Sediments and Microfauna off the Coasts of Mississippi and Adjacent States

BY

CHARLES F. UPSHAW
WILGUS B. CREATH
FRANK L. BROOKS

BULLETIN 106

MISSISSIPPI GEOLOGICAL, ECONOMIC AND TOPOGRAPHICAL SURVEY

WILLIAM HALSELL MOORE
DIRECTOR AND STATE GEOLOGIST

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LETTER OF TRANSMITTAL

Office of the Mississippi Geological, Economic and

Topographical Survey

Jackson, Mississippi

June 15, 1966

Mr. Henry N. Toler, Chairman, and

Members of the Board

Mississippi Geological, Economic & Topographical Survey

Gentlemen:

Herewith, is Mississippi Geological Survey Bulletin 106, "Sediments and Microfauna off the Coasts of Mississippi and Adjacent States," by Charles F. Upshaw, Wilgus B. Creath, and Frank L. Brooks.

This Bulletin is the work of members of the Research Department of Pan American Petroleum Corporation and also presents results of a study on the same area made as partial fulfillment of requirements for the Master of Science Degree at Mississippi State University. The Mississippi Geological Survey is indebted to Pan American and Mississippi State University for being allowed to publish these works.

As the search for oil and gas becomes more difficult, a greater understanding of the processes of sedimentation is needed. It is hoped that this study of modern sediments and fauna will serve as a key to help unlock the secrets of ancient seas and to add to our knowledge of both academic and economic geology.

Respectfully submitted,

William H. Moore
Director and State Geologist

SEDIMENTS AND MICROFAUNA OFF THE COASTS OF MISSISSIPPI AND ADJACENT STATES

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INTRODUCTION

The study of modern marine sedimentary environments is basic to the understanding of sediments in the geologic column. It is assumed that the sediments deposited in ancient seas were subjected to the same physical, chemical and biological processes as sediments deposited in the modern seas. The continental shelf areas are of major importance in understanding the genesis of ancient sediments because the majority of those sediments originated in relatively shallow water. Continental shelf sediments, made up of both allogenic and authigenic material, reflect the sum of the conditions impressed upon them by the marine environment.

In practice, open marine environmental assemblages are segregated on the basis of depth of water. Other assemblages are commonly specified on the basis of salinity values, i.e., freshwater, brackish, hypersaline, poikilohaline. By simultaneously studying faunal assemblages and physical factors of the enclosing environments, a relationship between organisms and environment can be established. When the significance of this interrelationship becomes known, then the one may be interpreted from a study of the other. Thus, by empirically analyzing organic remains in rocks, it is possible to reconstruct ancient environments in situations where most of the physical factors can no longer be measured.

This report presents a portion of the results of a comprehensive study of modern sediments from the Gulf of Mexico off the coasts of Mississippi and adjacent states by members of the Research Department of Pan American Petroleum Corporation. It also presents results from a study in the same area by Brooks submitted in partial fulfillment of requirements for the Master of Science Degree at Mississippi State University.

OBJECTIVE AND SCOPE

The objective of this study was to describe the lithologic, microfaunal and environmental characteristics of a modern depositional province.

The study area (Figure 1) covers approximately 7800 square miles on the continental shelf of the northern Gulf of Mexico. It extends from the eastern margins of the Mississippi Delta in Louisiana to a line extending southward from the eastern end

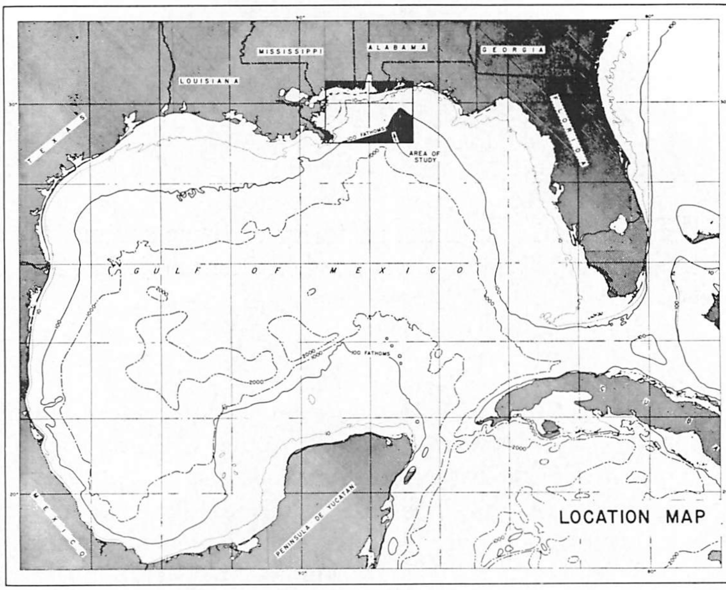


Figure 1

of Pensacola Bay in Florida, and from the mainland coast of Mississippi, Alabama, and Florida to the margin of the continental shelf. A total of 761 core and grab samples (Figure 2) were taken from shoreline areas and in water depths from sea level to 480 feet.

Studies reported here include size and composition of sediments and distribution of foraminifera and ostracoda. Size and compositional analyses by Brooks are based on 55 bottom samples from open marine environments. Clay analyses were made on 90 samples; carbon isotope ratios were determined from 90 samples; acid soluble percentage, grain size distribution, and counts of groups of foraminifera and ostracodes were determined for 451 samples. These latter studies involve samples from rivers, bays, lagoons, marshes, and beaches as well as open marine environments. The resulting data are presented in tables and form the basis for a series of maps and profiles.

PREVIOUS INVESTIGATIONS

In recent years, much attention has been given to the study of modern marine shelf sediments and organisms. Important investigations wholly or partially concerned with the area of this study are those of Goldstein (1942), Brown, *et al.* (1944), Phleger (1954b), Parker (1954), Priddy, *et al.* (1955), Treadwell (1955), Bandy (1956), Ludwick and Walton (1957), Smith (1958), Walton (1960), Foxworth, *et al.* (1962), Ludwick (1964), Walton (1964), and Rainwater (1964).

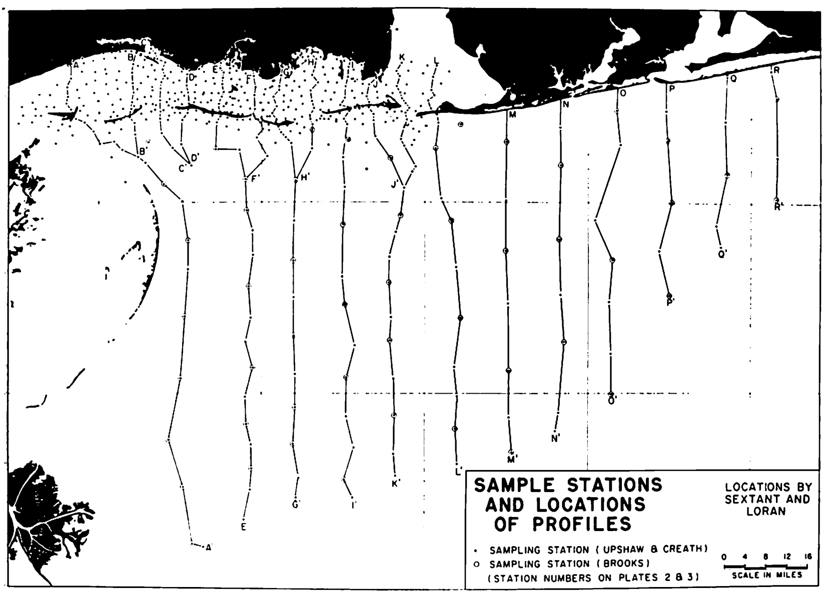


Figure 2

Goldstein (1942) studied the mineralogy of sediments in the area and recognized different major sources for an "Eastern Gulf Province" and a "Mississippi River Province." Foxworth, *et al.* (1962) made a detailed study of heavy mineral assemblages along the coast of Mississippi and adjacent islands. Brown, *et al.* (1944) reported on the geology and ground water resources of the coastal area of Mississippi. Priddy, *et al.* (1955) contributed to an understanding of the physical and chemical nature of bottom sediments in Mississippi Sound. Ludwick (1964) described the sediments of the continental shelf from the Chandeleur Islands, Louisiana, to Cape San Blas, Florida, and discussed the Holocene sedimentary history of the area. Characteristics of Chandeleur Sound and adjacent marshes and barrier islands have been described by Treadwell (1955). Rainwater (1964) described the late Pleistocene and Recent history of Mississippi Sound based on 22 borings along a line from the mainland to Ship Island.

Distribution of the microfauna has been investigated by a number of workers. Phleger (1954b), defined the distribution patterns of foraminifera in Mississippi Sound and interpreted them in terms of known or inferred environmental factors. Parker (1954), in a regional study of foraminifera in the northeastern Gulf of Mexico, analyzed samples from two traverses on the continental shelf in the area of this investigation. Bandy (1956), studied the ecology of foraminifera off the west coast of Florida, and included one sample traverse south of Mobile Bay. The microfauna associated with calcareous prominences on the outer shelf was described by Ludwick and Walton (1957). Diagnostic species variations and variations in gross population characteristics of foraminifera in a traverse across Horn Island, Mississippi, were reported by Walton (1960). Smith (1958) studied a series of sediment cores near Horn Island and interpreted Recent sedimentary history from the sequence of indicated environments. Walton (1964), in a study extending from the Mississippi Delta to Cape San Blas, presented a series of maps showing the distribution of selected taxa and gross population characteristics. Criteria developed from these observations were then applied to paleoecologic analysis of the Oligocene of Texas and it was concluded (Walton, 1964, p. 237) that "paleoecologies can be determined and paleobathymetric maps can be made throughout the Gulf Coast Tertiary using criteria developed from modern faunas."

CHARACTERISTICS OF THE AREA

CLIMATE

The area of study has a humid, warm-temperate to subtropical climate although occasional subfreezing temperatures occur. Seasonal temperature variations normally range from 45 to 89°F. Rainfall at Biloxi, Mississippi ranges from 34.5 to 90.0 inches per year, with an average of 58.9 inches, as reported by the U. S. Weather Bureau. Precipitation is rather evenly distributed with only slight concentration in the summer months. Winds are predominantly northerly and northeasterly during winter months and southerly and southeasterly during the summer.

COASTAL TOPOGRAPHY

The following description of the coastal area is modified from Price (1954, p. 47).

The coastline of Mississippi, Alabama and western Florida is classified as an "alluvial coast: terraced deltaic plain." It has a fairly steep coastal plain, sloping as steeply as eight feet per mile near the coast in some places, with two Pleistocene-and-Recent deltas (Pascagoula and Pearl), a minor amount of embayment of drowned stream valleys (St. Louis, Biloxi and Mobile Bays) and a series of low, parallel elevated shoreline scarps. This coast is similar to that of the southern Atlantic coastal plain with which it has a common geologic history. In both areas, the Appalachian Mountains are reasonably near, but do not border, the coast. Drainage basins extending across the coastal plain are small in relation to those of the deltaic-alluvial coast of Louisiana and Texas. Because of the steep alluvial coast, the shore and coastal marsh is narrow and relatively inconspicuous as compared with Louisiana and peninsular Florida. The long, broad and shallow Mobile Bay is a striking feature of this coast. A series of five major barrier islands extends from the mouth of Mobile Bay westward to the vicinity of the Mississippi River delta margin.

DRAINAGE

The large streams which influence the area of study are the Mississippi, Pearl, Pascagoula and Mobile Rivers (Plate 1). Between the Pearl and Pascagoula are several smaller streams which flow southeast and then turn to parallel the shore and enter Mississippi Sound through estuaries and bays. Most prominent of these are the Jordan and Wolf Rivers flowing into St. Louis Bay, and the Biloxi and Tchoutacabouffa Rivers which flow into Back Bay of Biloxi. Drainage between Pass Christian and Biloxi was altered on the landward side by construction of a seawall and artificial beach. Eastward of Mobile Bay, the Perdido, Escambia and Blackwater Rivers empty into Perdido and Pensacola Bays (Plate 3) and thence into the Gulf. Farther to the east, outside the study area, the Choctawhatchee and Apalachicola Rivers empty into the Gulf, and sediments from these streams may be transported westward by longshore drift into the region of this investigation. Some of the rivers are influenced by tides for a few miles upstream and are fringed with marsh. The mainland shore east of Biloxi Bay is indented with numerous smaller tidal streams or estuaries many of which are locally called bayous. To the west of the study area lie the extensive marshes and tidal drainage systems along the eastern margins of the Mississippi River delta.

WATER AREAS

The three principal water-divisions of the sampled area are Mississippi Sound, Mobile Bay, and a portion of the Gulf of Mexico (Plate 1).

MISSISSIPPI SOUND. — Mississippi Sound is a shallow body of brackish water about 80 miles long and 7 to 15 miles wide extending from longitude 89°45′ west to longitude 88° west. It is bordered by Mobile Bay to the east, the mainland coast to the north, a line of barrier islands to the south, and it merges with Chandeleur Sound and Lake Borgne on the west. To the north, Mississippi Sound merges with St. Louis, Biloxi, Point Aux Chenes, Middle, Grand, Portersville, Foul River, and Heron Bays. Eastward it is joined to Mobile Bay by Grant's Pass and Pass Aux Herons; it communicates with the open Gulf through Petit Bois, Horn Island, Dog Keys, and Ship Island Passes; it connects westward with Lake Borgne through Grand Island Pass and Pass Marianne.

The northern part of the Sound is generally less than 10 feet deep; the average depth of the southern part is about 15 to 20 feet except for locally deeper troughs near the islands and inlets. There are local irregularities in bottom contour in many places including areas of "hard" bottom supporting oyster reefs.

Tidal variation in Mississippi Sound is normally less than two feet. There is a slow longshore current which moves westward at about 0.8 knots. Nevertheless, the current apparently is sufficient to cause a gradual westward drift of sand-size sediments.

Salinities are variable from 0 to 30 parts per thousand as compared to open Gulf salinity of 30 to 40 parts per thousand. The denser and more saline waters of the open Gulf invade the Sound through deep tidal channels, locally elevating salinities.

Heavy mineral studies (Goldstein, 1942; Foxworth *et al.*, 1962) have shown that the sediments of the Sound and barrier islands are being derived from Appalachian and Gulf Coastal Plain sources.

Temperatures of the shallow Sound waters fluctuate greatly. Rapid response to changes in atmospheric temperature results in waters which are warmer in summer and colder in winter than the open Gulf waters. Average surface water temperatures near the barrier islands are known to range from 65°F. in February to 84°F. in August (Fuglister, 1947).

MOBILE BAY. — Mobile Bay is a north-south trending estuary about 27 miles long and 8 to 20 miles wide with extensive delta deposits at its northern end and barrier bars and islands partially closing its southern end. The bay is very shallow; its floor is composed of sands, silts, and clays (Parker, 1960, p. 306) derived from the drainage basin of the Mobile River and its tributaries. Except for the greater influence of river waters in its upper part (Parker, 1960), Mobile Bay conditions are similar to those of Mississippi Sound.

OPEN GULF. — In this area, the Gulf floor is composed largely of sands with local areas of silt and clay mud. The sediment surface is relatively smooth, although slight undulations provide relief of a few feet. The seaward depth gradient varies from 3.0 to 20.0 feet per mile to the edge of the continental shelf. Salinity is 30 to 40 parts per thousand.

BARRIER ISLANDS

Within the study area are two systems of barrier islands, the east-west trending Mississippi Sound islands, and the north-south trending Chandeleur Islands. Cat, Ship, Horn, Petit Bois, and Dauphin Islands form the southern limits of Mississippi Sound. The Chandeleur Islands form the eastern limits of Chandeleur Sound, a shallow body of brackish water about 48 miles long and about 20 miles in width extending from latitude 29°30″ north to latitude 30°05″ north. Both systems exhibit the major divisions that characterize barrier islands, *viz.*, an outer beach with a broad berm, a belt of dunes, and an inner marsh or flat. The Mississippi Sound barrier islands consist mostly of beaches and dunes developed on both sides with narrow swamp and pond areas in the interior. The Chandeleur Islands differ in having elevated shell sand flats beyond the beach and dune areas. Beyond the shell sand flats are mangrove swamps which extend into Chandeleur

Sound. Both systems are separated from the mainland by a shallow body of water, have much greater length than width and have a straight seaward margin in contrast to a crenulate lagoonal shoreline.

The following general description of the Mississippi Sound barrier islands is slightly modified from Phleger (1954b):

The largest of the Mississippi Sound barrier islands is Horn Island, due south of Pascagoula, Mississippi. East of Horn Island are Petit Bois and Dauphin Islands, and to the west lie Ship and Cat Islands. Dunes on the islands rise a few feet to as much as 40 feet above sea level and there are small lakes and areas of marsh on the surfaces. The islands are separated by inlets, locally called "passes."

The sides of the islands descend rather abruptly to the floor of the Sound on the north side, where the depths are more than 20 feet in places, especially on the northern side of Horn and Petit Bois Islands. On the seaward side, the sediment surface slopes abruptly to depths of about 20 feet within less than one-half mile and then slopes gently, with only minor irregularities, to depths in excess of 100 feet.

Dunes on the barrier islands commonly rise to elevations of ten to twenty feet above sea level. Forty-foot dunes are present on Cat Island and Dauphin Island. The total thickness of sand deposits composing the barrier island chain is unknown throughout most of its length. However, in a well drilled on Cat Island (Brown, *et al.*, 1944) 86 feet of sand was penetrated before encountering what was believed to be the Pleistocene Citronelle formation.

The barrier islands represent depositional features formed between bay sediment on one side and marine sediment on the other. The origin of the Mississippi Sound offshore islands has been discussed by Shepard (1960b, p. 214) as follows:

"For some barriers, there appears to be no good land source of sand. For example, the Mississippi islands have no nearby bluffs to supply the sediments, and the chief river source enters the head of the lengthy Mobile Bay. Transportation of sand across the long muddy stretches of the bay seems unlikely, although a little sand may move along the bay shore. Because of the small waves, this is a doubtful source of the large quantities required. The easterly winds and currents are carrying the sand from the present islands to the west. Therefore, unless there is an eastern source, the sand should give out on the eastern side, but the maps of the past 100 years do not show a net loss. In fact, the islands are somewhat more continuous than is indicated on the old charts, which shows there must be an adequate source. The only sand available seems to be from the continental shelf. The presence of a mud zone outside the islands and a mud-filled trench along part of the island front . . . apparently indicates that the shelf source is east of Mobile Bay where, according to the chart, sand appears to be continuous out from the shore over the shoal bottom. Thus, the evidence from the Mississippi islands favors an offshore source, but also indicates the importance of longshore drift."

Shepard (1960b, p. 210) further states:

"The islands . . . have changed considerably in position along their length. All of them have been growing to the westward in the direction of the predominant current and are being eroded on the east side. The growth on the west, however, has exceeded the loss on the east, so that the islands are apparently increasing in size along with the gradual narrowing of the deep passes in between."

Erosion of the eastern shoreline of Cat Island is illustrated in Figure 3. The westward migration of the beach is indicated by a drowned forest.

Figure 3.—Eastern beach of Cat Island. Westward retreat of the shoreline is indicated by the drowned forest. Photograph by F. Lockett, August 1960.

Abrupt changes in barrier island configuration as a result of hurricane waves and tides are illustrated in Figures 4-9. Many maps (e.g., Plate 1) show a breach across Ship Island. Field observations in 1960 and aerial photographs in 1962 (Figure 4) showed that the breach had been filled. The middle portion of the island was uniformly developed, at that time, with low dunes held by sparse vegetation. Figure 5 illustrates that new breaching of the island resulted from Hurricane Betsy of September 9, 1965, eight days before the photograph was taken. The island has been reduced to, and slightly below, sea level in two places. A considerable quantity of sand appears to have been moved northward into Mississippi Sound. Normal wave action and longshore movement of sediment will undoubtedly restore the island again.

The eastern end of Horn Island shows prominent effects of the hurricane's passage. Figure 6, taken one month before, and Figure 7, taken eight days after the storm, show the removal of a large northeastern spit leaving a large shoal area and a smaller spit recurved northward. In addition, numerous stumps in the surf indicate a northward retreat of the south beach. Similar changes on the eastern end of Petit Bois Island are shown in Figures 8 and 9.

The photographs before and after Hurricane Betsy illustrate but one of the mechanisms bringing about constant changes in the area of study. Topographic and bathymetric contours, shoreline configurations, distributional patterns of bottom sediments and the content of organic communities are continuously altered in response to physical, chemical and organic forces at work in the area. Our sampling, and the resulting data presented in this report, essentially represents a point in time. It cannot fully reveal the history of the area nor predict the future. Instead, it provides a fixed model against which ancient sediment sequences may be compared.

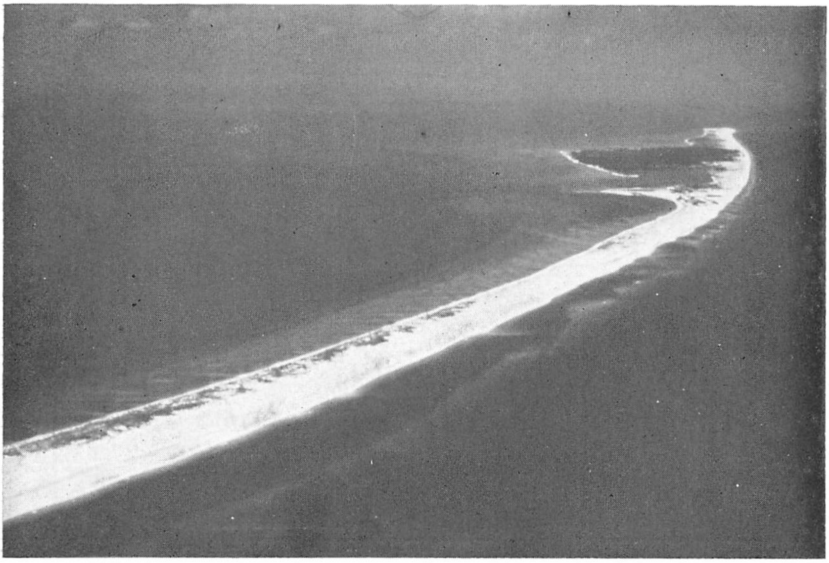


Figure 4.—East end of Ship Island, September 1962, looking northeast, to illustrate conditions before Hurricane Betsy of September 9, 1965. Photograph by D. Feray.

Figure 5.—East end of Ship Island, September 17, 1965, looking northeast, showing changes resulting from Hurricane Betsy of September 9, 1965. Note wash-over areas both east and west of buildings. Photograph by Byron Houston.

Figure 6.—East end of Horn Island, August 11, 1965, looking northeast, to illustrate conditions before Hurricane Betsy of September 9, 1965. Photograph by Eric Michaelis.

Figure 7.—East end of Horn Island, September 17, 1965, looking northeast, showing changes resulting from Hurricane Betsy of September 9, 1965. Note removal of spit and retreat of south beach indicated by tree stumps offshore. Photograph by Byron Houston.

Figure 8.—East end of Petit Bois Island, September 1962, looking northeast to illustrate conditions before Hurricane Betsy of September 9, 1965. Photograph by D. Feray.

Figure 9.—East end of Petit Bois Island, September 17, 1965, looking northeast, showing changes resulting from Hurricane Betsy of September 9, 1965. Note removal of spit and development of storm berm outlined by debris. Photograph by Byron Houston.

CULTURAL EFFECTS ON ENVIRONMENTS

A feature along the mainland which would affect faunal and sedimentological studies is the 27 miles of artificial beach between Henderson Point at Pass Christian on the west and Biloxi Lighthouse at Biloxi on the east in Harrison County, Mississippi (Figures 10-13). In 1951, 5,700,000 cubic yards of sand were used to construct a beach 300 feet in width with a berm elevation of 5 feet above mean sea level. The sand was obtained from a borrow channel located 1500 feet offshore, essentially parallel to the shore, which was dredged to a depth of 14 feet. Therefore, samples taken on or close to the beaches of the mainland in this area have no validity for this study. The westernmost samples from the mainland beaches which would be useful would be those located immediately east of Biloxi Bay.

Pollution apparently is not a major problem affecting sediments and microfauna in the study area. The Public Health Service (1954, p. 558) considers it "unlikely that pollutional wastes originating in the coastal area have appreciable effects upon either water or resources in the open waters of the Gulf" because of tremendous quantities of available dilution water. However, they indicate that pollution may have localized effects on coastal waters or on the lower reaches of tributary streams. The total extent of such pollution is not known.

Channel dredging should be mentioned as a factor in the dislocation of bottom sediments. Major channels are those from Ship Island Pass to Gulfport, Horn Island Pass to Pascagoula and Bayou Casotte, and Mobile Pass to the port of Mobile. Along portions of the Intracoastal Waterway, dredging is required. Two such areas are Pass Aux Herons between Dauphin and Mon Louis Islands and the shoal areas between Horn and Round Islands.

Figure 10.—Henderson Point groin before beach development. Note seawall east of groin. Photograph by Corps of Engineers, October 1950.

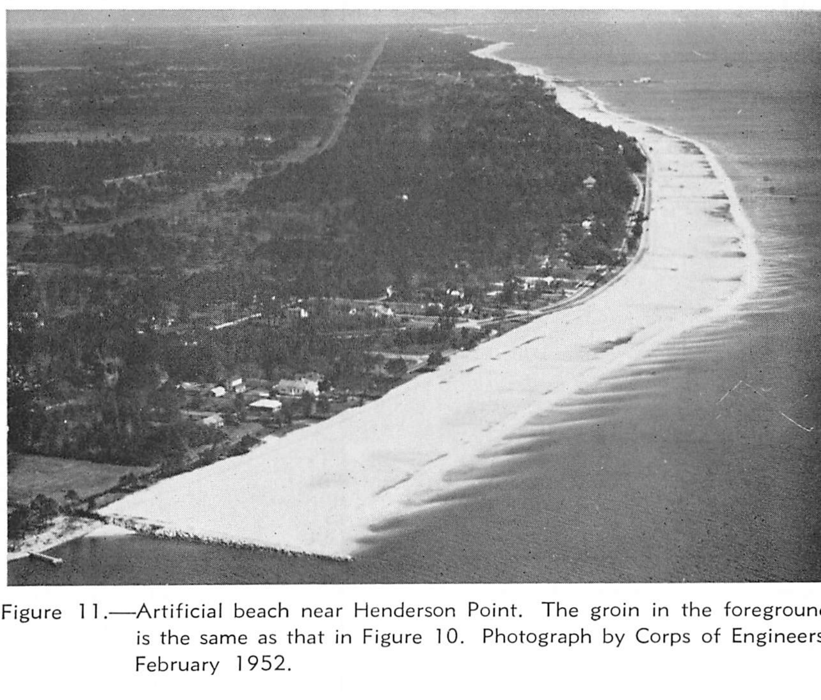


Figure 11.—Artificial beach near Henderson Point. The groin in the foreground is the same as that in Figure 10. Photograph by Corps of Engineers, February 1952.

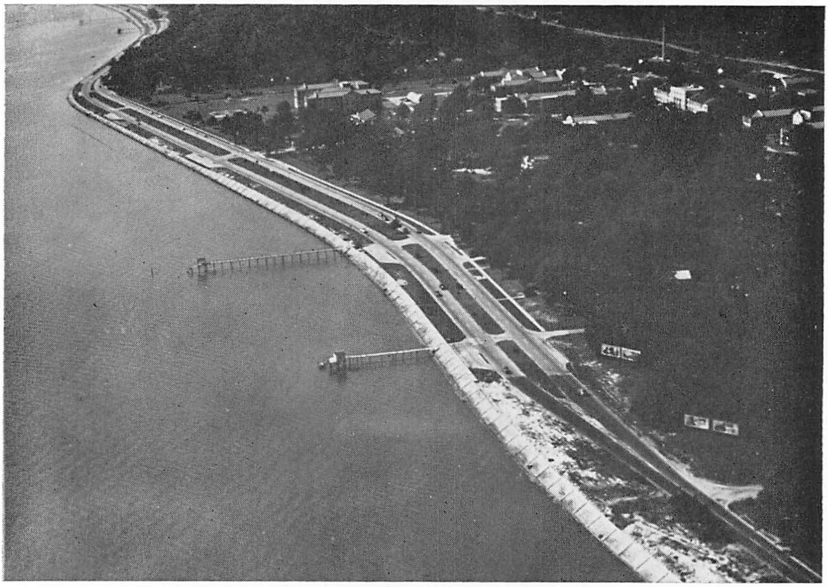


Figure 12.—Seawall near Gulfport before development of artificial beach, looking northwest. Photograph by Corps of Engineers, October 1950.

Figure 13.—Artificial beach near Gulfport, looking northwest. The area shown is approximately the same as that of Figure 12. Photograph by Corps of Engineers, February 1952.

COMPARISON WITH OTHER AREAS

In many respects, the Mississippi-Alabama coast represents an "intermediate" or "average" coastline of the Gulf of Mexico.

According to Price (1954) in a study of dynamic environments of the continental shelf, the Mississippi coast is intermediate in type between the coasts of western Florida and southwestern Texas. Wave energy (per cent of deep-water wave energy expended on the shore face) is highest in Texas (0.9 to 1.0), lowest in Florida (0.4), and intermediate along the central Gulf coast (0.7). In the immediate vicinity, the continental shelf surface is very irregular off the mouth of the Mississippi River, smooth off the Chandeleur Islands and off northwestern Florida, and intermediate in being only partly smooth off the barrier islands of the Mississippi coast. The Mississippi coastal shelf has a gradient of 2.7 feet per mile compared to 1.3 to 2.5 off western Florida, 0.9 to 1.2 off western Louisiana, and 3.4 to 4.0 off the southwestern coast of Texas.

Salinity values in Mississippi Sound are lower than those of the open Gulf and remain relatively consistent, since rainfall in the area is not markedly seasonal. In contrast, the salinity of San Antonio Bay, on the central Texas coast, varies from well below to well above normal marine levels. Even more striking is the Laguna Madre area of the southwest Texas coast where Fisk (1959) reports that salinities are consistently higher than those of the open Gulf.

The rate of deposition in Mississippi Sound is not known although various estimates have been made. Ludwick (1964, p. 220), on the basis of sediment thickness above a weathered zone dated by C^{14} to be 5000 $\pm$ 300 years B.P., estimated the minimum rate of sedimentation above this weathered zone to be 0.8 feet per 1000 years. Phleger (1960b, p. 286) suggested a high rate of sedimentation in Mobile Bay and Mississippi Sound based on ratios between living foraminifera and total foraminiferal populations. He stated that the rate is significantly higher than that in the area near Rockport, Texas, but perhaps less than that of the southeast Mississippi Delta area. The depositional rate for San Antonio Bay at Rockport, Texas, has been estimated by Moore (1955, p. 1600) to be 2.5 feet per 1000 years for the period from 2000 to 5000 years ago; Shepard (1953, p. 1919) estimated a depositional rate of 12.6 feet per 1000 years for Texas bays in general. Thus, Phleger presumed a much greater rate of sedimentation for Mississippi Sound than did Ludwick. Rainwater (1964), in a study of twenty-two borings between the mainland and Ship Island concluded that the rate of post-Pleistocene deposition has been approximately 4.0 feet per 1000 years based upon the thickness of post-Pleistocene sediment in the Sound.

Ludwick supported his estimate of a low rate of sedimentation by comparing 1860, 1920, and 1947 USC and GS charts of Mississippi Sound which show almost superimposable depth contours (Ludwick, 1964, p. 220). However, a depositional rate of approximately 8 feet per 1000 years would be required to affect the depth contour pattern significantly over the 87 year period between 1860-1947. Thus, rates of 4 feet per 1000 years (Rainwater, 1964) or more than 2.5 feet per 1000 years (Phleger, 1960b) are compatible with the evidence from USC and GS charts. Therefore, the question about the rate of deposition in Mississippi Sound is not resolved.

PROCEDURES

SAMPLING AND SAMPLE HANDLING

FIELD PROGRAM

A total of 761 samples were collected during two periods in 1960. At each sampling station, measurements were made of depth, bottom-water temperature and density.

In February and March, 1960, during operations conducted from the Gulf Coast Research Laboratory at Ocean Springs, Mississippi, a total of 628 sediment samples were collected. Of these, 220 were short cores and 408 were grab samples. Sampling was concentrated in Mississippi Sound, Mobile Bay, and adjacent islands, beaches, rivers and marshes and extended for a short distance into the open Gulf.

In June 1960 sampling was conducted in the open Gulf from the trawler *Kabevi*. A total of 133 grab samples was obtained.

EQUIPMENT AND APPARATUS

During February and March, sampling was conducted where water depths permitted, from the Gulf Coast Research Laboratory boat *Hermes*, a 40-foot trawler (Figure 14). Small boats equipped with outboard motors were used in shallow water areas. Location of stations was by line-of-sight sextant readings in the near shore areas. A continuous recording fathometer and U. S. Coast and Geodetic Survey navigation charts were used for determining water depths. Salinity was determined by collecting bottom water at the sampling site for a density-temperature measurement from which the salinity could later be calculated. The

Figure 14.—Gulf Coast Research Laboratory trawler **Hermes.** Photograph by W. B. Creath, March 1960.

water sampling device used was designed by members of the Research Department of Pan American Petroleum Corporation. This instrument consisted of a copper-encased glass bottle seated in a copper cylindrical sleeve in such a manner as to allow the bottle vertical movement within the sleeve. The neck of the bottle was attached to a hoisting mechanism consisting of a 1 mm. steel wire rolled on a manually-operated reel. A bar across the top of the cylindrical sleeve held an attached cork which sealed the mouth of the bottle as long as enough tension was applied to the hoisting wire to keep the bottle in the upper part of the cylinder. When the apparatus reached the bottom, the wire relaxed, the bottle moved downward through the cylinder away from the cork and the bottom water flowed in. After allowing a short length of time for the bottle to fill, tension was again applied to the wire, causing the bottle to move up through the cylinder to the cork.

The apparatus was lifted to the boat deck and the trapped water was transferred into a graduated glass cylinder, its density determined by the hydrometer method and its temperature taken immediately to gain data for salinity calculations.

The temperature of the bottom water was obtained by use of a thermistor, an instrument that utilizes a heat-sensitive alloy. A galvanometer and power supply sends a small, constant current through the circuit and the galvanometer reading varies with the resistance, which varies with the temperature. The thermistor element was attached to the water bottle apparatus and the temperature of the bottom water was taken at the time the water sample was collected.

Core samples were taken with a shallow-water coring device (Figure 15) designed by members of the Research Department of Pan American Petroleum Corporation. It consists of a stainless steel core barrel with removable cutting head which contains a plastic core-liner 3 inches in diameter and 3 feet in length. The device is fitted with a wooden handle, 30 feet in length in 5 foot detachable segments, by which it is forced into the substrate. A valve allows outflow of water and aids in retention of the core. A cable attached to the side of the core barrel and to a motor-driven winch facilitates retrieval.

The grab sampling apparatus utilized was of the Petersen type described by Hough (1939) and Hedgpeth (1957). This sampling apparatus (Figure 16) was modified by the Research Department of Pan American Petroleum Corporation and differed slightly from the original Petersen sampler. The grab consisted of two flat-sided, tooth-edged scoops, hinged together and fitted with a device that held them apart until contact was made with the substratum. A catch released when the hoisting cable became slack and the scoops closed as a pull was applied to the cable, which was wound on a motor-operated winch. Lead weights were attached to the upper distal portions of the scoops to ensure a strong scraping action on the bottom. The weight of the grab was approximately 50 pounds and an area of about 0.9 square feet was sampled.

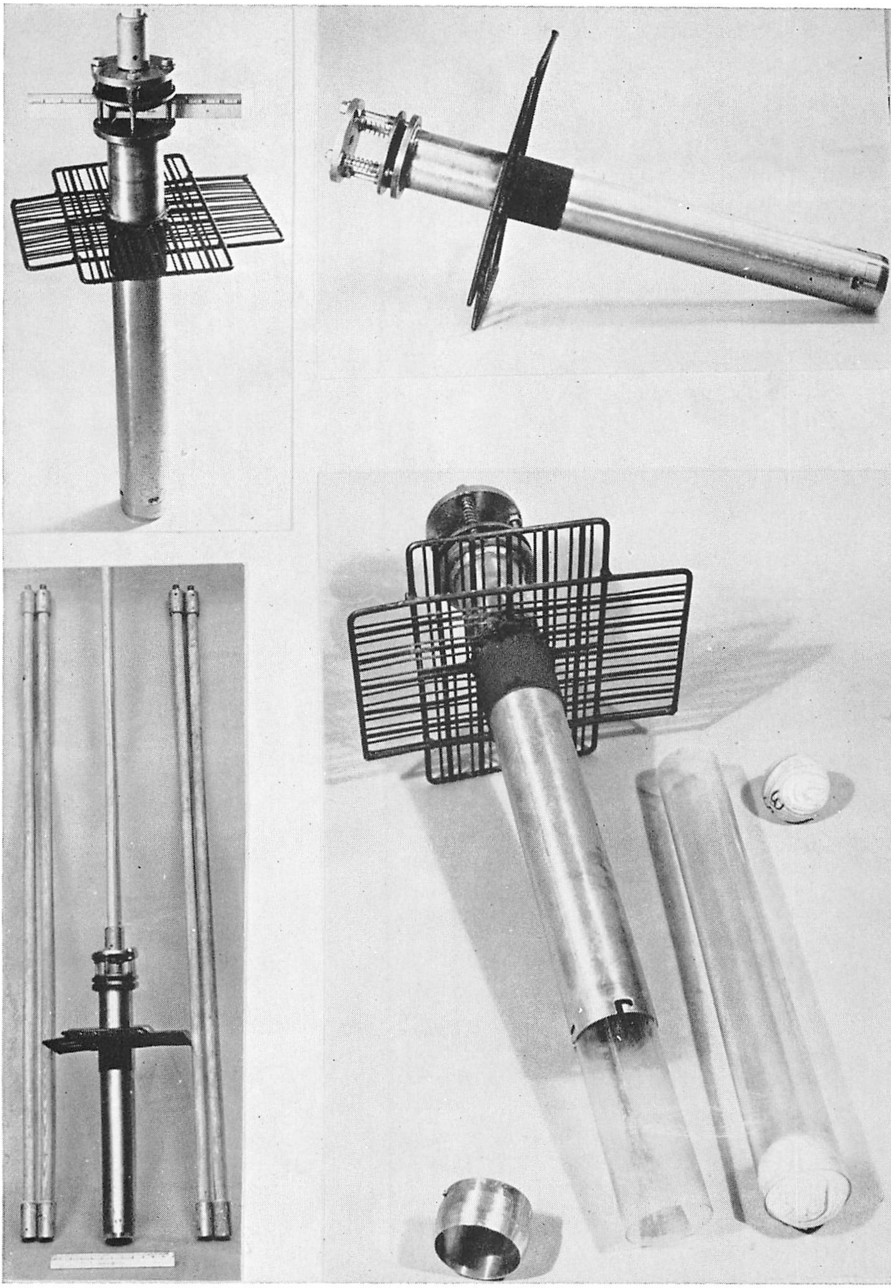


Figure 15.—Coring device. Photographs by J. R. Derby, December 23, 1965.

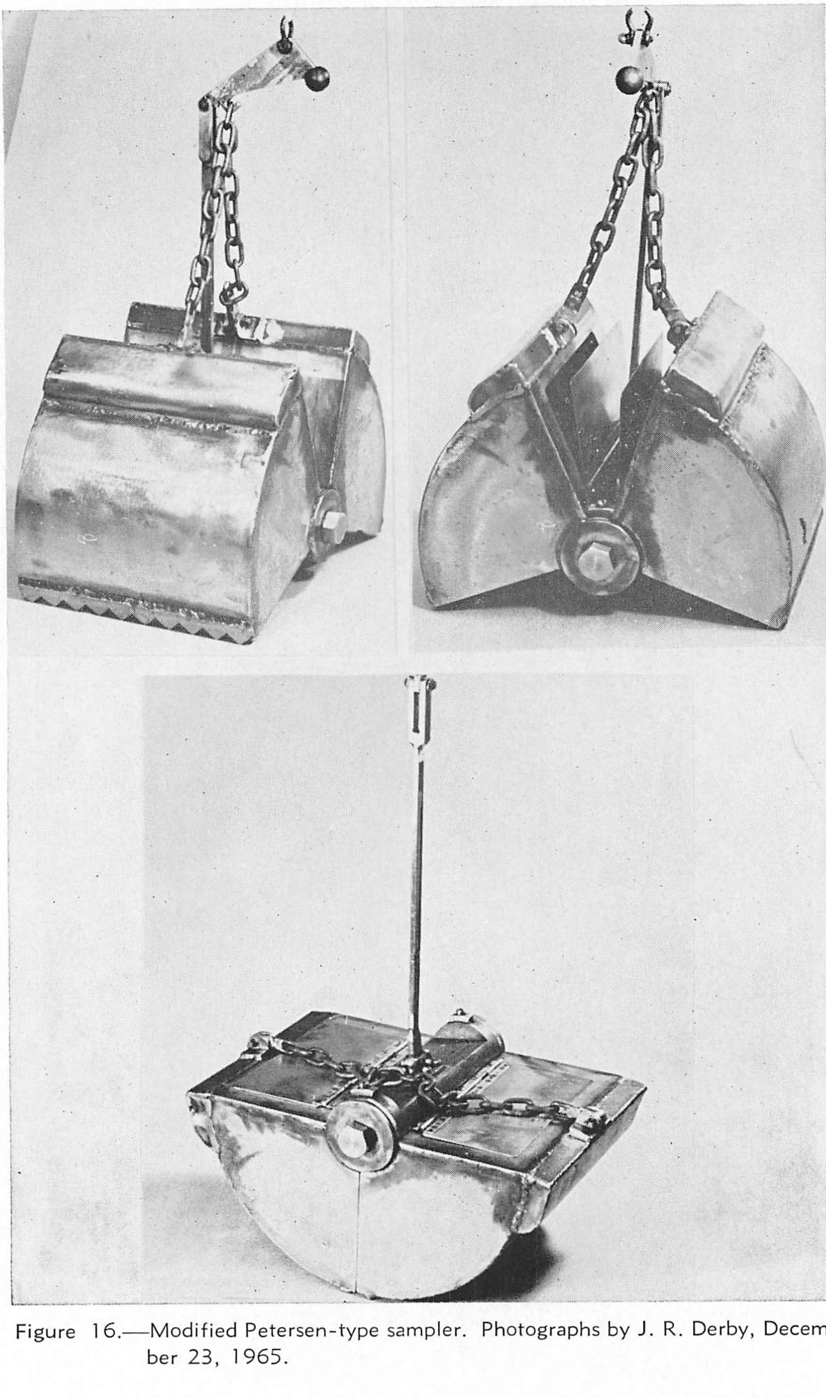


Figure 16.—Modified Petersen-type sampler. Photographs by J. R. Derby, December 23, 1965.

After closing, the grab was raised to the boat deck and the trapped sediment was released into a container.

Sampling in the deeper waters of the open Gulf was conducted from the *Kabevi,* a 62 foot long, 21 foot wide diesel-powered shrimp trawler owned by Mr. Marcus Shanteau of Ocean Springs, Mississippi. Twelve north-south traverses were made. Initial positioning was by dead reckoning; the exact position of the sampled station was determined by sextant in some near-shore areas and by use of LORAN elsewhere.

Procedures for measuring salinity and bottom water temperatures were the same as those used in the shallow water sampling program. Sediment samples from the deeper water, however, required use of a larger Petersen type grab sampler. The device weighed approximately 100 pounds and sampled an area of about 2.8 square feet. In design and construction, it was similar to the sampling device used in shallower waters.

PRESERVATION OF SAMPLES

During February and March, each sample was treated at the time of collection with ethylene oxide to prevent bacterial decay. Later applications of mercuric chloride and alcohol were made for the same purpose. The poisons were not equally effective against all the marine organisms involved and decay was not completely avoided in most samples, particularly in cores. The open Gulf samples taken during June were split into two fractions. One of the samples taken from the container was placed in a half-gallon glass jar to be shipped to the Research Center of the Pan American Petroleum Corporation. The other sample collected was placed in a plastic bag for shipment to Mississippi State University. To each, approximately 100 cc. of methanol was added to kill bacteria and arrest organic decomposition.

LABORATORY PROCEDURES

SEDIMENTOLOGY

Brooks' study. Samples were dried in an electric oven until all appreciable moisture was removed. Fifty-five samples (Figure 2) were selected for study and were chosen in such a way as to provide an evenly distributed coverage of the open Gulf portion of the region. A 100-gram portion of each sample was weighed and split by the spatial method (Krumbein and Pettijohn, 1938) to obtain amounts needed for each investigation. One-half of the material was stored for reference. Of the remaining material, 25 grams were used in the physical and chemical studies and the remainder was used for investigation of environmental constituents.

A 25-gram portion of each sample was treated with dilute hydrochloric acid (10:1) and the per cent of carbonate as reflected by weight loss was calculated. The residue was boiled and washed in a 10 per cent "Calgon" solution (sodium hexametaphosphate) to deflocculate the extremely small fraction. This deflocculated material in suspension was siphoned off, the residue dried and weighed, and the amount of small fraction removed was calculated and listed under the heading of Silt-Clay. The residue was then placed in a column of sieves (Tyler Standard Sieve Series) with screen openings ranging from .062 mm. to 3.962 mm. and agitated on a Cenco-Meinzer Sieve Shaker for five minutes. The portion of the residue retained on each screen was weighed and recorded. The weight of sediment caught by the pan (less than .062 mm. in diameter) was added to the amount of small fraction siphoned off previously to determine total silt-clay content. The total weight of sand in the insoluble residue was obtained by adding the amounts of material retained by the screens.

Analysis of the sediment for determination of the environmental constituents was accomplished by examination of the particles with a binocular microscope. This type of analysis is similar to the "coarse fraction" method described by Shepard and Moore (1954). The sediment portion used in the present study was deflocculated by the previously described method. The fine sediment was siphoned off and only those particles with median diameters greater than approximately .062 mm. were retained for examination. The selection of particles to be identified depended on the abundance of foraminifera present in the sample. In those samples with abundant foraminifera, linear traverses were made and 200 specimens were identified and recorded along with every accompanying particle on the traverse between the first and last counted specimen. It was found that approximately 2000 quartz grains were counted during this procedure; therefore, in samples of low foraminiferal content, 2000 quartz grains and all accompanying particles on the traverse between the first and last grains were counted. Particle groups counted are quartz, heavy minerals, glauconite, mica, broken shell, Mollusca, Foraminifera, Ostracoda, Coral and Algae, and other miscellaneous particles (Table 2).

Pan American studies. The sediment distribution maps (Plates 2 and 3) and the acid soluble per cent map (Figure 25) are based on sedimentological analyses of 451 samples (Table 3) as follows:

1. Two representative aliquots were taken from each core or grab sample. Only the upper three inches of the cores were analyzed.

2. One aliquot was dried, weighed, placed in 15% HCl until reaction ceased, washed, dried, and weighed again. Weight loss was converted to percentage and forms the basis for Figure 25.

3. The second aliquot was dried, weighed and washed through 250μ and 62μ sieves. The fractions were dried and weighed, and the >250μ, 62-250μ, and <62μ values were converted to percentages which form the basis for Plates 2 and 3. The entropy-ratio mapping method employed has been described by Forgotson (1960).

CLAY ANALYSES

Clay analyses of 90 samples (Table 4, Fig. 27) were made by A. J. Nash. Mineral identification procedures involved analysis of samples heated to 600°C. in 100°C. increments. Kaolinite, illite, and montmorillonite were found to constitute the bulk of the clay mineral assemblage. Chlorite was minor to absent in most samples.

The clay mineral distribution map (Figure 27) is based on *ratios* among major clay minerals in the <2μ fraction determined by the following procedure:

1. Wash sample free of NaCl.
2. Treat sample with H_2O_2 to remove organic material.
3. Flocculate with 0.5N HCl to remove carbonates.
4. Wash with distilled water.
5. Disperse in water with ultrasonic generator and separate <2μ fraction by water elutriation.

6. Spread $<2\mu$ sample on glass slides and dry at 90°C.
7. X-ray diffraction of dry sample.
8. Glycolate.
9. X-ray diffraction of glycolated sample.
10. Determine peak heights (in chart divisions) from an arbitrary approximate background line to the highest point of each of the three peaks: 17.5 A° (montmorillonite), 10 A° (illite), and 7.2 A° (kaolinite).
11. Calculate ratios of montmorillonite/kaolinite and montmorillonite + kaolinite/illite.

CARBON ISOTOPE ANALYSES

Isotopic composition of organic carbon in 90 samples was determined by W. M. Sackett. Procedures used have been described (Sackett and Thompson, 1963, p. 525-526) as follows:

"The combustion, purification and isotopic analysis procedures were approximately the same as used by Craig (1953) and others. The samples, acidified to eliminate any CO_2 contribution from carbonates and dried at 60-80° C. for about 48 hours, were combusted over copper oxide in an oxygen atmosphere at 800-900°C. The CO_2 produced contained oxides of nitrogen and sulfur. These were removed by passing the gases through a tube heated to 500°C., containing copper metal which reduced the nitrogen oxides to nitrogen gas, and manganese dioxide which combined with SO_2. Further purification of the CO_2 was achieved by passing the gas through traps cooled to dry ice temperature to remove water and pumping off gases, noncondensable at liquid nitrogen temperature.

The CO_2 samples were analyzed in a Nier-McKinney type mass spectrometer.

The results, corrected for mixing of sample and standard gas, O^{17} contribution to mass 45 peak, for the tail of mass 44 under the mass 45 peak and background, are expressed as per mil deviations (δ) from the C^{13}/C^{12} ratio of a standard material as follows:

$$\delta \text{ (in ‰)} = \frac{(C^{13}/C^{12} \text{ sample} - C^{13}/C^{12} \text{ standard})}{(C^{13}/C^{12} \text{ standard})} \times 1000$$

The standard was National Bureau of Standards Tentative Isotope Reference Sample No. 22. However, the results [presented in Table 6 and Figure 33] are relative to the Chicago PDB standard using -29.4 as the conversion factor.

The standard deviation for a series of 10 standard material preparations was 0.05 ‰ and for a series of 8 preparations of one sample with an average δ=5.25 relative to the working standard was 0.17 ‰."

MICROFAUNAL ANALYSES

Cores were plug-sampled taking a ½ inch diameter core from the upper three inches of the sediment. From the grab samples, a representative 30 cc. aliquot was taken. They were prepared for study by rinsing through a 200-mesh sieve in a Curtin Paleontological Sample Washer. Residues were examined under the binocular microscope and counts were made of planktonic, arenaceous, and calcareous benthonic foraminifera, and ostracodes. Up to 828 specimens were counted in each sample. In sand samples, the organisms were concentrated with a modified "Syntron" apparatus (Anderson and Hoffman, 1963).

PHYSICAL OCEANOGRAPHY

DEPTH

The bathymetry in the open Gulf sample area is shown in Figure 17. The greatest water depth from which sample control is available from the area of investigation is 480 feet. The open shelf bottom topography is relatively smooth with a uniform slope of 3.2 feet per mile south from Dauphin Island and 8.5 feet per mile south from Pensacola Bay to a depth of approximately 180 feet. At this depth, the slope increases to about 31 feet per mile to a depth of 600 feet in both areas. The continental slope is about 210 feet per mile in the west and 56 feet per mile in the east. Minor irregularities are largely confined to the central portion of the area at depths of about 120 feet. The width of the shelf is about 70 miles in the western portion and about 35 miles in the eastern. Gradients of traverses A-A′ through R-R′ are graphically shown in a series of profiles in Figures 39 to 42.

Depths in Mississippi Sound and Mobile Bay are generally less than 10 feet in the northern half. In the southern portion, depths average 15 to 20 feet. Surge channels in the inlets between barrier islands are 25 to more than 50 feet deep. Locally, these channels lead into deep troughs lying behind and immediately adjacent to the barrier islands.

Topography of the Sound is largely related to sediment type and distribution. Shoal areas commonly are sand bars and oyster reefs. Deeper waters generally lie above a mud bottom.

SALINITY

The salinity map (Figure 18) is based upon the determination of total dissolved solids calculated from measurements of density and temperature. Equivalent salinities were then read from the graph given by Harvey (1955, p. 128). Thus, the values represent an approximation of total dissolved solids and are not based on chemical analyses.

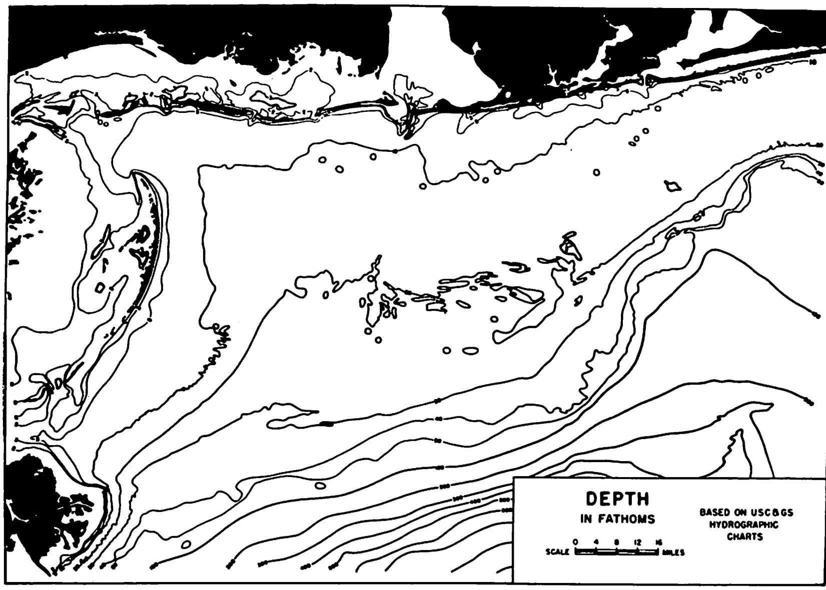


Figure 17

The resulting salinity map (Figure 18) presents a rather irregular picture because observations were made only once at each station during the entire field season. Condition of tides, amount of fresh water influx and turbidity were variable during the period of sampling. Nevertheless, the map generally indicates the relative stability and high salinity level of the open Gulf and the variability and relatively low salinity of Mississippi Sound. Salinity values of between 20 to 30 parts per thousand were obtained at most sampling stations in Mississippi Sound. Lower values occur in the proximity of major river mouths. This is indicated on the western edge of the Sound, which is influenced by the Pearl River, and an area of lower values in the central Sound, related to Biloxi Bay and the Pascagoula River system; the area of low values between Dauphin Island and the mainland coast apparently reflects the westward flow of river waters from Mobile Bay. Although the contour pattern is highly irregular and subject to error, there is a slight indication of lower salinity values near the shoreline extending from the vicinity of Pensacola Bay westward along the barrier island chain. Farther seaward, salinity values are rather consistently higher than 35 parts per thousand.

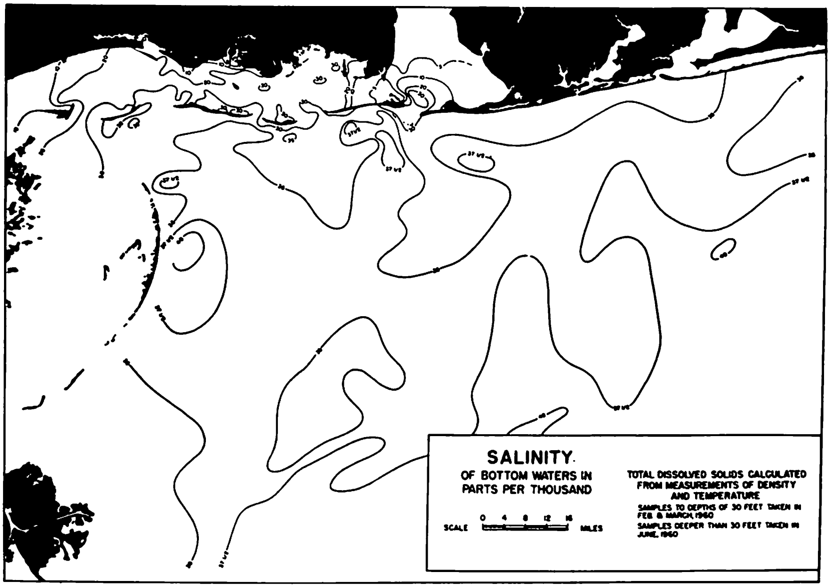


Figure 18

Treadwell (1955) shows values ranging from approximately 20 to more than 28 parts per thousand in Chandeleur Sound.

TEMPERATURE

The water temperature map (Figure 19) shows a progressive decline of bottom water temperatures from the shallow waters offshore of the barrier islands into deeper waters. The temperatures recorded within Mississippi Sound and adjacent near-shore areas are not included on this map. The high variability of those water temperatures reflects response to fluctuations in the ambient air temperatures. Data from Springer and Bullis (1956) indicate a seasonal fluctuation of temperature from about 16 to 28°C. for waters less than 10 fathoms in depth in the northern Gulf of Mexico. Significant diurnal temperature variations also affect these shallower waters.

In the area of study, there is a general correlation between depth and temperature, especially in the deeper areas near the shelf edge where temperatures are as low as 14° and 15°C. An extensive low-temperature lobe (17-19°C.) occupies much of the central part of the shelf south of Mobile Bay. This may reflect

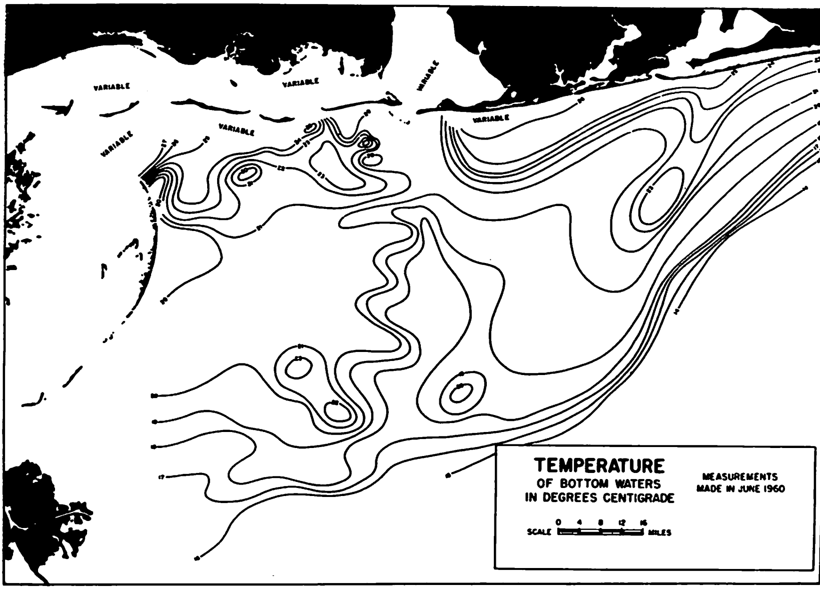


Figure 19

movement of warmer waters east and west of the area of lower temperatures. The eastward high may be an extension of warmer waters from Perdido and Pensacola Bays. The westward high may be caused by waters flowing into this area from Mississippi Sound and Mobile Bay, and possibly part of the Mississippi River drainage system. However, firm conclusions cannot be drawn because of the nature of the sampling program. Diurnal temperature changes undoubtedly occurred between sampling traverses. These would be most pronounced in shallower waters but probably would explain much of the irregularity of contour pattern in the deeper water areas as well.

CURRENTS, TIDES, WAVES, AND WINDS

The major water movement in this portion of the Gulf of Mexico (Figure 20) consists of slow westward drift across the central continental shelf turning southward opposite Mobile Bay, and slow (4 miles per day) eastward drift seaward of the continental shelf margin (Leipper, 1954).

The strongest local currents appear to be those moving through the inlets between barrier islands. Although water

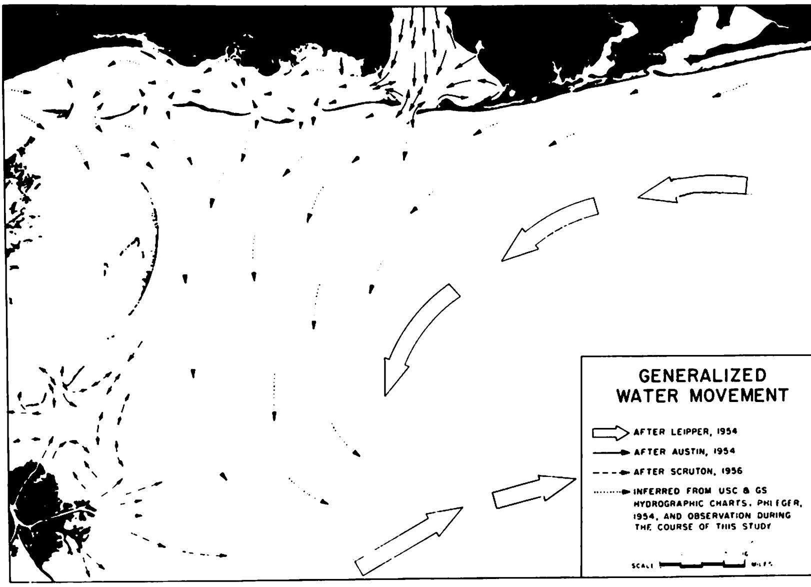


Figure 20

movement is both north and south through the inlets, the latter appears to be dominant. Worthy of special mention is the fact recorded by Phleger (1954b) and confirmed by this work that saline waters of the Gulf move through the inlets and behind the barriers along the bottom. This is indicated by the salinity map (Figure 18) and by the distribution patterns of the benthonic foraminifera, Plate 5. Behind the barriers, waters move slowly westward from Mobile Bay to the vicinity of Cat Island, where they meet east-flowing waters from Pearl River. The union of the two currents results in a southward movement of brackish waters into the Gulf. Seaward of the barriers, the longshore drift is westward as indicated by sediment patterns and westward migration of the islands.

The following information on prevailing winds, waves and tides has been condensed from Phleger (1960b) and Curry (1960).

Resultant winds have been computed for the northern Gulf of Mexico by the United States Weather Bureau. In January, the winds are northeasterly along the eastern and central Gulf shore and in the Gulf itself. During March, the winds shift and by May they are generally east-southeast. Southerly winds prevail throughout the summer months with an easterly shift occurring in September. Northerly winds prevail during the remainder of the year.

Wave action intensity in the Gulf of Mexico, compared to the oceans, is low with wave periods ranging from 3 to 8 seconds and heights rarely over three feet. Such waves affect the bottom only in the near-shore zones; however, the longshore transport of sediments by these waves is of major importance. The intense wave action associated with hurricanes is an important factor in the reworking of sediments on the shelf, but little horizontal displacement takes place in offshore areas. On the other hand, in barrier bar zones, hurricane waves may move considerable quantities of sand into lagoonal areas (Figures 4-9). Near the edge of the shelf, sediments are stirred about once every five years; the rest of the shelf is affected about once every two years. This stirring action results in a mixing of top sediments and fauna with layers underneath.

Tidal fluctuations in the area of study are diurnal with amplitudes generally less than one foot. Extreme hurricane tides of over ten feet have been reported along the shoreline. Sedimentation may be controlled to some degree in the area by tidal currents which attain large velocities in crossing the shelf and probably reach a maximum velocity near the shelf edge.

SEDIMENTS

SIZE DISTRIBUTION

GROSS SEDIMENT PATTERNS

The gross sediment maps (Plates 2 and 3) are based on mechanical sieving of the total raw samples into three sizes: greater than 250μ, $250\text{-}62\mu$ and less than 62μ.

Entropy-ratio maps were chosen to illustrate the distribution of the various grain sizes. An entropy-ratio map is generally similar to the more commonly used combined ratio map but emphasizes areas where one group is strongly dominant over the other two; it is designed to show the degree of mixing or the degree of purity of the three end members. The basis for entropy mapping has been described by Forgotson (1960), and others.

In Mississippi Sound (Plate 2), silt and clay muds (less than 62μ) are the dominant sediments in much of the central portion. The muds grade into fine and very fine sands (62 to 250μ) in several areas. One such area extends southward from Deer Island at the mouth of Biloxi Bay through Dog Keys Pass between Ship and Horn Islands. Another, in which the sands attain medium grain size (more than 250μ), is the large area around and south of Round Island just south of Pascagoula. A third extends southwestward from Bayou La Batre along the Grand Batture Islands and southward between the Isle aux Herbes and Mon Louis Island. Most of the sands in the open Sound are fine to very fine with the exception of those between Round and Horn Islands which are medium to coarse.

Medium and coarse sands lie along the mainland beaches west of the Pascagoula River and along the chain of barrier islands. Fine sands, silts and clays border the mainland east of Pascagoula and dominate the sediments of Mobile Bay. The areas of maximum mixing immediately south of Deer Island, west of Round Island, and south of the Grand Batture Islands and against the north shore of Dauphin Island, are principally mixtures of mud and fine to very fine sand. On the other hand, the area of maximum mixing north of Horn and Petit Bois Islands is primarily a mixture of sands in the various size ranges.

A prominent feature is the elongate, mud-floored trench north of the eastern end of Horn Island. A similar feature occurs north of the western end of Ship Island.

Generally, fine sands lie seaward of the barrier island chain. A notable exception is the elongate mud area immediately seaward of Dauphin Island.

Except for local interruptions, prominent size gradients are exhibited in open Gulf sediments (Plate 3). Coarse and medium sands on the open shelf east of Mobile Bay give way westward to fine and very fine sands and these in turn give way to silt and clay muds. The same trend is apparent, though more abrupt, from north to south across the continental shelf margin. A substratum with a high percentage of sand borders the Chandeleur Islands' southeastern coastline. Another forms an extensive lobe south of Mobile Bay. Fine sediments occupy the interior part of the shelf in a "mixing belt" (St. Bernard prodelta deposits of Ludwick, 1964) extending from near the barrier islands to the Mississippi delta distributaries; samples at the south end of this belt have sand content as low as one per cent.

The high sand concentration bordering the Chandeleur Islands is thought to represent reworking of the old Mississippi delta by waves (Russell, 1936; Treadwell, 1955; Scruton, 1960; Ludwick, 1964). A northeast-southwest trending concentration of sand which is lobate in outline, is part of the eastern shelf substrata referred to by Curry (1960) as a product of Holocene sea transgressions. In places, this sand lobe consists of 93 to 96 per cent sand. Sands of the eastern shoreline and barrier island trend are thought to have been concentrated by longshore drift of particles derived from the sandy area on the shelf which lies in the southern and eastern portions of the region (Shepard, 1960b). The north-south trending mud area (mixing belt) east of the Chandeleur Islands may represent foreset and bottomset beds of the abandoned St. Bernard subdelta of the Mississippi River delta complex.

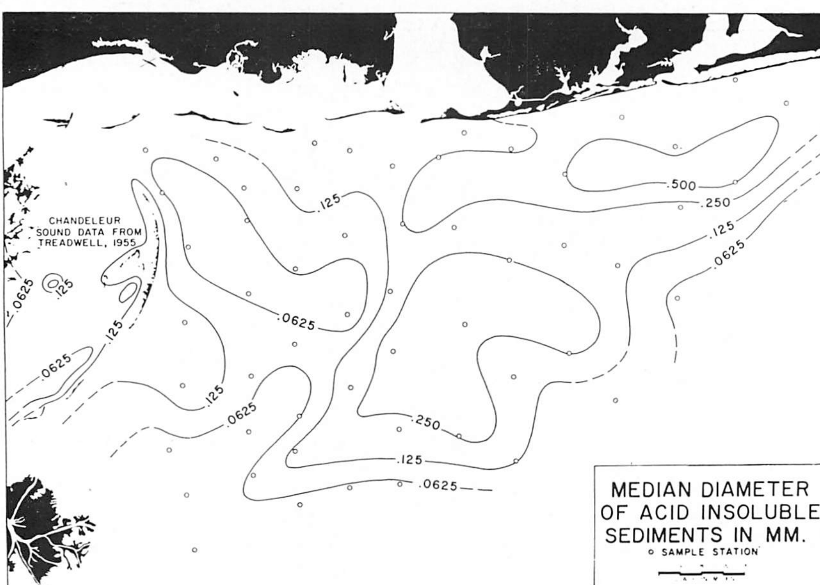


Figure 21

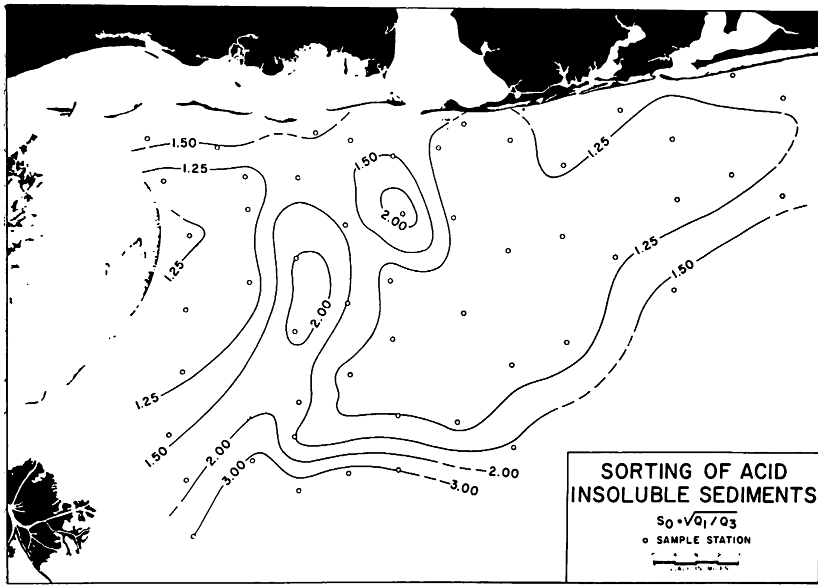


Figure 22

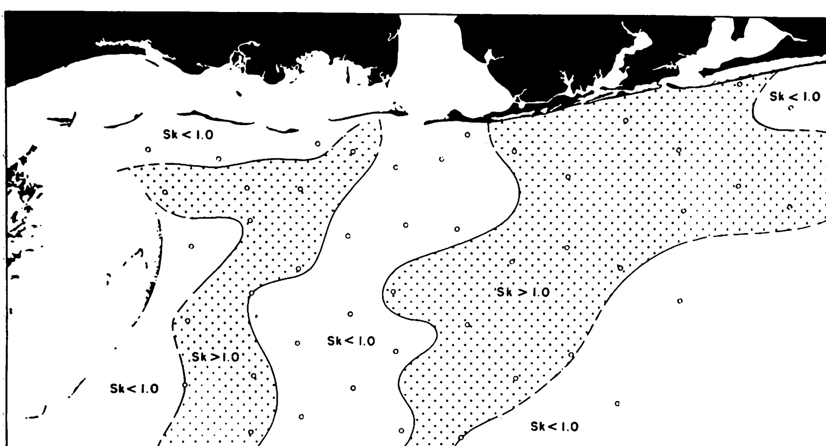


Figure 23

MEDIAN DIAMETER

The median diameter map (Figure 21) is taken from cumulative weight percentage frequency curves for acid insoluble samples (see Graphs 1-12) plotted for the 55 sample stations shown. The map indicates a general shoreward increase in diameter. The largest particle sizes occupy areas of high sand concentrations. The area along the edge of the shelf and the mixing belt east of the Chandeleur Islands contain sediments with median diameters less than .125 mm.

SORTING

The coefficient of sorting of acid insoluble samples is contoured in Figure 22. The results indicate that in the area of study, the sediments are predominently well sorted. According to Trask (1932), well-sorted marine sediments have values of S_0 (sorting coefficient) less than 2.5. Moderately sorted sediments range from 2.5 to 4.0 and poorly sorted sediments have values larger than 4.0. In this study, it was found that the coefficient of sorting for the bulk of the sediments was less than 2.5. The sand areas in the region exhibit the best sorting whereas along the edge of the shelf and in the mixing belt the sorting coefficients are larger.

SKEWNESS

Values for the geometric skewness were determined according to the formula, $S_k=Q_1 Q_3 / Md^2$, given by Trask (1932). Values varied from 0.425 to 1.188. Areas with values higher (positive skewness) or lower (negative skewness) than 1.0 are indicated on Figure 23. High values characterize the eastern sand area as well as a north-south trending belt which includes portions of the Chandeleur sand sheet and the western margins of the mixing belt. The outer margins of the shelf area and the central and eastern portions of the mixing belt are characterized by lower skewness values.

SILT AND CLAY

Figure 24 shows the distribution of silt- and clay-size materials in the total raw samples. Although the silt-clay distribution area is shown in Plate 3, it is undifferentiated. Figure 24 illustrates measured percentages of silt and clay at 55 stations in the

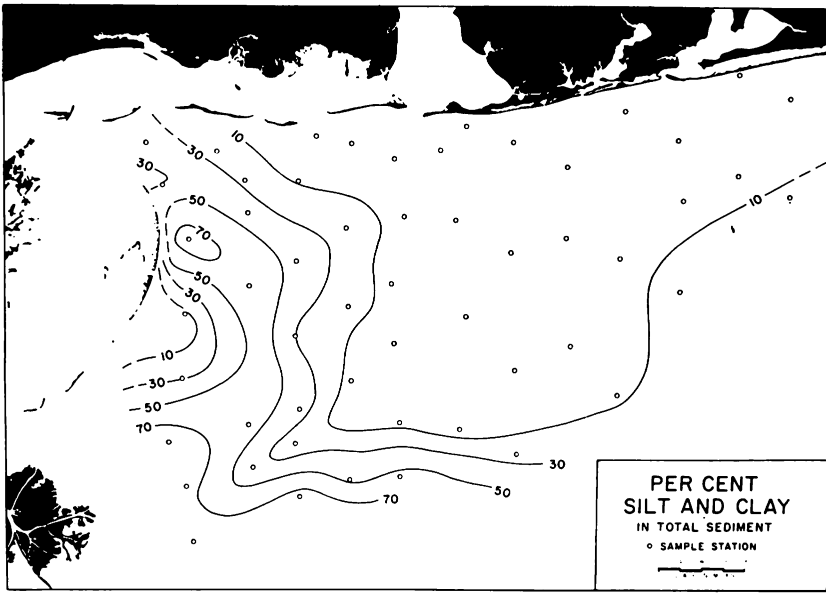


Figure 24

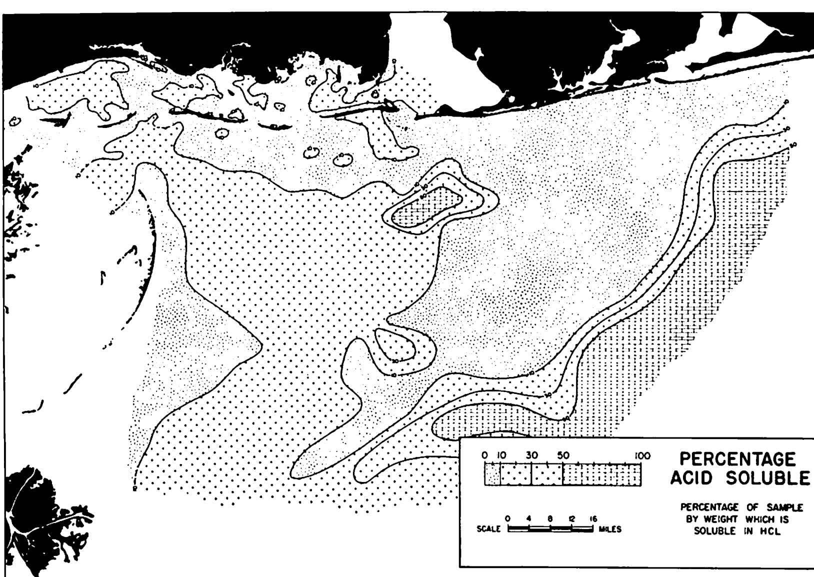


Figure 25

open Gulf. The silt-clay fraction is prominent in the western part of the region where high percentages of this material are concentrated in the substratum bordering the Chandeleur Islands sand deposits near the Mississippi delta distributaries and seaward from the edge of the shelf. The major interior shelf trend of fine-grained particles is north-south in the mixing belt that borders the Mississippi delta. The low percentage of fine-grained sediments in the area south and southeast of Mobile Bay again reflects the high concentration of sand in the eastern part of the study area.

COMPOSITION

CARBONATES

Distribution of carbonates (per cent of sample soluble in HCl) is shown in Figure 25. A large percentage of the carbonates in the study area consist of fragmental organic remains. With one major exception, the carbonate percentages of predominantly mud areas is slightly above that of sand areas. The exception is that area which has been described as the Mississippi-Alabama Reef and Inter-reef Facies (Ludwick and Walton, 1957; Ludwick, 1964). This facies lies along the seaward margin of the major sand area. Smaller carbonate concentrations south of Mobile Bay are more localized shell banks. The higher carbonate percentages in mud areas may reflect the differential preservation of organic remains in these finer grained sediments.

Ludwick (1964) describes the outer shelf reef and inter-reef deposits as highly variable, but generally consisting of two types. The first, a carbonate sand facies, averages 70% carbonate sand, 20% terrigenous sand, and 10% silt and clay. The second, described as a sand-silt-clay facies, averages 20% carbonate sand, 30% terrigenous sand, and 50% silt and clay. Pinnacles are a distinctive feature of the reef area. Calcareous algae comprise the most common biogenic constituent. Molluscan debris is common in the coarser fraction of inter-reef sediments.

BROKEN SHELL

The percentage of broken shell in the sediment is shown on Figure 26.

Nearshore areas in the eastern part of the region and the sandy area bordering the Chandeleur Islands contain few shell

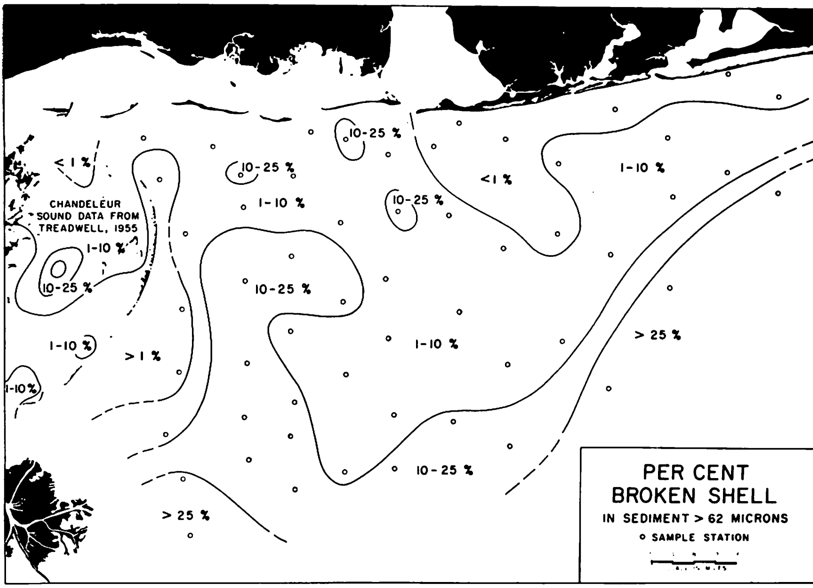


Figure 26

fragments. In general, there is a gradation seaward toward high percentages of shell fragments with the highest concentrations located along the edge of the shelf where sediments contain more than 25% shell fragments. Samples from the western part of the mixing belt and a small area south of Dauphin Island contain moderate percentages (10-25%) of broken shells. Near the Mississippi River distributaries high broken shell percentages occur. Treadwell (1955) shows low percentages of shell in the southern portion of Chandeleur Sound with the exception of a small area near Breton Island. He reports moderate percentages from the northern half of the Sound and a high percentage from an oyster reef in the west-central portion of the Sound.

CLAY MINERALS

Figure 27 shows the results of analyses for montmorillonite, kaolinite, and illite. The montmorillonite/kaolinite ratio shows a response both to source area and to longshore transport. On the open shelf, the ratio decreases eastward indicating an increase in kaolinite as the Appalachian drainage is approached. Close to shore, in the region of effective longshore sediment transport, low montmorillonite/kaolinite ratio values extend westward along

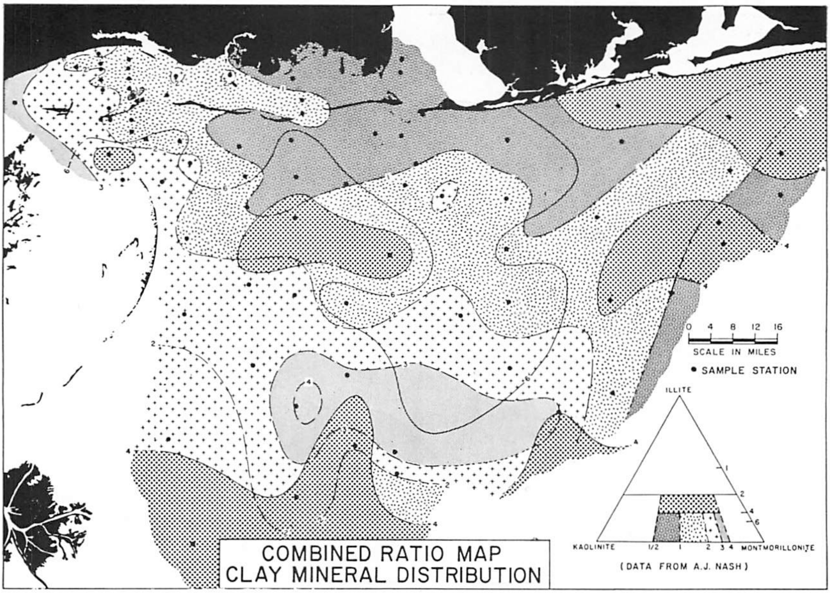


Figure 27

the barrier island trend indicating movement of Appalachian clays into the area. The montmorillonite + kaolinite/illite ratio shows an irregular pattern in which there is a tendency for an increase in illite content toward the shelf edge. This may be explained by the possibility that most of the illite is in the very fine grain sizes and that only particles of this very fine size are presently being carried as far as the shelf edge. Another possible cause of the observed distribution may be the selective destruction of kaolinite in the finest particle size range in alkaline environments.

QUARTZ

In the eastern portion of the area, a seaward decrease in quartz percentage in the $>62\mu$ fraction occurs near the outer edge of the continental shelf (Figure 28). In that area, the decrease in quartz reflects the build-up of carbonate sediments (Figure 25).

In the western portion of the area, high quartz percentages occur in a wide zone bordering the Mississippi Sound barrier islands and in a narrow belt becoming broader southward adjacent to the Chandeleur Islands and Mississippi delta. These are areas of well-sorted quartz sands.

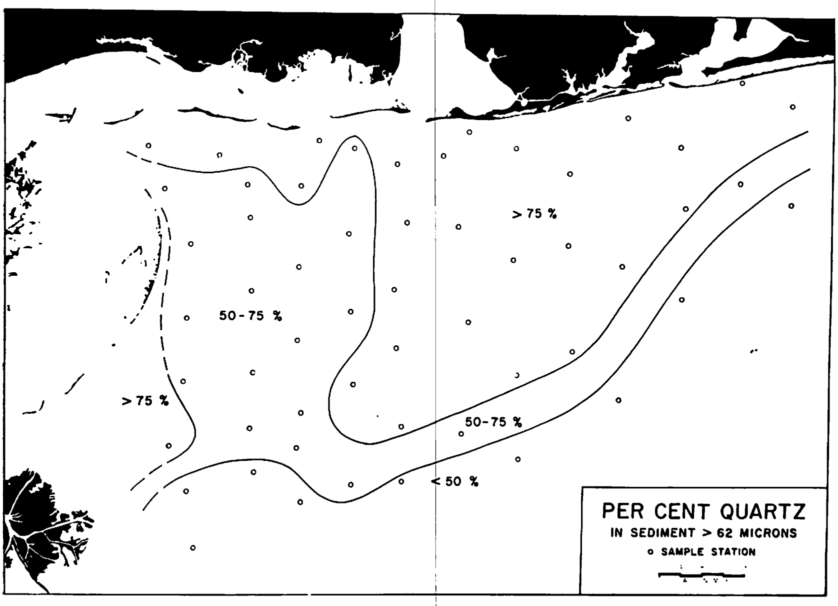


Figure 28

In the mixing belt, quartz percentages decrease with an increase in mica, glauconite, heavy minerals, broken shell and foraminifera. A further decrease in quartz south of the mixing belt coincides with a prominent area of clay muds (Plate 3).

HEAVY MINERALS

Heavy minerals of the shelf east of the Mississippi delta have been studied by Goldstein (1942), Shepard (1956), van Andel and Poole (1960), van Andel (1960), and Foxworth, *et al.* (1962). On the basis of heavy mineral suites, the region is divided into an Eastern Province and a Mississippi Province, with a narrow transition zone which is located approximately along longitude 88° 45′W (due south of Horn Island, Mississippi). The heavy mineral assemblages in the Eastern Province are composed mainly of metamorphic mineral suites high in ilmenite, staurolite, kyanite, zircon, and tourmaline; the source area for these minerals is the Appalachian region. The Mississippi assemblages consist of igneous mineral suites such as amphibole, pyroxene, epidote, ilmenite and biotite; sources for these minerals are areas in the interior of the continent drained by the Mississippi River. The

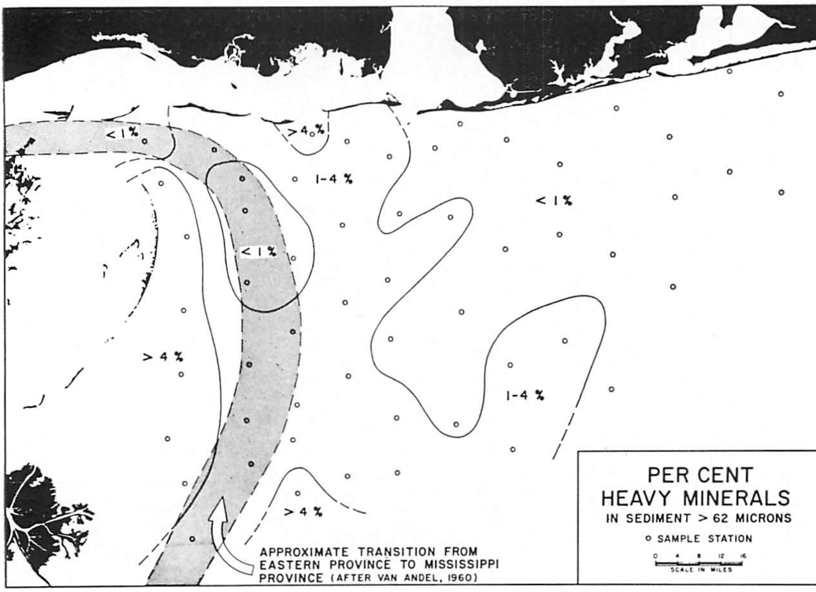


Figure 29

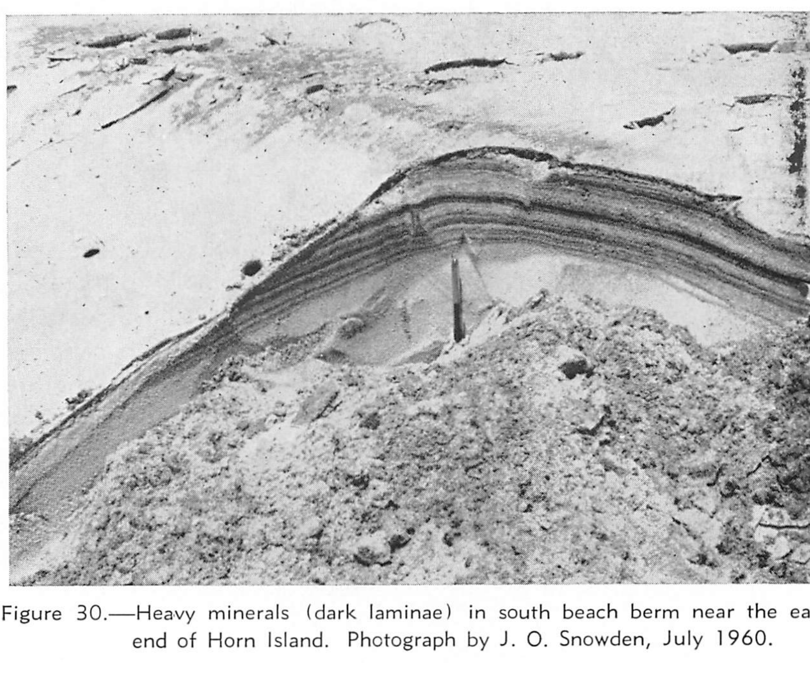


Figure 30.—Heavy minerals (dark laminae) in south beach berm near the east end of Horn Island. Photograph by J. O. Snowden, July 1960.

two provinces are delineated primarily by the dominance of staurolite and kyanite in the Eastern Province and amphiboles and pyroxenes in the Mississippi Province. Figure 29 illustrates heavy mineral percentages in the sediments. The Mississippi Province, bordering the Chandeleur Islands, contains the largest percentage of heavy minerals (greater than 4 per cent) in the samples studied. These heavy minerals are well rounded, rather large, and probably have been concentrated by reworking of the ancient delta. There is one concentration (greater than 4 per cent) of heavy minerals bordering Petit Bois Island in the Eastern Province. Low percentages (less than 1 per cent) of heavy minerals are found in the sand lobe southeast of Mobile Bay and occur mainly as inclusions in large quartz grains. Between the two heavy mineral provinces, there is a transition zone of mixed assemblages containing 1 per cent to 4 per cent heavy minerals. This zone corresponds to the mixing belt of the present study.

According to van Andel (1960, p. 51):

> ". . . westward the Eastern Province dips under Mississippi deposits. Kyanite-staurolite-bearing sediments have been observed 10 miles east of the bird-foot delta beneath 11 feet of Mississippi material . . . and in basal post-Pleistocene sediments in borings south of Lake Borgne, in Chandeleur Sound and the bird-foot delta . . . The western limit is unknown."

Striking occurrences of heavy minerals may be observed in the field along the outer beaches of the Mississippi Sound barrier islands (Figure 30). In these areas, dark laminae, rich in heavy minerals, are interbedded with lighter colored layers containing few heavy minerals. These occurrences have been fully illustrated and are discussed in detail by Foxworth, *et al.* (1962).

MICA

Mica concentrations near the Mississippi River delta have been discussed by Shepard (1956) who stated that mica has a close relationship to modern deltaic sediments. Sediments with a high mica content are described as a "tongue" extending eastward from the active Mississippi delta. The ancient delta sediments contain little mica, a condition attributed to reworking by current and waves in the shallow water. Mica is recorded as being particularly scarce in "old shelf deposits," which may be

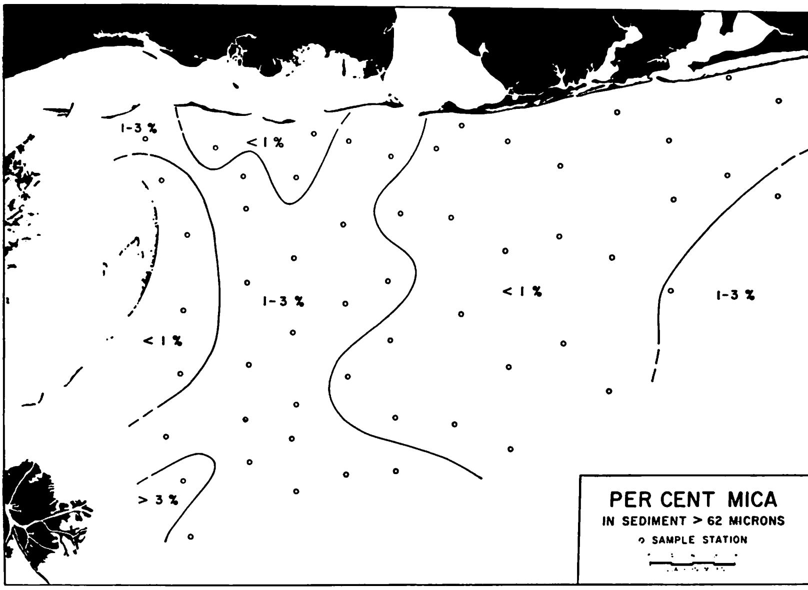


Figure 31

due to the fact that these sediments were derived from the southern Appalachian rivers which do not transport nearly as much mica as the Mississippi River.

Figure 31 shows three areas deficient in mica (less than 1 per cent) within the region of the present study. Two of the areas with low percentages of mica, the reworked delta deposits east of the Chandeleurs and the eastern shelf deposits, are consistent with Shepard's findings. The remaining area with low mica content borders Petit Bois and Horn Islands and possibly is due to reworking. The mixing belt contains concentration of mica varying from one to three per cent. One station, 636, contains 4 per cent mica suggesting that this sample is part of the mica "tongue" described by Shepard (1956). Sources of the high mica concentrations in the mixing belt are probably the Mississippi River, the reworked delta, and possibly rivers entering Mobile Bay.

GLAUCONITE

The term "glauconite" is applied to a grass-green to dark-green mineral, generally occurring as globular aggregates. Most of the glauconite in the samples studied seems to be authigenic because of its frequent occurrence in foraminiferal tests. In this area glauconite is a sediment of the open Gulf and is usually associated with areas of non-deposition (Shepard, 1956). Cloud

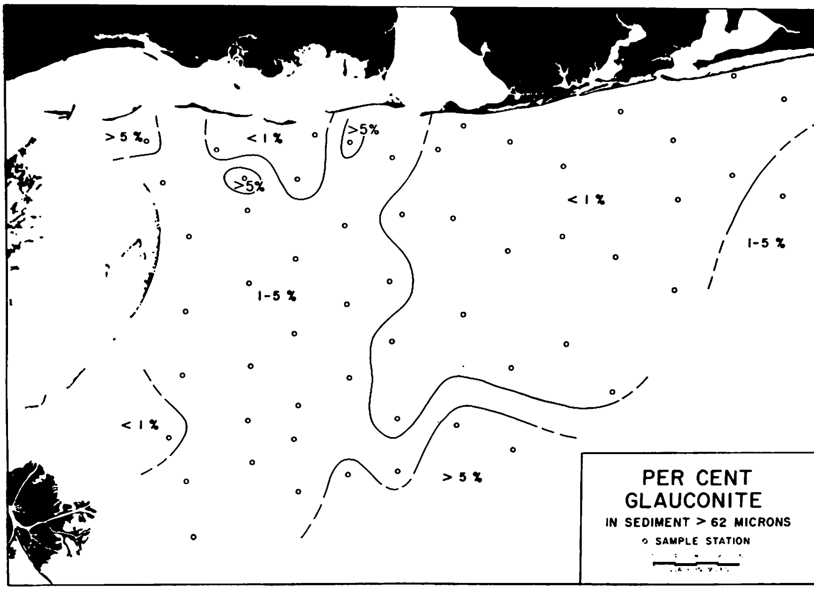


Figure 32

(1955) discusses depositional environments of glauconite and concludes that the mineral is formed in marine water of normal salinity and fairly wide temperature and depth range. The activity of organisms also appears to be a necessary condition.

Figure 32 shows four patches with high glauconite content. Sample 629 near Dauphin Island contains 15 per cent glauconite. High concentrations (5 per cent to 10 per cent) are located south of Ship Island in the extreme northwest part of the area, south of the eastern tip of Horn Island, and along the south central margin of the shelf. These glauconite concentrations are similar to patches described by Curry (1960) on the western Gulf shelf where they occur in zones of poorly sorted, terrigenous and organic material. The mixing belt contains from 1 per cent to 5 per cent glauconite. Glauconite constitutes less than 1 per cent of sediment in samples southeast of Mobile Bay.

CARBON ISOTOPES

Many of the carbon isotope values presented in Figure 33 and the following discussion are from Sackett and Thompson, 1963. Additional data provided by the same authors are included in Figure 33 and Table 5.

The isotopic composition of carbon is expressed as per mil deviations (δ) from the C^{13}/C^{12} ratio of a standard material as follows:

$$\delta\ C^{13}/C^{12}\ (\text{in }‰) = \frac{(C^{13}/C^{12}\ \text{sample} - C^{13}/C^{12}\ \text{standard})}{C^{13}/C^{12}\ \text{standard}} \times 1000$$

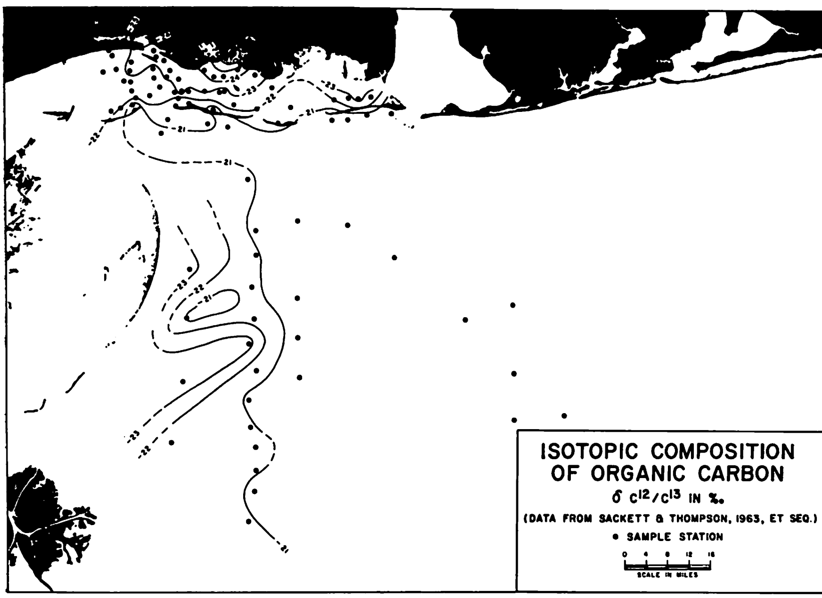


Figure 33

The standard was National Bureau of Standards Tentative Isotope Reference Sample No. 22. However, the results are presented (Figure 33) relative to the Chicago PDB standard using -29.4 ‰ as the conversion factor.

The range of values for 18 samples of river sediments (not shown on Figure 33) is -28.3 to -24.3 ‰ with an average of -26.2 ‰. Values for samples from the Gulf of Mexico average about -20.0 ‰. Sediments of Mississippi Sound and the Chandeleur shelf exhibit a systematic variation from river to open marine values. This pattern indicates a probable mixing of river and marine derived materials. Since most of the river muds have an organic carbon content of 1-3 per cent, the same range as for Biloxi Bay and Mississippi Sound mud sediments, there is apparently sufficient land derived organic carbon ($\delta \sim$-26.0 ‰) being introduced into the marine environment by transported river muds to mix with marine derived organic carbon ($\delta \sim$-20.0 ‰) to produce the systematic variation shown in Figure 33.

MICROFAUNA

FORAMINIFERA

The distribution of foraminifera in Mississippi Sound and offshore areas has been reported by Phleger (1954b), Ludwick and Walton (1957), and Walton (1960, 1964). Similar studies in adjacent areas are those of Bandy (1954, 1956), Parker (1954), Phleger and Parker (1951), Treadwell (1955), Lankford (1959), Lowman (1949) and Phleger (1955).

Phleger (1954b) studied the distribution of foraminifera and associated microorganisms in Mississippi Sound and adjacent shallow marine waters. His study was based on approximately 400 samples of bottom sediments from a variety of environments. He determined the species which constitute four major geographic and ecological assemblages in the area.

Ludwick and Walton (1957) described foraminiferal assemblages associated with calcareous shelf-edge prominences in the south-central part of the present study area. They recognized many forms which are not indigenous to the area at the present time.

Walton (1960) described detailed variations in the foraminiferal fauna in a traverse of 200 samples across Horn Island. He recognized nine environmental zones based on species composition, faunal diversity, population size, character of the fauna and faunal dominance.

Walton (1964) described the regional distribution of foraminifera from the eastern margin of the Mississippi delta to Cape San Blas, Florida. His study was based on 649 analyses of his own together with 744 analyses from other workers. From the integrated data he produced maps showing the distribution of individual genera, selected species, and gross faunal characteristics.

The present study is based on 451 sediment samples (Table 3) from Mississippi Sound and adjacent nearshore waters and from the open Gulf to depths of 480 feet. Since numerous data have been produced on distribution of individual species and species assemblages, this report is confined to description of the occurrence of major bionomic groups. The groups considered are the planktonic, arenaceous and calcareous benthonic foraminifera. In addition, quantitative estimates of the foraminiferal contribution to the sediments were made on 55 open Gulf samples (Table 2).

Even gross bionomic groups of organisms, especially of the foraminifera and the ostracodes, appear to be sufficiently sensitive to indicate environmental patterns. More detailed reconstruction of environments may be made from more detailed knowledge of microfaunal assemblages. However, the more details one acquires the more time one consumes. Gross microfaunal groups are sufficiently distinctive to warrant consideration as a rapid means of assembling environmental data. Where time does not permit detailed study, biofacies mapping of major bionomic groups (Upshaw and Stehli, 1962; Stehli and Creath, 1964) is a useful reconnaissance tool in the recognition of ancient environments.

ARENACEOUS

Plate 4 illustrates the distribution of the arenaceous foraminifera as a percentage of the total foraminiferal population. These forms make up a prominent part of the microfauna in two areas—the low salinity waters of lagoonal and marshy areas and the deeper outer portion of the continental shelf.

The brackish-water fauna is, in many areas, dominated by arenaceous forms, notably in sheltered areas behind the barrier islands and in areas adjacent to mainland sources of fresh water. The river-bay-marsh fauna contains large numbers of *Miliammina* while the lagoonal fauna is rich in *Ammobaculites*. In areas opposite the inlets between barrier islands, the arenaceous fauna diminishes in proportion to the influx of open Gulf water bearing calcareous benthonic forms.

The outer-shelf arenaceous fauna, generally comprising from 10 to slightly more than 30 per cent of the total, occurs in a broad, discontinuous belt at depths of about 150 to 250 feet. Bigenerina is a prominent genus in the open shelf arenaceous fauna.

The pronounced influence of the barrier islands on occurrence of arenaceous species is graphically illustrated in profiles A-A′ to J-J′ (Figures 39, 40). The profiles also illustrate the less prominent increase of these forms in portions of the outer continental shelf zone.

These results are consistent with those reported by Phleger (1954b) but differ in the magnitude of the percentages recorded. In general, Phleger records higher percentages of arenaceous forms from stations in Mississippi Sound and adjacent low-salinity waters because, as he reports (1954b, p. 647), formaldehyde preservative broke down to formic acid which dissolved calcium carbonate foraminiferal tests. His results tended to exaggerate the importance of the remaining arenaceous element of the fauna. However, our results confirm that his generalizations and hypotheses remain valid. In addition to Phleger's (1954b) work in Mississippi Sound, other works on areas along the Gulf Coast provide comparisons useful in determining the factors controlling distribution of the microfauna in this province.

Bandy (1956), in his work on the area from Mobile Bay to Caloosahatchee River, Florida, showed that arenaceous forms reached a peak abundance in excess of 30 per cent of the foraminiferal population in areas of 30 to 50 fathoms depth on the open shelf. Seaward of this zone, they decreased rapidly in abundance. This is in general agreement with our findings off the coasts of Mississippi and adjacent states.

San Antonio Bay, on the central Texas coast, has been studied by Parker, Phleger and Peirson (1953). They report that arenaceous foraminifera make up the bulk of the population in only a few small areas, most of them near the delta of the Guadalupe River. In the lagoonal area immediately behind Matagorda Island, the arenaceous forms make up less than 20 (in most cases less than 10) per cent of the population. The reason for this lesser importance of arenaceous forms appears to be the higher average salinity of San Antonio Bay in contrast with Mississippi Sound.

Still greater contrast exists between Mississippi Sound and Laguna Madre (Rusnak, 1960) along the south coast of Texas. Arenaceous foraminifera occur in very small percentages of the total fauna of Laguna Madre. There appear to be two reasons, the principal one being the consistently high salinity of the lagoon. In addition, the bottom sediments are mostly sands in contrast to the muds found in bays to the north and east.

The foregoing results and comparisons indicate that salinity exerts a strong control over the distribution of the brackish-water arenaceous assemblage.

CALCAREOUS BENTHONIC

Plate 5 shows the distribution of the portion of the benthonic foraminifera with calcareous test composition. In Mississippi Sound and adjacent nearshore areas, the pattern is a reciprocal of the arenaceous distribution pattern of Plate 4. Farther seaward, the percentage of calcareous benthonic forms varies with changes in both arenaceous and planktonic distributions.

Calcareous benthonic types dominate the foraminiferal fauna in all open continental shelf environments. Their dominance extends to variable distances into lagoonal areas through the inlets between barrier islands. The peak dominance of the calcareous benthonic forms is in open marine waters at depths of less than 150 feet. At greater depths, the planktonic forms play an increasingly important role. In shallow waters of less than normal marine salinity, the arenaceous forms are relatively more numerous.

Streblus and *Elphidium* are most important in very shallow areas, whereas *Nonionella, Rosalina* and *Hanzawaia* dominate the middle shelf area. *Epistominella* and *Cassidulina* are most prominent along the outer shelf and in upper continental slope environments. Areas of generic dominance have been mapped by Walton (1964, p. 156-157, Figure 2).

The relative importance of calcareous benthonic forms is further shown in a series of profiles (Figures 39-42).

Since percentages of calcareous benthonic forms vary inversely with those of arenaceous forms in shallow waters, and with those of planktonic forms, for the most part, on the outer shelf, comparisons with published works in the preceding and following sections are applicable to this group.

PLANKTONIC

The percentage of planktonic forms in the foraminiferal population is depicted on Plate 6. Planktonic types dominate the assemblage in sediments seaward of the continental shelf margin. The percentage of planktonic forms decreases shoreward until they comprise less than 5% of the assemblage in waters shallower than 100 feet. The limit of planktonic distribution is very near the shoreline seaward of the barrier islands. Infrequent specimens may occur in lagoonal samples.

The major seaward deflection of the 5 per cent isopleth may reflect movement of the large east-to-west current (Leipper, 1954). This deflection coincides with the prominent lobe of coarser clastic sediments.

Representatives of *Globigerinoides* and *Globigerina* dominate the planktonic assemblage.

The pronounced relationship of planktonic foraminiferal percentage to the edge of the continental shelf is clearly shown in several profiles (Figures 39-42).

The works of Phleger (1954b), Curry (1960), Walton (1964), and others have shown that the pattern of deposition of planktonic foraminiferal tests is essentially the same in all areas of the Gulf of Mexico. Significant percentages of planktonic forms appear in the assemblages near the outer edge of the continental shelf. Seaward, they increase rapidly in importance until, at the shelf edge, they comprise approximately 50 per cent of the foraminifera. They continue to increase rapidly so that they are the dominant forms of the slope and deep environments, and in most of the latter they make up more than 90 per cent of the total population.

TOTAL ASSEMBLAGE OF FORAMINIFERA

Plate 7 utilizes entropy-ratio mapping techniques to illustrate the total foraminiferal assemblage in terms of three end-members:

arenaceous, calcareous benthonic and planktonic. Overwhelming dominance of calcareous benthonic types in the normal marine inner shelf area is clearly shown. Arenaceous forms dominate low salinity waters of inner Mississippi Sound and adjacent bays, rivers and estuaries. On the outer shelf, an increase of arenaceous forms together with a build-up of planktonic percentages produces the only areas of "maximum mixing." Beyond the shelf edge, the planktonic types are dominant in sediment samples.

Foraminiferal assemblages of the major environments are shown by means of triangular coordinate graphs in Figures 34-36. Those samples from rivers, estuaries, and marshy areas along the mainland shore are collectively called the "Marsh and Bay" fauna. The "Sound" fauna is from the open waters of Mississippi Sound between the mainland and the barrier islands. The shelf has been arbitrarily divided into inner, middle and outer zones. The graphs reveal that the inner and middle shelf faunas are closely similar, and that the Sound fauna is transitional between the inner shelf and the Marsh and Bay faunas. The graph of "environmental assemblages" is a generalization of the other five. It shows the spectrum from arenaceous through calcareous benthonic to planktonic which corresponds, in general, to progressively greater distance from shore. It must be remembered, however, that the assemblages illustrated here apply only to the area under consideration. Areas with different physical environments would exhibit different biological characteristics.

PER CENT FORAMINIFERA IN SEDIMENTS

In 55 open shelf samples, estimates were made of the contribution of foraminifera to the sediment. The results are shown in Figure 37. The largest percentages of foraminifera occur along the edge of the shelf and in the mixing belt. Samples from nearshore areas, and from the eastern sand area, contain fewer foraminifera.

Similar patterns of foraminiferal abundance are given by Walton (1964, Figures 19, 20). His results are given as estimates of numbers of foraminifera per unit volume of sediment. He shows a reversal of values south of our study area in which foraminiferal numbers decrease beyond the continental shelf margin.

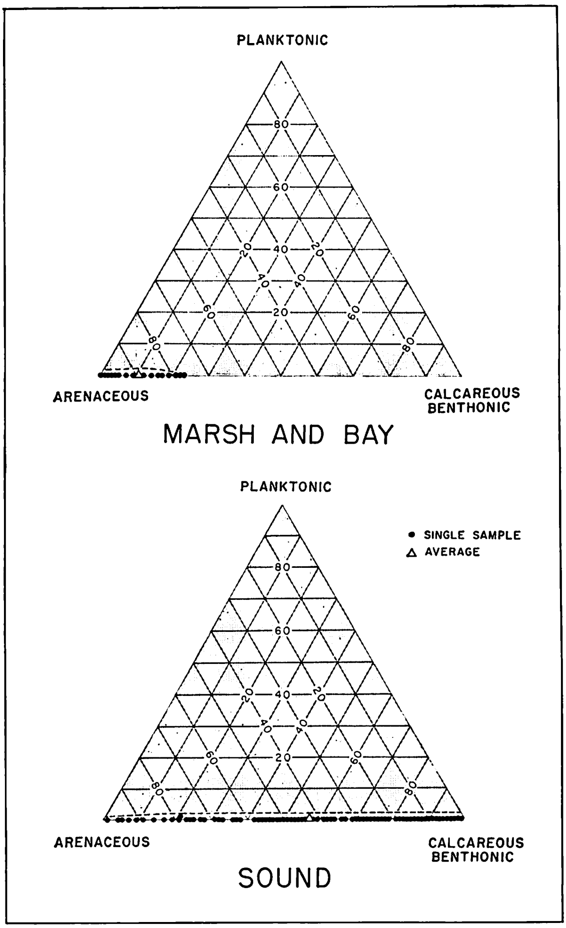


Figure 34.—Foraminiferal assemblages.

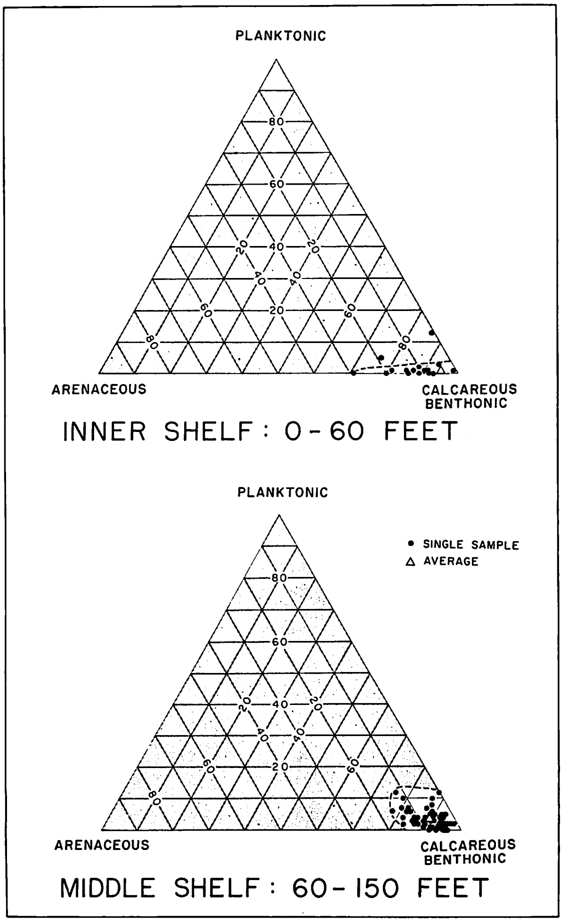


Figure 35.—Foraminiferal assemblages.

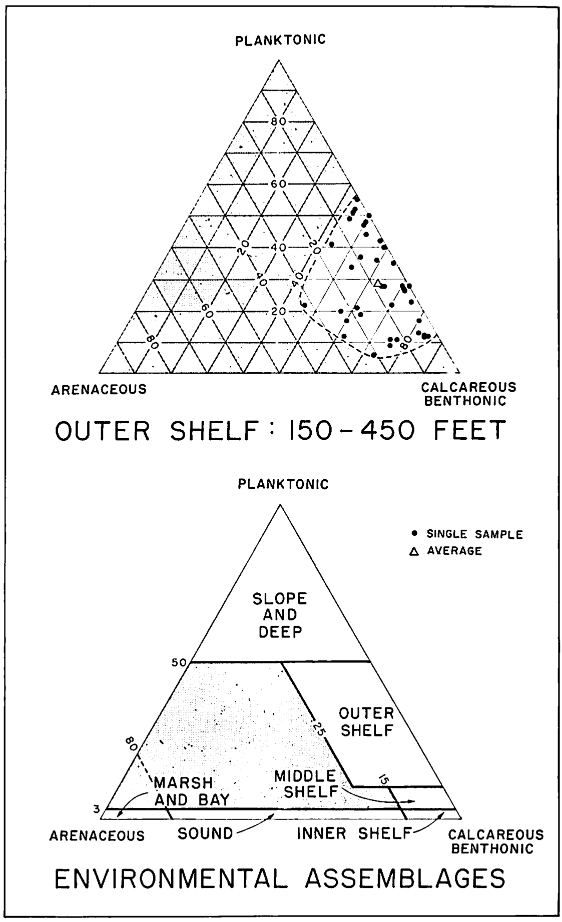


Figure 36.—Foraminiferal assemblages.

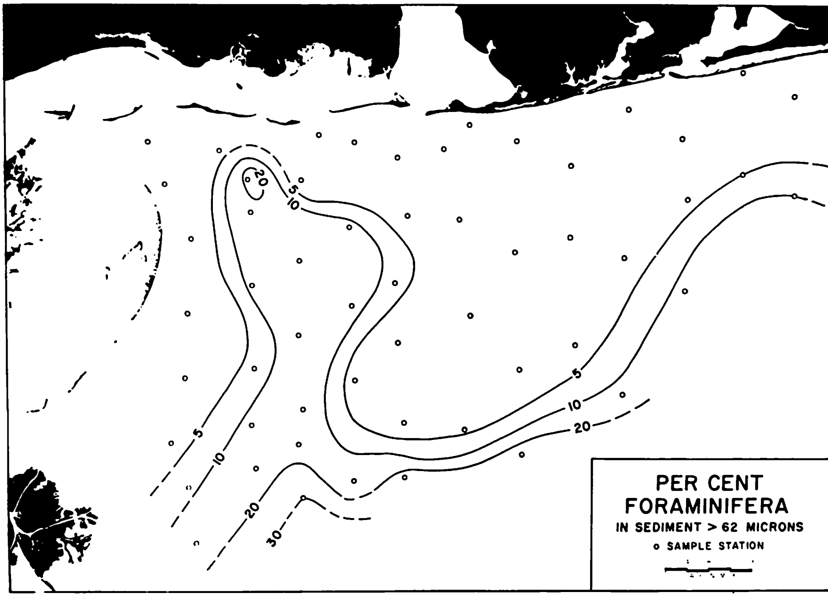


Figure 37

Higher percentages of foraminifera in sediments of the mixing belt and the outer shelf may be related to better living conditions or to better likelihood of preservation in finer-grained sediments.

NUMBER OF SPECIES

Figure 38, after Walton (1964, Figures 22, 23), illustrates the number of species in the foraminiferal assemblage of the study area. According to Walton (1964, p. 209), "With the Foraminifera, the number of benthonic species is inversely proportional to the variability of the environment." The highest numbers of species occur along the shelf margin and in the mixing belt. This distribution corresponds to that of the percentage contribution of foraminifera to the sediment. As a result, Walton suggests that the zone of maximum numbers of benthonic specimens occurs in areas on the continental shelf where there is relatively little dilution of population by detrital sediments. Other possible controls include greater productivity because of higher nutrient concentrations or greater likelihood of preservation in finer-grained sediments.

NON-INDIGENOUS FORAMINIFERA

A group of foraminifera occur on the continental shelf in the study area which have not been found living in these environments. They have been referred to as the "brown fauna" (Ludwick and Walton, 1957) and "West Indian species" (Phleger, 1951; Parker, 1954). They appear to be related to calcareous prominences on the exterior shelf. Walton (1964, Figure 22) shows the distribution of this anomalous fauna and his map is reproduced here as a part of Figure 38.

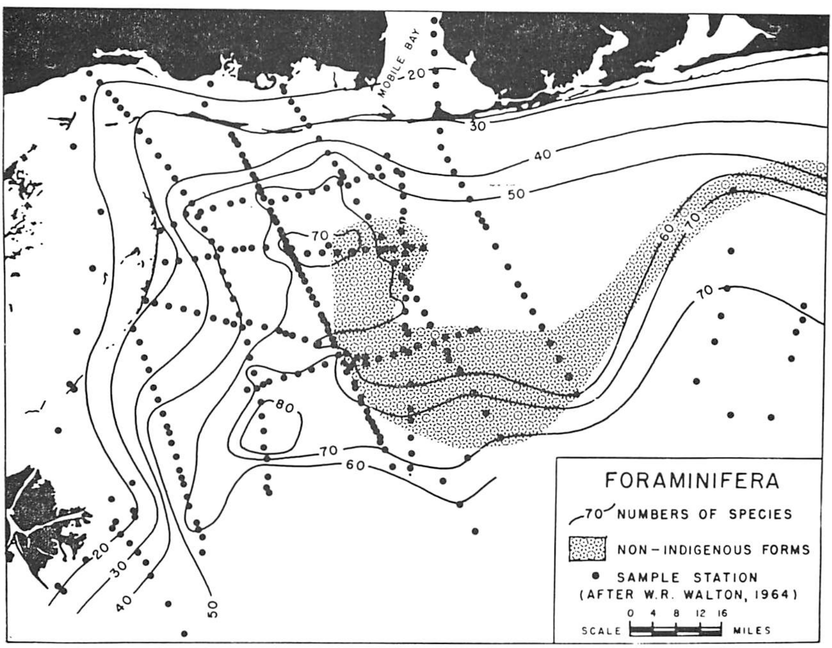


Figure 38

OSTRACODES

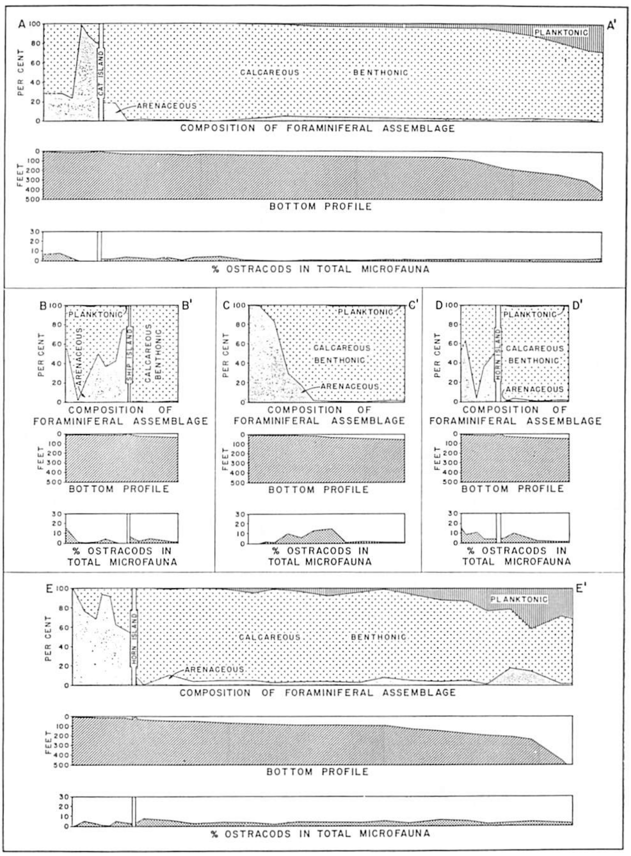
Distribution of ostracode carapaces, measured as a percentage of the total microfauna (foraminifera + ostracodes) and integrated into a three end-member system, is shown on Plate 8. The entrophy-ratio map illustrates the contribution of the ostracodes to a three end-member system the other two members of which are planktonic and benthonic (arenaceous + calcareous) foraminifera. The ostracodes do not dominate the microfauna in any part of the area. Except for a few limited areas, their principal contribution to the assemblage is along the barrier island trend and in nearshore waters eastward to the vicinity of Pensacola Bay. These high energy waters may be a preferred environment or the observed distribution may reflect differential preservation.

Rusnak (1960) records few ostracodes in Laguna Madre except for areas where salinity conditions are not extreme. In contrast, Swain (1955) reports that ostracodes are about five times as abundant in San Antonio Bay as in the adjacent open Gulf. Curtis (1960) found the opposite to be true in waters adjacent to the southeastern Mississippi delta. She reports that ostracodes are much more abundant in numbers and species in the open Gulf than in shallower waters near the delta margin. However, local shallow-water samples contain exceptional numbers of ostracodes.

Our results are most similar to those reported by Curtis (1960). With few exceptions, ostracode carapaces are abundant in samples from offshore normal marine waters. In the inlets and in marsh-bay-lagoon areas, they may be wholly absent to extremely numerous. The contrast between open Gulf and Sound is one of uniformity versus extreme variability of occurrence.

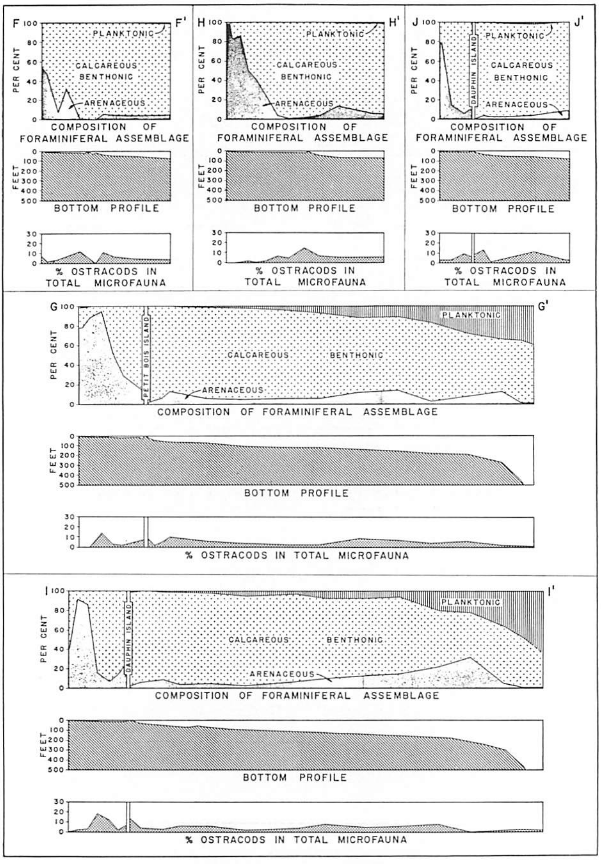
It should be pointed out that Plate 8 is based on numbers of ostracodes *relative* to those of foraminifera, and is not based on numbers per unit volume of sediment.

Ostracode percentages are graphically shown in Profiles A-A′ to R-R′ (Figures 39-42).



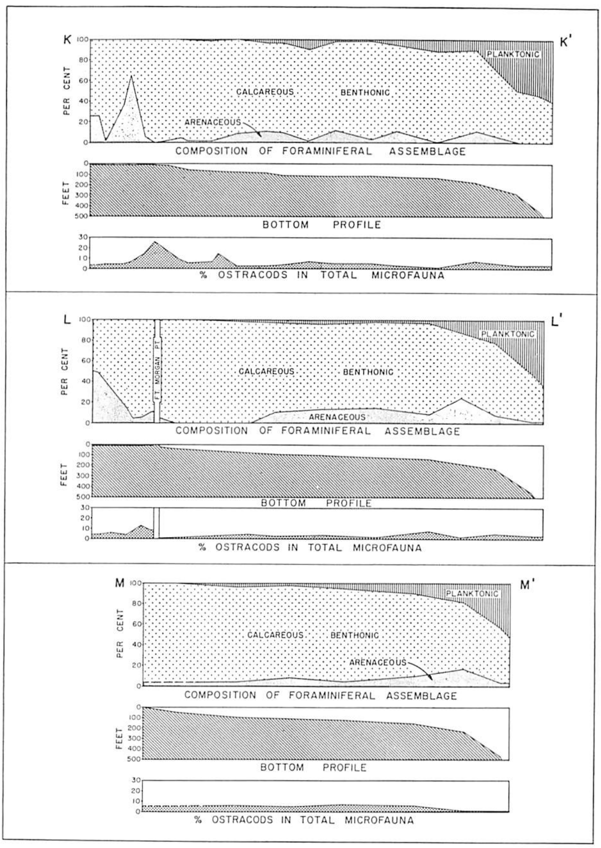
BATHYMETRY AND FAUNAL COMPOSITION

Figure 39



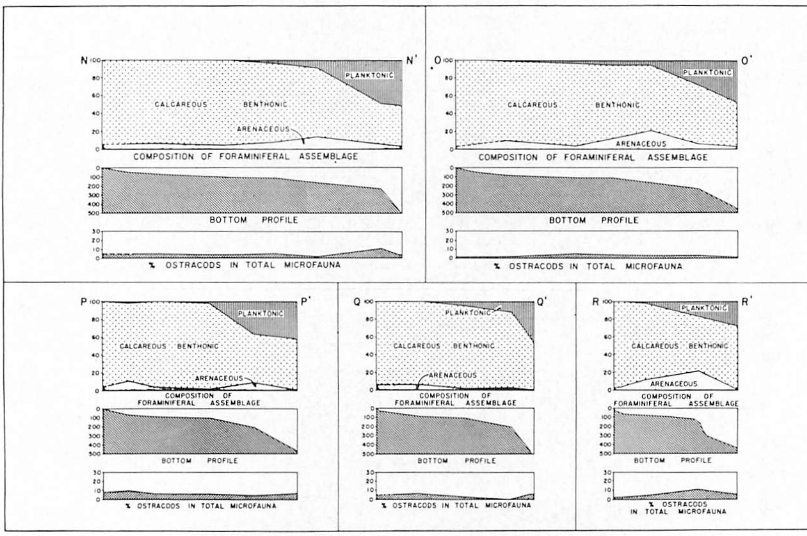
BATHYMETRY AND FAUNAL COMPOSITION

Figure 40



BATHYMETRY AND FAUNAL COMPOSITION

Figure 41



BATHYMETRY AND FAUNAL COMPOSITION

Figure 42

SUMMARY

The results of this study, and those of other workers, provide a model of a Continental Shelf area against which ancient sediment sequences may be compared. The principal objective, to describe the lithologic, microfaunal and environmental characteristics of a modern depositional province, generally has been met. Exhaustive treatment was precluded, however, because of the scope of the problem. It is hoped that this report will serve to indicate areas and directions for more detailed research.

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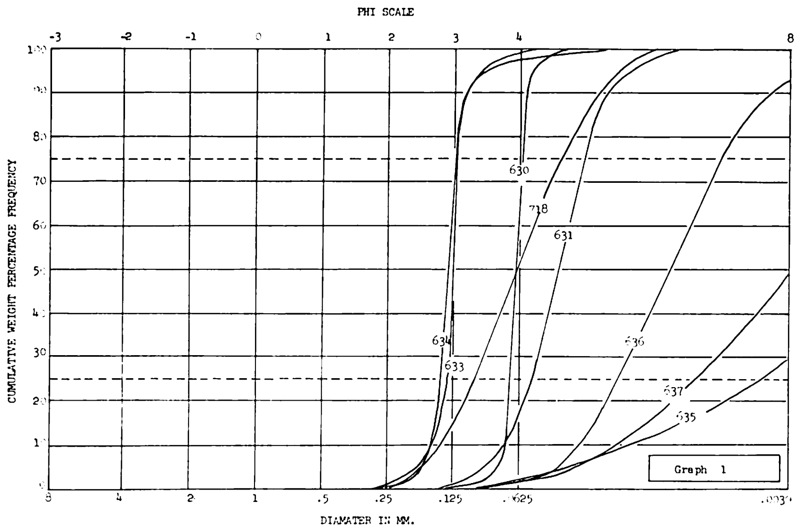
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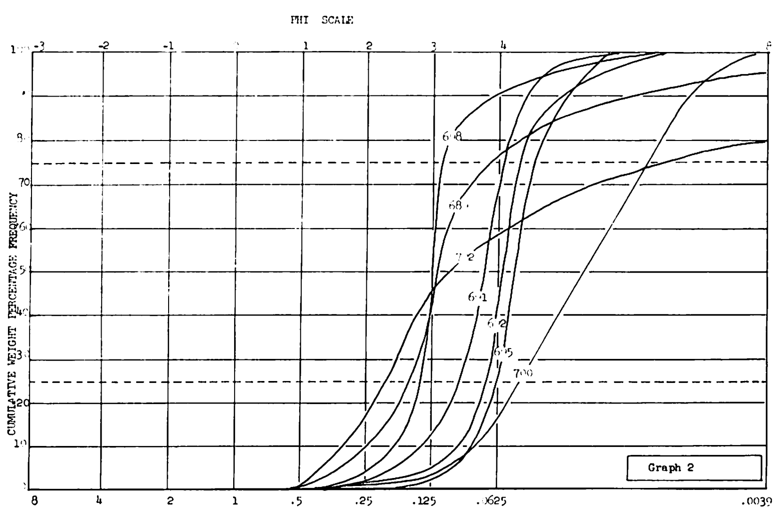
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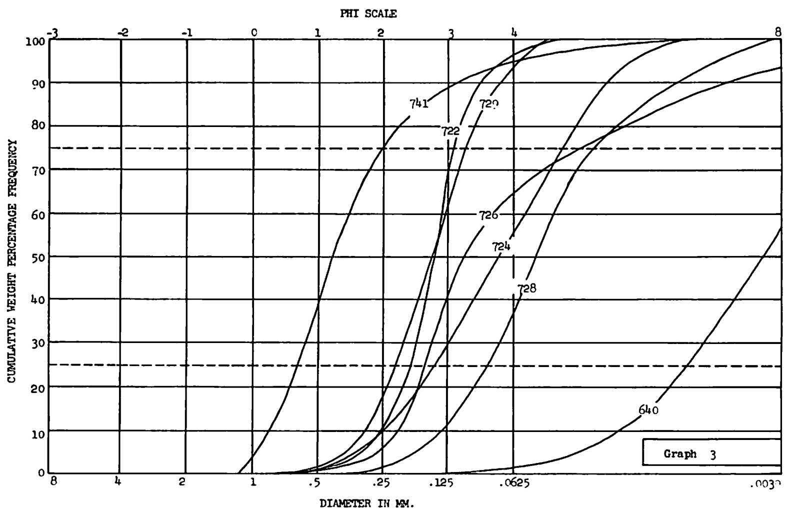
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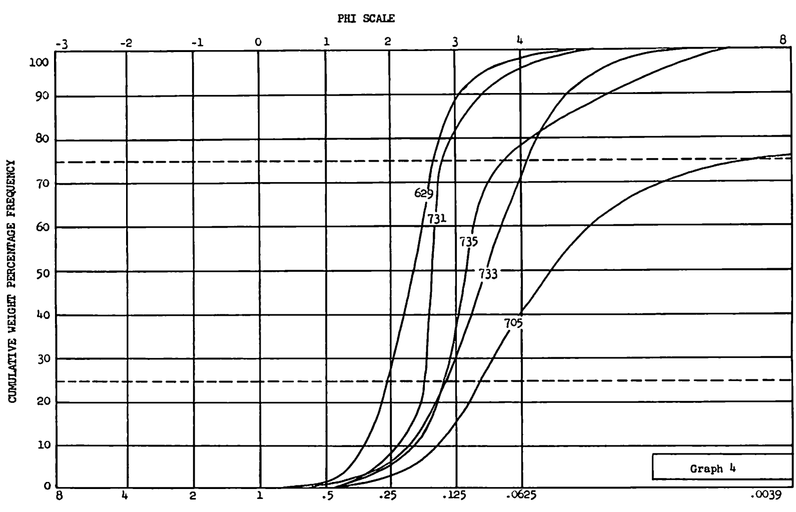
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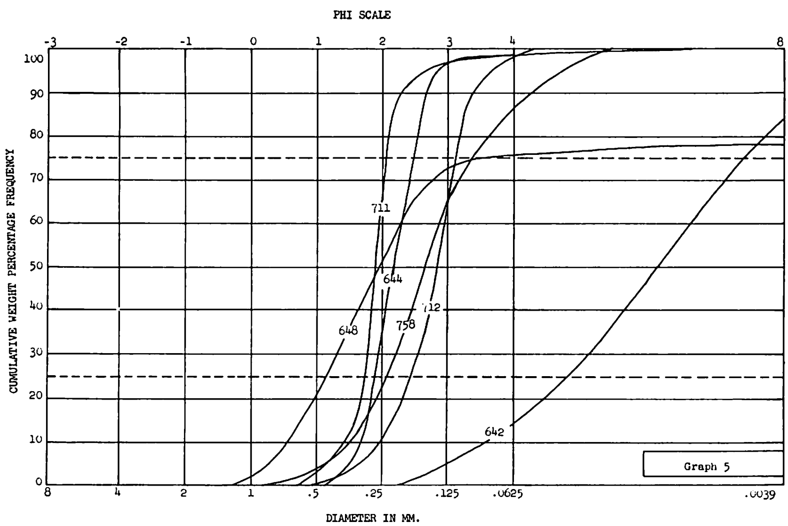
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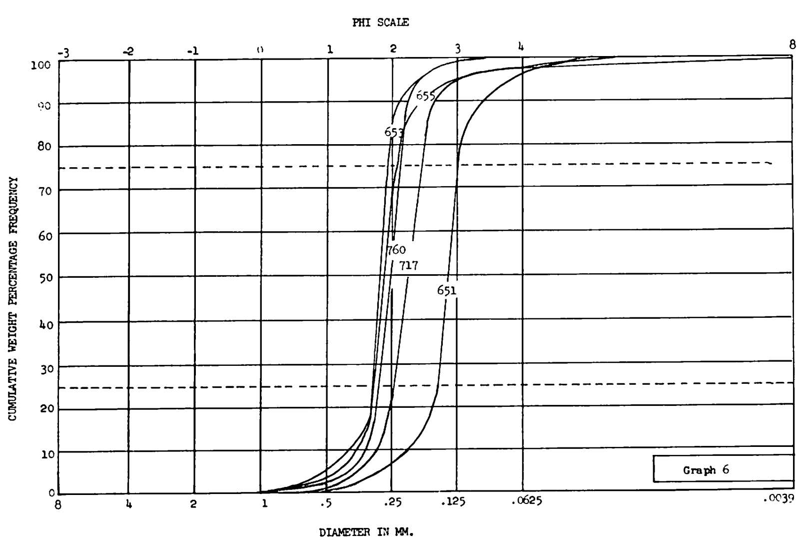
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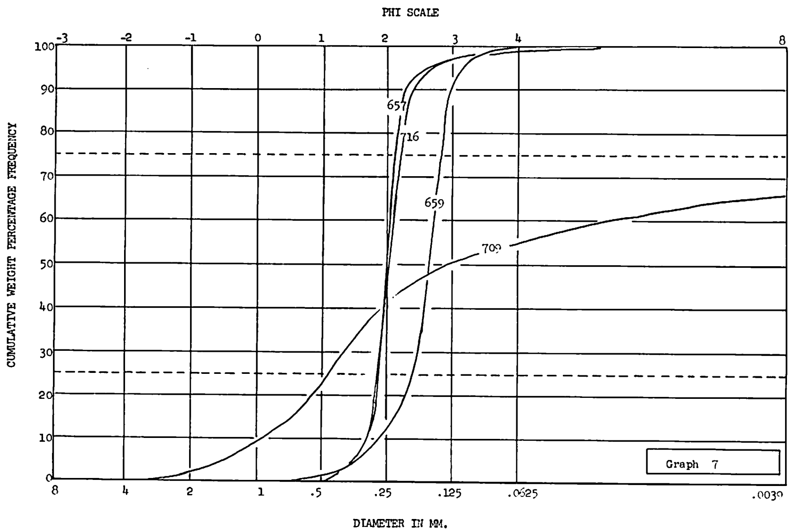
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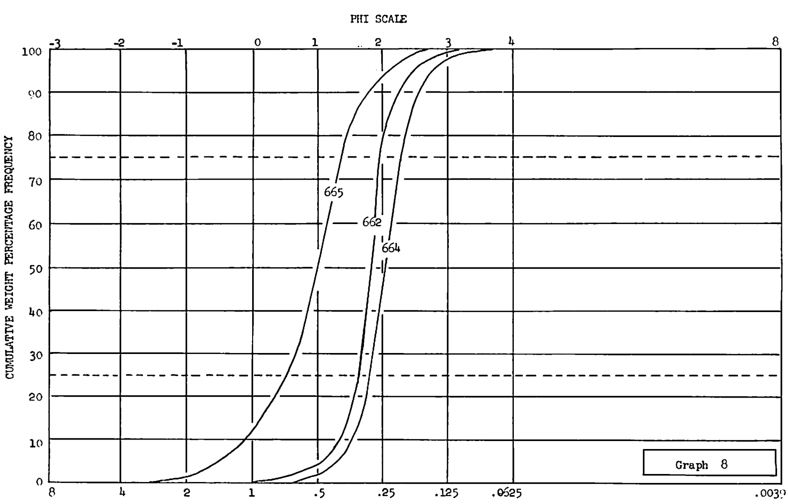
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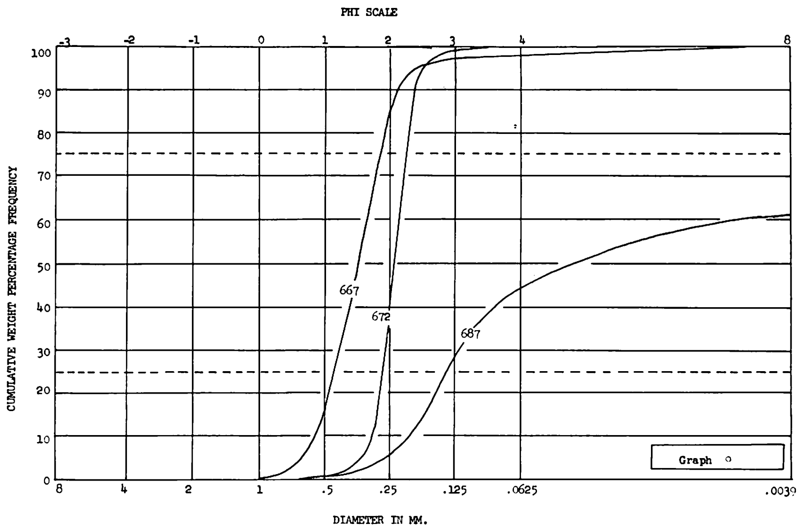
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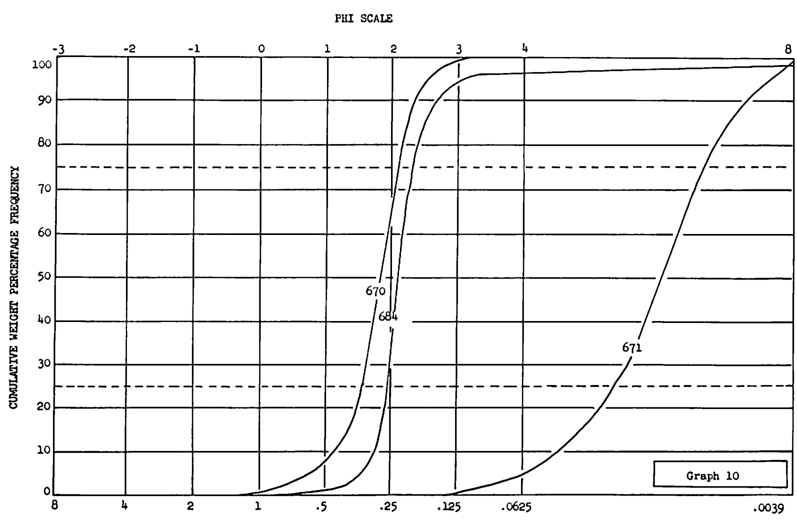
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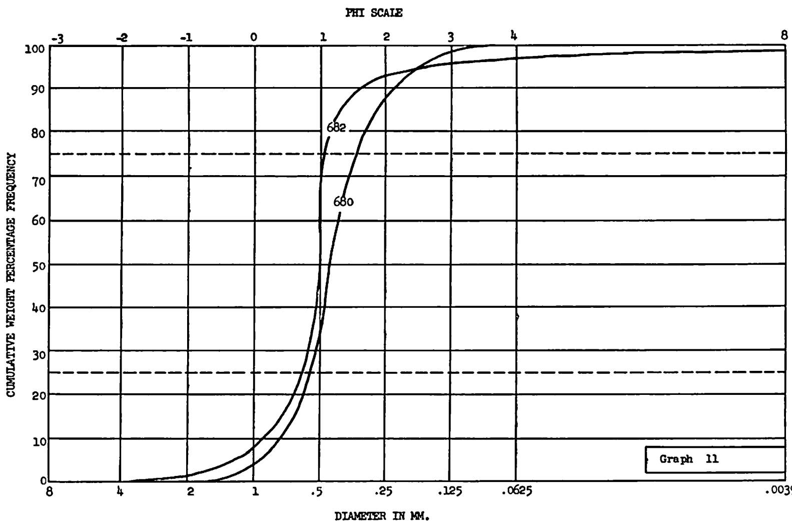
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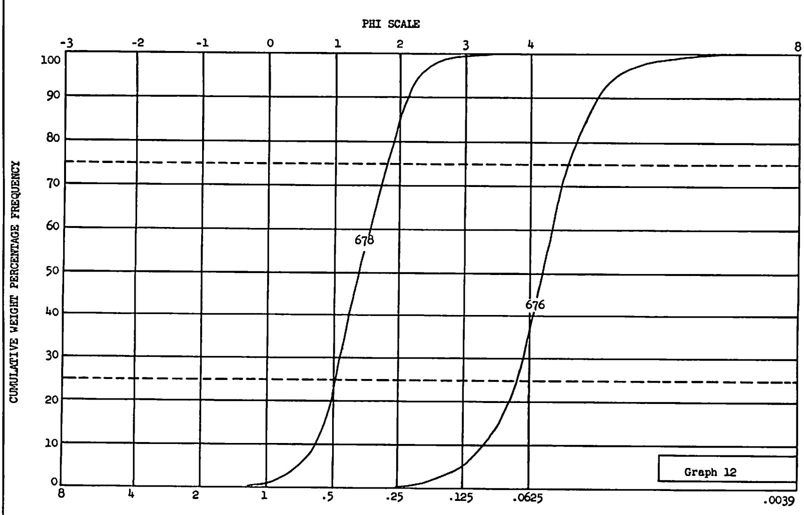
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TABLE 1. - Gross sedimentology and size distribution (Brooks).

Sample Station	Total Sediment			Acid Insoluble Sediment				
	Per Cent Acid Soluble	Per Cent Terrigenous Sand	Per Cent Silt and Clay	Median Diameter M_d	First Quartile Q_1	Third Quartile Q_3	Sorting S_o	Skewness S_k
629	8.4	89.4	2.1	.195	.260	.160	1.28	1.044
630	6.2	68.5	25.33	.064	.070	.0625	1.05	1.04
631	6.9	15.8	77.4	.042	.055	.032	1.31	0.80
633	5.3	93.0	1.59	.128	.138	.120	1.07	1.005
634	4.4	92.4	3.01	.130	.140	.120	1.10	1.00
635	10.3	2.4	87.3	---	---	---	---	---
636	16.6	1.3	82.0	.013	.022	.0076	1.70	1.018
637	14.4	1.4	84.3	---	---	---	---	---
640	11.4	0.4	88.3	.0046	---	---	---	---
642	23.6	10.8	65.7	.014	.046	.0058	2.78	1.188
644	5.0	92.8	1.7	.225	.270	.180	1.23	0.98
648	75.9	18.1	5.98	.260	.460	.090	2.26	0.781
651	8.6	87.8	3.34	.138	.158	.125	1.12	0.99
653	6.2	93.3	0.54	.280	.310	.260	1.09	1.015
655	25.7	71.5	2.5	.265	.300	.235	1.13	1.00

TABLE 1. - Gross sedimentology and size distribution (Brooks).

Sample Station	Total Sediment			Acid Insoluble Sediment				
	Per Cent Acid Soluble	Per Cent Terrigenous Sand	Per Cent Silt and Clay	Median Diameter M_d	First Quartile Q_1	Third Quartile Q_3	Sorting S_o	Skewness S_k
657	9.5	90.0	0.4	.250	.280	.230	1.11	1.10
659	4.9	94.0	1.00	.158	.190	.140	1.17	1.035
662	11.1	87.8	0.73	.280	.320	.250	1.13	1.01
664	3.2	96.3	0.02	.240	.290	.210	1.18	1.03
665	18.1	81.4	0.33	.500	.700	.390	1.34	1.044
667	1.7	95.0	3.28	.350	.455	.270	1.29	1.01
670	6.7	93.2	0.07	.270	.340	.230	1.22	1.035
672	4.5	95.0	0.3	.235	.270	.205	1.15	1.001
674	63.6	1.6	34.7	.015	.024	.0094	1.63	0.98
676	67.6	12.0	20.4	.054	.072	.042	1.31	1.018
678	3.2	96.5	0.09	.380	.485	.290	1.29	0.99
680	1.9	98.0	0.03	.410	.600	.330	1.35	1.088
682	77.6	21.0	1.05	.500	.580	.460	1.12	1.035
684	6.4	89.4	4.13	.225	.260	.200	1.14	1.015
687	88.8	5.02	6.14	---	---	---	---	---

TABLE 1. - Gross sedimentology and size distribution (Brooks).

Sample Station	Total Sediment			Acid Insoluble Sediment				
	Per Cent Acid Soluble	Per Cent Terrigenous Sand	Per Cent Silt and Clay	Median Diameter M_d	First Quartile Q_1	Third Quartile Q_3	Sorting S_o	Skewness S_k
689	9.2	70.6	20.2	.115	.157	.072	1.48	0.927
691	12.8	61.0	26.3	.072	.094	.060	1.25	1.044
692	23.6	36.5	43.6	.06	.072	.050	1.20	1.015
695	16.3	22.1	61.5	.052	.063	.043	1.22	1.00
698	16.3	76.1	7.4	---	---	---	---	---
700	21.4	13.8	64.7	.026	.052	.0135	1.92	1.04
702	17.6	48.2	34.2	.105	.200	.010	4.48	0.425
705	24.7	30.0	45.0	.046	.096	.005	4.38	0.476
709	53.0	25.2	21.5	.125	---	---	---	---
711	37.7	61.4	1.44	.270	.300	.240	1.12	0.995
712	15.2	81.8	2.38	.140	.180	.120	1.23	1.05
716	1.6	98.0	0.33	.230	.260	.210	1.11	1.015
717	3.3	94.1	2.61	.210	.248	.176	1.18	0.995
718	10.3	47.8	41.4	.066	.105	.041	1.60	0.994
722	5.8	90.5	3.22	.145	.190	.118	1.26	1.035

TABLE 1. - Gross sedimentology and size distribution (Brooks).

Sample Station	Total Sediment			Acid Insoluble Sediment				
	Per Cent Acid Soluble	Per Cent Terrigenous Sand	Per Cent Silt and Clay	Median Diameter M_d	First Quartile Q_1	Third Quartile Q_3	Sorting S_o	Skewness S_k
724	19.3	45.4	35.2	.074	.145	.038	1.95	1.005
726	15.3	54.8	29.8	.105	.165	.030	2.34	0.67
728	24.1	28.3	47.3	.050	.080	.027	1.72	0.929
729	14.1	63.7	18.3	.150	.220	.110	1.41	0.86
731	6.5	89.6	3.88	.160	.175	.143	1.10	0.99
733	20.7	58.7	20.6	.092	.140	.060	1.52	0.995
735	18.1	65.1	17.5	.110	.140	.074	1.37	0.921
741	15.1	79.0	5.91	.420	.620	.250	1.57	0.938
758	1.4	98.1	0.8	.155	.231	.100	1.52	0.98
760	9.5	78.0	12.3	.255	.280	.228	1.11	0.99

TABLE 2. - Composition of sediment > 62 μ (Brooks).

Sample Station	Percentage of a count of more than 2000 particles.									
	Quartz	Heavy Minerals	Glauconite	Mica	Broken Shell	Mollusca	Foraminifera	Ostracoda	Coral and Algae	Other
629	56.0	2.8	15.3	1.4	14.1	2.8	4.7	1.4	---	1.5
630	71.0	25.5	2.8	0.7	---	---	---	---	---	---
631	67.8	24.4	2.8	0.7	3.4	---	0.9	---	---	---
633	66.4	29.9	3.3	0.4	---	---	---	---	---	---
634	75.0	22.0	2.4	---	---	---	0.6	---	---	---
635	91.6	4.1	0.5	1.6	1.3	---	0.6	---	---	---
636	47.9	3.6	3.1	3.8	32.0	---	9.6	---	---	---
637	50.5	1.4	1.8	2.8	25.3	---	18.0	---	---	---
640	48.8	---	2.1	2.1	13.0	---	33.0	---	---	1.0
642	29.5	2.9	3.6	2.9	21.3	1.4	29.0	2.9	---	6.5
644	93.8	1.7	---	0.7	1.9	---	1.9	---	---	---
648	81.7	---	---	---	11.9	1.8	2.4	0.2	---	2.0
651	85.5	1.5	0.9	---	5.3	1.1	5.1	0.6	---	---
653	96.0	0.7	---	---	2.5	0.2	0.5	0.1	---	---
655	70.0	0.8	9.4	0.5	13.0	1.7	3.3	0.3	---	1.0

TABLE 2. - Composition of sediment > 62 μ (Brooks).

Sample Station	Percentage of a count of more than 2000 particles.									
	Quartz	Heavy Minerals	Glauconite	Mica	Broken Shell	Mollusca	Foraminifera	Ostracoda	Coral and Algae	Other
657	98.1	---	---	---	1.5	---	0.4	---	---	---
659	92.4	2.3	0.05	0.1	2.7	---	2.3	0.05	---	---
662	91.1	1.0	0.6	---	5.5	0.4	1.4	---	---	---
664	99.1	---	---	---	0.2	0.2	0.4	0.1	---	---
665	94.1	0.6	---	---	2.8	0.7	0.2	0.4	1.2	---
667	99.2	0.2	---	---	0.5	---	0.1	---	---	---
670	92.4	0.3	0.1	0.2	4.3	1.0	1.0	0.2	0.5	---
672	94.0	0.3	0.1	0.1	4.2	0.2	0.9	0.2	---	---
674	15.9	---	---	1.9	52.6	5.4	17.6	0.5	---	6.1
676	23.1	0.6	1.1	1.3	52.4	2.6	11.2	1.3	---	6.4
678	98.4	0.5	---	---	0.5	0.1	0.3	0.1	0.1	---
680	99.9	---	---	---	---	0.1	---	---	---	---
682	60.4	0.1	---	0.1	4.0	0.9	5.2	0.3	29.0	---
684	94.2	0.5	---	0.1	2.4	0.2	2.4	0.2	---	---
687	5.8	---	---	---	25.4	12.2	44.5	4.4	6.4	1.3

TABLE 2. - Composition of sediment > 62 μ (Brooks).

Sample Station	Percentage of a count of more than 2000 particles.									
	Quartz	Heavy Minerals	Glauconite	Mica	Broken Shell	Mollusca	Foraminifera	Ostracoda	Coral and Algae	Other
689	86.1	1.0	0.6	0.4	6.2	0.6	3.5	0.6	---	1.0
691	52.4	0.8	7.1	3.5	11.5	---	23.0	---	---	1.7
692	70.4	0.5	3.8	1.6	9.1	1.0	10.8	1.0	---	0.8
695	55.8	0.9	1.8	3.6	20.9	1.2	13.7	0.9	---	1.2
698	70.1	1.9	3.1	1.4	13.6	0.9	7.0	0.4	---	1.6
700	63.6	2.3	2.3	2.3	16.2	---	10.2	0.9	---	2.2
702	49.0	1.6	2.8	2.8	23.3	0.8	16.0	0.5	---	3.2
705	68.4	4.0	6.8	1.8	4.2	1.0	12.0	0.6	---	1.2
709	15.7	3.4	7.0	0.7	22.4	2.1	27.4	2.1	15.8	3.4
711	83.4	0.4	0.2	0.4	7.7	2.0	2.8	0.4	1.0	1.7
712	88.3	2.3	1.4	1.4	---	0.4	5.1	1.1	---	---
716	99.4	---	---	---	0.5	0.05	0.05	---	---	---
717	99.0	---	---	---	0.7	0.3	---	---	---	---
718	78.5	0.4	9.9	2.0	3.9	0.2	3.9	0.2	---	1.0
722	93.0	2.0	0.5	0.2	3.7	0.1	0.4	0.1	---	---

TABLE 2. - Composition of sediment > 62 μ (Brooks).

Sample Station	Percentage of a count of more than 2000 particles.									
	Quartz	Heavy Minerals	Glauconite	Mica	Broken Shell	Mollusca	Foraminifera	Ostracoda	Coral and Algae	Other
724	61.0	0.7	0.7	2.1	18.0	0.7	14.0	1.4	---	1.4
726	73.0	1.2	2.2	1.7	8.7	1.0	10.0	1.0	---	1.2
728	56.2	1.3	1.7	1.8	17.3	1.3	17.5	0.9	---	2.0
729	64.9	2.4	3.1	1.4	11.0	1.0	14.0	0.7	---	1.5
731	88.7	1.0	1.3	0.5	4.1	0.3	3.5	0.1	---	0.5
733	61.6	1.2	1.5	1.2	21.0	0.6	12.0	0.9	---	---
735	73.3	1.5	2.1	1.1	8.9	1.5	10.3	0.2	---	1.1
741	88.2	7.3	0.3	0.2	2.2	0.3	1.4	0.1	---	---
758	85.8	1.3	1.3	2.8	4.8	0.8	3.0	0.2	---	---
760	99.4	---	---	---	0.5	0.1	---	---	---	---

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
26	Core	6.0	4.0	12.8	11.75	14.86	73.39	13.79	235	0	232	3	0
27	Core	3.0	2.0	13.0	45.92	15.15	38.93	4.44	167	0	146	19	2
31	Core	9.0	27.5	16.2	1.00	14.53	84.47	12.27	264	0	6	254	4
32	Core	10.5	27.0	16.2	2.18	32.81	65.01	7.42	100	1	23	76	0
33	Core	12.0	27.2	16.8	0.26	39.50	60.24	9.05	101	0	50	50	1
34	Core	13.0	27.5	16.8	0.13	45.13	54.74	8.35	51	0	18	31	2
35	Core	16.0	31.8	18.5	12.55	53.89	33.56	6.27	51	0	6	44	1
37	Grab	12.0	31.5	17.6	2.43	77.37	20.27	0.17	198	1	148	49	0
38	Grab	6.0	30.1	17.4	25.54	70.41	4.05	1.15	218	1	8	200	9
39	Grab	12.0	32.0	17.0	0.17	4.39	95.44	8.98	185	0	134	50	1
40	Core	6.0	26.0	16.2	0.38	9.64	89.98	11.76	500	0	9	488	3
41	Core	11.0	27.0	16.2	0.15	15.99	83.86	8.88	306	0	8	298	0
42	Core	12.0	27.2	16.8	0.06	27.22	72.72	10.23	73	0	36	35	2
43	Core	18.0	28.5	16.9	0.17	16.39	83.44	13.44	35	0	15	20	0
44	Core	9.0	28.9	17.0	51.90	45.71	2.38	1.56	112	0	21	78	13
46	Core	16.0	28.8	17.0	37.36	61.68	0.93	2.08	104	0	10	77	17

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
47	Core	12.0	28.8	17.4	0.11	44.81	55.08	9.85	104	0	31	72	1
48	Core	10.0	25.0	17.4	0.72	45.39	53.89	9.07	56	0	25	28	3
49	Core	8.0	25.0	17.0	7.38	43.68	48.94	5.96	103	0	19	79	5
50	Grab	3.0	25.0	17.0	12.17	87.54	0.29	0.56	55	0	28	25	2
51	Core	6.0	---	14.8	3.09	15.50	81.41	11.70	500	0	20	470	10
52	Core	10.0	---	15.6	0.08	11.71	88.21	12.24	500	2	6	492	0
53	Grab	27.0	---	---	5.95	65.39	28.65	4.87	66	0	31	25	10
54	Grab	3.5	---	---	26.32	56.70	16.96	13.47	228	1	202	23	2
55	Grab	6.0	---	---	1.97	80.86	17.16	5.31	281	0	280	1	0
56	Core	5.0	15.0	15.4	3.33	41.55	55.12	6.51	222	0	221	1	0
57	Core	9.0	17.8	15.4	7.50	15.30	77.20	10.66	222	0	201	16	5
58	Core	9.0	24.3	16.2	0.15	3.86	95.99	14.44	210	0	172	36	2
59	Grab	2.0	17.0	15.4	22.21	64.81	12.98	1.79	37	0	37	0	0
60	Grab	0.5	25.2	11.0	14.42	80.92	4.66	1.21	104	0	53	51	0
61	Grab	1.0	25.8	13.3	---	---	---	1.70	99	0	41	58	0
62	Core	1.0	25.8	12.1	1.09	6.74	92.17	7.92	394	0	16	378	0

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
65	Grab	1.0	24.9	10.0	19.81	67.87	12.32	18.56	101	0	5	74	22
66	Core	1.0	25.2	11.7	0.80	60.26	38.94	3.38	103	0	97	6	0
67	Core	10.0	27.0	13.0	0.13	9.83	90.04	13.43	501	0	56	443	2
68	Core	12.0	27.1	13.4	0.76	9.77	89.47	11.95	206	0	54	152	0
69	Core	13.0	27.2	14.0	0.11	7.69	92.20	12.76	115	1	37	77	0
71	Core	17.0	32.0	15.0	0.32	6.13	93.55	14.93	28	0	7	21	0
72	Core	16.0	27.0	13.5	0.06	24.47	75.47	10.26	74	0	53	21	0
73	Core	14.0	27.1	12.8	0.04	20.59	79.37	11.46	67	0	28	38	1
74	Core	13.0	25.8	13.5	0.05	13.81	86.14	12.51	91	0	69	22	0
75	Core	8.0	27.0	---	10.28	34.87	54.85	7.14	204	0	74	128	2
77	Core	8.0	25.8	12.8	19.61	39.73	40.66	5.44	210	0	71	137	2
78	Core	7.0	25.9	12.8	1.29	10.07	88.64	8.96	393	0	46	325	22
79	Core	11.0	25.7	12.6	7.57	27.04	65.39	7.76	253	0	37	205	11
80	Core	6.0	18.1	12.8	36.19	41.43	22.38	5.63	135	0	37	85	13
81	Core	6.0	19.5	12.6	24.61	31.08	44.31	6.10	111	0	44	58	9
82	Core	8.0	21.8	13.0	2.24	5.86	91.90	10.92	459	0	139	306	14

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
83	Core	18.0	26.2	14.8	0.10	2.84	97.06	12.19	402	0	277	108	17
84	Core	18.0	29.1	16.4	12.97	83.53	3.48	11.90	283	1	15	255	12
85	Grab	18.0	30.5	16.4	43.72	55.67	0.60	2.96	304	4	1	271	28
87	Core	24.0	32.0	16.8	1.22	76.88	21.88	7.78	501	0	9	472	20
89	Grab	12.0	31.0	16.0	87.25	12.65	0.07	1.64	50	0	1	45	4
90	Grab	12.0	30.0	16.0	64.26	35.64	0.08	0.75	35	0	7	18	10
91	Grab	14.0	31.0	15.4	33.85	70.03	0.19	1.56	101	1	25	50	25
92	Core	16.0	31.0	15.4	5.33	54.36	40.31	7.40	183	0	19	157	7
93	Core	12.0	27.0	15.4	2.63	49.59	47.78	6.40	109	0	29	75	5
94	Core	11.0	25.8	14.0	3.36	18.90	77.74	11.14	363	0	60	281	22
102	Grab	0.5	---	---	---	---	---	1.20	55	0	51	4	0
105	Grab	0.5	11.3	15.1	---	---	---	13.95	53	0	27	22	4
107	Core	6.0	28.0	15.0	22.32	23.73	53.95	6.28	120	0	15	104	1
109	Core	7.0	23.5	14.4	11.02	29.83	59.15	11.02	175	0	31	134	10
110	Core	16.0	30.5	14.8	5.57	67.36	27.07	5.67	180	0	13	152	15
112	Grab	17.0	32.5	15.8	12.71	81.22	6.07	12.71	105	0	2	89	14

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
114	Grab	17.0	32.0	15.4	13.86	84.28	1.84	3.71	136	0	3	120	13
115	Grab	18.0	33.0	15.8	46.41	53.37	0.21	3.94	230	1	4	191	34
116	Grab	1.0	34.0	15.0	0.87	22.28	76.85	15.14	214	0	99	79	36
118	Grab	6.0	29.0	13.8	---	---	---	15.02	156	0	77	73	6
119	Core	14.0	31.8	15.4	1.01	16.44	82.55	14.40	116	0	70	40	6
120	Core	18.0	31.0	15.4	0.06	5.06	94.88	13.75	359	0	281	77	1
121	Core	18.0	32.5	15.0	0.46	10.13	89.41	13.98	143	0	85	53	5
122	Core	8.0	28.2	14.6	0.05	4.11	95.84	14.16	275	0	25	236	14
123	Core	12.0	20.3	14.8	0.04	1.12	98.84	17.05	191	0	66	117	8
124	Core	13.0	24.0	14.4	0.12	3.74	96.14	13.62	299	0	233	70	6
125	Core	12.0	30.5	14.0	0.07	7.14	92.79	18.76	193	0	92	92	9
126	Core	14.0	29.0	13.9	15.30	36.67	48.03	8.16	102	0	51	48	3
127	Core	13.0	24.8	13.2	10.02	21.31	68.67	7.85	100	0	51	37	12
128	Core	9.0	24.2	13.2	3.62	14.73	81.65	12.78	222	0	204	17	1
129	Grab	3.0	23.2	13.2	21.60	61.97	16.43	3.04	106	0	42	54	10
131	Grab	12.0	25.2	13.3	25.35	51.42	23.23	2.97	83	0	50	29	4

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
132	Core	7.0	20.0	13.2	3.88	34.42	61.70	4.94	101	0	94	6	1
133	Core	8.0	20.0	13.2	0.18	8.13	91.67	14.79	123	0	79	39	5
134	Core	6.0	20.0	13.8	1.06	21.29	77.65	24.87	135	0	30	104	1
135	Core	9.0	19.0	12.8	0.06	6.96	92.98	0.57	214	0	56	157	1
136	Core	6.0	19.8	15.4	0.31	13.58	86.11	14.53	525	0	148	351	16
137	Core	4.0	19.0	12.8	16.43	18.55	65.02	7.34	131	0	20	102	9
138	Core	8.0	18.4	12.6	0.10	2.15	97.75	11.51	477	0	60	367	50
139	Core	7.0	25.2	13.9	3.03	9.94	87.03	13.05	310	0	12	263	35
140	Grab	5.0	27.2	14.0	56.44	41.54	2.02	0.76	55	0	35	8	12
142	Grab	12.0	30.5	14.8	0.55	13.12	86.33	7.77	109	0	103	6	0
143	Grab	6.0	32.2	15.2	0.90	5.86	93.24	9.88	201	0	50	140	11
144	Grab	20.0	29.8	14.4	---	---	---	1.38	101	0	53	45	3
145	Core	7.0	21.8	14.8	35.92	43.92	20.16	3.27	121	0	64	53	4
148	Core	7.0	24.2	13.8	1.37	5.14	93.49	11.11	330	0	87	221	22
149	Core	8.0	23.0	13.6	8.92	29.13	61.95	7.39	293	1	152	130	10
150	Grab	9.0	24.0	13.6	34.90	60.29	4.79	1.78	108	0	72	33	3

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
151	Grab	9.0	21.8	13.6	2.15	37.01	60.84	4.72	197	0	132	60	5
153	Grab	12.0	25.0	13.8	68.47	24.54	6.97	6.46	54	0	7	30	17
172	Grab	12.0	29.5	15.0	24.68	74.49	0.81	3.31	102	0	32	46	24
173	Core	14.0	29.0	15.2	0.17	10.63	89.20	7.78	162	0	130	30	2
177	Grab	3.0	27.0	14.0	1.42	50.59	47.98	16.02	106	0	2	102	2
179	Grab	6.0	27.0	15.0	0.76	5.00	94.24	10.79	303	0	75	211	17
181	Grab	3.0	28.5	15.0	1.39	7.59	91.02	11.85	441	1	27	389	24
182	Grab	0.5	30.0	15.4	---	---	---	3.48	215	0	76	90	49
207	Grab	---	---	---	---	---	---	8.09	174	0	170	3	1
209	Grab	---	---	---	---	---	---	0.59	473	0	469	3	1
212	Grab	---	---	---	---	---	---	9.35	119	0	18	19	82
220	Core	15.0	24.8	15.8	53.06	23.75	23.19	4.21	114	0	25	82	7
221	Core	17.0	25.0	14.8	24.18	18.09	57.73	10.99	252	0	92	154	6
223	Core	20.0	31.0	17.5	21.09	45.64	33.27	8.19	167	0	2	145	20
229	Grab	23.0	34.5	18.2	43.93	55.82	0.24	1.00	49	0	4	44	1
230	Grab	17.0	34.5	17.5	51.18	48.63	0.17	2.52	101	0	6	84	11

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
231	Grab	22.0	34.5	18.2	19.65	77.29	3.28	3.99	114	0	1	106	7
232	Grab	23.0	33.9	17.8	16.19	83.25	0.56	2.00	101	0	8	89	4
233	Grab	38.0	34.0	17.7	3.37	64.04	32.59	8.92	426	0	2	388	36
235	Core	18.0	27.0	16.4	28.48	48.55	22.97	6.26	210	0	16	177	17
236	Core	18.0	29.8	16.6	0.33	8.83	90.84	15.41	207	0	64	129	14
237	Grab	13.0	26.0	15.0	26.44	45.37	28.19	3.40	339	1	27	298	13
238	Core	7.0	23.0	14.4	0.15	11.30	88.55	12.28	272	0	129	138	5
239	Core	5.0	20.2	14.4	1.39	51.17	47.44	6.82	111	0	88	23	0
240	Core	10.0	23.0	15.2	0.21	1.42	98.37	13.60	315	0	153	149	13
241	Core	6.0	27.0	15.4	69.88	12.55	17.57	3.63	102	0	24	74	4
245	Grab	22.0	30.2	16.4	15.88	82.94	2.75	0.87	66	0	4	56	6
246	Grab	22.0	32.5	16.5	10.70	89.07	0.20	0.12	110	0	0	104	6
247	Grab	17.0	33.0	15.8	6.88	87.47	1.90	2.48	116	0	9	100	7
249	Grab	22.0	30.0	16.4	13.95	85.02	1.01	2.12	114	1	9	98	6
250	Grab	40.0	32.0	16.8	22.08	60.97	16.95	6.35	217	1	7	197	12
251	Grab	40.0	34.0	16.9	14.41	77.44	8.15	5.31	130	0	5	122	3

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
252	Grab	34.0	32.0	16.4	7.96	75.12	16.92	10.78	147	1	5	126	15
253	Grab	32.0	33.0	16.6	2.08	86.17	11.75	9.12	209	1	2	175	31
304	Grab	10.0	18.5	15.2	0.25	7.44	92.31	5.00	242	0	231	10	1
323	Grab	3.0	16.0	14.0	---	---	---	6.77	226	0	193	32	1
326	Core	1.5	3.5	10.0	0.21	18.43	81.36	8.17	446	0	442	4	0
333	Grab	4.0	4.2	12.0	5.34	67.25	27.41	0.97	52	0	50	2	0
334	Grab	4.0	7.5	12.5	11.79	72.02	16.19	3.92	114	0	96	16	2
337	Core	4.0	12.5	---	0.84	66.40	32.76	5.28	113	0	82	25	6
358	Core	13.0	31.0	17.0	5.00	22.46	72.54	10.14	190	0	47	130	13
359	Core	10.0	29.5	16.0	3.29	54.15	42.56	6.03	163	0	66	85	12
360	Grab	9.0	24.2	14.0	10.62	88.89	0.48	1.32	50	0	41	2	7
361	Grab	8.0	24.2	15.4	22.70	76.63	0.67	1.56	50	0	42	5	3
362	Core	9.0	24.0	14.4	5.26	88.35	6.39	1.66	104	0	59	44	1
363	Grab	9.0	24.8	15.0	1.10	54.86	44.04	3.83	142	0	55	86	1
364	Core	7.0	24.0	14.0	1.16	63.46	35.38	4.07	113	0	56	55	2
365	Core	9.0	29.0	15.0	6.07	58.26	35.67	5.71	130	0	65	63	2

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
366	Core	8.0	30.5	15.4	1.02	21.98	77.00	11.64	344	0	50	285	9
370	Grab	0.0	---	---	---	---	---	16.20	120	0	6	33	81
373	Grab	0.0	---	---	---	---	---	1.98	116	0	87	11	18
380	Grab	9.0	28.3	---	69.42	30.50	0.05	0.68	51	0	1	48	2
381	Grab	24.0	29.9	---	15.72	84.12	0.15	0.87	51	0	1	46	4
383	Grab	14.0	28.7	---	36.74	63.21	0.04	0.97	23	3	0	20	0
384	Grab	41.0	34.0	---	42.73	56.55	0.71	2.90	53	0	3	44	6
385	Grab	44.0	34.2	---	55.59	42.66	1.74	9.30	147	0	2	138	7
386	Grab	42.0	34.0	---	26.73	64.56	8.71	7.74	122	0	5	115	2
387	Grab	50.0	35.5	---	27.31	63.49	9.20	6.12	204	0	11	182	11
389	Grab	40.0	32.5	---	36.29	29.37	34.34	5.87	206	2	2	170	32
390	Grab	35.0	29.5	---	35.88	63.98	0.13	2.74	55	0	3	48	4
393	Core	12.0	27.0	---	0.82	30.62	68.56	4.26	251	0	101	142	8
394	Core	15.0	22.8	---	0.35	40.75	58.90	10.40	126	0	51	74	1
395	Core	14.0	24.5	---	0.74	39.53	59.73	8.54	152	0	26	117	9
396	Core	15.0	27.0	---	7.13	49.62	43.25	6.27	196	0	46	150	0

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
399	Core	9.0	21.5	---	4.55	37.92	57.53	9.58	199	0	46	146	7
400	Core	13.0	26.0	---	0.20	10.37	89.43	14.40	208	0	129	62	17
401	Core	17.0	28.5	---	1.48	35.98	62.54	5.35	199	0	20	178	1
402	Core	17.0	27.4	---	0.34	20.15	79.51	10.07	139	0	50	82	7
404	Core	6.0	29.0	---	24.20	53.14	22.66	6.53	174	2	1	151	20
406	Core	7.0	29.0	---	22.00	56.18	21.82	7.85	110	0	5	78	27
407	Grab	22.0	30.0	---	0.27	1.11	98.62	12.07	307	0	41	244	22
409	Grab	3.0	30.1	---	79.31	14.91	5.78	1.54	146	0	6	117	23
410	Grab	6.0	29.0	---	59.54	40.38	0.08	0.98	50	0	3	41	6
411	Grab	4.0	28.8	---	24.90	74.94	0.15	2.97	119	0	1	107	11
412	Grab	3.0	28.0	---	56.66	43.24	0.08	1.43	101	0	2	84	15
413	Grab	18.0	26.0	---	50.23	49.42	0.32	1.13	133	1	2	113	17
414	Core	16.0	27.3	---	0.08	2.99	96.93	13.12	480	1	35	397	47
415	Core	15.0	25.9	---	0.09	1.21	98.70	14.73	302	0	22	243	37
416	Core	13.0	23.3	---	0.43	16.00	83.57	10.70	433	0	39	373	21
419	Grab	10.0	32.3	15.4	28.26	71.62	0.11	0.95	102	1	1	98	2

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
421	Grab	35.0	31.3	15.8	85.19	14.71	0.08	0.66	49	0	3	44	2
422	Grab	40.0	29.0	---	26.87	39.94	33.19	10.27	227	2	6	189	30
423	Grab	35.0	34.0	16.2	19.28	29.44	51.28	10.34	387	0	4	354	29
424	Grab	32.0	35.0	16.0	0.73	17.18	82.09	14.72	288	0	11	238	39
426	Grab	25.0	29.0	15.4	1.55	8.47	89.98	18.45	320	5	8	283	24
427	Grab	23.0	30.0	15.0	0.10	18.81	81.09	19.37	322	2	10	269	41
428	Grab	20.0	32.8	15.4	0.12	3.33	96.55	15.13	434	2	3	359	70
429	Grab	20.0	34.0	15.4	0.23	12.52	87.25	14.23	443	0	3	401	39
430	Core	16.0	29.0	15.4	0.30	4.89	94.80	19.86	298	2	33	233	30
434	Grab	40.0	31.8	14.8	---	---	---	1.09	101	0	5	87	9
435	Grab	57.0	31.6	14.8	5.13	25.24	69.63	9.61	543	2	11	497	33
436	Grab	55.0	34.0	15.0	0.85	17.45	81.70	11.20	293	1	14	241	37
441	Grab	22.0	32.5	---	---	---	---	1.73	109	0	5	103	1
444	Core	7.0	4.0	---	7.62	14.46	77.92	9.38	469	0	37	401	31
445	Core	8.0	4.0	---	6.69	6.68	86.63	12.44	334	0	11	287	36
446	Core	9.0	7.0	---	16.27	33.42	50.31	8.47	541	0	52	449	40

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
447	Core	7.0	5.0	---	0.13	4.33	95.54	10.74	482	0	26	413	43
448	Core	5.0	6.0	16.0	0.61	7.80	91.59	9.08	678	0	90	566	22
449	Core	6.0	7.0	14.0	12.36	49.20	38.44	5.63	217	1	94	115	7
450	Core	8.0	8.0	14.0	4.72	27.02	68.26	10.31	438	0	148	264	26
451	Core	9.0	9.0	10.0	42.10	41.31	16.59	2.40	187	0	85	102	0
452	Core	3.0	10.0	10.2	13.91	65.31	20.78	3.72	119	0	28	84	7
453	Core	11.0	18.0	---	0.07	1.96	97.97	9.92	383	0	24	314	45
454	Core	8.0	23.0	---	0.07	4.62	95.31	11.01	404	0	52	279	73
455	Core	8.0	25.0	---	17.27	47.44	35.29	3.44	176	0	25	145	6
456	Core	13.0	23.0	---	0.07	0.73	99.20	13.24	461	0	73	357	31
457	Core	14.0	23.0	---	0.74	0.50	98.76	16.37	257	0	34	191	32
458	Core	13.0	23.2	---	3.85	43.46	52.69	6.66	668	0	149	465	54
460	Core	17.0	30.0	---	3.93	48.34	47.73	8.84	443	2	16	415	10
461	Core	18.0	27.0	---	18.57	42.71	38.72	8.46	217	0	9	199	9
462	Core	20.0	25.0	---	14.39	34.00	51.61	7.35	234	0	4	211	19
464	Core	8.0	25.5	---	26.48	44.96	28.56	4.60	138	0	62	68	8

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
465	Core	8.0	27.0	---	3.73	35.14	61.13	10.12	132	0	118	14	0
467	Core	3.0	25.0	---	0.91	42.40	56.69	3.82	108	1	84	23	0
468	Core	3.0	24.5	---	1.87	39.27	58.86	3.49	117	0	110	6	1
469	Core	2.0	21.5	---	0.88	28.45	70.67	4.52	159	0	112	26	1
470	Core	1.0	21.5	---	0.09	33.01	66.90	2.98	15	0	15	0	0
476	Core	3.0	23.0	---	28.85	53.41	17.74	2.35	52	0	19	31	2
477	Core	13.0	27.2	---	0.64	15.21	84.15	9.27	191	0	163	27	1
478	Core	4.5	27.0	---	0.11	46.13	53.76	4.65	108	0	90	18	0
479	Core	5.0	23.0	---	1.14	60.23	38.63	7.01	106	0	92	9	5
480	Core	5.0	22.0	---	0.30	48.00	51.70	3.84	109	0	104	5	0
481	Core	3.0	21.5	---	2.62	44.20	53.18	3.27	125	0	125	0	0
482	Core	3.0	20.5	---	19.31	28.55	52.14	3.16	101	0	97	4	0
483	Core	2.0	22.0	---	0.27	56.95	42.78	2.06	109	0	109	0	0
484	Core	2.0	23.0	---	13.48	52.12	34.40	3.69	108	0	106	2	0
485	Core	6.0	22.0	---	0.90	50.11	48.99	3.96	153	0	132	21	0
487	Core	18.0	31.0	---	0.58	24.52	74.90	8.74	155	0	39	113	3

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
488	Core	20.0	23.0	---	2.17	41.47	56.36	8.79	270	0	10	240	20
489	Core	22.0	24.5	---	2.00	51.60	46.40	10.11	278	0	4	259	15
490	Core	16.0	22.0	---	6.07	43.14	50.79	6.92	152	0	11	137	4
491	Core	15.0	25.0	---	5.17	40.04	54.79	7.00	254	0	33	198	23
492	Core	19.0	29.5	---	3.54	44.54	51.92	8.95	218	0	20	181	17
494	Grab	24.0	30.0	---	1.24	15.13	83.83	7.80	188	0	53	132	3
495	Core	16.0	28.5	---	0.30	11.49	88.21	8.23	184	0	93	85	6
497	Grab	20.0	29.8	---	13.00	83.23	3.75	8.30	109	0	3	100	6
498	Grab	16.0	27.0	---	15.05	84.77	0.17	1.24	50	0	0	47	3
500	Grab	18.0	27.0	---	1.65	94.69	3.66	4.25	138	1	0	136	1
501	Core	21.0	30.0	---	1.62	82.35	16.03	5.87	319	0	1	299	19
502	Core	25.0	28.7	---	9.80	58.15	42.15	9.41	323	1	1	314	7
503	Grab	30.0	31.5	---	8.09	10.62	81.29	18.09	442	0	4	430	8
508	Grab	24.0	31.5	---	0.87	11.16	87.97	9.21	110	0	56	51	3
509	Core	18.0	29.5	---	0.45	15.91	83.64	15.66	205	0	30	148	27
510	Core	8.0	17.0	---	0.27	6.76	92.97	18.13	482	0	46	400	36

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
511	Grab	42.0	22.0	14.0	3.56	3.96	92.48	9.11	104	0	4	75	25
514	Core	13.0	22.0	---	26.53	29.43	44.04	1.99	58	0	0	43	15
516	Core	16.0	22.0	---	2.66	23.16	74.18	17.40	311	0	15	248	48
517	Core	29.0	29.0	---	12.92	37.55	49.53	11.56	170	1	11	105	53
518	Core	22.0	24.0	---	64.83	27.31	7.86	3.17	53	0	0	31	22
519	Grab	35.0	36.0	---	1.46	23.06	75.48	11.84	206	0	10	184	12
520	Core	6.0	24.0	---	1.52	54.65	43.83	5.78	188	0	151	37	0
521	Core	6.0	24.0	---	10.22	48.08	41.70	17.72	246	0	177	69	0
522	Core	1.0	25.3	---	1.02	43.93	55.05	18.70	102	0	85	16	1
524	Grab	40.0	31.0	---	1.46	34.74	63.80	12.70	310	0	9	271	30
525	Core	12.0	5.0	13.8	0.18	9.51	90.31	17.73	416	0	49	315	52
526	Grab	16.0	3.8	13.3	3.47	3.06	93.47	7.23	185	0	113	59	13
529	Core	7.0	14.5	15.3	0.77	4.70	94.53	19.61	318	0	32	256	30
530	Core	20.0	36.5	15.5	0.12	1.63	98.25	21.42	516	1	21	465	29
531	Core	13.0	23.5	15.5	0.40	25.42	74.18	19.22	378	0	20	307	51
532	Core	9.0	17.7	15.0	0.05	2.15	97.80	18.11	298	0	13	260	25

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
533	Core	9.5	14.2	14.5	0.10	1.77	98.13	17.52	314	0	45	257	12
534	Core	12.0	21.8	---	0.24	3.08	96.68	18.03	429	0	39	358	32
535	Core	13.0	17.0	14.3	0.03	0.30	99.67	21.83	574	0	110	407	57
536	Core	14.0	34.0	---	0.07	3.97	95.96	20.70	356	0	245	107	4
537	Core	13.0	19.5	14.0	0.09	0.77	99.14	19.07	360	0	125	218	17
539	Core	10.5	5.0	15.0	0.15	2.20	97.65	17.99	279	0	69	199	11
540	Grab	---	---	---	0.11	1.14	98.75	19.56	537	0	122	348	67
541	Core	10.0	5.0	13.8	0.03	0.24	99.73	16.71	703	0	333	350	20
542	Core	11.0	6.2	14.0	0.14	0.76	99.10	19.52	690	0	381	273	36
543	Core	10.0	4.0	14.1	0.21	0.27	99.52	16.24	828	0	390	403	35
544	Core	10.0	9.0	15.0	0.26	0.50	99.24	18.14	564	0	150	385	29
545	Core	11.0	8.0	15.0	0.13	1.15	98.72	20.21	373	0	32	309	32
546	Core	9.0	7.0	14.5	0.05	1.25	98.70	15.21	410	0	124	263	23
547	Core	10.0	5.0	---	0.01	0.37	99.62	14.17	621	0	186	418	17
548	Core	11.0	5.5	---	0.03	3.88	96.15	15.46	794	0	189	577	28
549	Core	11.0	5.0	15.1	0.02	0.20	99.78	16.84	357	0	8	332	17

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
550	Core	7.0	6.5	15.7	0.48	8.23	91.29	15.15	471	0	161	246	64
551	Core	10.0	26.0	15.9	0.41	34.10	65.49	9.64	237	0	33	199	5
552	Core	3.5	7.0	---	0.85	16.12	83.03	7.87	228	0	173	47	8
553	Core	6.0	6.8	---	3.60	14.80	81.60	7.66	220	0	61	143	16
554	Core	2.0	8.0	---	6.03	65.81	28.16	3.05	130	0	102	26	2
555	Core	3.0	15.0	---	5.81	72.17	22.02	3.57	142	0	118	19	5
556	Core	5.0	17.8	---	0.10	25.04	74.85	7.16	162	0	155	7	0
557	Core	4.0	18.0	---	0.03	25.20	74.77	11.27	177	0	171	6	0
558	Core	6.0	17.5	---	0.26	38.21	61.53	11.88	220	0	200	16	4
559	Core	---	5.0	19.0	2.09	46.82	51.09	8.69	131	0	125	5	1
560	Core	---	---	---	0.75	65.22	34.03	6.15	118	0	113	4	1
564	Grab	17.0	33.0	18.0	64.66	35.29	0.05	4.11	25	0	0	19	6
566	Grab	27.0	32.8	18.2	1.51	44.44	54.05	7.29	323	4	3	302	14
567	Grab	30.0	31.5	18.9	1.28	2.14	96.58	6.64	693	2	6	656	29
568	Grab	28.0	31.8	19.0	27.47	61.38	11.15	25.39	251	0	0	241	10
569	Grab	26.0	32.0	19.0	5.05	71.45	23.50	11.08	530	4	11	481	34

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
570	Grab	28.0	35.0	17.5	33.62	66.13	0.24	0.94	111	0	1	108	2
571	Grab	23.0	30.8	18.5	6.46	85.22	8.31	5.57	336	1	3	324	8
572	Grab	23.0	30.5	18.5	36.26	58.38	5.36	1.07	360	0	8	341	11
575	Core	18.0	25.8	19.0	0.11	1.49	98.40	15.95	151	0	137	13	1
576	Core	20.0	24.5	19.2	0.07	7.17	92.76	18.18	146	0	60	79	7
577	Core	17.0	23.0	19.5	0.03	4.61	95.36	10.33	226	0	27	184	15
578	Core	14.0	19.7	20.5	0.03	4.32	95.65	15.55	206	0	49	148	9
579	Core	12.0	22.2	20.3	0.06	4.08	95.86	14.72	219	0	12	203	4
580	Core	11.0	21.0	20.2	0.05	8.88	91.07	14.53	318	0	42	274	2
581	Core	10.0	19.5	20.5	0.02	10.19	89.79	12.46	253	0	17	235	1
582	Core	9.0	18.3	20.5	0.26	5.66	94.08	13.58	515	0	53	426	36
583	Core	8.0	18.5	20.9	0.32	7.29	92.39	8.46	603	0	257	338	8
584	Core	8.0	17.0	20.8	0.37	15.24	84.39	5.75	414	0	167	247	0
586	Grab	3.0	6.5	---	16.35	68.90	14.73	2.11	102	0	57	38	7
587	Grab	3.0	4.5	---	16.01	78.74	5.23	1.16	103	0	60	34	9
588	Core	10.0	13.8	19.1	0.08	6.17	93.75	16.96	270	0	72	177	21

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
589	Core	13.0	15.0	18.9	0.01	1.20	98.79	14.65	367	0	83	268	16
590	Core	13.0	21.7	19.0	0.05	3.63	96.32	16.72	110	0	109	1	0
591	Grab	10.0	8.0	19.4	21.28	73.37	5.35	0.71	52	0	42	10	0
592	Core	15.0	20.5	19.5	0.50	30.98	68.52	12.58	105	0	93	12	0
593	Core	14.0	7.0	19.0	0.34	13.97	85.69	10.17	130	0	125	5	0
594	Grab	9.0	6.0	19.5	21.28	51.70	27.02	2.51	101	0	88	13	0
595	Grab	20.0	7.2	19.5	0.07	5.00	94.93	9.28	155	0	136	17	2
597	Core	11.0	14.0	20.0	10.34	9.73	79.93	8.78	101	0	87	13	1
599	Core	7.0	13.2	20.5	6.15	18.64	75.21	8.49	93	0	89	4	0
601	Grab	14.0	---	18.0	15.62	82.14	2.23	3.66	53	0	15	37	1
602	Grab	20.0	23.3	20.0	3.34	37.43	59.23	6.84	305	0	58	240	7
606	Core	12.0	20.5	19.5	5.34	19.88	74.78	8.18	108	0	25	82	1
610	Core	20.0	---	---	0.57	22.25	77.18	11.90	108	0	87	16	5
613	Core	14.0	---	---	0.03	1.47	98.50	13.22	379	0	370	8	1
614	Core	13.0	---	---	0.07	3.84	96.09	13.28	144	0	134	10	0
629	Grab	58.0	36.8	22.9	31.25	67.84	0.80	8.76	148	1	13	129	5

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
630	Grab	40.0	38.0	22.8	0.16	16.36	83.48	4.91	102	0	0	97	5
631	Grab	56.0	41.7	22.6	1.09	13.19	85.72	10.15	373	4	20	349	0
632	Grab	52.0	40.0	22.8	0.29	29.30	70.41	9.69	107	3	4	99	1
633	Grab	44.0	39.0	23.2	3.06	96.06	0.89	4.62	---	---	---	---	---
635	Grab	138.0	33.2	21.8	0.15	6.34	93.51	12.20	436	20	11	396	9
636	Grab	210.0	35.5	20.6	0.09	0.55	99.36	16.25	465	55	12	388	10
637	Grab	300.0	34.5	20.8	0.21	0.67	99.12	18.22	443	116	7	309	11
638	Grab	390.0	36.4	20.0	4.54	12.37	83.09	13.17	580	158	1	406	15
639	Grab	450.0	39.0	19.9	0.01	0.50	99.49	14.46	527	144	9	359	15
640	Grab	456.0	39.6	19.9	0.10	1.00	98.90	18.50	774	267	7	489	11
641	Grab	468.0	---	19.9	3.20	28.18	68.62	24.89	311	146	4	151	10
642	Grab	456.0	39.2	19.6	0.61	9.79	89.60	19.47	535	287	1	231	16
643	Grab	282.0	37.0	20.6	2.53	16.06	81.41	35.19	600	288	3	288	21
644	Grab	180.0	37.0	21.0	37.24	62.13	0.61	5.43	103	11	11	74	7
645	Grab	138.0	34.8	20.9	12.34	87.06	0.58	3.82	104	12	0	91	1
646	Grab	117.0	36.1	21.4	12.90	86.23	0.86	7.40	132	3	4	118	7

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
647	Grab	114.0	33.9	22.4	7.69	79.89	9.64	18.32	174	17	4	140	13
648	Grab	84.0	32.7	21.8	95.32	0.67	4.01	75.59	104	4	11	86	3
649	Grab	66.0	32.4	23.5	15.43	82.65	1.91	5.53	110	2	2	98	8
650	Grab	75.0	32.7	23.1	83.00	12.76	4.24	70.90	172	4	0	160	8
651	Grab	90.0	32.7	23.0	8.78	89.61	1.61	8.18	144	4	16	119	5
652	Grab	99.0	35.2	22.2	19.64	79.99	0.37	3.26	108	4	15	85	4
653	Grab	120.0	36.0	21.4	84.60	15.18	0.20	5.60	101	2	15	82	2
654	Grab	132.0	36.9	22.2	24.27	75.28	0.45	6.60	160	4	14	129	13
655	Grab	228.0	36.7	21.2	88.60	10.45	0.94	82.80	191	41	14	127	9
656	Grab	96.0	35.0	23.8	16.95	81.48	1.56	8.71	226	7	11	194	14
657	Grab	102.0	37.3	22.8	46.19	53.52	0.27	6.49	112	2	10	94	6
658	Grab	120.0	38.9	22.5	13.87	85.51	0.59	4.47	136	7	7	112	10
659	Grab	153.0	38.4	22.3	14.91	84.59	0.49	3.37	146	14	14	109	9
660	Grab	228.0	39.2	22.0	87.32	11.79	0.86	76.59	219	42	38	136	3
661	Grab	234.0	40.1	21.6	25.37	72.41	2.10	37.40	316	138	16	126	36
662	Grab	162.0	37.1	22.7	76.82	22.94	0.24	8.63	113	10	16	85	2

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
663	Grab	114.0	37.3	22.9	30.30	69.40	0.27	5.81	107	4	8	90	5
664	Grab	102.0	36.1	22.9	47.66	52.07	0.24	2.26	101	0	5	92	4
665	Grab	75.0	36.4	24.4	95.23	4.57	0.19	9.50	100	1	7	87	5
666	Grab	42.0	34.4	28.5	69.96	29.98	0.16	1.63	---	---	---	---	---
667	Grab	45.0	35.2	28.2	83.27	16.24	0.12	0.94	---	---	---	---	---
668	Grab	78.0	37.1	24.0	86.56	13.31	0.11	3.02	100	1	10	87	2
669	Grab	66.0	34.8	25.0	85.12	14.75	0.12	8.49	53	1	5	41	6
670	Grab	84.0	35.2	24.3	64.34	35.49	0.15	5.06	104	0	4	93	7
671	Grab	114.0	37.8	23.9	21.06	78.34	0.59	8.91	128	5	5	111	7
672	Grab	114.0	37.3	24.0	40.49	59.32	0.18	3.79	103	6	12	81	4
673	Grab	162.0	37.0	22.8	93.16	6.67	0.17	8.34	126	7	26	89	4
674	Grab	459.0	37.8	19.9	1.44	2.45	96.11	63.58	569	222	5	301	41
675	Grab	474.0	40.0	18.2	0.20	3.95	95.85	64.80	506	192	3	282	29
676	Grab	426.0	37.8	19.0	0.42	2.61	96.97	68.18	323	81	5	214	23
677	Grab	159.0	34.8	22.3	93.42	6.01	0.56	53.43	285	44	56	151	34
678	Grab	84.0	35.0	24.8	83.36	16.51	0.12	2.73	107	2	12	88	5

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
679	Grab	60.0	36.7	26.5	93.34	6.54	0.10	2.28	107	0	4	100	3
680	Grab	33.0	36.7	27.8	94.41	5.52	0.06	1.53	---	---	---	---	---
681	Grab	87.0	35.2	24.4	74.66	25.21	0.11	4.64	108	0	7	93	8
682	Grab	108.0	35.0	22.9	99.45	0.46	0.07	73.13	127	6	2	115	4
683	Grab	207.0	37.0	22.0	97.67	2.15	0.16	53.71	128	16	4	108	0
684	Grab	102.0	35.8	26.2	37.22	62.56	0.21	4.88	134	3	3	119	9
685	Grab	204.0	38.0	22.9	63.82	35.12	1.05	6.94	129	45	11	66	7
686	Grab	237.0	36.9	22.4	87.90	10.37	1.71	92.93	219	60	14	139	6
687	Grab	432.0	37.3	19.0	82.96	15.20	1.83	90.34	318	148	9	157	4
688	Grab	45.0	35.8	27.4	0.96	18.19	79.85	9.20	326	4	1	315	6
689	Grab	43.0	35.8	27.4	8.64	46.30	45.06	7.88	293	3	31	240	19
690	Grab	40.0	34.7	27.4	14.20	85.04	0.75	0.91	106	0	4	99	3
691	Grab	72.0	35.5	25.2	8.53	58.14	33.33	14.20	463	6	24	416	17
692	Grab	84.0	35.2	25.8	1.09	28.79	70.12	20.98	709	33	38	614	24
693	Grab	87.0	35.5	24.2	1.11	29.11	69.88	22.81	462	4	16	434	8
694	Grab	90.0	36.7	16.3	0.83	29.48	69.69	19.73	558	18	21	497	22

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250μ	62-250μ	<62μ			Planktonic	Arenaceous	Calcareous Benthonic	
695	Grab	96.0	36.1	23.5	0.67	17.63	81.20	17.31	509	39	19	430	21
696	Grab	98.0	36.7	23.6	0.14	16.27	83.59	10.69	414	18	11	374	11
697	Grab	102.0	36.4	23.4	0.30	27.77	71.93	6.68	113	1	9	97	6
698	Grab	126.0	36.7	23.1	0.26	8.02	91.72	11.84	474	26	25	411	12
699	Grab	162.0	37.3	22.5	0.48	11.46	88.06	14.17	601	67	21	479	34
700	Grab	180.0	36.1	22.4	0.29	9.38	90.33	19.67	350	42	18	273	17
701	Grab	198.0	36.0	21.2	0.24	5.78	93.98	19.56	459	106	6	338	9
702	Grab	210.0	35.2	22.2	22.93	30.36	46.71	17.71	291	57	48	164	22
703	Grab	255.0	36.0	21.5	20.14	22.69	57.17	11.60	155	61	22	66	6
704	Grab	270.0	38.7	22.4	33.65	61.79	4.55	9.93	252	84	31	131	6
705	Grab	288.0	35.2	22.0	3.39	24.94	71.67	27.86	344	120	18	198	8
706	Grab	207.0	38.8	21.6	82.45	16.10	1.44	5.20	115	25	37	53	0
707	Grab	177.0	37.3	23.0	71.63	28.02	0.32	22.72	100	12	25	61	2
708	Grab	456.0	---	19.5	0.97	15.82	83.21	26.91	228	116	5	100	7
709	Grab	468.0	40.6	19.0	80.24	12.70	7.03	18.27	408	178	17	209	4
710	Grab	450.0	37.9	19.6	9.06	73.65	17.28	52.62	373	184	13	161	15

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
711	Grab	123.0	37.0	23.6	90.31	9.06	0.60	43.72	165	9	18	133	5
712	Grab	117.0	37.0	23.0	24.51	73.05	2.43	18.95	206	5	24	166	11
713	Grab	108.0	37.0	25.6	8.41	88.51	3.06	13.40	188	8	18	155	7
714	Grab	76.0	36.0	25.8	29.92	69.52	0.56	3.69	110	0	10	97	3
715	Grab	57.0	40.0	27.3	34.84	64.89	0.26	1.71	51	0	3	44	4
716	Grab	48.0	34.9	28.3	38.80	61.00	0.19	1.36	---	---	---	---	---
717	Grab	30.0	33.5	28.9	23.63	76.17	0.19	3.30	23	1	4	16	2
718	Grab	36.0	33.7	30.2	2.98	33.84	63.18	11.57	272	1	0	264	7
719	Grab	42.0	32.1	28.5	13.25	57.01	29.75	7.90	105	0	10	82	13
720	Grab	45.0	32.3	27.3	80.38	19.47	0.13	7.07	62	1	6	52	3
721	Grab	54.0	33.7	26.9	27.11	70.79	2.09	8.31	107	0	13	83	11
722	Grab	69.0	34.8	24.6	12.58	85.66	1.76	5.71	133	1	7	117	8
723	Grab	102.0	35.8	23.5	3.27	48.19	43.54	19.60	484	10	24	430	20
724	Grab	111.0	36.0	23.0	9.19	31.51	59.30	20.25	320	12	18	280	10
725	Grab	115.0	35.8	23.2	7.68	42.31	50.01	17.09	238	16	13	202	7
726	Grab	129.0	35.9	23.4	5.16	36.46	58.88	17.81	294	31	33	203	27

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
727	Grab	150.0	34.8	24.6	10.59	39.03	50.38	18.55	349	35	47	243	24
728	Grab	174.0	33.2	22.9	2.65	29.41	67.94	24.42	401	65	13	307	16
729	Grab	186.0	34.3	22.4	6.99	25.65	57.46	19.16	348	92	26	209	21
730	Grab	171.0	33.2	25.2	20.31	78.18	1.50	10.80	187	35	38	99	15
731	Grab	141.0	35.2	22.4	12.50	86.01	1.49	6.76	192	11	28	142	11
732	Grab	126.0	33.0	23.3	17.85	80.69	1.45	8.59	157	10	19	120	8
733	Grab	129.0	35.9	23.3	6.42	55.10	38.48	18.37	250	16	24	189	21
734	Grab	117.0	35.8	24.0	6.55	60.55	32.90	20.43	339	9	22	294	14
735	Grab	102.0	35.0	23.0	10.38	58.49	31.13	16.57	226	11	7	204	4
736	Grab	78.0	34.9	27.0	21.11	78.20	0.58	4.45	108	2	5	95	6
737	Grab	66.0	33.7	25.3	18.23	33.08	48.69	17.81	260	2	11	230	17
738	Grab	60.0	33.7	26.7	16.21	46.44	37.38	8.60	206	2	9	179	16
739	Grab	60.0	33.7	25.9	17.96	51.90	30.14	8.47	136	1	24	104	7
740	Grab	63.0	34.8	25.4	27.95	47.22	24.83	9.84	174	2	23	138	11
741	Grab	45.0	32.3	27.4	78.86	18.57	2.55	7.27	106	0	4	95	7
742	Grab	54.0	33.3	25.7	14.08	84.82	1.10	5.25	118	0	5	107	6

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera			Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic	
743	Grab	54.0	34.6	27.0	0.11	7.79	92.10	14.10	348	2	6	336	4
744	Grab	51.0	34.8	27.4	0.15	17.83	82.02	12.79	357	1	8	346	2
745	Grab	42.0	33.7	28.9	1.00	12.89	86.11	15.58	394	1	3	383	7
746	Grab	44.0	32.3	30.0	0.13	33.12	66.75	7.99	103	0	0	99	4
747	Grab	30.0	32.3	31.0	0.22	12.77	87.01	13.37	113	0	7	106	0
748	Grab	27.0	31.2	31.0	0.06	1.67	98.27	17.22	254	0	10	238	6
749	Grab	42.0	30.8	22.3	0.11	0.66	99.23	15.93	236	0	3	231	2
750	Grab	42.0	30.8	22.2	0.95	19.88	79.17	13.75	446	1	5	436	4
751	Grab	42.0	36.4	22.2	9.45	41.34	49.21	11.93	262	0	8	230	24
752	Grab	39.0	35.9	22.1	50.25	49.27	0.46	3.04	---	---	---	---	---
753	Grab	45.0	37.8	22.1	18.40	81.11	0.47	2.55	115	0	5	102	8
754	Grab	37.0	33.1	22.8	57.70	42.05	0.22	6.38	---	---	---	---	---
755	Grab	49.0	37.8	22.8	86.19	13.64	0.17	1.96	---	---	---	---	---
756	Grab	49.0	36.8	23.2	30.66	67.21	2.11	4.30	110	3	3	98	6
757	Grab	50.0	37.8	23.2	11.20	56.54	32.26	10.56	244	1	8	222	13
758	Grab	54.0	37.8	23.2	29.28	47.99	22.73	9.36	185	3	6	156	20

TABLE 3. - Physical, Chemical and Microfaunal Data (Upshaw and Creath)

Sample Station	Sample Type	Approximate Water Depth in Feet	Bottom Water		Percentage of Gross Sample in each Size Range			Per cent Acid Soluble	Total Microfauna Counted	Numbers of Foraminifera				Ostracodes
			Salinity o/oo	Temperature °C.	>250µ	62-250µ	<62µ			Planktonic	Arenaceous	Calcareous Benthonic		
759	Grab	68.0	35.2	23.2	30.41	54.20	15.39	7.87	157	1	6	127		23
760	Grab	48.0	36.8	24.0	53.08	42.91	0.16	1.13	---	---	---	---		---
761	Grab	48.0	36.8	24.0	16.39	81.04	2.55	6.99	135	0	6	125		4

TABLE 4. - Clay analyses.

Peak heights expressed in chart divisions from approximate background line to highest point of each of three peaks. (Data provided by A. J. Nash)

Sample Station	Montmorillonite 17.5 A° Peak	Illite 10.0 A° Peak	Kaolinite 7.2 A° Peak
26	38	7	28
27	27	8	45
31	36	3	28
32	45	5	30
33	37	3	19
34	48	4	30
35	31	7	35
36	36	5	39
51	34	6	11
52	49	11	35
57	26	2	20
67	29	5	13
69	34	5	12
71	39	6	17
91	32	8	27
114	19	4	14
122	33	6	15
150	51	4	24
333	14	4	14
362	48	10	57
411	40	6	25
434	60	9	61
442	14	3	15
460	41	5	34
467	40	9	42

TABLE 4. - Clay analyses.

Peak heights expressed in chart divisions from approximate background line to highest point of each of three peaks. (Data provided by A. J. Nash)

Sample Station	Montmorillonite 17.5 A° Peak	Illite 10.0 A° Peak	Kaolinite 7.2 A° Peak
497	30	5	31
500	29	7	27
501	30	6	12
540	37	11	59
549	25	9	41
567	34	18	8
568	35	6	25
570	24	4	14
572	34	10	14
582	39	7	21
600	16	9	12
602	17	10	12
611	46	8	14
630	40	12	16
631	32	10	17
633	48	17	22
635	14	6	12
637	18	15	16
640	51	18	20
642	22	7	11
643	33	8	10
647	28	14	20
649	26	8	26
650	25	5	12
653	39	6	17

TABLE 4. - Clay analyses.

Peak heights expressed in chart divisions from approximate background line to highest point of each of three peaks. (Data provided by A. J. Nash)

Sample Station	Montmorillonite 17.5 A° Peak	Illite 10.0 A° Peak	Kaolinite 7.2 A° Peak
656	43	8	36
657	36	12	34
658	42	10	32
659	39	8	15
661	45	15	15
667	16	13	25
668	19	12	34
671	39	16	37
673	43	18	27
674	33	12	32
675	54	32	67
676	12	7	35
677	23	5	33
681	41	10	33
682	42	17	31
683	21	17	32
687	17	7	15
688	36	10	23
690	29	9	44
691	30	8	19
692	21	9	20
695	29	10	12
698	27	7	12
706	49	21	25
714	35	8	27

TABLE 4. - Clay analyses.

Peak heights expressed in chart divisions from approximate background line to highest point of each of three peaks. (Data provided by A. J. Nash)

Sample Station	Montmorillonite 17.5 A° Peak	Illite 10.0 A° Peak	Kaolinite 7.2 A° Peak
716	30	9	42
718	64	21	35
721	32	13	39
722	38	19	45
723	12	5	10
725	30	8	11
728	52	12	13
731	44	14	14
733	11	3	9
735	31	11	26
736	41	14	40
738	46	15	61
743	42	9	18
747	46	14	16
748	51	20	18

TABLE 5. - Isotopic Composition of Organic Carbon.

(Data provided by W. M. Sackett and R. R. Thompson)

Sample Station	Organic Carbon	
	Per Cent	$\delta C^{13}/C^{12}$
26	2.4	-24.7
27	2.2	-25.1
28	1.6	-25.9
30	1.8	-25.5
31	1.4	-23.0
32	1.2	-23.2
33	1.3	-22.8
34	1.3	-22.5
35	0.8	-22.0
40	1.7	-22.6
41	1.3	-22.6
42	1.0	-22.7
44	1.4	-20.6
46	0.8	-22.0
56	1.3	-23.9
57	1.2	-23.9
58	1.7	-23.5
67	0.8	-22.2
71	0.9	-22.1
78	1.2	-22.9
81	1.4	-23.4
82	1.5	-23.8
83	2.3	-23.0
84	1.0	-21.7
87	0.8	-21.7

TABLE 5. - Isotopic Composition of Organic Carbon.

(Data provided by W. M. Sackett and R. R. Thompson)

Sample Station	Organic Carbon	
	Per Cent	$\delta C^{13}/C^{12}$
94	1.0	-22.5
96	1.2	-22.3
107	1.4	-23.2
109	1.5	-22.9
110	0.9	-22.8
116	1.7	-21.4
118	1.7	-21.5
120	1.3	-22.8
123	1.3	-22.2
125	2.2	-23.0
127	1.2	-22.6
128	1.3	-22.7
134	1.2	-24.2
136	1.6	-24.2
143	1.8	-20.8
151	1.0	
220	1.2	-22.8
223	1.3	-22.0
238	1.2	-23.5
326	3.6	-26.2
327	2.2	-26.1
334	1.8	-25.0
399	0.7	-22.1
407	1.6	-21.4
419	0.02	-18.9

TABLE 5. - Isotopic Composition of Organic Carbon.

(Data provided by W. M. Sackett and R. R. Thompson)

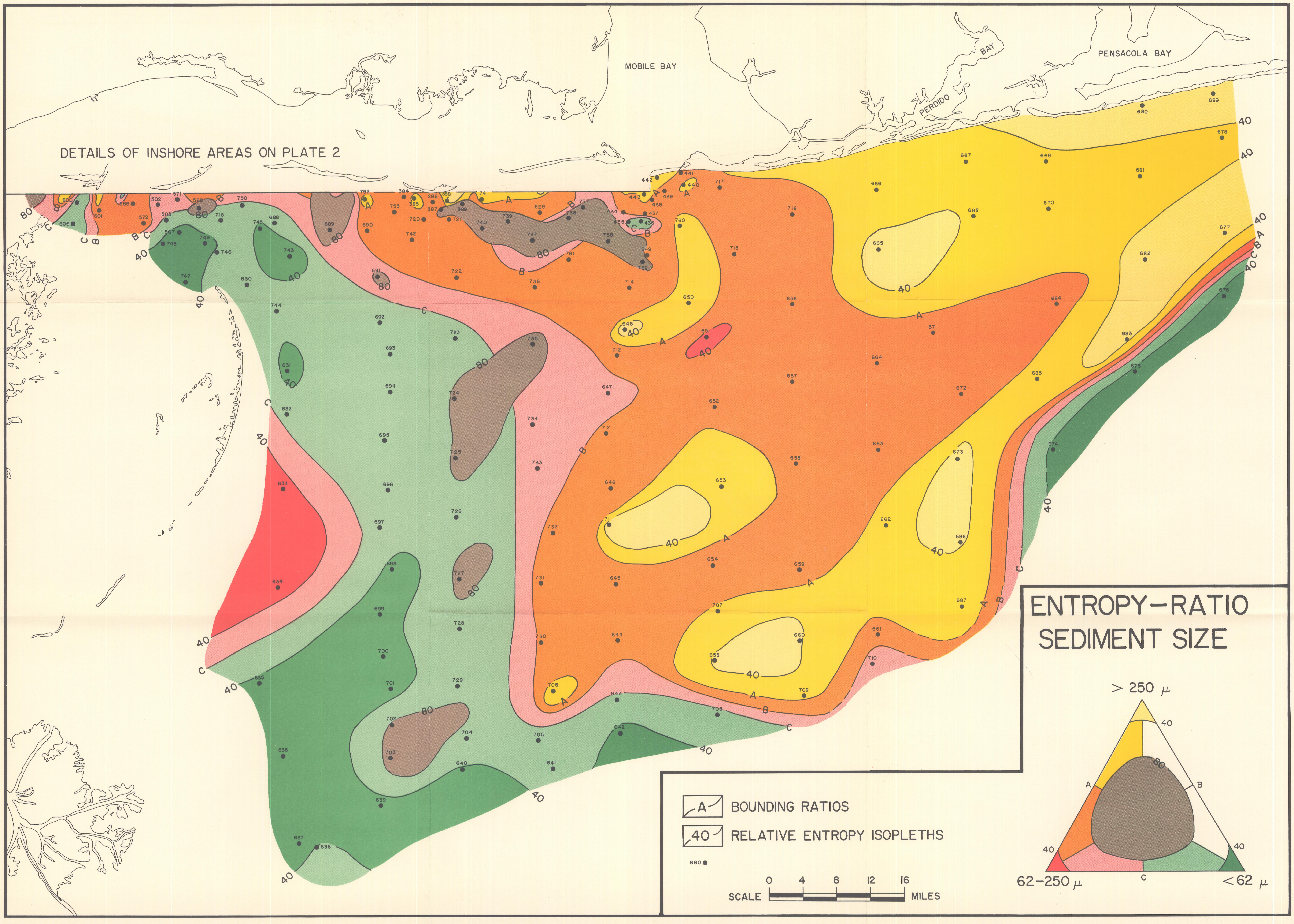
Sample Station	Organic Carbon	
	Per Cent	$\delta\ C^{13}/C^{12}$
421	0.2	-20.0
423	0.9	-20.8
431	0.09	-19.5
447	1.3	-22.7
450	1.3	-23.5
453	1.1	-22.4
457	1.4	-22.1
461	0.53	-21.7
632	0.4	-23.3
633	0.05	-21.0
634	0.05	-23.4
635	0.6	-21.4
639	1.4	-21.2
647	0.2	-20.8
653	0.05	-21.1
658	4.2	-19.5
659	4.2	-19.9
660	2.8	-19.9
661	0.2	-19.8
691	0.3	-21.1
693	0.6	-20.4
694	0.6	-21.2
695	0.7	-21.1
696	0.5	-21.8
697	0.5	-23.3

TABLE 5. - Isotopic Composition of Organic Carbon.

(Data provided by W. M. Sackett and R. R. Thompson)

Sample Station	Organic Carbon	
	Per Cent	$\delta\ C^{13}/C^{12}$
698		-21.3
699	0.7	-20.8
700	0.7	-21.1
701	0.9	-21.2
702	0.4	-21.2
703	0.4	-20.1
709	2.5	-20.0
719	0.2	-21.8
723	0.3	-20.9
725	0.6	-20.7
726	0.4	-20.2
727	0.4	-20.0
735	0.3	-20.1
750	0.2	-20.1
751	0.5	-20.6


Scale 1:250,000
20 Statute Miles
30 Kilometers
10 Nautical Miles
CONTOUR INTERVAL 50 FEET
WITH SUPPLEMENTARY CONTOURS AT 25 FOOT INTERVALS
DE SOTO NATIONAL FOREST
MOBILE
PRICHARD
MOBILE BAY
MOBILE SHIP CHANNEL
PICAYUNE
SLIDELL
GULFPORT
BILOXI
Ocean Springs
Pascagoula
Long Beach
Pass Christian
Bay St Louis
Waveland
Mississippi City
Kreole
Bayou La Batre
GULF OF MEXICO
MISSISSIPPI SOUND
CHANDELEUR SOUND
LAKE BORGNE
LAKE PONTCHARTRAIN
NEW ORLEANS
INTRACOASTAL WATERWAY
SHIP ISLAND BAR CHANNEL
GULFPORT CHANNEL
CAT ISLAND CHANNEL
CAT ISLAND
SHIP ISLAND
HORN ISLAND
PETIT BOIS ISLAND
Dauphin Island
PELICAN BAY
Horn Island National Wildlife Refuge
Breton National Wildlife Refuge
Restricted area
ST TAMMANY PARISH
ORLEANS PARISH
ST BERNARD PARISH
HANCOCK COUNTY
HARRISON COUNTY
MISSISSIPPI
ALABAMA
PLATE I


ENTROPY-RATIO
SEDIMENT SIZE
DETAILS OF INSHORE AREAS ON PLATE 2
MOBILE BAY
PERDIDO BAY
PENSACOLA BAY
BOUNDING RATIOS
RELATIVE ENTROPY ISOPLETHS
SCALE
0 4 8 12 16
MILES
> 250 μ
62-250 μ
<62 μ

(DETAILS OF OPEN GULF AREAS ON PLATE 3)

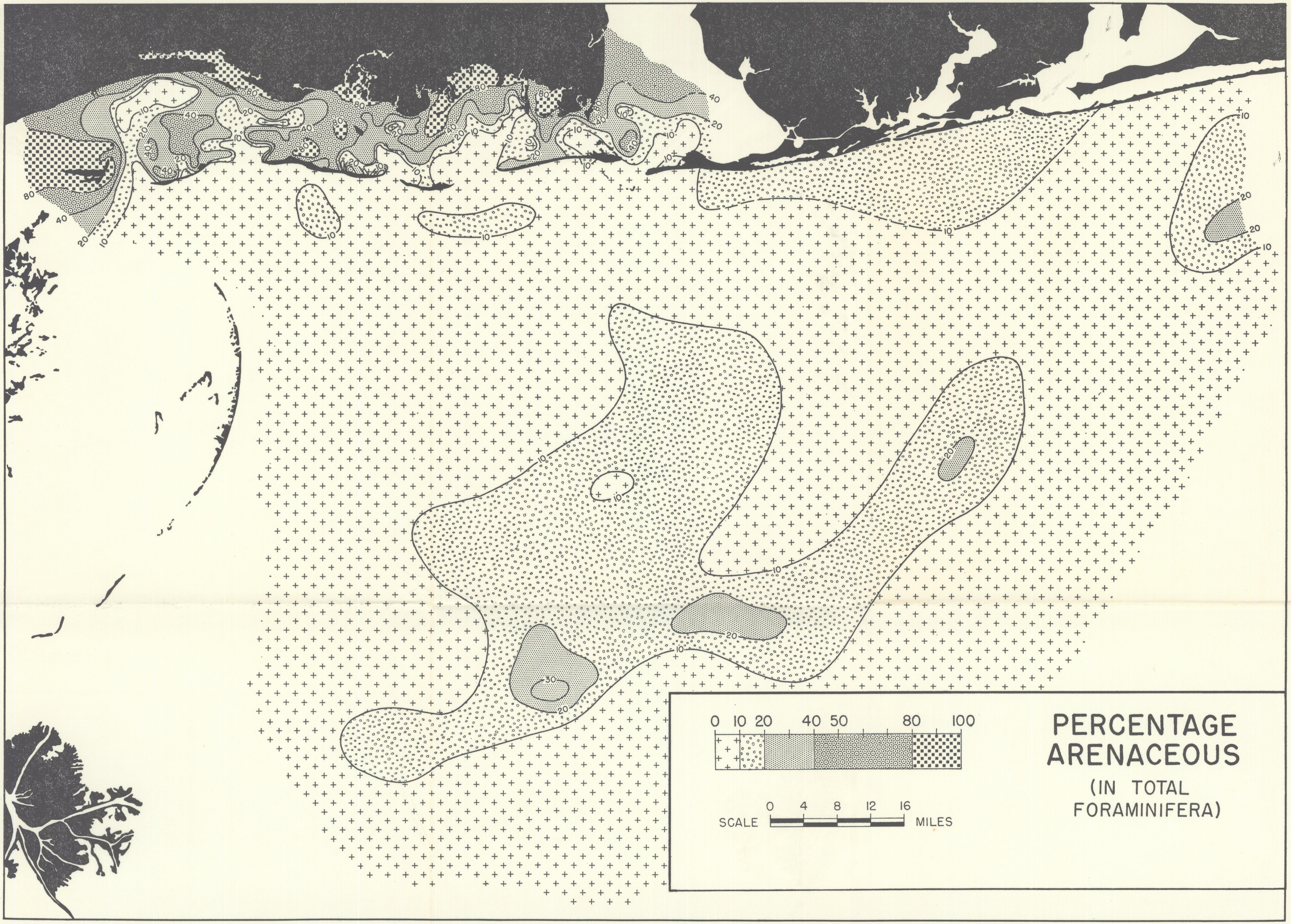
0 1 2 3 4 5
SCALE IN MILES

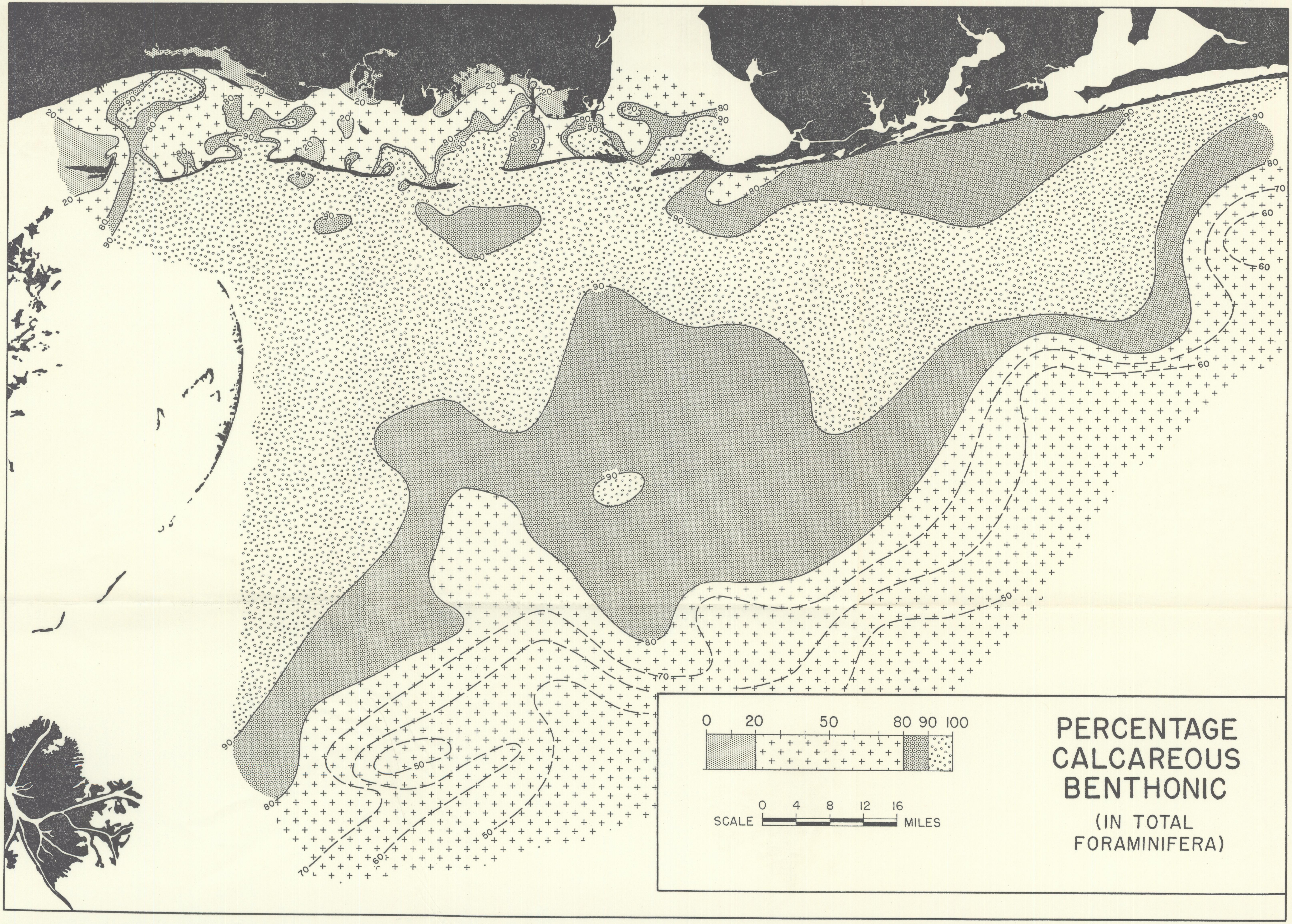
ENTROPY - RATIO SEDIMENT SIZE

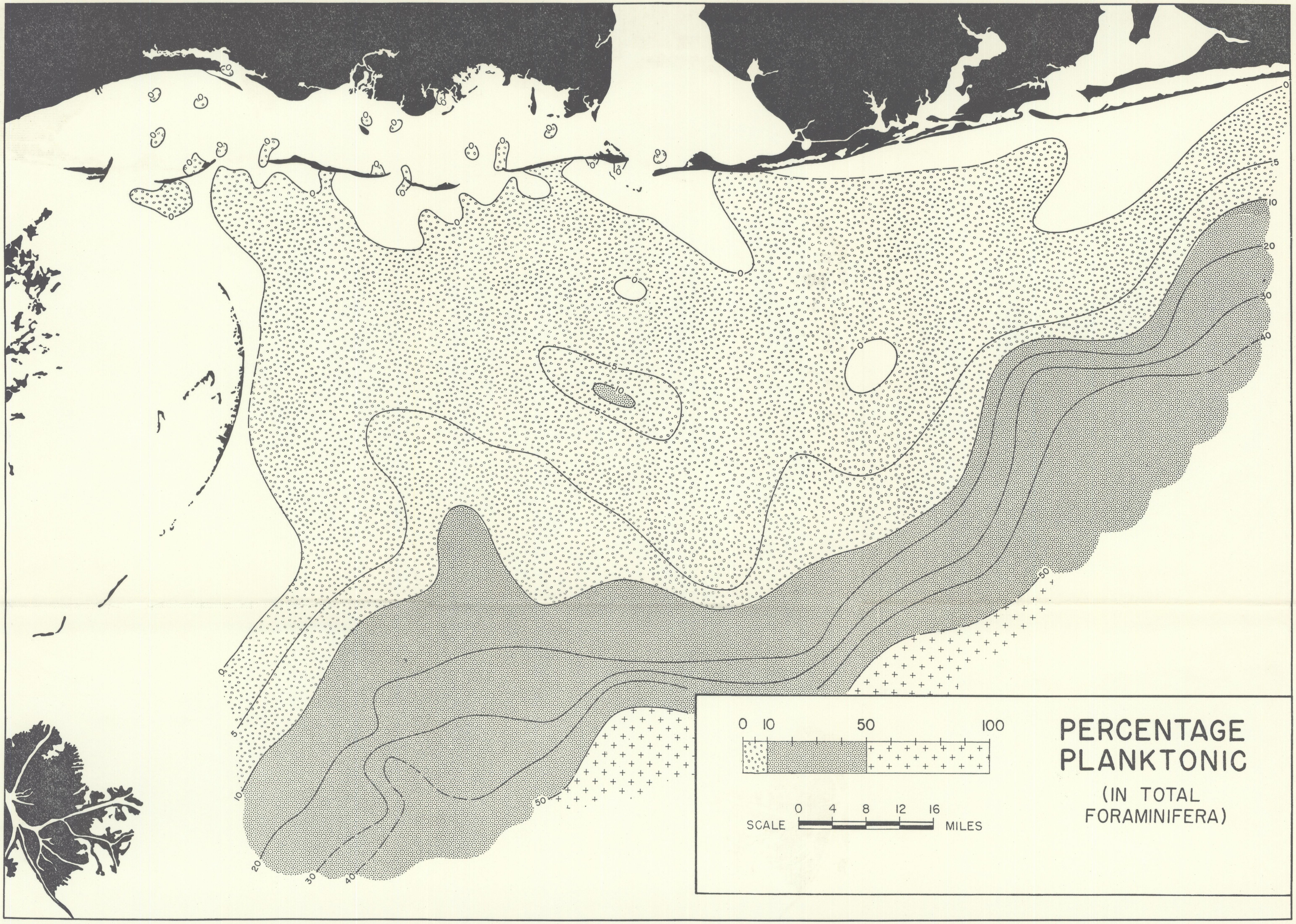
A — BOUNDING RATIOS

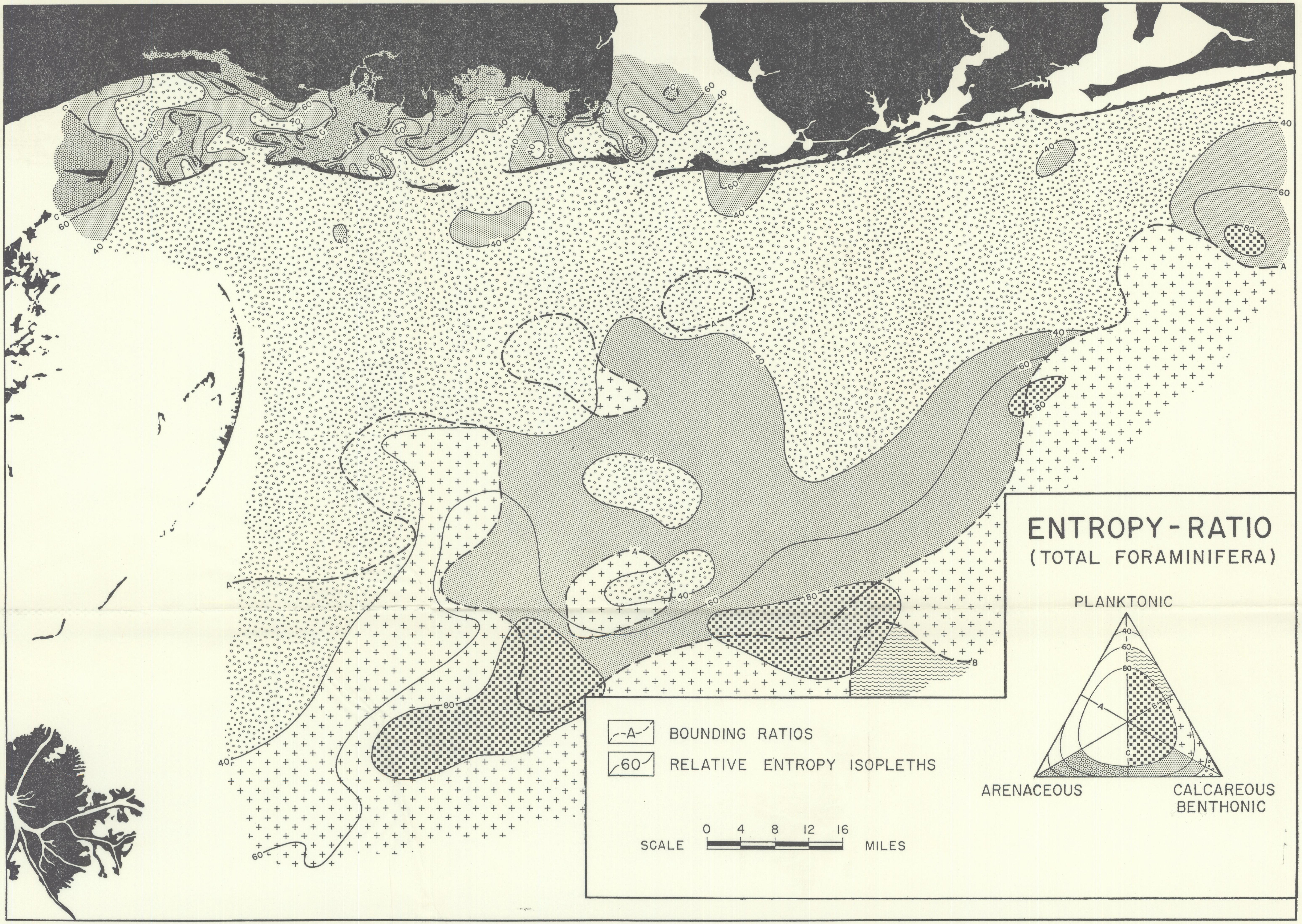
40 — RELATIVE ENTROPY ISOPLETHS

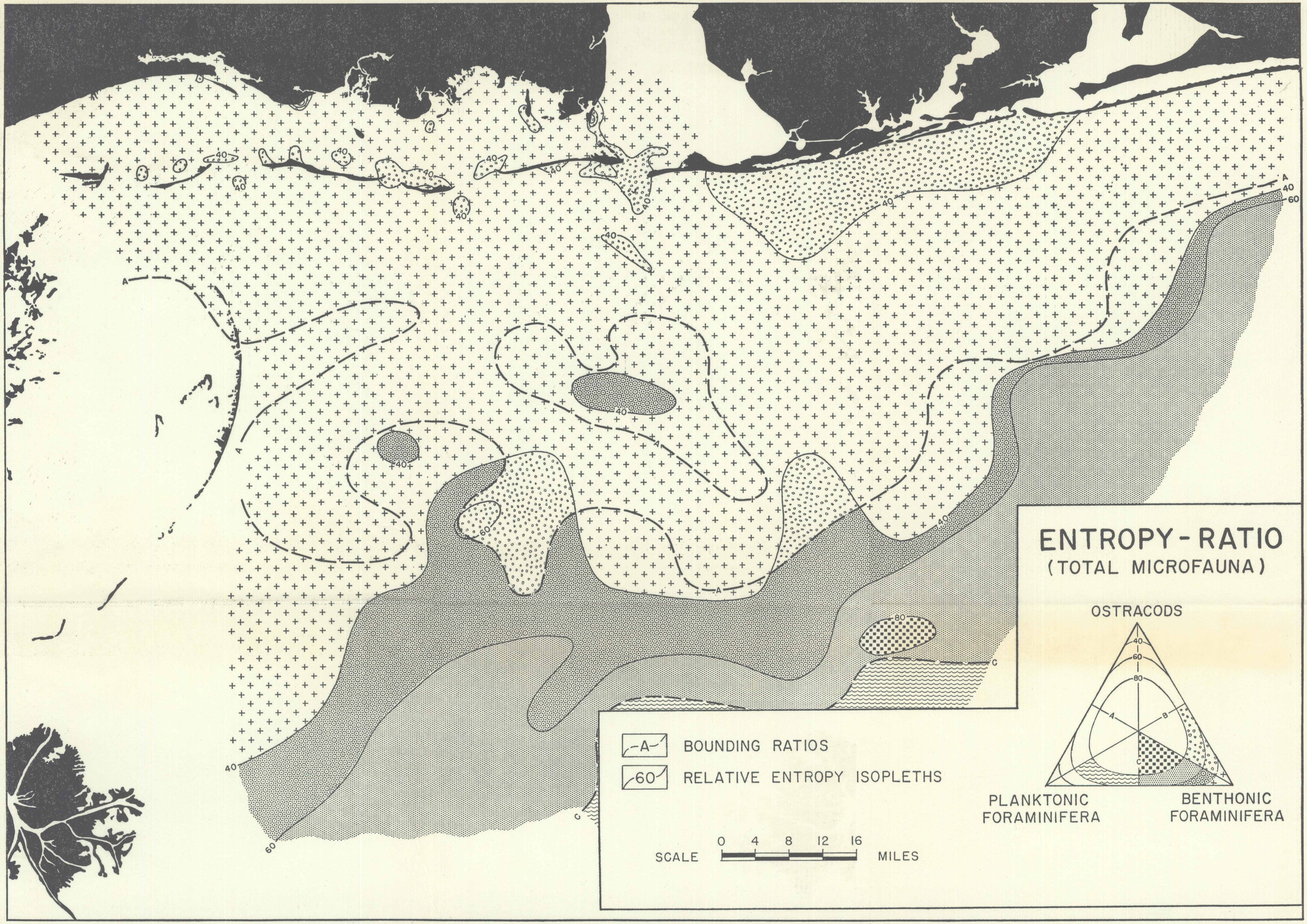
715 • SAMPLE STATION


0 10 20 40 50 80 100
SCALE 0 4 8 12 16 MILES
PERCENTAGE
ARENACEOUS
(IN TOTAL
FORAMINIFERA)


PERCENTAGE
CALCAREOUS
BENTHONIC
(IN TOTAL
FORAMINIFERA)
0 20 50 80 90 100
SCALE 0 4 8 12 16 MILES


PERCENTAGE
PLANKTONIC
(IN TOTAL
FORAMINIFERA)
0 10 50 100
SCALE 0 4 8 12 16 MILES


ENTROPY - RATIO
(TOTAL FORAMINIFERA)
PLANKTONIC
ARENACEOUS
CALCAREOUS BENTHONIC
-A- BOUNDING RATIOS
60 RELATIVE ENTROPY ISOPLETHS
SCALE
0 4 8 12 16
MILES


ENTROPY - RATIO
(TOTAL MICROFAUNA)
OSTRACODS
PLANKTONIC FORAMINIFERA
BENTHONIC FORAMINIFERA
A BOUNDING RATIOS
60 RELATIVE ENTROPY ISOPLETHS
SCALE 0 4 8 12 16 MILES
40
60
80
A
B
C