has grown over an outcrop of Tertiary sandstone. On both dives, observations were made of both reef rock and slabby outcrops. The presence of both bare rock outcrops and outcrops capped by reef growth suggests that the bare rock outcrops have been exposed at the seafloor due to recent movement on the central graben boundary faults.

The sediments from the four stations on Coffee Lump are as follows:

Station 1 - muddy sand	Station 3 - muddy, gravelly sand
Station 2 - muddy, gravelly sand	Station 4 - sand

The coarse fraction (> .062 mm) of the sediment consists primarily of quartz sand grains, with minor amounts of mollusc fragments, glauconite, foraminifers, and echinoderm fragments. The quartz and glauconite are the erosion products of the outcrops of Tertiary rocks on the bank. The fine fraction (< .062 mm) consists primarily of smectite, with minor amounts of illite and kaolinite and traces of chlorite in samples 2-4.

CHEMISTRY

(PI's: P. Parker, K. Winters, R. Scalan)

A survey of the levels of petroleum type hydrocarbons in four Coffee Lump sediment samples was made (see also Volume Two, Chapter IX-C).

The high molecular weight hydrocarbon (HMWH) composition, pristane-phytane ratios (Pr/Ph), odd-even ratios (OEP), and GC/MS confirmation of aromatic hydrocarbons were used as indicator parameters of petroleum contamination. Results of the analyses of these samples were similar to the other banks studied and indicate Coffee Lump is relatively clean (see Volume Two, Chapter IX-C, Table IX-C-1).

The range of Delta C-13 values for the samples was -21.00 to -22.53. These values are slightly more negative (approx. 1 per mil) than the 1977 values, but still are consistent with the assessment that Coffee Lump is relatively clean.

The range of the total organic carbon (TOC) values was 0.13 to 0.59%. These TOC values were lower than the values of the other banks, but still consistent with the assessment that Coffee Lump is clean and shows no obvious contamination by petroleum. Of course, TOC is a crude parameter and will only respond to gross contamination.

Overall, the low, but detectable levels of aromatic hydrocarbons, and the slight decrease in Delta C-13 values justify continued monitoring of this environment.

WATER AND SEDIMENT DYNAMICS
(PI: D. McGrail)

Hydrographic sampling at Coffee Lump was carried out on 22 June 1979 at four locations (Figure XI-1). Stations 1 and 2 were occupied twice because of a malfunction of the profiling current meter on the first occupation. The low relief of the bank, combined with the close proximity of the station, rendered the sampling nearly equivalent to a 6 station, 10 hour time series. Plots of all parameters measured at each station appear as Figures XI-6 through 11.

Salinity

The June samples showed that the surface waters over the bank possessed low but highly variable salinities typical of spring and early summer conditions on the Outer Continental Shelf (Smith, 1980). The heavy spring rains of the Gulf Coast produce low salinity coastal water which extends as a thin, patchy lens over the oceanic waters of the shelf. The patchiness of this lens is evidenced by the range of surface salinities in the temperature and salinity (T-S) plots from the Coffee Lump stations (Figure XI-12). This strong surface stratification inhibits wind mixing and keeps the thermocline shallow.

Our previous studies (Bright and Rezak, 1978a, b) show that as the summer progresses, diminution of fresh water runoff, evaporation, and prolonged wind mixing increase the salinity of the surface layer and homogenize it to a depth of 15-20 m. In the late fall, the high winds associated with cold frontal passages stir the waters so deeply that the upper and lower boundary layers merge, resulting in the elimination of stratification over Coffee Lump.

Internal Waves

From the time series plot of the isotherms at Coffee Lump stations (Figure XI-13), it is obvious that a rather complex set of internal waves was passing over the bank during the sampling period. The magnitude of the wave can be seen in the 15 m maximum displacement of the 22°C isotherm over the sampling interval. The divergence of the isotherms at station 4 appears to be a topographic effect. It is remotely possible, however, that the divergence is due to the superposition of a higher frequency, 2nd vertical mode wave on the lower frequency 1st mode wave. The oscillation of the 19°C isotherm, which was in or just above the bottom boundary layer (BBL), was slightly out of phase with that of the isotherms in the thermocline. This deformation of the waveform could have arisen as a result of shoaling or interaction of the wave with a coexisting current.

The internal wave, or waves, exerted a profound influence on the boundary layer and sediment dynamics. At the first occupation of station 1 (0825, 22 Jun 79) the BBL was 12 m thick and essentially isothermal-isohaline. By the time of the second occupation, ten hours later, the identifiable BBL was only 4 m thick, approximately 1°C warmer, and slightly less saline. The change in temperature and salinity of the bottom water appears to be the result of both vertical and horizontal displacement of the water in the BBL as first the crest, then the trough of the internal wave passed over station 1.

The following describes what would be the logical process for producing the step-like structure at the base of the thermocline, such as the one in the temperature profile of station 2A (Figure XI-10). First, as the trough of the wave passes, water relatively high up in the water column is brought into contact with the bottom, then subjected to rapid lateral movement before being displaced upward by the passage of the wave crest. In the process of streaming horizontally over the bottom, the warmer less saline water would be mixed by turbulence and have sediment entrained in it. Finally, as this water is displaced upward, most of the suspended sediment would come out of suspension, and colder more saline water would move in to replace it. This process would account for the small decrease in transmissivity associated with the mixed layer overlying the BBL in profile 2A (Figure XI-10).

Current Velocity Profiles

The velocity profiles at stations 2A, 3, and 4 fit expectations. The currents were vertically sheared with respect to both speed and direction (a characteristic of baroclinic flow fields), and the speeds were in the range commonly observed around the banks. The flow at the bottom of station 4 appears to have been accelerated by convergence over the topography, increasing the speed of the flow just above the bottom to 28 cm/sec. At station 1A, however, the flow was remarkably strong, exceeding 60 cm/sec at both top and bottom. The flow there also displayed much less depth dependence than was observed at the other stations. These aberrations in the currents at station 1A were almost certainly manifestations of the internal waves.

Transmissivity

Transmissivity in the surface waters varied considerably from station to station. Low surface transmissivity values are usually associated with high concentrations of plankton. The variability observed suggests that the distribution of the plankton was quite patchy during the sampling interval.

The transmissivity profiles provided several pieces of information. At stations 1, 1A, 2A, and 3, the top of the nepheloid layer was coincident with the top of the BBL in spite of the fact that the bottom current speeds varied from 11 cm/sec to 68 cm/sec and the top of the BBL varied from 4 m to 12 m height above the bottom. The absence of a nepheloid layer at station 4 appears to have resulted from a compression of the boundary layer over station 4 (see Figure XI-13) and the absence of silt and clay in the substrate. Station 4 is the only one at Coffee Lump which did not possess significant quantities of fine

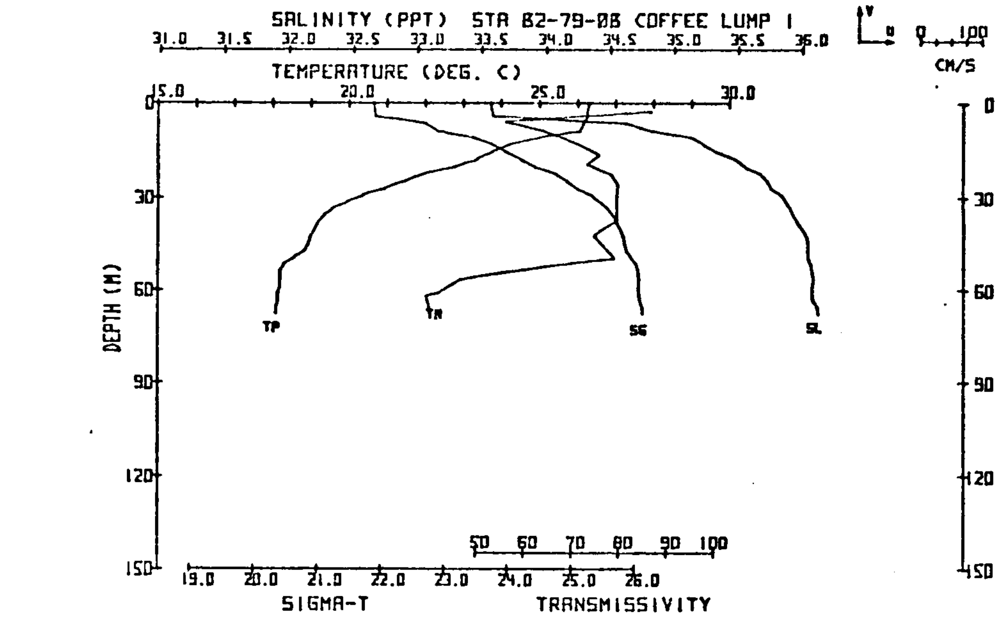

Figure XI-6. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 1.

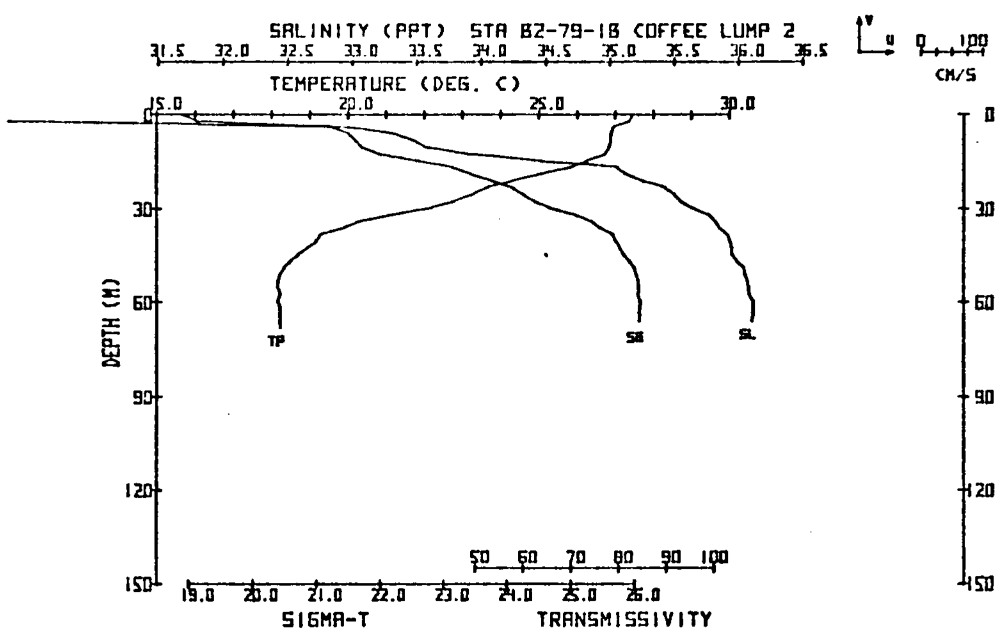

Figure XI-7. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 2.

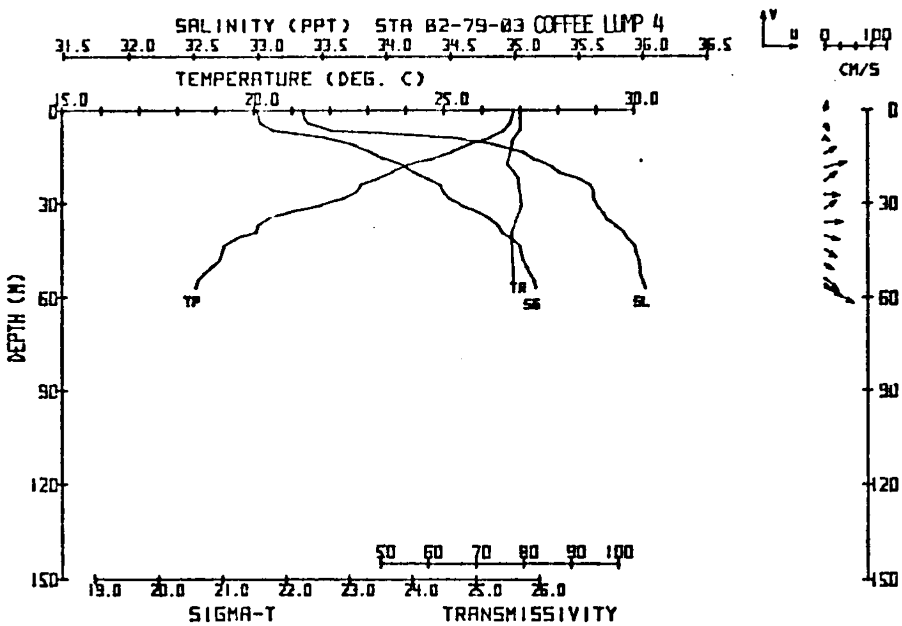

Figure XI-8. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 4.

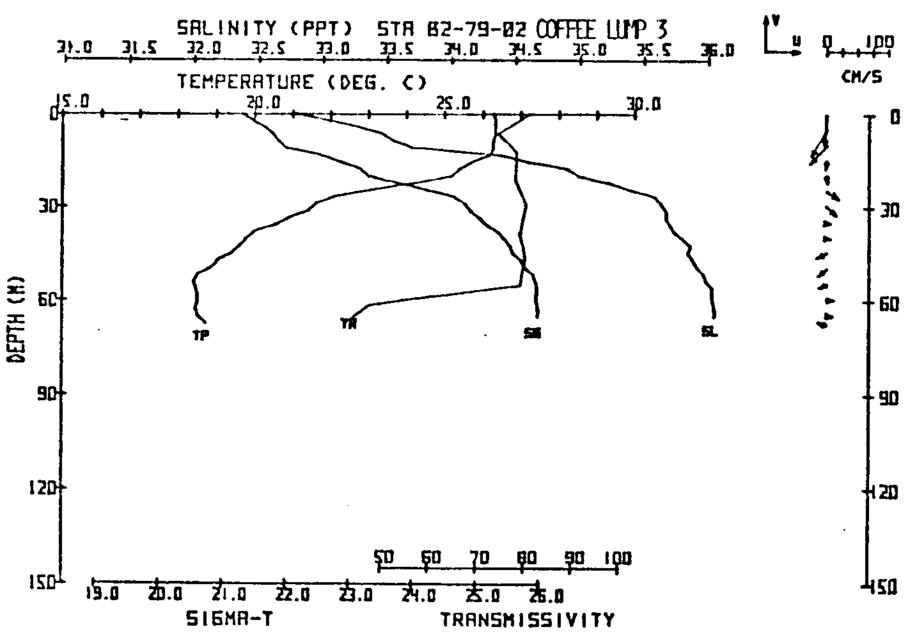

Figure XI-9. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 3.

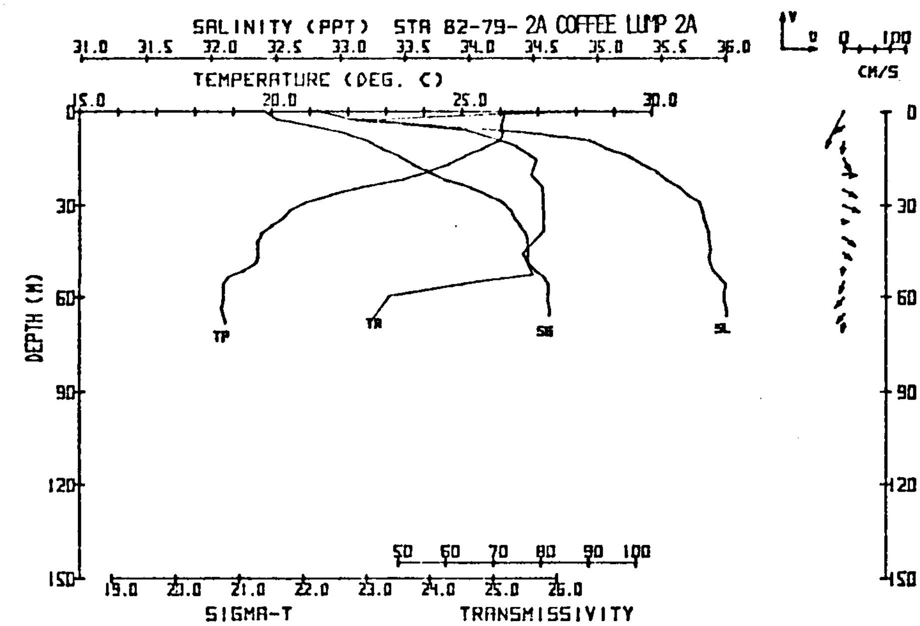

Figure XI-10. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 2A.

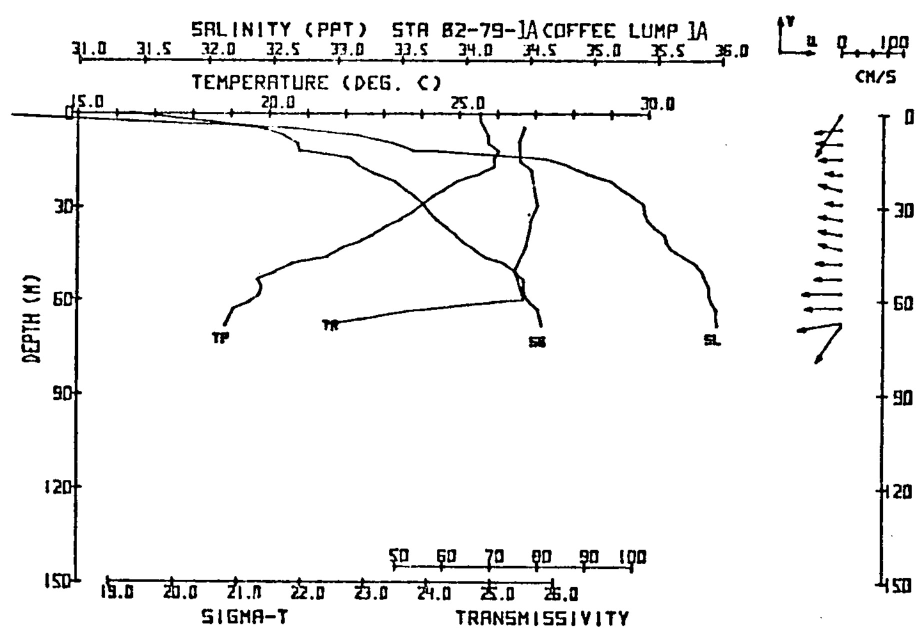

Figure XI-11. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Coffee Lump 1A.

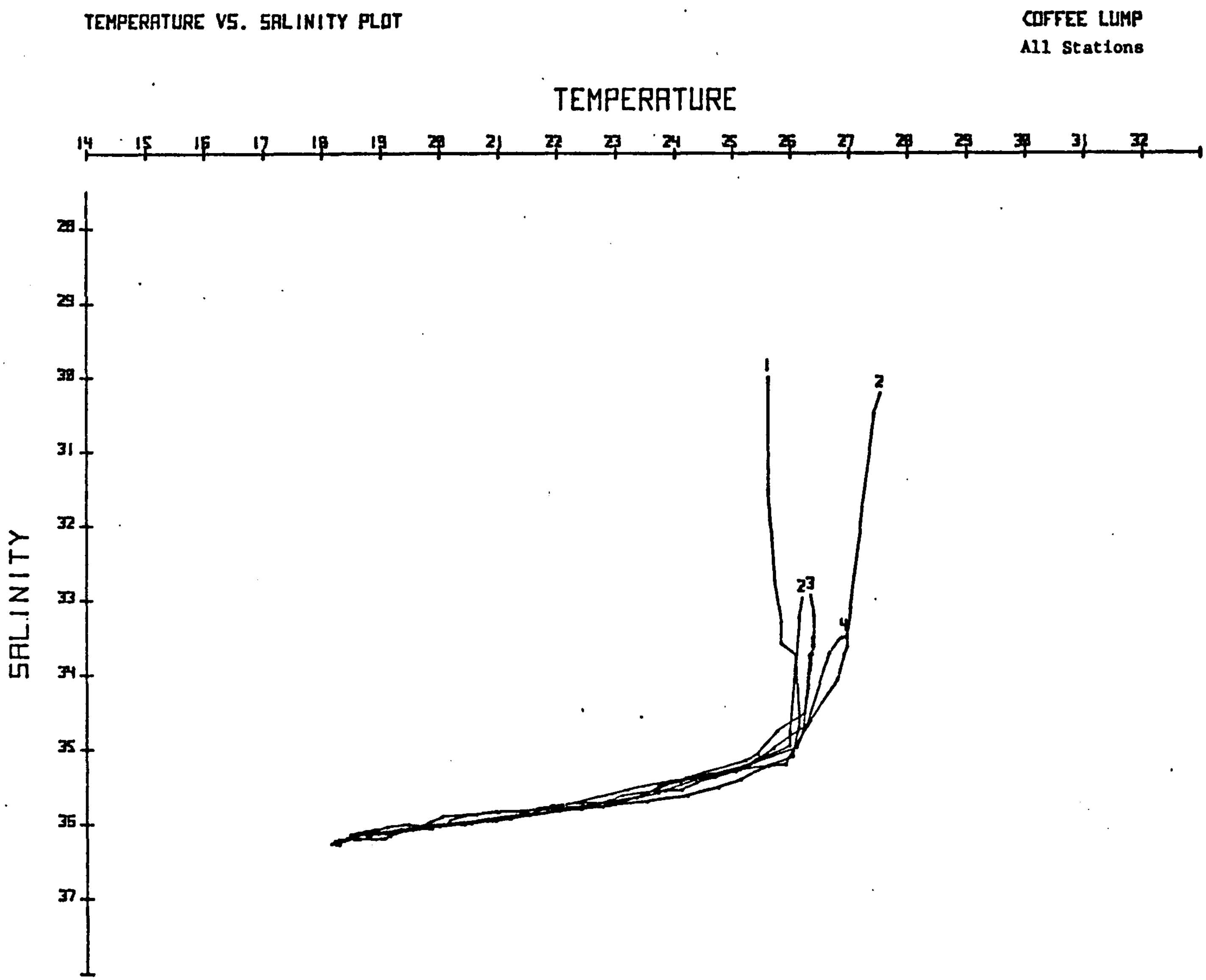

Figure XI-12. Temperature vs. salinity plot for all stations at Coffee Lump.

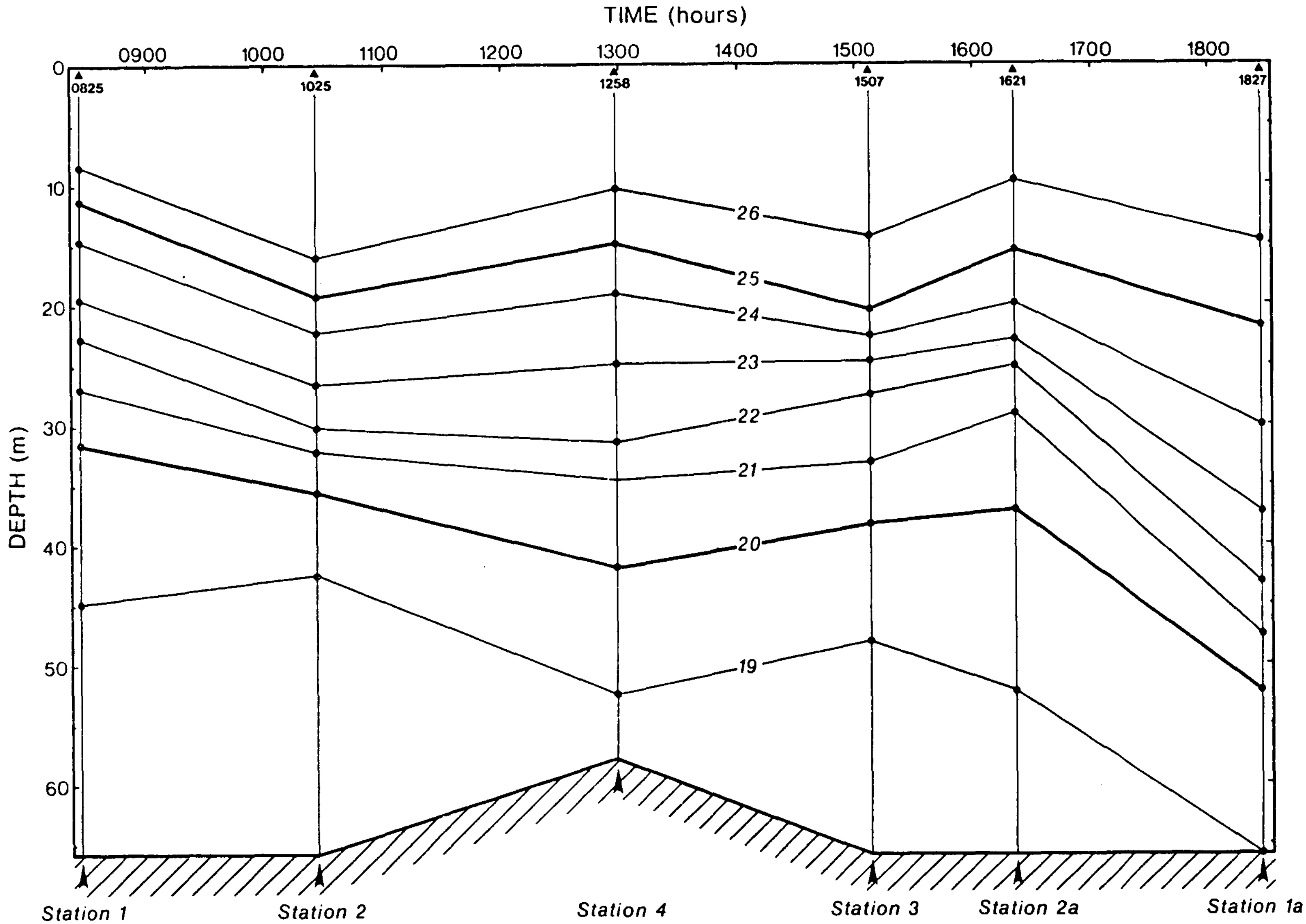

Figure XI-13. Plot of isotherm depths vs. time for all six Coffee Lump stations. Hatched line at base of figure represents the seafloor.

sediment. The compression of the BBL at station 4 depressed the sediment-laden waters of the nepheloid layer beyond the station depth, bringing clear waters from higher in the water column into contact with the bank. Even though the velocities at station 4 were sufficient to resuspend fine sediment, none was present for resuspension. It is quite likely that if the internal wave had been in a different phase at the time of sampling, a nepheloid layer would have been present from laterally advected waters.

From these observations, it appears likely that Coffee Lump is completely enveloped in a nepheloid layer most of the time. Topographically accelerated flow would, however, inhibit accumulation on the uppermost portions of the bank.

BIOLOGY

(PI: T. Bright)
(Figures XI-14 through 17, Table XI-1, and Appendix D, Table XI-1)

The submersible transect made for the purpose of determining the nature of benthic communities occupying Coffee Lump ranged between 59.5 and 67.7 m depth. Most of the bottom traversed on the biological dive was composed of an unconsolidated mixture of clay, silt, sand, shell and rubble (64.0 to 67.7 m depth), with occasional large boulders a metre or so across and a half a metre high. Two major hard-bottom features were encountered. One was a reef-like carbonate rock ledge (62.5 to 65.5 m depth)(Figure XI-14) and the other a large, almost horizontal, slabby outcrop of siltstone (59.5 to 64.0 m depth).

Where the soft-bottom consists of substantial amounts of sand, shell, and rubble there is a predominance of antipatharian whips (*Cirripathes* sp.); Comatulid crinoids; large asteroids such as *Narcissia trigonaria* (Figure XI-17) and *Goniaster* sp.; the urchin *Clypeaster ravenelii*; the sea cucumber *Isostichopus badionatus* (Figure XI-16); small branching corals; small benthic fishes, and an enormous population of minute crustaceans, including pagurid (hermit) crabs, "decorator" crabs, other brachyuran crabs, and small anomurans.

The extremely large populations of small fishes and crustaceans on the soft-bottom above 68 m are significant. These organisms may be the most abundant on Coffee Lump. They are closely associated with the innumerable small burrows on the bank and were seen producing tracks and trails in the sediment. These animals must be a major source of food for larger fishes and other predators occupying the bank.

The assemblage of organisms inhabiting hard-bottoms above 68 m depth at Coffee Lump is similar in composition and structure to assemblages encountered on South Texas OCS fishing banks such as Southern and South Baker Banks. The most conspicuous, predominant, and abundant organisms are antipatharian whips (*Cirripathes* sp.), comatulid crinoids, encrusting coralline algae, sponges (including a large population of *Ircinia campana*), large hydroids, and fragile white "bushes" of serpulid worms (?*Filograna* sp.)(Figure XI-14, and Appendix D, Table XI-1).

Coralline algae cover up to 30% of the rocks at the tops of outcrops or ledges. Cobble-sized rocks lying on the soft-bottom frequently bear small patches of coralline algae on their upper surfaces.

A significant population of hermatypic agariciid corals was detected on the shallower parts of the larger hard-rock structures (59.5-64 m depth). Other small branching corals were seen on the hard-bottom, and solitary corals almost certainly occur there. Those parts of the rocks not covered by corals, coralline algae, or encrusting sponges are generally laden with sediment veneers or a sediment-epifauna mat (Figure XI-15).

Most of the larger fishes seen were associated with the hard-bottom. Predictably, the Yellowtail reeffish, Chromis enchrysurus, are the most abundant. Schools of Vermilion snapper, Rhomboplites aurorubens, were present. Other fishes recorded are typical of hard-bottom at these depths throughout the northwestern Gulf of Mexico (Table XI-1).

CONCLUSIONS AND RECOMMENDATIONS

Coffee Lump is a relatively inactive bank that is underlain by a salt diapir that has not moved upward appreciably since Late Pleistocene time. The removal of salt by phreatic marine waters from the crest of the bank has been minimal, as evidenced by the low relief at the crest of the bank.

The bank is continually immersed in a nepheloid layer, and the fauna and flora of the bank are similar to those of the South Texas OCS fishing banks, which are also immersed in a nepheloid layer.

Preliminary analysis of community structure indicates that above 68 m, at least, Coffee Lump harbors a soft-bottom macro-epifaunal community which is distinctly bank-related and differs substantially from soft-bottom epifaunal communities found adjacent to banks in the northwestern Gulf of Mexico. The upper Coffee Lump soft-bottom communities appear to be more diverse and to harbor a greater abundance of organisms than is typical of off-bank, soft-bottom communities.

Biotically, the hard-bottom is an Antipatharian Zone, harboring an assemblage of organisms very similar in composition to those of the South Texas fishing banks. The distribution of such hard-bottom epibenthic communities on Coffee Lump is probably coincident with the bottom irregularities detected in side-scan sonar records.

Coffee Lump is a low priority bank similar to the South Texas banks, and **no restrictions to hydrocarbon exploration and production activities are required.**

TABLE XI-1

ORGANISMS OBSERVED AT COFFEE LUMP, WITH INDICATION OF APPARENT RELATIVE ABUNDANCE

LEGEND

1-Present 3-Abundant
2-Significant Population 4-Numerically Predominant

Organism	Relative Abundance	
	Hard-Bottom	Rubble Strewn Soft-Bottom
Coralline algae	3	2
Sponges		
Ircinia campana	3	2
Neofibularia nolitangere	1	2
Callyspongia sp.	1	
other sponges	4	2
Coelenterates		
agariciid corals	2	
branching corals	1	3
solitary corals		2
muricid alcyonarians	1	
paramuricid alcyonarians	2	1
other alcyonarians	1	
large hydroid colonies	3	1
large anemones		1
antipatharians (Cirripathes sp.)	4	4
Molluscs		
Spondylus americanus	2	2
Lyropecten nodosus	1	1
Arcidae		2
Pteria sp.?	1	
auger or turret shell	1	4
Conus daucus	1	2
Murex sp.	1	
Fasciolariidae	1	
Echinoderms		
ophiuroid		1
Narcissia trigonaria		3
Goniaster sp.		3
Astropecten sp.?		1
Diadema sp.		2
Arbacia sp.?	1	
Stylocidaris sp.		2
Clypeaster ravenelli		3
Isostichopus badionotus	2	3
comatulid crinoids	4	3

Organism	Relative Abundance	
	Hard-Bottom	Rubble Strewn Soft-Bottom
Bryozoans		
Holoporella sp.	2	2
white branching	2	2
Polychaetes		
white "bushy" serpulid	3	2
"feather dusters"		1
Crustaceans		
small pagurid crabs		4
small brachyuran crabs		4
Stenorynchus sp.	2	2
large portunid crab		1
small anomurans		2
small shrimp		1
Active bioturbation		
patterned burrows	2	4
tracks and trails	2	4
Fishes		
Holocentrus spp.	2	
Lutjanus sp.	1	
Rhomboplites aurorubens	3	
Pomadasyidae	2.	
Calamus	2	
Priacanthus sp.	2	2
Apogon sp.	2	
Mycteroperca sp.	1	1
Serranus phoebe	2	3
Liopropoma eukrines	2	
Equetus umbrosus	2	
Equetus lanceolatus	2	
Chromis enchrysurus	3	
Chaetodon sedentarius	2	1
Holacanthus bermudensis	1	
Bodianus pulchellus	2	
Synodontidae		2
Triglidae		2
Seriola sp.	2	1
Bothidae		2
Sphaeroides sp.?		2
Canthigaster rostrata	1	
Acanthostracion sp.	1	1
very small fishes		4

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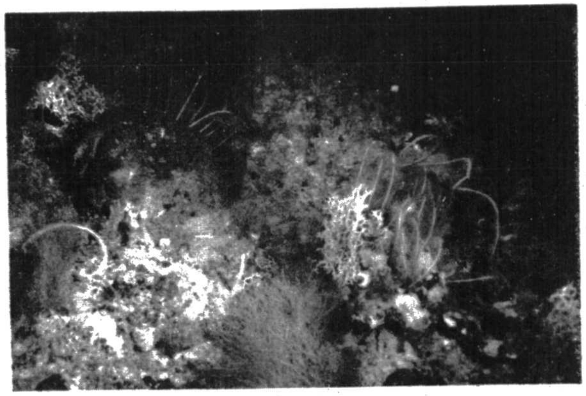

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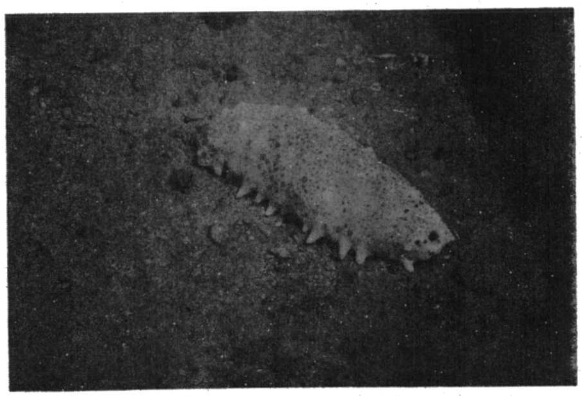

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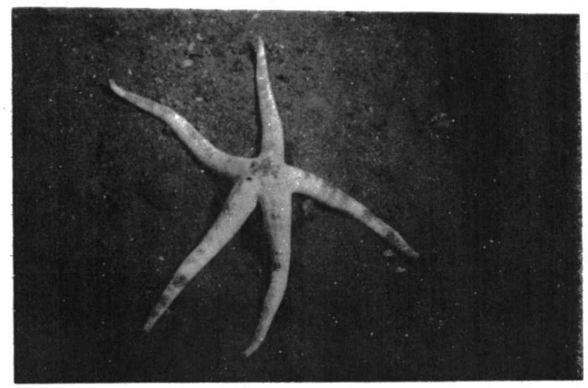

Figure XI-14 (UL). Coffee Lump: hard carbonate structure bearing diverse assemblage of epifauna including antipatharians, hydroids, sponges, crinoids, serpulid worms, and others.

Figure XI-15 (UR). Coffee Lump: sediment-covered hard substratum (non-carbonate). Large fish is *Priacanthus*.

Figure XI-16 (LL). Coffee Lump: *Isostichopus* on level bottom which comprises most of top of Coffee Lump. Note fecal cast produced by the sea cucumber, lower right.

Figure XI-17 (LR). Coffee Lump: *Narcissia trigonaria* on level bottom at Coffee Lump.

CHAPTER XII

FISHNET BANK

R. Rezak, T. Bright, D. McGrail,
T. Hilde, G. Sharman, L. Pequegnat

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Fishnet Bank included mapping and sub-bottom profiling and hydrographic sampling. Results of these studies are presented under the headings Structure and Physiography, Hazards, Sedimentology, Water and Sediment Dynamics, and Biology.

GENERAL DESCRIPTION

Fishnet Bank is located at 28°09'N latitude and 91°48'30"W longitude (Volume One, Figure III-1). The bank lies in the northeastern quarter of Block 356 in the Eugene Island Area. It is the smallest of the eight banks mapped, covering only 1.9 km^2. The bank is nearly circular, with a relatively flat crest that lies at depths of 66-70 m. A raised rim along the southeastern and southern margins of the bank appears to be a reef build-up. Three separate peaks on that reef attain minimum depths of just greater than 60 m. Surrounding water depths are about 78 m on all sides of the bank. An east-west channel, 78-79 m deep, extends along the base of the north side of the bank (Figure XII-1).

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Two patterns of local relief are found atop Fishnet Bank: 1) a fringing reef pattern along the southern and southeastern perimeter of the bank, and 2) ellipsoidal patterns suggesting bedding outcrops resulting from the truncation of the underlying domal uplift.

The fringing reef occupies the break in slope at the margins of the relatively flat top of the bank. It is characterized by moderate relief (1-3 m) and high spatial density (> 10 features/hectare) in a narrow band, generally less than 100 m wide. The reef can be mapped as a continuous feature, with the exception of the northwest side of the bank (Figure XII-2). The ellipsoidal outcrop patterns are caused by steeply dipping, erosionally truncated sedimentary beds in the central part of the bank. These features have less than one metre of relief and appear as concentric patterns on the seafloor roughness map (Figure XII-2).

Two seismic units were mapped on Fishnet Bank: 1) the acoustic basement, which is the main body of the bank, and 2) the surrounding, uppermost sedimentary unit (Figure XII-3). Additionally, carbonate reef areas were identified. It is difficult to recognize internal structure in the acoustic basement unit because of the surface multiple train of the boomer signal source (Figure XII-4a).* Steeply dipping beds, however, do appear on the 3.5 kHz record (Figure XII-5a).

The sediment sequence mapped around the margins of the bank onlaps the bank and underlying sediments and appears to be only slightly tilted upward towards the bank (Figures XII-4 and 5). This suggests that uplift of the bank was nearly completed prior to deposition of this sequence.

The sequence below the mapped unit is truncated by an angular unconformity that appears to have formed at the same time as the truncation of the beds that crop out on the top of the bank. This sequence is severely fractured by a pattern of radial faults. Many of these faults extend into the acoustic basement unit of the bank proper, as demonstrated by the discontinuous pattern of outcrops in Figure XII-2. These faults were formed due to the doming of the strata overlying the salt diapir as it was rising. The faults and their associated sediments were truncated during the Late Wisconsin low stand of sea level. With the beginning of the Holocene transgression, deposition of the overlying sediments began to bury the unconformity. Renewed movement on the faults in Recent time has displaced the unconformity and created broad, shallow depressions on the seafloor.

The renewed movement on the faults varies in direction from place to place on the diapir. On line 4 (Figure XII-4b), which lies to the west of the bank, the sense of the movement is upward toward the crest of the dome. On line 9 (Figures XII-4d and 5b), which lies to the east of the bank, the sense of movement is downward toward the crest of the dome. This difference in relative movement implies a shift in the geographic location of the center of uplift of the diapir.

HAZARDS
(PI: R. Rezak)

Fishnet appears to be a rejuvenated dome with the locus of uplift having moved to the southwest. Renewed movement along faults should be expected to continue for some time to come. Both upthrusting of the diapir below the southwest margin of the bank and collapse structures in off-bank areas to the north and east should be expected.

A diffuse pattern of reflections within the water column over the bank proper is observed in all of the boomer crossings of the bank (Figure XII-4a and c). This is in sharp contrast to those crossings off the margins of the bank, which show considerably less of this

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*For the sections of seismic reflection profiles shown in Figures XII-4 and 5, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

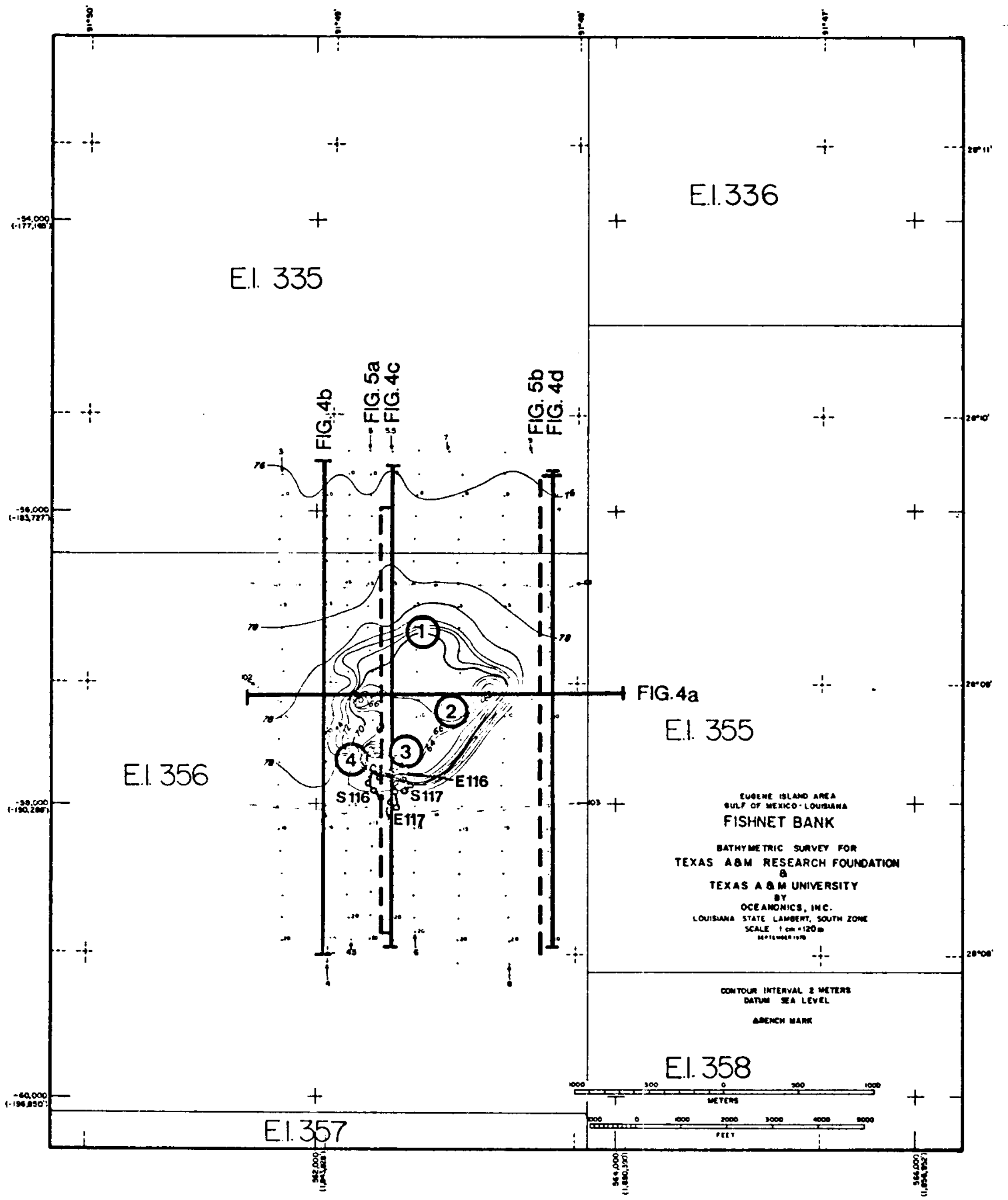

Figure XII-1. Bathymetry of Fishnet Bank. Location and number of boomer and 3.5 kHz seismic reflection profiles shown in Figures XII-4 and 5. Submarine transects, dives 116 and 117: S = Start, E = End. Sample stations: 1-4.

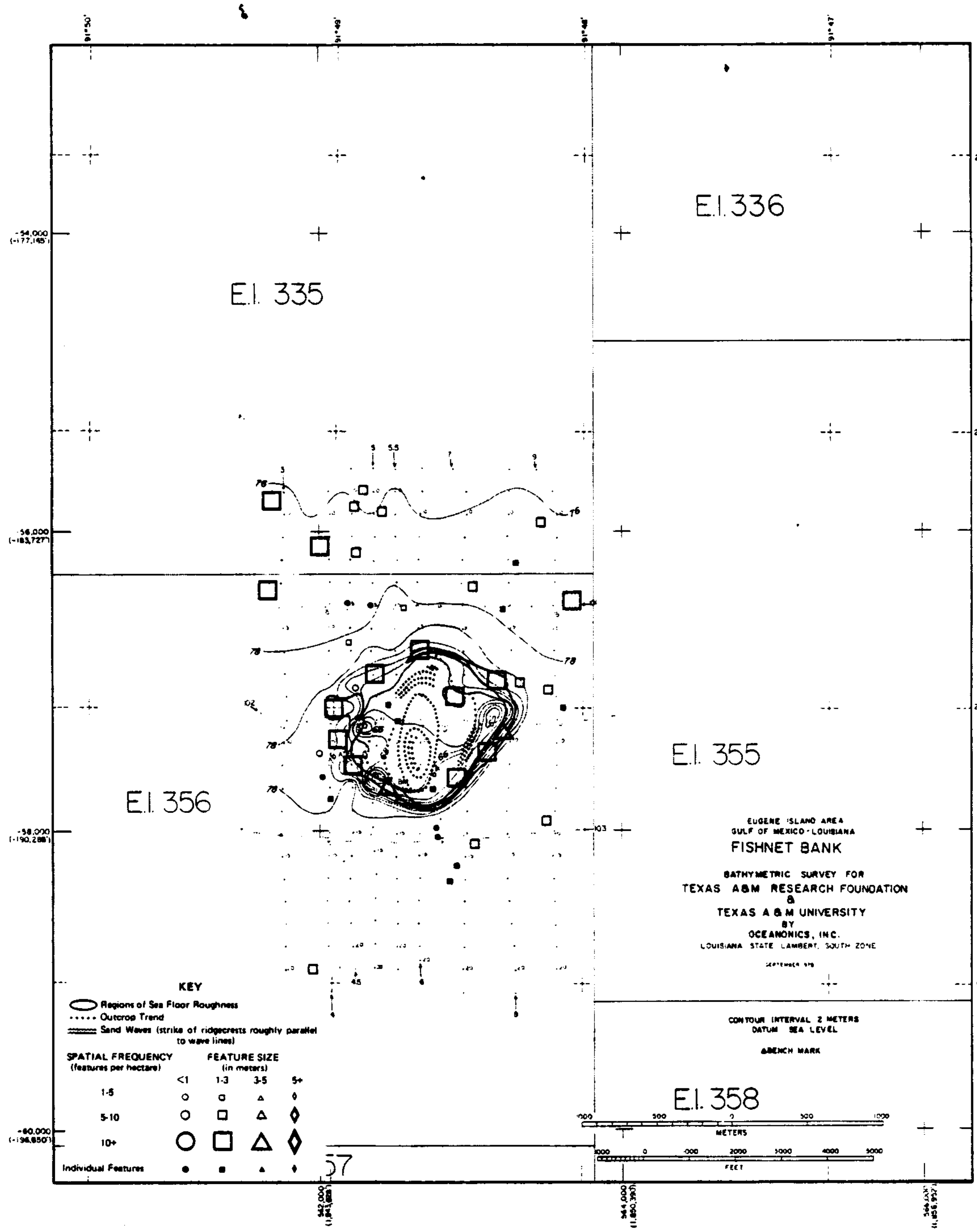

Figure XII-2. Seafloor roughness, interpreted from side-scan sonar records.

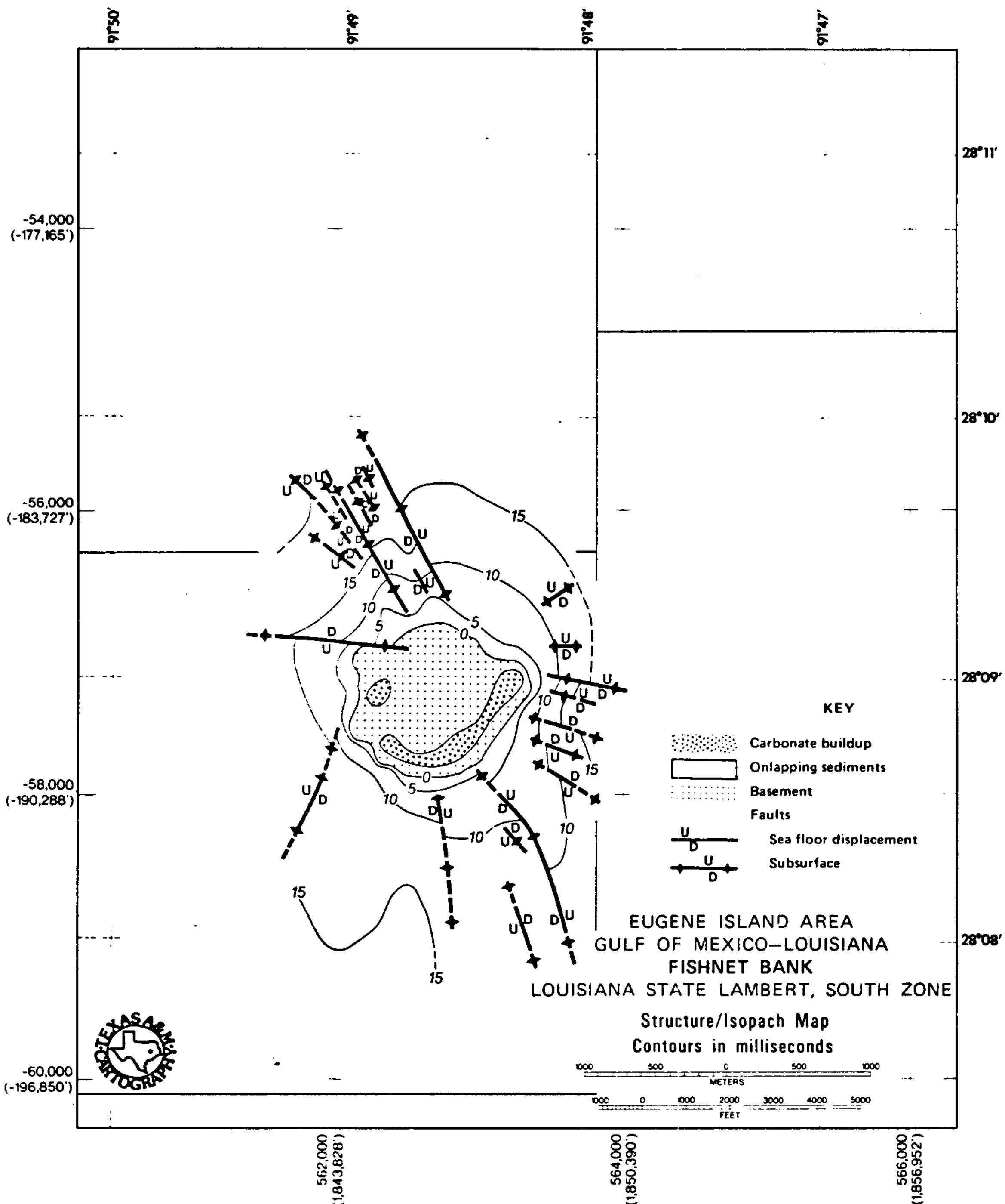

Figure XII-3. Structure/isopach map of Fishnet Bank. Contours represent thickness of the uppermost, surrounding, and onlapping sedimentary seismic sequence.

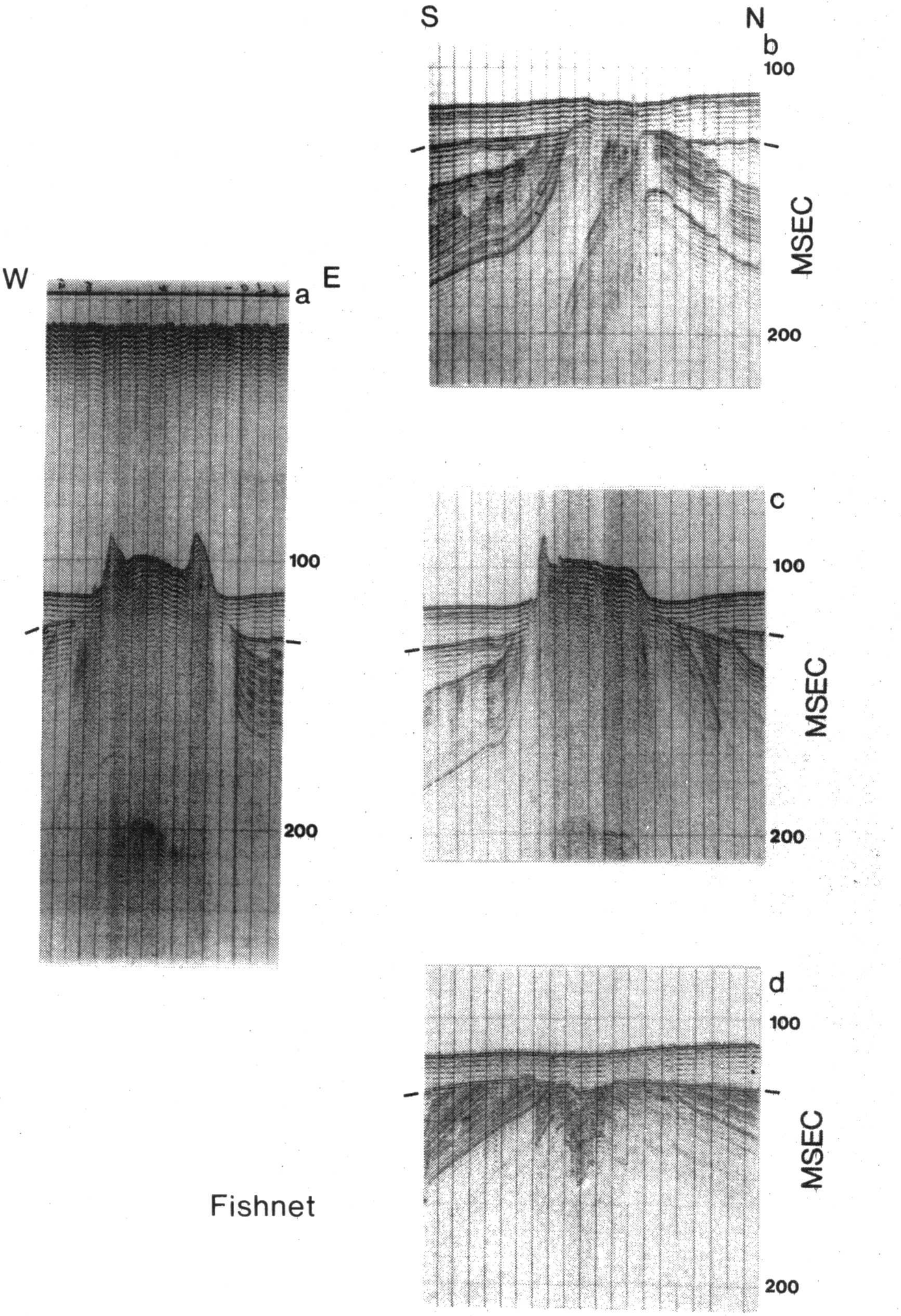

Figure XII-4. Boomer seismic reflection profiles. Locations are indexed on Figure XII-1. The base of the contoured sequence (mapped in Figure XII-3) is indicated along the record margins.

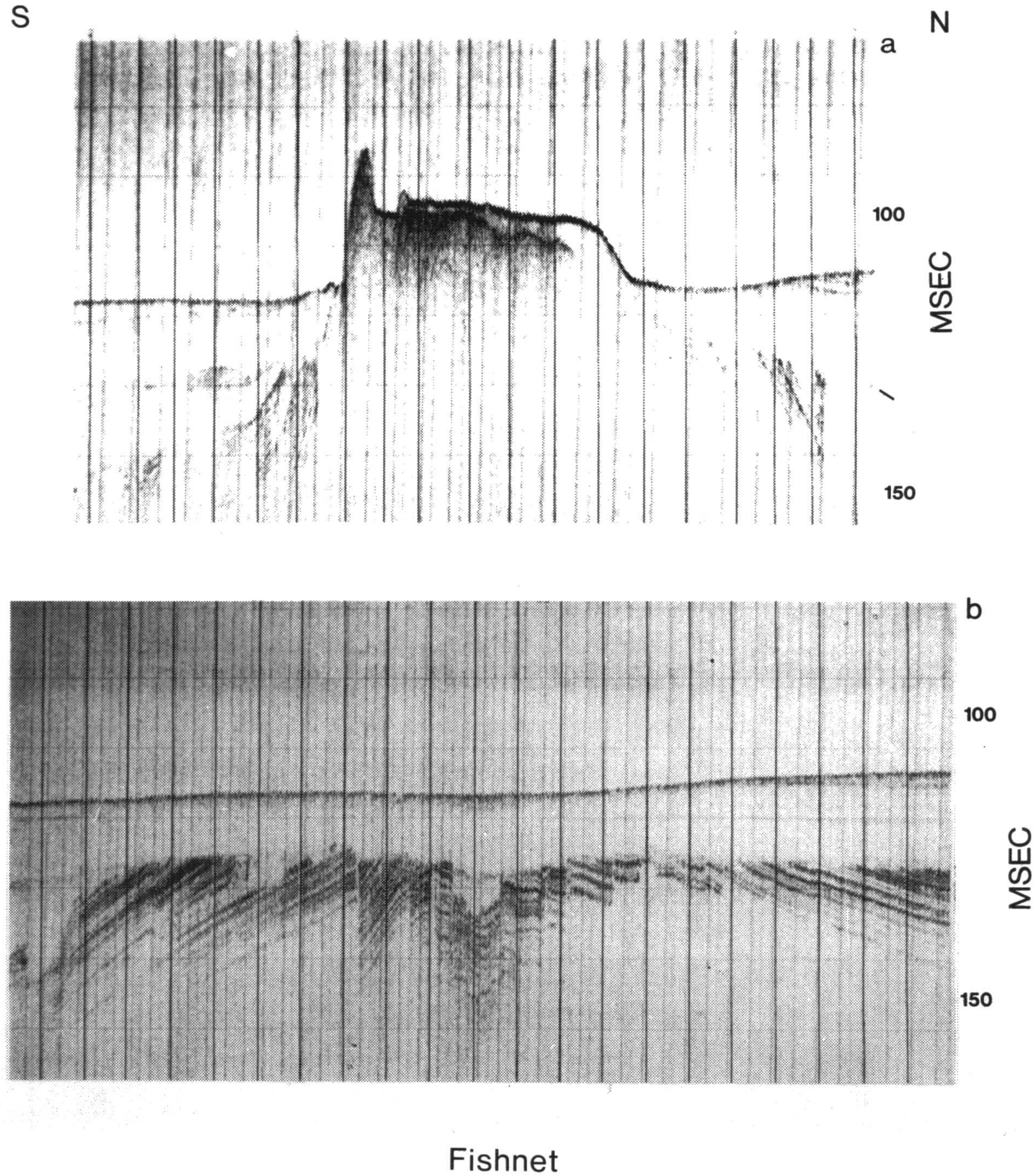

Figure XII-5. The 3.5 kHz seismic reflection profiles. See Figure XII-1 for locations and Figure XII-4 for other information.

pattern (Figure XII-4b and d). Wipe-out of bedding reflectors due to the presence of gas is also displayed on the sub-bottom profiles. While there are no obvious vents, it does appear that Fishnet Bank is seeping a considerable amount of gas into the water column. In June 1974, W.E. Sweet observed gas seeps on the bottom (unpublished data).

SEDIMENTOLOGY
(PI: R. Rezak)

The 3.5 kHz profiles and side-scan sonar records indicate a lack of sediment cover at Fishnet Bank (submersible transects made during 1974 and 1978). The only location information for the 1974 dive is that it was made on the southwest margin of the bank. W.E. Sweet's log of a dive on 20 June 1974 indicates that along the southwest side of the bank, where maximum relief occurs, there is a high blocky ridge (unpublished data). Numerous large blocks had broken off the ridge and slumped down the flanks of the bank. Other discontinuous ridges were noted on the bank. On the top of the bank, a thin veneer of fine sediment overlies a fairly hard substrate composed of shale. Sweet reported that the top of the nepheloid layer was encountered at a depth of 79 m and that the visibility at 82 m was about one metre.

During dive 116 on 13 October 1978, the top of the nepheloid layer was at a depth of 61 m. The bottom at the beginning of the dive was at 78 m and consisted of a very fine, easily suspended mud with shell hash and finger coral fragments on the surface. On the way up the slope, large blocks of rock were encountered, similar to those described by Sweet. The top of the talus slope lies at 70 m depth. From that point to the top of the ridge, at a depth of 64 m, the rock forms a vertical cliff. All of the rocks encountered during dive 116 were Tertiary bedrock. On dive 117, two peaks were observed that are quite different from the ones seen on dive 116. The peaks consist of cavernous rocks that resemble the drowned reefs that have been observed on other banks. Both bare rock outcrops and drowned patch reefs occur on Fishnet Bank.

Four grab samples were taken at Fishnet Bank (Figure XII-1), and a sediment sample was taken during dive 116 at a depth of 82 m near the base of the talus slope south of the southwest peak. The sediment types are: gravelly, sandy mud (stations 1, 2, 3) and sandy, muddy gravel (station 4).

Sediment texture parameters are listed in Appendix A, Tables III-1 through 5. The coarse fraction consists of molluscs, foraminifers, lithoclasts, and quartz sand grains. X-ray diffraction analysis of this size fraction shows low-Mg calcite to be the most abundant mineral, with high-Mg calcite, aragonite, quartz, and dolomite following in that order. The low-Mg calcite, quartz, and dolomite are derived from erosion of the bedrock outcrops on the bank. The high-Mg calcite, aragonite, and a small amount of the low-Mg calcite represent the skeletal composition of carbonate-producing organisms living on the bank at the present time. Clay mineral analysis of the fine fraction (< .062 mm) shows the clays to be normal for this part of the Gulf of of Mexico. Smectite is the most abundant clay mineral, with minor amounts of illite and kaolinite. Traces of chlorite were found in samples 1 and 3.

WATER AND SEDIMENT DYNAMICS
(PI: D. McGrail)

In spite of the availability of fine sediment in the substrate at all of the Fishnet Bank stations (Figure XII-1), only station 4 had a well developed nepheloid layer. It should be noted that station 4 was also the only one with a distinct, homogeneous bottom boundary layer (BBL). These two attributes are, of course, related. Both the mixing of the water in the BBL and suspension of fine sediment there are due to turbulence. The turbulence is induced by the adhesion of water molecules to one another (viscosity) and to the bottom, under flow conditions. That is, when the main body of the water is moving horizontally, the water at the sediment-water interface sticks to the bottom, causing a torque to develop, leading to rotation in the fluid. This rotation takes place as turbulent eddies. The greater the velocity differential between the near-bottom water and that just above it, the more intense the turbulence. The eddies act as momentum and material transporters in the BBL. They move low velocity bottom water up into the water column and high velocity water down to the bottom, where its velocity is scrubbed off by molecular friction. When the turbulence is sufficiently intense, it overcomes the electrostatic and gravitational forces binding silt and clay particles to the bottom, causing erosion and suspension of sediment. It may also overcome the buoyant forces present in a stably stratified fluid and mix it.

A finite amount of time is required for a flow to fully develop its turbulence. This feature is the probable explanation for the lack of a nepheloid layer and mixed BBL in stations 1, 2 and 3 of Fishnet Bank. The picture portrayed by the station data (Figures XII-6 through 9) is that of a developing ebb tidal current, modified by local topography. High tide at Galveston on 23 June 1979, the day the sampling at Fishnet was accomplished, was at 1327 CDT. At Fishnet it would have been about three or four hours earlier. At 1052, when station 1 was taken, the flow in the upper 16 m was northerly. Below that the flow swung to the east and increased in velocity with depth. At station 2 the northerly flow was restricted to the upper 8 to 10 m, below which strong easterly flow was developing. Maximum near-bottom currents possessed speeds of approximately 40 cm/sec. By the time station 3 was taken, 1227 CDT, the flow was to the east-southeast throughout the water column, with speeds greater than 60 cm/sec below 35 m. An hour and a quarter later, when station 4 was taken, the speed had slacked somewhat so that flow in the lower 10 m was under 50 cm/sec. Sufficient time had elapsed by then for this high speed flow to fully develop a sediment-laden, mixed BBL.

Even though an extensive nepheloid layer was not observed during the extremely limited hydrographic sampling, it is obvious that the nepheloid layer frequently envelops this low relief bank. There are two sources of evidence for this conclusion: 1) R. Rezak's observations from the submersible (October 1978), when the nepheloid layer

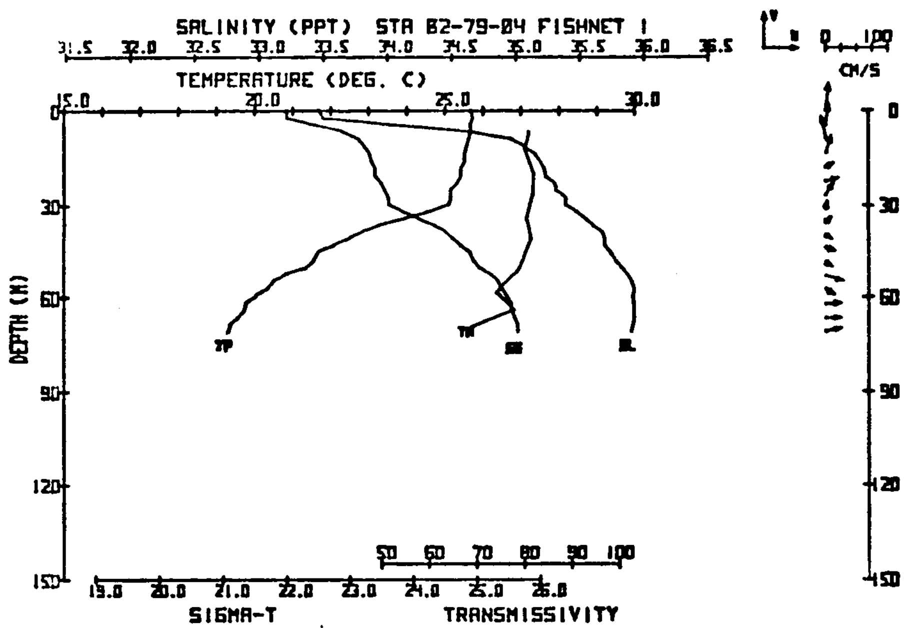

Figure XII-6. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Fishnet 1.

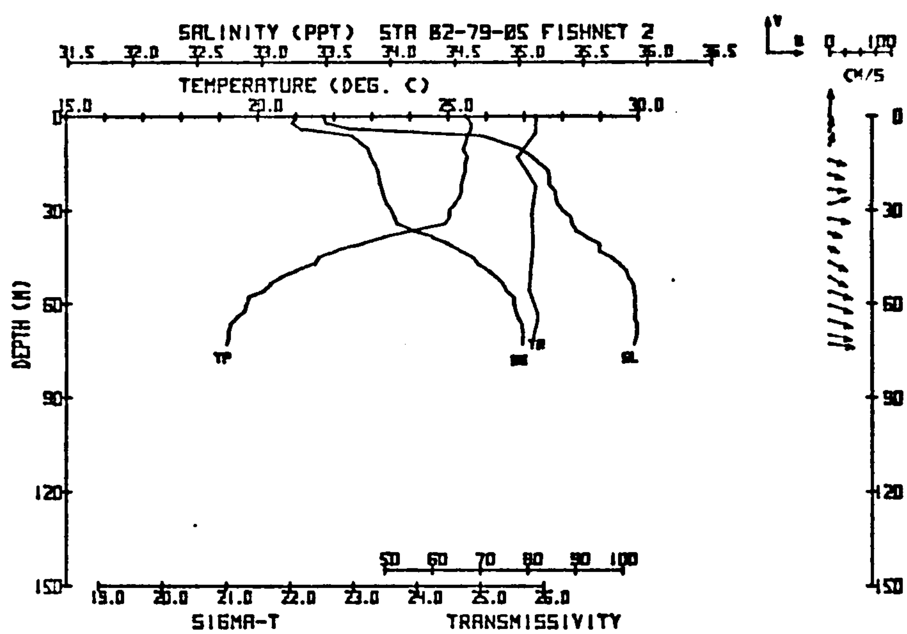

Figure XII-7. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Fishnet 2.

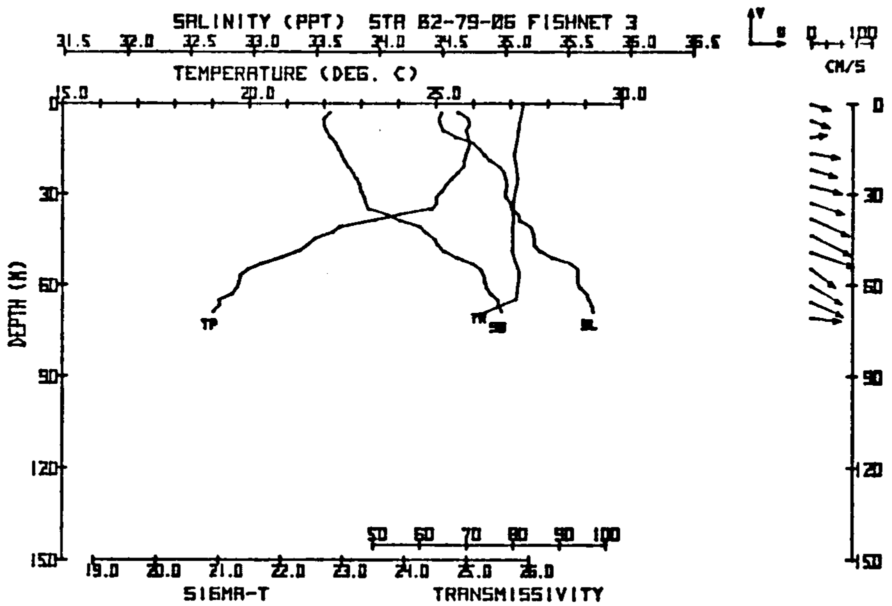

Figure XII-8. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Fishnet 3.

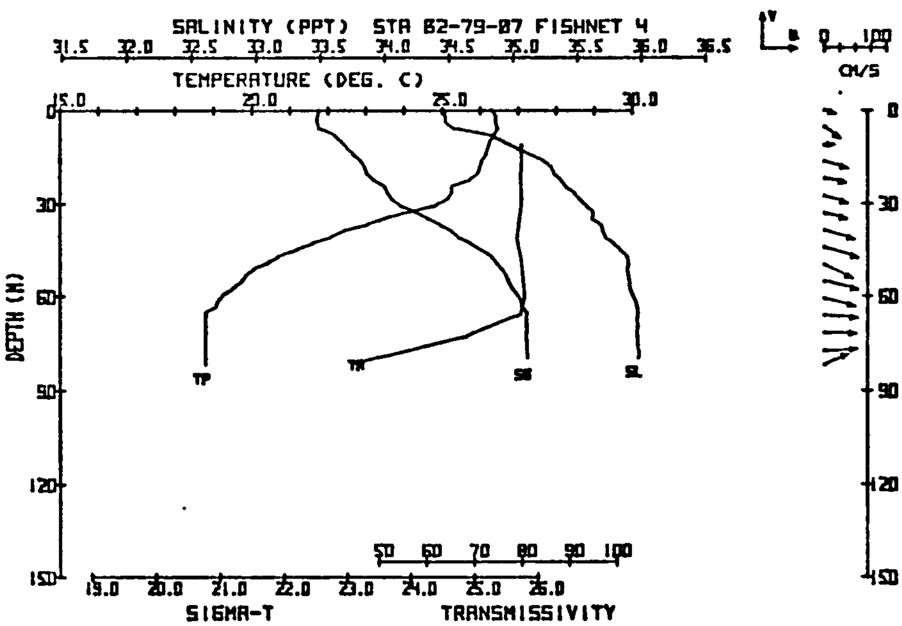

Figure XII-9. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Fishnet 4.

was encountered at a depth of 61 m; and 2) the presence of silt and clay in all of the grab samples at the bank. The first observation demonstrates that a nepheloid layer has enveloped the bank; the second implies that this happens often enough for material to settle out of the nepheloid layer and accumulate.

At all of the stations, the bottom-most velocity vectors were nearly parallel to the local isobaths. The lower bottom temperatures at station 4, however, imply that some upslope transport had taken place.

BIOLOGY
(PI: T. Bright)
(Appendix D, Table XII-1)

The upper platform of Fishnet Bank (70-75 m) is covered by a mixture of sediment varying from cobble size to clay size. The general appearance is of a rubble-strewn bottom covered everywhere by a veneer of very fine sediment. Outcrops and apparent drowned reefal structures of several lithological types are numerous, varying in height from less than 1 m to over 7 m above the surrounding bottom. Chronic high turbidity, sediment resuspension, and settlement on the bank are indicated by the fine sediment veneer and the poor visibility encountered during the reconnaissance dives.

The assemblage of benthic organisms occupying Fishnet Bank appears to be of low diversity and limited abundance, as is typical of turbid water hard-bottom communities in the northwestern Gulf of Mexico. The upper bank may be loosely classified as an Antipatharian Zone, employing the scheme we have used for other banks in the region (see Volume One, Chapter IV).

Small patches of crustose coralline algae occur on the upper portions of outcrops and drowned reefs above 70 m depth but are not significant elsewhere. No other algae were encountered.

Large comatulid crinoids, basket stars (Astrophyton?), and antipatharians of the genus Cirripathes are the most conspicuous invertebrates due to their large size and abundance. The basket stars are generally restricted to the larger outcrops and drowned reefs and are particularly numerous at the crests of such structures. Encrusting, massive and tubular sponges are present on rocks, as are several species of alcyonarians.

Only 17 species of fish were seen on the bank, most associated with the larger rock structures. Typically, Holanthias martinicensis (Rough tongue bass) and Chromis enchrysurus (Yellowtail reeffish) are the most numerous on the rocks (66-73 m). Schools of Vermilion snapper (Rhomboplites aurorubens) and Creolefish (Paranthias furcifer) were seen. Other fishes frequenting the rocks include the Bank butterflyfish (Chaetodon aya), Queen angelfish (Holacanthus ciliaris), Blue angelfish (Holacanthus bermudensis), Wrasse bass (Liopropoma eukrines), Cottonwick (Haemulon melanurum), Bigeye (Priacanthus sp.), Cubbyu (Equetus umbrosus), snappers (Lutjanus sp.), and small scorpionfishes

(Scorpaenidae). The Tattler (*Serranus phoebe*) and what is presumed to be the Hovering goby (*Ioglossus* sp.) occur on the comparatively "level" bottom between rock structures. Amberjacks (*Seriola* sp.) cruise the top of the bank. An enormous school of scombrids, possibly the Little tuna, was encountered at a depth of 15 m, above the bank.

Fishnet Bank does not appear to support clear-water, reef-building communities at the present time, probably due in part to chronic turbidity and sedimentation. The benthic community on the bank is presumably adjusted to such conditions, being comparatively low in diversity and numbers. Nevertheless, snappers and certain other potentially commercial and game fishes are numerous.

CONCLUSIONS AND RECOMMENDATIONS

Evidence for Recent activity of faults on and in the immediate vicinity of Fishnet Bank suggests that areas in close proximity to the bank may be subject to seafloor instability. Care should be taken to avoid emplacement of structures on the bottom in areas of severe normal faulting that does not appear to intersect the seafloor but shows subtle signs of Recent movement.

The nepheloid layer frequently envelops Fishnet Bank, and an assemblage of benthic organisms exists on the bank equivalent to the Antipatharian Zone of the South Texas banks. This bank should be assigned a low priority for protection from drilling activities.

CHAPTER XIII

DIAPHUS BANK

R. Rezak, T. Bright, D. McGrail, T. Hilde,
G. Sharman, L. Pequegnat

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Diaphus Bank included mapping and sub-bottom profiling, and hydrographic sampling. Results of these studies are presented in this chapter under the headings Physiography and Structure, Hazards, Sedimentology, Water and Sediment Dynamics, and Biology.

GENERAL DESCRIPTION

Diaphus Bank is located at 28°05'18"N latitude and 90°42'26"W longitude (Volume One, Figure III-1) in Blocks 314-317 of the South Timbalier Area. It lies close to the shelf edge and is about 50 miles west of the Mississippi Trough. The bank is rectangular and covers an area of about 33 km^2. Superimposed upon this rectangle are two ridges that intersect at nearly right angles to form a rough cross. The surrounding water depths range from 110 m on the north to 130 m on the south, with increasing depths to the south, down the upper continental slope. The bank stands about 40 m above the surrounding shelf, with the shallowest depth at a peak in the center of the bank lying at 73 m (Figure XIII-1).

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

The most prominent feature of the bank is an east-west ridge which has an extremely steep (locally about 90 m/km) and linear south side. The slope on the north side is much more gentle, being only about 20 m/km. A smaller ridge extends to the north (about 2.5 km) and to the south (about 1.7 km) from the center of the east-west structure.

Local relief on the bank is concentrated along the crests of the intersecting ridges, mainly on the bathymetric highs. This relief is primarily related to outcrop of the acoustic basement unit and patches of carbonate reef growth (Figure XIII-4). Examples of these features are clearly seen in boomer profiles through the center of the bank (Figure XIII-5c) where the steeply dipping acoustic basement unit crops out south of the east-west scarp and where apparent carbonate reef growth can be seen at the base of the northern slope.* Areas

*For the sections of seismic reflection profiles shown in Figures XIII-5 and 6, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

interpreted as carbonate reef growth in the boomer profiles are generally pinnacles or narrow ridges with little or no internal reflectors and beneath which there is commonly a wipeout of seismic signal.

The seismic reflection records reveal that Diaphus Bank is a domal diapiric structure that has been breeched by a major down-to-the-sea, normal fault, creating the massive, south-facing scarp that is so prominent on the bank. Radial faults have created the less prominent north-south ridge. Major east-west faults commonly occur in salt domes that are situated close to the shelf break off the Louisiana coast. In such situations, salt begins to move laterally towards the slope, which is a region of less resistance, and the normal faulting parallel to the shelf break occurs (Henry Berryhill, personal communication). A large bulge in the seafloor south of Diaphus Bank attests to this process.

Two seismic sequences were mapped (Figure XIII-4): 1) the exposed acoustic basement unit, which is highly reflective and consists of well stratified sedimentary rock; and 2) a poorly reflective sedimentary unit which surrounds the bank and can be seen to overlie and unconformably onlap the basement unit (Figures XIII-5 and 6). The distribution and thickness of the upper unit are shown by isopach contours in Figure XIII-4. The upper boundary of this unit is the seafloor, and the lower boundary is the unconformity. Unlike many of the banks, the overlying sediments are not steeply tilted upward where they onlap the basement unit. This fact suggests that the doming which produced the primary uplift and tilting of the basement unit took place prior to deposition of the surrounding sediments.

HAZARDS
(PI: R. Rezak)

Considering the location of the bank with respect to the shelf break and the displacement on the major east-west fault, it is reasonable to predict that future movement is possible.

Gas seeps are not obvious except between shot points 20 and 21 on line 6 on the western part of the bank crest. No gas seeps were encountered on dives 118 and 119 on Diaphus Bank. Examples of signal wipeout that may indicate the presence of gas are shown beneath the crest of the bank on Figure XIII-5b and beneath the northern slope of the bank on Figure XIII-5c. However, these indications of possible gas are minor by comparison with other banks, such as Fishnet.

SEDIMENTOLOGY
(PI: R. Rezak)

Four grab samples were taken at Diaphus Bank. The sediment types represented at this bank are as follows:

Station 1 - Gravelly sand
Station 2 - Gravelly, muddy sand
Station 3 - Sandy muds
Station 4 - Sandy muds

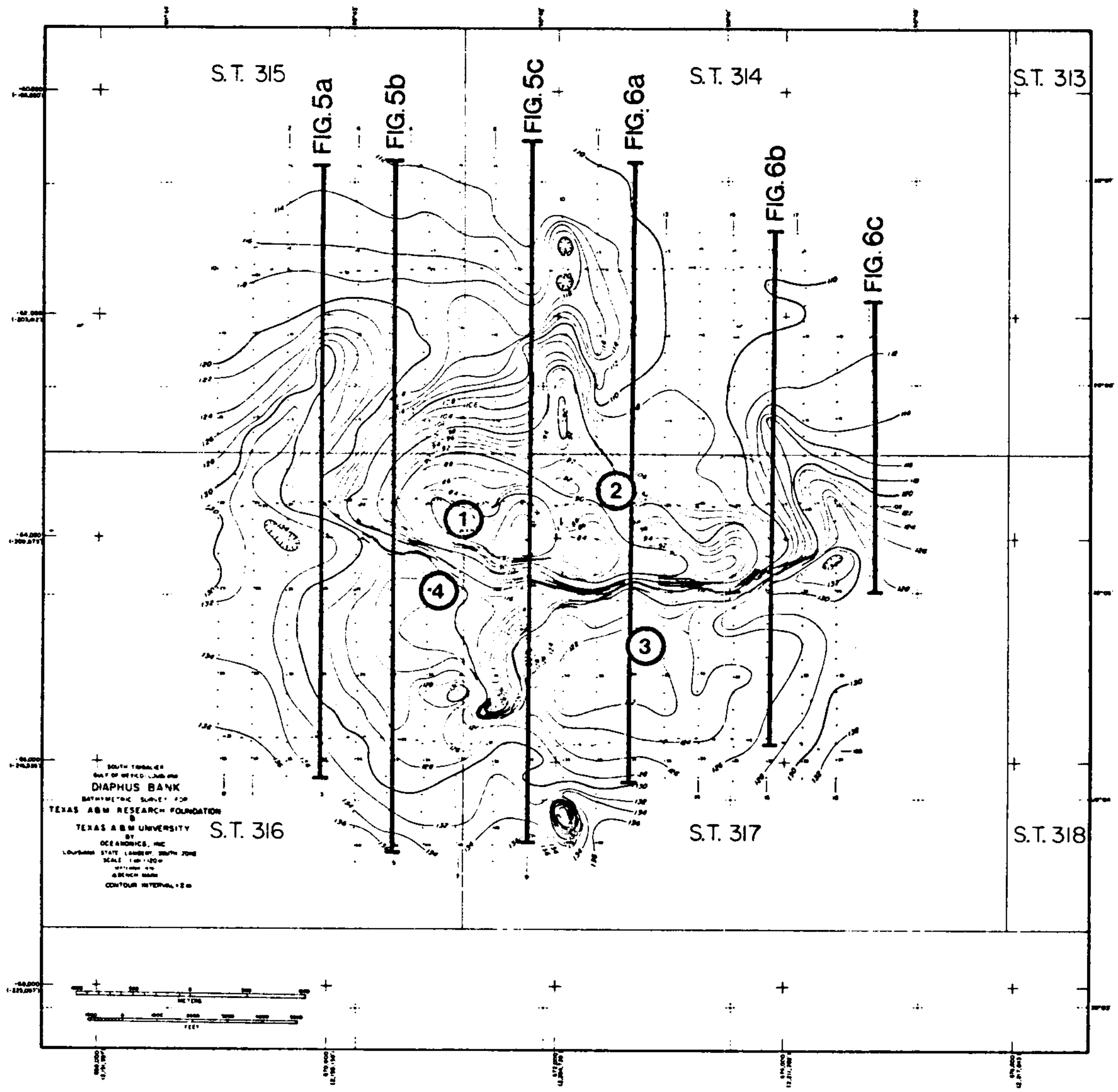

Figure XIII-1. Bathymetry of Diaphus Bank. Solid lines and letters indicate tracks from which boomer profiles are shown in Figures XIII-5 and 6. Sample stations, 1-4.

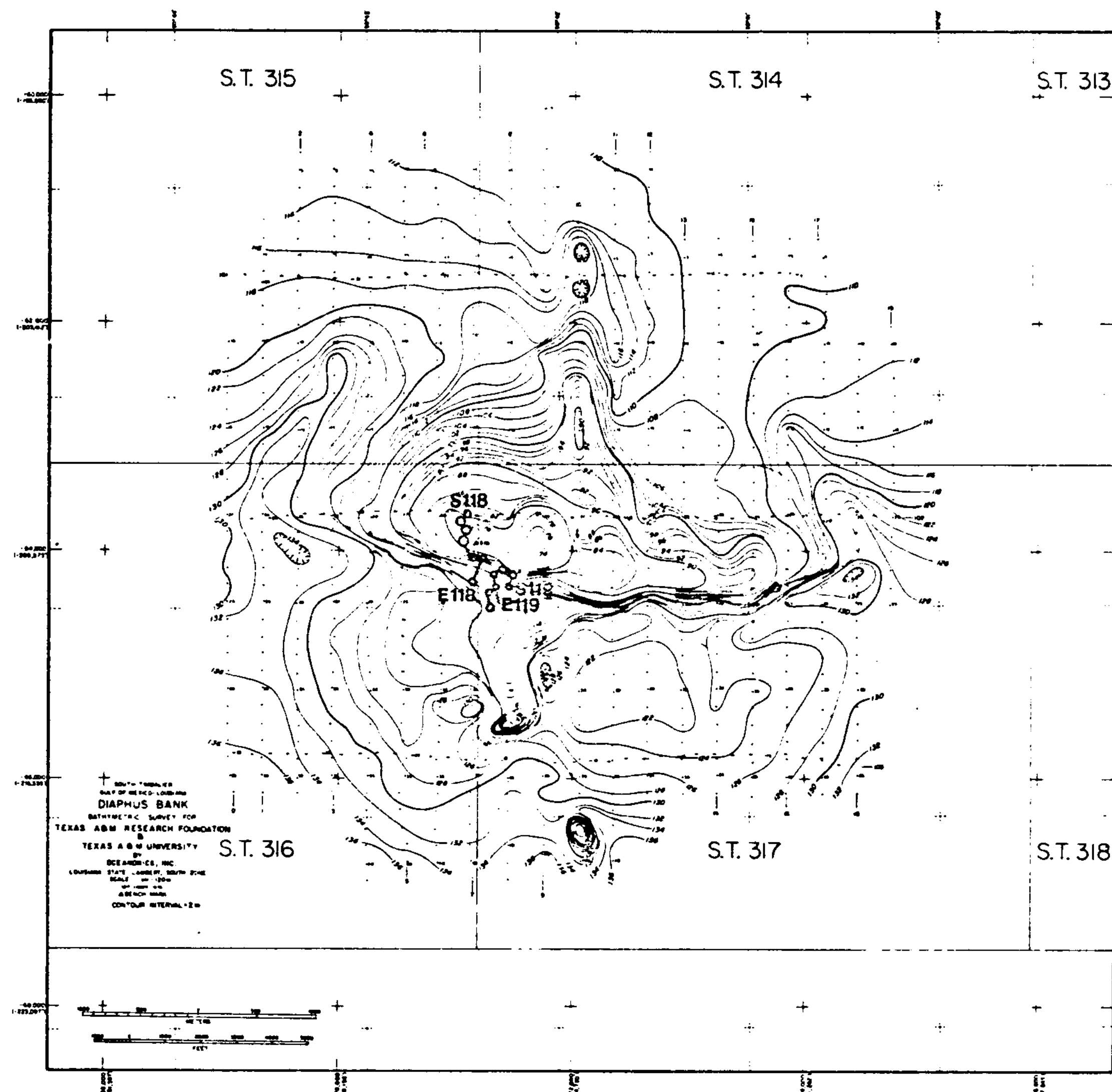

Figure XIII-2. Submersible transects on Diaphus Bank, dives 118 and 119: S = Start, E = End.

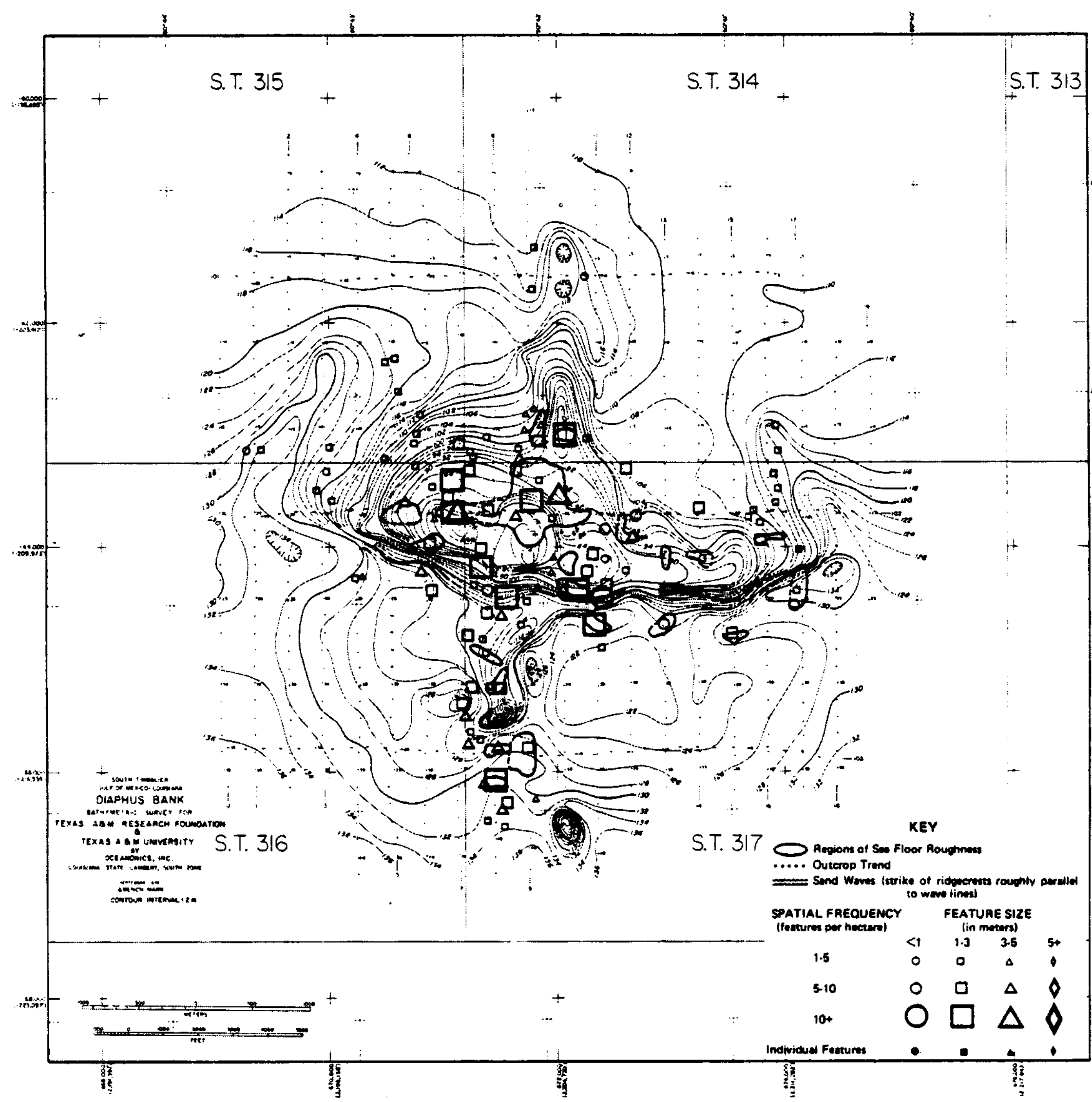

Figure XIII-3. Seafloor roughness map of Diaphus Bank constructed from side-scan sonar records.

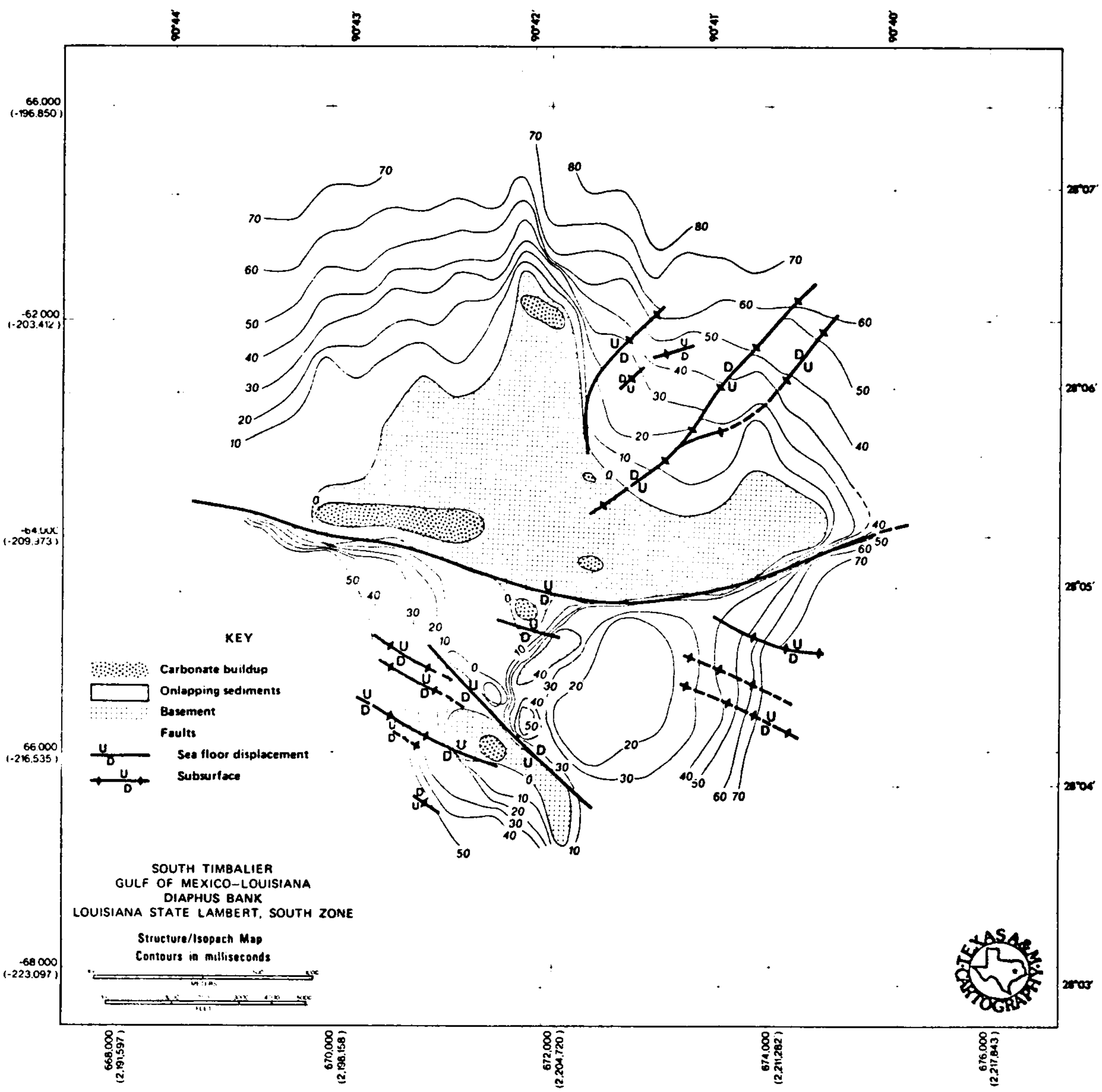

Figure XIII-4. Structure/isopach map of Diaphus Bank.

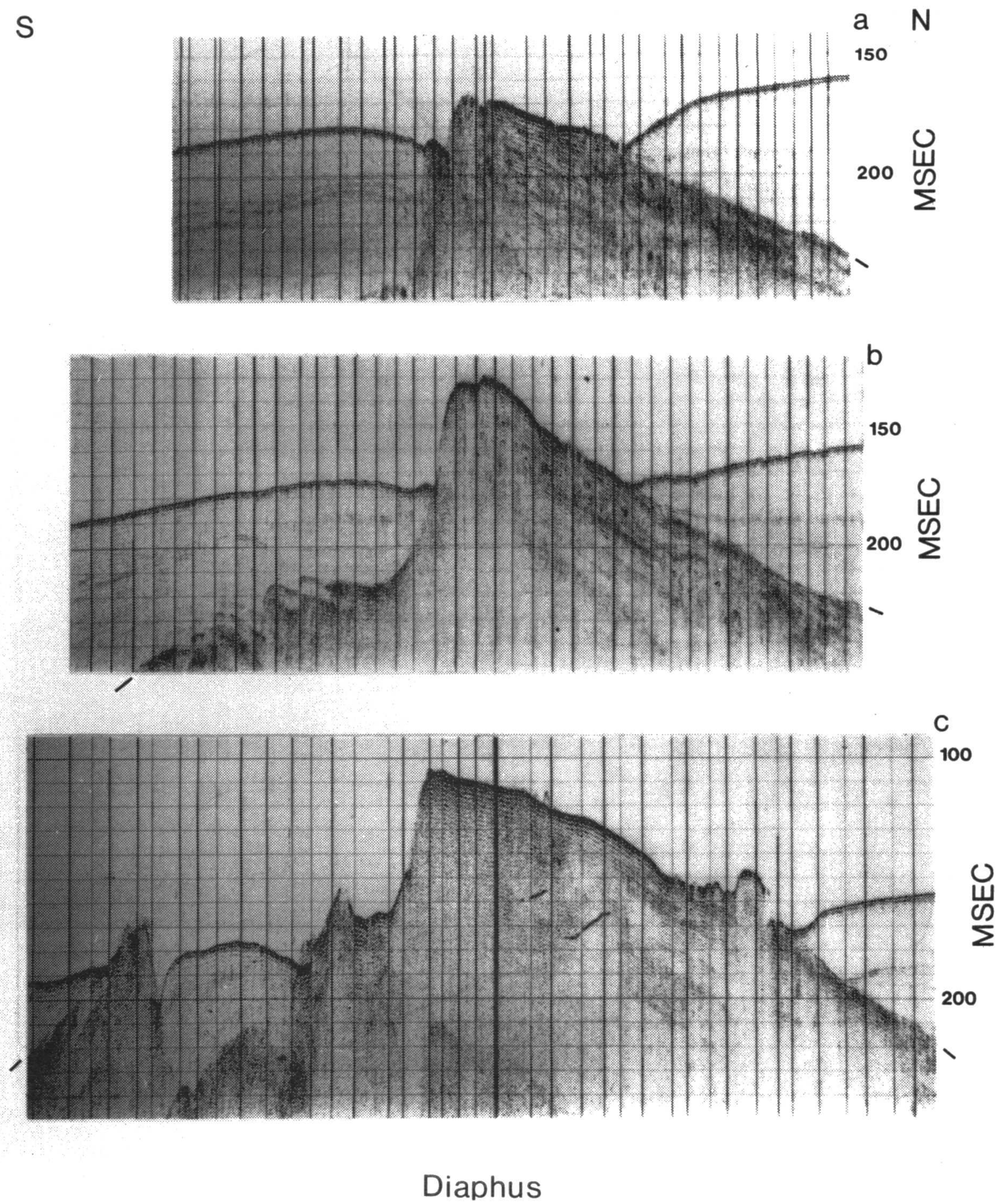

Figure XIII-5. N-S boomer profiles. Locations shown in Figure XIII-1. Boundary between upper sediment sequence and basement is marked at margins of the profiles.

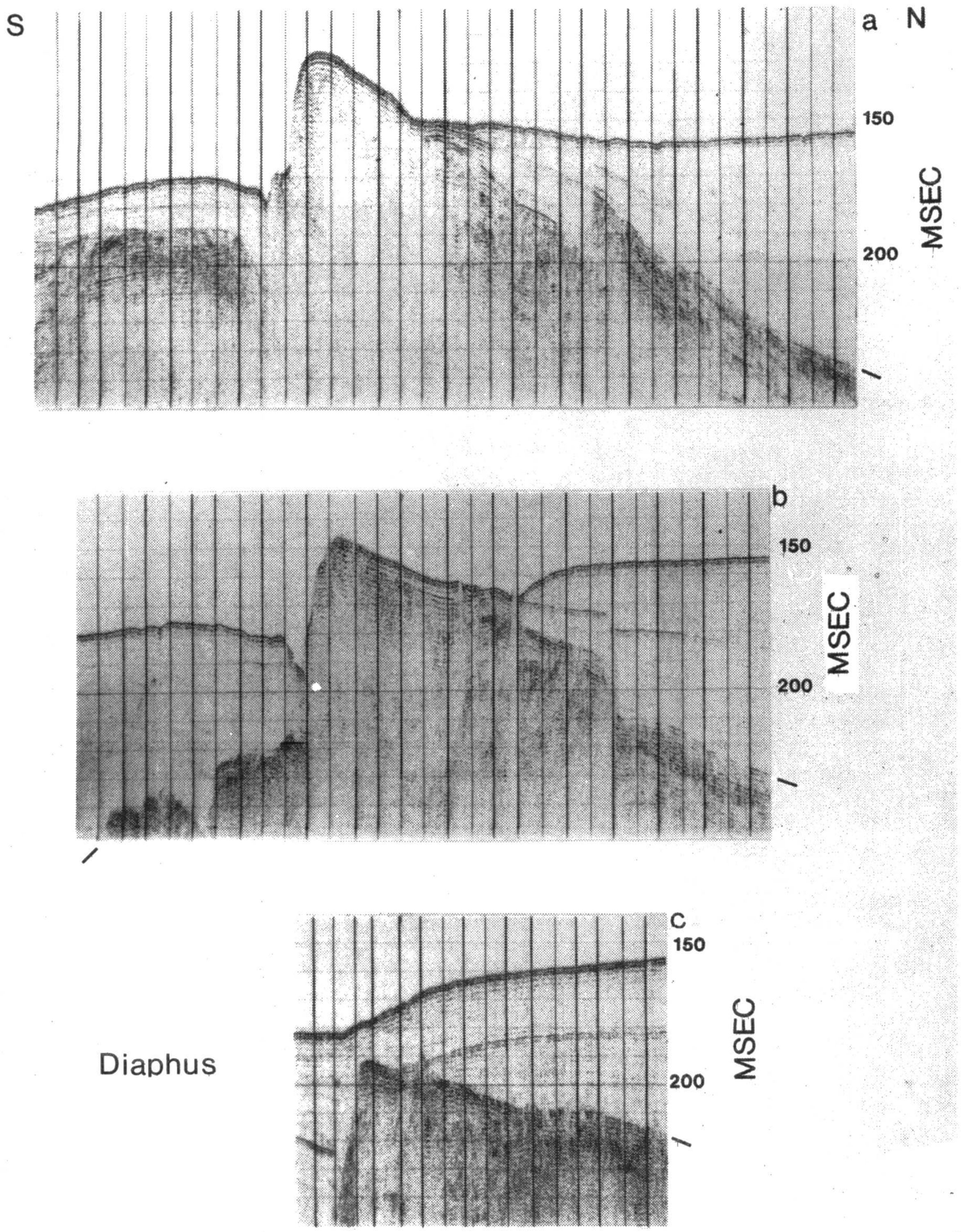

Figure XIII-6. N-S boomer profiles. See Figure XIII-5 for further explanation.

Observations during submersible transects (Figure XIII-2) suggest that these are the main sediment types on the bank. The dominant sediment at the crest of the western peak (76 m depth) is a coarse, carbonate sand with scattered algal nodules on its surface. This sediment occurs in between large coralline algae-encrusted reef masses (4 m to 6 m high). The dominant particle types in this sediment are coralline algae and Amphistegina. The depth at station 1 is close to the lower limit of the Gypsina-Lithothamnium Facies at the West Flower Garden Bank. At Diaphus Bank, both the Gypsina-Lithothamnium Facies and the Amphistegina Sand Facies occur together. This combination is typical of the transition zone between the two facies at the West Flower Garden Bank.

The mineralogy of the sediment at station 1 is mainly high-Mg calcite with lesser amounts of low-Mg calcite and aragonite. This mineralogy reflects the primary source of the particles, which is mainly coralline algae whose composition is high-Mg calcite.

Station 2 is in deeper water (depth 100 m), and the sediments there contain about 28% mud that is derived from the nepheloid layer. About 72% is sand and gravel in which coralline algae and mollusc fragments are dominant. The coarse fraction in this sediment is derived from higher on the bank and is moved downslope by gravity. Mineralogically, the sediment consists of: high-Mg calcite, low-Mg calcite, aragonite, and quartz, in order of decreasing abundance. No quartz was identified during particle type analysis. Quartz, however, is the most abundant non-clay mineral in the < .002 mm fraction, indicating that it is transported onto the bank in the nepheloid layer.

The samples from stations 3 and 4 (depth 118 and 123 m) are quite similar in all respects. They are predominantly mud, with only 12% and 21% coarser than .062 mm. The dominant particle types in the coarse fraction are planktonic foraminifers. The fine fraction consists mainly of smectite, with lesser quantities of illite and kaolinite. Quartz is the dominant non-clay mineral in the < .002 mm fraction. Here again is evidence that the nepheloid layer is restricted to the bottom boundary layer and that upslope transport of sediment does not occur.

WATER AND SEDIMENT DYNAMICS
(PI: D. McGrail)

Hydrographic sampling at Diaphus Bank was carried out on 26 June 1979 at four stations distributed about the bank as shown in Figure XIII-1. The high relief and unusual configuration of this bank precluded the possibility of treating the stations as a time series. Topographic and temporal changes from station to station are irresolvable. The very pronounced stratification, the baroclinicity of the current profiles, and the marked differences in current magnitude among the stations imply that internal waves were active at the time of sampling.

The water column over Diaphus Bank possessed very strong thermohaline stratification. The lowest surface salinity values observed at Diaphus Bank were 33.84 °/oo, nearly 2 °/oo higher than minimum values observed at Coffee Lump. This difference suggests that much of the lowest salinity water from the spring runoff and discharge from the Mississippi River had been advected westward well beyond Diaphus Bank. Still, the surface salinities were sufficiently low to render the surface extraordinarily stable. One measure of this stability is the buoyancy or Brunt-Vaisala frequency (Turner, 1973):

$$N = \left(- \frac{g}{\rho_{\circ}} \frac{\partial \rho}{\partial z} \right)^{1/2}$$

where

g is the gravitational acceleration
z is the vertical coordinate
ρ is the density of the water
$\rho_{\circ}$ is a reference density (mean density over the interval Δz)

This is often called the natural frequency of the water column. It represents the frequency with which a parcel of water would oscillate about its equilibrium position if given a small displacement. If the water is statically stable (denser water on the bottom), N is a real, positive number. The intensity of the stability is represented by the magnitude of N. Figure XIII-7 is a plot of N against depth for the four stations at Diaphus Bank. Notice that the surface maxima for N range from 14 to 20 cycles per hour (CPH) for these stations. That is stability in the extreme.

Figures XIII-8 through 11 are plots of salinity, temperature, sigma T (σ_T), transmissivity, and current velocity versus depth. The effects of the sharp, shallow halocline are manifested in the absence of a wind mixed surface layer and lack of correlation between the direction of surface currents and of the wind. The very strong stratification suppressed the production of turbulence and therefore suppressed mixing in the surface layer. Thus vertical momentum transfer from the wind would have been limited to molecular viscosity except in the upper metre or so. In effect then, the thin veneer of low salinity water at the surface decoupled the sea from wind forcing.

Currents at stations 1 and 2 were very strong, directed toward the east, and sheared so that flow below approximately 60 m was slightly faster than that above 60 m and possessed of a somewhat different orientation. At both stations, near-bottom speeds exceeded 30 cm/sec. In contrast, the flow at stations 3 and 4 was rather weak (< 20 cm/sec) and highly baroclinic. Near-bottom flow in all cases was roughly parallel to the local isobaths.

There was a well developed nepheloid layer at all of the stations except station 1. The reduction in transmissivity at the bottom of station 1 (Figure XIII-8) appears to have resulted from hitting the bottom with the transmissometer. The last reading above the bottom was

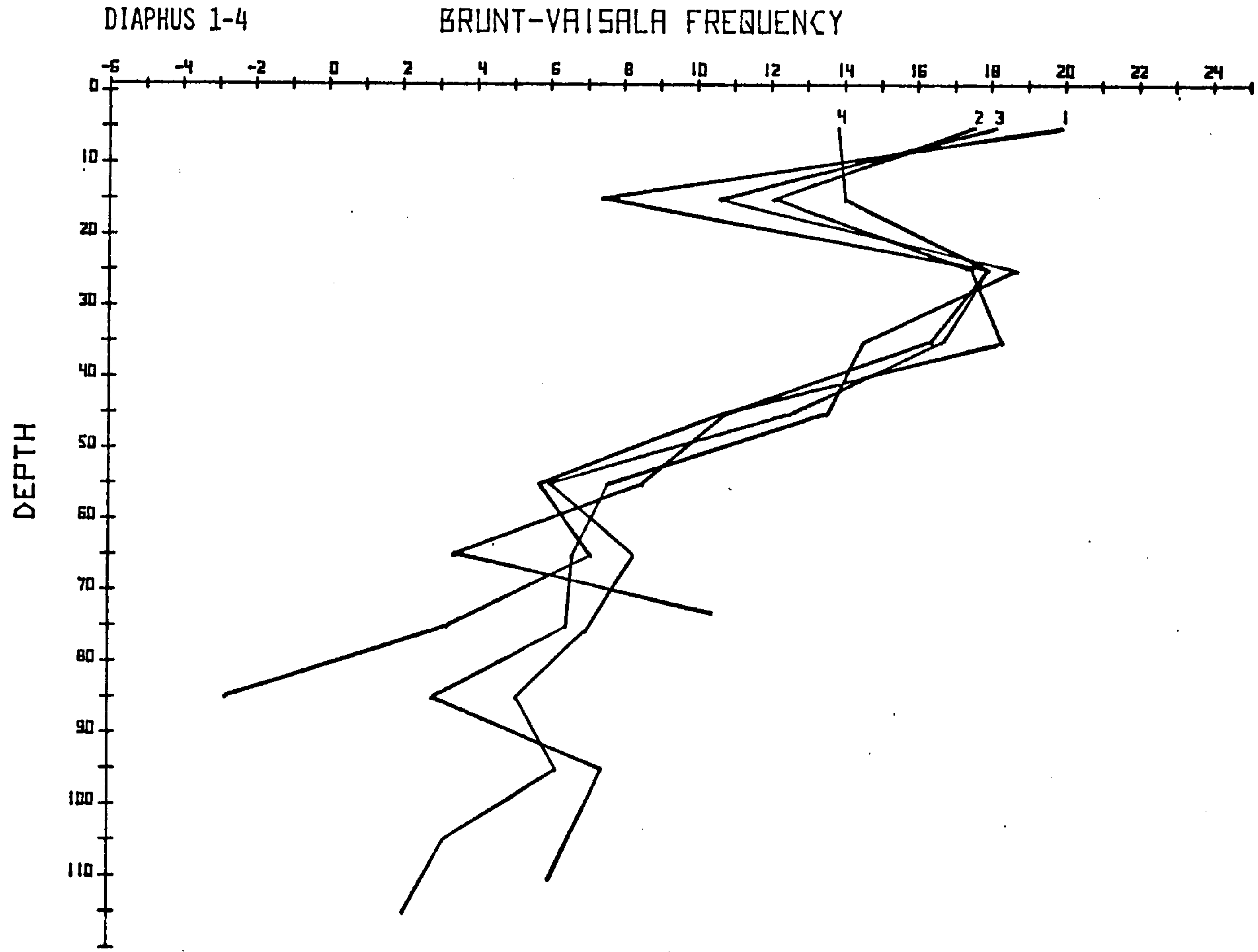

Figure XIII-7. Plot of Brunt-Vaisala frequency (N) against depth for the four stations at Diaphus Bank.

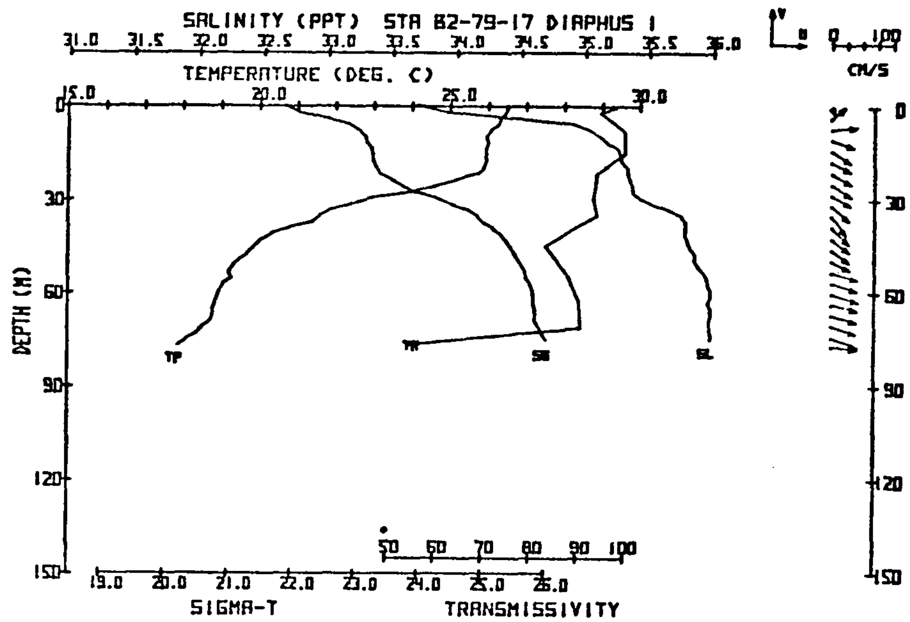

Figure XIII-8. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Diaphus 1.

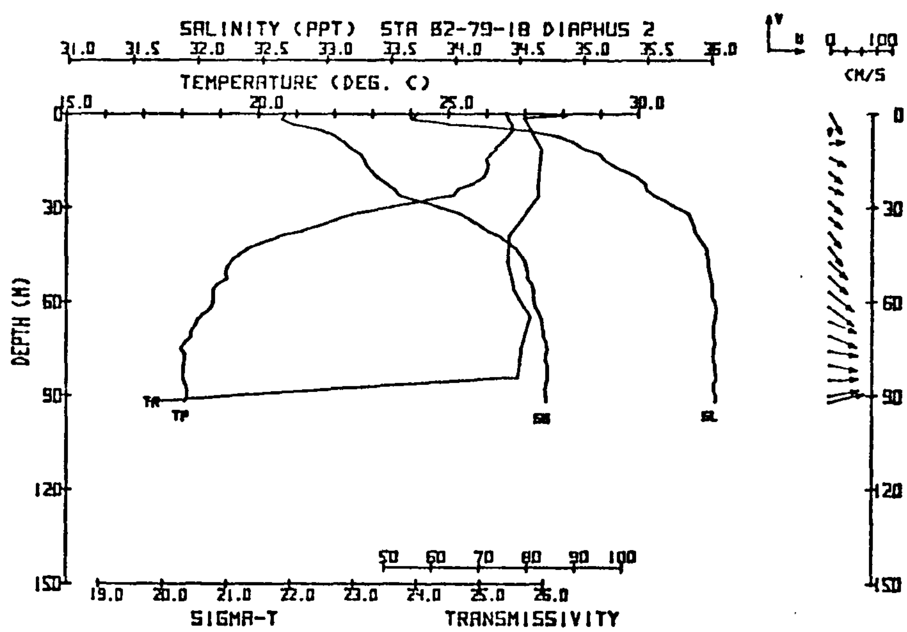

Figure XIII-9. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Diaphus 2.

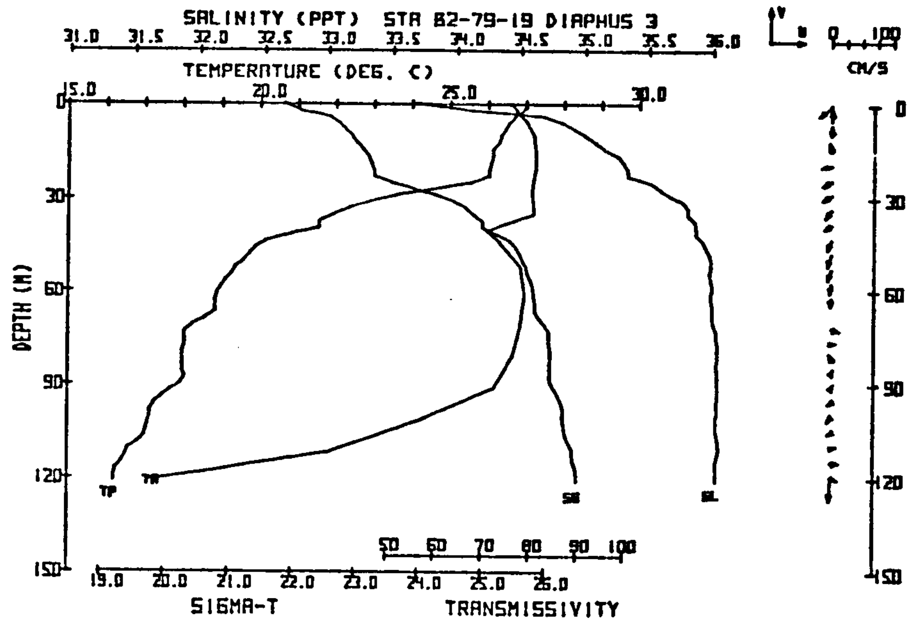

Figure XIII-10. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Diaphus 3.

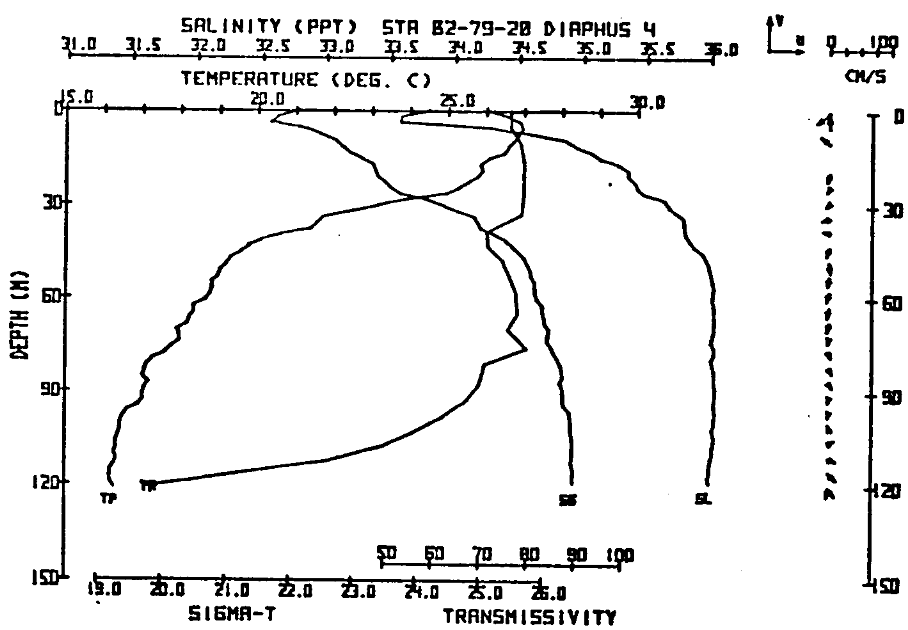

Figure XIII-11. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Diaphus 4.

approximately 80%/m, then dropped to 61%/m at the depth corresponding to bottom from the fathometer. At station 2, the nepheloid layer was approximately 6 m thick, with a minimum transmissivity reading of approximately 20%/m. The turbid layer at stations 3 and 4 extended approximately 30 m from the bottom with a diffuse upper limit. The 60%/m level occurred at 100 m at both stations 3 and 4, or about 20 m above the bottom.

Observations from the submersible regarding fine sediment on the bank suggest that the nepheloid layer may extend up to a depth of 80 m at times. Over much of the year, background suspended particulates from the Mississippi River may occur in substantially higher concentrations at Diaphus Bank than at the banks to the west.

Secondary minima in all of the transmissometry profiles between approximately 40 m and 50 m were probably caused by concentrations of plankton riding the sharp density gradient at that depth.

BIOLOGY

(PI: T. Bright)

(Figures XIII-12 through 16, and Appendix D, Table XIII-1)

Although scleractinian corals and coralline algae live on Diaphus Bank, no substantial populations of either were encountered during our survey. Reef-building appears to be arrested at present, although old drowned reef patches occur at least down to 107 m depth. These currently inactive (non-growing) reefs are covered with fine sediment or sediment-epifauna mats and sponges with small amounts of coralline algae.

The largest drowned reefs (2.5 to 3 m high) were seen between 85 and 95 m depths, marking the break in slope at the edge of the bank's upper platform. This is presumably the level of most active past reef building. Progressing from the bank edge toward the top central portion of the bank (82 m depth), the drowned reefs become increasingly less elevated above the bottom (some only 0.5 m high), but their lateral dimensions (averaging 3 to 6 m across) and spacing (generally 3 to 9 m or more apart) are fairly uniform. Below 95 m, the drowned reefs are smaller and more heavily laden with fine sediment (Figures XIII-13 and 14).

Sediment cover on the drowned reefs is somewhat less above 88 m depth, but even at 82 m it is substantial, sometimes occurring on 90-95% of the rock surface. Above 95 m, at least, the sediment on rocks is most often entrapped by low-growing populations of attached epibenthic organisms forming a mat. At greater depths, the fine sediment cover may be so great as to obscure or preclude most small attached benthos (Figures XIII-15 and 16).

Coralline algal cover on the drowned reefs on top of the bank generally varies from nil to 10-15% and probably averages 3-5%. The greatest cover (20-30%) was encountered on a very large reef (3 m high) at 88 m on the bank edge. Although a few living patches of coralline

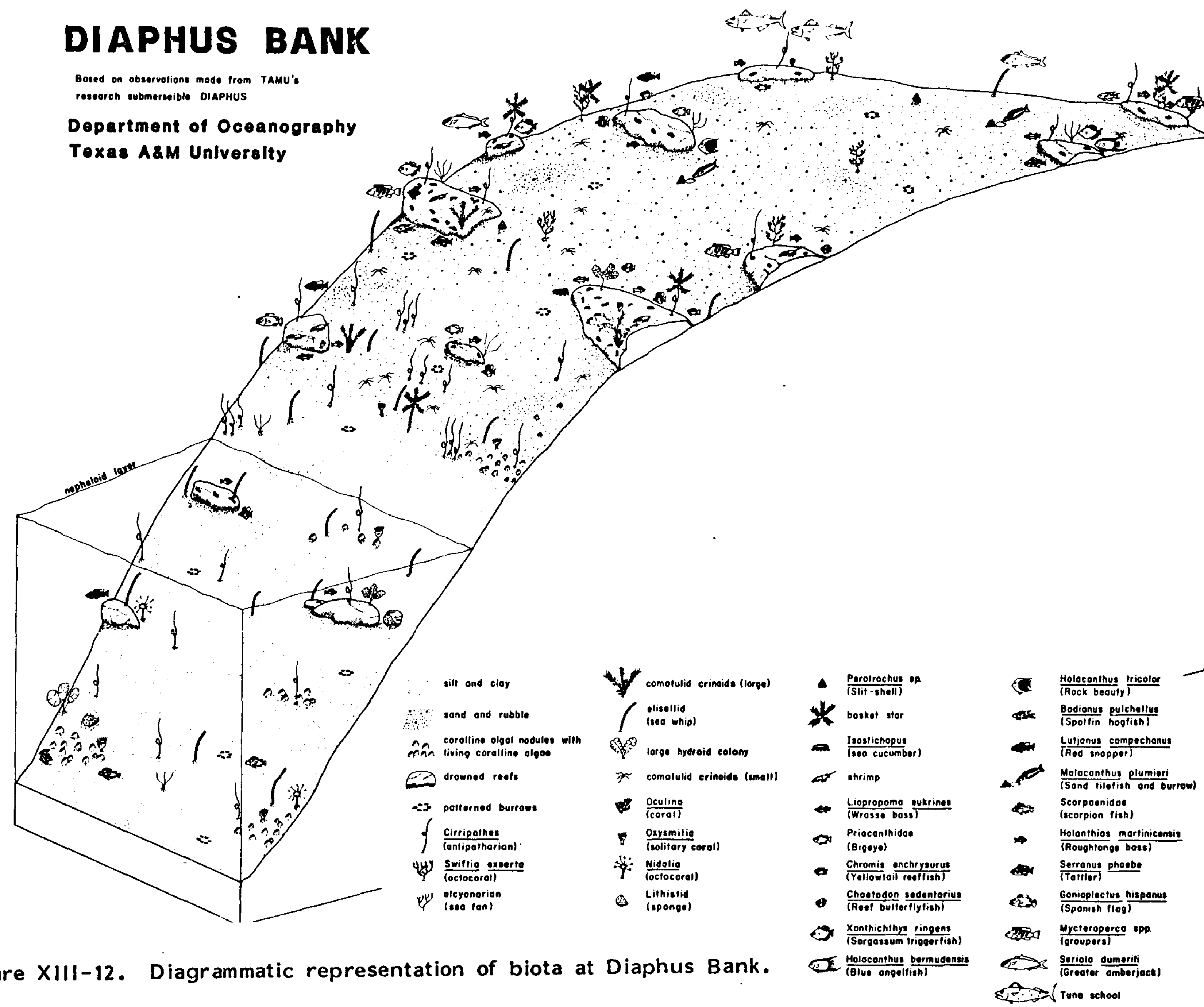

Figure XIII-12. Diagrammatic representation of biota at Diaphus Bank.

algae were seen down to 107 m depth, very little occurs below 98 m. In general, the contemporary coralline algae population is incidental on the part of the bank surveyed and cannot be considered to comprise an effective reef-building population.

Between the drowned reefs on top of the bank (above 88 m), the bottom is sandy, with carbonate rubble and little else except tracks and burrows of benthic organisms. Algal nodules were seen only between 94 and 116 m depth (the deepest point of our dive). Those seen, though often large and fairly numerous, were typically covered with sediment (totally, below 98 m) or by combination of sediment and epibenthos (above 95 m). In one location at 95 m, exposed portions of partly buried nodules bore a 10-20% cover of coralline algae, attesting to the durability and persistence of these organisms when given the slightest chance to occupy hard substratum even under seemingly very adverse conditions (high turbidity, low light).

A change in the nature and composition of benthic populations is apparent at approximately 87 m depth, above which they are generally more diverse and abundant. Even so, the limited diversity and abundance of benthic communities atop Diaphus Bank are probably quantitatively comparable to those of communities on the upper platforms of banks such as Southern, Baker, and Sackett, although species composition and community structure are substantially different.

The almost insignificant coralline algal population has been described above. A small amount of flat purplish leafy algae was seen at 83 m depth, but the population was minor. Encrusting sponges are significant on the hard substratum down to at least 95 m depth. Lithistid sponges found on the deeper flanks of most shelf edge banks in the northwestern Gulf are present here from 105 to 116 m, attached to drowned reefs or old nodules (Figure XIII-15).

Scleractinian coral populations are sparse, and no hermatypic varieties were seen. Solitary corals similar in appearance to Oxysmilia occurred at all depths but were most conspicuous below 94.5 m, possibly because of the generally low diversity and abundance of other benthic organisms there. Branching corals with an Oculina-like growth form were seen in fair numbers on drowned reefs and old nodules between 85 and 116 m.

Among the conspicuous macrobenthic invertebrates, crinoids, antipatharians, and alcyonarians are numerically predominant. Possibly the most numerous benthic animal detectable from the submersible is a small swimming crinoid, probably Hypolometra sp. It was seen almost everywhere above 91 m depth, sometimes in populations which must exceed $100/m^2$. They were apparently not as abundantly distributed on the drowned reefs as they were on the intervening unconsolidated bottom where they often covered small nodules or sea whips forming beard-like clusters of arms directed upward. Larger, less mobile species of comatulid crinoids were present in the same depth range but not in great abundance.

White antipatharian whips, Cirripathes sp., are abundant throughout the entire depth range surveyed (82 to 116 m) attached to drowned reefs, nodules, or rubble and often occurring in localized clusters. Other less abundant types of antipatharians, some shaped like a bottle brush (Antipathes pedata or barbadensis), were seen down to 105 m.

Ellisellid alcyonarian sea whips, though smaller in size than Cirripathes, are numerically almost as important around 91 to 98 m depth and occur in significant numbers from 82 to 113 m. Because of its large size and branching nature, the orange and white alcyonarian, Swiftia exserta, is visually the most conspicuous species on the bank, though its numbers are fewer than those of the aforementioned organisms. Smaller paramuriceid alcyonarian fans are significantly abundant at all depths, and white muriceid fans occur above 95 m and possibly deeper. The small, club-shaped alcyonarian Nidalia sp. occurs below 107 m depth.

Clinging to the larger antipatharians and alcyonarians above 91 m depth is a substantial population of white basket stars (Astrocyclus sp.). Occasionally, small ophiuroids and often small crinoids were also seen on the sea whips and fans. Other echinoderms encountered were two species of large holothuroids, including Isostichopus sp., a large red ophiuroid (possibly Ophioderma), and the asteroid Narcissia trigonaria, all of these above 94.5 m depth.

Interestingly, no Spondylus americanus (American thorny oyster) were seen on Diaphus Bank. However, there is apparently a significant population of the large slit shell, Entemnotrochus sp., on top of the bank above 87 m. The slit shell, because of its rarity, is highly valued by shell collectors.

One of the most interesting components of the Diaphus Bank benthic community is the abundant population of the strikingly colored shrimp, Parapandalus sp., which occurs in great numbers on the drowned reefs above 95 m (Figure XIII-14). The species is the subject of a taxonomic paper in preparation by Dr. Linda Pequegnat. The visual sightings at Diaphus Bank, along with a specimen captured at Elvers Bank, add to the knowledge of the shrimp's distribution, habitat, and live coloration.

Fish diversity on Diaphus Bank apparently is not great. Of the 26 species seen, only 3 occurred below 98 m (a Lizardfish, Synodontidae, at 107 m; a sizeable population of small Red scorpionfishes, Scorpaenidae, between 113 and 116 m; and the Rough tongue bass, Holanthias martinicensis). By far the most abundant fish on the bank is Holanthias martinicensis, which congregates in large numbers around drowned reefs above 107 m and is most abundant above 95 m. It is noteworthy that Holanthias martinicensis is more numerous on Diaphus Bank than is Chromis enchrysurus (83 to 91 m), which is often numerically dominant on other banks. This may be a function of the deeper crest depth of Diaphus Bank compared to most other shelf-edge banks studied in the northwestern Gulf. Other species of fish worth noting because of their abundance are: Sand tilefish, Malacanthus plumieri (82 to 88 m); groupers, Mycteroperca spp. (83 to 87 m); Bank butterflyfish, Chaetodon aya (84 to 98 m); Sargassum triggerfish, Xanthichthys ringens (84 to 86 m); Bigeye, Priacanthus sp. (84 to 95 m); and Spanish flag, Gonioplectrus hispanus (88 to 95 m). One Red snapper, Lutjanus campechanus, was seen at 95 m, and several other snappers of the genus Lutjanus were encountered above 95 m. An enormous school of over 1000 scombrid fishes, possibly the Little tuna (?Euthynnus alletteratus), circled the submarine at 83 m depth.

In summary, that part of Diaphus Bank explored by submersible (82 to 116 m depth) appears to be composed surficially of a grouping of drowned, largely sediment covered, non-growing reef patches, the largest of which occur near the break in slope at the edge of the bank's upper platform (85 to 95 m). Sediment between the shallower drowned reefs is sand and rubble with little else. Below the break in slope, the ratio of very fine unconsolidated sediment increases, the sediment cover on rocks is thicker, and turbidity of the water is greater.

CONCLUSIONS AND RECOMMENDATIONS

Typical of shelf-edge banks, Diaphus Bank may be expected to continue in the development of its normal faults. Continued movement along the major east-west fault should be expected.

The apparent lower diversity and abundance of epibenthic biota and fishes below the break in slope is probably related to depth, light penetration, water turbidity, and sedimentation. Overall, the diversity and abundance of benthic biota on Diaphus Bank are low compared to that of many other shelf-edge banks in the northwestern Gulf. This may be due to the somewhat deeper crest depth of Diaphus Bank and/or its rather closer proximity to the Mississippi River outfall.

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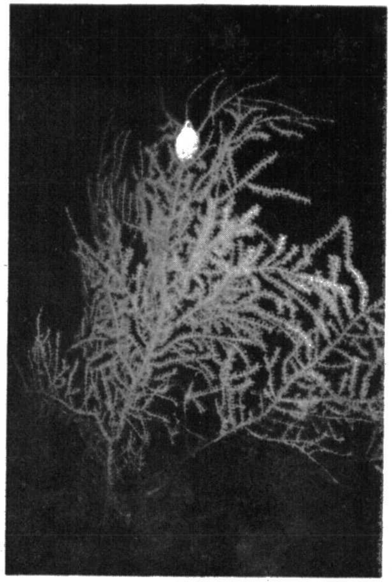

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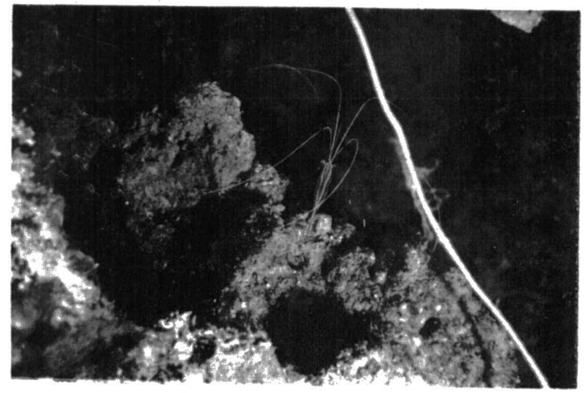

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Figure XIII-13 (UL). Diaphus: *Swiftia exserta* with a white basket star attached (84 m depth).

Figure XIII-14 (UR). Diaphus: the shrimp *Parapandalus* sp. on a drowned reef at 95 m depth.

Figure XIII-15 (LL). Diaphus: Lithistid "bracket" sponges on rock which is covered with substantial layer of sediment (105 m depth).

Figure XIII-16 (LR). Diaphus: small rocks heavily covered with fine sediment (116 m depth).

CHAPTER XIV

JAKKULA BANK

R. Rezak, D. McGrail, T. Bright, T. Hilde,
G. Sharman, L. Pequegnat, D. Horne, S. Jenkins, F. Halper

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Jakkula Bank included mapping and sub-bottom profiling, and hydrographic sampling. Results of these studies are presented in this chapter under the headings Structure and Physiography, Hazards, Sedimentology, Water and Sediment Dynamics, and Biology.

GENERAL DESCRIPTION

Jakkula Bank is located close to the shelf edge at 27°58'56"N latitude and 91°39'16"W longitude (Volume One, Figure III-1) in Blocks 5 and 6 of the Green Canyon area, Blocks 975 and 976 of the Ewing Bank Area, and Block 390 in the Eugene Island Area (Figure XIV-1). The bank is rhomboidal and covers an area of about 8.3 km^2. The main body of the bank is a domal structure. However, the shallowest part is a narrow north-south ridge near the west margin of the bank, with least depths of 59 m (Figure XIV-1). The remainder of the bank crest lies at depths of 63-66 m. Surrounding water depths range from about 140 to 160 m. Slopes on the margins of the bank have gradients ranging from 80 to 200 m per km. The seafloor on the north and west sides displays highly irregular topography due to a combination of structural, erosional, and depositional processes.

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Local relief on the bank is not as great as on the lower flanks and surrounding seafloor, particularly on the north and west sides. On the bank proper, small scale roughness features appear to be carbonate patch reefs and possibly rock outcrops (Figure XIV-2). On the lower slopes and areas surrounding the bank, the local relief is somewhat greater, not as well reflected in the roughness map, and primarily related to faulting and erosion. An extensive area of carbonate build-up is indicated north of the bank (Figure XIV-3). Relief is high in this area with numerous 5-10 m high peaks or ridges with no internal reflectors (Figure XIV-4).*

*For the sections of seismic reflection profiles shown in Figure XIV-4, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

Three units are mapped on the structure/isopach map (Figure XIV-3): 1) the acoustic basement, which is the poorly reflective core of the bank; 2) the uppermost unconsolidated sediments on the seafloor surrounding the bank (thickness shown by solid contours); and 3) the sedimentary sequence beneath, down to a prominent reflector that represents an unconformity (thickness shown by dashed contours). The lower boundary of this third unit is indicated at the margins of the boomer profile (Figure XIV-4). As is the case for most of the banks discussed, the surrounding sediments are tilted steeply upward where they onlap the core of the bank, indicating uplift of the central structure due to diapirism. The outline of the diapir is not seen in the boomer records. The surficial sediments surrounding the bank have irregular distribution, and in several places, the underlying sequence is exposed at the seafloor (Figure XIV-3). It is the intermediate sequence which causes the rough topography on the east and north sides of the bank. As can be seen on the north side of the profiles in Figure XIV-4a, b, and c, only the larger scale features are of fault origin. Deeper reflectors below the smaller scale roughness are unbroken by faults. Some of this relief is clearly erosional, but the areas of dense peaks are suspected to be carbonate build-ups.

The entire perimeter of the bank proper (the limits of the core, mapped as exposed basement) is essentially a fault boundary with the relative displacement being upward on the bank side of the fault. However, the radial faults shown on Figure XIV-3 indicate the opposite sense of movement, typical of the radial grabens that occur due to removal of salt from the crest of salt diapirs. This displacement is best illustrated in Figure XIV-4a, where the lower boundary of the intermediate seismic sequence is clearly displaced downward towards the center of the bank. There is also a radial graben on the northeast side of the bank (Figures XIV-3 and 4d). Both of the surrounding sedimentary sequences are thicker within this graben than in any other region surrounding the bank, indicating growth faulting.

HAZARDS
(PI: R. Rezak)

Faulting appears to be confined to the perimeter of the bank, and most of the faults clearly intersect the seafloor. The most dramatic fault displacements are on the north and southwest margins of the bank and clearly show recent activity.

Gas seepage or venting into the water column is not apparent on the reflection records although some of the surface features that are interpreted as reefs resemble in appearance mud craters that can build up around gas vents (Figure XIV-4c and d). The only shallow wipe-out of reflectors occurs beneath these features and could be due to either reef growth or gas. Brightened reflectors exist in the area to the northeast of the bank (Figure XIV-4d), but these are more likely related to faulting, folding, and lateral facies changes in the lower section.

Dive 124, on 19 October 1978, encountered a large field of gas seeps at a depth of 64 m near the southwestern peak of the bank. The reason for the lack of evidence for gas on the seismic records is not known at this time. It may be due to the fine tuning of the recorder.

SEDIMENTOLOGY
(PI: R. Rezak)

Four sediment samples were taken at Jakkula Bank. The sediments represented at this bank are:

Station 1 - gravelly muddy sand
Station 2 - algal nodule gravel
Station 3 - mud
Station 4 - gravelly sand

Submersible observations during dive 124 indicate that the samples are typical of the sediments on the bank.

The sediment at station 1 consists primarily of mollusc fragments and planktonic foraminifers, with lesser amounts of coralline algae, benthic foraminifers, and echinoderms. The dominant minerals in the coarse fraction are high-Mg calcite, low-Mg calcite, aragonite, and quartz. Quartz is the dominant non-clay mineral in the $< .002$ mm fraction.

The sample from station 2 consisted entirely of algal nodules. Sand and mud size sediment were insufficient to permit textural and mineralogical analysis of the sample.

At station 3, over 98% of the sample was silt size or finer. The 2% coarse fraction consisted of 66% planktonic foraminifers and 28% benthic foraminifers. In addition to the normal clay minerals for this part of the Gulf of Mexico, quartz is the dominant non-clay mineral in the $< .002$ mm fraction. The sediments at this station are the normal off-bank sediments for this portion of the continental shelf.

The sediments from station 4 contain only 1.5% mud. The coarse fraction consists primarily of coralline algae and <u>Amphistegina</u>, with lesser amounts of foraminifers, echinoderms, and molluscs. The minerals in the coarse fraction are high-Mg calcite, low-Mg calcite, and aragonite. The $< .002$ mm fraction contains the normal clay minerals and quartz, low-Mg calcite, and aragonite. This is clearly a bank sediment.

Observations on dive 124 show the algal nodules of the <u>Gypsina-Lithothamnium</u> Facies extending to depths of about 90 m. Below this, a carbonate sand is present. Conspicuous amounts of mud are apparent at 97 m, with a gradual increase in fines with increasing depth and the sediment finally becoming mud by a depth of 135 m.

Large drowned reefs occur at 70-75 m, and much smaller reefs were observed on sandy bottoms down to 94 m.

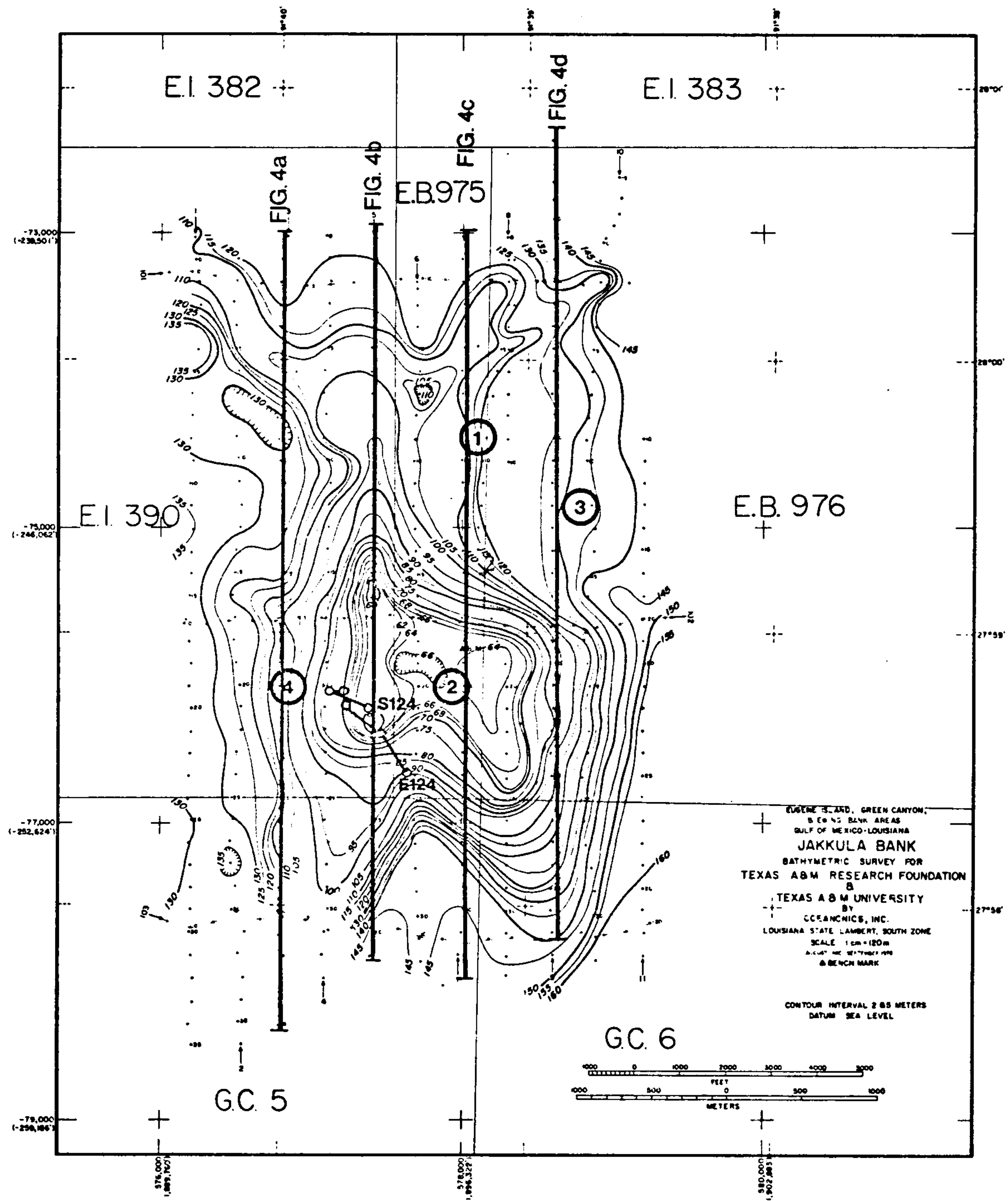

Figure XIV-1. Bathymetry of Jakkula Bank. Locations and number of boomer seismic reflection profiles shown in Figure XIV-4 are indicated. Submersible transect, dive 124: S = Start, E = End. Sample stations: 1-4.

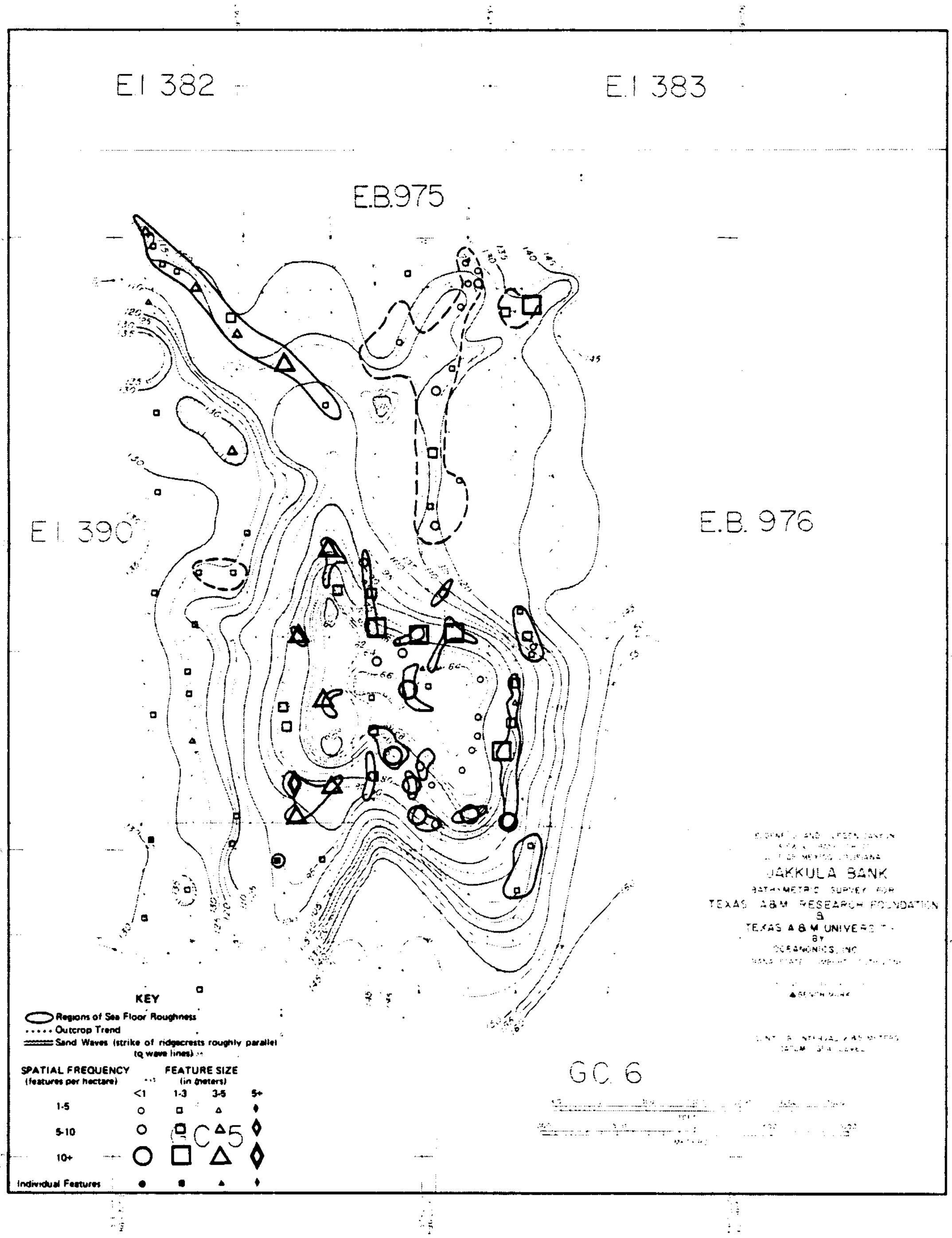

Figure XIV-2. Seafloor roughness, interpreted from side-scan sonar records.

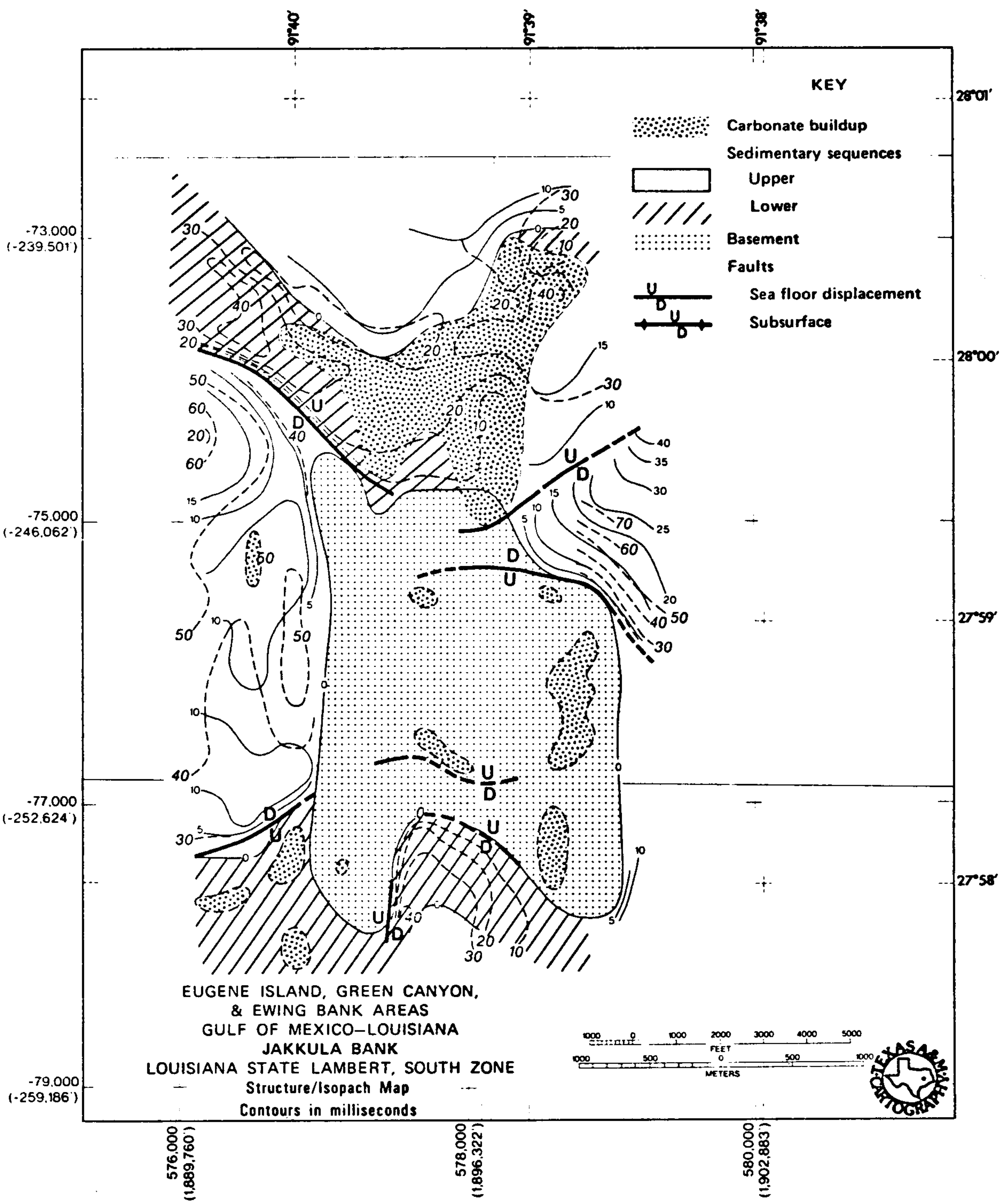

Figure XIV-3. Structure/isopach map of Jakkula Bank. Contours represent thicknesses of the surrounding sedimentary sequences.

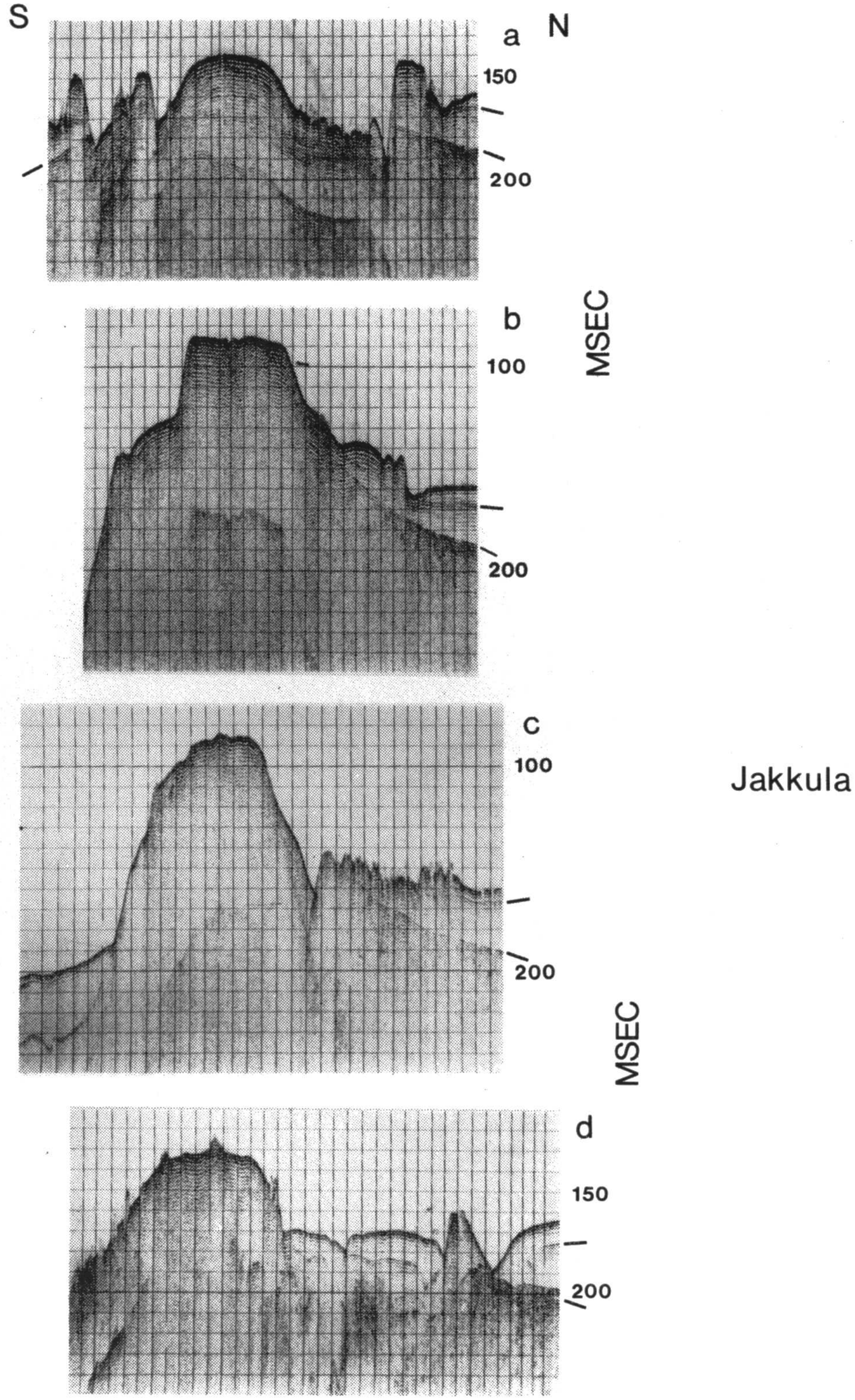

Figure XIV-4. N-S boomer seismic reflection profiles. Locations are indexed on Figure XIV-1. The base of the contoured intermediate or middle sequence and the base of the Recent unit in Figure XIV-3 are indicated along the record margins.

WATER AND SEDIMENT DYNAMICS
(PI: D. McGrail)

Given only four stations with which to characterize the banks, distribution in time and space was achieved as well as possible at Jakkula Bank. The spatial distribution (Figure XIV-1) provided measurements from flank to crest and at a station in each quadrant of the bank. Temporally, two of the stations were occupied 24 hours apart, a critical period for the latitude of the bank. Both inertial oscillations and the diurnal tide have periods close to 24 hours at this location. Profiles of current velocity, salinity, temperature, and transmissivity at each station appear as Figures XIV-5 through 8.

Station 1 was occupied at 1350 on 24 June 1979. The currents were particularly strong, especially near the bottom, where the speed approached 2 knots (100 cm/sec). From top to bottom the flow was from the west-northwest, but there was considerable acceleration with increasing depth across the pycnocline at 30 m. Station 4, occupied at 1330 on 25 June, also possessed strong west northwesterly flow from top to bottom, with a slight increase in speed and slight but definite change in direction near 30 m depth. At station 2, taken two hours after station 1, the currents were dramatically weaker, were from the south and east rather than the west, and were much more depth dependent. It would appear that station 1 was taken at the peak of a tidal current (probably ebb, judging from the direction of flow) and station 2 sampled the turning of the tide. In the profile of station 3, occupied at 1105 on 25 June, the currents were quite depth dependent, weaker than at station 4, but principally to the west. This appears to have been the early ebb.

It should be noted that this assessment of the currents is predicated on the knowledge gained from studying the records from the moored current meters at the Flower Garden Banks and from examining approximately 70 other profiles from various banks. Assessment would not have been possible on the basis of the four Jakkula stations alone.

The current profile at station 4 is the first clear evidence obtained of cross isobath flow on the steep flanks of a bank. Note the cold temperature spike at the base of the profile (Figure XIV-8); the temperature there was only 16.87°C. At station 3, the only other to encounter water that cold, 17°C water was found at 113 m, or 18 m deeper. However, isotherms throughout the profile of station 4 were displaced upward relative to those in the other stations. For example, the 22°C isotherm was 8 m shallower at station 4 than at station 3, and the 19°C isotherm was 16 m shallower. This appears to represent the pressure bulge that forms on the upstream side of an obstacle in strong flow. This condition may have been augmented by channeling of the flow along the south flank of the ridge located just to the north of station 4 (Figure XIV-1). The low level of suspended sediment in the bottom waters at station 4 and the near absence of silt and clay in the substrate at that station suggest that no significant amounts of sediment are transported onto the bank by this mechanism. The absence of any suspended sediment in the profile of station 2 implies that none of the

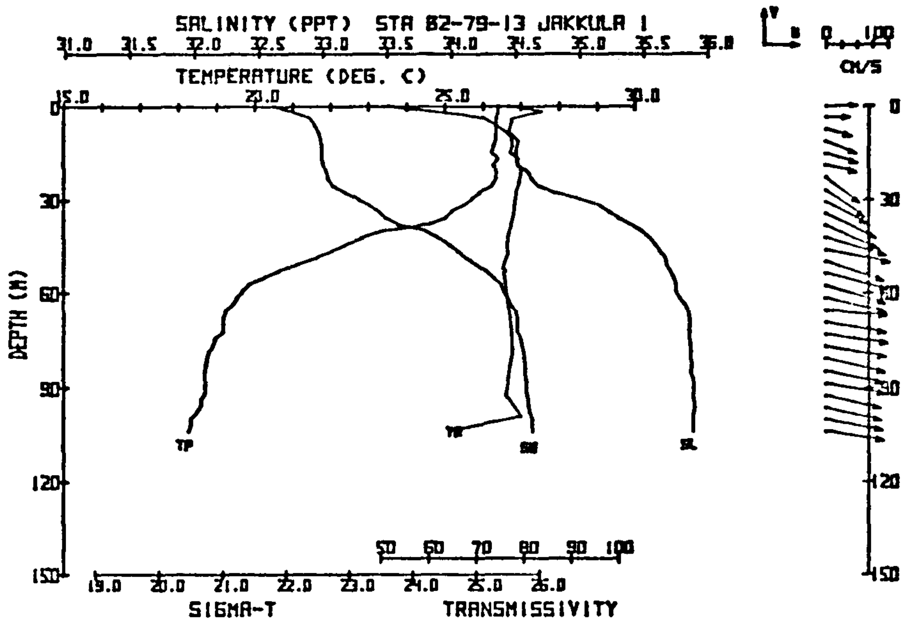

Figure XIV-5. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Jakkula 1.

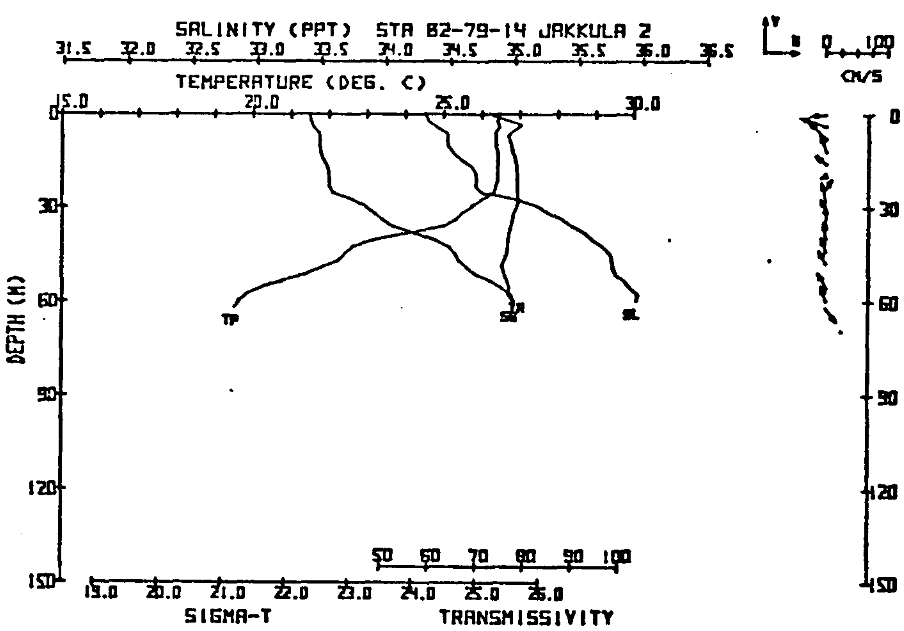

Figure XIV-6. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Jakkula 2.

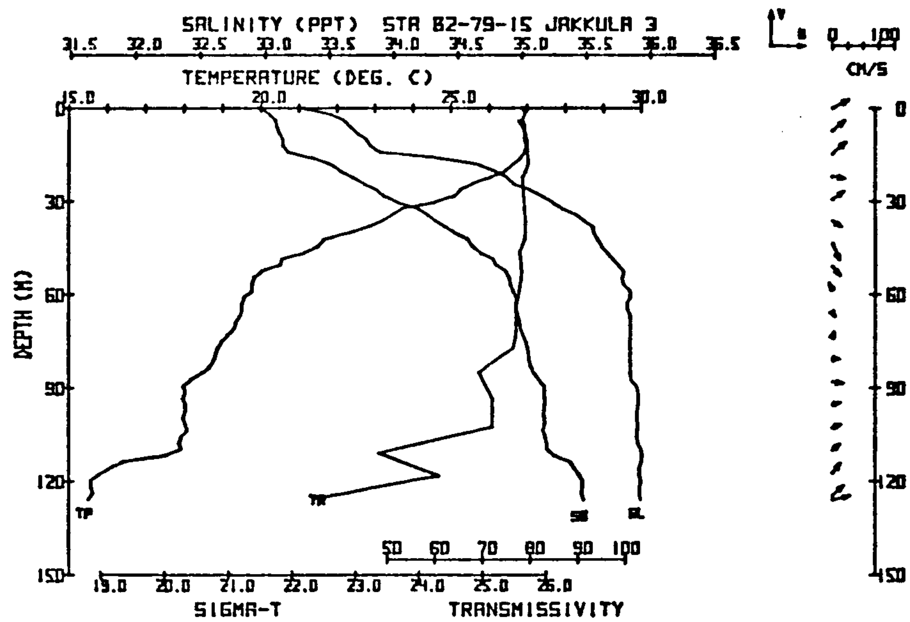

Figure XIV-7. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Jakkula 3.

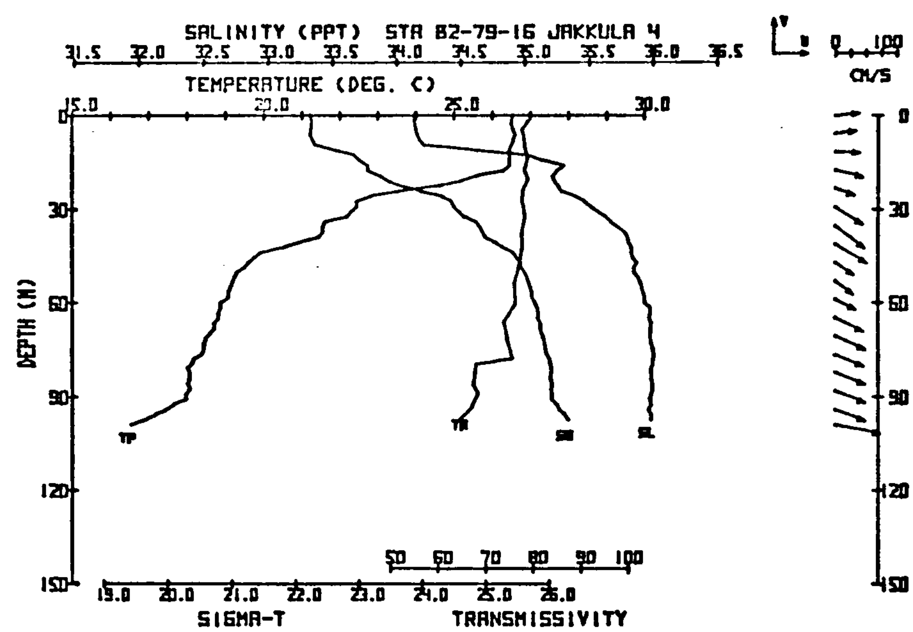

Figure XIV-8. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Jakkula 4.

sediment-laden bottom water penetrated as high as 62 m. To do so, the shallowest water containing elevated levels of suspended sediment would have to have been displaced 36 m above its equilibrium position. It can be demonstrated that such an occurrence would be most unlikely.

Multiple layers of turbidity and step-like structures at the base of station 3 (Figure XIV-7) appear to have originated from interaction of the flow with the bank to the west of the station. The secondary transmissivity minimum at 112 m is at the same depth as the broad platform less than 1 km to the west of the station (Figure XIV-1).

BIOLOGY

(PI: T. Bright)

(Figures XIV-9 through 12, and Appendix D, Table XIV-1)

Jakkula Bank is one of the features with immediate surrounding depths in excess of 120 m and an upper platform well above the lower depth limit of vigorous coralline algal populations. Algal nodules on coarse carbonate sand, therefore, predominate on the bank above approximately 78 m depth (Figures XIV-9, 10, and 11), becoming smaller and less abundant below 76 m depth. The nodules are generally replaced by carbonate sand and gravel below 90 m.

Large drowned reefs of up to 3 m relief and well covered with healthy crusts of coralline algae characterize the break in slope at the edge of the uppermost platform (70-75 m)(Figure XIV-12). Much smaller drowned reefs, less than 1 m high with significant coralline algal crusts, were encountered on sandy bottoms down to 94 m.

At least one species of fleshy green algae also occurs as deep as 91 m on the rocks and on the sand among the scattered carbonate rubble. Leafy algae in general, however, were most abundant on the very top of the bank above approximately 67 m depth.

Small tufts of white filamentous growths resembling algae occur immediately surrounding gas seeps, which are abundant on top of the bank (Figure XIV-10). The presence of these tufts provides the only visually apparent modification of the macrobenthic population in the vicinity of gas seeps.

Hermatypic corals of the genus *Madracis* and either *Agaricia* or *Helioseris*, or both, occur among the algal nodules on the uppermost part of the bank (recorded at 64 m depth). The most frequently seen large benthic invertebrates associated with the nodules above 65 m were the anemone *Condylactis gigantea*, the sponge *Neofibularia nolitangere*, the antipatharians *Cirripathes* sp. and *Antipathes* sp., bush-like growths of serpulid worms (*Filograna* sp.?), and the arrow crab *Stenorynchus* sp. (see also Appendix D, Table XIV-1). A "herd" of large urchins, *Astropyga* sp., was seen on the nodule bottom. The "herd" was accompanied by one or more fishes similar in appearance to young Marbled groupers. It is presumed that the species composition and diversity of benthic algal and invertebrate populations in the Algal-

Sponge Zone at Jakkula Bank are comparable to those of the Algal-Sponge Zones on other shelf-edge banks in the northwestern Gulf of Mexico (viz. 28 Fathom, East Flower Garden, 18 Fathom Banks, etc.).

Several groups of four to five sea hares, Aplysia morio, were observed apparently spawning on the bank crest (64 m)(Figure XIV-9). The animals were clasping each other and emitting strings of brilliant orange material which adhered to the substratum among the nodules.

The edge of the upper platform at Jakkula Bank is indicated by an increase in slope at approximately 67 m depth. Between 67 and 76 m on the upper bank slope, nodules are generally larger than they are at shallower or deeper depths, although the proportion of nodule and associated gravel cover is 80-100%, regardless of nodule size. The percent cover of nodules diminishes with depth below 76 m to approximately 50% at 79 m, 30% at 87 m, and gives way to predominantly carbonate sand with some gravel around 91 m. Conspicuous amounts of finer grained sediment (silt size) are apparent at 97 m, with a gradual increase in fines with increasing depth, transforming to a mud bottom by 135 m and becoming very soft below 145 m. Water turbidity was not great even at 151 m, though there was a noticeable increase in turbidity below 146 m.

Depth-related changes in the substratum are accompanied by changes in the composition of benthic communities. The extinction of significant coralline algal populations between 87 and 94 m has been mentioned. The diverse assemblage of benthic invertebrates and fishes commonly associated with the nodule- and algae-encrusted reefal structures of the Algal-Sponge Zone is generally restricted to depths shallower than 87 m, and many species apparently remain essentially on the upper platform above 75 m. Conspicuous exceptions are the antipatharian Cirripathes sp. seen at all depths down to 98 m, large comatulid crinoids (at 104 m or less), and the arrow crab Stenorynchus (at 108 m or less).

A large population of small comatulid crinoids occurs between 90 and 92 m depth on the sandy, gravel strewn bottom. The occurrence of such populations is typical of the shelf-edge banks in the northwestern Gulf under similar circumstances of depth and substratum type. The smaller crinoids appear to require gravel or nodular material to cling to within the preferred depth range. Where conditions are appropriate, crinoid populations can be enormous.

The soft-bottom community on the lower slope of the bank is characterized by anemone-like cerianthid cnidarians (seen between 100 and 145 m depth), the crab Parthenope portalesii (103-130 m), hermit crabs in Scaphella? or Fasciolaria? shells and in Murex shells (112-147 m), and small fleshy pennatulacean anthozoans (sizeable population around 122 m). Other conspicuous organisms observed on the deepest part of the transect (146-150 m) were squid, scallop, the sand dollar Clypeaster ravenelii, and portunid crabs.

Fish populations at Jakkula Bank are basically similar to those of other nearby shelf-edge banks. Chromis enchrysurus (Yellowtail reeffish), usually numerically dominant among visually detectable bank fishes above 100 m on other banks, was surprisingly scarce on Jakkula Bank at the time the transect was made. Centropyge agri (Cherubfish) was extremely abundant among the algal nodules on the upper part of the bank. Larger fishes tended to occur in greater numbers at the edge of the upper bank platform near the larger drowned reefs (67-70 m depth). Here were observed sizeable schools of Creolefish (Paranthias furcifer) and a considerable number of groupers (Mycteroperca spp.).

Interestingly, at 66 m, a Gray triggerfish (Balistes capriscus) repeatedly picked up and dropped algal nodules and fed upon benthic organisms so exposed. Burrows of the Sand tilefish (Malacanthus plumieri) are abundant among the nodules. Activities of these species and others must have a measurable effect on the configuration of the substratum within the Algal-Sponge Zone.

Hook-and-line fishing near the bank edge resulted in the capture of Red snapper (Lutjanus campechanus), Vermilion snapper (Rhomboplites aurorubens), and Red porgy (Pagrus sedecim).

As is the case on every bank examined, Holanthias martinicensis (Rough tongue bass) is abundant on the deeper drowned reefs (70-98 m). The deep, soft-bottom is frequented by batfishes (Ogcocephalidae), Sea robins (Triglidae), Snake eels (Ophichthidae), and a sizeable population of flatfishes (Pleuronectiformes).

A sea turtle was sighted at the surface while we were anchored adjacent to the bank.

CONCLUSIONS AND RECOMMENDATIONS

Active faults, as evidenced by those that intersect the seafloor, and lack of evidence for collapse of the central portion of the bank warrant the designation of Jakkula Bank as one which may have a very unstable crest that should be monitored.

At the crest of the bank the presence of a large area designated as the Algal-Sponge Zone warrants the protection of this bank by shunting stipulations within a distance of one mile from the 85 m isobath.

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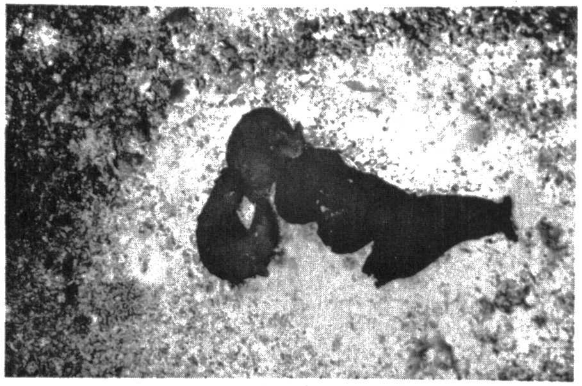

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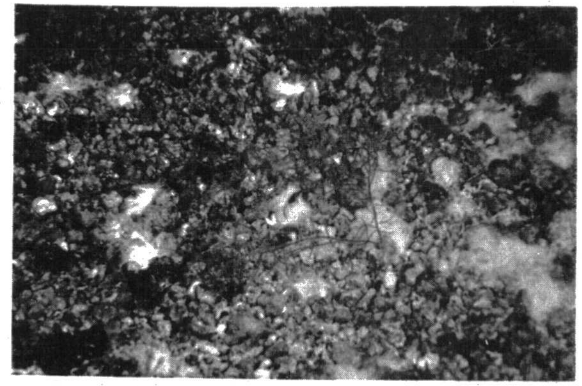

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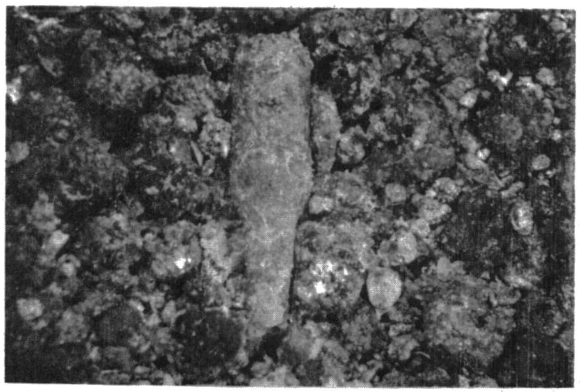

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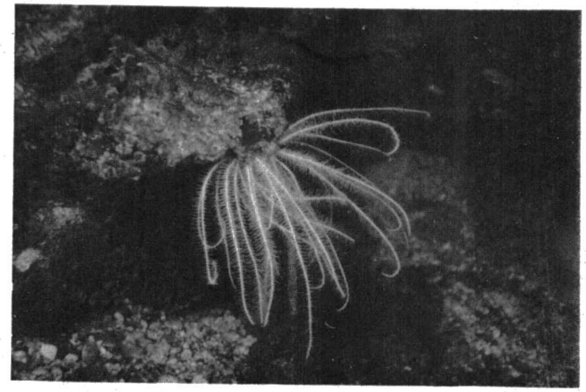

Figure XIV-9 (UL). Jakkula: group of five sea hares (Aplesia morio) apparently breeding on nodule-covered bottom at 64 m depth.

Figure XIV-10 (UR). Jakkula: white areas are filamentous growths surrounding points of emission of natural gas seeps in nodule-covered bottom at 64 m depth.

Figure XIV-11 (LL). Jakkula: beer bottle encrusted with coralline algae among algal nodules at 76 m depth.

Figure XIV-12 (LR). Jakkula: large crinoid on partly drowned reef at 76 m depth.

CHAPTER XV

ELVERS BANK

R. Rezak, T. Bright, T. Hilde,
G. Sharman, L. Pequegnat

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Elvers Bank were limited to mapping and sub-bottom profiling. Results of these studies are presented under the headings Structure and Physiography, Hazards, Sedimentology, and Biology.

GENERAL DESCRIPTION

Elvers Bank is located at 27°49'15"N latitute and 92°53'36"W longitude (Volume One, Figure III-1) in Blocks 109, 110, 153, 154, and 197 of the Garden Banks Area (Figure XV-1). The bank is sigmoid in shape and covers an area of about 55 km^2. Just northwest of the bank, a large conical peak rises from depths of 160 m to a crest of less than 70 m. The northern, east-west ridge on the bank rises to depths between 100-110 m. On the southern ridge, the crest depth ranges between 60 and 70 m. Locally, the slopes on the sides of these ridges exceed 30°. The two ridges are connected by an irregular north-south trending high that reaches a crest at 100 m. The seafloor surrounding the bank has depths of between 180 m and 220 m. The northern ridge is 7.4 km long and about 1.6 km wide. The southern ridge is also about 1.6 km wide but only 4.2 km long. These physiographic features make up one of the most structurally complex banks surveyed during this contract.

Local relief on the bank is primarily related to outcrops and patch reefs (Figure XV-2). On the northern ridge, linear roughness patterns appear to be outcrops of folded and faulted, nearly vertical beds.

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Structurally, the bank consists of tilted fault blocks of stratified rocks bounded by a series of east-west and east northeast-west southwest striking normal faults. Four seismic sequences were mapped in addition to areas of possible carbonate reef build-up. They are: 1) acoustic basement, which is generally poorly reflective but seems to consist of stratified beds (constituting the exposed core of the bank); 2) a lower sequence that onlaps the acoustic basement and consists of stratified sedimentary rock and is truncated and exposed in numerous places along the margins of the acoustic basement sequence; 3) a middle sequence that overlies and onlaps the lower sequence, has been erosionally truncated, and crops out on the seafloor without Recent sediment

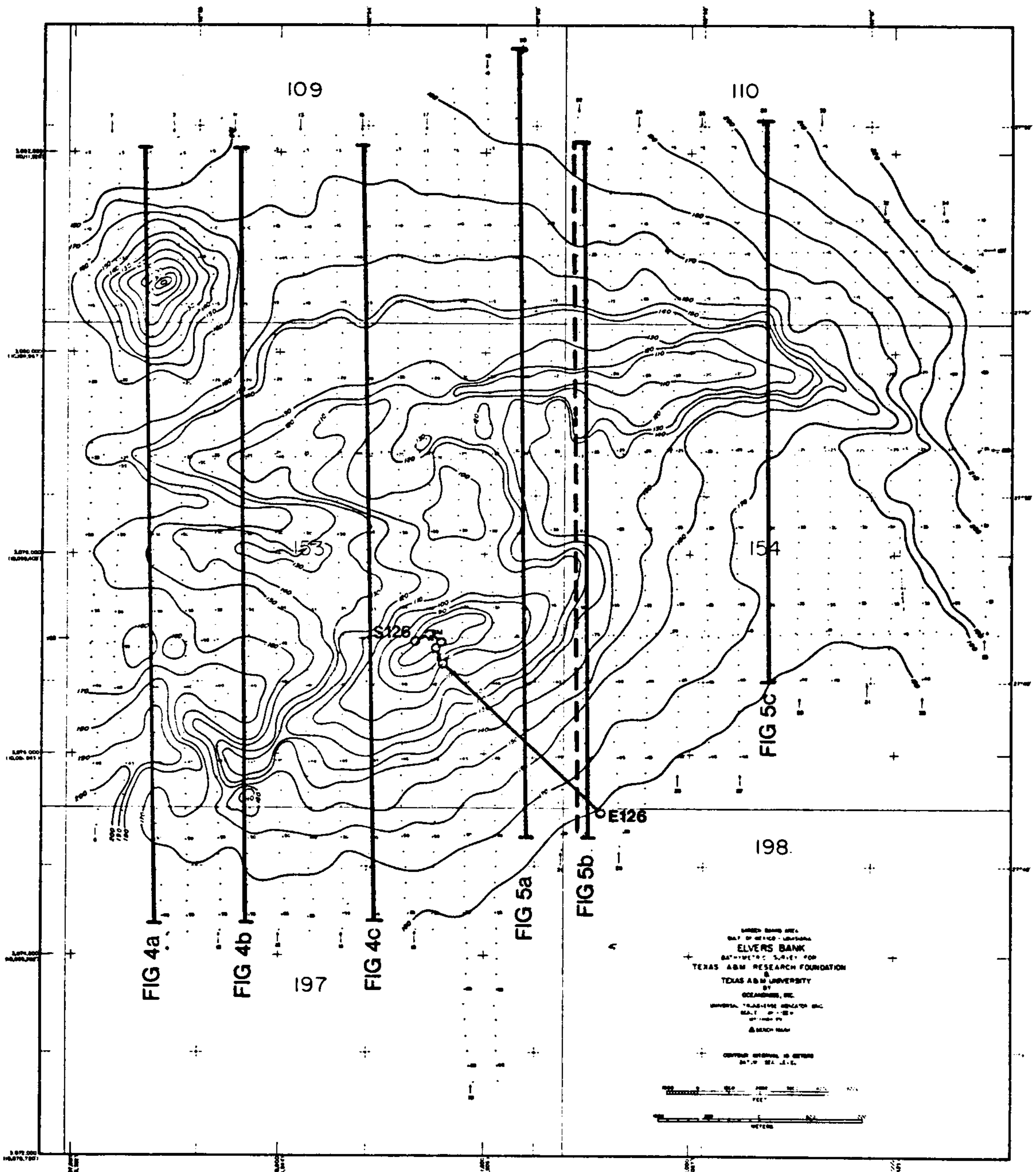

Figure XV-1. Bathymetry of Elvers Bank. Locations and number of boomer and 3.5 kHz reflection profiles shown in Figures XV-4, 5, and 6 are indicated. Submersible transect, dive 126: S = Start, E = End.

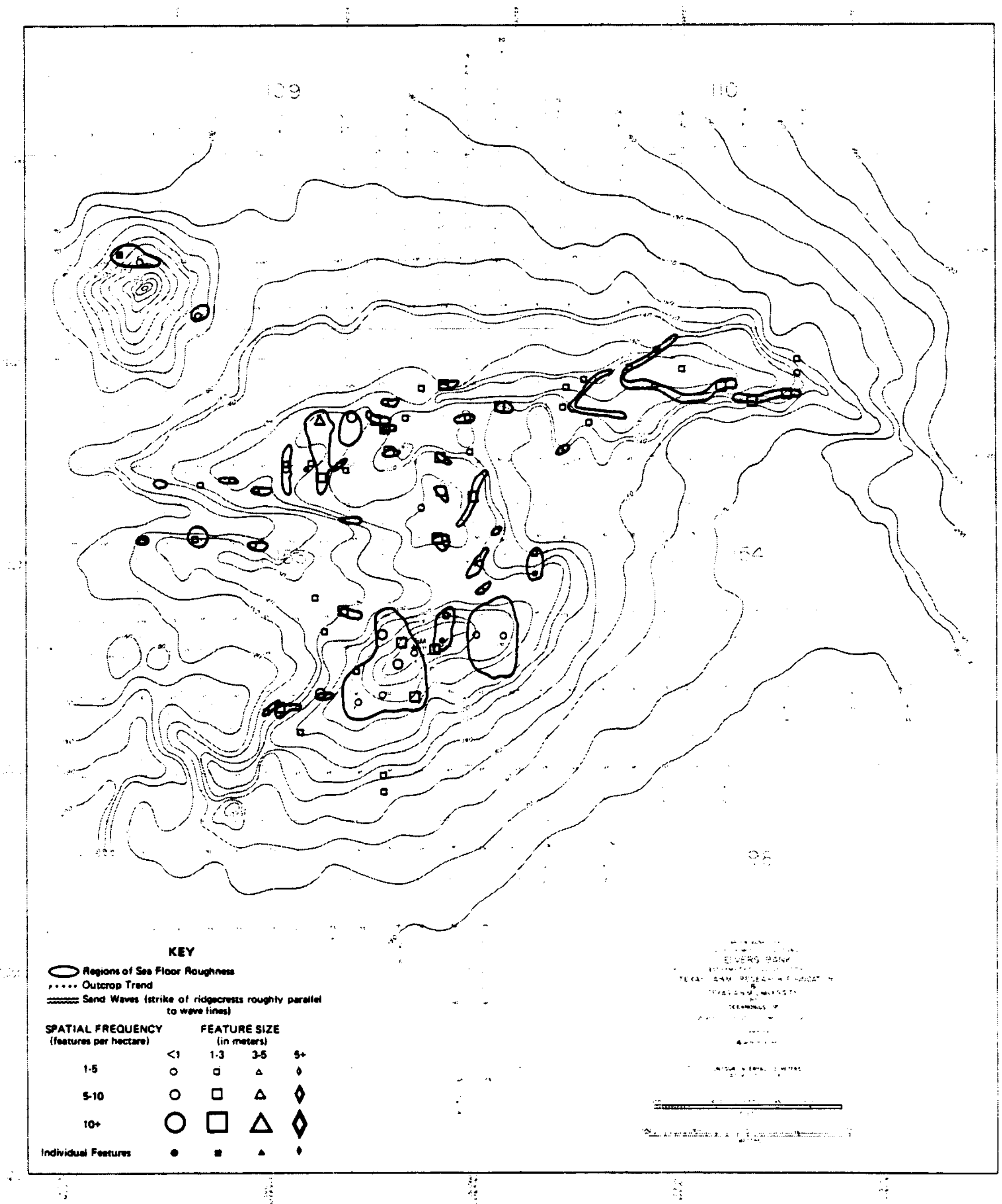

Figure XV-2. Seafloor roughness, interpreted from side-scan sonar records.

cover in most of the area surrounding the bank; and 4) a wedge of Recent unconsolidated sediment that onlaps the middle sequence on the lower northeast slope of the bank. All of these sequences are reflective to varying degrees and are separated by unconformities against which onlap reflection termination patterns are clearly displayed. Truncation of the middle sequence reflectors over broad areas of the seafloor and the reflectors of the lower sequence and acoustic basement along the ridges indicate extensive erosion during subaerial exposure (Figures XV-4, 5,and 6).* Two facts indicate that uplift has been ongoing and is presently or recently active: 1) onlapping beds are progressively more steeply dipping with depth; and 2) all faults cut the seafloor.

Most of the faults that occur on the bank strike east-west between the two major ridges (Figure XV-3). The two ridges are essentially erosional remnants of an anticlinal arch, the crest of which has been breeched by normal faulting (Figures XV-4, 5, and 6). Erosional truncation and outcrops of resistant units are displayed high on the outer flanks of the two ridges (Figures XV-4a, 4c, 5, and 6).

The large circular peak in the northwest corner of the survey area is also mapped as a basement unit (Figures XV-1 and 3) because it lacks internal reflectors. It is apparently fault controlled and may represent an uplifted block on top of which there is extensive carbonate reef growth.

Evidence for carbonate reef growth can be seen on the lower flanks of the southern ridge in Figure XV-4b and c. Typically, these small peaks are not related to the underlying structure, lack internal reflections, and wipe out the seismic signal beneath them.

HAZARDS
(PI: R. Rezak)

Elvers Bank is extensively faulted and most of the faults displace the seafloor. This displacement suggests that activity on the faults has been Recent. Activity of faults may be expected to continue because 1) the bank is located at the shelf edge; 2) the dominant orientation of the faults is parallel to the shelf edge; and 3) there is a history of Recent movement along the faults.

There is no obvious evidence for gas seepage either in the water column, as vents on the seafloor, as bright spots, or as gas-produced reflector wipeout within the structure of the bank.

Slope stability may be an important consideration on the steeply dipping beds on the flanks of the bank, depending upon the degree of consolidation of the sediments. However, slumping is not evident on

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*For the sections of seismic reflection profiles shown in Figures XV-4, 5, and 6, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

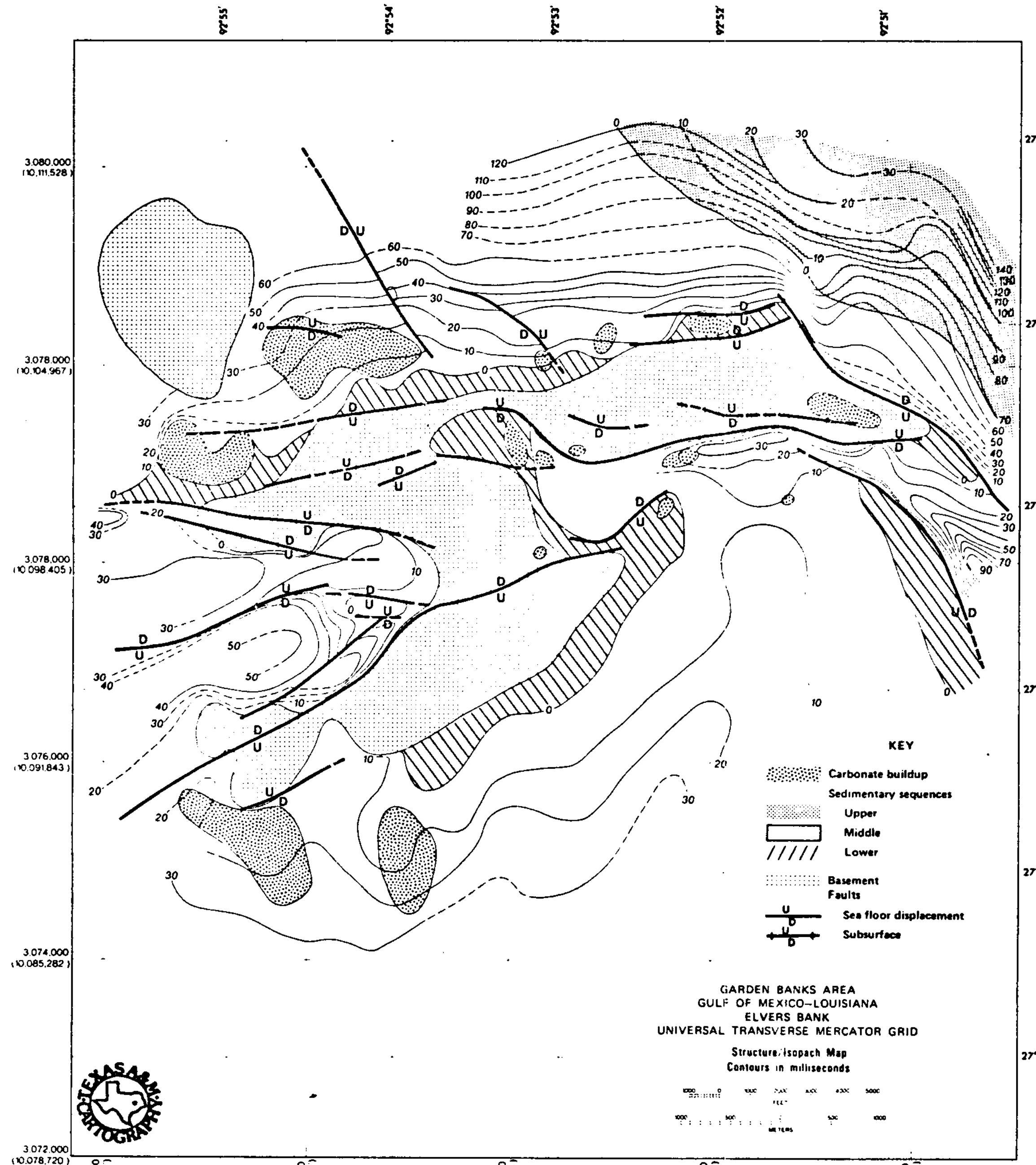


Figure XV-3. Structure/isopach map of Elvers Bank. Contours represent thicknesses of surrounding sedimentary sequences.

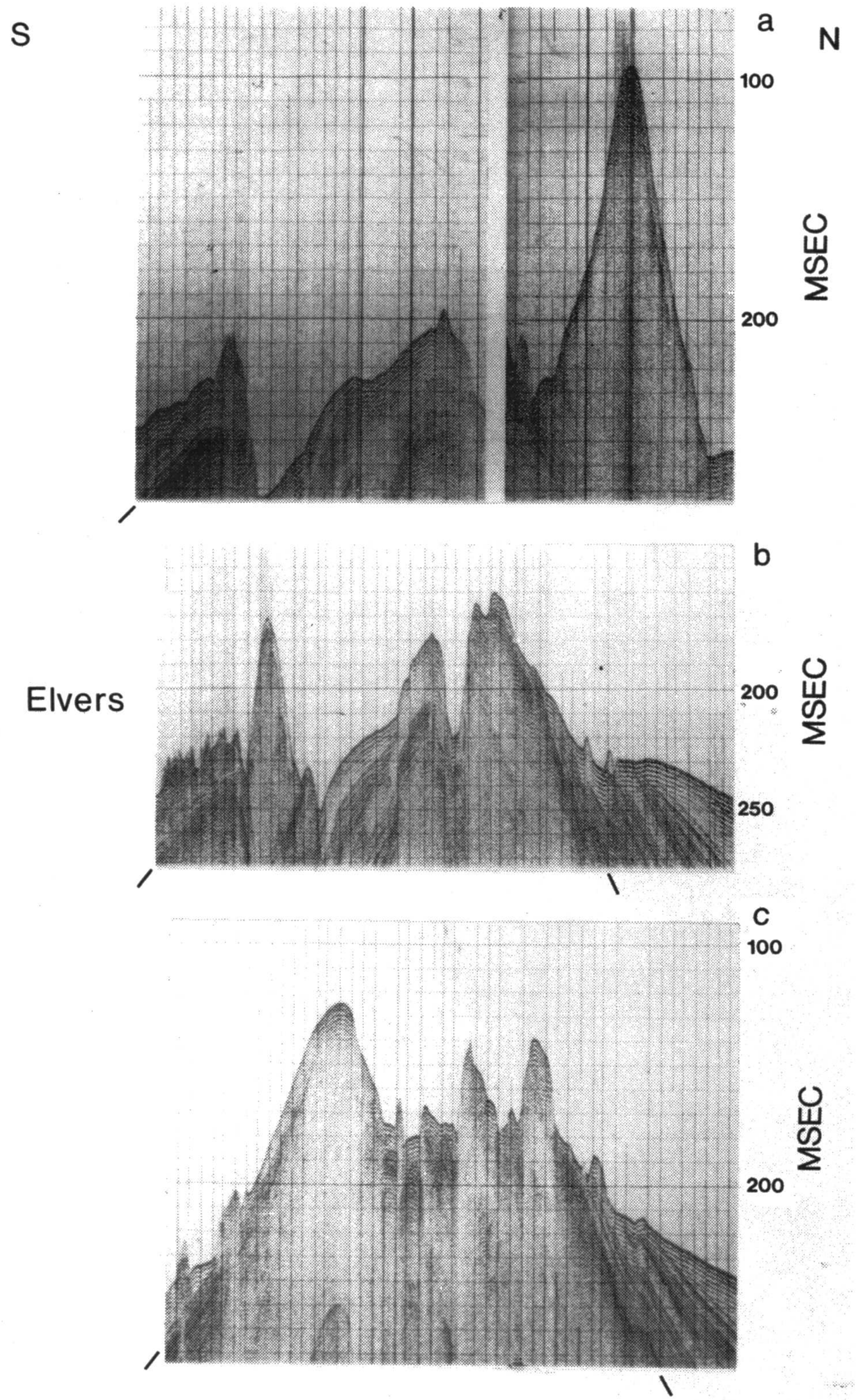


Figure XV-4. N-S boomer seismic reflection profiles. Locations are indexed on Figure XV-1. The base of the intermediate, or middle, sequence in Figure XV-3 is indicated along the record margins.

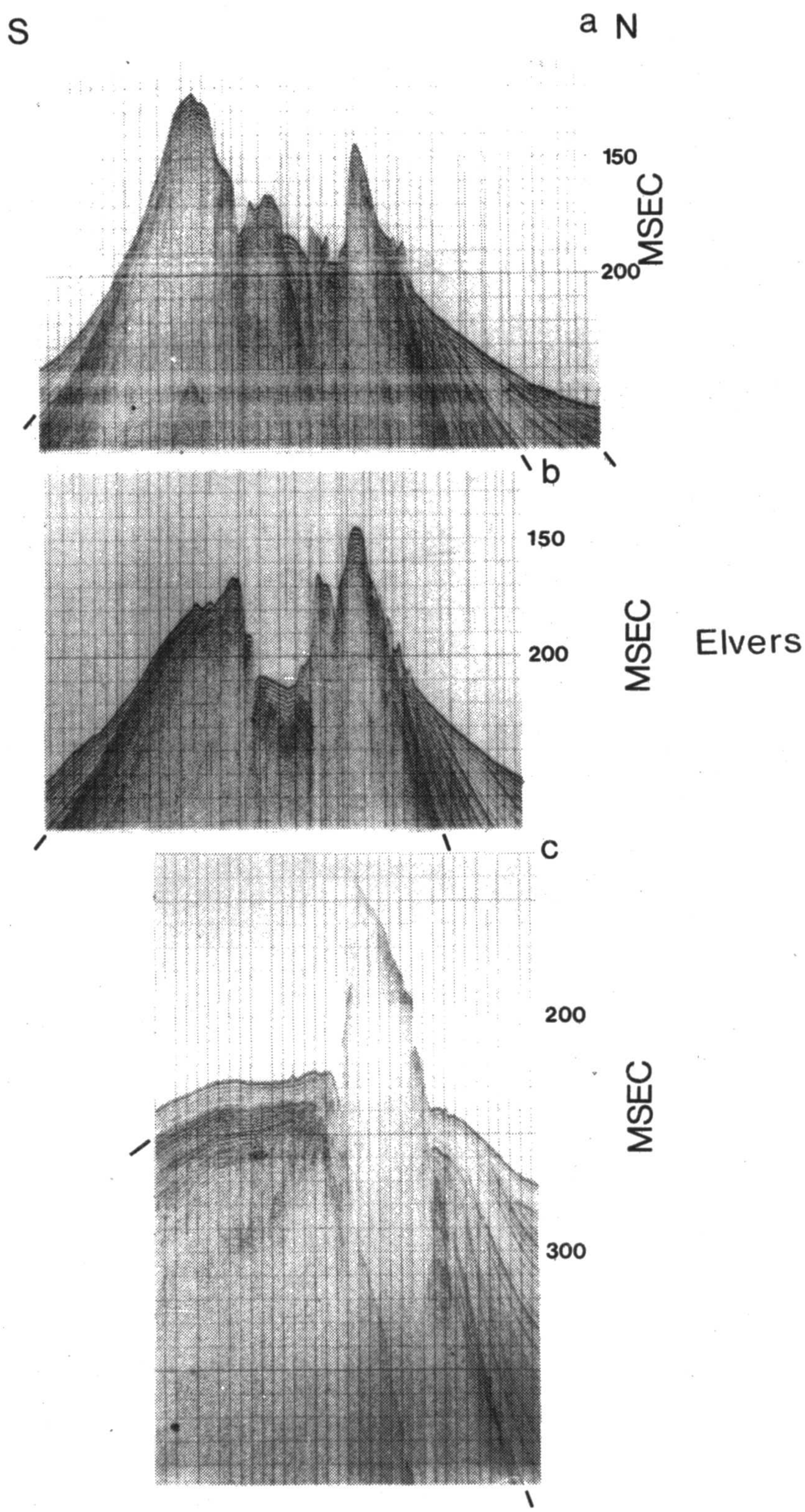


Figure XV-5. N-S boomer seismic reflection profiles. Locations are indexed on Figure XV-1. The bases of the intermediate or middle, and the upper sequences in Figure XV-3 are indicated along the record margins.

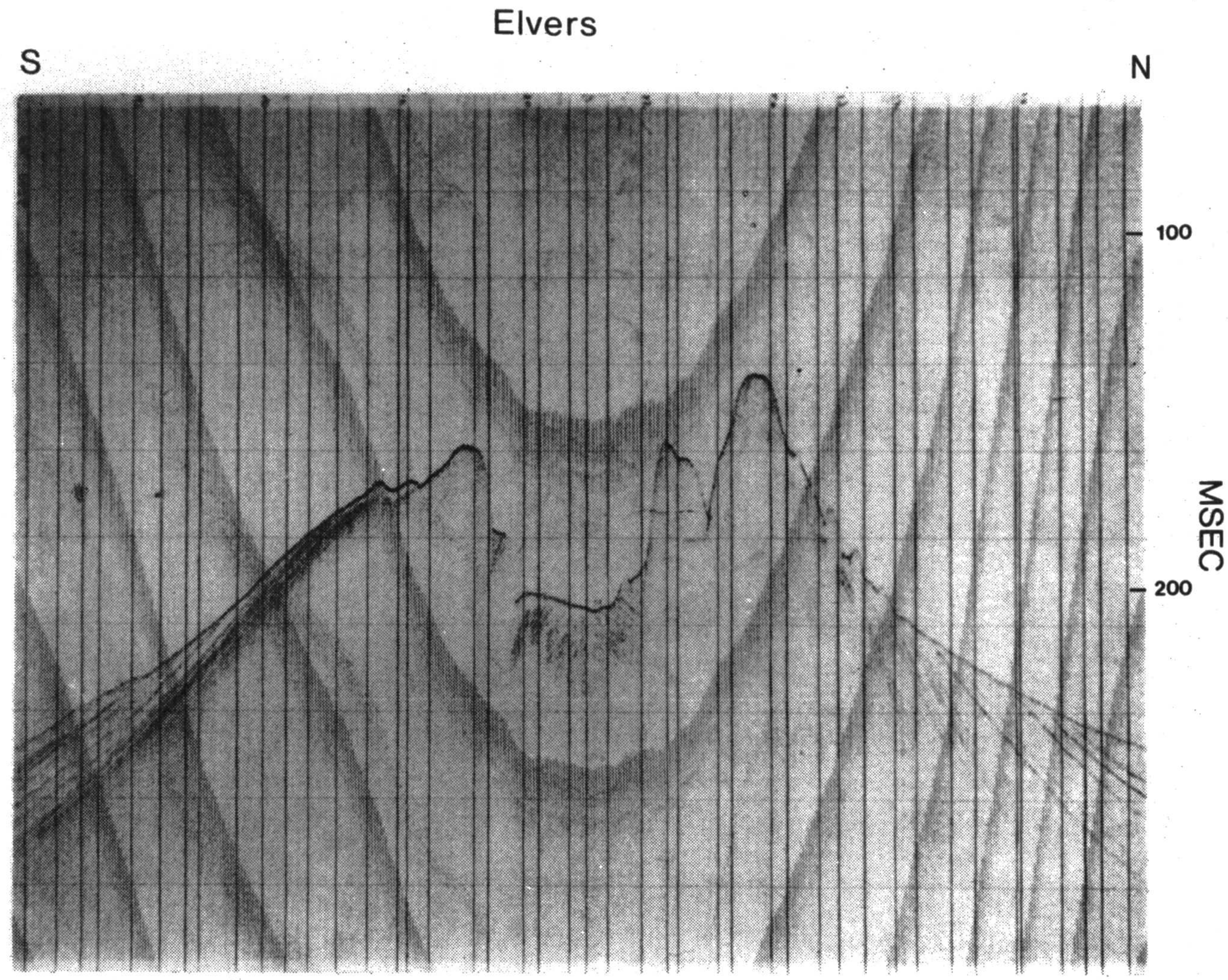


Figure XV-6. The 3.5 kHz profile across Elvers Bank (indicated by a broken line on Figure XV-1).

the bank except for the hummocky topography on the south slope of the southern ridge (Figure XV-4a).

SEDIMENTOLOGY
(PI: R. Rezak)

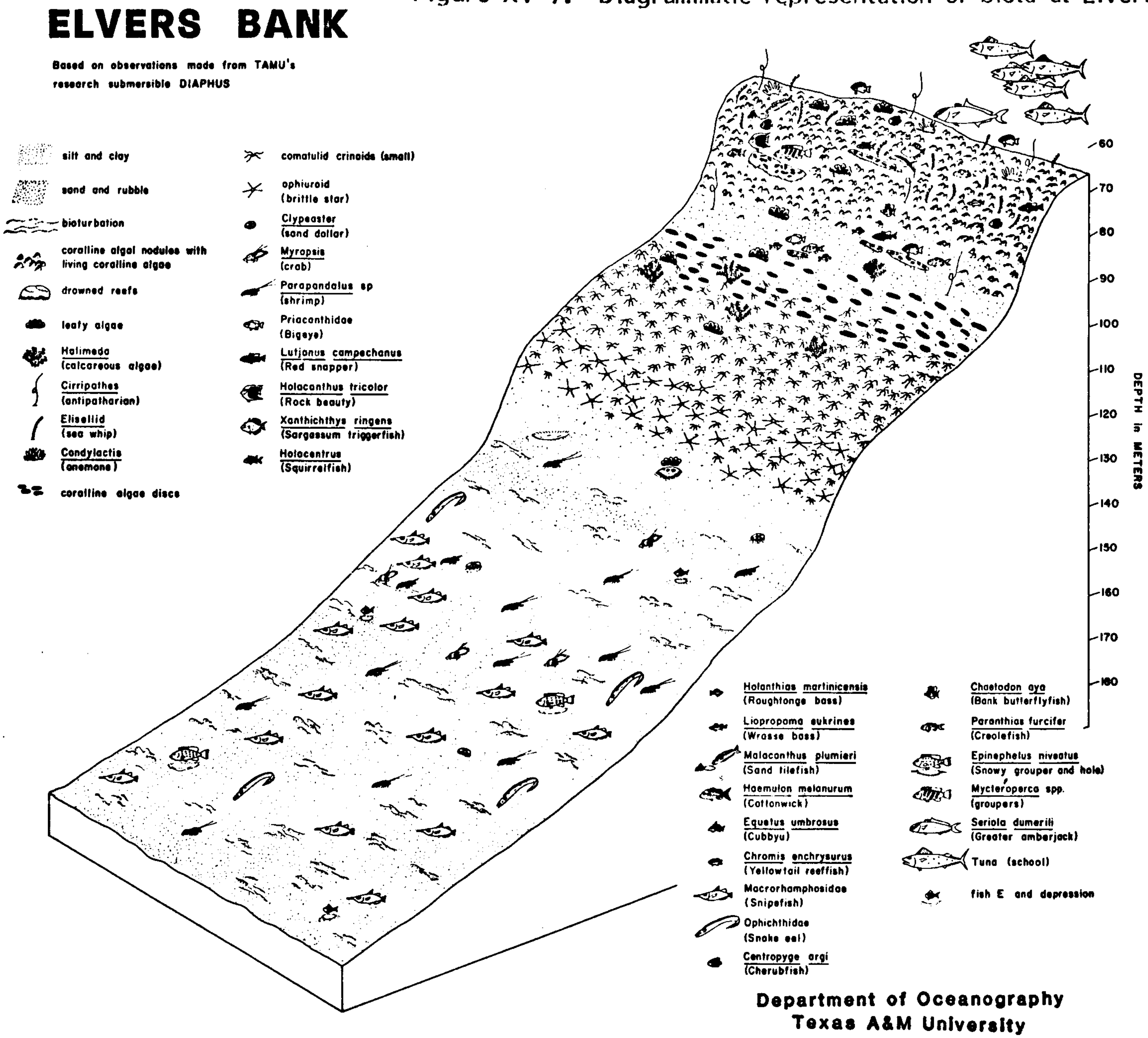
No sediment sampling was carried out at Elvers Bank, but one submersible transect (dive 126) (see Figure XV-1) was made on the southern slope of the south ridge. On this transect the sediment facies seem to correlate fairly well with the facies at the Flower Garden Banks. The living reef and the coral debris facies are absent at Elvers Bank. The top of the southern ridge is covered with large algal nodules of the Gypsina-Lithothamnium Facies. This facies continues to a depth of 84 m, where a coarse carbonate sand was encountered. This is most probably the Amphistegina Sand Facies. Carbonate sand is the predominant sediment down to about 110 m. Below that depth, and as depth increases, more and more mud size sediment is encountered. Drowned reefs were observed at depths of 71 m, 77 m, and 90 m.

BIOLOGY
(PI: T. Bright)
(Figures XV-7 through 11, and Appendix D, Table XV-1)

Elvers Bank has substantial vertical relief, rising from surrounding depths approximately 200 m to a crest slightly shallower than 70 m. Substantial areas of sea bottom deeper than those found on the flanks of most of the other shelf-edge banks provide habitat wherein exist deep, bank-related soft-bottom communities not previously encountered. High relief, or the lack of it on other banks, may be a significant factor influencing the distribution of benthos sensitive to light and suspended sediment.

Calcium carbonate secreting coralline algae are the overwhelmingly dominant organisms on the uppermost part of Elvers Bank. Above 76 m, 75-100% of the bottom is covered with large coralline algal nodules, accompanied by carbonate gravel and underlain by coarse carbonate sand (Figures XV-7 and 8). Below 84 m, the large nodules are replaced by a carbonate sand with substantial amounts of carbonate gravel and shell material bearing live crusts of coralline algae. Between 90 and 97 m, an abundant population of very thin, pancake-sized discs of coralline algae occurs, covering over 20% of the sand and rubble bottom in places (Figure XV-10). This zone of algal discs terminates rather abruptly at 97 to 98 m depths. Living coralline algae encrust gravel, flakes, and chips lying on the sand to depths of at least 108 m, but populations of coralline algae are substantially reduced on the unconsolidated sediment below 100 m. Carbonate sand with gravel persists as the predominant sediment down to approximately 110 m. Below this, with increasing depth, greater and greater amounts of silt size and clay size particles are present.

Figure XV-7. Diagrammatic representation of biota at Elvers Bank.



Abundant covers of coralline algae occur on reef rock down to at least 94 m depth (Figure XV-9). A 10-15% live coralline algae cover was observed on a small (1 m high) boulder-like reefal structure encountered at 123 m in a hole in the sand and silt bottom. Significant algal populations on rocks at this great depth have not been seen on other banks studied in the northwestern Gulf (with the exception of Geyer Bank, which has relief and surrounding depths similar to Elvers Bank).

It is suspected that the extreme depths to which living coralline algae extend on Elvers and Geyer Banks are in some way related to their greater relief compared to neighboring shelf-edge banks. Possibly, the high relief tends to reduce the frequency of occurrence and magnitude of turbid nepheloid layers at mid-depths on the bank, thereby facilitating deeper and more continuous penetration of light essential to algal growth. Thus at Elvers and Geyer Banks, environmental circumstances may be such that downward limits of algal distribution are controlled primarily by the extent of light penetration through rather clear water, uncomplicated by the blocking effects of greatly increased turbidity, which reduces the degree of light penetration at similar depths on the other banks.

Populations of leafy algae parallel those of the coralline algae, being most abundant among the large algal nodules above 84 m. A green filamentous species was particularly conspicuous at the time observations were made (October 1978). A fleshy green variety (Codium sp.) occurred throughout the range of coralline algae, even on the rock at 123 m depth. The green calcareous algae, Halimeda spp., were seen from 82 to 97 m and shared predominance with the coralline algal discs between 95 and 97 m depth, contributing considerably to the coarse fraction of the carbonate sand substratum.

The population of invertebrate animals at Elvers Bank is composed of species found also on other shelf-edge carbonate banks of similar depth, structure, and distance from shore in the northwestern Gulf of Mexico. On the upper part of the bank, Cirripathes is conspicuous down to 91 m; Antipathes is present above 85 m; ellisellid octocorals are extremely abundant above 72 m; the anemone Condylactis gigantea is numerous above 225 feet; stichodactyline anemones are very abundant at 69 m; Spondylus americanus is fairly abundant above 79 m; a mating group of the sea hare, Aplysia morio, was seen at 66 m; Neofibularia, Geodea, Agelas, tethyids and other sponges are present; large crinoids and basket stars are present near the bank's crest; starfish are fairly abundant above 79 m; and arrow crabs (Stenorynchus sp.) occur down to 119 m and are numerous above 78 m.

Hermatypic corals were rarely seen, the only sighting noted being a colony of saucer-shaped agariciids at 64 m. Otherwise, the invertebrate assemblage associated with the algal nodules is comparable to that of banks such as 28 Fathom Bank and the East Flower Garden Bank. Small comatulid crinoids, probably Hypolometra sp., attain numerical predominance among conspicuous organisms on the soft bottom between 95 and 122 m depth, with population levels of 50-60/m^2 in places, possibly more (Figure XV-11). Similar populations of small ophiuroids ($30-40/m^2$) were seen on the same bottom between 108 and 113 m.

The position of the immense populations of small crinoids (seen on similar bottoms at other banks) is correlated with a transition in substratum from primarily sand and gravel to a mixture of silt, clay, sand, and small amounts of gravel at approximately 122 m. The trend toward increasing predominance of fine-grained sediment continues with increasing depth resulting in softer, muddier bottom at 131 m and deeper.

The assemblage of benthic invertebrates and fishes inhabiting the large expanse of mud bottom creates total surficial bioturbation. Mounds, depressions, tracks, trails and burrows of various sizes are abundantly present. The most spectacular "bioturbator" is the Snowy grouper, Epinephelus niveatus, which digs deep, vertical holes in the bottom up to 1/3 m diameter. Apparently, when older or abandoned, the walls of these holes collapse to form cone-shaped depressions a metre or so in width and depth. Some depressions seen were almost 6 m across and a metre or so deep. Several Snowy groupers lurking in sizeable depressions between 167 and 177 m were observed to dive down burrows in the bottom of the holes as the submersible passed. Smaller bowl-shaped depressions several inches deep but without burrows are occupied by an unidentified bottom fish (Fish E), the population of which is substantial below 128 m.

The most abundant fish frequenting the mud bottom is a small snipefish, Macrorhamphosus. Between 146 and 180 m, a tremendous population of these odd-shaped fishes was encountered unevenly spaced but averaging about one animal per 3 m linear distance. Their typical stance is snout down, hanging vertically several centimetres to a metre above the bottom. There is no indication that they have burrows since their escape reaction involves swimming away horizontally rather than diving into holes in the bottom. The distribution and stance of these fish are probably similar day and night; they were observed during daylight hours at Geyer Bank and at night at Elvers Bank. Other fishes seen on the soft bottom included a substantial number of eels (apparently ophichthids, mostly less than 0.3 m in length, but one of which was 1.5 m long); several small flatfish; a few hake-like fish; several fish shaped somewhat like brotulids; sea robins; and one which resembled a tilefish, Lopholatilus sp. Reliable identifications of these fish based on brief sightings were impossible.

Small shrimps (Parapandalus sp.) are abundant on the deep mud bottom between 126 and 180 m, and possibly deeper. Around 146 m, they were numerically predominant and the most conspicuous organism on the bottom. The species was seen in great abundance on the drowned reefs on Diaphus Bank at shallower depths during the daytime. The Elvers Bank observations were made at night. There is, therefore, the implication of possible diurnal depth migration for this species but such migration is highly speculative without additional information. Other species of shrimp were seen on the mud bottom at Elvers Bank. One individual had the size and appearance of a commercial variety of penaeid shrimp.

Crabs are significant components of the mud zone. Hermit crabs in *Scaphella*? or *Fasciolaria*? shells, auger shells, and *Murex* shells were seen from 126 to 176 m. The crabs leave numerous tracks on the bottom. Small mud crabs, Xanthidae, and a type of grapsoid crab were associated with burrows at 160 to 165 m, and probably at other depths. *Myropsis* sp. was the most conspicuous of the crabs. One pair of this species appeared to be joined in mating posture adjacent to a burrow. Long-armed swimming crabs, Portunidae, were seen occasionally below 122 m.

A very substantial population of small galatheid crustaceans was in evidence below 177 m (580 feet); they were particularly abundant around the borders of large grouper holes where cohesive mud was exposed. One mantis shrimp was seen at 152 m depth.

Among the molluscs of the mud bottom, squid were encountered most frequently (120 to 177 m). These were probably pelagic species which also frequent the soft bottom. Much zooplankton was seen just above the bottom, and it is possible that zooplankton abundance is greater there than in the overlying water column, thereby making the near benthos a choice feeding zone for active raptors such as squid and the several types of fishes mentioned above.

Other living mud zone molluscs included a population of sea pens, Pinnidae (134 to 168 m), and an *Octopus* sp. seen in a beer bottle at 177 m (several other bottles on this bottom also contained live organisms).

Echinoderms are present on the mud bottom but not in the overwhelming numbers seen at shallower depths. Sea urchins, *Stylocidaris* sp., occur between 119 and 131 m, but the population seen at Elvers Bank was sparse by comparison to *Stylocidaris* populations seen on several other banks. Sand dollars, *Clypeaster ravenelii* (126 to 160 m), are more numerous and leave rather broad tracks, adding substantially to surficial bioturbation.

CONCLUSIONS AND RECOMMENDATIONS

Most of the faults on Elvers Bank displace the seafloor, indicating that it is a tectonically active bank. **Extreme caution should be exercised prior to placing any kind of structure on this bank.**

The distribution of benthic biota on Elvers Bank, particularly at the great depths to which algal populations extend, indicates a somewhat different balance of environmental factors influencing populations at this bank compared to banks bearing similar communities slightly closer to shore (28 Fathom, 18 Fathom, the Flower Garden Banks, etc.). The obvious physical difference is Elvers Bank's greater base depth and consequent greater relief. Also to be noted is the failure to detect substantial turbidity in the bottom water at Elvers even at 180 m during the reconnaissance dive. Simplistically, biological conditions at Elvers and Geyer Banks seem to imply that the greater the relief of the bank the less likely it is for turbid water layers to occur at mid or shallow depths on the bank.

We can only speculate concerning the ecological significance of interrelationships between light, water clarity, turbulence, circulation, sediment suspension, sedimentation, turbidity, geological structure, and other environmental factors. That balances occur between these natural factors greatly influencing hard-bank benthic populations is, however, certain. Careful observation and study of the aforementioned factors and processes relating to them at several selected banks could do much to clarify critical aspects of natural physical-geological-biological interrelationships on and around the banks.

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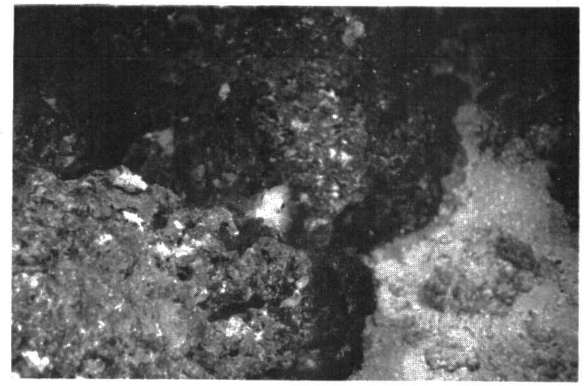

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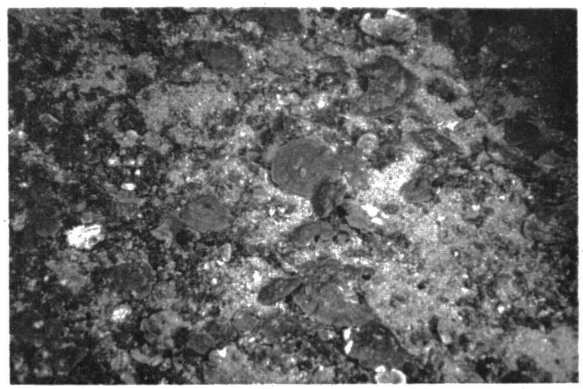

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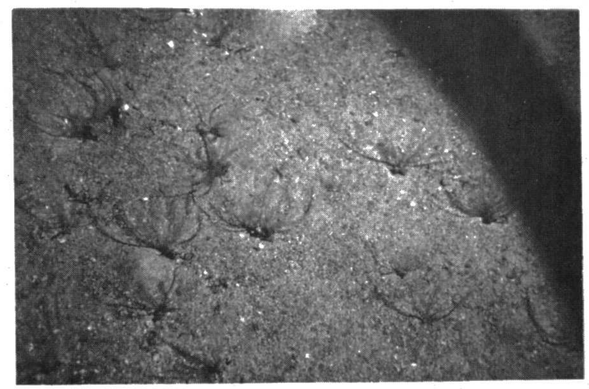

Figure XV-8 (UL). Elvers: algal nodules and alcyonarians at 67 m depth.

Figure XV-9 (UR). Elvers: small scorpionfish on partly drowned reef covered substantially by coralline algae. Carbonate sand in lower right, 90 m depth.

Figure XV-10 (LL). Elvers: pancake-like growths of coralline algae lying on sand and gravel bottom at 92 m depth.

Figure XV-11 (LR). Elvers: extremely abundant small crinoids clinging to gravel on sandy bottom at 117 m depth.

CHAPTER XVI

GEYER BANK

R. Rezak, T. Bright, T. Hilde,
G. Sharman, L. Pequegnat

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Geyer Bank were limited to mapping and sub-bottom profiling. Results of these studies are presented under the headings Structure and Physiography, Hazards, Sedimentology, and Biology.

GENERAL DESCRIPTION

Geyer Bank is located at 27°51'17"N latitude and 93°04'09"W longitude (Volume One, Figure III-1). The bank lies in the Garden Banks Area, Blocks 105, 106, 149, 150, 193, and 194 (Figure XVI-1).

Situated just south of the shelf break on the upper continental slope, the bank rises from depths of 210 m on the north and 190 m on the south. It is a north-south elongated structure covering about 55 km^2 in area. The steepest slopes are found at the northern end of the bank, with gentle slopes on the east and west sides and moderately steep slopes on the southeast and southwest sides. The bank is "ham-shaped" with the "shank" end to the north. The top of the bank is broad and relatively flat, with prominences on the north and south ends rising to depths of less than 60 m and separated by a saddle around 90 m depth.

The unusual distribution of depths surrounding the bank is due to the fact that Geyer Bank is the northern part of an arcuate salt diapir complex. The southern boundary of Geyer Bank is on a saddle between the bank and the next diapir to the south.

STRUCTURE AND PHYSIOGRAPHY
(PIs: R. Rezak and T. Hilde)

The internal structure of the core on Geyer Bank is difficult to interpret because the surface of the bank reflects a large part of the seismic energy. This difficulty is well illustrated on the profiles in Figure XVI-4 by the strong surface return and the presence of a strong multiple.* However, the surface configuration of the bank, as shown on

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*For the sections of seismic reflection profiles shown in Figures XVI-4 and 5, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

Figures XVI-4 and 5, gives some clues to the structure. These are substantiated by direct observations of the bottom from the submersible during dive 127 (Figure XVI-1).

Two structural units were mapped on the basis of the seismic profiles: 1) the acoustic basement, which underlies most of the bank proper; and 2) the surrounding stratified and tilted sedimentary sequence. The acoustic basement displays very weak internal reflective patterns due to the loss of signal strength by reflection from the hard surface of the bank and the nearly vertical bedding surfaces within the bank proper. Outcrops of nearly vertical beds were observed during dive 127. The overlying stratified unit, seen on the flanks of the bank, is bounded above by the seafloor and below by a more steeply dipping sequence upon which the mapped unit overlaps (Figures XVI-3, 4, and 5). The lower limit of the mapped unit is indicated at the margins of the boomer profiles in Figures XVI-4 and 5. Contours of this sequence are isopachs representing thickness of the unit or depth below the seafloor to its lower boundary. Clearly, there are highly reflective, parallel bedded sediments beneath this unit, extending to considerable depth, but these were not mapped because a lower boundary could not be determined.

It is apparent that the overlapping sediments are progressively more steeply tilted along the margin of the bank with increasing depth (Figures XVI-4 and 5). Numerous pinch-outs within the surrounding sediments section suggest that the bank has been exposed to subaerial conditions several times (Figures XVI-4c, 5a, and 5b).

The steep slopes on the margins of the bank are most likely fault scarps. Only one major and two minor faults have been mapped on the basis of sub-bottom data. However, the numerous nearly vertical slopes on the upper surface of the bank are probably fault scarps, indicating that the upper part of the acoustic basement unit is more extensively block faulted than appears on the structural map (Figure XVI-3). The areas mapped as slumps on that figure may also be fault blocks.

The entire bank is essentially fault bounded. The zero isopach or limit of exposed acoustic basement may be considered to be a series of interconnected faults caused by the upward thrust of the salt diapir. The faults on the top of the bank, those inferred from topographic expression and direct observation of nearly vertically oriented beds, are most probably normal faults caused by collapse of the crest of the bank due to the removal of salt by dissolution.

It should be noted that the darker subsurface area, just beneath the surface at the top of the bank on each of the boomer profiles, is an artifact created by a malfunction of the recorder signal gain control. It does not represent real structure.

HAZARDS
(PI: R. Rezak)

The seismic profiles indicate little evidence for gas either being vented or within the sediments at Geyer Bank. However, during dive 115

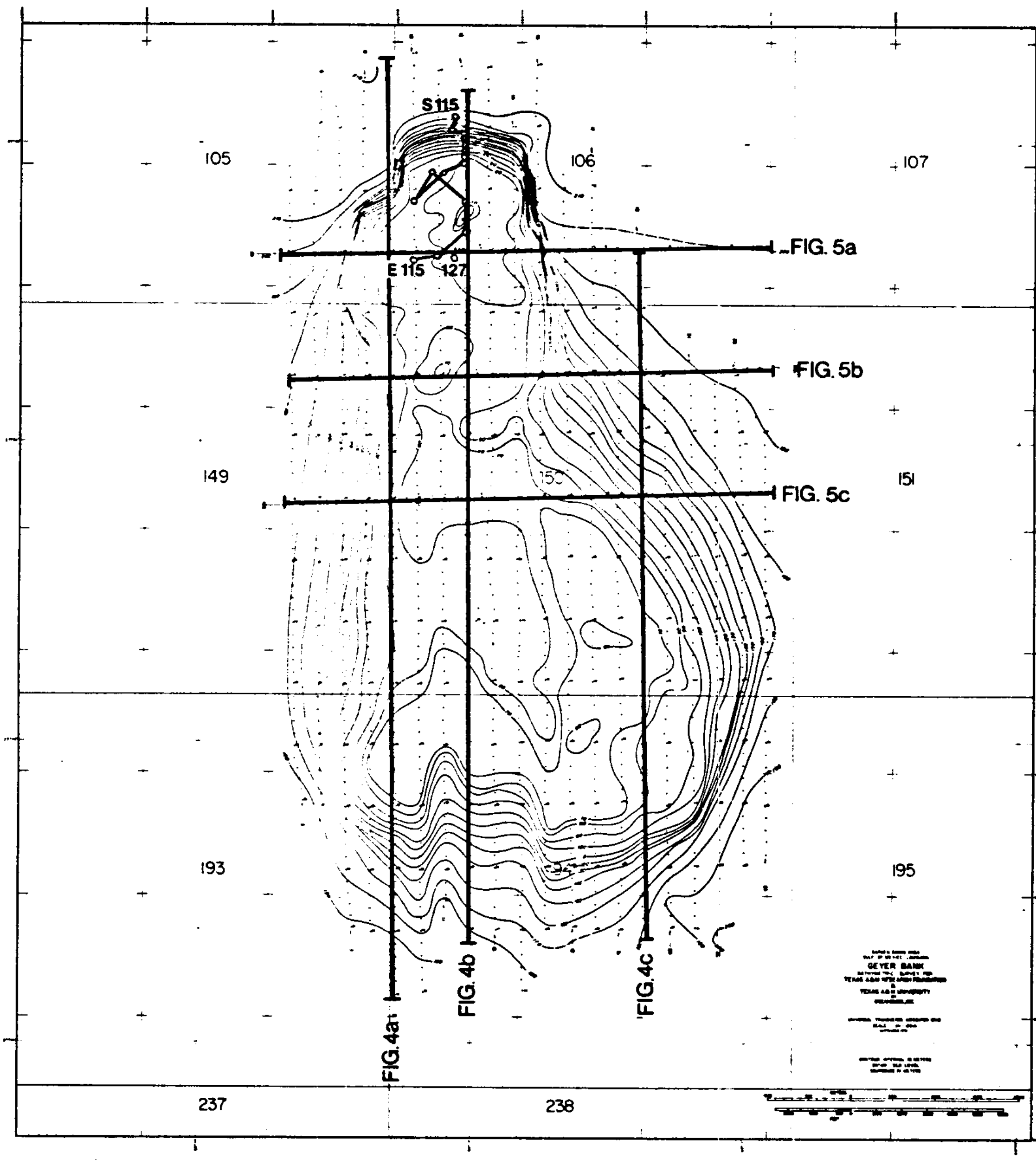


Figure XVI-1. Bathymetry of Geyer Bank. Location and figure number of boomer seismic reflection profiles. Submersible transects, dives 115 and 127: S = Start, E = End.

(Figure XVI-1), an area of gas seeps was encountered at a depth of 82 m. Faulting is the primary hazard on the bank, and the entire upper surface of the bank should be suspect in terms of the possibility of collapse. Recent movement along faults at the top of the bank is suspected because of the presence of bare rock outcrops along with outcrops that are relatively heavily encrusted by coralline algae and other organisms. If all outcrops on the bank had been exposed at the same time, then all of them should now be encrusted with nearly the same amount of reef-building organisms.

SEDIMENTOLOGY
(PI: R. Rezak)

Although no sediment samples were taken on Geyer Bank, seismic and side-scan sonar data together with direct observations of the bottom from the submersible give a general idea of the nature of the sediments on the bank. There is little or no evidence on the boomer and 3.5 kHz records for recent sediment cover on top of the bank. However, the side-scan sonar records show large areas of sand waves in the central and southern parts of the bank. The wave patterns toward the perimeter of the bank appear to have a general wave structure, regularly spaced with nearly uniform amplitude, with the trend of the crests nearly at right angles to the isobaths.

In the southern part of the bank; there is a region of what appears to be a cross wave pattern, developed by two sets of sand waves oriented at approximately right angles. This pattern is represented in Figure XVI-2 by the superposition of the wave symbol at right angles. Just to the west of this cross pattern of waves is a third configuration of sand waves. Here the relief occurs as depressions in what otherwise would be a relatively flat surface, suggesting truncated waves where the depressions observed are the "interdunal flats" atop the bank.

The differences between the side-scan signatures of the sand waves suggest differences in sediment type. The sediment descriptions on the video tapes of dive 115 (see Figure XVI-1) show large areas of algal nodules and carbonate sand between depths of 60 and 75 m. The large scale sand waves are probably composed of algal nodules, and the sand sheets with "interdunal flats" are probably equivalent to the *Amphistegina* Sand Facies at the Flower Garden Banks.

The sediment at 213 m depth on the north side of the bank is a very cohesive clay. Large angular fragments of clay were thrown up into a pile ahead of the battery pod of the submersible as it plowed into the bottom. At a depth of 187 m, coralline algal nodules were observed lying on the muddy bottom. These must have rolled from the top, where they grew, down the steep slope of the bank.

Drowned reefs were observed at 98-94 m, 87 m, 78 m, 76 m, and 70 m depths.

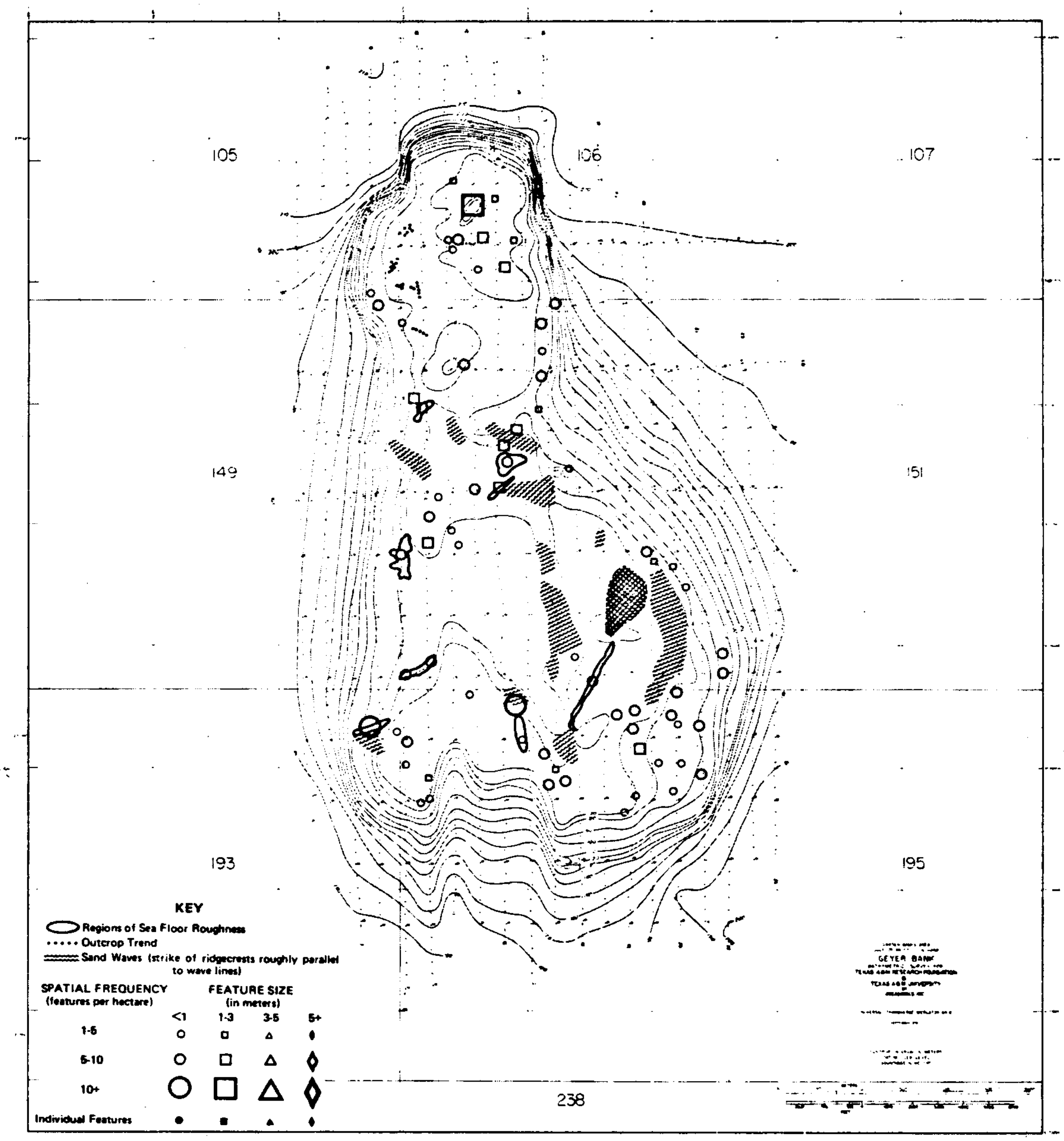


Figure XVI-2. Seafloor roughness, interpreted from side-scan sonar records.

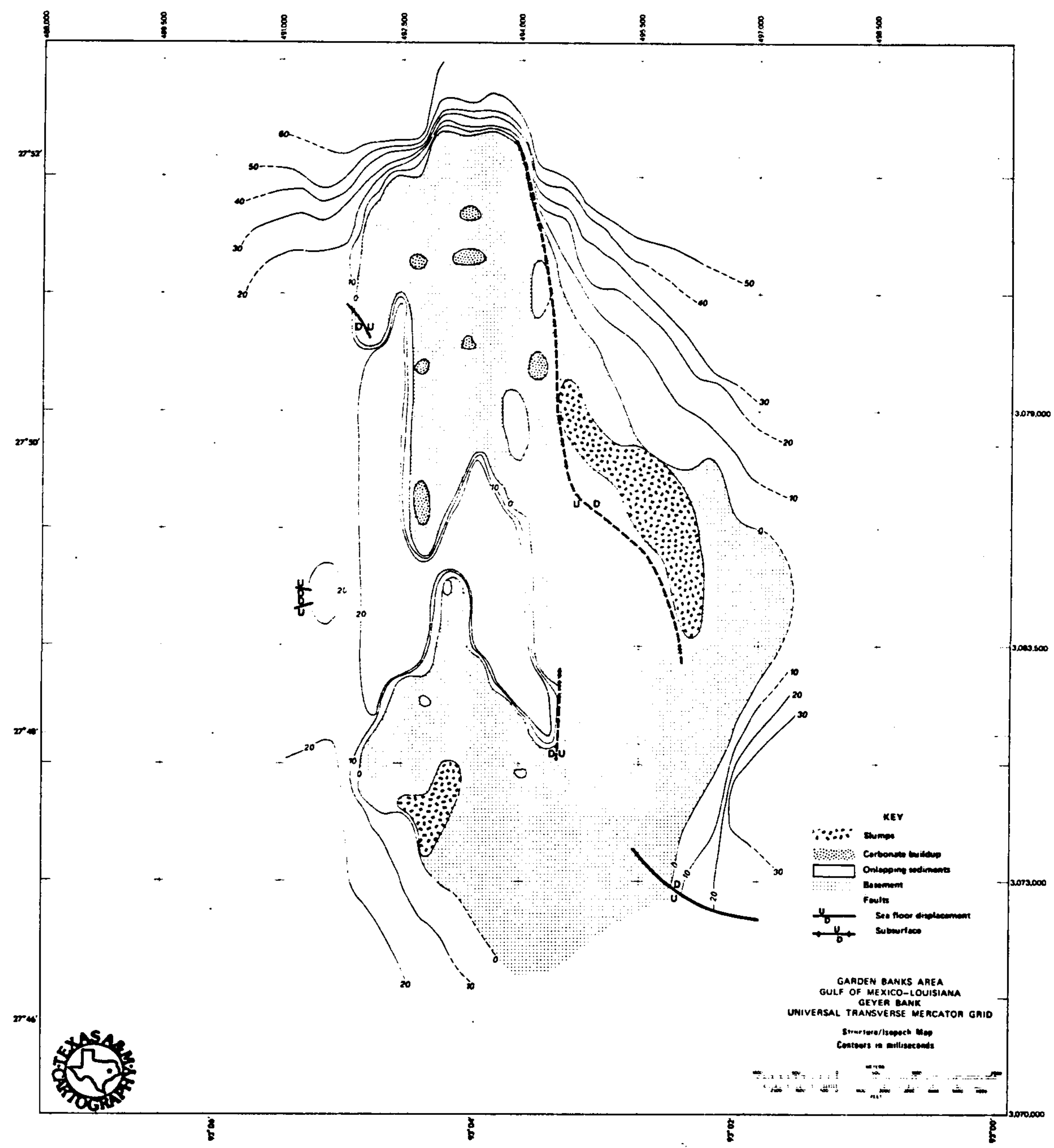


Figure XVI-3. Structure/isopach map of Geyer Bank. Contours represent thickness of the uppermost, surrounding, and onlapping sedimentary seismic sequence.

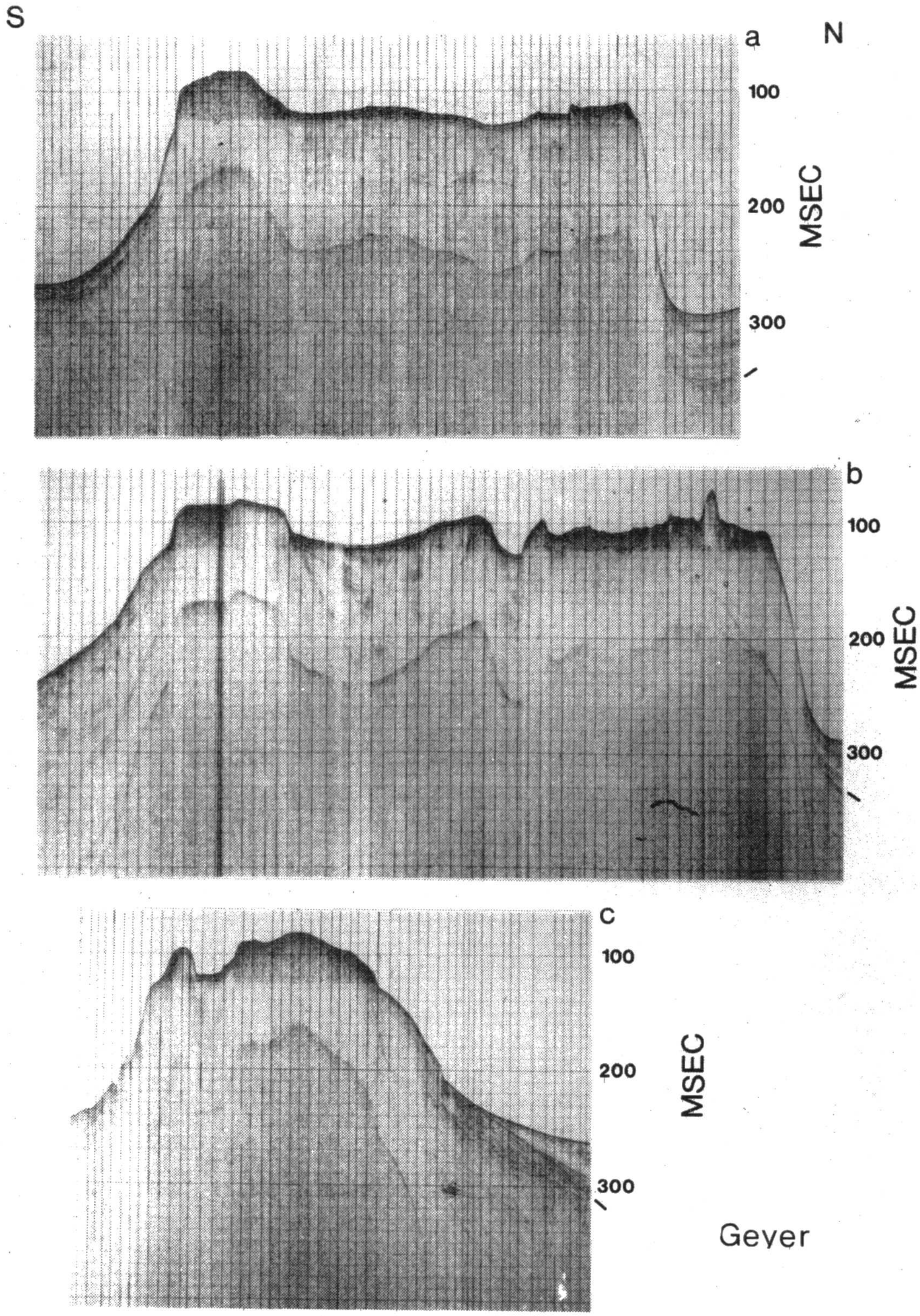


Figure XVI-4. Boomer seismic reflection profiles. Locations are indexed on Figure XVI-1. The base of the onlapping sedimentary sequence, mapped in Figure XVI-3, is indicated along the record margins.

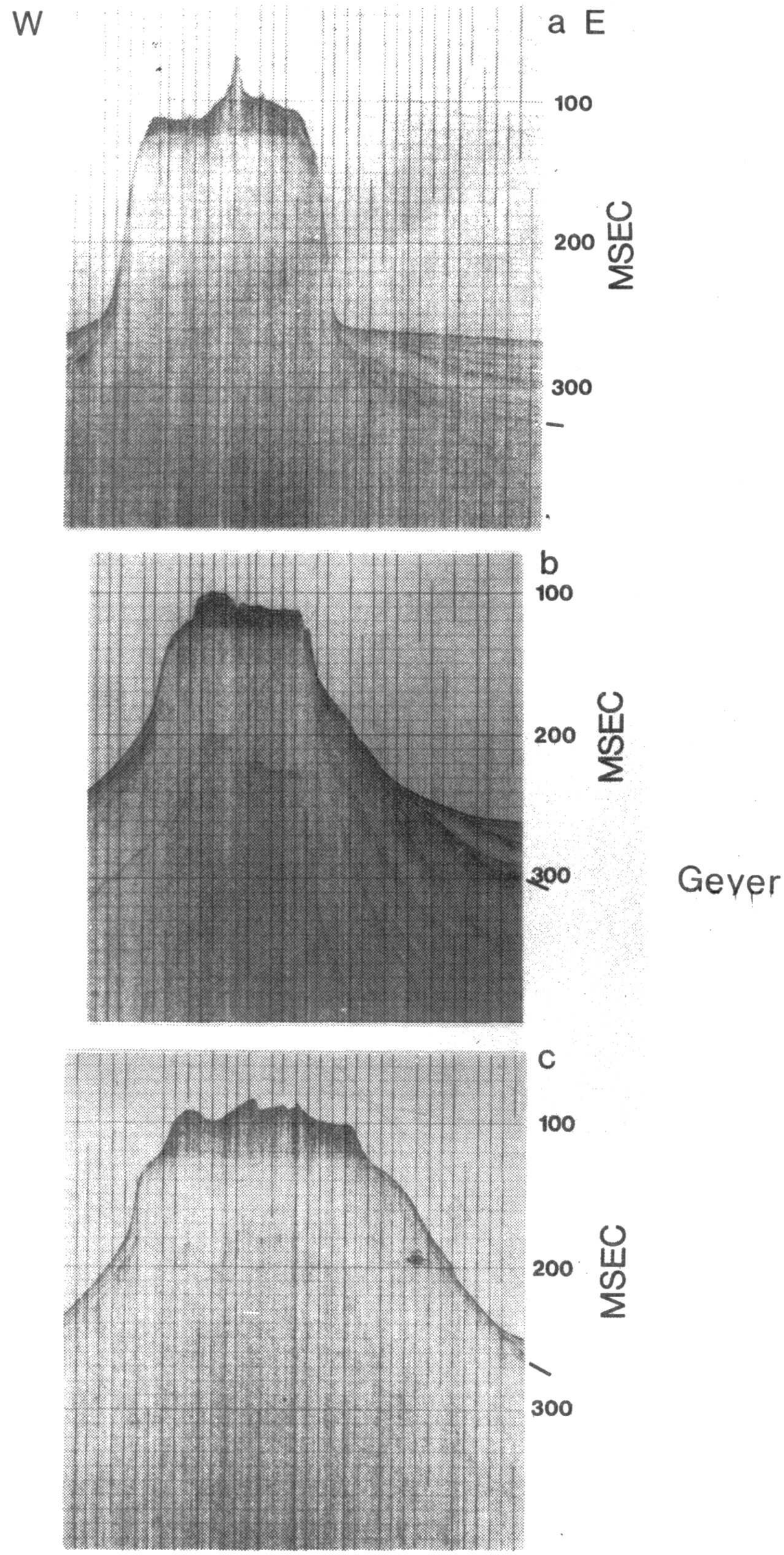


Figure XVI-5. Boomer seismic reflection profiles. See Figure XVI-1 for location and Figure XVI-4 for other information.

BIOLOGY

(PI: T. Bright)

(Figures XVI-6 through 10, and Appendix D, Table XVI-1)

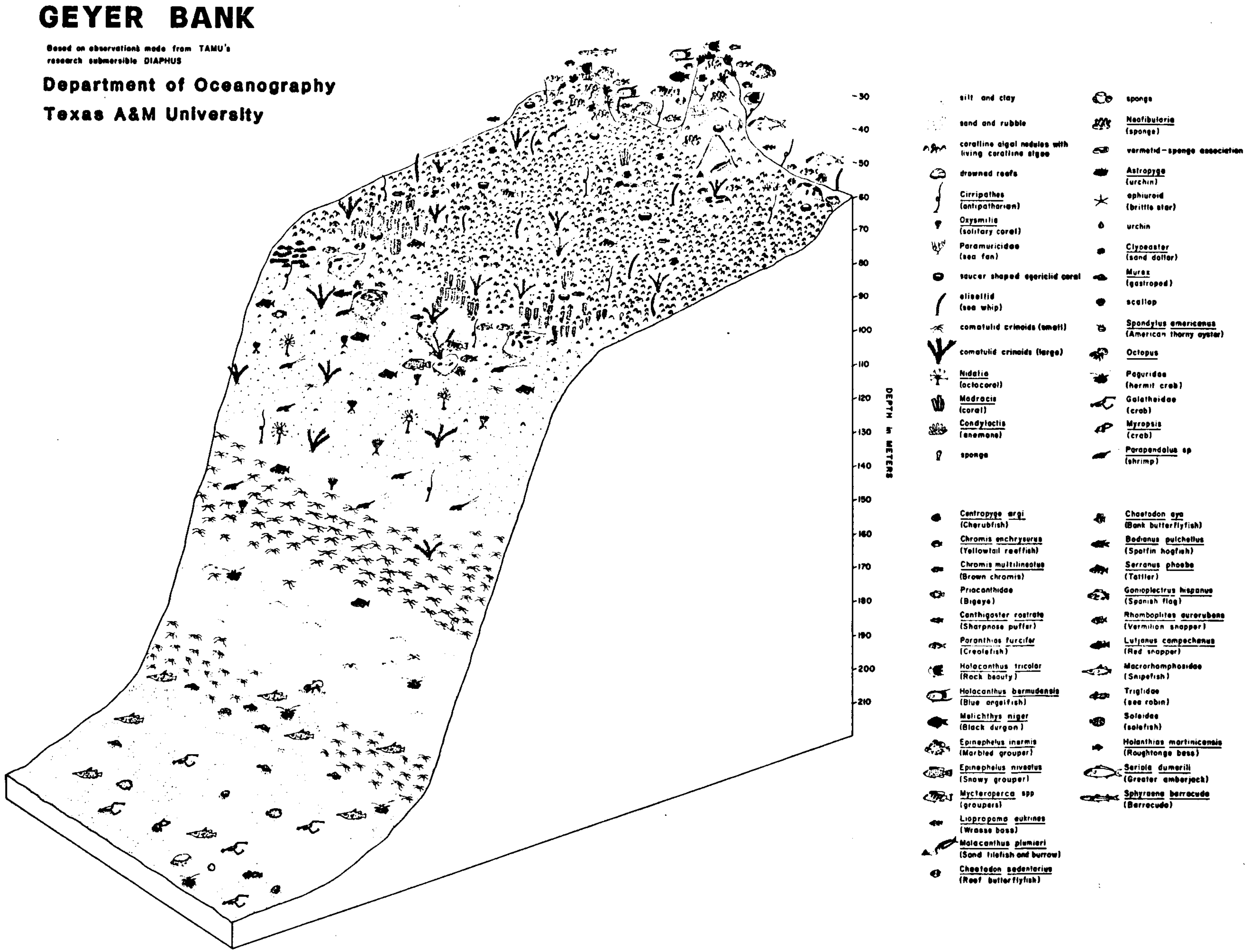
The structure and surficial geology of Geyer Bank make it one of the more interesting of the topographical features in the northwestern Gulf of Mexico. Like Elvers Bank, Geyer Bank arises from surrounding depths (200 m) greater than those adjacent to other shelf-edge banks studied. Bedrock outcrops occur on the shallowest part of the bank, 37 to 64 m (Figures XVI-6 and 7). Between 64 and approximately 83 m, the bottom is covered with calcium carbonate algal nodules and rubble, generally underlain by carbonate sand. Calcium carbonate reef structures occur here and there between 94 and 98 m, being more numerous and generally larger at the edge of the upper bank platform between 87 and 95 m. The carbonate nodule- and gravel-covered bottom on the steeply sloping face of the bank gradually changes to mud between approximately 91 and 200 m. Fine grained sediment is mixed with carbonate sand and rubble at 104 m, and with increasing portions of silt- and clay-size particles as depth increases. At 200 m and below, the bottom is a coherent, sticky mud with a veneer of looser, easily stirred clay size particles.

Zonation of benthic biota is correlated with substratum type and depth. The community established on rock outcrops at the crest of Geyer Bank bears a substantial resemblance to those occupying claystone, sandstone, and siltstone outcrops at similar depths on Stetson and Sonnier Banks and is recognizable as a *Millepora*-Sponge community (Figures XVI-6 and 7). The hydrocoral *Millepora* is particularly conspicuous near the crests of bedrock peaks and outcrops (peak crests examined were at 37 m and 49-52 m). Sponges, including *Neofibularia nolitangere*, *Agelas* sp., and various massive demosponges, are possibly more evenly distributed on the bedrock outcrops and predominate in places on the steeper slopes or cliffs. Coralline algae occur as crusts in patches on the bedrock, but are not significant reef builders in the *Millepora*-Sponge Zone. Leafy algae are abundant in places on the outcrops, particularly on the crests. Only two small colonies of hermatypic corals were seen on the bedrock, one a platelike crust of an agariciid and the other a monocentric variety with small polyps. The large anemone *Condylactis gigantea* is conspicuous and abundant on the bedrock; in places it is the prevalent invertebrate. *Diadema antillarum* and *Spondylus americanus* populations are substantial on the bedrock.

The most abundant fish frequenting the outcrops are Yellowtail reeffish (*Chromis enchrysurus*) and Creolefish (*Paranthias furcifer*). Other conspicuous species include the Marbled grouper (*Epinephelus inermis*), Rock beauty (*Holacanthus tricolor*), and, at the 37 m peak, the Brown chromis (*Chromis multilineatus*). At least 28 additional species of fish were encountered on the outcrops.

Much of the rock is not occupied by epifauna, possibly because it is poorly cemented and apparently disintegrates easily. The rock is riddled by holes, probably produced by rock-boring pelecypods. Unconsolidated sediments on tops of the peaks are composed primarily of

Figure XVI-6. Diagrammatic representation of biota at Geyer Bank.



rock chips, Millepora rubble, and shell fragments. Finer erosional products occur in "channels" on the less steep slopes of the bedrock peaks. Near the slope bases, talus aprons of cobbles and chips occur, the lower portions of which (64 m or so) are mixed with carbonate rubble and algal nodules derived from the surrounding terrace.

Between 64 and 83 m, the biotic communities and surficial sediments are dominated by calcium carbonate producing organisms, primarily coralline algae, but also in places by large populations of small branching corals of the genus Madracis. Coralline algal nodules and rubble underlain by coarse carbonate sand comprise most of the substratum between 64 and 76 m depth. The nodules in this range are generally large and their exposed surfaces are almost totally covered with growing coralline algae engaged in the production of carbonate substratum.

Patch reef-like structures occur on Geyer Bank from 64 to at least 98 m depth. The largest of these were encountered at 64-67 m near the bedrock outcrops and at 87-95 m at the edge of the upper platform of the bank. Some of these structures were 3 to 5 m in height. Smaller patches 1/3 to 1 m high were seen between 70-82 m and 94-98 m. All were covered with healthy populations of living coralline algae, but the abundance of coralline algae decreased below 90 m.

Although coralline algae are certainly the most important substratum producers and reef builders on Geyer Bank, immense populations of the small hermatypic branching coral Madracis sp. were encountered between 76 and 82 m depth. On the reconnaissance transect, live Madracis and Madracis remains comprised almost all of the substratum from 79 to 82 m depth. Where such populations occur, Madracis must be the dominant frame-building organism in a local sense (Figure XVI-8).

Associated with the Madracis populations are extensive covers of a flattish, maroon-colored leafy alga, which in places occupies 50%-90% of the bottom on top of Madracis remains (Figure XVI-8). This alga is an effective competitor for bottom space which otherwise would probably be occupied by living Madracis, and consequently may locally retard substratum production by the corals. Other leafy algae occur on the bank at all depths down to 107 m. Clusters and individual stalks of the calcareous green alga Halimeda were seen from 61 m on the siltstone outcrops down to 76 m on the nodule terrace.

Other conspicuous and abundant invertebrates on the part of the bank dominated by coralline algae or Madracis include: small saucer-shaped agariciid coral colonies (down to 82 m); ellisellid sea whips (72-77 m); Cirripathes (throughout, as well as shallower and deeper); clusters of vermetid gastropods embedded in the sponge Chelotropella sp. (abundant from 72 to 79 m, attaining the size of a bushel basket); large crinoids (72 m and deeper, tremendous populations between 75 and 81 m); and a small yellow sponge which is extremely abundant between 76 and 78 m depth (Figure XVI-8). The diversity and abundance of invertebrates is probably greater among the algal nodules and Madracis (67-82 m) than elsewhere on the bank.

The fishes most frequently seen on the nodule and Madracis bottom were small: Sharpnose puffer, Canthigaster rostrata; Orangeback bass, Serranus annularis; Cherubfish, Centropyge agri; and Yellowtail reef-fish, Chromis enchrysurus. Many very small fishes were seen darting about among the algal nodules but none could be identified. Evidence of burrowing by the Sand tilefish, Malacanthus plumieri, was seen above 72 m.

Where reefal structures occur, more and larger fishes congregate: numerous Creolefish, Paranthias furcifer; Reef butterflyfish, Chaetodon sedentarius; Rough tongue bass, Holanthias martinicensis; and 25 additional species, including snappers (Lutjanus sp. and Rhomboplites aurorubens), groupers of the genus Mycteroperca and, at 97 m, Snowy groupers, Epinephelus niveatus.

At approximately the lower limit of the profuse growth of small Madracis (82 m), the slope increases to 5° or so. A greater slope increase occurs at 91 m. These breaks in slope mark the edge of the upper bank platform and also the upper part of an interesting zone of sedimentological and biological transition on the bank slope extending downward to the mud bottom near 189 m. Scattered algal nodules and sizeable carbonate gravel were found as deep as 197 m, but it is felt that most of such material encountered below 91 m has been carried downslope from the upper platform. Generally, below 82 m, the unconsolidated bottom contains less and less coarse carbonate gravel and sand. At 104 m the sediment is a combination of sand and finer grained material with a 30-40% cover of carbonate gravel. At 128 m it has graded to a mixture of silt-clay-sand-gravel, and at 177 m it is mostly muddy, with silt- and clay-size particles and some remaining coarser material. At 198 m the bottom is sticky, coherent mud, and the slope is slight compared to that existing between 91 and 189 m. Although the limited number of sizeable algal nodules found on this slope appear to be washed down from above, they were observed to be spaced as closely as 1 or 2 m even at 128 m depth. No living coralline algae were seen on these nodules below 113 m, where only small living patches occurred on the tops of the nodules.

A rather diverse and abundant assemblage of attached epifauna is established on the parts of these nodules not covered by coralline algae (Figure XVI-9). This richness and diversity extends down to over 140 m, and substantial epifauna was seen on nodules as deep as 162 m. The organisms found on the nodules of the bank slope are not the types which would occur on hard substrata on the upper bank platform. They are typical of hard substrata on the flanks of other banks in the northwestern Gulf at similar depths. The most conspicuous attached invertebrates associated with these nodules are small sponges (generally more abundant above 110 m), solitary corals similar to Oxysmilia (100-160 m) (Figure XVI-9), branching corals having the appearance of Oculina (123-152 m, observed), the octocoral Nidalia sp. (105-131 m), and small octocoral fans, which are generally oriented parallel to the bank slope, indicating a predominance of currents running horizontally, parallel to the face of the bank rather than upslope-downslope.

The bank slope harbors impressive populations of echinoderms. At 91 m an aggregation of several hundred (possibly 700 or more) very large black urchins, Astropyga magnifica, was seen on the sand and rubble bottom. These aggregations occur on other banks in the northwestern Gulf at similar depths on similar bottoms. They continually cycle surficial sediment through their guts, egesting small spherical fecal pellets through the dorsal aboral pore. During the examination of this urchin aggregation, at least two were observed to emit apparent reproductive products from five pores surrounding the aboral gut opening. The white reproductive fluid was shed by one urchin after being touched by the submarine's manipulator arm. Subsequently, an adjacent undisturbed urchin also emitted the white fluid, as if some cue from the first urchin had triggered a similar response in the second. As at other banks, several small fishes resembling a young Marbled grouper (but possibly not that species) accompanied the Astropyga aggregation, swimming above and between the urchins and often contacting their spines.

Another colorful, large, spiny urchin, Coelopleurus floridanus, was seen on the slope between 143 and 178 m. Its population must be significant insofar as four sightings were recorded within that narrow depth range. Two of these sightings, however, were of the remains of urchins, apparently recently eaten. Only one Stylocidaris urchin was seen (151 m) on the transect, even though at other banks these organisms are often very abundant on such bottoms.

Small crinoids capable of rather graceful swimming actions occur on the slope from 91 to 175 m clinging to rubble or any other objects on the bottom. Between 136 and 160 m, the population of these organisms is phenomenal, peaking at about 137 to 146 m.

The most frequently encountered fish on the steeper bank slope was the Tattler, Serranus phoebe, seen down to 175 m, but more abundant around 107 m. Numbers of Bank butterflyfish, Chaetodon aya, Spanish flag, Gonioplectrus hispanus, and Snowy grouper, Epinephelus niveatus, were seen on the large reefal structures between 91 and 98 m at the top of the slope, but not elsewhere. It is suspected that the range of the Snowy grouper extends considerably deeper.

The slope of the bank decreases below approximately 189 m. Even at that depth a substantial amount of carbonate gravel is mixed with the basically muddy sediment. The gravel content of the sediment decreases below 193 m or so, leaving a very sticky, coherent mud bottom with a thin veneer of loose, easily stirred fine material which must undergo repeated disturbance by the active community of mobile benthic animals existing there. Tracks, trails, burrows, depressions, large holes and small mounds are the recognizable features on this bottom (Figure XVI-10). Most, or all, reflect movements or excavating activities of the limited number of species of echinoderms, molluscs, crustaceans, and fishes which appear to be the main components of the soft-bottom biota.

The most numerous organisms seen between 189 and 197 m were small ophiuroids, 5 cm or so in length, which covered the bottom in places almost arm tip to arm tip. Hermit crabs, mostly occupying Murex shells, are frequent below 165 m. Several other types of crabs occur on the mud bottom. Small galatheid crustaceans must be rather abundant, being frequently observed in burrows and small holes between 201 and 213 m. They were particularly apparent in the openings of numerous small burrows in the sticky mud rims of larger (1/3 m diameter) holes, which were apparently fish holes.

An octopus was seen in its hole at 186 m. Swimming scallops were seen at 207 and 213 m. A sizeable population of Murex occurs around 197 m. One was seen in the apparent act of preying upon a Clypeaster sand dollar at 201 m. The tracks left by these organisms tell the story of the attack (Figure XVI-10). Remains of dead urchins were seen a number of times between 151 and 213 m. They apparently are prime forage for more active benthic predators on the bank slope and deeper mud bottom.

The urchins, crabs, and gastropods must be responsible for many of the fresh tracks and trails seen on the soft bottom. One of the more distinctive tracks seen was produced by flatfish (Pleuronectiformes), dragging their bodies along the bottom by undulations of the dorsal and anal fins, which leave a series of small indentations on either side of the linear track left by the central part of the fish.

The distinctiveness, variability, abundance, and freshness of the tracks, trails, and burrows are indicative of a very active assemblage of organisms on the deep, soft bottom. Some are probably deposit or detritus feeders (the urchins and ophiuroids primarily, possibly some of the crabs and galatheids). Four suspension or filter feeding types were seen, a penshell (dead but in place) at 206 m, stalked colonial coelenterates at 204 m, worms (apparently sabellids) with tentacles extended above the bottom 193-204 m, and the aforementioned scallops. Benthic predators (fishes, crabs, gastropods, octopods, asteroids) are probably the most active group and may be responsible for a majority of the tracks and trails.

At least nine different types of fishes were seen on the mud bottom below 189 m. Some lurk in the bottoms of large, steep-sided holes, and one was seen inside a dead penshell; flatfish and sea robins rest on the sediment. The most interesting and abundant fish, however, is the Snipefish, Macrorhamphosus sp., seen hovering above the bottom, nose down, at a steep angle, just as was observed at Elvers Bank. These fish, seen from 189 to 213 m, were most abundant between 189 and 197 m and numerous at least down to 204 m. They probably do not feed extensively, if at all, on benthic organisms. Plankton abundance adjacent to the bottom appeared greater than in the water some distance above. It is possible that these fishes make a good living in the narrow bentho-pelagic realm near the bottom by feeding primarily on planktonic organisms.

The presence of fresh and abundant tracks, trails, burrows, and holes in the deep Mud Zone is indicative of a healthy and active soft-bottom benthic community.

CONCLUSIONS AND RECOMMENDATIONS

Geyer Bank lies on an active salt diapir on the upper continental slope. Because of its great relief and evidence for Recent movement on faults at the crest of the bank, one would expect accelerated dissolution of salt and continuing activity of faults on the crest and along the margins of the bank. Emplacement of large structures on the crest of the bank or in close proximity to its flanks should be discouraged.

The presence of large areas characterized by the Millepora-Sponge Zone and the Algal-Sponge Zone biotic communities warrants the protection of Geyer Bank. These unique communities should be protected by the same kinds of stipulations to drilling activity as are in use at the East and West Flower Garden Banks.

Geyer Bank possesses four distinct biotic zones characterized by differences in substratum, depth, and structure of biotic communities: Millepora-Sponge Zone (37-61 m, bedrock outcrops); Algal-Sponge Zone (61-87 m, algal nodules, algal reefs extending to 97 m, carbonate sediment); Bank Slope Zone (approximately 87-189 m, carbonate sand, gravel, nodules and fines at top, grading to mud with carbonate gravel at bottom); and the Mud Zone (189-213+ m).

The Algal-Sponge Zone harbors by far the most diverse and abundant populations and is overwhelmingly dominated by frame-building coralline algae, with substantial local contribution by small branching hermatypic corals. Probably because of the bank's great relief, coralline algae are significant to depths of 113 m or so and occur as deep as 123.5 m.

The great depth to which coralline algae grow at Geyer Bank (123.5 m, observed) is a feature held in common with Elvers Bank (122.5 m, observed) but not other shelf-edge banks. Physiographically, Geyer and Elvers Banks arise from greater surrounding depths (215 m or more) than do the others. As indicated in the description of Elvers Bank, we speculate that the survival and growth of coralline algae populations at great depths on Geyer and Elvers Banks is related to the banks' high relief and the relief's influence on bottom hydrography and sedimentation on and adjacent to the banks. (In effect, compared to banks of lesser relief, clearer water favoring algal growth exists at greater depths on the flanks of high relief banks.) Water clarity was good even at depths over 185 m at both banks during reconnaissance dives.

It is strongly recommended that additional work be conducted at Geyer Bank. As can be seen on Figure XVI-1, only a very small part of the bank has been observed from the submersible. Additional submersible observations are needed to characterize the biota, to determine the nature of the bedrock outcrops, and to observe the lineations shown on Figure XVI-2 in order to determine whether or not they represent recently active faults. Geyer Bank would be an excellent site for emplacing sea-bottom sensors to record tectonic activity on the bank. The major tectonic activity observed on the sub-bottom profiles is the upward movement of the salt diapir. The presence of both bare bedrock outcrops and well developed reef growth at the crest of the bank indicates Recent and possibly continuing movement along normal faults that will eventually develop into a central graben.

It is strongly recommended that this bank be considered a highest priority bank for protection by drilling stipulations.

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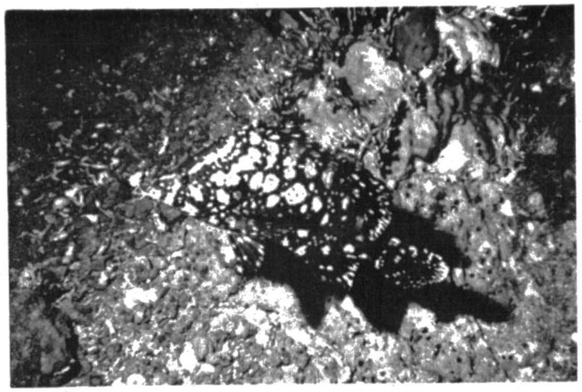

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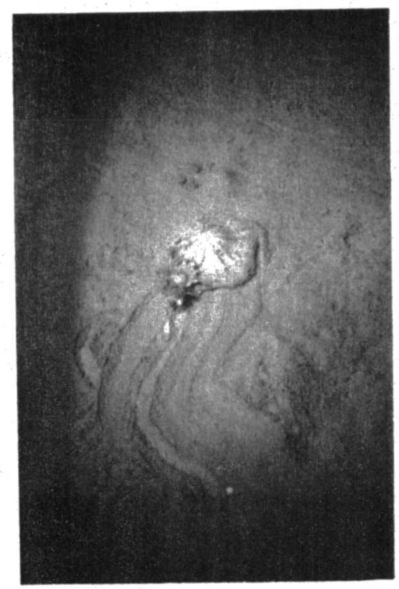

Figure XVI-7 (UL). Geyer: Marbled grouper (Epinephelus inermis) over claystone outcrop at 37 m depth. Substratum is perforated by holes produced by rock-boring pelecypods. Claystone chips are mixed with shell material. Millepora encrusts rock directly above fish.

Figure XVI-8 (UR). Geyer: 79 m depth. Substratum of Madracis skeletons covered by leafy algae (possibly Lobophora). Feathery organisms are crinoids.

Figure XVI-9 (LL). Geyer: nodule on sand-silt-gravel bottom at 123 m. Large solitary coral.

Figure XVI-10 (LR). Geyer: sand dollar, Clypeaster ravenelii, producing typical track at 202 m depth. The sand dollar has been "attacked" by a Murex-like gastropod, whose track can be seen superimposed on the sand dollar track as well as to the left of and partly obscured by the sand dollar track, indicating that the encounter took place in the lower part of the picture.

CHAPTER XVII

REZAK-SIDNER BANK

R. Rezak, T. Bright, T. Hilde,
G. Sharman, L. Pequegnat

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Rezak-Sidner Bank were limited to mapping and sub-bottom profiling. Results of these studies are presented under the headings Structure and Physiography, Hazards, Sedimentology, and Biology.

GENERAL DESCRIPTION

Rezak and Sidner Banks are described as a single unit in this report because they are parts of a single geological structure. The center of the structure that forms the two banks is located at 27°57'N latitude and 92°23'W longitude (Volume One, Figure III-1) in Blocks 404, 405, 411, and 412 of the Vermillion Area. The Rezak-Sidner structure is rectangular in shape and covers an area of 78 km^2. It is bounded by steep slopes on the north, east, and south sides, with a more gentle slope to the west (Figure XVII-1). Local depressions are abundant at the base of the eastern and southern slopes. The eastern slope has very irregular and complex relief. Although it is a single structural unit, the bank can be divided into northern and southern halves on the basis of bathymetry. The shallowest portion of the northern half (Rezak Bank) has a minimum depth of 60 m on a peak at the northeast corner of the structure. Depths of the adjacent seafloor around the northern half are mostly between 120 and 140 m on the north and east sides, and 98-110 m on the west side. The northern half is about twice the width of the southern half and has a very gentle slope to the west (about 10 m/km).

The southern half has a minimum depth of 55 m on the ridge that forms the eastern margin and has surrounding depths of 140-180 m.

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Structurally, the bank is a tilted fault block of well stratified sedimentary rock that has been uplifted on the east and dips to the west (Figures XVII-3 and 4).* It is bounded by steeply dipping normal

*For the sections of seismic reflection profiles shown in Figures XVII-4, 5, and 6, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

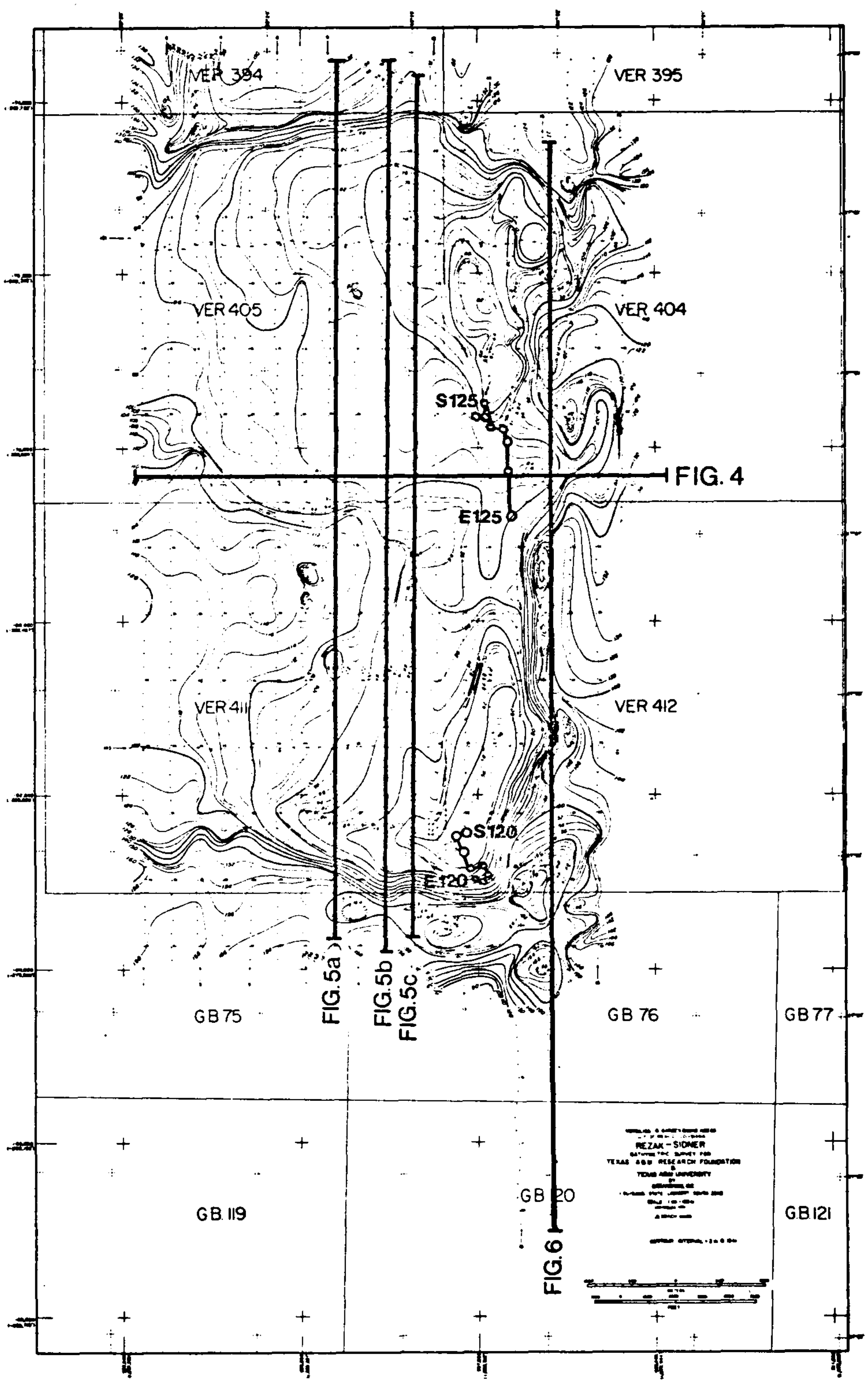

Figure XVII-1. Bathymetry of Rezak-Sidner Bank. Solid lines and numbers indicate the boomer profiles that are shown in Figures XVII-4, 5, and 6. Submersible transects, dives 120 and 125: S = Start, E = End.

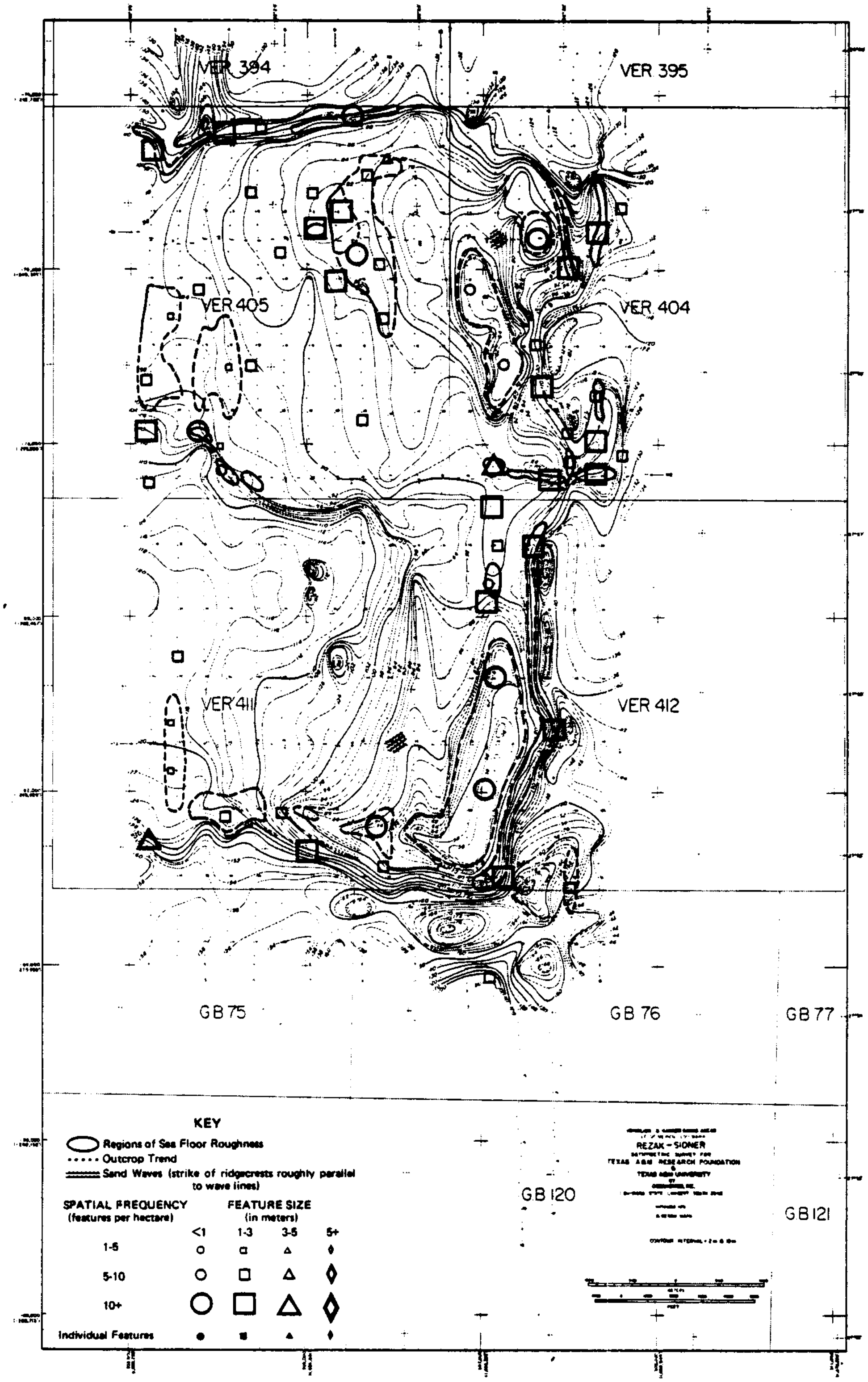

Figure XVII-2. Seafloor roughness of Rezak-Sidner Bank as interpreted from side-scan sonar data.

faults on its east, north, and south sides. As seen in the three north-south boomer profiles in Figure XVII-5, the shallow structure of the bank consists of four seismic sequences separated by strong reflectors interpreted as unconformities. The stratification in each sequence is represented by weak yet recognizable reflections. Care must be taken not to confuse the bedding reflections with the strong ringing of the seismic source. Despite the troublesome multiples, it is possible to see reflection termination patterns that define erosional truncation, depositional onlap, and, on the north side of the bank, truncation by faulting.

The three profiles shown in Figure XVII-5 were selected to illustrate the thinning and pinchout of the three upper seismic sequences from the west to the east and northeast. Note how the thin middle sequence thins and pinches out from profile a to c in these closely spaced sections. Three units were mapped in addition to surface carbonate reef growth (Figure XVII-3). These units are: 1) seafloor exposure of the deepest observed unit; 2) the combined thickness of the upper two seismic sequences beneath the bank proper; and 3) the upper or Recent sequence of sediments that has been deposited around the margins of the bank. The deepest reflector seen on the seismic reflection profiles (Figures XVII-4 and 5) dips steeply to the west, deeper than the capabilities of the boomer used during the survey. It was, therefore, not possible to map the thickness of the lower unit. Instead, the combined thickness of the upper two sequences which could be seen beneath most of the bank, was mapped to characterize the overall structure/sediment distribution of the bank. The isopachs of these combined sequences are shown for the bank area, and isopachs surrounding the bank area are of the more recent sediments (Figure XVII-3).

Although faulting is extensive along the margins of the bank, the interior of the bank is unbroken by faults (Figure XVII-5). The eastern and southern margin of the bank consists of complex fault structures (Figure XVII-3). Figure XVII-6, a north-south profile along the eastern margin, shows sections of acoustic basement along the eastern bank face, in between which are pockets of the uppermost Recent sedimentary unit. The folded and disturbed nature of these Recent sediments suggests that faulting is presently active along this margin of the bank. The shallow structure at the far south end of this profile is another topographic feature south of Rezak-Sidner Bank. The highly faulted area just north of this feature is the fault zone just off the southeast corner of Rezak-Sidner (Figure XVII-3). That area appears to be an ENE-WSW graben that separates Rezak-Sidner from the structure to the south.

The lowest sequence that can be observed, the seismic basement, appears to have internal bedding reflectors, although they are not as obvious as in the overlying sequences. The strong reflector separating this sequence from those above has all the characteristics of an unconformity, and the seismic basement is very likely composed of sedimentary rock. Nevertheless, Rezak-Sidner, like the other banks, was most likely formed due to salt diapiric intrusion at a depth beyond the penetration of the boomer records.

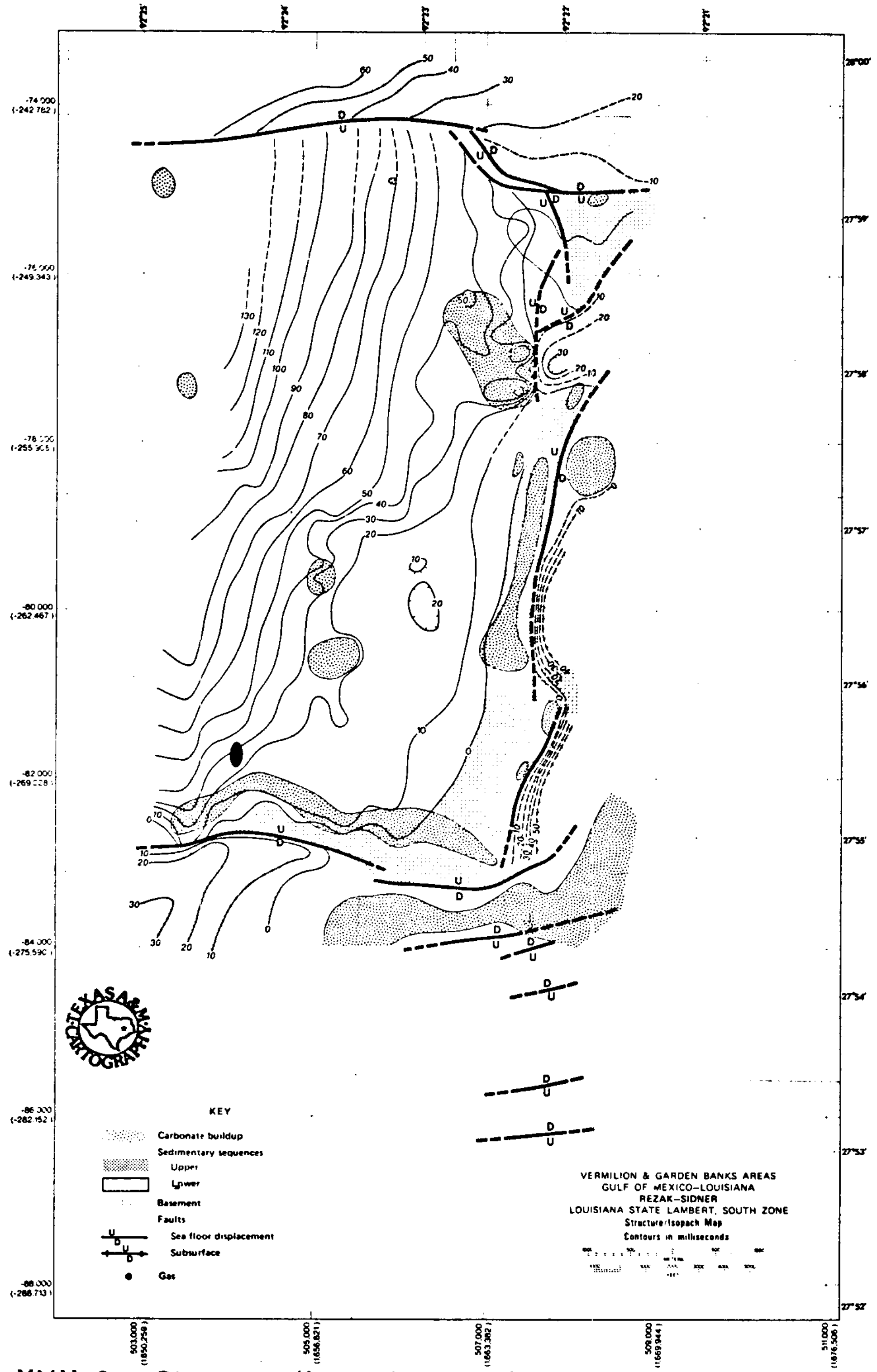

Figure XVII-3. Structure/isopach map of Rezak-Sidner Bank. Contours on the bank proper and around the margins of the bank show thicknesses of older uplifted sedimentary rock and Recent surrounding sediments, respectively.

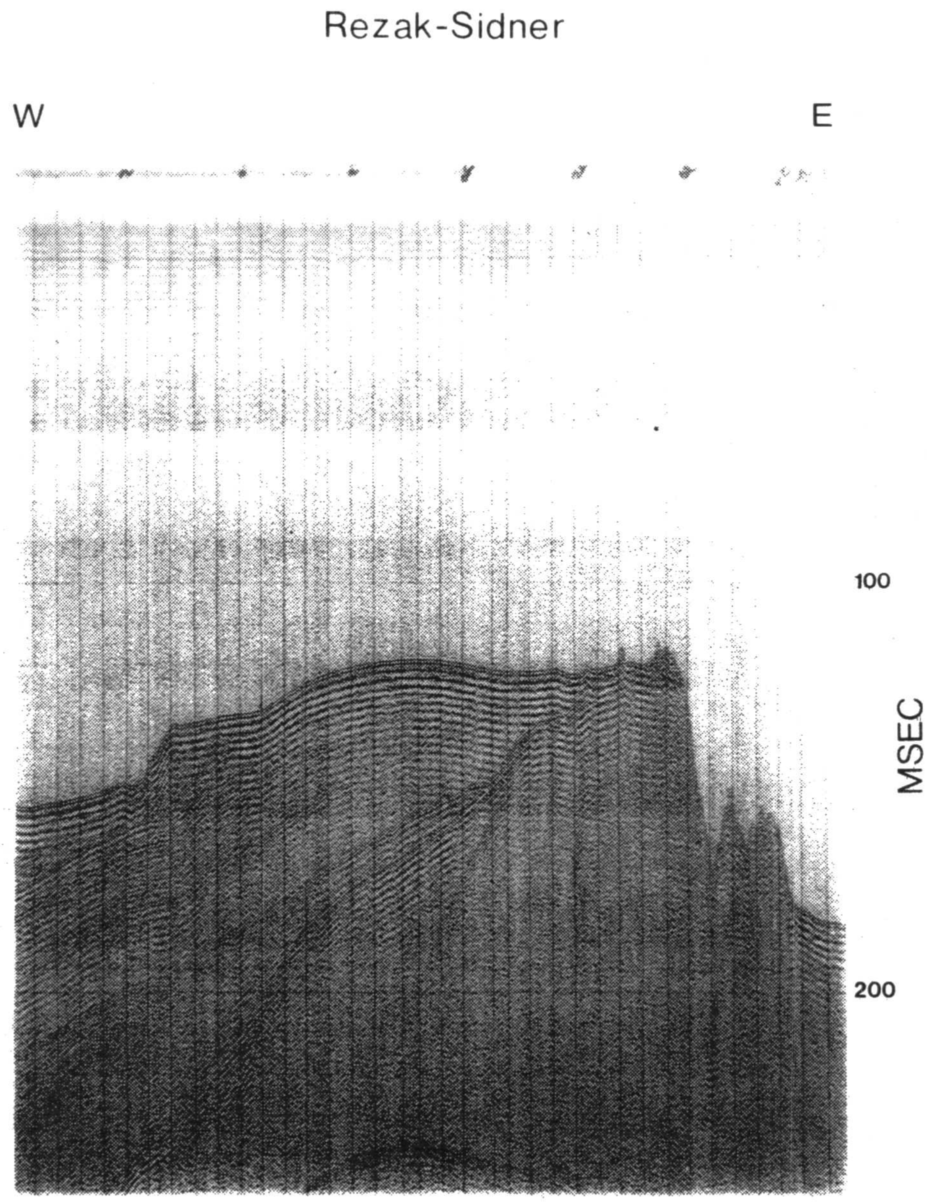

Figure XVII-4. E-W boomer profile showing westward dipping seismic sequences and unconformable boundaries. Location shown in Figure XVII-1.

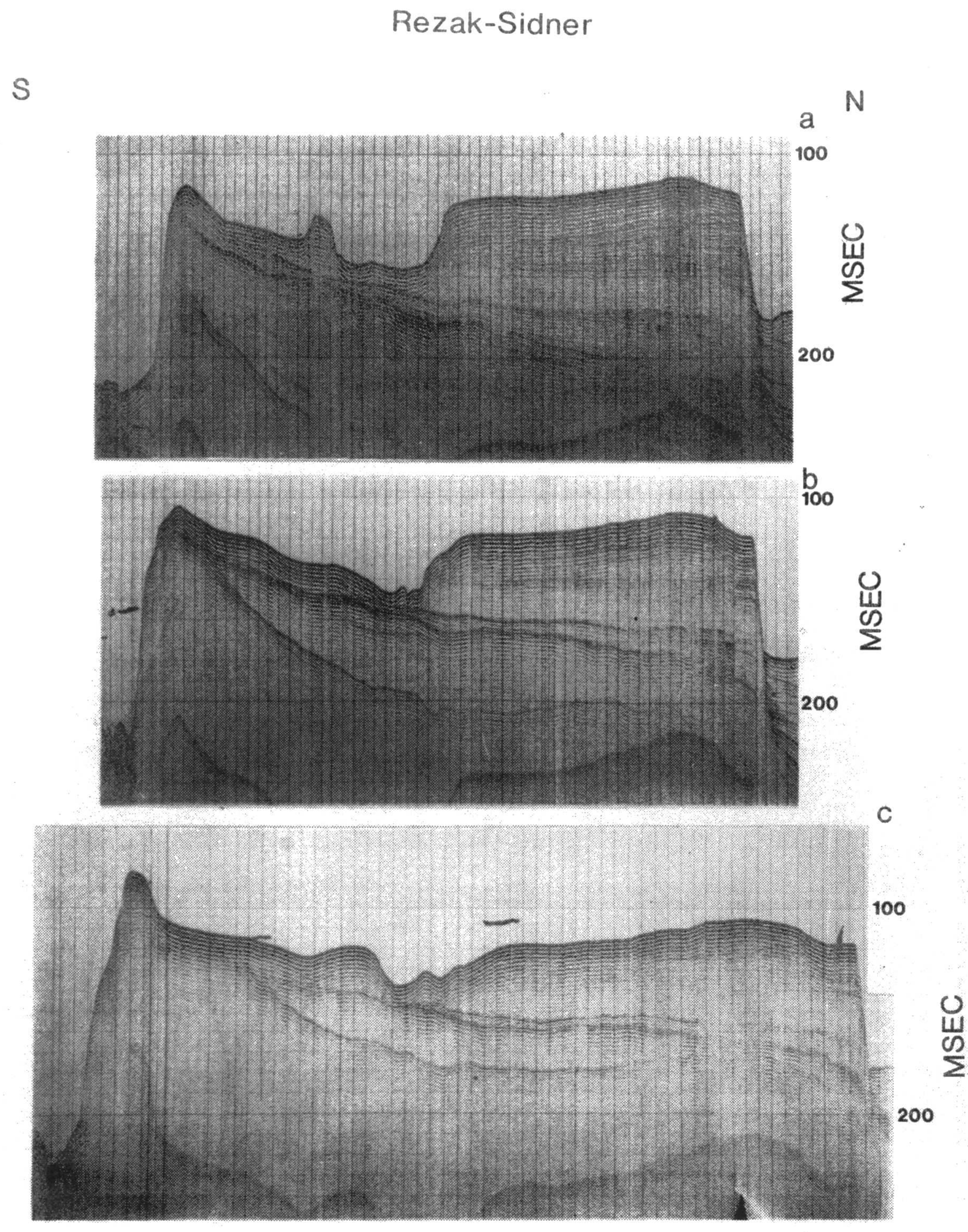

Figure XVII-5. N-S boomer profiles through the central portion of the bank, showing progressive thinness of units to the east. Locations shown in Figure XVII-1.

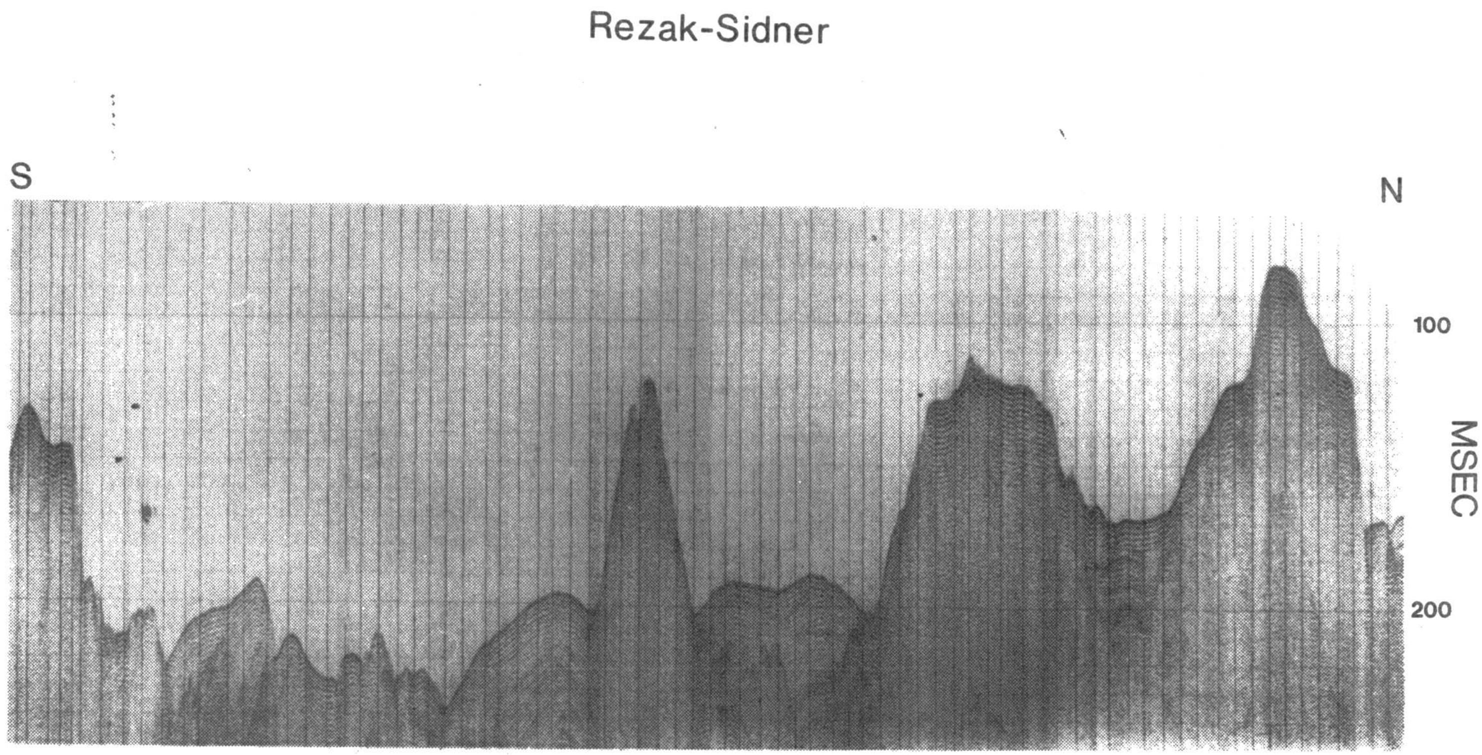

Figure XVII-6. N-S boomer profile along eastern faulted margin of the bank. Location shown in Figure XVII-1.

Seafloor relief on the top of the bank is due to erosion and, to a lesser extent, carbonate reef growth. The reflectors within the fault block are truncated by faulting on the north and south sides of the bank. The saddle in the middle of the bank appears to be an erosional feature, and a large part of the upper seismic sequence has been removed by erosion. The three erosional unconformities, the surface erosion, and the progressively greater tilt of the individual seismic sequences with depth all suggest that this bank has experienced several stages of uplift and tilting during a period of several rises and falls of sea level.

Four patterns of roughness (Figure XVII-2) occur on Rezak-Sidner Bank: 1) fringing patterns; 2) broad regions occupying the high; 3) sand waves; and 4) linear trends that suggest bedding outcrop or fault control.

The fringing reef roughness patterns have the greatest spatial distribution and some of the most interesting implications. These patterns are restricted to the upper portion of the steep slopes bounding the bank on the north, east, and south side, generally paralleling the isobaths. The depth distribution of these fringing patterns suggests a progressive deepening of the fringing reef from the northwest to the southeast, which would in turn suggest tilting of the bank since the establishment of the reef.

Atop the bank there are several broad areas of roughness that correlate well with the topographic highs on the bank and suggest broad areas of reefal growth.

Two small areas of sand waves were observed in the side-scan records on the upper, flat portion of the bank, one in the northeast corner of the bank and the other in the south central region. Both sets of wave patterns were oblique to the local isobaths and exhibited wave crests trending in a northeast-southwest direction.

A series of east-west elongate regions of roughness near the middle of the bank corresponds to the change in strike of the isobaths in this region of the bank. These would seem to be fault controlled, either directly by the topography generated by the tectonics, or indirectly by outcrop bedding patterns exposed along the fault. However, the sub-bottom profiles provide no evidence for east-west faults in this area.

HAZARDS
(PI: R. Rezak)

Faulting has been active in Recent time along the margins of the bank, but no fault activity is apparent within the main body of the bank. Faults along the margins intersect the seafloor, and the most recent sediments show displacement and disturbance.

One apparent gas vent exists in the southwest corner of the bank (Figure XVII-3). There are also diffuse reflections in the water column over some areas of the bank, particularly over the eastern margin.

These reflections, however, are not obvious in the profiles chosen for illustration. One gas seep was observed during dive 125 (Figure XVII-1) at a depth of 69 m just south of the 62 m peak near the southwest corner of Block 404. There is little or no seismic signal wipeout of subsurface reflectors anywhere on this bank, nor are there any bright spots.

SEDIMENTOLOGY
(PI: R. Rezak)

No grab samples were required, but submersible observations during dives 120 and 125 (see Figure XVII-1) indicate the general nature of the bottom sediment.

At a depth of 55 m on dive 120, the bottom consisted of algal nodules (Gypsina-Lithothamnium Facies). At a depth of 60 m a fringing reef was encountered, and from there to a depth of 131 m the margin of the bank consisted of alternating vertical walls of drowned reef and ledges covered with coarse carbonate sand and scattered coralline algal nodules.

At a depth of 61 m on dive 125, the bottom was covered with algal nodules with scattered patches of carbonate sand. At a depth of 69 m, the coralline algae had bridged across between nodules and formed a continuous pavement of living algae. At 91 m depth, a large area of low-lying reef rock was encountered. Around the reef rock, the sediment was a coarse carbonate sand. About two-thirds of the way through the dive, one of the east-west ridges that was noted on the side-scan records was crossed and verified as a reef. Drowned reefs were encountered frequently during the part of the transect that ran along the 91-92 m depth. The reefs are extensively bioeroded and cavernous but have well developed crusts of coralline algae, even at depths of 91 m.

BIOLOGY
(PI: T. Bright)
(Figures XVII-7 through 10, and Appendix D, Tables XVII-1 and 2)

Biological studies focused on the southern half of Rezak-Sidner Bank, i.e. Sidner Bank, except for submersible reconnaissance, from which the Rezak Bank species list was produced (Appendix D, Table XVII-1). Rezak Bank is presumed to be biologically similar to Sidner Bank, which is described below.

Sidner Bank is typical of the high relief shelf-edge carbonate banks in the northwestern Gulf of Mexico. Its upper portions (above 100 m) support the expected clear-water benthic communities dominated by crustose coralline algae. The bank's flat upper platform bears a 90 to 100% cover of algal encrusted nodules and gravel underlain by coarse carbonate sand (Figure XVII-7).

Between 59.5 and 64 m depths, the edge of this platform is defined by sizeable ledge-like reefal structures up to 3 m in height with cavernous overhangs and clefts. Below these, the bottom slopes substantially but is still almost totally covered with living algal nodules and gravel over coarse sand. The nodule cover is somewhat reduced between 81 and 84 m and thins considerably below 87 m. Even so, large nodules bearing substantial coralline algal crusts are scattered on coarse carbonate sand at 91 m.

The top of another system of large, ledge-like reefal structures occurs between 93 (Figure XVII-8) and 96 m, with nearly vertical cliffs extending to 108 m. Whereas coralline algal crusts are abundant on reefal structures at 90 m, their extent is visibly decreased on hard substratam at 95 m. Only a small amount of coralline algae was observed on reef rock at 102 m, and none was noted below 107 m.

From the base of the cliff (108 m) downward, the bottom is primarily coarse carbonate sand with scattered sediment-covered nodules and gravel (Figure XVII-9). Finer, easily stirred sediment is apparent below 128 m, but the coarser elements are still present. Small drowned reefal structures occur seemingly at random below 116 m (Figure XVII-10). No observations were made deeper than 131 m.

Leafy algae populations generally parallel the coralline algae in distribution and abundance. Large populations of what appeared to be Dictyota and an adnate Padina-like species occurred on and among the algal nodules above 59.5 m. Between 64 and 68.5 m a fine, filamentous variety was the predominant soft alga, in places occupying the tops of all nodules, apparently overcoming the coralline algae to a significant extent, at least temporarily. As at several other banks studied, a leathery, green, adherent alga (possibly Codium sp.) occurred alongside coralline algae at the greatest observed depth (170 m). Significant leafy algae populations, however, seem to be restricted to depths less than approximately 100 m.

Slight decreases in water clarity were encountered at various depths on the bank (57, 59.5, and 74.5 m), but highly turbid water was not encountered at any depth visited (to 131 m). The predominance of coarse sand and gravel at depths less than 122 m indicates that nepheloid layers bearing suspended fine sediments are probably not overly common on the upper- to mid-slope of Sidner Bank. Accordingly, reduction of light levels and sedimentation associated with bottom nepheloid layers may not be factors greatly influencing depth distribution of algae at Sidner Bank, as may be the case at other banks in the northwestern Gulf where turbid water is common at shallower depths (viz. Sackett, Sonnier, Southern, East and West Flower Garden Banks, etc.). Geyer and Elvers Banks also seem to fit the Sidner Bank pattern (see discussions of these banks in other chapters of this report).

Invertebrates appear to be most diverse and abundant on the upper platform above approximately 61 m. There is evidence of three intergrading depth zones wherein invertebrate assemblages are to some extent distinct (above 76 m, between 76-107 m, and below 107 m).

The uppermost depth interval contains many species one may find in relatively shallow reef zones throughout the Caribbean. Hermatypic corals are represented by saucer-sized agariciid colonies and small branching growths of Madracis sp., though none were seen below 57 m. Other notably conspicuous and abundant invertebrates included the anemone, Condylactis gigantea; the American thorny oyster, Spondylus americanus; large comatulid crinoids; and the antipatharian Cirripathes sp. Only the crinoids and Cirripathes were encountered below 68.5 m depth. Both of these occur in all of the depth zones, down to 123 m or more.

The intermediate depth zone (76 to 107 m) is interesting because of the abundance of additional varieties of antipatharians (Antipathes spp.); numbers of tiny alcyonarians; a large branching alcyonarian, Swiftia exserta; the Slit shell, Entemnotrochus sp.; and the small comatulid crinoid frequently seen on other banks at comparable depths.

Below 107 m the invertebrate assemblages, though similar in respect to those of the mid-depth zone, are quite different from those in the uppermost zone. Presumably, the lower depth zone is recognizably deep-water in nature. Characteristically, there is an abundance of small branching alcyonarians, mostly yellow in coloration. At 122 m depth, a large population of these fan-like suspension feeders were all aligned parallel to the slope of the bank. This is taken as an indication that the prevailing bottom currents are transverse (around-bank) with little if any appreciable vertical component.

Another exceptionally abundant form in the lower depth zone was a small lace-like cup sponge. It was detected in large numbers between 119 and 131 m and was the most conspicuous organism at the deepest point on our transect, 131 m. Much less abundant, but typical of deep water on the Texas-Louisiana fishing banks, was a bracket-like lithistid sponge detected at 123 and 126.5 m. There was only one sighting of a large solitary, deep-water coral, probably Oxysmilia, at 123 m.

Approximately thirty species of fish were seen on Sidner Bank, most of these above 64 m. Twelve species were associated with the reefal structures bordering the upper platform of the bank from 59 to 64 m. These structures were preferred by large groupers, Mycteroperca spp. and Epinephelus inermis; schools of Creolefish, Paranthias furcifer; numerous squirrelfishes, Holocentrus sp.; and other sizeable fishes.

Among the nodules above 59 m, there was a tremendous population of very small fish, probably juveniles. Multitudes of Yellowtail reeffish, Chromis enchrysurus, occupy the bank above 64 m and occur in lesser numbers down to 78 m. Sand tilefish and their burrows are numerous among the algal nodules above 64.5 m. Schools of large Amberjack, Seriola dumerili, were common on the bank's upper platform, above 64 m. Larger schools of several hundred tuna, probably the Little tuna, Euthynnus alletteratus, were encountered over the nodule platform between 55 and 56.5 m.

The fish assemblage below 85 m is recognizably different from that of the uppermost part of the bank. Except for the Tattler, Serranus phoebe, most of the fishes seen at the greater depths were associated with the partly drowned or drowned reefal structures. The most distinctive and abundant species between 85 and 126.5 m was the Rough tongue bass, Holanthias martinicensis. A school of Creolefish and Vermilion snapper, Rhomboplites aurorubens, was seen at 93 m atop the large carbonate ledge. Other notable deep dwelling fishes were Bigeye, Priacanthus sp. (90-102 m); Spanish flag, Gonioplectrus hispanus (108-126.5 m); and Bank butterflyfish, Chaetodon aya (119-123.5 m).

Benthic communities at Sidner Bank are therefore well developed, diverse, and abundant clear-water assemblages with active reef building by coralline algae above 100 m depth. The bank is comparable to Geyer, Elvers, and 28 Fathom Banks in structure and biotic development. Its upper portion (above 100 m depth) is biologically an Algal-Sponge Zone comparable to the Algal-Sponge Zone at the East Flower Garden Bank.

CONCLUSIONS AND RECOMMENDATIONS

Rezak-Sidner Bank appears to be a geologically active structure that has been created by a deep-seated salt diapir. Although there is evidence of repeated exposure of the bank during the Pleistocene epoch, there is no normal faulting within the bank proper that would indicate removal of salt from the crest of a diapir by dissolution. In general, the movement of the bank has been in an upward direction and will probably continue to be so for some time to come.

Biologically, Rezak-Sidner is similar to Geyer, Elvers, and 28 Fathom Banks. The upper part of the bank (above 100 m) is comparable to the Algal-Sponge Zone at the East and West Flower Garden Banks. **The biota of this zone should be protected.**

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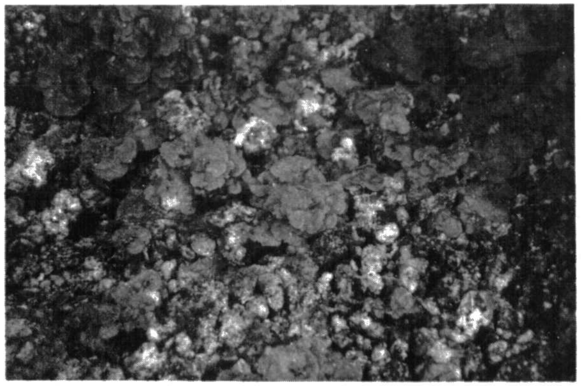

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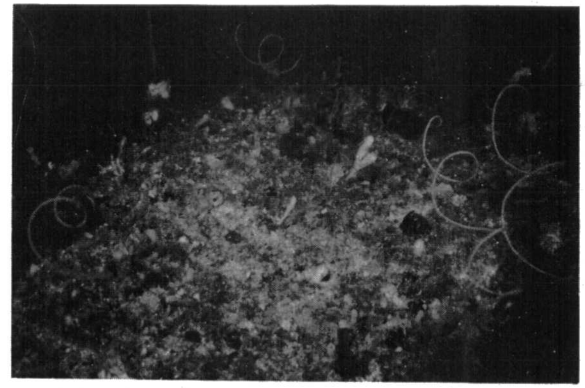

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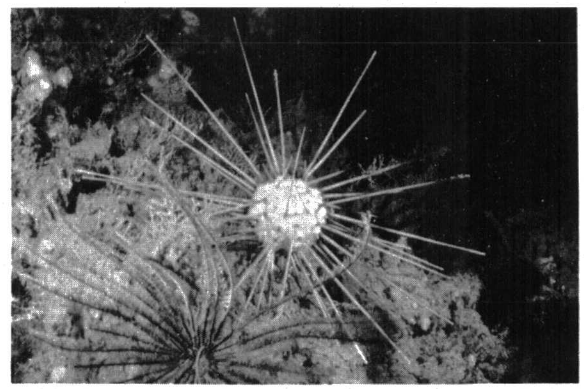

Figure XVII-7 (UL). Sidner: green algae growing on algal nodules at 55 m depth.

Figure XVII-8 (UR). Sidner: diverse epifaunal cover on drowned reef at 93 m depth, including Cirripathes, several species of sponges, coralline algae, leafy algae, alcyonarians, and numerous other organisms.

Figure XVII-9 (LL). Sidner: small stalked sponge (?) and other epifauna occupying nodules on sand and gravel bottom at 116 m depth.

Figure XVII-10 (LR). Sidner: large urchin, Calocidaris micans, crinoid, and other epifauna on drowned reef at 126 m depth.

CHAPTER XVIII

ALDERDICE BANK

R. Rezak, T. Bright, D. McGrail, T. Hilde,
G. Sharman, L. Pequegnat, D. Horne, S. Jenkins, F. Halper

INTRODUCTION

In addition to geological and biological reconnaissance and sampling from the submersible, studies at Alderdice Bank included mapping and sub-bottom profiling, sedimentological analyses, and hydrographic sampling. Results of these studies are presented under the headings Structure and Physiography, Hazards, Sedimentology, Water and Sediment Dynamics, and Biology.

GENERAL DESCRIPTION

Alderdice Bank is located at 28°04'40"N latitude and 91°59'36"W longitude (Volume One, Figure III-1) in Blocks 170, 171, 178, and 179 of the South Marsh Island Area (Figure XVIII-1). The bank is an oval, elongate in an east-west direction, and covers an area of about 16 km^2. The top of the bank is relatively flat, with depths ranging from 78 to 82 m. Superimposed upon this broad surface is a smaller scale relief formed by ridges and peaks. The shallowest bank depths (59 m) are two of these peaks. Depth of the seafloor surrounding the bank on the south, west, and northwest sides is about 92-94 m, while on the northeast and east sides it is about 84 m. Although the relief is not great along the margins of the bank (generally less than 10 m), the margins are rather steep around the western half of the bank. Although the features on top of the western part of the bank have a rather random distribution, the eastern part of the bank displays a dominant north-south ridge. There is also a gentle north-south oriented swell on the seafloor extending northward from the eastern part of the bank (Figure XVIII-1). The gentle depression on the northwest margin of the bank is the head of a north-south oriented valley that curves around the western margin of the bank. This valley was probably eroded during a lower stand of sea level during Late Pleistocene or Early Holocene time.

STRUCTURE AND PHYSIOGRAPHY
(PI's: R. Rezak and T. Hilde)

Structurally, Alderdice Bank is a uniformly uplifted salt dome with a non-reflective core or acoustic basement and surrounded by onlapping sediments that are tilted upward along the margins of the bank and are progressively more steeply tilted with depth (Figures XVIII-5 and 6).* The main body of the bank has been mapped (Figure XVIII-4)

*For the sections of seismic reflection profiles shown in Figures XVIII-5 through 8, the vertical scale is two-way travel time in milliseconds (msec); the horizontal scale equals 500 ft between shot points (vertical lines on the records).

as exposed acoustic basement (the non-reflective core, which may be cap rock and salt). Extensive areas of carbonate reef occur on this surface. These patches include the peaks referred to above.

There is a single prominent reflector at about 5 to 10 m depth beneath most of the bank (Figures XVIII-5 and 7). This reflector is very flat and may be an artifact or may represent the upper surface of the cap rock. On Figures XVIII-5 and 7 it is seen only under the lows on both sides of prominences on the upper surface of the bank.

The sequences mapped in Figure XVIII-4 are: 1) acoustic basement; 2) an intermediate sedimentary sequence on the east end of the bank, which has been uplifted with the non-reflective core of the bank; and 3) the onlapping, more recent sediment around the rest of the bank. Contours in Figure XVIII-4 represent thickness of the sedimentary sequences down to the deepest reflector that can be interpreted as a sequence boundary. The lower boundaries are marked at the margins of the boomer profiles shown in Figures XVIII-5, 6, and 7.

The surrounding sedimentary sequences, mapped in Figure XVIII-4, contain two prominent erosional unconformities with clear truncation of bedding reflectors upon which the overlying sediments onlap towards the bank. The base of the mapped sequence is also an unconformity. Below this surface is another well stratified sequence, but no additional unconformities are displayed in the deeper section (Figure XVIII-5).. The presence of the angular unconformities, together with the increasing dips with depth, indicate that the bank has been in the process of uplift over a long period of time including several periods of erosion and subsequent deposition.

Two patterns of faults are present on the bank: 1) the annular fault that encircles the bank; and 2) the radial faults. All show evidence of Recent activity as seen by displacement, such as in Figure XVIII-6b and c. However, the surficial sediments in some cases are not offset (Figure XVIII-7b). Along the eastern margin of the bank (Figure XVIII-6c), it appears that the seafloor and sub-bottom structure have opposite displacements along the same faults--and that is actually the case. The central block is a radial graben that was formed during the last regression of sea level. With renewed sedimentation following the subsequent transgression, the surface relief on this part of the bank was buried. In very recent time, upward movement of salt has reversed the relative movement along these faults and the Recent sediments have been bowed upward over the graben. The directional sense of this movement can be seen where each of the faults intersects the seafloor.

An example of the 3.5 kHz profiles (Figure XVIII-8) shows peaks that are suspected of being outcrops of bedrock covered by carbonate reef growth. One such ridge on the southwestern peak of the bank was examined during dives 122 and 123 (Figure XVIII-2). The ridge is about 200 m long, 24 m high, 5 m wide at the base, and at a depth of 55 m. It is a massive ledge of nearly bare basalt that strikes 055° and dips about 80° to the SSE. A magnetic profile reveals a local anomaly of about +25 gammas directly over the outcrop. Petrographic analysis of the rock indicates that it is a basalt. Neutron activation analysis shows an enrichment in the light rare earth elements, indicating that the rock is an alkalic basalt. K-Ar age determination yields an age of 76.8 $\pm$ 3.3 m.y. (Late Cretaceous). This is the oldest known rock exposed on the continental shelf off Louisiana and Texas.

The feature is interpreted as a dike or sill that has been rafted to the surface by the salt diapir. It has been exposed at the seafloor due to dissolution of the surrounding salt and the subsequent collapse of the adjacent cap rock on either side of the feature. This implies a sizeable root zone still embedded in the salt. Similar features have been observed on Red Sea salt domes in East Africa and in the Zechstein region of Germany. Mounting evidence of Late Mesozoic igneous activity, together with published multi-channel seismic data (Martin, 1978; Humphris, 1978), strongly indicate a rifted origin for the Gulf of Mexico.

HAZARDS
(PI: R. Rezak)

Faulting occurs over the entire bank and surrounding seafloor, as evidenced by the discontinuous outcrop patterns on the side-scan sonar record (Figure XVIII-2) and by displacement of reflectors in the boomer records (Figures XVIII-6 and 7). Evidence for Recent movement along faults may be found in the outcrop of basalt and on boomer records (Figure XVIII-6c). The basalt outcrop is covered by a millimetre thick crust of coralline algae, sponges, and bryozoans. If this rock had been exposed at the seafloor since Late Pleistocene time, one would expect more massive encrustations over the bedrock outcrops, such as those on the peak just to the east, and on other banks such as the Flower Gardens. The presence of such thin crusts suggests a brief time span for colonization by encrusting organisms, probably a year or two at the most.

A diffuse pattern of reflections in the water column over most of the bank, particularly the western half, is probably due to general gas seepage from nearly vertical beds seen on the side-scan records. Specific vents are also evident over the western part of the bank (Figure XVII-5b).

SEDIMENTOLOGY
(PI: R. Rezak)

Four grab samples were taken at Alderdice Bank (Figure XVIII-1). The sediment types at these stations are as follows:

Station 1 - gravelly sand	Station 3 - muddy, sandy gravel
Station 2 - gravelly, muddy sand	Station 4 - gravelly sand.

Submersible observations indicate that below 82 m the sediment is primarily fine mud. At station 1 the sediment is a coralline algal nodule gravel and sand.

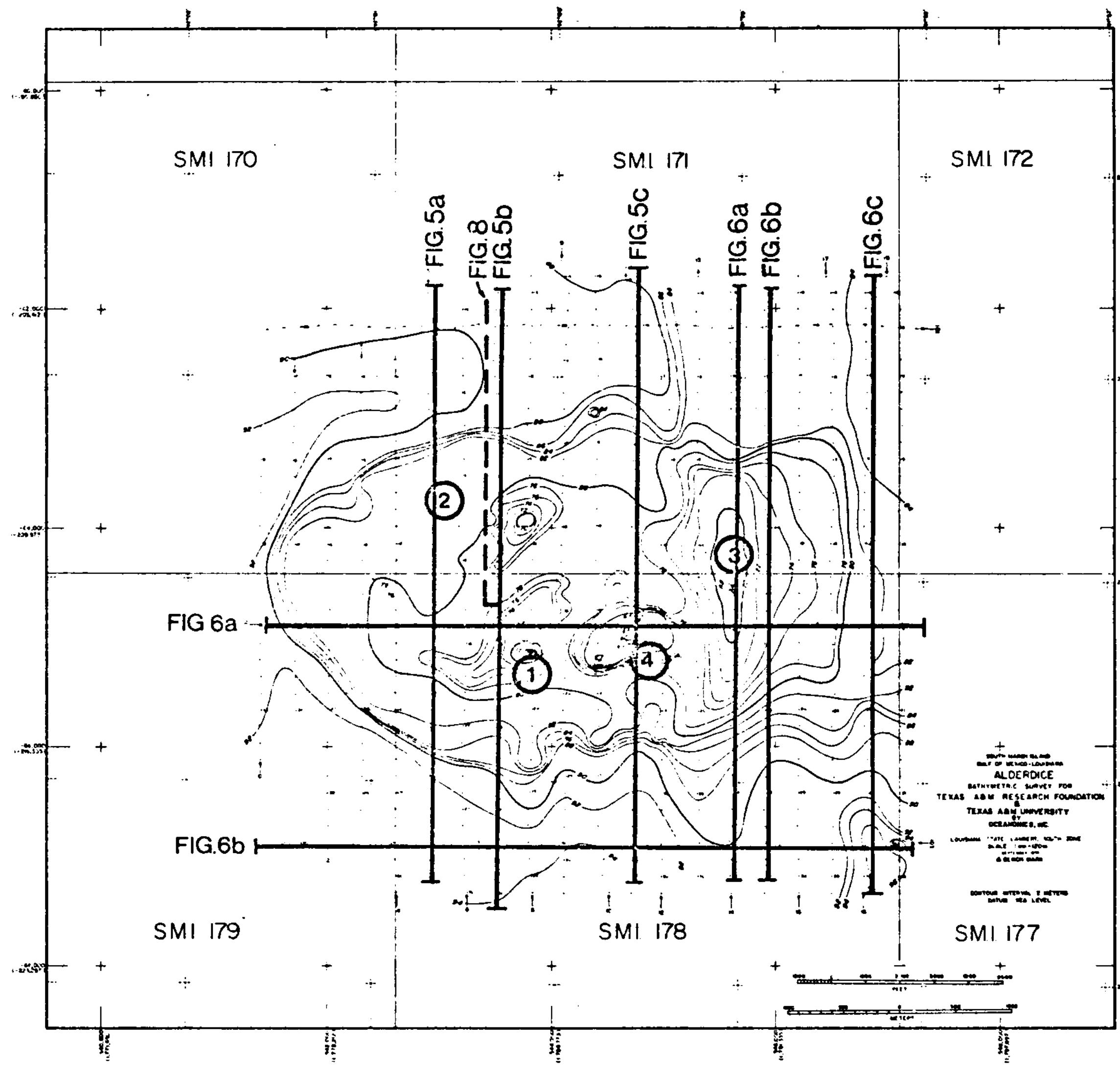

Figure XVIII-1. Bathymetry of Alderdice Bank. Location and number of boomer and 3.5 kHz seismic reflection profiles shown in Figures XVIII-4, 5, 6, and 7 are indicated. Sample stations: 1-4.

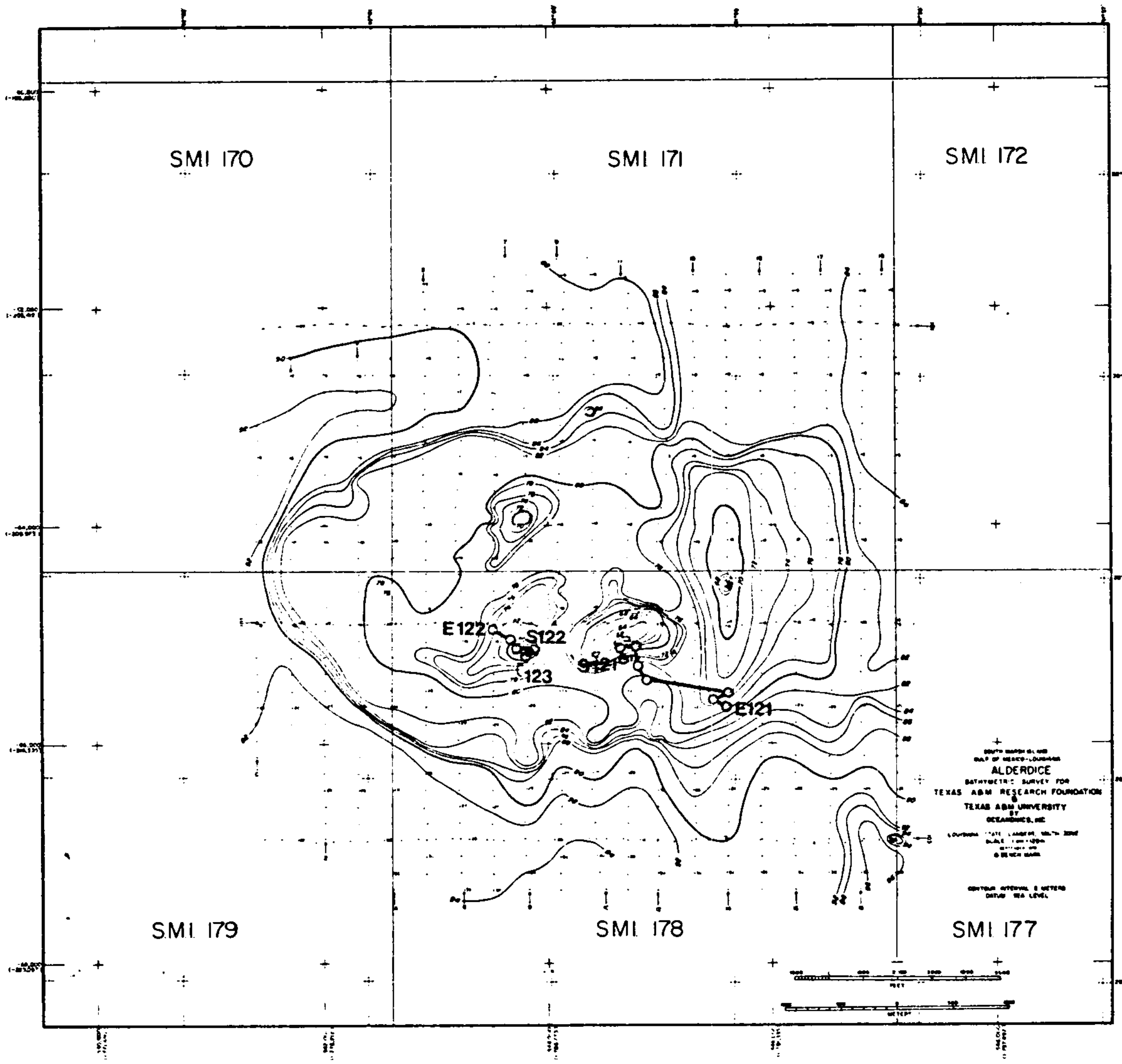

Figure XVIII-2. Submersible transects on Alderdice Bank, dives 121, 122, and 123: S = Start, E = End.

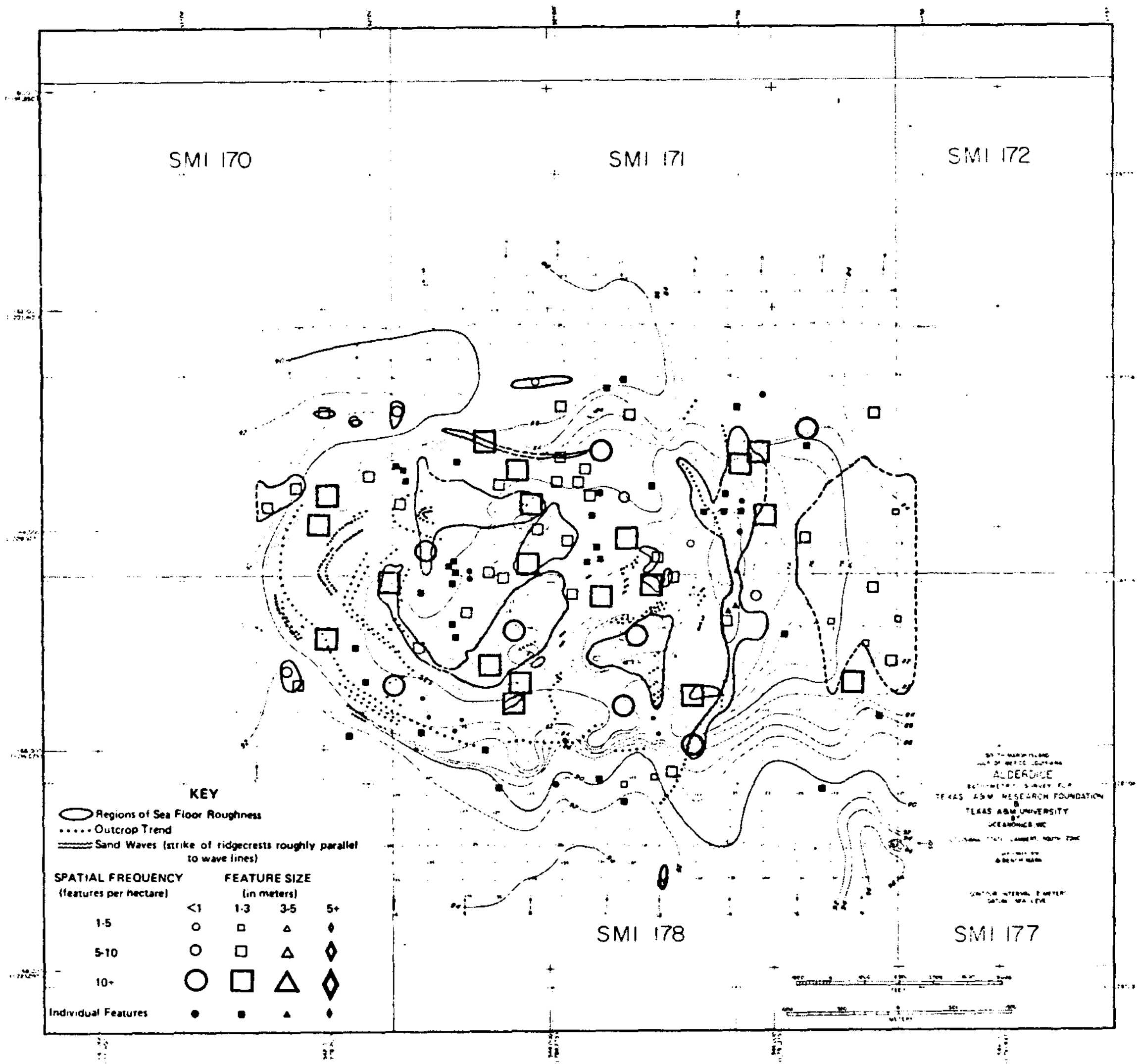

Figure XVIII-3. Seafloor roughness, interpreted from side-scan sonar records.

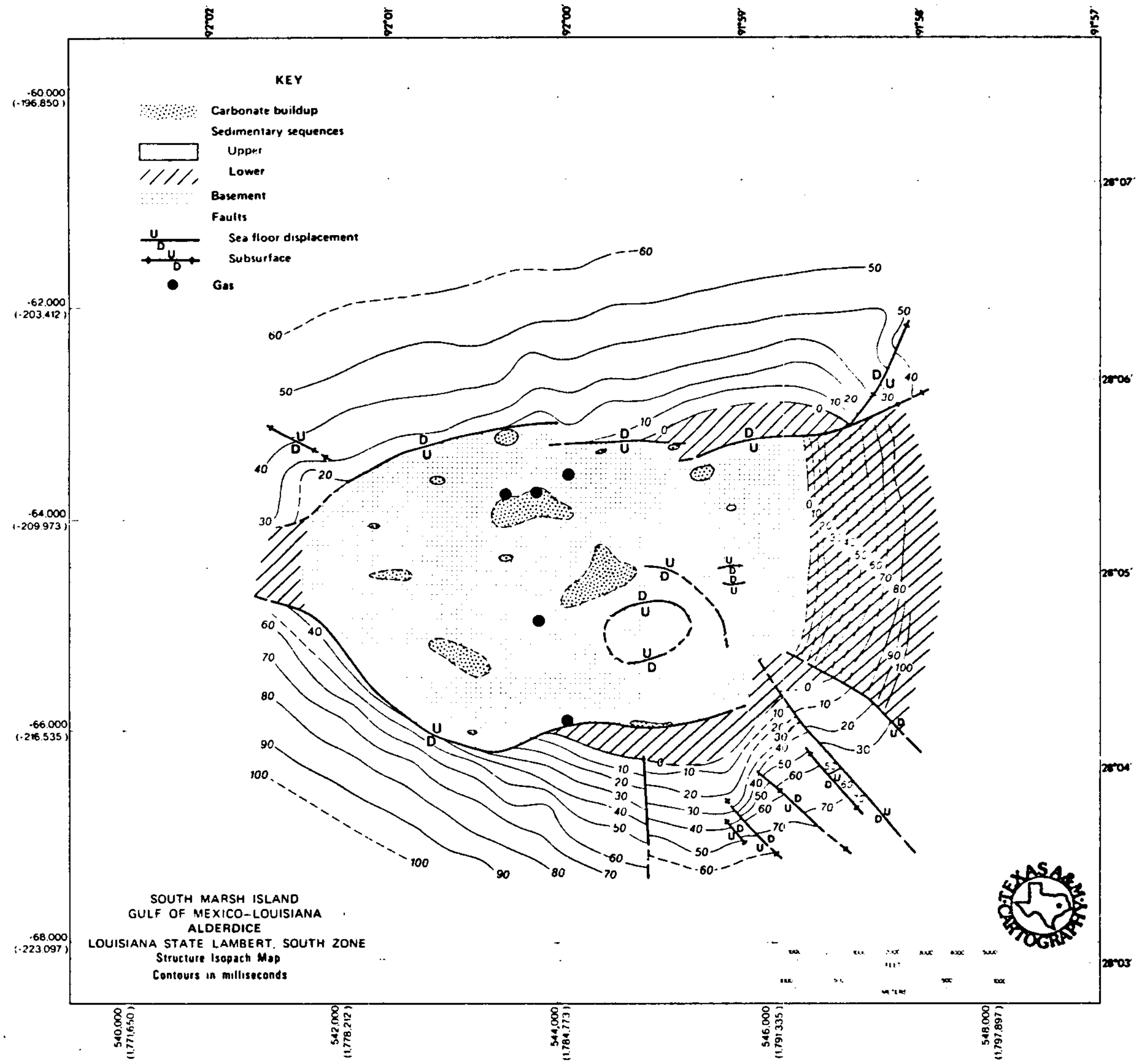

Figure XVIII-4. Structure/isopach map of Alderdice Bank. Contours indicate thickness of the surrounding sedimentary sequences.

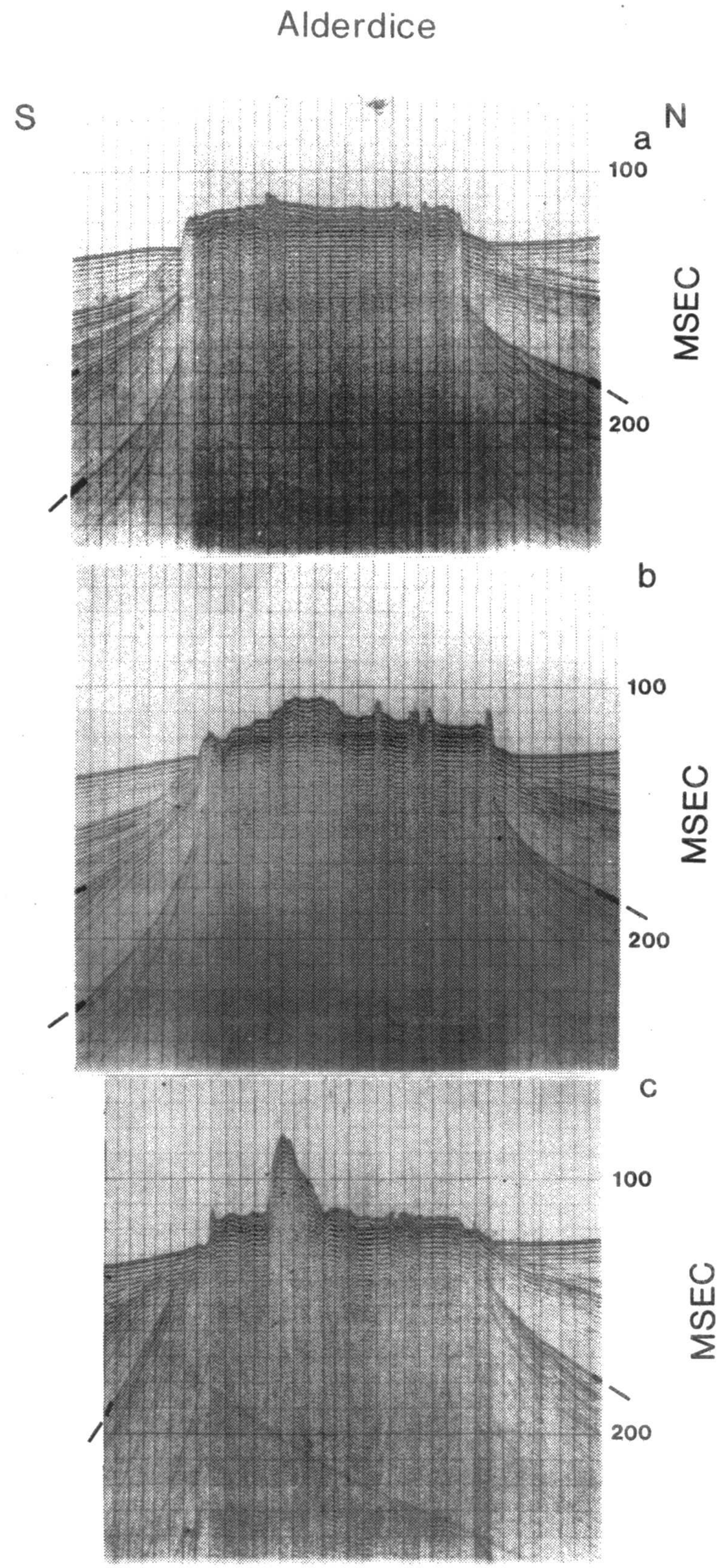

Figure XVIII-5. N-S boomer seismic reflection profiles across western part of the bank are indexed on Figure XVIII-1. The base of the contoured sequence in Figure XVIII-3 is indicated along the record margins.

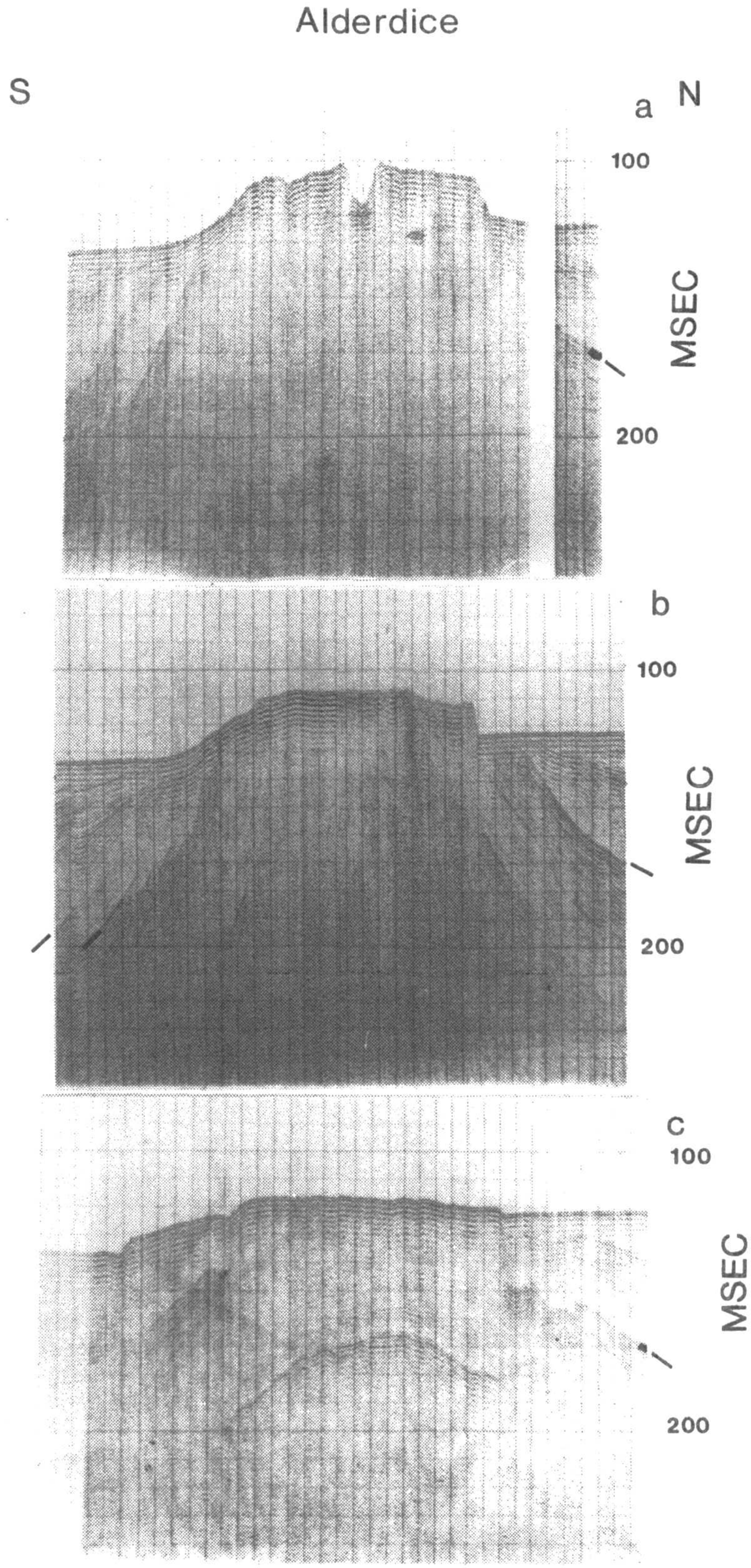

Figure XVIII-6. N-S boomer seismic reflection profiles across eastern part of the bank. Locations are indexed on Figure XVIII-1. The base of the contoured sequence in Figure XVIII-3 is indicated along the record margins.

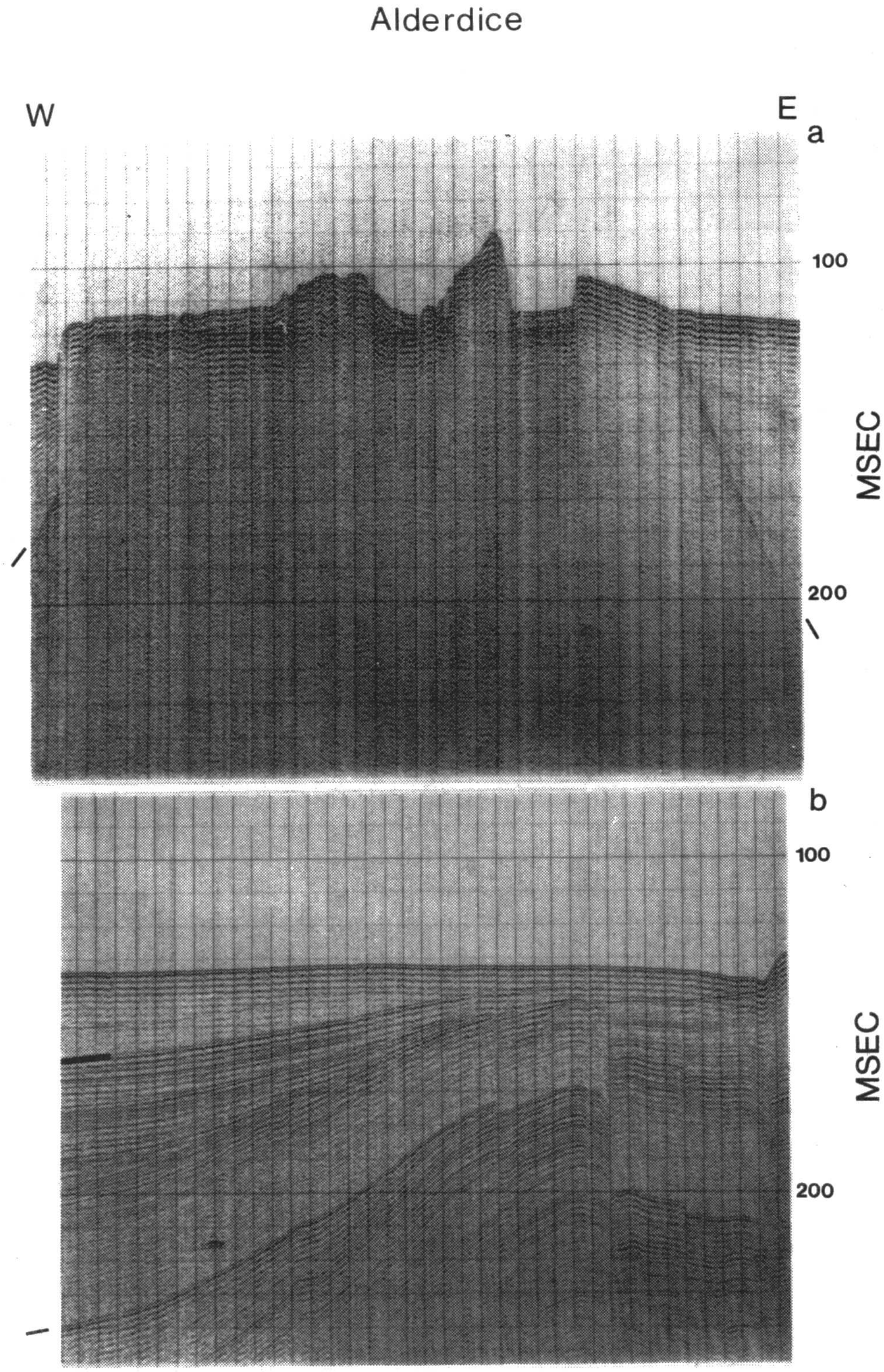

Figure XVIII-7. E-W boomer profiles across Alderdice Bank. See Figure XVIII-1 for locations. The base of the mapped unit is indicated on the sides of profiles.

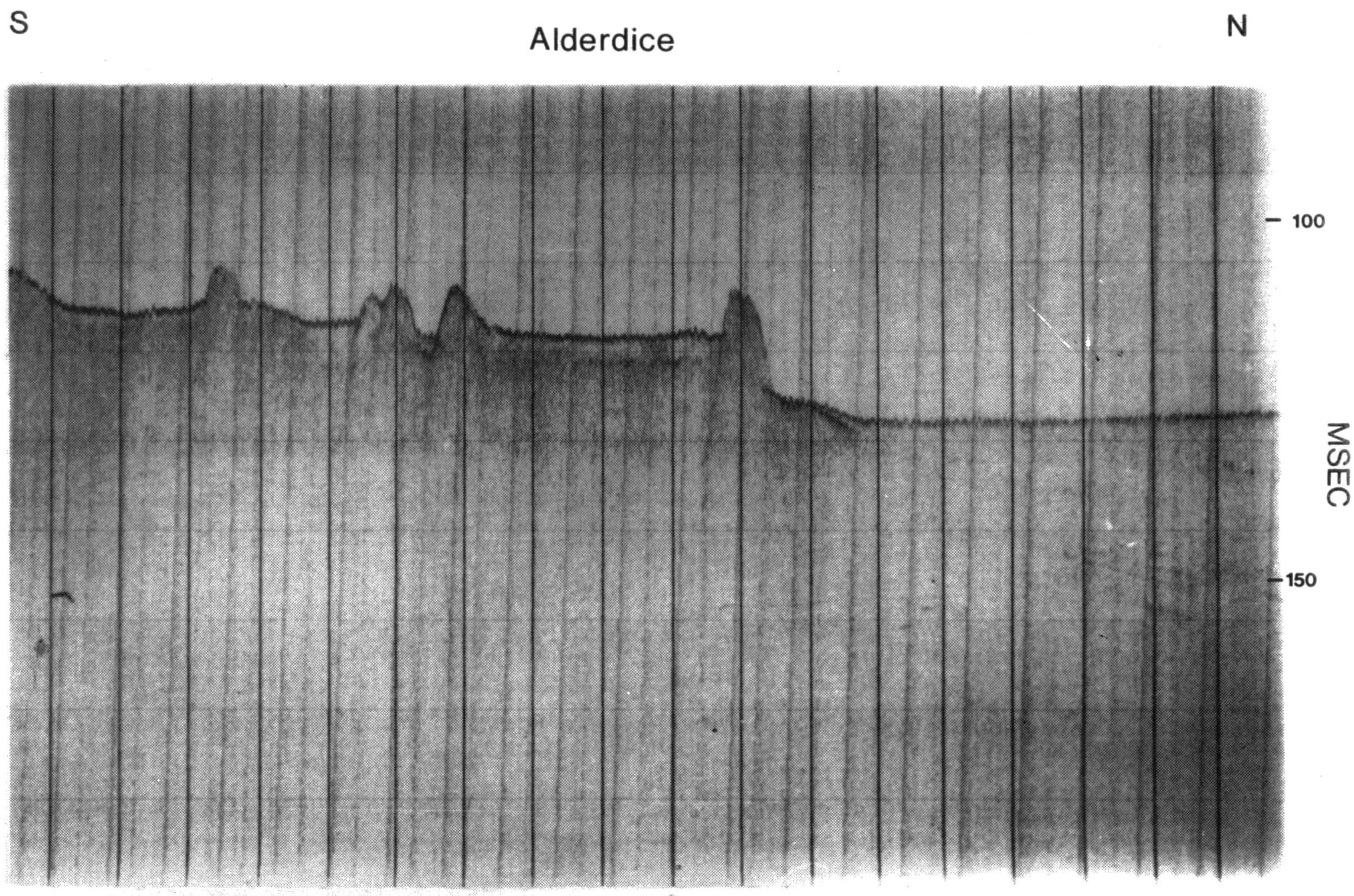

Figure XVIII-8. N-S 3.5 kHz profile of the northern portion of Figure XVIII-5b.

The sand fraction contains mollusc and echinoderm fragments, foraminifers, and coral. The mineralogy of the coarse fraction is primarily high-Mg calcite, followed by low-Mg calcite, aragonite, and quartz, in order of abundance. In the < .002 mm fraction, quartz is the most abundant non-clay mineral.

The sediment at station 2, on the north-south ridge at the east end of the bank, is a coralline algal nodule gravel, but it also contains about 25% mud. At a depth of about 70 m, this is an unusual amount of mud in the sediment. As the center of upward movement of salt has moved eastward, the ridge could have been at a greater depth until relatively recent time and then uplifted to its present position. At the shallower depth, the fines would be winnowed out of the upper centimetre of sediment, leaving a lag of sand that could serve as a substrate for the growth of the coralline algal nodules. The mineralogy of the coarse fraction is primarily high-Mg calcite with lesser amounts of low MG-calcite, aragonite, and quartz. The dominant non-clay mineral in the < .002 mm fraction is quartz.

The sediment at station 3 is a muddy, sandy gravel containing about 19% mud. Mollusc fragments are the dominant particle type, but coralline algae are next in abundance, followed by bryozoans, enchinoderms, and lithoclasts. Mineralogically, the coarse fraction consists of high-Mg calcite followed in abundance by aragonite, low Mg calcite, and quartz. The dominant mineral in the < .002 mm fraction is quartz. An alternative hypothesis for the presence of mud containing an abundance of quartz at shallow depths is that the mud is derived from the bioerosion of Tertiary bedrock outcrops that appear to be so abundant on the bank. The abundance of quartz and lithoclasts in the coarse fraction also support this hypothesis.

The sediment at station 4 is a gravelly sand that contains less than 1% mud. The gravel in this sediment is coralline algae. The most abundant particle type is *Amphistegina*. This sediment is the equivalent of the *Amphistegina* Sand Facies on the Flower Garden Banks. The mineralogical composition of the coarse fraction is mainly high-Mg calcite, followed in order of abundance by low-Mg calcite, aragonite, and quartz.

WATER AND SEDIMENT DYNAMICS
(PI: D. McGrail)

Hydrographic stations 1 and 2 (Figures XVIII-9 and 10) at Alderdice Bank were occupied on the evening of 23 June 1979. Stations 3 and 4 (Figures XVIII-11 and 12) were occupied the following morning. The locations of the stations are shown in Figure XVIII-1. Between the evening of 23 June and the morning of 24 June, the surface waters (approx. upper 24 m) over the bank changed significantly. This change is apparent in both the plots of the Brunt-Vaisala frequency (Figure XVIII-13) and the T-S diagram (Figure XVIII-14). In the evening, the surface waters possessed salinities of approximately 33.7 o/oo and temperatures of approximately 26.5°C. By morning the salinities were of the order of 34.5 °/oo and temperatures were approximately 25.8°C.

Judging from the current meter profiles, it would appear that the southerly and easterly surface flow observed in the evening brought warm low salinity from the shelf out over the bank. This is somewhat surprising since the wind was blowing gently (< 2.5 m/sec) out of the southeast. By the morning of 24 June the surface flow was from the south and west. The cooler, more saline waters appear, therefore, to have been advected in from offshore as the fresher water was displaced back over the continental shelf.

The very thin mixed layer in the surface waters and opposition of wind and current during the evening of 23 June illustrate how little effect the gentle southeasterly breezes have on the circulation of the Outer Continental Shelf in the spring.

As with all of the reconnaissance stations occupied during the June 1979 cruise, the flow observed at Alderdice Bank stations was strongly depth and time dependent and topographically steered. The depth dependence means that the pressure gradients driving the flow were induced by inclinations of the isopycnals against geopotential surfaces rather than inclination of the sea surface. The time dependence was on a sufficiently short time scale to be observed over the approximately 18-hour sampling period. It seems likely, therefore, that those fluctuations in speed and direction among the stations not accounted for by topography were due to the baroclinic tide or inertial oscillations.

Since all of the stations at Alderdice Bank were located on the bank itself, no observations were made regarding the suspended sediment distribution around the base of the bank. However, because the substrate surrounding the bank is reported to be silt and clay (BLM, 1979a, visual #3), it is anticipated that a well developed nepheloid layer should exist there much of the time. At the time of the June sampling, really turbid bottom water was observed on the bank only at station 3, although there were minor amounts of suspended sediment below about 60 m at station 2. The near-bottom deflections in the transmissivity profiles from the other two stations were caused by the instrument hitting bottom. Bottom sediment samples from both stations 2 and 3 contained significant quantities of silt and clay, whereas samples from stations 1 and 4 did not. It would appear, therefore, that the suspended sediment observed at stations 2 and 3 was locally derived and not advected across the bank from sources off the bank.

From the data available it is not possible to determine whether sediment resuspended from the adjacent seafloor is ever advected over the broad platform of Alderdice Bank. It is reasonable to expect so because of the low relief of the bank and observations on the vertical extent of the nepheloid layer around other banks, such as the East Flower Garden. It seems highly unlikely, however, that sediment resuspended from the substrate adjacent to the bank reaches the crests of the peaks that rise from the surface of Alderdice Bank.

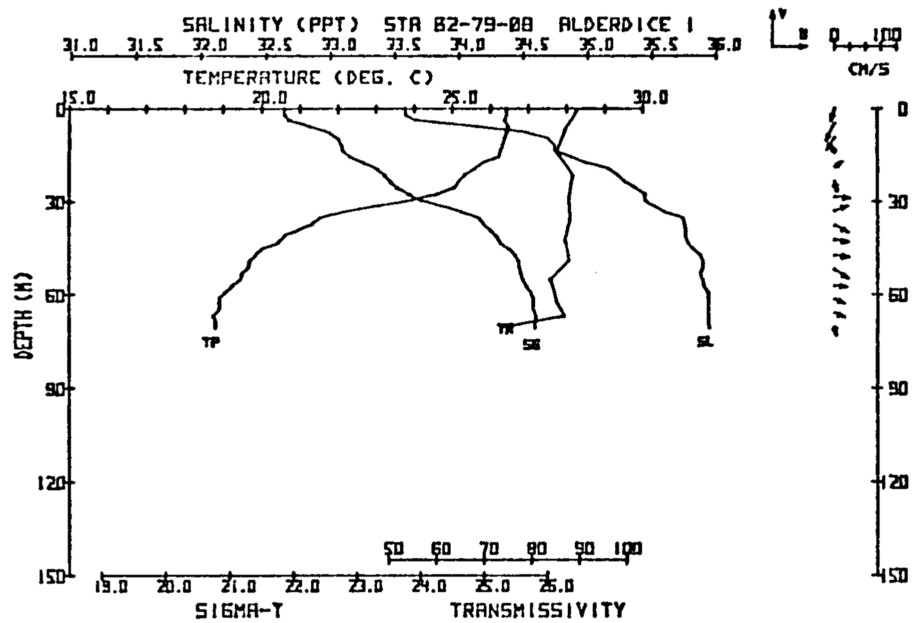

Figure XVIII-9. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Alderdice 1.

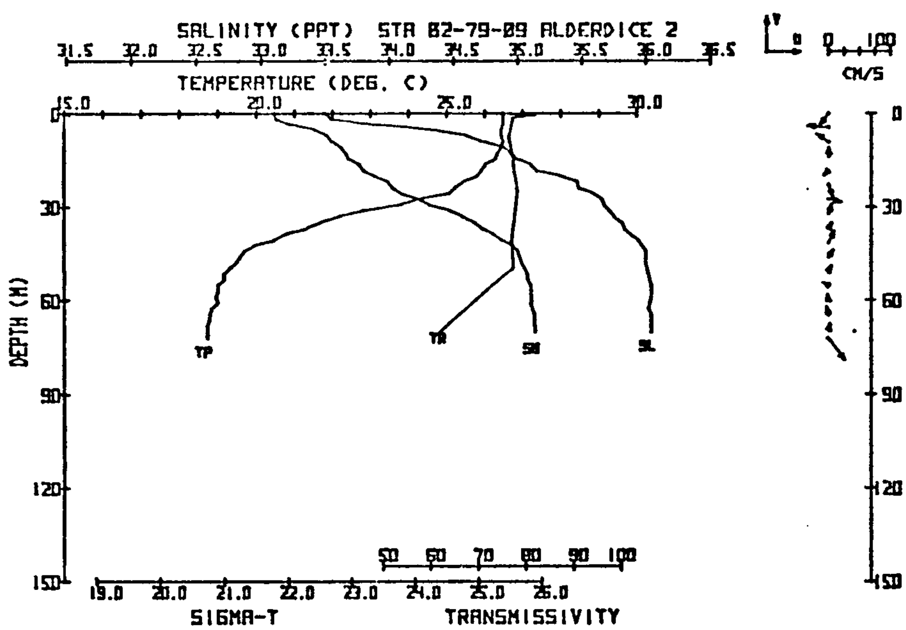

Figure XVIII-10. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Alderdice 2.

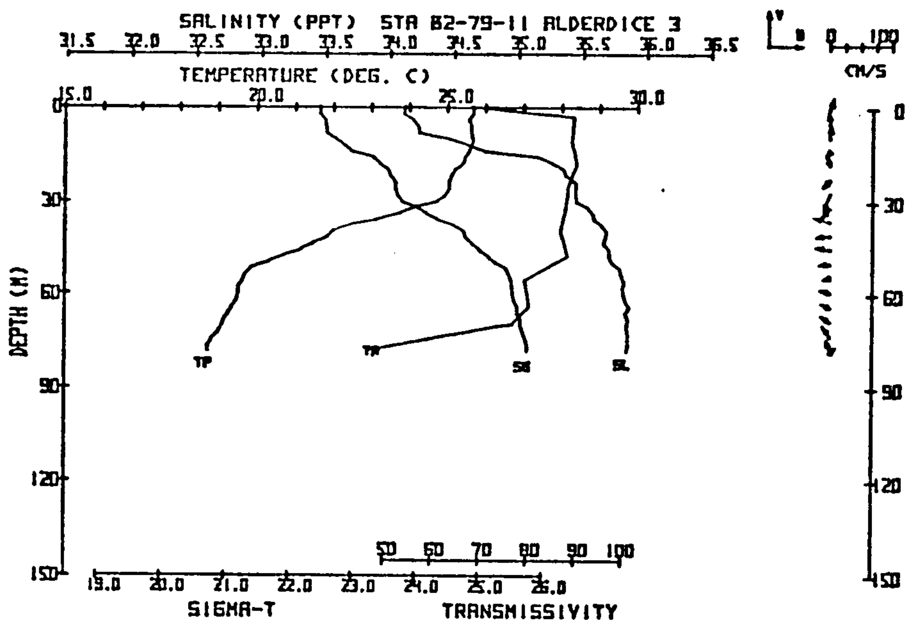

Figure XVIII-11. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Alderdice 3.

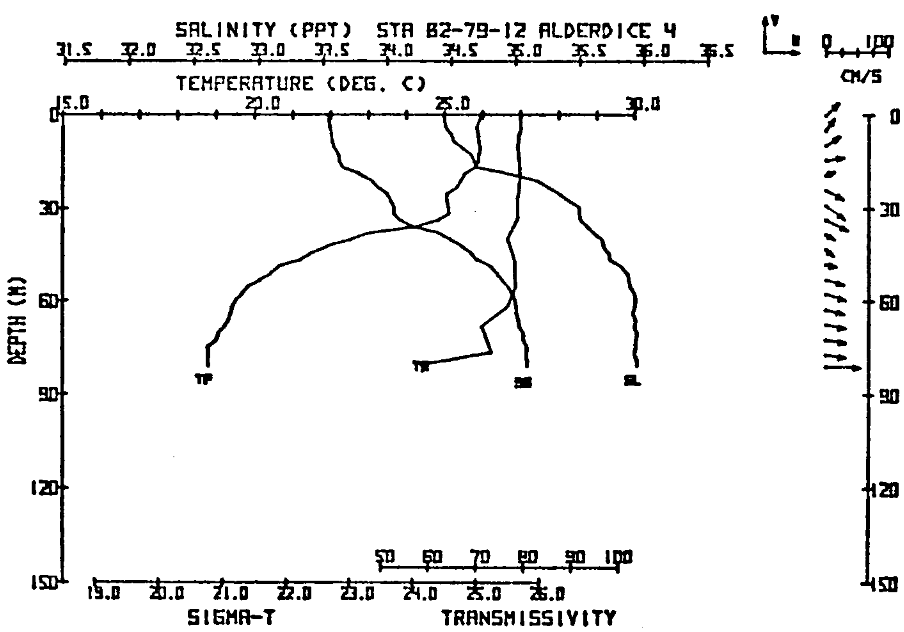

Figure XVIII-12. Plot of salinity (SL), temperature (TP), transmissivity (TR), and sigma-t (SG) from Alderdice 4.

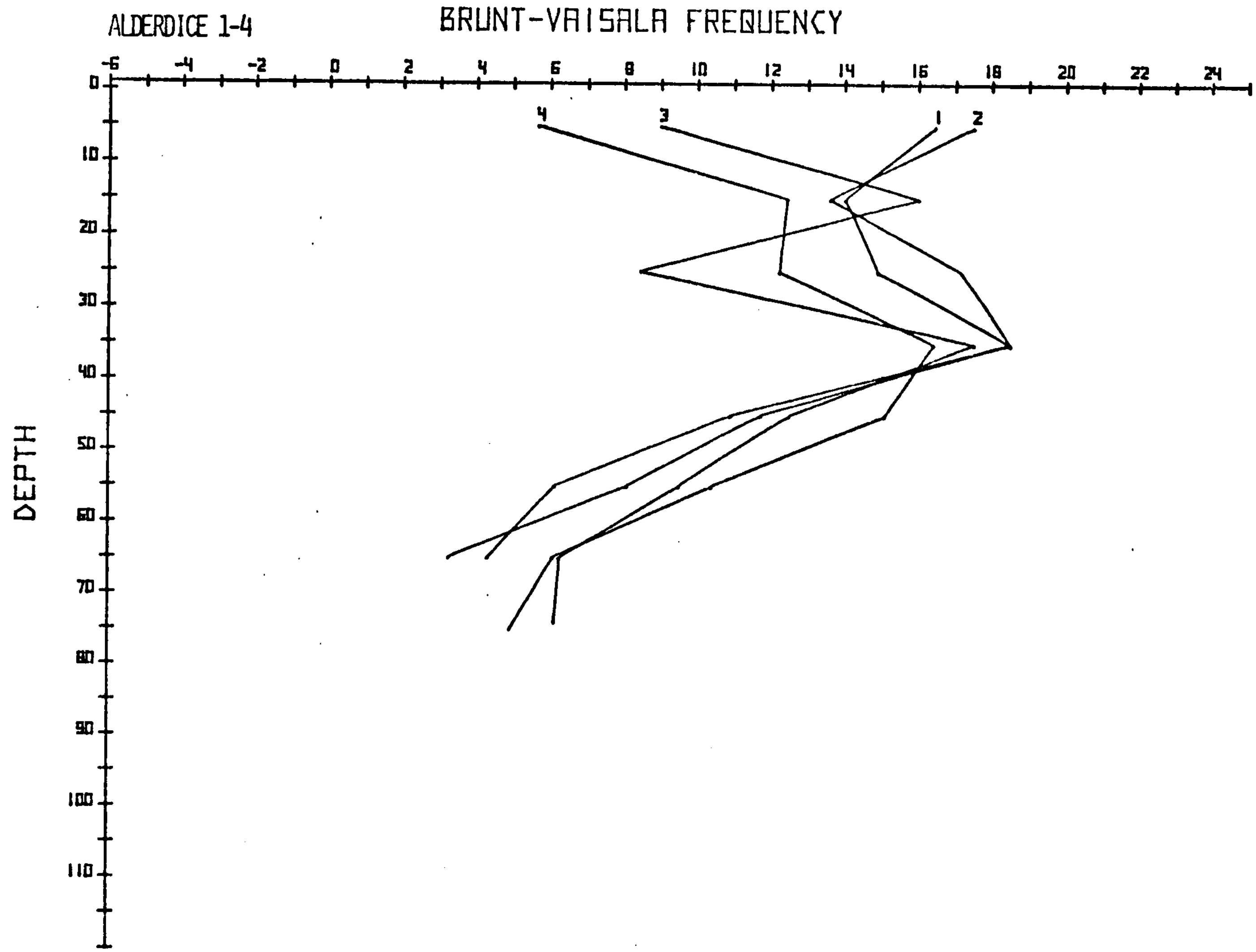

Figure XVIII-13. Plot of Brunt-Vaisala frequency (N) against depth for the four stations at Alderdice Bank.

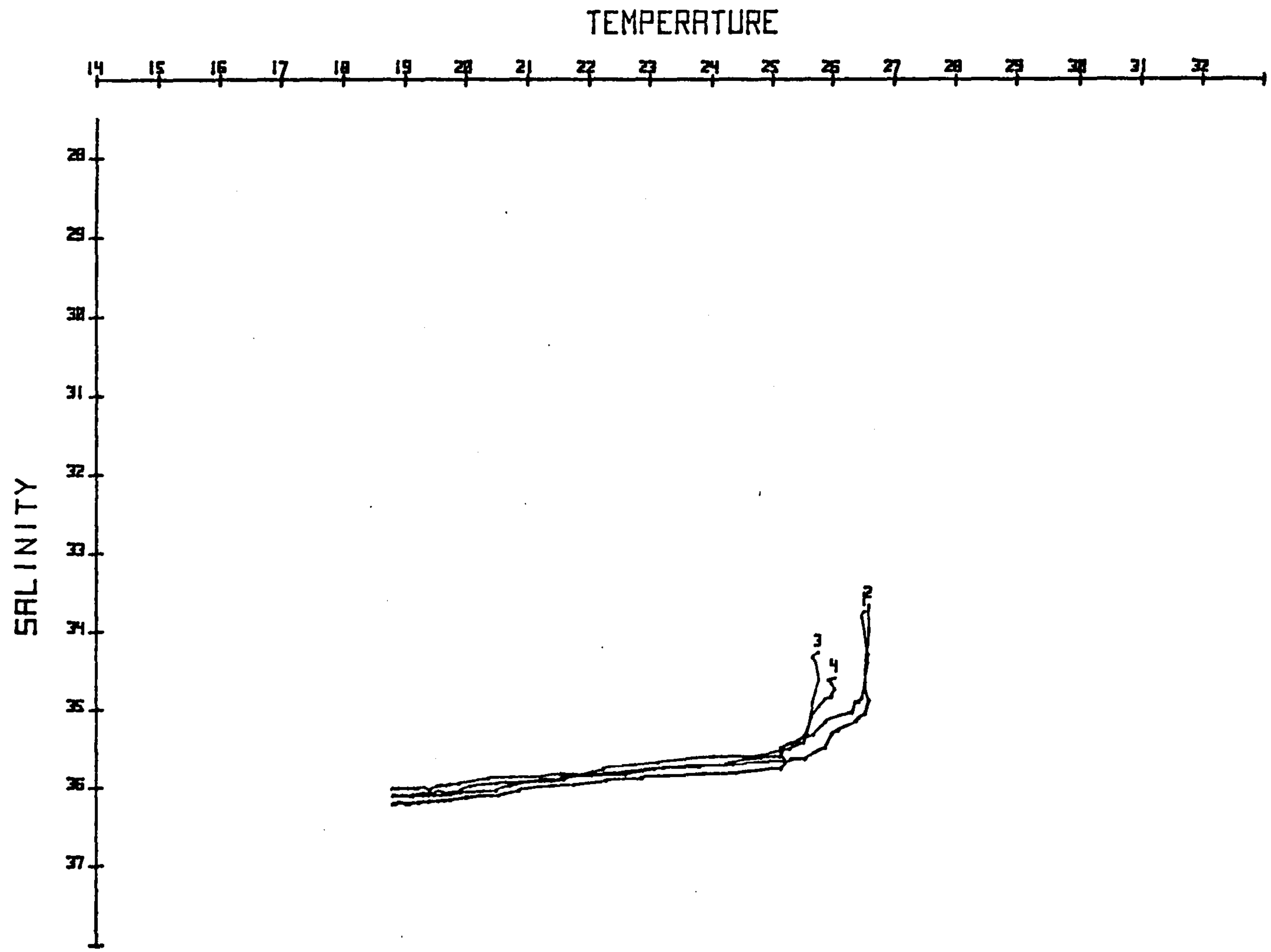

Figure XVIII-14. Temperature vs. salinity plot for Alderdice Bank.

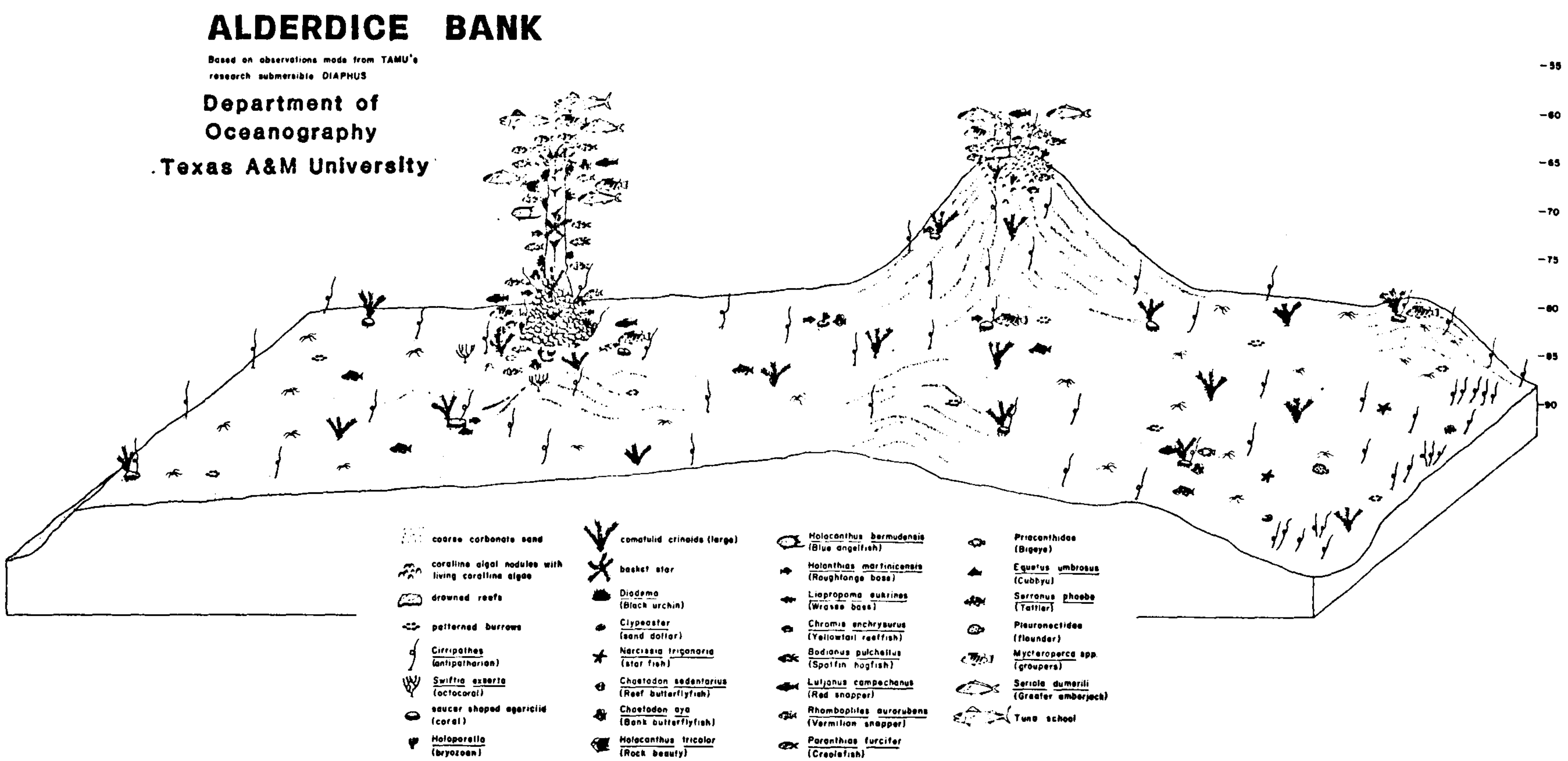

Figure XVIII-15. Diagrammatic representation of biota at Alderdice Bank.

BIOLOGY
(PI: T. Bright)
(Figures XVIII-15 through 18, and Appendix D, Table XVIII-1)

Alderdice Bank is composed of four major topographical peaks on a flattish platform of about 80 m depth. In addition, a spectacular basalt outcrop juts vertically out of the bottom at 76 m, cresting at 55 m (Figures XVIII-16, 17, and 18). Reconnaissance of one of the major peaks, the basalt outcrop, and a good part of the 80 m platform, revealed basic differences in biotic communities occupying the three structural zones.

Healthy, growing coralline algal nodules underlain by carbonate sand occur at the crest of the large southeastern peak (58 to 67 m depth). The nodules are accompanied here and there by very small reefal structures and carbonate blocks covered with the dominant coralline algae. The extreme variability in size of nodules, blocks, and firmly affixed reef rock gives the substratum an irregular appearance not typical of other algal nodule zones. Contributing to the irregularity is the "lumpy" nature of the highly bioturbated sand, where it is exposed.

The most conspicuous invertebrates on the peak are Cirripathes, massive sponges of several species, and large branching bryozoan colonies (Holoporella). An exceptionally large number of Yellowtail reeffish, Chromis enchrysurus, was encountered above 67 m; the peak was literally swarming with them. Creolefish, Paranthias furcifer, were numerous; groupers, Mycteroperca sp., congregated on top; schools of snappers (Lutjanus spp. and Rhomboplites aurorubens) and Greater amberjack (Seriola dumerili) were seen.

The Algal-Sponge Zone described above is probably restricted to the crests of the several peaks at Alderdice Bank and, therefore, is of limited areal extent. It nevertheless is a zone of active reefbuilding and carbonate substratum production deserving special consideration from the standpoint of environmental protection.

Small "drowned" reefal structures occur on the bank down to at least 85 m depth, surrounded by the large expanse of unconsolidated sediment which comprises most of the bank. The sediment grades from carbonate sand, gravel, and nodular material (75 m), to mixtures of sand, silt, clay, and gravel (79 m), to soft, primarily fine sediment (82 m). Reefal structures below the Algal-Sponge Zone are typically laden with veneers of sediment which is entrapped by mats of low epifaunal growth (Figure XVIII-17). Below 82 m the drowned reefs are almost totally covered with thin layers of fine sediment. Small amounts of coralline algae, nevertheless, occur on the drowned reefs down to at least 79 m (5% cover at 76 m). No algae were seen below 79 m.

Cirripathes is generally the most conspicuous invertebrate at all depths and is particularly abundant locally below 84 m. Between 76 and 85 m enormous populations of small comatulid crinoids occur on the unconsolidated bottom, clinging to rocks and rubble. Larger crinoids are numerous on rocks and drowned reefs between 76 and 85 m, and were seen to 88 m. Branching colonies of Holoporella are abundant above 76 m. Various alcyonarians occur on the rocks between 76 and 79 m, the largest being white muriceid fans and the orange and white branching form Swiftia exserta.

The deeper, muddy bottoms below 82 m are comparatively barren but are abundantly etched with tracks, trails, and burrows, indicating an active population of mobile benthic invertebrates. The sand dollar, Clypeaster ravenelii is fairly numerous below 85 m, and the starfish, Narcissia trigonaria, was seen between 82 and 85 m.

Two species of hermatypic corals were encountered at 76 m, saucer-shaped agariciids and a small head of what appeared to be Stephanocoenia sp. Neither was abundant, and both occurred on drowned reefs.

Holanthias martinicensis was the most frequently seen fish around the drowned reefal structures below 76 m. Others included Yellowtail reeffish, Chromis enchrysurus; Spotfin hogfish, Bodianus pulchellus; Blue angelfish, Holacanthus bermudensis; Reef butterflyfish, Chaetodon sedentarius; Cubbyu, Equetus umbrosus; Spanish flag, Gonioplectrus hispanus; and Bigeye, Priacanthus sp. A school of snappers, Lutjanus sp., and several groupers, Mycteroperca sp., were also seen. Tattlers, Serranus phoebe, were numerous on the unconsolidated bottom.

The most impressive feature on Alderdice Bank is the basalt outcrop. It is an elongated narrow ridge extending vertically upward from the 76 m surrounding depth to 55 m crest depth. Spires examined at the crest were two or so metres across at the top (Figures XVIII-16 and 17), with sheer cliffs extending downward to approximately 67 or 69 m, below which large blocks of bedrock talus were piled around the base of the outcrop (Figure XVIII-18).

The hard basalt is covered with millimetre-thin crusts of coralline algae, sponges, bryozoans and other epifauna. Near the top of the outcrop, these crusts are nearly total, up to 50% being coralline algae. At 69 m on the large blocks, coralline algal cover is 70-80%, but the cover decreases with increasing depth to small patches at 76 m.

Large Basket stars, Diadema urchins, and branching colonies of the bryozoan Holoporella are particularly abundant and visible on the outcrop and talus slope. Basket stars tend to accumulate at the very peak of the outcrop (Figure XVIII-17). Cirripathes, Antipathes, large comatulid crinoids, and small branching alcyonarians are numerous on the talus slope surrounding the outcrop (Figure XVIII-18).

Fishes swarm around the crests of the outcrops. Frequenting the outcrop crests are large schools of Creolefish, Paranthias furcifer; Vermilion snapper, Rhomboplites aurorubens; Greater amberjack, Seriola dumerili; and tuna, as well as large Red snapper, Lutjanus campechanus, and groupers, Mycteroperca. Creolefish and Vermilion snapper were the most numerous large fishes on the structure at all depths. Holanthias

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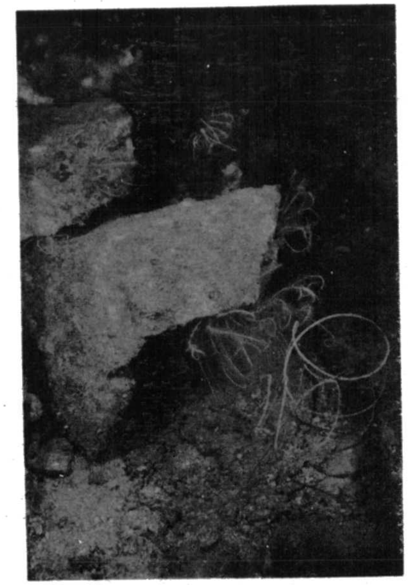

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Figure XVIII-16 (UL). Alderdice: crest of basalt spire encrusted with coralline algae, sponges, bryozoans, and other epifauna at 55 m depth. Basket stars are numerous.

Figure XVIII-17 (UR). Alderdice: large basalt blocks at base of spire at 76 m depth. *Cirripathes*, crinoids, sponges, and other epifauna.

Figure XVIII-18 (L). Alderdice: drowned reef (carbonate rock) at 76 m depth. Crinoids are numerous. Dark area in center is hermatypic coral, *Stephanocoenia* sp.

martinicensis was abundant, particularly on the talus slope. Closely associated with the outcrop and talus blocks are the Wrasse bass, Liopropoma eukrines; Spotfin hogfish, Bodianus pulchellus; Bank butterflyfish, Chaetodon aya; Blue angelfish, Holacanthus bermudensis; Rock beauty, Holacanthus tricolor; and a damselfish which resembles Chromis scotti.

CONCLUSIONS AND RECOMMENDATIONS

Alderdice Bank is another tectonically active bank. Faulting is common both on the crest of the bank and on its flanks. The shift in the locus of upthrusting by the salt diapir, as illustrated by Figure XVIII-6c, creates potentially dangerous conditions on and around the bank. If the locus of the greatest upward movement has actually shifted and dissolution of salt is continuing beneath the present crest, then an increased rate of collapse of the crest may be expected. This situation on Alderdice Bank indicates that instability of the sea bottom due to tectonism is not restricted to the crest of the bank but may occur some distance away from the crest in areas that otherwise may appear stable.

Because of the existence of clear-water reefal communities on at least one, and probably all, of the major topographic peaks at Alderdice Bank, and because of the presence of spectacular basalt outcrops bearing a diverse assemblage of epibenthic organisms and fishes, **it is recommended that Alderdice Bank be classified as a top priority bank from the standpoint of environmental protection.**

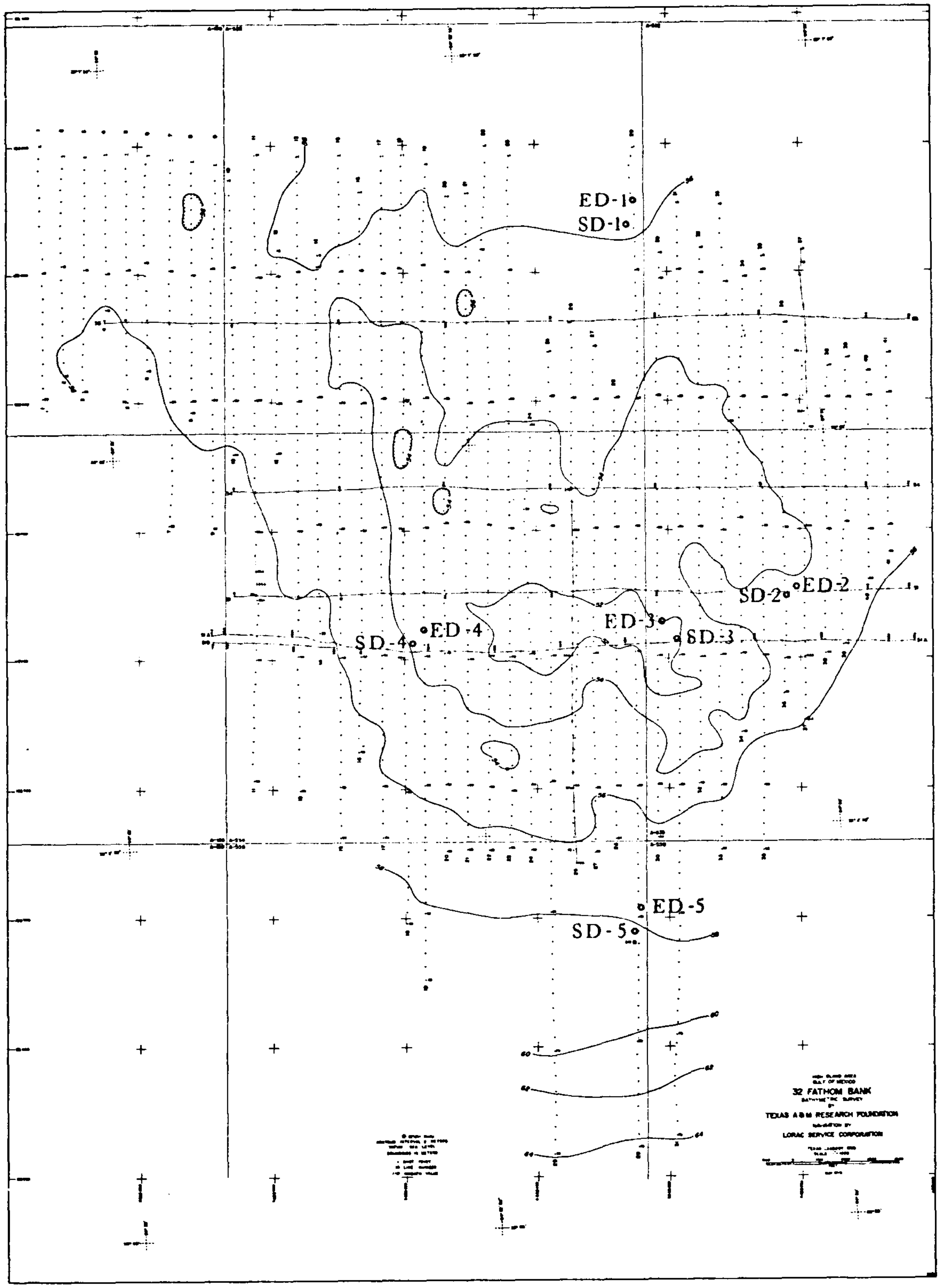

Figure XIX-1. Bathymetry on 32 Fathom Bank with dredge haul locations. SD = Start Dredging, ED = End Dredging.

CHAPTER XIX

32 FATHOM BANK

R. Rezak, T. Bright, L. Pequegnat

INTRODUCTION

32 Fathom Bank was mapped in May 1975 on Contract #08550-CT5-4, which specified only the acquisition of bathymetric and side-scan sonar data. No sub-bottom profiling nor submersible observations and sediment sampling were specified. During the present contract, a requirement for dredging was included in order to characterize the biota and sediments on the bank.

GENERAL DESCRIPTION

The bank is located at 28°01'47"N latitude and 94°31'29"W longitude (Volume One, Figure III-1) in Blocks 532-535, 558, and 559 of the High Island Area (Figure XIX-1). It is a nearly circular bank covering an area of about 45 km^2. It has a broad dome shape with a total relief of about 6 m. The shallowest depth is 52 m and the greatest depth is 58 m. Two sub-bottom profiles made during the spring 1975 mapping cruise indicate that 32 Fathom Bank is a deeply eroded diapir similar to Coffee Lump.

SEDIMENTOLOGY
(PI: R. Rezak)

Five rock dredge hauls were made on 32 Fathom Bank (Figure XIX-1). Four of these stations yielded sediment samples. Station 3 was a hard substrate that yielded a living hard bottom calcareous biota.

The sediment types at the other four stations were gravelly, muddy sand (stations 1 and 2) and slightly gravelly sand (stations 4 and 5).

Particle type identification shows that at all four stations quartz is the dominant component of the sediment, with minor amounts of molluscan hash. The texture and composition of the sediments are similar to those parameters of the sediments at Coffee Lump, indicating a common origin.

BIOLOGY
(PI: T. Bright)

No submersible dives were made at 32 Fathom Bank, and the samples dredged were less satisfactory for interpretation of biotic communities than were those taken at Applebaum Bank. The types of organisms taken in the dredge (Appendix D, Table XIX-1) are reminiscent of the types seen and collected at Coffee Lump. For lack of better information, we tentatively suggest that 32 Fathom Bank is somewhat similar to Coffee Lump in "quality" of biotic community development.

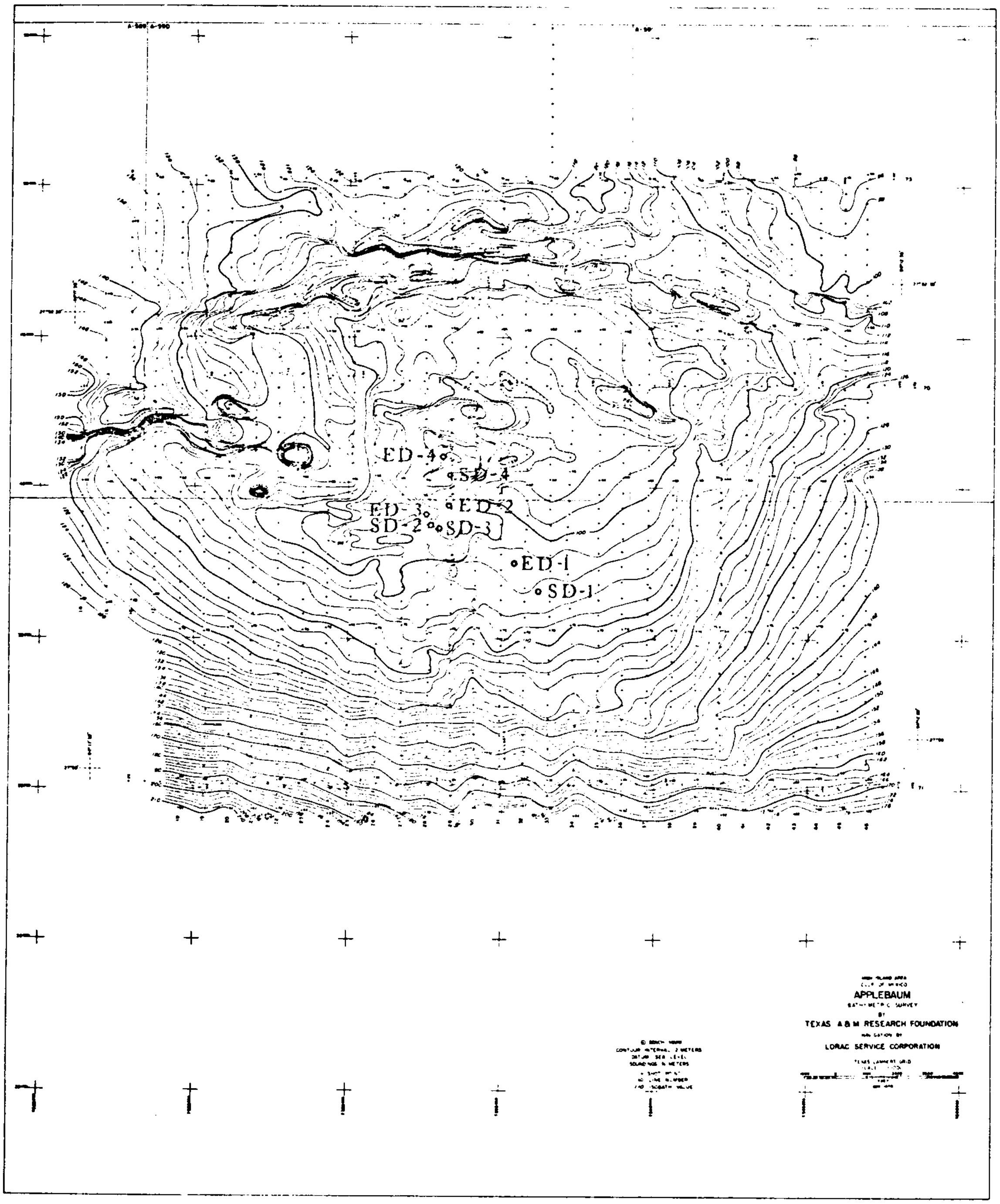

Figure XX-1. Bathymetry on Applebaum Bank showing dredge sample locations. SD = Start Dredging, ED = End Dredging.

CHAPTER XX

APPLEBAUM BANK

R. Rezak, T. Bright, L. Pequegnat

INTRODUCTION

Applebaum Bank (previously designated incorrectly as Little Sister Bank) was mapped in May 1975 and has the same history of study as 32 Fathom Bank. During the present contract, a requirement for dredging was included in the work statement in order to characterize the biota and sediment on the bank.

GENERAL DESCRIPTION

The bank is located at 27°51'41"N latitude and 94°15'16"W longitude (Volume One, Figure III-1). The northern half of the bank is located in Blocks 589-591 of the High Island Area. The remainder of the bank is in the East Breaks Area (Figure XX-1). It has an oval shape, elongate to the east and west, and covers an area of about 35 km^2. The bank lies on a salt diapir situated at the shelf break. The shallowest peak, near the center of the bank, rises to a depth of 76 m. To the north, the base of the bank lies at a depth of about 120 m, and to the south the base of the bank merges into the upper continental slope at a depth of about 160 m.

The shallowest part of the bank is a north-south elongate, amoeboid peak that rises from a depth of 92 m. Immediately adjacent to the peak, on the east side, is a large depression that bottoms at greater than 100 m. These centrally located prominences and depressions must be related to normal faulting at the crest of a salt diapir.

SEDIMENTOLOGY
(PI: R. Rezak)

Four rock dredge stations were made on Applebaum Bank. At only one of these stations was there enough fine sediment to permit textural analysis. The other three stations are mainly algal nodules, molluscan gravels, and algal reefs. The sediment type at Station LIS-1 is a slightly gravelly sandy mud. It is very poorly sorted and consists of molluscan hash, benthic foraminifers, planktonic foraminifers, echinoderms, coralline algae, and quartz grains in the > .062 m fraction. The coarse silt and very fine sand fractions contain only quartz and planktonic foraminifers.

BIOLOGY
(PI: T. Bright)

No submersible dives were made at Applebaum Bank and dredge samples are an inadequate basis for interpretation of benthic community structure, zonation, and distribution of marine organisms. Little can be said concerning the biology of Applebaum Bank except the following:

1. The rocks retrieved in the dredge were carbonate, produced primarily by coralline algae, but less than 3% of the surface of the rocks bore live coralline algae.

2. Encrusting sponges covered more of the collected rocks (possibly 20%) than did other types of organisms.

3. The organisms collected are typical of outer continental shelf banks in the northwestern Gulf of Mexico (Appendix D, Table XX-1). The antipatharian *Cirripathes*, various small alcyonarians, gorgonocephalan basket stars, other ophiuroids, and the Rough tongue bass, *Holanthias martinicensis*, were also collected and are probably conspicuously abundant on the bank. Leafy algae are also present.

4. Based on the nature of the dredge sample, it is speculated that Applebaum Bank bears areas of carbonate hard-bottom with an assemblage of organisms resembling that found on some of the South Texas Fishing Banks (viz. Southern and South Baker Banks).

APPENDIX D:

SPECIES LIST

TABLE XI-1
COFFEE LUMP SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Auletta sp.	d 113	1
Halichondridae	d 1	3
Poeciloscleridae	d 1	1
Timeinide	d 1	1
Unidentified Sponge	d 1	2
Alcyonarians		
Thesea granulosa	d 1	
Antipatharians		
Cirripathes (Stichopathes) sp. A	d 13	
Cirripathes (Stichopathes) sp. B	d 1	
Scleractinian Corals		
Madracis asperula	d 1 & d 13	
Paracyathus pulchellus	d 1 & d 13	
Polychaeta		
Anaitides madeirensis	d 113	6
Chrysopelalidae/Palmyridae?	d 1	1
Dorvillea sociabilis	d 1	1
Harmothoe sp.	d 1	1
Hesionidae Genus B	d 1	1
Hypsicomus sp.	d 113	1
Lysidice ninetta	d 1	1
Nematonereis sp. A	d 113	1
Nereis riisei	d 113	1
Paleanotus debilis	d 1	1
Pherusa cf. parmata	d 1	1
Pista sp. A	d 1	1
Trypanosyllis sp.	d 1	1
Typosyllis alternata	d 1	1
Bivalve Mollusks		
Arca zebra	d 1	5
Barbatia candida	d 1	3
Pinnidae sp. (badly broken juvenile)	d 1	1
Gastropod Mollusks		
Diodora sp.	d 1	1
Polyplacophorans		
Small Unidentifiable Chiton	d 1	1
Amphipod Crustaceans		
Ceradocus sheardi	d 1	1
Corophiidae	d 1	1
Maera sp.	d 1	1
Melita appendiculata	d 1	1

TABLE XI-1 (Continued)

Coffee Lump

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Decapod Crustaceans (Natantia)		
Synalpheus townsendi	d 1	1
Decapod Crustaceans (Reptantia)		
Galathea rostrata	d 1, 113	5
Micropanope lobifrons	d 1	3
?Pagurus piercei	d 1	1
Thalassinid X	d 1	1
Asteroids		
Goniaster tessellatus	d 1	1
Tosia parva	d 113	1
Echinoids		
Astropyga magnifica	d 1	1
Clypeaster ravenelii	d 1	2
Ophiuroids		
Amphioplus sepultus	d 1	8
Amphioplus sp. (juvenile)	d 1	1
Axiognathus squamatus	d 1	2
Ophiothrix angulata	d 1 & d 113	7
Bryozoans		
Alderina smitti	d 1	
Aplousina filum	d 1	
Arthropoma cecilii	d 1	
Buskea dichotoma	d 1	
Celleporaria tubulosa	d 1	
Cleidochasma contractum	d 1	
Cleidochasma porcellanum	d 1	
Cribellopora trichotoma	d 1	
Cupuladria canariensis	d 1	
Hippaliosina rostrigera	d 1	
Hippoporidra edax	d 1	
Labioporella granulosa	d 1	
Membraniporella aragoi	d 1	
Microporella ciliata	d 1	
Parasmittina nitida	d 1	
Parellisina latirostris	d 1	
Schizoporella sp.	d 1	
Smittipora levinseni	d 1	
Stenopsella fenestrata	d 1	
Stylopoma spongites	d 1	
Tremogasterina mucronata	d 1	
Tubulipora sp.	d 1	

TABLE XII-1
FISHNET BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Axinellidae	d 116,117	
Polychaetes		
Anaitides madeirensis	d 117	3
?*Autolytus* sp. A	d 117	2
Autolytus sp. B	d 117	4
?*Autolytus* sp.	d 117	1
Dorvillea sociabilis	d 117	2
Eurythoe complanata	d 117	1
Harmothoe sp.	d 117	6
Nicon sp. A	d 117	11
Paleanotus debilis	d 117	1
Paratyposyllis sp. A	d 117	1
Polydora sp. (cf. *armata*)	d 117	3
Polydora sp. (cf. *ciliata*)	d 117	3
Pseudovermilia sp. A	d 117	1
Salmacina sp. A	d 117	1
Sphaerosyllis bulbosa	d 117	1
Spiophanes wigleyi	d 117	1
Syllis gracilis	d 117	2
Typosyllis alternata	d 117	2
Typosyllis regulata carolinae	d 117	2
Typosyllis cf. *taprobanensis*	d 117	1
Unidentified Polychaetes (small)	d 116,117	39
Bivalve Mollusks		
Arcopsis conradiana	d 116,117	1
Barbatia condida	d 116,117	1
Propeamussium sp.	d 117	1 juv.
Amphipod Crustaceans		
Ampelisca cristoides	d 117	
Ampelisca schellenbergi	d 116,117	1
Ampelisca venetensis	d 117	1
Ceradocus sp. A	d 116,117	2
Corophiidae	d 116,117	2
Gammaropsis n. sp.	d 117	10
Liljeborgia bousfieldi	d 116,117	2
Unknowns	d 117	4
Decapod Crustaceans (Natantia)		
Palaemonid shrimp	d 116,117	2
Synalpheus townsendi	d 117	1
Decapod Crustaceans (Reptantia)		
Galathea rostrata	d 117	3 juv.
Paguridae sp.	d 117	1
Pilumnus floridanus	d 117	1
Pseudomedaeus ?*distinctus* (juveniles)	d 117	2
Isopod Crustaceans		
Asellote isopod	d 117	1
Cirolana mayana	d 116,117	4

TABLE XII-1 (Continued)

Fishnet

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Tanaidaceans		
Apseudes propinquus	d 116,117	3
Leptochelia sp. A (subadult)	d 117	1
Paratanaid sp. D	d 117	2
Pseudotanais n. sp.	d 117	2
Echinoids		
Cidaroid juvenile	d 117	1
Ophiuroids		
Ophiactis algicola	d 117	3
Ophiothrix angulata	d 116,117	1
Bryozoans		
Aplousina filum	d 117	
Arthropoma cecilii	d 117	
Arthropoma circinatum	d 117	
Celleporaria albirostris	d 116,117	
Celleporaria tubulosa	d 117	
Cleidochasma contractum	d 116,117	
Cleidochasma porcellanum	d 117	
Colletosia radiata	d 116,117	
Crepidacantha cf. setigera	d 117	
Cribellopora trichotoma	d 116,117	
Crisia eburnea	d 117	
Dakaria biserialis	d 117	
Desmeplagioecia sp.	d 117	
Escharina pesanseris	d 117	
Hippoporina americana	d 117	
Idmidronea atlantica	d 117	
Idmidronea flexuosa	d 117	
Labioporella granulosa	d 117	
Mastigophora porosa	d 116,117	
Membraniporella aragoi	d 116	
Microporella ciliata	d 117	
Parasmittina cf. crosslandi	d 116,117	
Parasmittina spathulata	d 116,117	
Parasmittina trispinosa	d 116,117	
Parasmittina sp.	d 116,117	
Parellisina latirostris	d 117	
Parellisina sp.	d 117	
Reptadeonella violacea	d 116	
Smittina nitidissima	d 117	
Stylopoma spongites	d 117	
Tremogasterina lanceolata	d 116,117	
Trypostega venusta	d 117	
Tubulipora sp.	d 117	

TABLE XIII-1
DIAPHUS BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Higginsia sp.	d 119	2
Hydroids		
Cryptolaria pectinata	d 119	
Alcyonarians		
Bebryce cinerea	d 119	
Caliacis ?nutans	d 119	
Callogorgia verticillata	d 119	
Ellisella barbadensis	d 119	
Nicella guadalupensis	d 119	
Swiftia exserta	d 119	
Thesea grandiflora	d 119	
Scleractinian Corals		
Caryophyllia parvula (first Gulf record)	d 118	
Caryophyllia sp. (may be a new species)	d 118	
Coenosmilia arbuscula (first N. Gulf record)	d 119	
Madracis asperula	d 118	
worn Madracis sp.	d 119	
Madrepora carolina	d 118	
worn Oculina sp.	d 119	
Oxysmilia rotundifolia	d 119	
Paracyathus pulchellus	d 118	
Polychaetes		
Armandia maculata	d 119	1
Eunice vittata	d 119	1
Glycera papillosa	d 119	1
Glyceridae (genus A species A)	d 119	1
Harmothoe sp.	d 119	10
Leocratides filamentosa	d 119	4
Nereis riisei	d 119	3
Nicon sp. A	d 119	4
Opisthodonta sp. A	d 119	1
Paleanotus heteroseta	d 119	1
Palmyridae	d 119	1
Phyllodocidae	d 119	1
Pionosyllis sp. A	d 119	1
Pionosyllis sp. B	d 119	1
Polycirrus eximius dubius	d 119	2
Pomatoceros sp. A	d 119	1
Typosyllis alternata	d 119	4
Typosyllis prolifera	d 119	1
Unidentified Polychaetes	d 118,119	20
Bivalve Mollusks		
Nemocardium transversum	d 118	1
Gastropod Mollusks		
Anachis lafresnayi	d 119	1
Antillophos candei	d 118	1
Bursa ?finlayi	d 119	1
Cerithiopsis sp.	d 118	1 dead
Cuvierina columnella	d 118	1 dead
Glyphostoma dentifera	d 118	1
Mitra barbadensis	d 118	1
Nassarius sp.	d 118	2 dead
Perotrochus adansonianus	d 119	1
Siliquaria squamata	d 119	6
Triphora sp.	d 118	1 dead
Volvarina sp.	d 118	1 dead
Scaphopod Mollusks		
Dentalium laqueatum	d 118	2 dead

TABLE XIII-1 (Continued)

Diaphus

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Amphipod Crustaceans		
Ampelisca cristata	d 119	1
Ceradocus sp. A	d 118	1
Heterophoxus oculatus	d 118	1
Leucothoe spinicarpa	d 118	1
Unciola laminosa	d 118	3
Decapod Crustaceans (Natantia)		
Leptochela bermudensis	d 118, 119	2
Palaemonid shrimp	d 119	3
Synalpheus pandionis	d 119	3
Decapod Crustaceans (Reptantia)		
Brachyuran megalopa larva	d 118	1
Dardanus insignis	d 119	1
Iridopagurus sp. C	d 119	1
Munida pusilla	d 119	1
Paguridae sp.	d 118	1
Paguristes cf. oxyophthalmus	d 118	3
Crinoids		
?Hypalometra defecta	d 119	11
Echinoids		
Genocidaris maculata	d 118	1
Salenia goesiana	d 118	1
Ophiuroids		
Amphiurid juvenile (cf. Amphiodia sp.?)	d 118	1
Axiognathus squamatus	d 118	1
Ophiactus algicola	d 118,119	2
Ophioplax ljungmani	d 118,119	2
Bryozoans		
Alderina smitti	d 118	
Aplousina filum	d 119	
Buskea dichotoma	d 119	
Caberea boryi	d 118	
Celleporaria tubulosa	d 119	
Chaperia patula	d 119	
Cigclisula serrulata	d 119	
Cleidochasma contractum	d 118,119	
Cleidochasma porcellanum	d 118	
Colletosia radiata	d 118,119	
Crisia sp.	d 119	
Cupuladria biporosa	d 119	
Cupuladria canariensis	d 118,119	
Cupuladria cf. canariensis	d 119	
Cupuladria doma	d 119	
Diaperoecia floridana	d 119	
Escharina pesanseris	d 118,119	
Floridina antiqua	d 119	
Hippoporina americana	d 118	
Idmidronea flexuosa	d 119	
Mastigophora porosa	d 119	
Microporella ciliata	d 118	
Microporella sp.	d 119	
Parasmittina sp.	d 119	
Scrupocellaria sp.	d 118	
Smittoidea reticulata	d 119	
Stylopoma spongites	d 118,119	
Tremogasterina lanceolata	d 119	
Tremogasterina sp.	d 119	
Triporula stellata	d 119	
Trypostega venusta	d 118	
Tubulipora cf. liliacea	d 119	

TABLE XIV-1
JAKKULA BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Antipatharians		
Cirripathes (Stichopathes) sp. B	d 124	
Scleractinian Corals		
Madracis sp. (cf. M. formosa)	d 124	
Polychaetes		
Eunice antennata	d 124	1
Nicon sp. A	d 124	2
Amphipod Crustaceans		
Colomastix pusilla	d 124	1
Decapod Crustaceans (Reptantia)		
Munida pusilla	d 124	1
Parthenope pourtalesii	d 124	1
Isopod Crustacea		
Stenetrium occidentale	d 124	1
Tanaidaceans		
Leptochelia sp. A	d 124	1

TABLE XV-1
ELVERS BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Hydroids		
Zygophylax convallaria	d 126	
Alcyonarian Corals		
Bellonella n. sp.	d 126	
Ellisella elongata	d 126	
Nicella guadalupensis	d 126	
Polychaetes		
Pontogenia chrysocoma	d 126	1
Unidentified Polychaetes (small)	d 126	97
Bivalve Mollusks		
Americardia media	d 126	1
Arca zebra	d 126	1
Glycymeris pectinata	d 126	1
Gastropod Mollusks		
Cypraea spurca acicularis	d 126	1
Murex beanii	d 126	1
Strombus costatus	d 126	1
Turbo castanea	d 126	1
Amphipod Crustaceans		
Ceradocus sheardi	d 126	2
Corophiidae sp. A	d 126	1
Leucothoe spinicarpa	d 126	2
Decapod Crustaceans (Natantia)		
Alpheus amblyonyx	d 126	3
Palaemonid shrimp	d 126	1
Processa tenuipes	d 126	1
Decapod Crustaceans (Reptantia)		
Calappa angusta	d 126	3
Micropanope sculptipes	d 126	2
Munida simplex	d 126	1
Myropsis quinquespinosa	d 126	1
Paguristes sp.	d 126	1
Pylopagurus sp.	d 126	1
Sphenocarcinus corrosus	d 126	1
Isopod Crustaceans		
Aegia antillensis	d 126	1
Anthurid	d 126	2
Cirolana parva	d 126	2
Excorallana tricornis	d 126	1
Mysidacea		
Mysidae	d 126	2
Tanaidacea		
Paratanaid sp. C	d 126	1
Asteroids		
Chaetaster nodosus	d 126	1
Crinoids		
Antedonidae	d 126	4
Echinoids		
Clypeaster ravenelii	d 126	1
Clypeaster sp.	d 126	1
Tretocidans bartletti	d 126	1
Ophiuroids		
Amphiura sp.	d 126	1
Ophiactis quinqueradia	d 126	57
Ophiactis savignyi	d 126	1
Ophioplax ljungmani	d 126	1
Ophiothrix suensoni	d 126	1
Ophiura acervata	d 126	4
Bryozoans		
Celleporaria albirostris	d 126	
Celleporaria sp.	d 126	
Cleidochasma porcellanum	d 126	
Crepidacantha longiseta	d 126	
Drepanophora tuberculatum	d 126	
Retevirgula tubulata	d 126	

TABLE XVI-1
GEYER BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Agelas conifera	d 115	
Auletta sp.	d 115	
Chelotropella sp.	d 115	
Geodia gibberosa	d 115	
Hadromeridae	d 115	
Halichondridae	d 115	
Keratose sponge	d 115	
Poecillastra sp.	d 115	
Poecilosceridae	d 128	
Rhabdodictyon sp.	d 115	
Suberitidae	d 115	
Tretodictyum sp.	d 115	
Unidentified	d 115	
Hydroids		
Acryptolaria rectangularis	d 115	
Plumularia sp.	d 127,128	
Alcyonarians		
Bellonella n. sp. 2	d 127,128	
Callogorgia verticellata	d 127,128	
Ellisella elongata	d 127,128	
Ellisella funiculina	d 115	
Nicella guadalupensis	d 127,128	
Nidalia occidentalis	d 115	
Placogorgia rudis	d 127,128,115	
Riisea paniculata	d 115	
Scleracis guadalupensis	d 115	
Siphonogorgia agassizii	d 115	
Swiftia exserta	d 127,128	
Thesea guadalupensis	d 115	
Antipatharians		
Antipathes atlantica	d 115	
Antipathes pedata	d 115	
Aphanipathes abietina	d 115	

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Scleractinian Corals		
Helioseris culcullata	d 127,128	
Javania cailleti	d 115	
Madracis asperula	d 115,127,128	
Madracis myriaster	d 115	
Madracis sp. (cf. M. formosa)	d 115	
Oxysmilia rotundifolia	d 115	
Paracyathus pulchellus	d 115,128	
Polychaetes		
Ceratonereis irritabilis	d 115	1
Ceratonereis mirabilis	d 115	5
Chloenopsis sp. (atlantica?)	d 115	1
Eunice cf. antennata	d 115	1
Eunice vittata	d 115	3
Harmothoe cf. lunulata	d 115	2
Harmothoe sp. (juvenile)	d 115	1
Nereis riisei	d 115	4
Phyllodoce arenae	d 115	2
Podarke sp.	d 115	1
Typosyllis alternata	d 115	1
Vermiliopsis annulata	d 115	1
Unidentified polychaetes (small size)	d 115	6
Bivalve Mollusks		
Atrina sp. (near serrata)	d 115	1 dead
Jouannetia quillingi	d 127,128	1
Papyridea soleniformis	d 128	1
Pycnodonte hyotis	d 115	10

TABLE XVI-1 (Continued)

Geyer

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Gastropod Mollusks		
Astraea phoebia	d 115	1
Latiaxis mansfieldi	d 115	1
Murex beanii	d 115	1
Murexiella hidalgoi	d 115	1
Pterotrochus sp.	d 115	1
Siliquaria modesta	d 115	30
Polyplacophorans		
Undescribed chiton	d 127,128	2
Amphipod Crustaceans		
Ampelisca schellenbergi	d 127,128	1
Ampithoe sp.	d 127,128	3
Ceradocus sheardi	d 128	3
Ceradocus sp. A	d 127,128	2
Leucothoe spinicarpa	d 127,128	2
Liljeborgia bousfieldi	d 115,127,128	4
Lysianassa alba	d 115	1
Maera sp. 1	d 115	2
Maera n. sp.	d 128	2
Unciola dissimilis	d 128	7
Decapod Crustaceans (Natantia)		
Alpheopsis labis	d 128	1
Alpheus beanii	d 128	3
Hippolytid shrimp	d 115, 128	5
Palaemonid shrimp	d 128	2
Pseudocoutiera sp.	d 128	1
Synalpheus pandionis	d 129	2
Decapod Crustaceans (Reptantia)		
Clibanarius anomalus	d 115	1
?Euphrosynoplax clausa	d 115	1
Hexapanopeus lobipes	d 128	2
Homola barbata	d 115	1
Macrocoeloma concavum	d 128	1
?Micropanope urinator	d 115	3
Munida angulata	d 115, 128	3
Decapod Crustaceans (Reptantia)		
Munidopsis squamosa	d 115	2
Phimochirus n. sp.	d 128	1
Pilumnoides nudifrons	d 115	2
Pseudomedaeus distinctus	d 115	1
Isopod Crustaceans		
Cirolana mayana	d 115	2
Cirolana parva	d 127,128	5
Cirolana sp. (manca stage)	d 127,128	1
Mysidaceans		
Mysidae	d 128	1
Tanaidaceans		
Paratanaid sp. C	d 127,128	1
Asteroids		
Anthenoides piercei	d 115	1
Asterinopsis pilosa	d 115,127,128	2
Astropecten comptus	d 115	1
Hacelia superba	d 115	1
Crinoids		
Comactinea meridionalis	d 115	2
Crinometra brevipinna	d 115	2
?Hypalometra defecta	d 125	2
Leptonemaster venustus	d 115	1
Nemaster descoidea	d 128	fragments
Echinoids		
Astropyga magnifica	d 115	1
Brissus unicolor	d 115	1
Coelopleurus floridanus	d 115	1
Conolampus sigsbei	d 115	1

TABLE XVI-1 (Continued)

Geyer

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Ophiuroids		
Amphiodia pulchella	d 127,128	1
Amphiura sp.	d 127,128	1
Asteroschema intectum	d 115	1
Asteroschema oligactes	d 115	1
Axiognathus squamatus	d 115,128	2
Ophiocantha cf. hirsuta	d 127,128	1
Ophiactis savignyi	d 127,128	2
Ophiactis algicola	d 115,127,128	8
Ophiostigma isacanthum	d 115,127,128	6
Ophiothrix angulata	d 115,127,128	2
Ophiurochaeta littoralis	d 127,128	1
Bryozoans		
Aplousina filum	d 127,128	
Bracebridgia subsulcata	d 127,128	
Celleporaria mordax	d 127,128	
Celleporaria tubulosa	d 115	
Celleporaria cf. vagans	d 115	
Chaperia patula	d 115	
Cleidochasma contractum	d 115,127,128	
Cleidochasma porcellanum	d 127,128	
Codonellina montferrandii	d 115	
Colletosia radiata	d 115,127,128	
Escharina pesanseris	d 115	
Floridina antiqua	d 115,127,128	
Gemelliporidra aculeata	d 115	
Hippopodina bernardi	d 115	
Monoporella divae	d 115,127,128	
Parasmittina sp.	d 115,127,128	
Reptadeonella violacea	d 115	
Retevirgula tubulata	d 115,127,128	
Stephanosella cf. biaperta	d 115	
Setosella vulnerata	d 115	

TABLE XVII-1
SIDNER BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Agelas dispar	d 120	
Auletta sp.	d 120	
Cliona schmidti	d 120	
Didiscus sp.	d 120	
Epipolasidae	d 120	
Halichondridae	d 120	
Ircinia strobilina	d 120	
Ircinia sp. A	d 120	
Siphonidium sp.		
Tretodictyum sp.		
Hydroids		
Acryptolaria rectangularis	d 120	
Aglaophenia elongata	d 120	
Dynamena dalmasi	d 120	
Halecium sp.	d 120	
Alcyonarians		
Bebryce cinerea	d 120	
Bellonella n. sp. 2	d 120	
Caliacis ?nutans	d 120	
Nicella guadalupensis	d 120	
Riisea paniculata	d 120	
Scleracis guadalupensis	d 120	
Siphonogorgia agassizii	d 120	
Antipatharians		
Antipathes furcata	d 120	
Antipathes tanacetum	d 120	
Aphanipathes abietina	d 120	
Cirripathes (Stichopathes) lutkeni	d 120	
Scleractinian Corals		
Caryophyllia parvula	d 120	
Caryophyllia sp. (worn)	d 120	
Helioseris cucullata	d 120	
Millepora alcicornis	d 120	
Paracyathus pulchellus	d 120	
Polychaetes		
?Acanthicolepis sp. A	d 120	5
Eunice websteri	d 120	1
Paramyphsa sp. A	d 120	1
Paratyposyllis sp. A	d 120	2
Polydora armata	d 120	3
Potamilla cf. torelli	d 120	1
Pseudovermilia sp. A	d 120	1
Filograna sp.	d 120	2
Steninonereis ?martini	d 120	1
Syllis gracilis	d 120	23
Synelmis sp. A	d 120	1
Tachytrypane jeffreysii	d 120	1
Typosyllis alternata	d 120	2
Typosyllis prolifera	d 120	1
Typosyllis regulata carolinae	d 120	6
Vermiliopsis annulata	d 120	1
Unidentified polychaetes (small)	d 120	50
Bivalve Mollusks		
Barbatia domingensis	d 120	2
Chama sp.	d 120	1 juvenile
Pteria sp.	d 120	1
Trachycardium magnum	d 120	1
Gastropod Mollusks		
?Lobiger sp.	d 120	1
Amphipod Crustaceans		
Ampelisca schellenbergi	d 120	1
Ampithoidae	d 120	2
Carinobatea carinata	d 120	1
Chevalia aviculae	d 120	1
Colomastix pusilla	d 120	1
Elasmopus rapax	d 120	1
Leucothoe spinicarpa	d 120	14
Liljeborgia bousfieldi	d 120	1
Lysianassa alba	d 120	1
Melita appendiculata	d 120	1

TABLE XVII-1 (Continued)

Sidner

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Decapod Crustaceans (Natantia)		
Hippolytid shrimp	d 120	8
Periclimenaeus wilsoni	d 120	3
Synalpheus agelas	d 120	8
Synalpheus pandionis	d 120	3
Synalpheus townsendi	d 120	1
Synalpheus spp.	d 120	18
Decapod Crustaceans (Reptantia)		
?Axiopsis sp.	d 120	1
Micropanope sp.	d 120	2
Mithrax acuticornis	d 120	1
Munida angulata	d 120	2
Munida nuda	d 120	2
Munida simplex	d 120	3
Paguridae sp.	d 120	1
Pagurus brevidactylus	d 120	1
Pagurus piercei	d 120	1
Phimochirus holthuisi	d 120	1
Pilumnus floridanus	d 120	2
?Stenocionops furcata (juvenile)	d 120	1
Isopod Crustaceans		
Cirolana mayana	d 120	1
Mysidaceans		
Mysidae	d 120	8
Tanaidadeans		
Paratanaid sp. C	d 120	1
Paratanaid sp. D	d 120	1
Echinoids		
Calocidaris micans	d 120	1
Centrostephanus rubricingulus	d 120	1
Ophiuroids		
Amphiodia pulchella	d 120	3
Astroschema laeve	d 120	1
?Astrospartus mucronatus	d 120	1 arm frag
Ophiacantha cf. hirsuta	d 120	1
Ophiacanthella cf. troscheli	d 120	1
Ophiactis quinqueradia	d 120	125
Ophiuroids (Continued)		
Ophiactis savignyi	d 120	17
Ophiactis sp. (cf. algicola)	d 120	14
Ophiostigma sp. (cf. isacanthum)	d 120	2
Ophiothrix angulata	d 120	5
Bryozoans		
Almulosia uvulifera	d 120	
Aetea truncata	d 120	
Antropora tincta	d 120	
Caberea boryi	d 120	
Cauloramphus brunea	d 120	
Celleporaria albirostris	d 120	
Celleporaria tubulosa	d 120	
Cigclisula pertusa	d 120	
Cleidochasma contractum	d 120	
Cleidochasma porcellanum	d 120	
Codonellina montferrandii	d 120	
Colletosia radiata	d 120	
Crepidacantha longiseta	d 120	
Crepidacantha sp.	d 120	
Cribellopora trichotoma	d 120	
Disporella fimbriata	d 120	
Drepanophora tuberculatum	d 120	
Entalophora proboscideoides	d 120	
Escharina pesanseris	d 120	
Floridina antiqua	d 120	
Gemelliporidra aculeata	d 120	
Idmidronea atlantica	d 120	
Lichenopora radiata	d 120	
Mastigophora porosa	d 120	
Microporella ciliata	d 120	
Microporella marsupiata	d 120	
Mollia patellaria	d 120	
Monoporella divae	d 120	
Parasmittina cf. munita	d 120	
Parasmittina spathulata	d 120	
Parasmittina sp.	d 120	

TABLE XVII-1 (Continued)

Sidner

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Bryozoans (Continued)		
Parellisina latirostris	d 120	
Retevirgula tubulata	d 120	
Rhynchozoon verruculatum	d 120	
Setosella vulnerata	d 120	
Smittipora levinseni	d 120	
Stenopsella fenestrata	d 120	
Triporula stellata	d 120	
Tubulipora sp.	d 120	

TABLE XVII-2
REZAK BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Hydroids		
Monostaechas quadridens	d 125	
Alcyonarians		
Bellonella sp.	d 125	
Ellisella elongata	d 125	
Scleractinian Corals		
Madracis asperula	d 125	
Madracis sp. (cf. M. asperula	d 125	
Madracis sp. (cf. M. formosa)	d 125	
Oculina sp.	d 125	
Polychaetes		
Aglaophamus circinata	d 125	1
Nereis riisei	d 125	1
Typosyllis alternata	d 125	2
Decapod Crustaceans (Natantia)		
Hippolytid shrimp	d 125	1
Palaemonid shrimp	d 125	1
Decapod Crustaceans (Reptantia)		
Iridopagurus sp. C	d 125	1
Munida simplex	d 125	3
Asteroids		
Asterinopsis pilosa	d 125	1
Echinoidea		
Stylocidaris affinis	d 125	1
Holothuroidea		
Psolas tuberculosis	d 125	1
Ophiuroids		
Ophiocantha cf. hirsuta	d 125	1
Bryozoans		
Bracebridgia subsulcata	d 125	
Celleporaria albirostris	d 125	
Cupuladria biporosa	d 125	
Cupuladria cf. canariensis	d 125	
Entalophora proboscideoides	d 125	
Lekythopora longicollis	d 125	

TABLE XVIII-1
ALDERDICE BANK SPECIES LIST)
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Auletta sp.	d 122	1
Choristidae	d 121	1
Ircinia campana	d 121,122	
unidentified	d 122	1
Hydroids		
Dynamena dalmasi	d 121	
Alcyonarians		
Scleracis guadalupensis	d 122	
Thesea rugosa	d 122	
Antipatharians		
Antipathes barbadensis	d 122	
Antipathes pedata	d 122	
Cirripathes (Stichopathes) sp. B	d 122	
Scleractinian Corals		
Madracis pharensis or M. decactis	d 122	
Oculina diffusa	d 122	
Paracyathus pulchellus	d 122	
Polychaeta		
Chloeia viridis	d 121	1
Eupholoe ?philippinensis	d 121	1
Exogone dispar	d 122	4
Nereidae sp. (juvenile)	d 121	1
Opisthodonta sp. B	d 122	1
Polydora armata	d 122	9
Potamilla cf. torelli	d 122	1
Sabellastarte sp. A	d 122	4
Sphaerosyllis bulbosa	d 122	1
Typosyllis alternata	d 122	3
Unidentified polychaetes	d 122	> 100
Gastropod Mollusks		
Calliostoma roseolum	d 122	1
Doridae sp. (Nudibranch)	d 121	1
Nassarius sp.	d 121	2
Amphipod Crustaceans		
Ampelisca schellenbergi	d 122	1
Corophiidae A	d 122	14
Grandidierella bonneroides	d 122	1
Leucothoe spinicarpa	d 122	6
Liljeborgia bousfieldi	d 122	1
Lysianassa alba	d 122	1
Maera n. sp.	d 122	1
Paracyproid-like sp. (new genus)	d 122	1
Decapod Crustaceans (Natantia)		
Alpheus n. sp. ("yellow snapping shrimp")	d 121	1
Palaemonid shrimp	d 122	7
Synalpheus sp. (near townsendi)	d 122	7
Decapod Crustaceans (Reptantia)		
Dromidia antillensis	d 122	1
Galathea rostrata	d 122	4
Leptodius agassizii	d 122	1
?Microcassiope granulimanus	d 122	4
Pagurus sp.	d 122	2
Pilumnus floridanus	d 122	7
Isopod Crustaceans		
Asellidae (immature)	d 122	1
Cirolana parva	d 122	1
Excorallana tricornis	d 122	5
Jaeropsis sp. A	d 122	1
Tanaidacean Crustaceans		
Apseudes propinquus	d 122	1
Leptochelia sp. a (savignyi complex)	d 122	1
Synapseudes n. sp.	d 122	2
Crinoids		
Comactinia meridionalis meridionalis	d 122	2
Nemaster discoidea	d 122	4
Echinoids		
Arbacia punctulata	d 122	1

TABLE XVIII-1 (Continued)

Alderdice

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Ophiuroids		
Astrophytum muricatum	d 122	fragments
Axiognathus squamatus	d 122	1
Ophiactis quiqueradia	d 122	4
Ophiactis savignyi	d 122	14
Ophiactis algicola	d 122	38
Ophioderma cf. rubicundum	d 122	1
Ophiothrix angulata	d 121 & 122	3
Bryozoans		
Alderina smitti	d 122	
Aplousina filum	d 122	
Celleporaria albirostris	d 122	
Cleidochasma contractum	d 121,122	
Disporella hispida	d 122	
Entalophora proboscideoides	d 121	
Hippaliosina rostrigera	d 122	
Lichenopora sp.	d 122	
Microporella ciliata	d 122	
Microporella cf. coronata	d 122	
Microporella pontifica	d 121	
Parasmittina spathulata	d 121	
Plagioecia sarniensis	d 122	
Triporula stellata	d 122	
?Triporula stellata	d 121	

TABLE XIX-1
32-FATHOM BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Axinellidae	rock trawl 3a	1
Halichondridae	rock trawl 3a	1
Ircinia species "a"	rock trawl 3a	1
Neofibularia nolitangere	rock trawl 3a	1
Pseudaxinella rosacea	rock trawl 3a	1
Xestospongia halichondrioides	rock trawl 3a	1
Keratose sponge	rock trawl 3a	1
Hydroids		
Halecium sp.	rock trawl 3a	
Sertularia distans	rock trawl 3a	
Polychaetes		
Anaitides madeirensis	rock dredge 2	1
Arabella iricolor	rock dredge 2	1
Axiothella ? sp. A	rock dredge 1	1
Ceratonereis irritabilis	rock trawl 3a	3
Dasybranchus sp. A	rock dredge 1	1
Eunice antenna	rock dredge 1	1
Harmothoe sp.	rock trawl 3a	1
Inermonephtys inermis	rock dredge 1	2
Laonice cirrata	rock dredge 1	2
Lumbrineris heteropoda	rock dredge 1	1
Lumbrineris cf. papillifera	rock dredge 2	1
Marphysa sanguinea	rock trawl 3a	1
Onuphis quadricuspis	rock dredge 1	1
Phyllodoce arenae	rock trawl 3a	1
Potamilla ?	rock trawl 3a	7
Poecilochaetus johnsoni	rock dredge 1	1
Pomatoceros americanus	rock trawl 3a	1
Pomatostegus sp. A	rock trawl 3a	1
Spiophanes bombyx	rock dredge 1	1
Spiophanes wigleyi	rock dredge 1	1
Spirobranchus giganteus	rock trawl 3a	1
Sthenolepis cf. japonica	rock dredge 1	1
Terebellides stroemi	rock dredge 2	1
Typosyllis alternata	rock trawl 3a	1
Typosyllis regulata carolinae	rock trawl 3a	2
Unidentified polychaetes	s 2,3,3a,5	50
Bivalve Mollusks		
Aequipecten muscosus	rock dredge 3	1 dead valve
Americardia media	rock dredge 3	1 dead valve
Arca zebra	rock dredge 3	1
Arcinella cornuta	rock dredge 3	1 dead valve
Arcopsis conradiana	rock dredge 3	5
Argopecten gibbus	rock dredge 3	7 dead valve
Chama sinuosa	rock dredge 3	1 dead valve
Chlamys benedicti	rock dredge 3	2

TABLE XIX-1 (Continued)

32 Fathom

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Bivalve Mollusks (Continued)		
Corbula sp.	rock dredge 3	1 dead valve
Gouldia cerina	rock dredge 3	1 dead valve
Hiatella azaria	rock dredge 3	2
Laevicardium pictum	rock dredge 3	1 dead valve
Lyropecten nodosa	rock dredge 3	1 dead valve
Musculus lateralis	rock dredge 3	1
Nemocardium tinctum	rock dredge 3	1 dead valve
Papyridea soleniformis	rock dredge 3	1+1 dead pair
Pecten raveneli	rock dredge 3	1 dead valve
Varicorbula operculata	rock dredge 3	1 dead valve
Gastropod Mollusks		
Calliostoma roseolum	rock dredge 3a	1
Compsodrillia haliostrephis	rock dredge 3a	1 dead
Fissurellidae sp.	rock dredge 3a	2 dead
Nassarius sp.	rock dredge 3a	1
Psarostola minor	rock dredge 3a	2
Turritella exoleta	rock dredge 3a	1
Amphipod Crustaceans		
Ampelisca abdita	rock dredge 3a	1
Ampelisca sp.	rock dredge 1	2
Anamixis hanseni	rock dredge 3	1
Colomastix pusilla	rock dredge 3a	9
Leucothoe spinicarpa	rock dredge 3a	46
Decapod Crustaceans (Natantia)		
Palaemonid shrimp	rock trawl 3a	1
Penaeopsis goodei	rock trawl 3a	1
Periclimenaeus bredini	rock trawl 3a	1
Synalpheus townsendi	rock trawl 3a	9
Decapod Crustaceans (Reptantia)		
Arachnopsis filipes	rock dredge 5	1
Collodes cf. trispinosus	rock dredge 5	1
Galathea rostrata	rock trawl 3a	4
Hexapanopeus lobipes	rock trawl 3a	1
?Microcassiope granulimanus	rock trawl 3a	5
Mithrax acuticornis	rock trawl 3a	1
Pagurus piercei	rock trawl 3a	4
Palicus alternatus	rock trawl 3a	1
Pilumnus floridanus	rock trawl 3a	1
?Pilumnus sayi	rock trawl 3a	1
Podochela gracilipes	rock trawl 3a	1
Porcellana sp.	rock trawl 3a	1
Portunus spinicarpus	rock trawl 4	1
Pseudomedaeus distinctus	rock trawl 3a	3
?Stenocionops furcata (juvenile)	rock trawl 3a	1
Xanthidae sp.	rock trawl 3a	1

TABLE XIX-1 (Continued)

32 Fathom

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Isopod Crustaceans		
Cirolana parva	rock trawl 3a	2
Jaeropsis sp. A	rock trawl 3a	4
Tanaidacean Crustaceans		
Leptochelia sp. A	rock dredge 3a	8
Paratanaid sp. C	rock dredge 3a	1
Asteroids		
Tosia parva	rock dredge 3	1
Echinoids		
Eucidaris tribuloides	rock trawl 4	1
Stylochidaris affinis	rock trawl 4	1
Ophiuroids		
Amphiodia pulchella	rock dredge 3	1
Amphioplus sepultus	rock dredge 3	1
?Micropholis sp.	rock dredge 5	1
Ophiactis algicola	rock dredge 3	3
Ophiothrix angulata	rock dredge 3	3
Bryozoans		
Antropora tincta	s 3,3a	
Bracebridgia subsulcata	s 3a	
Buskea dichotoma	s 2	
Cellaria irregularis	s 3a	
Celleporaria albirostris	s 2,3,3a	
Celleporaria cf. vagans	s 3a	
Cigclisula sp. (very worn)	s 2	
Cigclisula turrita	s 2	
Cleidochasma contractum	s 2,3a	
Cleidochasma porcellanum	s 2,3a	
Colletosia sp.	s 3a	
Crepidacantha poissonii	s 3a	
Crepidacantha poissonii var. teres	s 3a	
Crisia elongata	s 3a	
Cupuladria biporosa	s 2,3a	
Cupuladria canariensis	s 2,3	
Cupuladria doma	s 2	
Diaperoecia floridana	s 2,3a	
Discoporella umbellata	s 2	
Drepanophora tuberculatum	s 2,3a	
Entalophora proboscideoides	s 2,3a	
Escharina pesanseris	s 3a	
Hippallosina rostrigera	s 3a	
Hippopetraliella bisinuata	s 3a	
Hippoporidra edax	s 3a	
Hippothoa distans	s 3a	
Labioporella granulosa	s 3a	
Mecynoecia delicatula	s 3a	
?Membranipora savartii	s 3	

TABLE XIX-1 (Continued)

32 Fathom

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Bryozoans (Continued)		
Microporella ciliata	s 2	
Parasmittina nitida	s 2,3a	
Parasmittina signata	s 2	
Parasmittina spathulata	s 3a	
Parasmittina sp.	s 3a	
Parellisina curvirostris	s 2	
Parellisina latirostris	s 3a	
Reptadeonella violacea	s 2	
Retevirgula tubulata	s 3a	
Schizoporella unicornis	s 2,3	
Schizoporella sp.	s 3	
Smittina nitidissima	s 3a	
Smittipora levinseni	s 2	
Stylopoma spongites	s 2,3a	
Tetraplaria dichotoma	s 3a	
Tremogasterina mucronata	s 3a	
Tremoschizodina lata	s 3a	
Tubulipora sp.	s 2,3a	

TABLE XX-1
APPLEBAUM BANK SPECIES LIST
(SPECIES COLLECTED DURING 1978 ON CRUISE 78G9-III)

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Sponges		
Auletta sp.	s 2,3	
Axinellidae	s 4	
Chelotropella sp.	s 4	
Desmanthus sp.	s 4	
Epipolasidae	s 2	
Eurypon clavata	s 2	
Hadromeridae	s 2	
Haliclonidae	s 2	
Haploscleridae	s 2	
Jaspidae	s 4	
Jaspis sp.	s 2	
Myriastrea fibrosa	s 4	
Microcionidae	s 2	
Poecilosceridae	s 4	
Superitidae	s 2	
keratose sponge	s 4	
Unidentified sponges	s 2,4	
Hydroids		
Acryptolaria rectangularis	s 2,3	
Cryptolaria pectinata	s 4	
Lafoea sp.	s 2	
Alcyonarians		
Bellonella n. sp.	s 2	
Callacis ?nutans	s 1	
Ellisella ?atlantica	s 2,4	
Nicella guadalupensis	s 4	
Scleracis guadalupensis	s 2,4	
Thesea granulosa	s 2	
Antipatharians		
Antipathes atlantica	s 2	
Cirripathes (Stichopathes) sp. A	s 1	
Cirripathes (Stichopathes) sp. B	s 4	
Polychaetes		
Anaitides madeirensis	s 4	3
Autolytus sp.	s 2	1
Ceratonereis irritabilis	s 4	1
Ceratonereis mirabilis	s 2	1
Ceratonereis sp.	s 2	5
Eunice vittata	s 2	1
Eunice sp.	s 4	1
Eupolymnia sp. A	s 2	1
Eurysyllis sp.	s 2	1
Glyptis brevipalma	s 2	1
Harmothoe sp.	s 4	1
Hesione sp. A	s 2	1
Kefersteinia cirrata	s 2	1

TABLE XX-1 (Continued)

Applebaum

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Nematonereis unicornis	s 2	1
Nothria sp. A	s 2	1
Paleanotus debilis	s 2,4	6
Paleanotus heteroseta	s 4	1
Pareurythoe americana	s 4	2
Pholoe dorsipapillata	s 2	2
Phyllodoce arenae	s 2	1
Pista sp. A	s 2	1
Podarke sp.	s 2	3
Sphaerosyllis bulbosa	s 2	1
Syllis gracilis	s 2	2
Typosyllis alternata	s 2	2
Unidentified polychaetes	s 2	107
Unidentified polychaetes	s 3	33
Unidentified polychaetes	s 4	50
Bivalve Mollusks		
Pteria sp.	s 4	1
Gastropod Mollusks		
Antillopsis candei	s 1	1 dead
Emarginula phrixodes	s 4	1
Polystira vibex	s 1	2 dead
Terebra limatula	s 1	1 dead
Scaphopod Mollusks		
Dentalium laqueatum	s 1	2 dead
Amphipod Crustaceans		
Ampelisca cristata	s 2	1
Anamixis n. sp.	s 2,4	2
Carinobata carinata	s 4	1
Ceradocus sp.	s 2	1
Corophiidae A	s 4	11
Corophiidae	s 3	2
Leucothoe spinicarpa	s 2,4	5
Liljeborgia bousfieldi	s 2,3	2
Lysianassa alba	s 4	2 juvenile
Maera sp.	s 3	1
Melita sp.	s 4	2
Decapod Crustaceans (Natantia)		
Discias sp.	s 2	2
Hippolytid shrimp	s 4	1
Salmoneus ortmanni	s 4	1
Synalpheus cf. agelas	s 2	1
Synalpheus pandionis	s 2	2
Synalpheus townsendi	s 4	2
Decapos Crustaceans (Reptantia)		
Hexapanopeus lobipes	s 4	1
Melybia thalamita	s 4	1

TABLE XX-1 (Continued)

Applebaum

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
?*Microcassiope granulimanus*	s 4	1
Micropanope sculptipes	s 2, 3, 4	23
Munida simplex	s 4	1
Pilumnus floridanus	s 4	1
Isopod Crustaceans		
Asellote isopod	s 4	1
Cirolana mayana	s 2,4	2
Cirolana parva	s 2,4	5
Excorallana sp.	s 2	1
Gnathia sp.	s 2	1
Stenetrium occidentale	s 2	1
Tanaidaceans		
Apseudes propinquus	s 4	2
Apseudes sp. A	s 4	1
Paratanaidae sp. C	s 4	1
Asteroids		
Asterinopsis lymani	s 2,4	2
Asterinopsis pilosa	s 2	1
Echinoids		
Stylocidaris affinis	s 2	1
Ophiuroids		
Amphiodia pulchella	s 2,4	2
Ophiactis algicola	s 4	3
Ophioderma cf. *rubicundum*	s 4	1
Ophiostigma isacanthum	s 2	2
Ophiothrix angulata	s 2	1
?*Ophiurochaeta littoralis*	s 4	1 juvenile
Bryozoans		
Aetea truncata	s 2,4	
Aplousina filum	s 2,3	
Arthropoma cecilii	s 2,3,4	
Arthropoma circinatum	s 2	
Bellupora bellula	s 2,3,4	
Chaperia patula	s 3	
Cleidochasma contractum	s 3,4	
Cleidochasma porcellanum	s 2,4	
Codonellina montferrandii	s 4	
Colletosia radiata	s 2,3	
Colletosia sp.	s 2	
Crepidacantha longiseta	s 4	
Crepidacantha poissonii var. *teres*	s 3	
Crepidacantha setigera	s 2	
Cribellopora trichotoma	s 2,3	
Crisia sp.	s 2	
Dakaria biserialis	s 2	
Disporella fimbriata	s 2,3	

TABLE XX-1 (Continued)

Applebaum

SPECIES	STATION(s)/ DIVE(d)	NO. OF SPECIMENS
Disporella sp.	s 4	
Escharina pesanseris	s 2,3,4	
Escharipora stellata	s 2	
Fenestrulina malusii	s 2,3	
Hippopetraliella lanceolata	s 3	
Hippoporina americana	s 4	
Hippothoa distans	s 2	
Idmidronea atlantica	s 4	
Labioporella granulosa	s 2	
Labioporella sinuosa	s 2	
Mastigophora porosa	s 2,3,4	
Mecynoecia delicatula	s 4	
Microporella ciliata	s 2,3,4	
Microporella marsupiata	s 4	
Microporella pontifica	s 2	
Mollia patellaria	s 2,4	
Monoporella divae	s 2	
Parasmittina mildredae	s 3	
Parasmittina spathulata	s 2,3	
Parasmittina trispinosa	s 2	
Parasmittina sp.	s 2,4	
Parellisina latirostris	s 2	
Retevirgula tubulata	s 3,4	
Schizomavella sp.	s 3	
Scrupocellaria harmeri	s 2	
Tremoschizodina lata	s 3	
Trypostega venusta	s 2,3,4	

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.