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W. E. SWEET

SOUTH TEXAS TOPOGRAPHIC FEATURES STUDY

EXECUTIVE SUMMARY
OF THE
FINAL REPORT

SUBMITTED TO THE

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

OUTER CONTINENTAL SHELF OFFICE

NEW ORLEANS, LOUISIANA

CONTRACT NO. AA550-CT6-18

DECEMBER 1978

RESEARCH CONDUCTED BY THE

COLLEGE OF GEOSCIENCES

TEXAS A&M UNIVERSITY COLLEGE STATION, TEXAS

Through The
TEXAS A&M RESEARCH FOUNDATION

SOUTH TEXAS

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From the

TEXAS A&M RESEARCH FOUNDATION
AND
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December, 1978

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BLM Contract AA550-CT6-18

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INTRODUCTION

In 1976 studies were performed under the Bureau of Land Management (BLM) contract on the nine topographical features (banks) listed in Table 1 and depicted in Figures I-1 through I-10 of the Final Report. Detailed bathymetric charts were produced for Stetson Bank, the East Flower Garden Bank and 28 Fathom Bank, Southwest Peak (Final Report, Figs. I-5, I-6 and I-7).

Descriptive reconnaissance studies were completed in 1976 for Aransas Bank, Blackfish Ridge, Mysterious Bank and 28 Fathom Bank (Fig. 1). A descriptive account of biotic communities inhabiting Claypile Bank was prepared using existing data. The reconnaissance studies include: geology and biology of the banks and surrounding sediments; hydrography in the vicinity of the banks; chemical analyses of sediments and selected faunal components for trace metals and heavy molecular weight hydrocarbons; chemical analyses of the water column for nutrients, dissolved oxygen, and low molecular weight hydrocarbon; and temperature, salinity and transmissivity profiles of the water column.

Post-drilling environmental assessments were made at Stetson Bank, South Baker Bank, Southern Bank and the East Flower Garden Bank. A high salinity brine lake was discovered and documented at the East Flower Garden Bank during the post-drilling assessment.

Quantitative ecological studies were pursued into the relationships of epibenthic community distribution and abundance to the nepheloid layers at Southern Bank and Hospital Rock.

A number of scientific papers have been presented and published during 1976 and 1977 based on work done under BLM funding (Bright and Rezak, 1977; Bright, 1977; Ichiye, Bright and Rezak, 1977a; McGrail and Rezak, 1977).

Table 1

TOPOGRAPHICAL FEATURES (BANKS) STUDIED DURING 1976

UNDER THE BLM CONTRACT

Topographical Feature	Nearest Coastal Pass	Range Nautical Miles	Bearing
1. Aransas Bank	Port Aransas	40 mi	114.5°
2. Blackfish Ridge	Port Aransas	68 mi	167°
3. Mysterious Bank	Port Aransas	74 mi	164.5°
4. Stetson Bank	Sabine Pass	109 mi	195°
5. East Flower Garden Bank	Sabine Pass	121 mi	173°
6. 28 Fathom Bank	Sabine Pass	123 mi	168°
7. Hospital Bank	Port Aransas	40 mi	121.5°
8. Southern Bank	Port Aransas	42 mi	131.5°
9. South Baker	Port Aransas	49 mi	104°

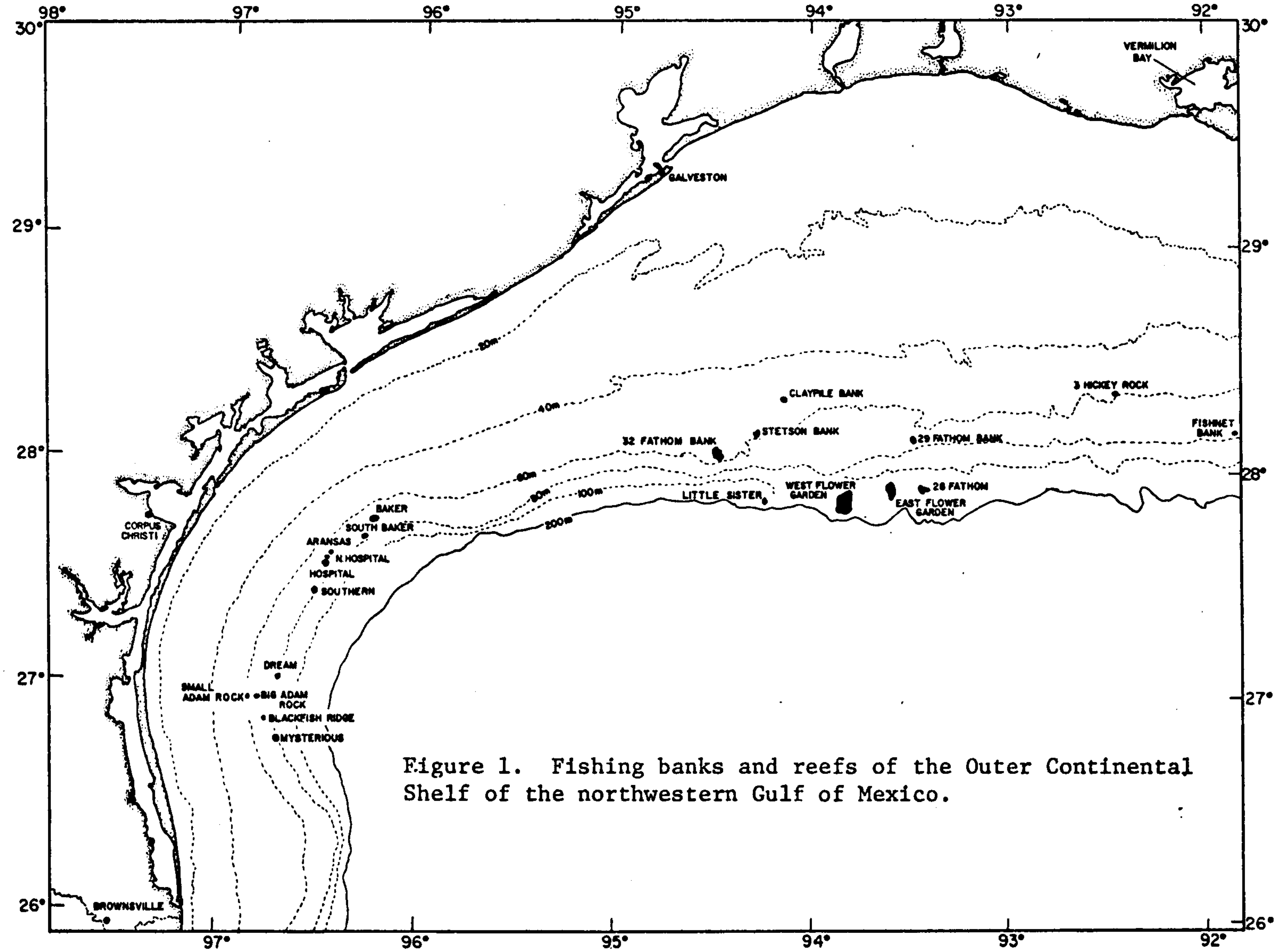

Figure 1. Fishing banks and reefs of the Outer Continental Shelf of the northwestern Gulf of Mexico.

STETSON BANK

GEOLOGY AND SEDIMENTOLOGY

Stetson Bank is a mid-shelf bank that consists primarily of Tertiary siltstones and claystones. The numerous nearly vertical beds that form ridges attest to the structural origin of the bank. The bank is elongate in a NE-S~~E~~W direction and is approximately 1300 m long and 500 m wide. Relief on the bank is about 30 m. The crest of the bank is generally at 30 m depth. However, a very narrow spine rises to 25 m in the East Central portion of the bank (Final Report, p. 106).

Sediments surrounding the bank range from gravelly sand to sandy mud. They reflect the presence of erosion products derived from the upturned beds that are characteristic of this bank (Final Report, p. 118-119). The sediments consist primarily of smectite with lesser amounts of illite and kaolinite, quartz and calcite (Final Report, p. 111 and Table IV-1, p. 159).

The nepheloid layer at Stetson was both thin (maximum 7 m thick) and less opaque than that observed on the southern shelf banks. Strong stratification inhibits the formation of either an isothermal layer at the boundary or a thick nepheloid layer by turbulent mixing (Final Report, p. 52-53).

DESCRIPTIVE BIOLOGICAL RECONNAISSANCE

In the Spring of 1974 our group performed a pre-drilling baseline survey of Stetson Bank (Fig. 2) for Signal Oil & Gas Company. We were asked by BLM to revisit Stetson in 1976 to make a compara-

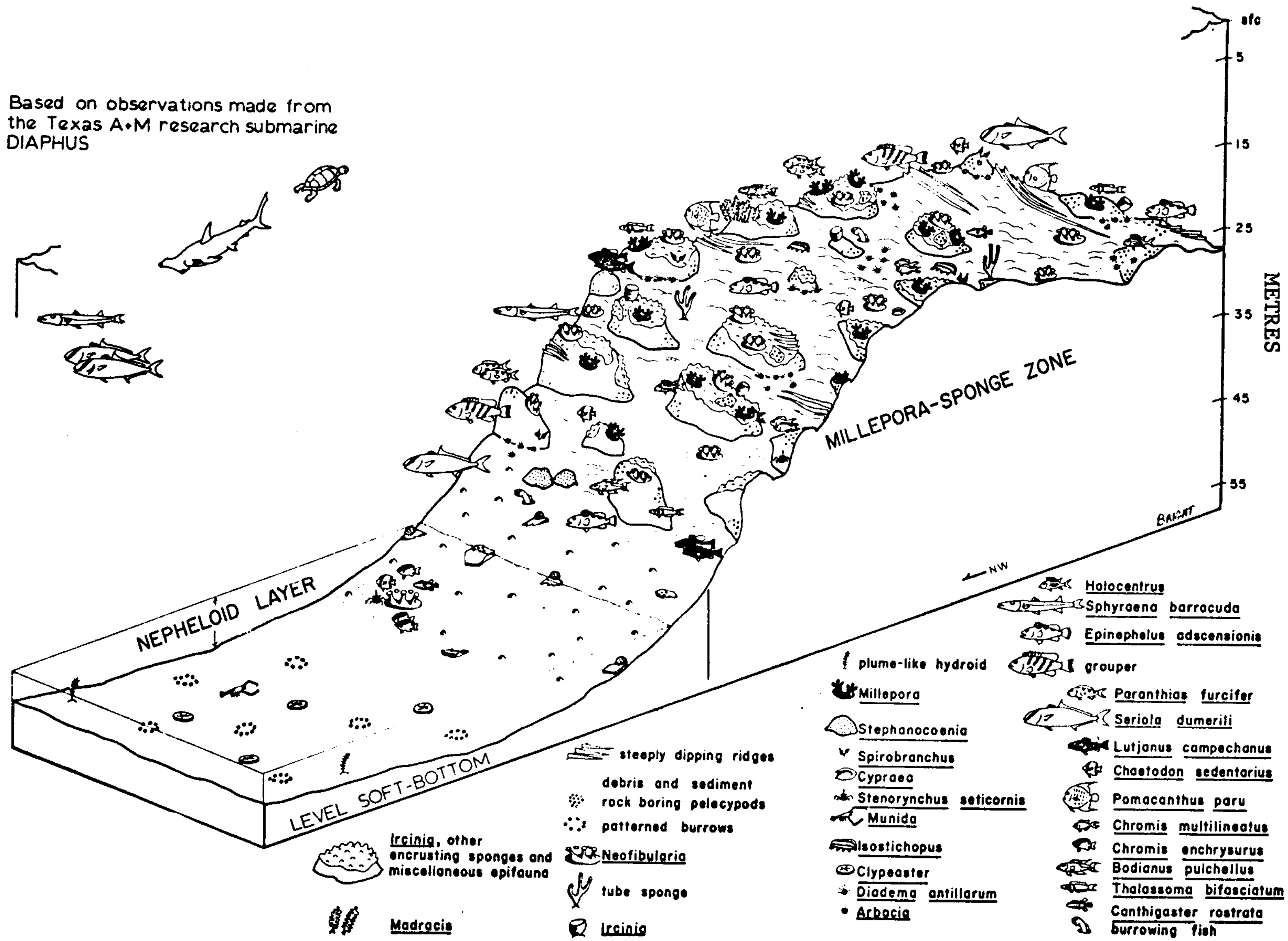

Figure 2. Stetson Bank

tive assessment of the condition of the communities there in an attempt to determine to what extent nearby drilling had affected the biota of the bank. We found no evidence of deterioration of biotic communities between 1974 and 1976 and could demonstrate no effects due to drilling. The biota found in 1976 were in virtually the same condition as seen in 1974 (Final Report, pp. 370-385).

In general, the siltstone outcrops at Stetson, which are larger and more numerous near the bank edges than on its interior, bear varying amounts of epifauna composed primarily of sponges and *Millepora* in a ratio approximating 60:40% respectively. We saw no leafy algae and no alcyonarian corals (see whips and sea fans). Encrusting calcareous algae, though present, are apparently insignificant as constructional agents.

Corals other than *Millepora* are not generally abundant at Stetson. Small heads of *Stephanocoenia intersepta* grow atop outcrops and large fallen slabs of claystone down to 50 m depth, well into the turbid nepheloid layer. Two large heads of *Stephanocoenia* (1.5 m diameter) were seen at 43 m. In 1976 we found a sizeable field of the branching coral *Madracis decactis* near the top of the bank.

At least 23 species of fish frequenting Stetson Bank can be considered sport and/or commercial varieties. Of particular sport or commercial importance due to their size or edibility are sharks, Great barracuda (*Sphyraena barracuda*), Rock hind (*Epinephelus adscensionis*), groupers (*Mycteroperca* spp.), Amberjack (*Seriola dumerili*), jacks (*Caranx* spp.), mackerels (*Scomberomorus* spp.), Red snapper (*Lutjanus campechanus*) and Vermilion snapper (*Rhomboplites aurorubens*). Red snappers, as at other banks, prefer large ledges and do not seem to be concerned with turbidity of the water.

MEIOFAUNA AND MACROINFAUNA

Certain interesting and administratively valuable generalizations regarding the meiofauna and macroinfauna of Stetson Bank, East Flower Garden Bank, 28 Fathom Bank, and 28 Fathom Bank, Southwest Peak, should be noted prior to attempting a characterization of each bank. It is considered appropriate to discuss them under Stetson Bank because each of the general points to be made is clearly demonstrated by this the shallowest of the banks around which the meiofauna and macroinfauna were studied.

It should be pointed out that the samples discussed here were not taken from the banks proper but from their flanks. Based on the decapod crustaceans, the group for which adequate comparative data are available, it appears that the fauna of the flanks is composed of species with fairly wide distributions, particularly as evidenced by the amphipod and isopod crustaceans.

The four banks show definitely higher meiofaunal and macroinfaunal populations downstream rather than upstream of the bank proper. It is noted that this phenomenon reflects the net flow of the bottom water in the region, which is assumed to be from the northeast to the southwest (See Final Report, p. 263). It is our thesis that the downstream populations are larger than those upstream due to the incorporation of organic materials from the flora and fauna on the reef tops, in the downstream sediments. This view is compatible with our previous observation that population size harpacticoid copepods in particular is positively correlated with organic content of surficial sediments. It is therefore significant that the harpacticoid populations are substantially higher at downstream stations, particularly on Stetson Bank. Depth may well be the modifying factor here since harpacticoids are generally more abundant in shallow than deep water; Stetson Bank stations are on the average only 53 m deep, as compared with depths of 110 m and deeper at the other banks.

Another observation that points to the strong correlation between inputs of organic matter into the sediments and the size of meiofaunal and macroinfaunal populations is that the stations on the flanks of the banks support much larger populations than those of comparable depths at the transect stations on the open shelf far removed from any bank and its productive biota.

The most evident value of the above findings is the clue it provides in attempts to ascertain the extent and direction any environmental perturbations caused by man might exert deleterious effects on the biota. Moreover, if a circumferential set of meiofaunal samples is taken around the flanks of a bank where the net movement of bottom water is unknown, it should be possible to predict the direction of the flow from the population size differentials.

What is not known is how far downstream these bank effects occur, simply because in most cases we have studied only one downstream station in comparison with the upstream stations. These downstream stations average less than 500 m from the peak of the bank. It is hoped that if the meiofaunal work is to be carried out in the future that a series of downstream stations can be established. The results derived therefrom could be expected to show the distance at and beyond which no enrichment of the infaunal populations occurred. Such information should be valuable in making decisions as to where oil and gas exploitation should be and should not be permitted.

Stetson Bank had the highest ratio, viz. 0.56, of harpacticoid copepods to nematodes of the four banks under study (Final Report, p. 266). In addition this bank had the most species of crustaceans (except Isopoda where it was second) and without exception the most individuals of crustacean taxa among the banks (Final Report, pp. 275-279). Depth could be an indirect factor contributing to the observed results in that the flanks surrounding Stetson average around 53 m, whereas those of 28 Fathom, East Flower Garden, and 28 Fathom, Southwest Peak average 92 m, 106 m, and 129 m, respectively. It is interesting to note that the harpacticoid:nematode ratio for the five stations of Transect II (see Fig. V-1, p. 182 of the Final Report for the location of this transect) with depths ranging from 22 to 98 m, is 0.09 at the same time of year, barely a sixth that of Stetson Bank. This is compatible with the organic enrichment thesis discussed in preceding paragraphs.

In 1974 Pequegnat and Gettleson reported the meiofauna to macroinfauna ratio of individuals on the flanks of Stetson Bank to be 495:1, based on total individuals of meiofaunal size. In the present study, the average of the three typical stations on this bank yields a ratio of 465:1, based only on the total of true meiofauna (Final Report, p. 288). If the temporary meiofauna are added to the total, the ratio is raised to 535:1. The two values average about 500:1, which is remarkably close to the 1974 study, especially considering that different sampling gear was used and that sampling was carried out in August instead of June. This reinforces an earlier conclusion of the senior author that the meiofauna:macroinfauna ratio is sufficiently stable that if the sediment cover is known the ratio can be used as a parameter for judging degrees of environmental impacts.

CLAYPILE BANK

DESCRIPTIVE BIOLOGICAL RECONNAISSANCE

Claypile Bank (Fig. 3) is predominently flat on top with occasional low outcrops of siltstone and claystone, all covered with a thin veneer of sediments (Final Report, pp. 326-336).

The predominant organisms occupying the broad top platform of Claypile Bank are low-growing mats and clumps of leafy algae. Sponges are conspicuous all over the bank, particularly Neofibularia. Hermatypic corals, Stephanocoenia and Siderastrea, are present at least on the flanks of the bank, but in limited quantity. Fishes typical of the shallower portions of the Texas-Louisiana reefs, banks and oil platforms are common at Claypile. Red snappers and large groupers of the genus Mycteroperca were seen in great numbers of the flank of the bank, around some of the outcrops.

There is a considerable amount of man-made "junk" on the platform of Claypile Bank which presumably was jettisoned during past drilling operations and fishing activities. This debris is probably beneficial, supplying elevated hard "artificial reef" substrates on a bank which is severely lacking in the topographic irregularities necessary for the development of substantial epibenthic and reef-fish populations.

Although the biotic communities of Claypile Bank seem relatively less diverse and less abundant than those occupying other nearby banks of comparable depth, they are nevertheless unique and worthy of environmental concern, particularly from the standpoint of the algal population occupying the upper bank platform.

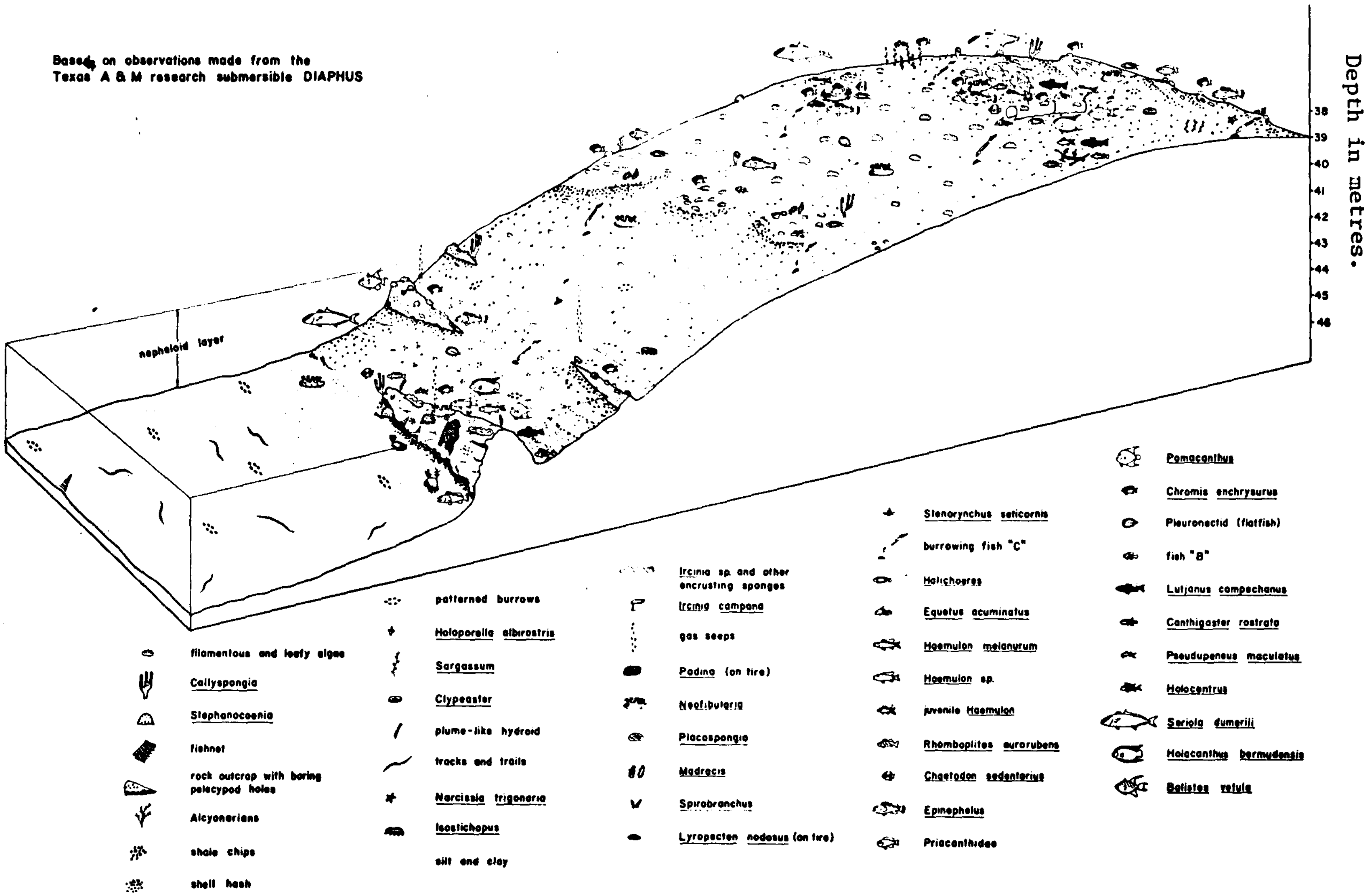

Figure 3. Claypile Bank

EAST FLOWER GARDEN BANK

GEOLOGY AND SEDIMENTOLOGY

The East Flower Garden Bank has a tear drop shape with the long axis oriented along a north-south line. This bank has the largest areal dimensions of those mapped during this study. It is about 9.5 km N-S by 6.7 km E-W. It also extends nearest to the sea surface, coming within 16 metres. This vertical prominence is undoubtedly due to the actively growing coral and coralline algae colonies on the crest.

The bank has relatively steep east and southeast marginal slopes, between about 50 to 110 or 120 metres. The west and northern margins are more gently sloping in this depth range. A gently sloping terrace-like platform is found between the 40 m and 50 m isobath. It is from this platform that the relatively narrow, N-S oriented pinnacle rises to form the two peaks of the reef crest. The northern peak extends to within 24 metres and the southern peak to within 16 metres of the sea surface (Final Report, pp. 104-105).

The different areas of the bank, as delineated by the depth zones, have different bottom characteristics and support different communities. The shallowest portion of the bank, above 40 m to 50 m is a hard bottom area due to the construction of the reef framework by corals and calcareous algae. There are pockets of carbonate sands, but they are restricted to isolated tunnels on the bank's surface. Between 40 and 50 metres, on the terrace, lies the Algal Sponge zone with a coarse sand covering. The soft bottom zone begins at about 80 m to 90 m depth.

The sediments sampled at the East Flower Garden are primarily sands to the west and sandy muds to the east of the bank. The mineralogical composition of the samples from the east side of the bank is dominated by clay minerals whereas to the west of the bank the sediment consists of over 70% calcium carbonate (Final Report, pp. 118, 123-125). This distribution tends to support the net transport of sediment from east to west as indicated by the meiofauna and macroinfauna.

No real nepheloid layer was observed at the East Flower Garden itself. Rather, at the seaward base of the bank, below 120 m, a thin (≃ 2 m) relatively weak (≃ 50% transmissivity) layer of suspended sediment was observed (Final Report, pp. 54-55).

MONITORING AND POST-DRILLING STUDIES

In 1976 we performed a post-drilling assessment of epibenthic community condition at the East Flower Garden. In general we found conditions and biota along the transect southeast of the bank's crest to be essentially the same as in previous years with no obvious effects of drilling on hard-bottom biotic communities and groundfish populations (Final Report, pp. 391-397).

Underwater television was used in combination with LORAC navigation to gather information concerning the locations of components of several clear-water biotic zones on the upper portion of the bank. Coral reefs (Diploria-Montastrea-Porites Zone) predominate in the central, shallowest portions of the transects made (Figs. 4 and 5). Significant fields of leafy algae (Leafy Algae Zone) occur most frequently adjacent to the coral reefs on their western and southern

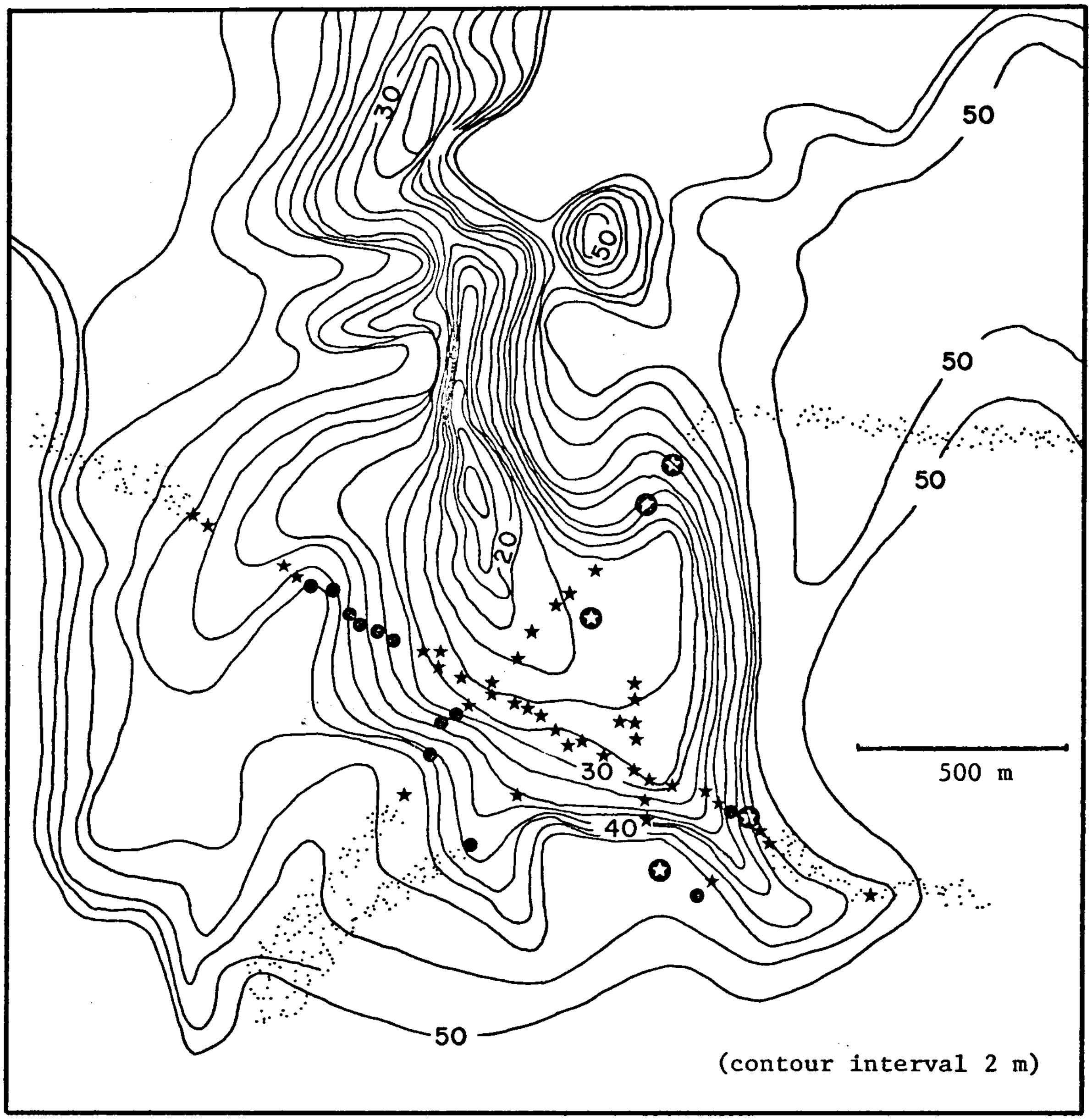

Figure 4. Distribution of clear-water communities along precision underwater television transects at East Flower Garden Bank.

★ Coral reef (Diploria-Montastrea-Porites Zone)

✪ Madracis Zone

● Leafy Algae Zone

∴ Algal-Sponge Zone. Based on underwater television transects which followed tracks shown. Absence of symbols on other parts of map does not imply absence of communities.

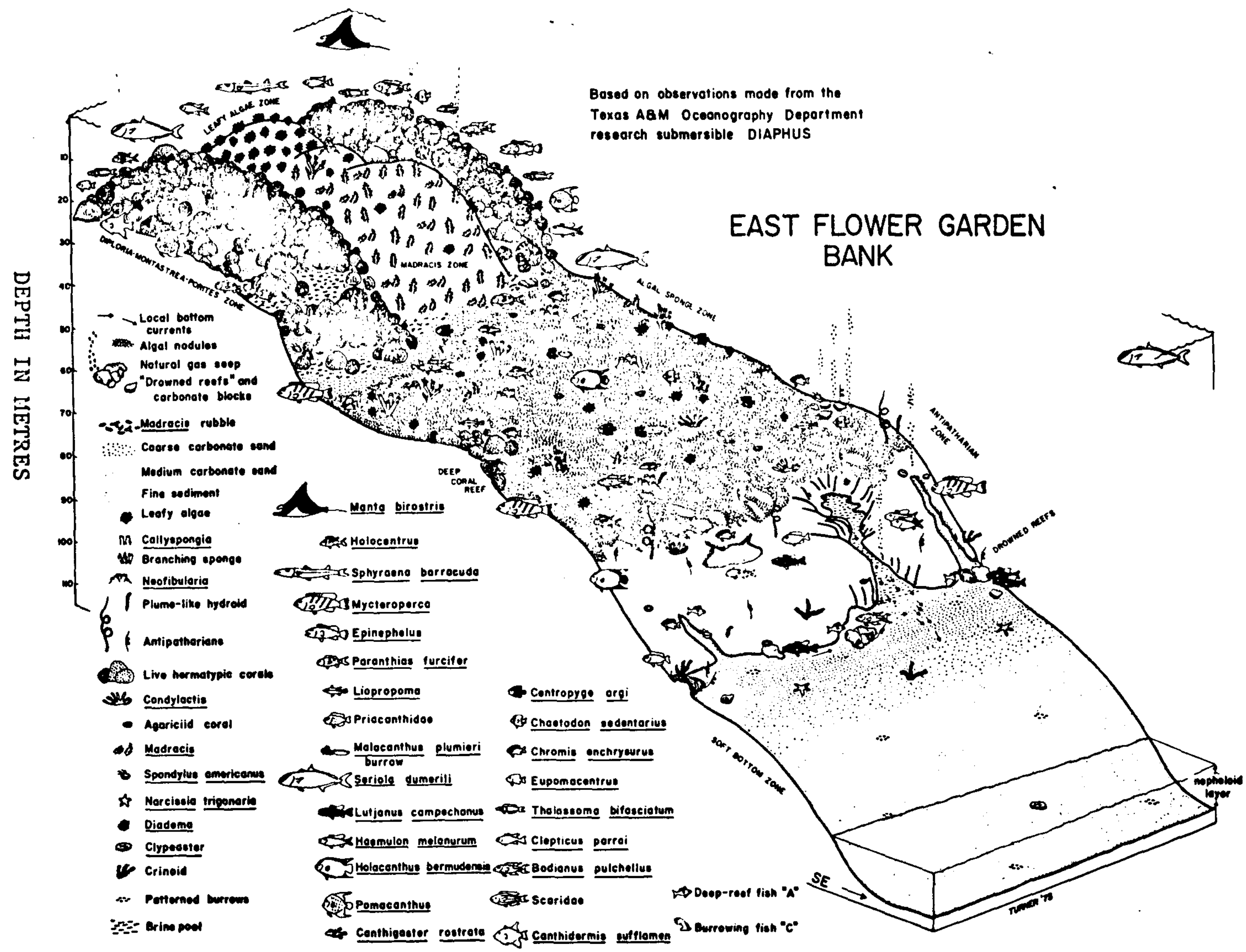

Figure 5. East Flower Garden Bank

sides. Beds of the small branching coral Madracis (Madracis Zone) are present primarily east of the coral reefs. Because of the importance of Madracis as a contributor to the sediments of the reef and upper Algal-Sponge Zone, and because of the importance of the leafy algae as primary producers, it is felt that more of these accurate determinations of community distribution should be made.

Natural gas seeps were seen on the living coral reefs as well as in the Algal-Sponge Zone and Antipatharian Zone deeper on the bank. In 1976 a sample of natural gas was collected from a seep on the coral reef at a neighboring bank, the West Florida Garden (Fig. 1). Chemical analyses indicated that the gas was of biogenic origin. Biogenic and petrogenic gas seeps are widespread on the East and West Flower Garden Banks. Both types of gas are 98 to 99% methane with small amounts of ethane and propane. Environmental effects of the gas seeps on surrounding communities appear negligable.

In order to determine whether or not the wellbeing of a marine benthic community has been affected by an episode such as drilling, it is necessary to assess the apparent "health" of, at least, the predominent biotic components of that community. Details of certain non-drilling-related "unhealthy" and pathological conditions of dominant corals were observed and assessed in 1976 (Final Report, pp. 397-420).

Mechanical damage to corals is the only obvious effect of man on the East Flower Garden reef. Overturned coral heads and small abrasions are presumably results of anchoring on the reef. Abrasions are also caused by divers. The extent to which mechanical damage is a threat to the East Flower Garden in comparison to "natural" mortality and pathological organisms is not known.

It may be that disease pathogens are the most important causes of coral mortality on the East Flower Garden reef. Once certain pathogens gain a foothold within the tissue of a coral colony, mortality can spread quickly, leaving a bare, deal surface which is soon recolonized by other epibenthic organisms. At the East Flower Garden, there may be a precarious competitive balance between the hermatypic corals, pathogens and fast growing epifauna such as Millepora and sponges.

Some of the apparently unhealthy conditions affecting corals at the East Flower Garden include: loss of zooxanthellae, involvement of certain algae in coral mortality; "leprosy"-like disintegration of coral tissue; discoloration of coral tissue; coating of a white, flake-like substance on coral surfaces; white inclusions in the coral mucus or epithelium.

MEIOFAUNA AND MACROINFAUNA

Generally, the East Flower Garden had the lowest number of taxa and fewest individuals. This was true of three crustacean groups at species level and also at the major taxon level for both macroinfauna and meiofauna (Final Report, Tables VI-2, p. 264 and VI-6, p. 269).

Although the meiofaunal populations of East Flower Garden Bank were found to be only slightly higher than those of 28 Fathom Bank and 28 Fathom, Southwest Peak, its macroinfaunal populations were unexpectedly low. As a result, its true meiofauna:macroinfauna ratio is high (442:1) and distinctly different from those of the 28 Fathom complex (Final Report, p. 289).

For more general considerations applying to the meiofauna and macroinfauna of this bank, see the discussion of Stetson Bank in this summary.

BRINE FLOWS

A brine pool was found in a depression on the eastern edge of the East Flower Gardens at a depth of 72 metres (Fig. 6). The 188 parts per thousand brine seeps from the substratum, flows over the margin of the pool, down the axis of a canyon cut into the hard carbonate rock, and out onto the surrounding sandy bottom at 80 metres depth. By the time the brine reaches the level, sandy bottom, it is diluted to 39.6 parts per thousand due to turbulent flow and mixing in the axis of the canyon. There is evidence that the sustained flow of dense water through the 7 to 15 metres deep canyon contributes locally to sediment transport and erosional processes, resulting in movement of sand-to-cobble-sized particles off the hard bank (Final Report, Fig. XI-6, p. 535).

The presence of gypsum on the substratum within the brine pool is indicative of contact between the brine and the gypsum caprock commonly associated with salt domes in the northwestern Gulf of Mexico. The brine probably seeps laterally from the salt dome underlying the East Flower Gardens.

A substantial population of low-growing leafy and filamentous algae occurs on the sand bottom directly adjacent to the brine pool. A significant bacterial population on the bottom of the brine pool is indicated by the presence of zones of white, olive and purple deposits on the carbonate rock or sand (Final Report, pp. 537-538).

In spite of its rather potent nature, the East Flower Garden brine does not appear to have affected epibenthic populations outside of

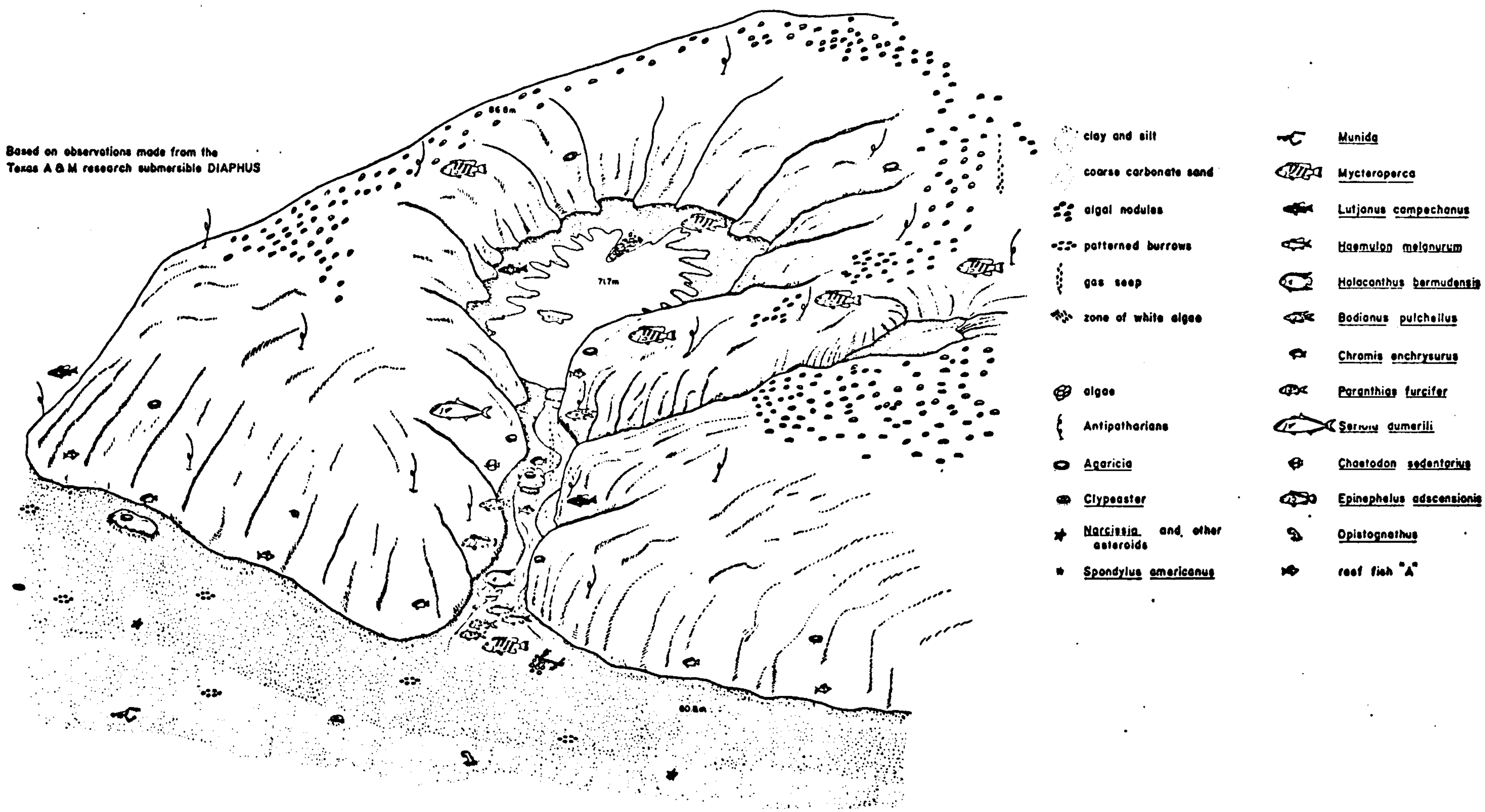

Figure 6. East Flower Garden Brine Seep

a ring extending a metre or so above the interface between the brine and overlying normal marine water. Fishes were not observed to enter the highly saline brine in the pool. However, groupers (*Mycteroperca* spp.) and Cottonwick (*Haemulon melanurum*) swam freely in and out of the mixing brine stream within the canyon. Large Red Snappers (*Lutjanus campechanus*) swam very close to the brine interface.

The East Flower Garden brine is chemically comparable to brine described from the Orca Basin located off Louisiana at 26°55'N and 91°21'W. The Orca Basin has a 2400 metre bottom depth, contains an anoxic brine lake 200 metres deep and is 1,000 sq. kilometres in extent (Shokes et al., 1977). The Orca Basin brine is very similar to brines found in the Red Sea except that the Red Sea brines are hot. The East Flower Garden and Orca brines are only slightly higher in temperature than surrounding sea water. Chemically, the East Flower Garden brine differs from the other deep-sea brines in that it is less salty, has much less dissolved silicate and contains dissolved petrogenic natural gas and hydrogen sulfide (Final Report, p. 538).

There may be additional brine seeps at the East Flower Garden and elsewhere around salt-dome induced structures off Texas and Louisiana. The East Flower Garden brine and the Orca brine are undoubtedly manifestations of a hitherto unrecognized and unique biogeochemical phenomenon of major proportion in the northwestern Gulf of Mexico.

28 FATHOM AND 28 FATHOM BANK, SOUTHWEST PEAK

GEOLOGY AND SEDIMENTOLOGY

The bank designated as "Unnamed" in the 1976 contract is in fact a southern knoll of the 28 Fathom Bank system and is hereafter referred to as 28 Fathom Bank, Southwest Peak. These two features are in close proximity to each other, with their peaks only 2.5 km apart. They might be considered part of the same bank but for a long, narrow trench-like depression that extends up the shelf from the west, passes north of 28 Fathom Bank, Southwest Peak, and terminates in a nearly circular depression 170 metres deep almost directly between the two peaks (Final Report, pp. 105-106).

28 Fathom Bank has a broad, sub-circular peak that comes within 52 meters of the surface. The bank extends to the north and east from the bank crest in ridge-like extensions with a spur also to the northeast. The bank is about 4.0 km wide (E-W) and 4.5 km in the direction N-S. There are numerous peaks of low relief along the sides of the ridges. A perspective view of this bank is in Bright, Rezak et al. (1976, p. 142). The crest of the bank is an algal nodule platform, as are the low peaks on other parts of the bank. Relief is greatest from the peak to the depression (120 m), but is only about 60-80 m to the surrounding shelf.

28 Fathom Bank, Southwest Peak, is smaller than 28 Fathom Bank and lacks the broad, flat peak of that feature. The shallowest portions of 28 Fathom Bank, Southwest Peak, are two peaks that come within 66 and 68 metres of the surface in the northern part of the bank. The rest of the bank slopes to the south until the surface of the shelf

is reached. The peaks and the terrace immediately surrounding them are carpeted with algal nodules, but little coral growth is evident.

Sediments from these banks are generally very coarse due to the fact that all stations are located within the bank complex and not in a normal sedimentary apron that surrounds a bank. All stations are high in total calcium carbonate, as would be expected for bank derived skeletal material (Final Report, pp. 119-120, 123-125).

It was not possible to obtain transmissometer profiles at these banks due to the high velocity of the currents. Some STD profiles had a stair step appearance with alternating isothermal and stratified layers. These may be related to the alternating turbid and clear layers observed by Dr. Bright from the DR/V Diaphus (Final Report, pp. 53-54).

DESCRIPTIVE BIOLOGICAL RECONNAISSANCE

Essentially, substratum and biota of 28 Fathom Bank (Fig. 7) are the same as those below the coral reefs at the East Flower Garden Bank Figs. 4 and 5). There are considerable populations of large asteriods and holothuroids within the Algal-Sponge Zone. Branching antipatharians are abundant, as are *Cirripathes* and alcyonarians of various types. Outcrops in clear water on top of the bank are heavily encrusted with coralline algae, which extend in significant quantities to depths of slightly over 90 metres. Algal nodules were found on the slopes of the bank down to 100 metres. No leafy algae were seen below 93 metres depth. The fish population is comparable to that seen in the Algal-Sponge zone at the Flower Gardens. Commercial snappers and groupers are

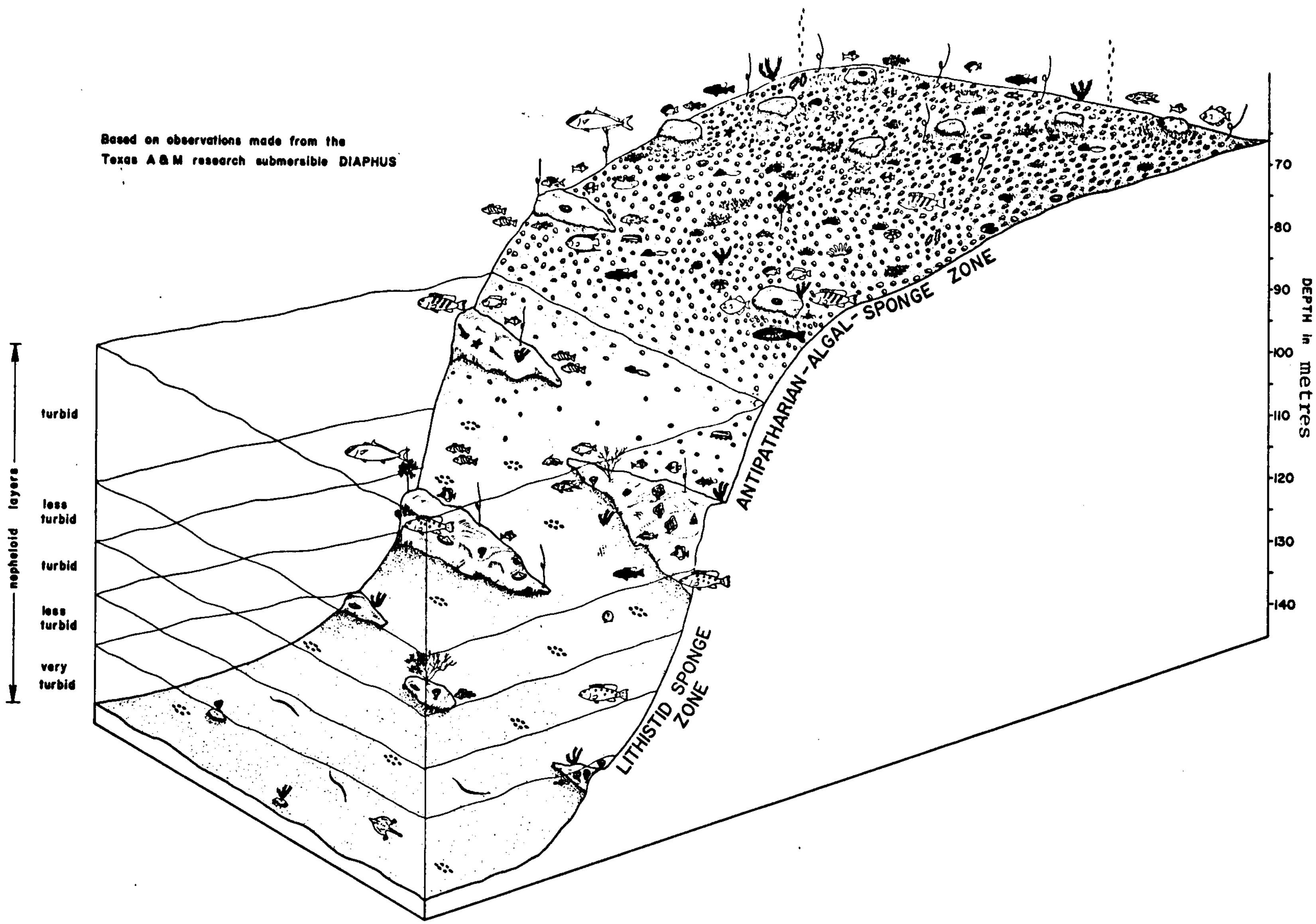

Figure 7. 28 Fathom Bank, Southwest Peak

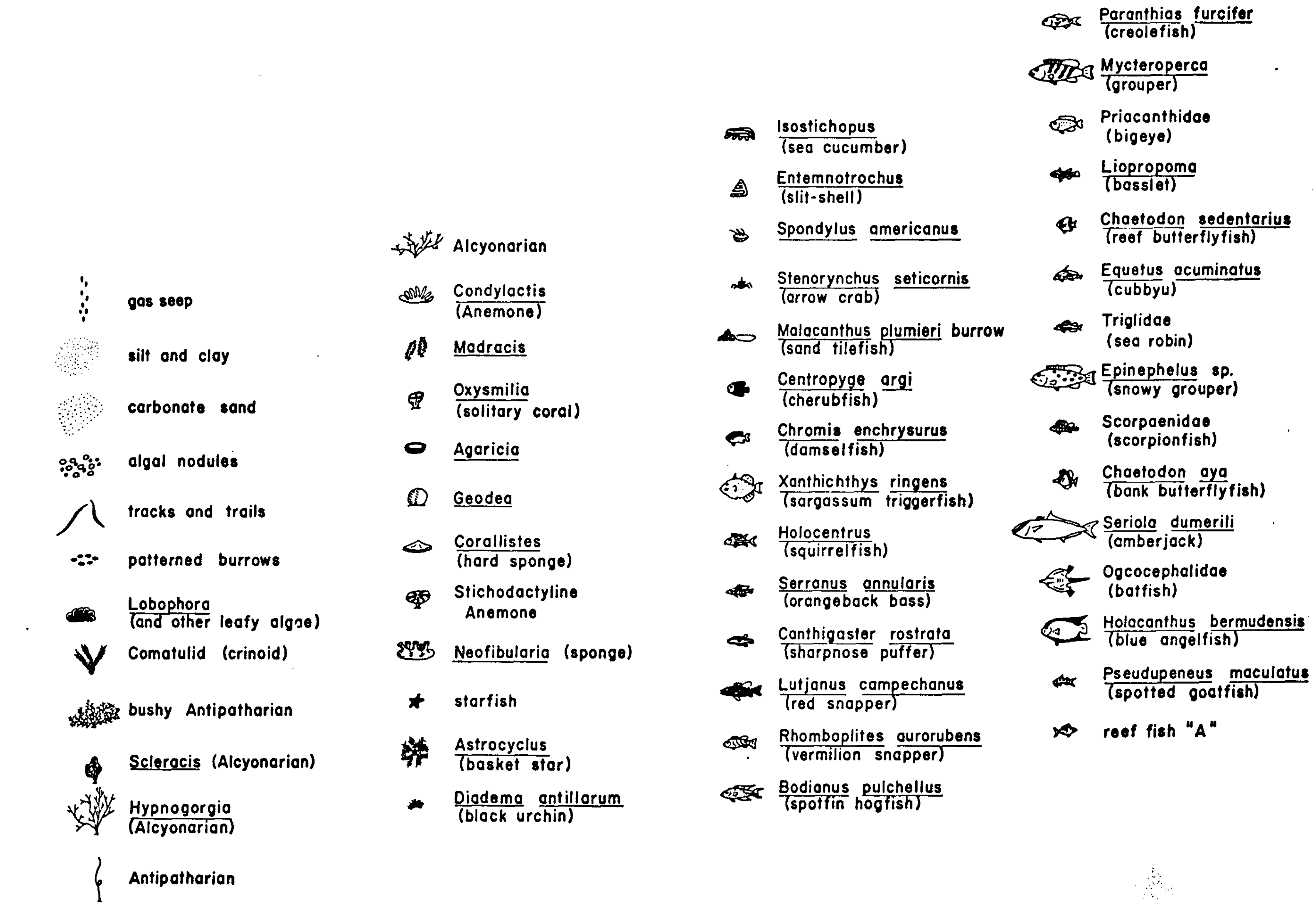

Figure 7 (cont.)

abundant (Final Report, pp. 309-318).

Diversity and abundance of the algae and epifauna decrease substantially below 80 metres depth. At about 97 metres components of a deeper, hard-bank community appear. Below 120 metres substantial populations of the hard bodied lithistid sponge, Corallistes sp. and the large solitary coral, Oxysmilia rotundifolia, occur (Final Report, pp. 323-324).

28 Fathom Bank bears a significant and highly diverse clear water biotic community above 80 metres. The commercial fish populations of its knolls are considerable. The biota of 28 Fathom Bank and 28 Fathom Bank, SW, should be classed among those about which there is primary environmental concern (Final Report, p. 326).

MEIOFAUNA AND MACROINFAUNA

It is difficult to separate these banks on the basis of faunal composition, since they are indeed part of the same complex. Generally, however, 28 Fathom, Southwest Peak, had higher numbers of species and individuals than 28 Fathom Bank. Taken together this bank complex ranks intermediate between Stetson Bank, which has the highest number of species and individuals, and East Flower Garden Bank with the lowest (Final Report, pp. 262 and 269).

It should be noted that 28 Fathom, Southwest Peak, is downcurrent of 28 Fathom Bank, a fact that may well account for its higher number of taxa. The harpacticoid:nematode ratios of these two banks are distinctive, that of 28 Fathom, Southwest Peak, being 0.42 and that of 28 Fathom being 0.23. Both values are intermediate between those of Stetson Bank (0.56) and East Flower Garden (0.11) (Final Report, pp.

266-267).

Interestingly, these banks have distinctive true meiofauna: macroinfauna characterizing ratios, that of 28 Fathom Bank being 74:1 and 28 Fathom, Southwest Peak, being 103:1. Both are well below those of Stetson Bank and East Flower Garden Bank (Final Report, p. 289).

For more general considerations applying to the meiofauna and macroinfauna of these banks, see the discussion of Stetson Bank in this summary.

SOUTH TEXAS FISHING BANKS

SOUTH BAKER BANK

We returned to South Baker Bank in 1976 and assessed the "health" of epibenthic communities in comparison to observations made by us in 1975 before nearby exploratory drilling had occurred. We saw no visual evidence of effects on bank associated biota due to drilling. The epibenthic community at the crest of South Baker is, if anything, more profuse than those viewed on some of the other South Texas banks such as Southern Bank and Hospital Rock (Final Report, pp. 385-389).

ARANSAS BANK

Biotically, physiographically and hydrographically, Aransas Bank is a typical high-relief South Texas fishing bank. The biotic communities of the bank are distinctly similar to those described in last year's report for all of the other high-relief South Texas banks and should be considered in the same category from the standpoint of environmental concern (Final Report, pp. 337-344).

SOUTHERN BANK

At Southern Bank, we compared conditions of "community health" in 1976 with those observed in 1975 in an attempt to assess the effects, if any, of nearby drilling operations carried out in the interim. There was no visual evidence of effects due to drilling on the biota. The list of living species detected this year compares well with that presented in our last year's report. Moreover, the 1976 list includes a number of leafy algae which we did not detect in 1975 (Final Report, pp. 389-391).

BLACKFISH RIDGE AND MYSTERIOUS BANK

The low relief of these two banks above the surrounding soft bottom, in an area of a chronically thick nepheloid layer, has seemingly limited the diversity and abundance of epibenthic communities (Fig. 8 and Final Report, pp. 344-346). The conspicuous organisms, however, are those which are also predominant on the South Texas banks of greater relief (Dream, Southern, South Baker, etc.). Such fishes as Red Snapper (*Lutjanus campechanus*), Vermilion Snapper (*Rhomboplites aurorubens*), Lookdown (*Selene vomer*), and Greater Amberjack (*Seriola dumerili*), were seen in schools. Groupers (*Mycteroperca* spp.) and the Great Barracuda (*Sphyraena barracuda*) were observed.

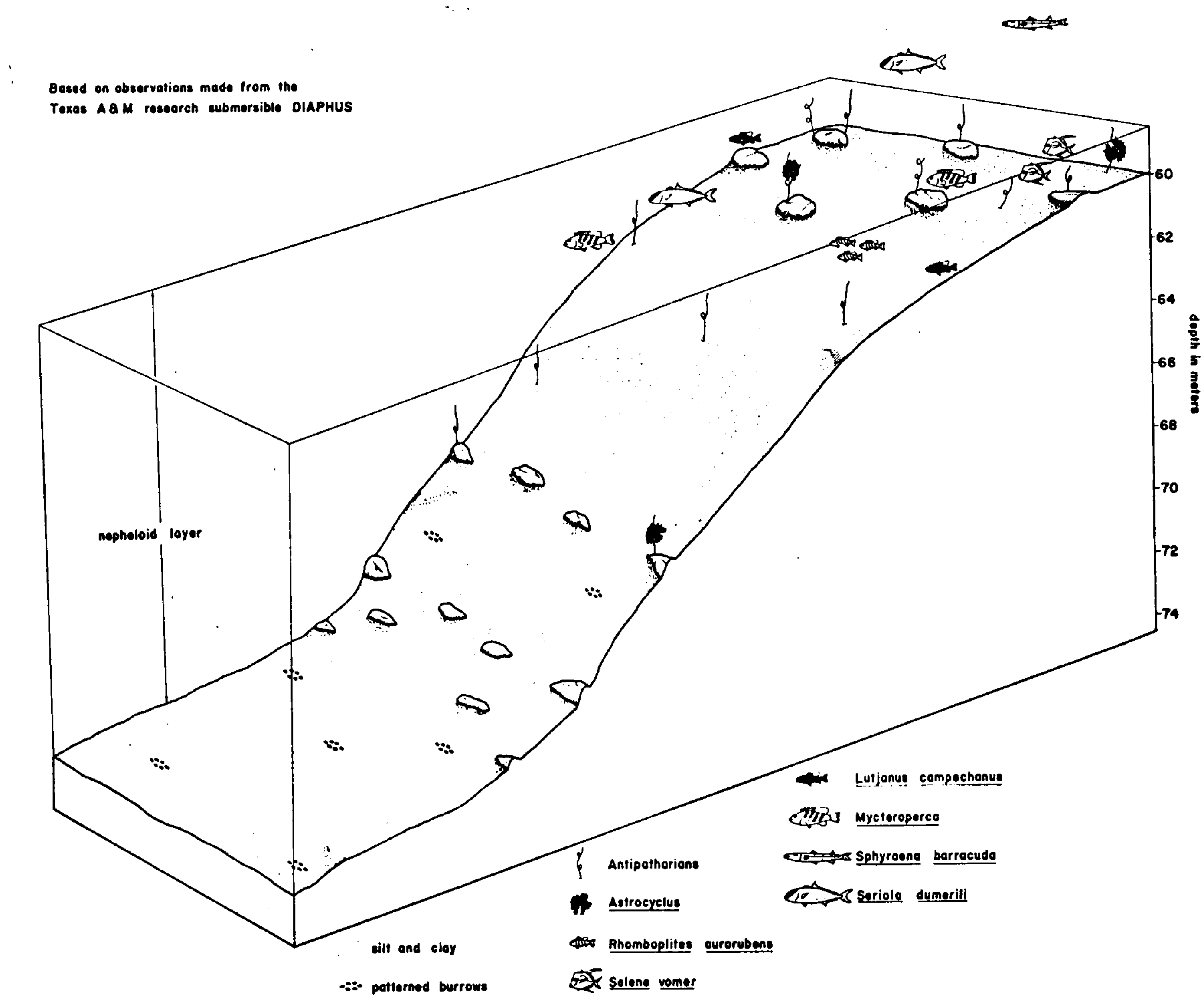

Figure 8. Blackfish Ridge

THE NEPHELOID LAYER AND ITS EFFECTS ON DISTRIBUTION OF EPIBENTHIC COMMUNITIES

ORIGIN OF THE NEPHELOID LAYER

A time series of STD and transmissometer profiles was taken on the southeast side of Southern Bank over a 12 hour period on 22 September 1976 (Final Report, pp. 42-52). Information derived from these profiles showed a migration of the 20^{o} C isotherm from 35 m to 43 m in the period of one hour. Such a migration of an isotherm, in conjunction with other observations using dye emission for flow visualization and precision depth recorder returns from density interfaces in the water column, strongly suggests that internal waves may supply considerable energy to shelf edge dynamics. Salinity contributes little to the density structure of the water column because of its uniformity (less than 1% variation) during late summer. The nepheloid layer is intimately bound to the processes which form the mixed benthic boundary layer. Though there is considerable temporal and spatial variation in the thickness of the nepheloid layer, its upper surface seems to range between 60 m and 70 m at Southern Bank and Hospital Rock.

The nepheloid layer consists of sediment that is resuspended from the bottom due to turbulence caused by a complex of internal waves, continental shelf waves, and tidal currents. The amount of suspended sediment in the nepheloid layer increases exponentially with depth in the layer.

EFFECTS ON EPIBENTHIC COMMUNITIES

We attempted to confirm through non-destructive quantitative sampling an impression that epibenthic populations occupying the high-relief South Texas fishing banks exhibit a substantial decrease in diversity and abundance with increasing depth, presumably due to environmental stress imposed by the chronic presence of nepheloid layers on the lower flanks of the banks (Final Report, Chapter IX, pp. 448-465).

Counts of conspicuous epibenthos and fishes were made at Southern Bank and Hospital Rock. The cumulative totals for average numbers of organisms counted per depth indicate that in comparison to epifaunal populations on the less turbid crests of the banks there is a decided trend toward differentially reduced populations around 67 m and severly reduced populations in the nepheloid layer below 72 m.

Based on a combination of qualitative and quantitative observations made from the research submersible, there seems little doubt that a correlation exists between the presence of persistently turbid water and thick sediment layers on rocks on the lower parts of the banks and a sharp decrease in abundance of the populations of coralline algae, intervertebrates, and fish. Undoubtedly the same relationship exists on other South Texas banks. The environmental factors of most significance in restricting epibenthic populations within the "permanent" nepheloid layer are reduced light, turbidity, sedimentation and increased sediment cover on elevated rocks.

NUTRIENTS, OXYGEN, AND LOW-MOLECULAR WEIGHT HYDROCARBONS IN THE WATER COLUMN AROUND SOUTHERN BANK AND HOSPITAL ROCK

Nutrients and dissolved oxygen concentrations are reported in Table III-4 (Final Report, p. 98) and light hydrocarbon concentrations (in nannoliters per liter) are reported in Table III-5 (Final Report, p. 99). Nutrient and oxygen concentrations are typical for the month of August on the South Texas shelf and compare favorably to those reported in the 1976 BLM South Texas Outer Continental Shelf report (Final Report, Biology and Chemistry). Nutrient concentrations generally increase in near-bottom waters of the bank stations, whereas dissolved oxygen begins to decrease below about 70 metres during August, due to stratification of the water column. Oxygen concentrations nearer the sea surface are generally in equilibrium with the partial pressure of atmospheric oxygen at the water temperature and salinity for this month.

Light hydrocarbon concentrations in the surface and half-photic zone samples also reflect equilibrium with the atmosphere, but near-bottom methane concentrations were all at least twice equilibrium values. These high concentrations indicate the presence of gas seepage from the bank sediments, and indeed, a sample of distinct, bubbling gas was later collected from Southern Bank with a submersible. The absence of dissolved ethane or propane anomalies coupled with the composition of the seep gas (99.98% methane; $\delta^{13}C \sim -60\ ^{o}/oo$) suggest that the seepage is of a microbial origin rather than related to reservoired petroleum. Near-bottom methane anomalies at Hospital Rock imply the existence of a seepage of a similar nature around that bank.

THE CONTAMINATION OF MACRONEKTON AND SPONDYLUS

HEAVY MOLECULAR WEIGHT HYDROCARBONS

Although petroleum hydrocarbons are known to be taken up relatively rapidly by marine organisms and have been detected at parts per million levels in animals from highly polluted areas, little is known about detecting trace or parts per billion levels of petroleum hydrocarbons. One obstacle to low level detection of petroleum hydrocarbons is interference from biogenic hydrocarbons. This interference may be minimized by obtaining profiles of biogenic hydrocarbons from different species. These biogenic profiles can then be subtracted from the profiles obtianed from organisms to be monitored to better detect trace levels of petroleum hydrocarbons. Thus, our major effort has been directed to defining biogenic profiles and to determining which organisms are most consistent and most suitable for monitoring purposes.

Samples for these studies consisted of macronekton and *Spondylus* that were obtained from stations at the East Flower Garden, 28 Fathom Bank, Stetson Bank, and 28 Fathom Bank, Southwest Peak. The macronekton were mainly Red and Vermilion Snappers. The distribution patterns of n-alkanes and the absence of aromatic hydrocarbons in the macronekton and *Spondylus* samples from the Topographic High Study area imply that very little or no heavy hydrocarbons of anthropogenic origins are present in the study area (Final Report, pp. 504-505).

TRACE METALS

Macronekton and spiny oysters were collected from selected topographical highs on the Texas Outer Continental Shelf and analyzed for trace metals content.

Macronekton (primarly 2 species of fish: Lutjanus campechanus and Rhomboplites aurorubens) were collected on cruises during September-October 1976 from four bank stations (East Flower Garden, Stetson Bank, 28 Fathom Bank and 28 Fathom Bank, Southwest Peak). American thorny oysters (Spondylus americanus) were collected from the same bank stations (except 28 Fathom Bank, Southwest Peak) during these cruises. The same fishes and thorny oysters were collected from Southern Bank and Hospital Rock nine times during 1976, including three seasonal sampling periods (i.e., January-February, May-June, September-October) and five monthly sampling periods (i.e., March, April, July, August, November).

Analyses for ten trace metals (Al, Ca, Cd, Cr, Cu, Fe, Ni, Pb, V, Zn), were conducted on materials from 30 macronekton samples and 15 Spondylus samples. Muscle, liver and gill tissue were analyzed from each macronekton sample. An aliquot from each of the whole Spondylus collected was analyzed.

The sample types in order of decreasing total trace metals content (except for Al and Ca) were: fish liver, Spondylus, fish gill and fish muscle. Considerable variability in trace metals levels was observed between sample types. Types in order of decreasing variability were fish livers, fish muscle, fish gills and Spondylus. With this level of variability small differences in trace metals levels (e.g., $\leqq$ 50%) could not be detected statistically.

Muscle tissue from fish had generally low, uniform trace metals concentrations with few apparent geographical, seasonal or interspecific differences. Gill and liver tissue from Rhomboplites aurorubens had generally higher concentrations of trace metals than similar tissue from L. campechanus. Cadmium levels were higher in livers than gills for both species. Spondylus had generally higher levels of all trace metals analyzed.

Cadmium levels were higher in samples from Hospital Rock than from Southern Bank. Levels of Cd, Cu, Pb and Zn were significantly higher in samples from the East Flower Garden than those from 4 other bank stations (Final Report, p. 533).

DISPERSAL OF SUSPENDED SEDIMENT AS MEASURED BY THE DISTRIBUTION OF REDEPOSITED CRETACEOUS COCCOLITHS

The distribution of redeposited Cretaceous coccoliths in the surface sediment of the south Texas continental shelf indicates that these fossils can be used to trace the transport of fine silt and clay particles in the area (Final Report, pp. 133-158). Specifically they indicate that in the northernmost part of the area the net transport of particles is onshore from the east. Immediately to the south of this area the net transport is offshore, extending across the continental shelf approximately due east from Port Aransas, in a long, relatively well defined tongue. In the central area of the South Texas continental shelf there seems to be very little basinward dispersal of land-derived fine silt and coarse clay size material; and if any significant offshore transport occurs in this area, it must be restricted to the very fine clay size fraction. In the southernmost part of the South Texas continental shelf the net transport again seems to be offshore, but the pattern is broad and diffuse and not as sharply defined as it is in the northern part of the study area.

Sediment samples taken on and around various banks, the several topographic highs on the Texas continental shelf, generally yield the same proportion of redeposited Cretaceous coccoliths as do the sediments in the general vicinity, except that on the basinward side of the shallower banks (Southern, Hospital, and Stetson) a significantly higher proportion of redeposited specimens is encountered. The two most nearly acceptable explanations for this anomalous distribution around these banks are 1) land derived sediments are being transported parallel to the shelf edge and deposited on the basin side of the banks; 2) the sediments on the basinward side of the banks are relict, possibly deposited during a lower stand of sea level at a time when the shoreline and, hence, the source of the redeposited Cretaceous coccoliths was closer to these banks.

SHELLED MICROZOOPLANKTON, GENERAL MICROPLANKTON AND SHELLED MICROZOOBENTHON FROM THE TOPOGRAPHIC HIGHS

Southern Bank and Hospital Rock (South Texas Banks) appear to be quite similar to the surrounding shelf regions. It appears that the higher standing crops of diatoms and ceratiums at the banks are due to obstruction upwelling caused by the presence of the banks. The benthonic foraminiferans do show some differences when comparing the primary banks with the surrounding bottom. These banks possess fewer species and a lower density of benthonic foraminiferan species than do the surrounding sediments. These banks do possess both shallow water and deep water components of benthonic foraminiferans, however (Final Report, pp. 194-195 and 237-241).

Stetson, East Flower Garden and 28 Fathom Banks (North Texas banks) are quite different in that they possess a much greater richness of species, different species (some of a more tropical nature) and a greater density of benthonic foraminiferans (Final Report, pp. 241-245). Of special interest are living, more likely very recently dead, shelled microplankton (mainly planktonic foraminiferans, but also diatoms and pteropods) that were west of each of the banks. This is very interesting because it suggests that the banks are influencing the plankton by either causing a rapid reproduction of plankton and therefore an abnormally high fall out of living forams or that they (the banks) have a deleterious effect on at least the shelled microplankton (and presumably other plankton) causing a mass moratility of the plankton as it moves over the banks.

The western stations also have greater standing crops of benthonic foraminiferans than did the other bank stations. These higher standing crops might indicate that the lee side of these banks is a "sink" for organic matter (coming out of the water column due to mortality as mentioned or due to higher standing crops of plankton caused by obstruction upwelling as seen over the primary banks). These preliminary observations should be examined in detail and, if documented, they should be investigated so that they are not confused with man's possible further pertubations.

Further monitoring of these banks might most economically be done by the use of benthonic foraminiferans (or other bottom dwelling species) as opposed to the use of shelled or general microplankton (or other plankton species) since the benthonic foraminiferans have a longer residence time on, in and around the banks than do the plankton.

CONCLUSIONS

BIOLOGY OF THE HARD ROCKS

Our biological reconnaissance assessments confirmed that the crest of 28 Fathom Bank, Southwest Peak, is occupied by a clear-water Algal-Sponge Zone community above approximately 76 m depth. Below this, there is a transformation downward to a unique deep-water epibenthic community (below 120 m) typified by lithistid sponges and large solitary corals. The communities and zonation at 28 Fathom Bank are essentially the same as those found at the East and West Flower Gardens below the shallow coral reefs.

Claypile Bank is a broad, flat platform covered to a significant degree by filamentous and leafy algae with occasional, possibly seasonal, patches of Sargassum. Outcrops of tertiary bedrock around the edge of the bank bear significant, but sparse, developments of epifauna including large branching bryozoans and the hermatypic corals, Siderastrea and Stephanocoenia. All of these bank-edge epifauna seem well adapted to chronic high turbidity and sedimentation. More profuse epifaunal and leafy algal populations have developed on discarded drill pipes, anchors, tires, etc., which serve as effective artificial reefs around which numerous fish congregate.

Aransas Bank is a typical high-relief South Texas fishing bank bearing an Antipatharian Zone community which is best developed above 70 m where water turbidity is not as severe and persistent as it is lower on the bank.

Blackfish Ridge and Mysterious Bank are classified as low-relief fishing banks. They are apparently almost always covered by highly turbid nepheloid layers. Consequently, the epifaunal populations there are sparse, though the large conspicuous attached organisms are the same ones found in the Antipatharian Zones of the high-relief banks to the north.

Post-drilling assessments at the East Flower Garden, Stetson, South Baker and Southern Banks revealed no obvious effects on epifaunal and groundfish populations due to drilling near the banks. In all cases, the benthic communities appeared as "healthy" in 1976 as in past years. No signs of catastrophic mortality were evident.

Quadrat counts at Southern Bank and Hospital Rock support the opinion that species diversity and abundance decrease with increasing depth on high-relief South Texas topographical highs in response to the high turbidity and sedimentation associated with chronic nepheloid layers investing the lower portions of the banks.

Accurate mapping of occurrences of biotic communities type above 50 m at the East Flower Garden indicates that there may be a recognizable upstream-downstream effect on the distribution of epifaunal populations at the bank. There appear to be more components of the Madracis zone upstream and more components of the Leafy Algae zond downstream.

At the East Flower Garden a unique brine seep was discovered and documented. The high salinity brine affects epifaunal communities only very locally (in a one metre or so band above the interface between brine and typical marine water.) Several unique species of leafy algae grow in or adjacent to the brine, but not elsewhere on the bank.

In examining the health of hermatypic corals at the East Flower Gardens, we found numerous instances of mechanical damage to corals and an array of coral pathological conditions involving filamentous algae, zooxanthellae extrusions, discoloration, "rotting" of coral tissue, white inclusions in coral mucus and white flake-like coatings of the coral colony surface.

A detailed laboratory-field study of the white inclusions in the mucus of Montastrea cavernosa revealed that they are botryoidal masses of spherical organic cells, each approximately 10 microns in diameter. The cells do not respond to bacterial, algal or fungal marine culture techniques. Electron micrography reveals cellular structure analagous to that of secretory cells. Field observations indicate that the presence of these inclusions in the mucus does not affect normal daily behavior of the coral and possibly is not of pathological significance. The white material does not appear to be infectious.

During the past two years, a concept of "environmental prioritization" has emerged relating to the nature of the Texas-Louisiana fishing banks described and studied by our group. In general, it is felt that the banks can be categorized and prioritized as follows, depending on their hydrographic, geomorphic and biological characteristics:

1. Shelf-edge constructional carbonate banks of high relief harboring clear-water epibenthic communities, including coral reef and Algal-Sponge Zone communities in which the

predominant active frame builders are hermatypic corals and coralline algae, respectively. Such banks include:

West Flower Garden

East Flower Garden

28 Fathom Bank

Probably other banks to the east of these banks

2. Mid-shelf claystone-siltstone banks of shallow crest depth (25-30 m) bearing on their upper portions depauperate clear-water epibenthic communities, including several species of hermatypic corals and numerous tropical reef fishes. Such banks include:

Stetson Bank

Claypile Bank

Sonnier Bank (3 Hickey Rock)

Probably other banks off Louisiana

3. Mid-shelf carbonate banks of deeper crest depth (around 56-67 m) and high relief bearing moderately developed Antipatharian Zone epifaunal communities, including a severely limited population of small corals. These communities are subject to frequent influxes of turbid water. Such banks include:

Baker Bank

South Baker Bank

Aransas Bank

North Hospital Rock

Hospital Rock

Southern Bank

Dream Bank

4. Mid-shelf carbonate banks of deeper crest depth (60-70 m) and low relief bearing poorly developed Antipatharian Zone benthic communities which are subject to nearly constant conditions of high turbidity and sedimentation. Such banks include:

   Big Adam Rock

   Small Adam Rock

   Blackfish Ridge

   Mysterious Bank

BIOLOGY OF SOFT BOTTOM ADJACENT TO THE BANKS

The meiofauna of the flanks of the hard banks off the Texas coast form a stable community that varies in regard to depth, orientation downcurrent of the main mass of the bank, sediment grain size and, presumably, in regard to the amount of labile carbon compounds in the sediments, although the latter has not been tested.

The bank meiofaunal populations are, on balance, substantially higher than those on the adjacent level bottoms of the outer continental shelf. This may be a reflection of greater inputs of organic materials into the sediments from bank debris and detritus, but again, this is as yet untested. The latter is suspected, however, because harpacticoid copepods, which respond positively to organic inputs, are significantly more abundant on banks than on level bottoms in this area.

It is noted that the harpacticoid: nematode ratio is significantly greater at the banks than at transect stations. Also, the ratio differs predictably among banks, indicating that banks have a signature ratio that will identify its condition of health. Whereas environmental impacts can be measured among the macro-epifauna, primarily by death or no death, such impacts can be estimated and predicted by ratio changes among these two components of the meiofauna.

The macroinfauna of the flanks of the hard banks off the Texas coast also form a stable community that varies less than the meio-fauna in the depth range of this study. However, as in the case of the meiofauna, it is more abundant downstream of the bank proper, and it is significantly more abundant on the bank flanks than on the level bottoms of the transects.

The meiofaunal annual production in the Gulf is believed to be two to five times greater than the macroinfauna.

The true meiofauna: macroinfauna ratio is considered to be another important signature marker of individual banks. It appears to be stable from year to year.

Both the meiofauna and the macroinfauna respond to changes in the characteristics of the sediment bed. However, it appears that the usual division of sediments into gravel, sand, silt and clay is too gross. Rather, the individual grain sizes should be divided into at least 16 categories and percentages for each derived.

GEOLOGY

The classification of banks in the previous section (p. 43-45) is in agreement with our geological observations with the following qualifications. The mid-shelf carbonate banks (categories 3 and 4) are also constructional features that are quite different from the mid-shelf claystone-siltstone banks (category 2). The carbonate is the result of the growth of corals and algae during the Pleistocene and Early Holocene epochs. The major difference between the mid-shelf carbonate banks and the shelf-edge carbonate banks (category 1) is that the mid-shelf carbonate banks are now dead. The mid-shelf carbonate banks have never been buried by terrigenous sediments, although they are now in the process of being buried. The mid-shelf claystone-siltstone banks are composed of lithified tertiary sediments that have been brought to the surface by salt tectonics.

The sediments surrounding the category 2, 3 and 4 banks are primarily clays with admixtures of sand and silt. Only in close proximity to these banks do the sediments become predominantly sand and gravel. The sands and gravels are derived from the submarine erosion of the banks.

The sediment aprons around category 1 banks are mainly carbonate sediments that are produced on the banks *in situ*. These sediments consist of the coral debris facies, surrounding the living reefs; the algal nodule facies; and the *Amphistegina* sands. The latter sands grade into the surrounding normal shelf sediments which are primarily terrigenous.

Direct observations of dye diffusion experiments and time series STD and transmissometer show the turbulence within the mixed boundary layer (nepheloid layer) to occur on several time scales, ranging from a few seconds to several minute intervals.

This turbulence is due to a complex of forces that includes internal waves, continental shelf waves and tidal currents.

The study of fossil coccoliths in the bottom sediment has revealed a net transport direction for sediments on the South Texas OCS. The use of fossil coccoliths as "tracers" has proved to be a valuable tool.

RECOMMENDATIONS

Although our post-drilling surveys and monitoring efforts at certain banks in categories 1, 2 and 3 have not revealed obvious effects of drilling on epibenthic biota, it is nevertheless recommended that restrictive measures on drill related activities be continued as originally imposed at the East and West Flower Garden (category 1), Stetson (category 2) and Southern and South Baker (category 3) Banks, and that similar restrictive regulations be extended to all other banks listed within each group.

In the case of banks in category 4, it is recommended that drilling not be allowed to occur on or within a reasonable distance from the bank. There should be no requirement for shunting in conjunction with drilling near category 4 banks because it is felt that such would serve to entrap drill effluents within the nepheloid layer which, though desirable in the vicinity of high-relief banks, is probably not advisable near low-relief banks whose crests are almost perpetually within the nepheloid layer.

It is recommended that all monitoring programs required for drilling at any of the banks include direct assessment of biotic communities by diver or underwater television and bottom photography, in addition to a minimal bioassay effort designed to indicate the degree to which the drill effluent affects selected OCS hard-bank epifaunal organisms (the coral Madracis mirabilis is suggested) and primary producers in the water column (phytoplankton). Such potentially useful procedures have been ignored in some past monitoring efforts, even though regulations apparently require biologically oriented real-time monitoring assessments.

Because the clear-water epibenthic communities of the category 1 banks are those about which most environmental concern has been expressed (coral reefs, Algal-Sponge Zone), it is recommended that more be learned of the ecology, condition and dynamics of at least the predominant organisms structuring these active assemblages, namely, the reef building corals and the coralline algae. Thus, continued investigations are called for concerning the effects on reef corals of mechanical damage, naturally occurring coral pathogens and drill effluents. These studies should be expanded to include the effects of drill effluents on the primary species of coralline algae currently active in building the platforms associated with shelf-edge banks in the northwestern Gulf of Mexico. The type of information generated by such studies is distinctly management related. The inadequacy of such information is currently recognized among USGS and BLM personnel closest to the management decision-making process. Certainly we should have a more comprehensive understanding of such factors prior to the advent of production drilling near these banks, not only from the standpoint of revising existing environmental regulations concerning drilling, but also because such information is essential to the proper implementation of long-term monitoring programs at the most sensitive sites.

It is recommended that the exploratory baseline studies of fishing banks in the northwestern Gulf of Mexico be continued until a complete and adequate inventory is achieved, and the characteristics of all of the banks are sufficiently understood to allow the sensible formulation to protective regulations relating to exploratory and production drilling.

Totally unique and scientifically invaluable features such as the brine seep at the East Flower Garden should be comprehensively documented and afforded the ultimate in conservative environmental protection.

It is recommended that meiofauna studies of the areas adjacent to hard banks be continued. The number of stations around and adjacent to at least one bank should be increased and carefully positioned in regard to the best possible bottom current information. Where there is evidence of a prevailing current, these stations should include upcurrent and downcurrent sites, with the downcurrent stations aligned on a transect of increasing distance from the bank. A determination of labile carbon content of the sediment should be made in each grab taken for meiofauna samples.

It is recommended that process oriented studies of the nepheloid layer be expanded to include long term current metre measurements. Only by understanding the processes active in the nepheloid layer can we begin to have a predictive capability concerning the transportation of pollutants on the continental shelf.

The coccolith study should be expanded to include the Texas-Louisiana continental shelf. This can be accomplished at low cost as the samples have already been taken and are available for our use. We need to know the extent of the influence of the Mississippi River in terms of sediment transport.

It appears that the transport of sediment from the mouth of the Mississippi River towards the west and southwest is much greater than originally thought. The relative concentrations of clay minerals in the suspended sediment flowing out of the major passes between Corpus Christi and Sabine Pass are Kaolinite $\geq$ Illite > Montmorillonite. Yet in the bottom sediments just six miles offshore, the concentrations are reversed. Perhaps Montmorillonite from the Mississippi River is transported as far south as Port Aransas. A monthly sampling of the passes seems to be in order and in addition, at least a seasonal sampling of the offshore areas from Port Aransas to Station 1 on Transect II at one mile intervals.

Geological sampling during rig monitoring studies should be conducted to determine the presence or absence of a nepheloid layer and to locate the drill effluent plume during drilling. Analyses for barium in the bottom sediment should be done by NAA. Atomic absorption techniques are not capable of distinguishing between calcium and barium without tedious preparation techniques that cannot be utilized by most analytical laboratories.

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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.