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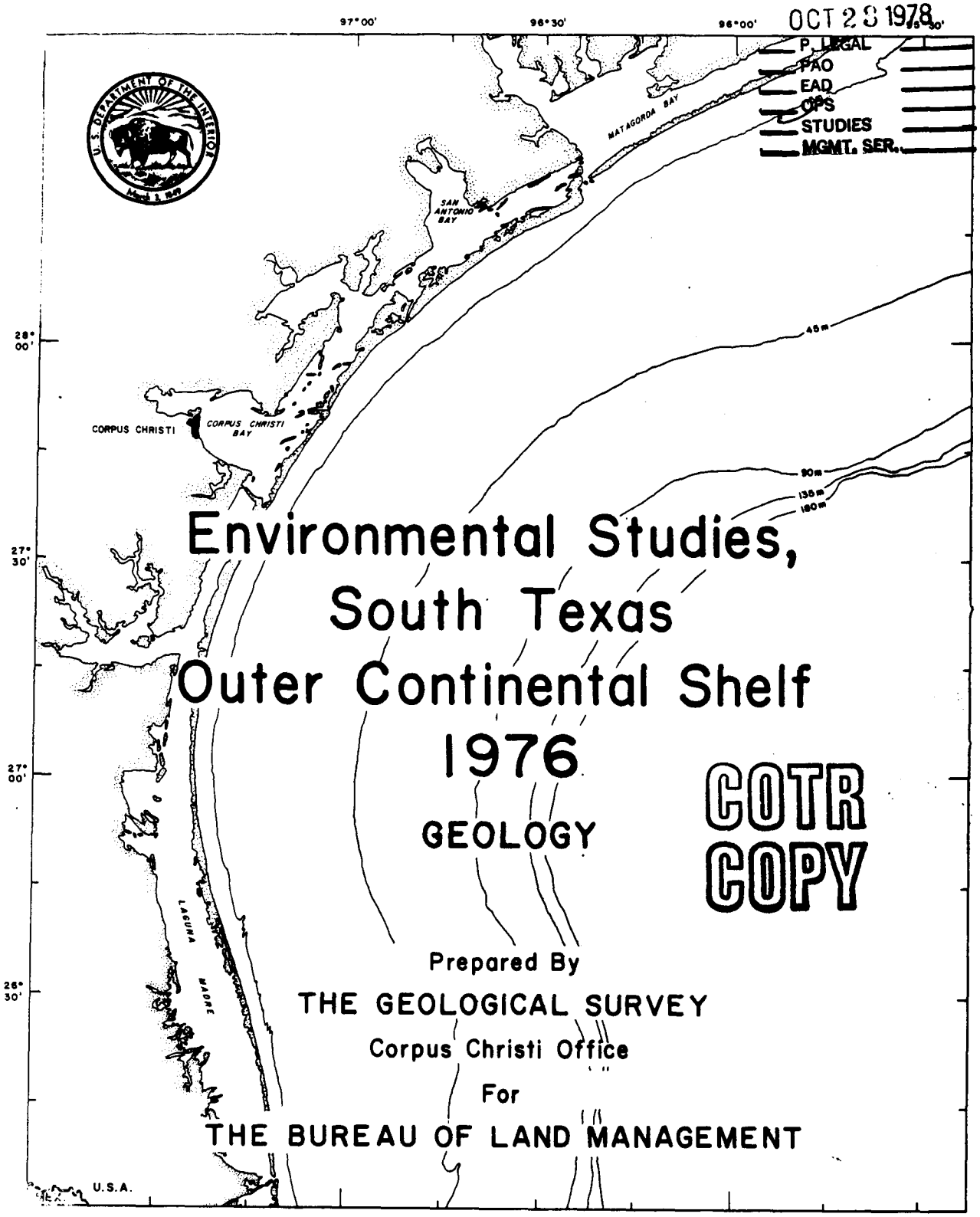

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GEOLOGY

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INTRODUCTION

The geologic studies of the South Texas Outer Continental Shelf made during 1976 were a continuation of the investigations started in late 1974, as a part of the National Outer Continental Shelf Environmental Studies Program sponsored by the Bureau of Land Management. The results of the studies made during the first year were reported by Berryhill and others, 1976. The initial investigations were keyed primarily to establishing baselines prior to the first petroleum lease sale for the South Texas OCS held in early 1975. The nature of the initial field investigations, the density of the data collected, and the scheduling of the field sampling were by necessity scaled to the few months of time available prior to the lease sale. The investigations for 1976 are based primarily on the results obtained during the first year. The study plan for the second year provides additional data coverage where the density of sample spacing during the first year was considered somewhat less than that necessary to give definitive results; it also provides further details and quantification of those sedimentary processes operative on the South Texas OCS that are of concern to the BLM both in establishing baselines and in monitoring petroleum operations in the future.

STUDY PLAN

The geographic limits of field operations during the second year remained the same as for the first year, which was the South Texas OCS lease area as defined by the Department of the Interior. The geographical delineation of the area in which the studies were conducted is shown by two figures: figure 1, which shows the location of the South Texas OCS regionally

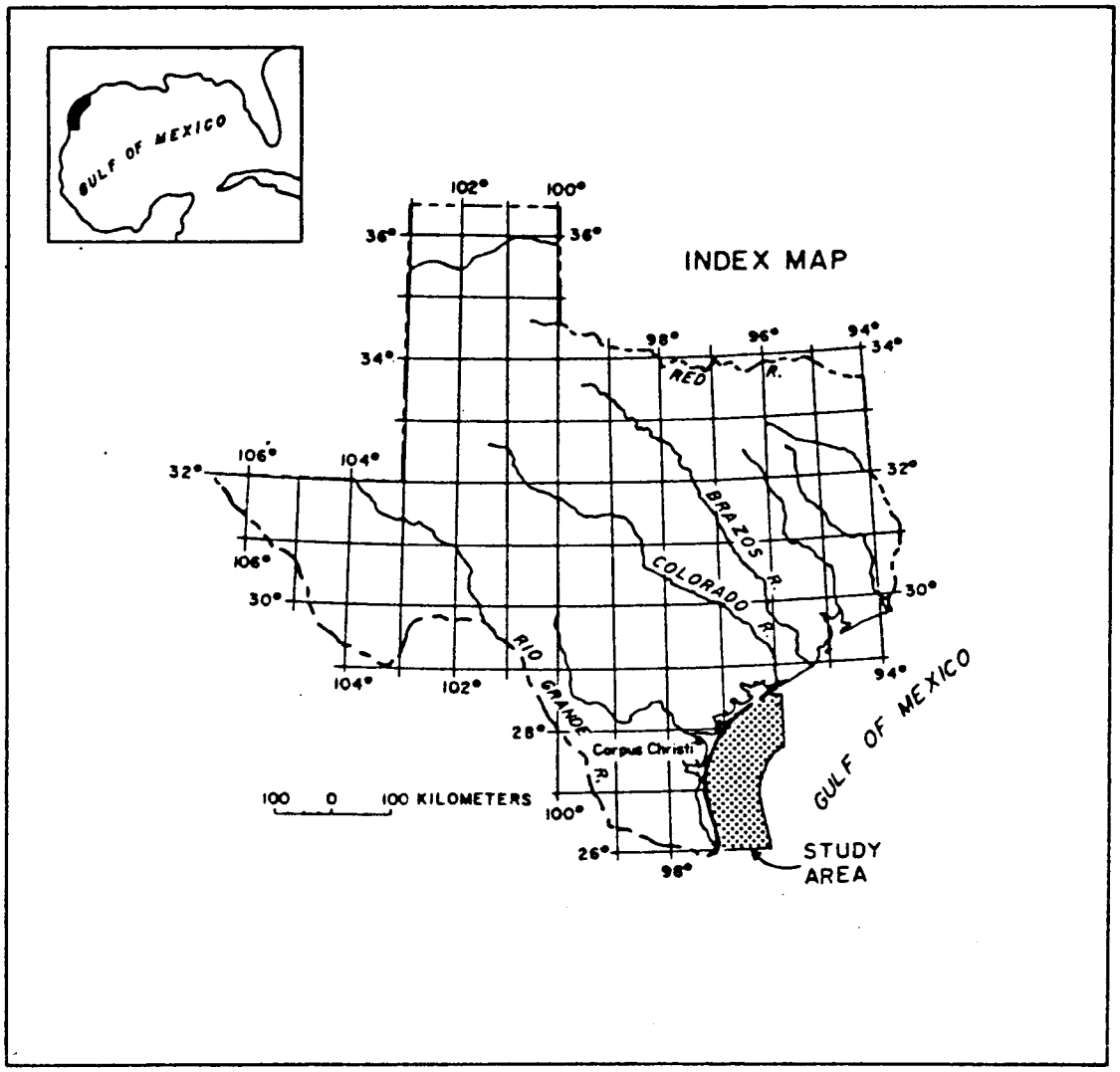


Figure 1. Location of the study area.

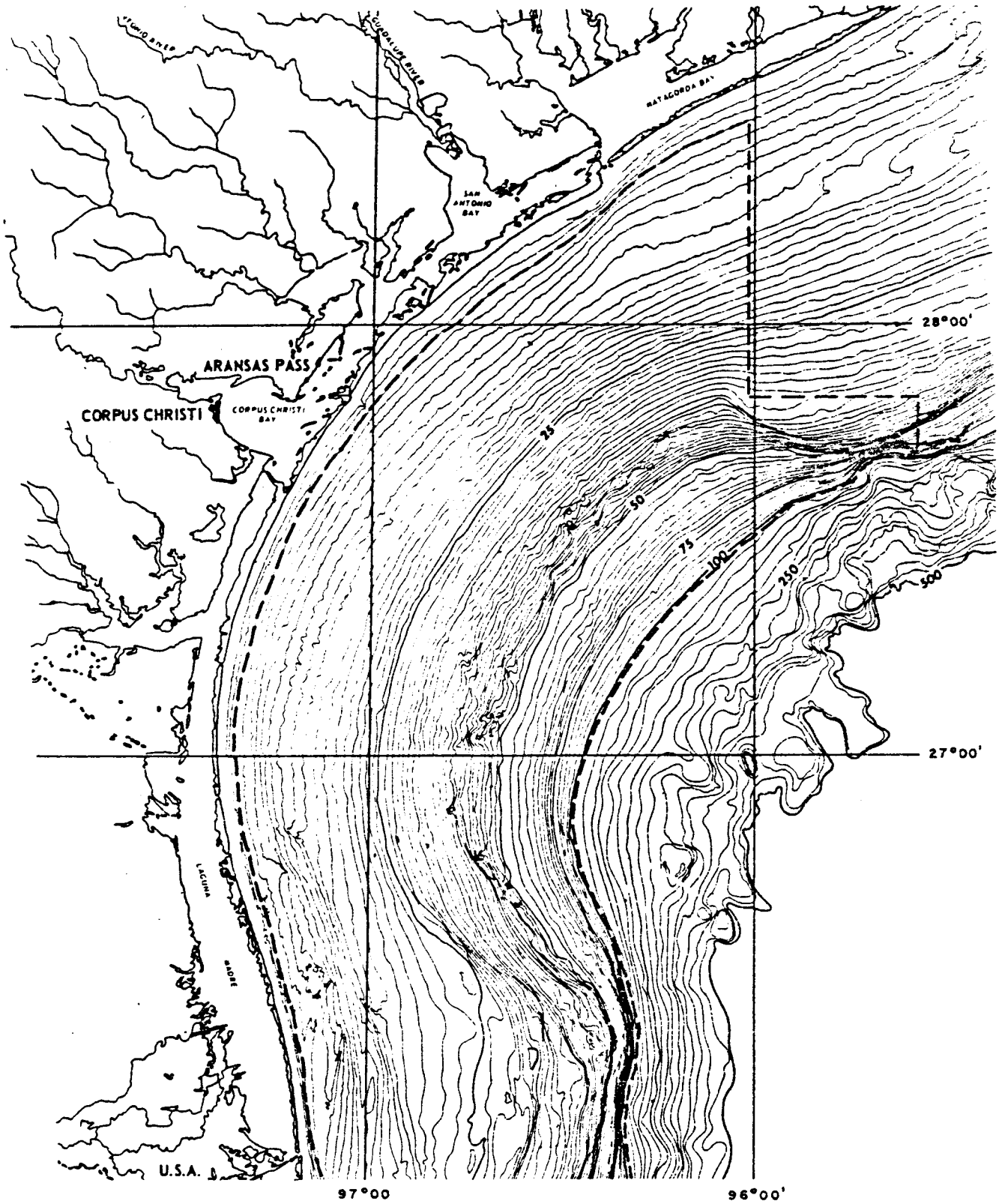


Figure 2. Geographic limits (heavy dashed line), physiography and bathymetry of the South Texas Outer Continental Shelf (depth in fathoms). From Berryhill and others, 1976, Part I, figure 3.

within the Gulf of Mexico; and figure 2, of a larger scale, which shows the geographic limits, physiography, and bathymetry of the South Texas OCS lease area.

OBJECTIVES AND RATIONALE

The elements of study were selected to provide qualitative data relative to defining the environmental character of the South Texas OCS, as pertinent to the mission of the BLM. The topics studied and the rationale for their selection are as follows:

1. The amounts, composition, sources, and dispersal patterns for inorganic particulate matter suspended in the water column--The nature and amounts of inorganic particulate matter introduced into the water column through natural processes and its origins must be known if anthropogenic pollutants are to be recognized and quantified. The types and amounts of trace metals that occur naturally in the sediment particles through chemical bonding or are otherwise entrained in the suspended material through natural processes are especially critical in establishing environmental baselines. Furthermore, the patterns of dispersal for the inorganic particulates, once they enter the marine system, are clues to predicting the probable directions of movement and the ultimate depositional fate of pollutants accidentally spilled. The dispersal patterns are strongly supplementary to oceanographic data in indicating the directional patterns of water mass movement over the region. During the first year, the amount and composition of the suspended sediments were determined from samples of water collected at three levels from 26 stations. The results were only broadly quantitative, as the samples were taken on three different cruises that covered a period of two months. They were not useful for determining

seasonal variations in either the types, amounts, or directions of dispersal, nor were they time synoptic. Consequently, during the second year, samples for the suspended sediments were collected on a seasonal basis and the composite net of 26 sample stations was covered during each period of seasonal sampling in the shortest time span possible so that the results would be nearly synoptic. In no case did a seasonal cruise exceed 4 1/2 days. Also, the sampling from three levels in the water was supplemented by transmissometry, which gave a turbidity profile from surface to bottom at each station. The locations of stations occupied for the seasonal suspended sediment cruises are shown by figure 3.

2. Textural stratigraphy and sedimentary structures, shallow subbottom sediments--The textural or grain size composition of sea floor sediments from the surface to a depth of 1 to 2 m gives a general indication of sources for the past thousand years or so and a more specific indication of how extensively the detritus ultimately was dispersed after it reached the continental shelf. The vertical variations in grain size from fine to coarse at a specific locality indicate the temporal ranges in transporting energy at that place through time; the lateral variations from one place to another indicate the degree to which energy conditions have varied geographically over the region. The gross textural stratigraphy of the shallow bottom sediments over the region, as indicated by the vertical alteration of very fine-grained sediments and layers of discrete sand plus the nature of the depositional structures implanted during deposition, records the prevalent directions of sediment dispersal and deposition with time and indicates the persistence of these patterns during the recent past. Consequently, data derived from the shallow

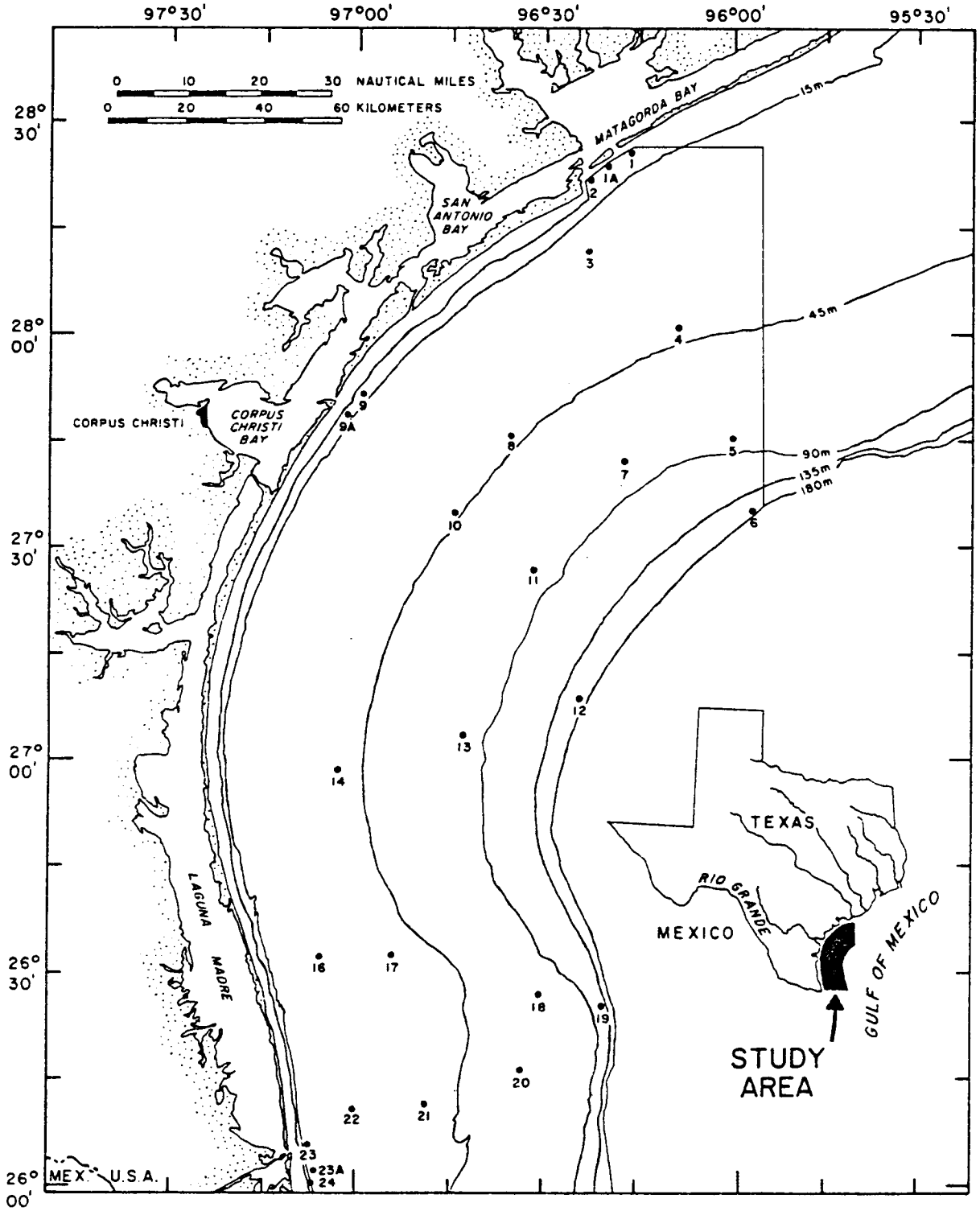


Figure 3. Locations of stations sampled for suspended sediments.

sediments supplement those for both suspended sediments and oceanography in providing the means for predicting likely dispersal patterns in the future. In addition, the textural composition is a key to the geotechnical properties of the sediments that determine the general stability of sea floor sediments and their strength for bearing manmade structures.

The samples used for studying the shallow sea floor sediments were a series of cores obtained by a gravity fall pipe containing a removable plastic liner. During the first year, 74 cores were obtained. Because the cores were spaced rather broadly as a result of time exigencies, the results provided a reconnaissance of the area. An additional 101 cores were obtained during the second year. Stations were selected primarily to fill in the larger geographical gaps in the previous station net; other stations were placed for verification of the results and interpretations made from data gathered during the first year. The locations for the cores obtained during the second year are shown by two figures: outlines of the principal geographic subareas sampled are shown by figure 4 and the locations of all cores taken during the two years of study by figure 5. The syntheses of core data are based on both sets of cores.

3. Animal-sediment relationships--The infauna can play a profound role in the process of sedimentation. Infaunal communities, depending on the types and density of population, alter significantly the textural composition of bottom sediments by the process of bioturbation. Where infaunal communities are well-established, bioturbation, or the mixing and burrowing of sediments, is a continuous process that almost immediately changes the original grain size arrangement of the sediment. As many of the animals

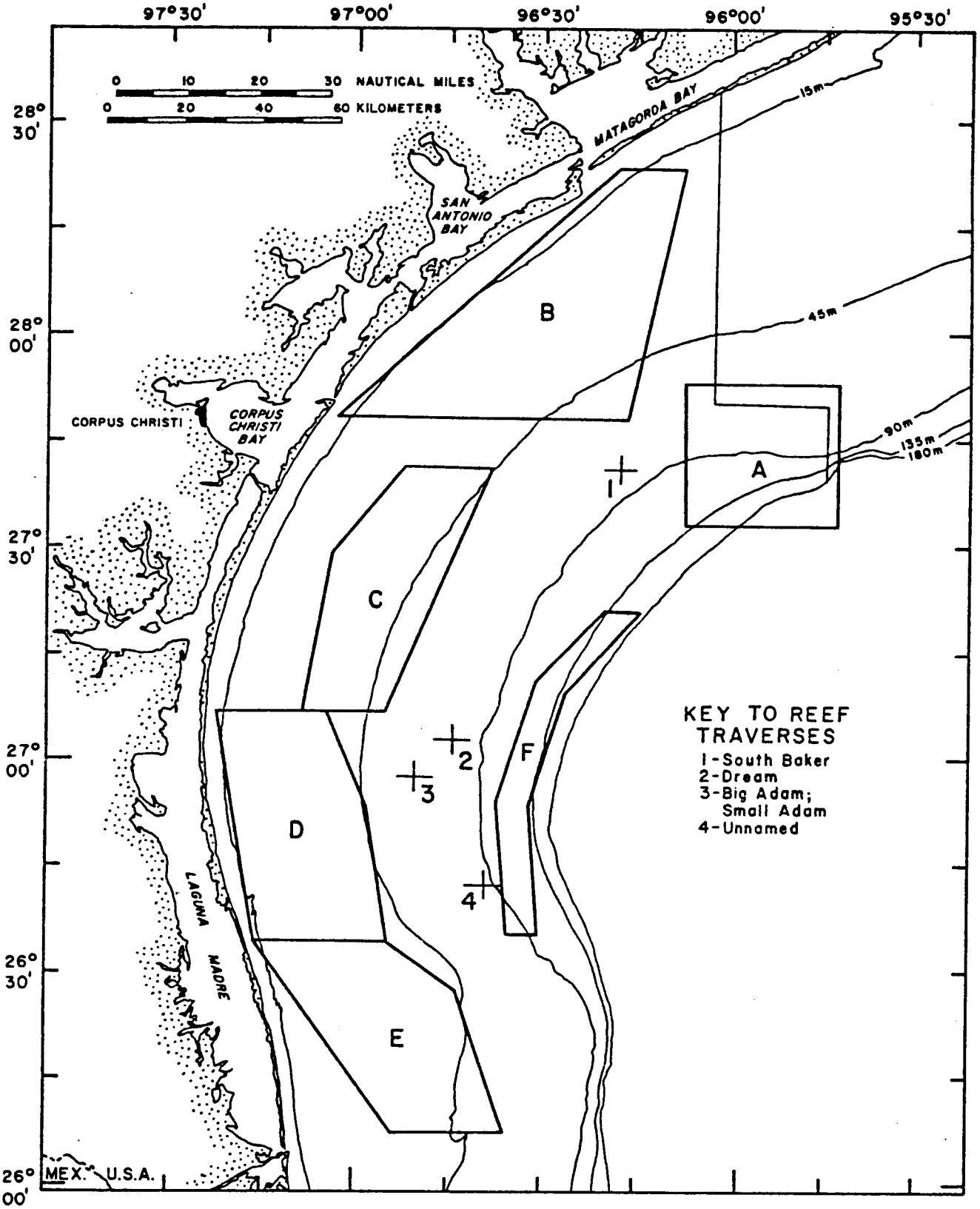


Figure 4. Locations of subareas on the shelf in which the sediments were cored. The locations of the reef traverses are indicated by crosses.

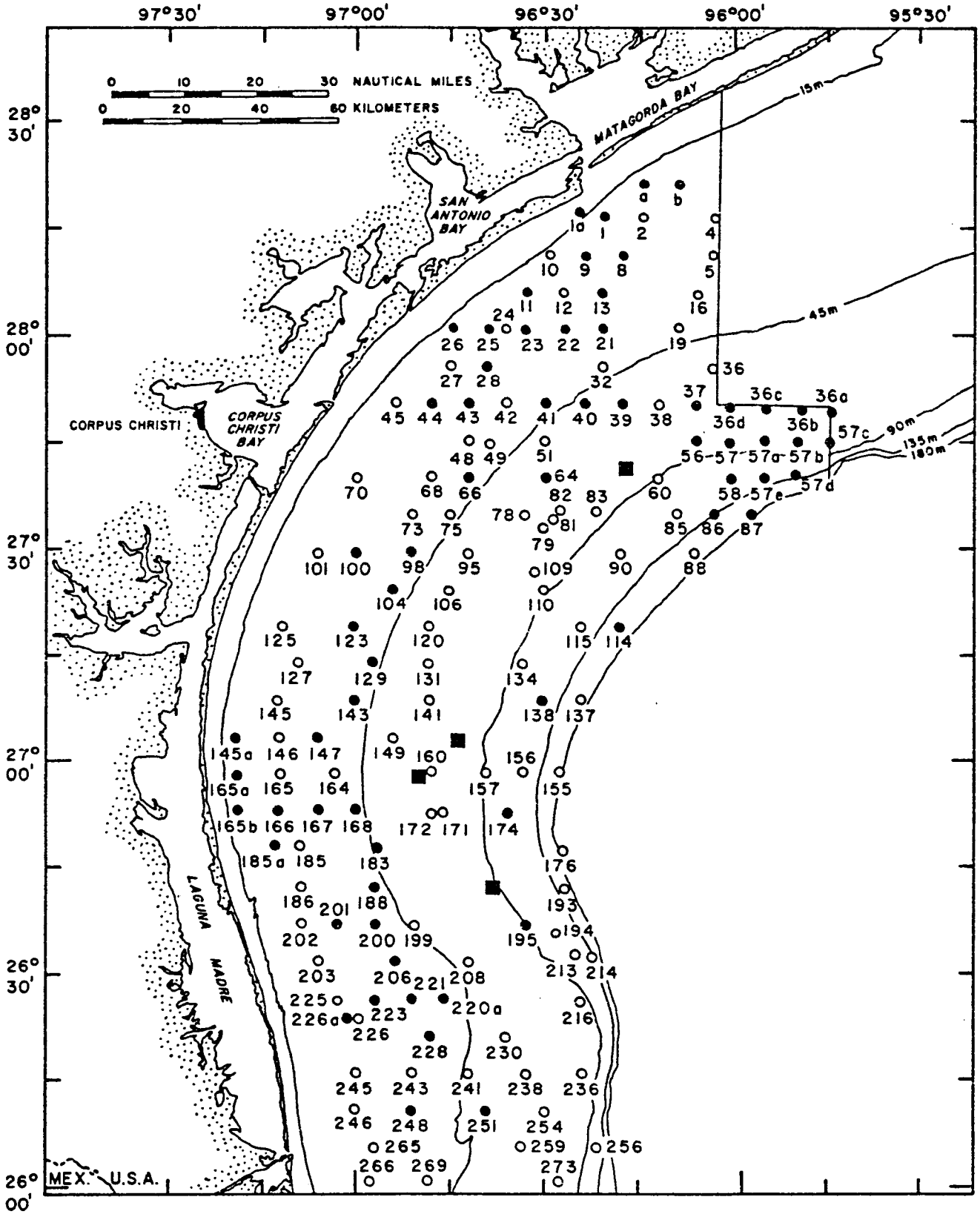


Figure 5. Locations of core sites on the South Texas OCS. Solid dots indicate the locations of cores collected for the 1976 studies; circles indicate those collected in 1975. The squares indicate the general location of the reef traverses.

that live in the bottom sediments have a preference for specific sizes of grains, they concentrate sediments of the preferred size, thus changing both the consistency and coherence of the sediments. Recognition and quantification of the extent and intensity of bioturbation is important in establishing the environmental characteristics of a region for two reasons: the intensity and depth of mixing will determine the extent to which pollutants are likely to be mixed into and concentrated in the bottom sediments by the activity of the infauna; the extent to which bioturbation has been abruptly terminated by a single sedimentological event, such as the deposition of a relatively thick sand layer during a storm, is an indication both of the higher ranges of transporting energy that can be expected and of the extent to which the geographic distribution of the infaunal communities can be changed by natural processes.

For the first year of study, the sediments collected by bottom grab sampling at the 74 pipe core sites were processed for identification of the infaunal communities, and X-radiographs of both the pipe cores and box cores from the same sites were studied to determine the extent of bioturbation. During the second year of study, the additional 186 grab samples collected during the first year were processed and 69 of the additional 101 cores collected during the second year were studied to provide a more complete documentation of the animal-sediment interactions. The station grid used for the biogeologic studies is shown by figure 6.

4. Rates of sedimentation--Some knowledge of the rates at which sediments accumulate on the sea floor is essential to understanding the sedimentological history of a region and to determining the dominant directions

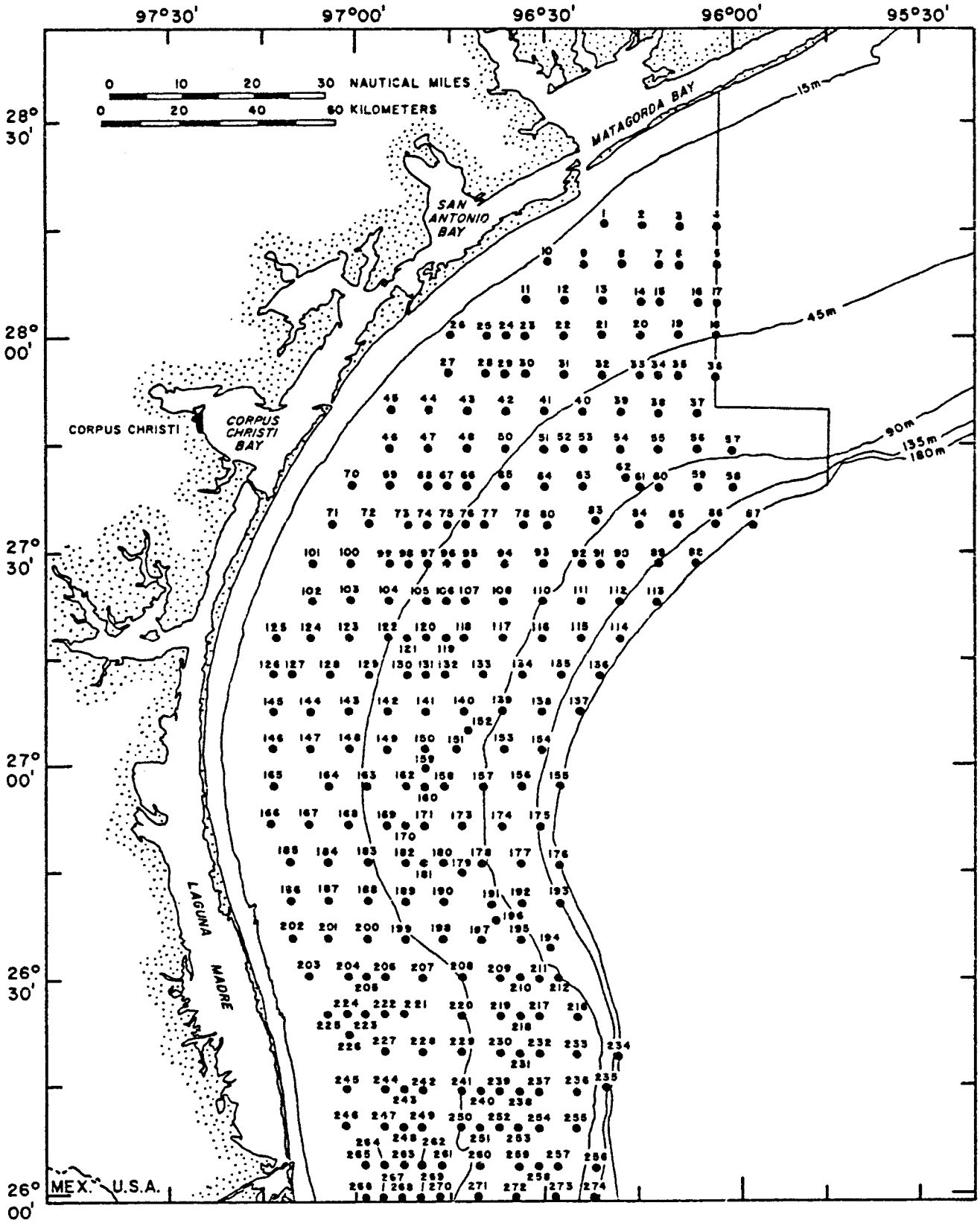


Figure 6. Locations of bottom grab sample stations used for the biogeologic studies.

of sediment movement and deposition through time. In a practical sense, recognition and delineation of areas of either abnormally high or abnormally low sedimentation is important in the selection of sites for manmade structures on the sea floor, such as platforms and pipelines. Until recently, methods for determining rates of recent sedimentation to a reasonable degree of precision had not been devised. Consequently, dating was based mainly on empirical relationships, was quantitatively gross, and was at best useful only as an average for relatively long periods of geologic time. The successful use of ^{210}Pb for dating the accumulation of ice in the Arctic provided a workable method, as ^{210}Pb is a ubiquitous isotope that has a half-life of only 22 years. As part of the second year's study, the upper section of 43 cores were dated in increments of 1 cm to determine rates of sedimentation over the region during approximately the past 150 years. The locations of the cores used for ^{210}Pb dating are shown by figure 7.

5. Relation of trace metals concentrations in bottom sediments to natural gas seepage--High resolution seismic reflection profiling during the first year of study strongly suggested that gas was seeping naturally from the sea floor at several places on the South Texas OCS, but predominantly in an area along the outermost shelf where faulting is both extensive and intensive. Study of the distribution of trace metals in bottom sediments during the first year showed that the amounts of some trace metals were largest in the same area of the outer shelf where the suspected gas seeps are most numerous. To reiterate, the differentiation of natural processes from anthropogenic activity is a fundamental concern in establishing environmental baselines. Equally important is the determination of the type of hydrocarbon, petrogenic or biogenic, where natural occurrence is either known or suspected.

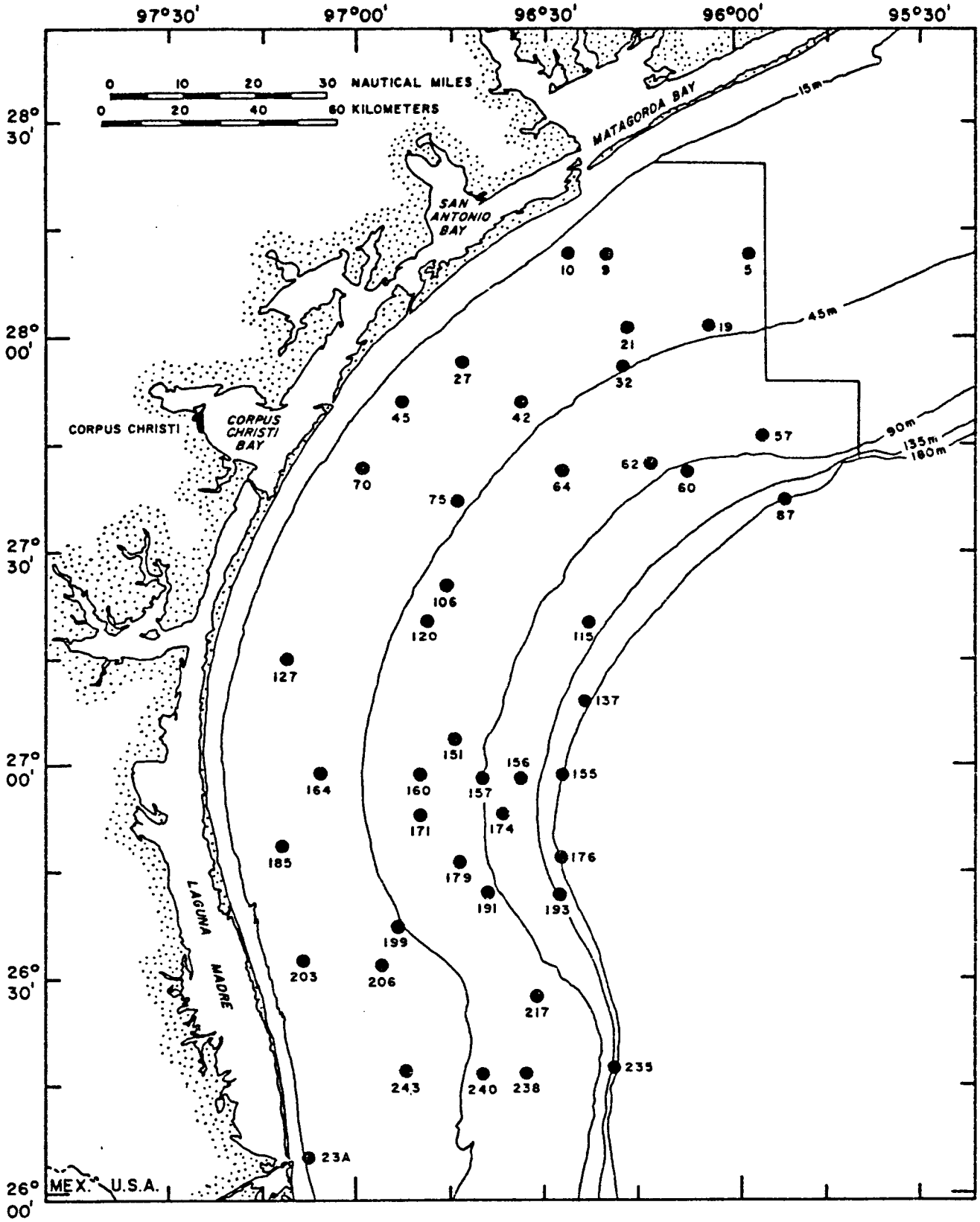


Figure 7. Benthic sample locations for rate of sedimentation study.

Working from the assumption that natural gas seeping upward from a petrogenic source might be carrying trace metals that would be eventually concentrated in anomalous amounts in the sediments around the seeps, a series of cores carefully sited in the area of suspected seeps was analyzed to determine if the larger amounts of certain trace metals were indeed related to gas seepage. The locations of the cores studied are shown by figure 8.

6. Late Quaternary history and Holocene geology of the South Texas OCS--An accurate and site-specific compilation of the principal geologic features of a region on a time-sequence basis is the most effective method of demonstrating the relative stability of the sea floor, of documenting the geologic mechanisms that have controlled the development of the continental terrace, and of predicting the geologic factors that will be of most concern during petroleum development. The three geologic factors that have controlled both structural development and sedimentation on the South Texas OCS are (1) the diapiric movement of less dense material from depth upward through overlying sediments of the continental terrace; (2) extensive gravity faulting that has progressed seaward with time; and (3) the sea level fluctuations caused by the cyclic waxing and waning of glaciation during the Pleistocene. All data that relate to the three predominant factors noted have been synthesized and compiled on a series of maps that show the chronological sequence of the geologic events that have molded the continental terrace from the late Quaternary to the present.

In addition to the work elements listed, analyses of sample material collected by the University of Texas were made by USGS at the request of the BLM. The samples were collected as a part of the biological monitoring studies, whose primary objective was to determine the ranges of variability in epifaunal

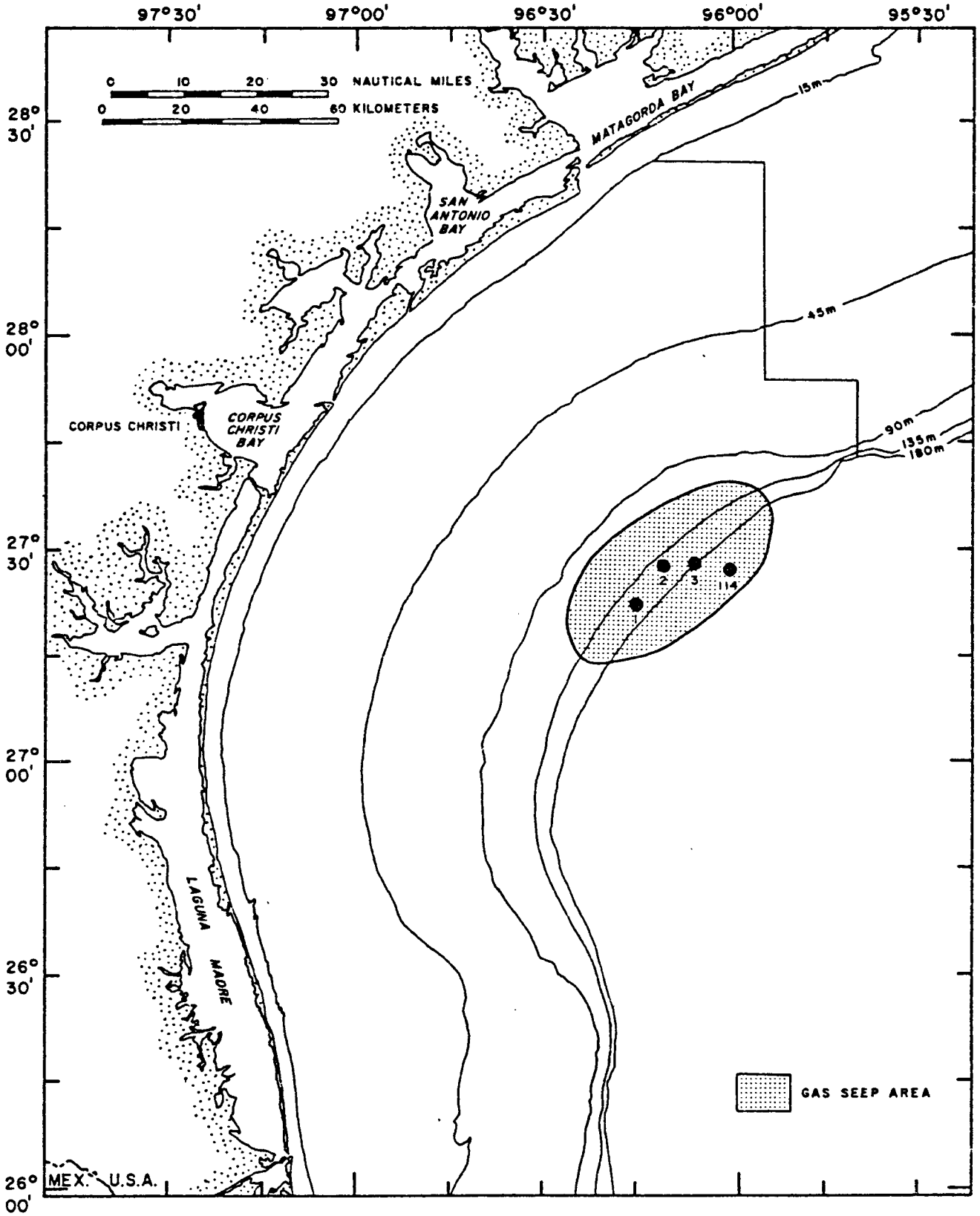


Figure 8. Locations of cores used for determining trace metals concentrations in the gas seep area.

and infaunal communities on a seasonal basis. As a part of the study, the Corpus Christi office did textural and trace metals analyses of the bottom sediments collected at the same time as the biological samples. In addition, similar analyses, but including suspended sediments, were made on samples collected by the University of Texas as part of a drill-site monitoring exercise. Three suites of samples were analyzed: one collected prior to drilling, one collected in the "plume" during drilling, and a third collected after drilling had been completed.

FIELD INVESTIGATIONS

The vessel used for the field investigations was the R/V FAY owned by TRACOR MARINE and under lease to the Atlantic-Gulf of Mexico Branch of the U.S. Geological Survey. The FAY, originally built as a geophysical research ship for a major oil company, was acquired by TRACOR MARINE in 1973 and modified for multi-objective general oceanographic research, including coring. The FAY has an overall length of 175 ft, maximum beam of 32 ft, and berthing space for a normal operating crew of 13 and a scientific crew of 16.

Field sampling was accomplished during five cruises: USGS Cruise No. 006, suspended sediments and transmissometry, fall season (11/15/75-11/21/75); USGS Cruise No. 007, coring of benthic sediments (11/21/75-11/26/75); USGS Cruise No. 010, suspended sediments and transmissometry, late winter season (3/2/76-3/6/76); USGS Cruise No. 014, coring of benthic sediments for dating and for analyzing trace metals concentrations around natural gas seeps (5/9/76-5/19/76); and USGS Cruise No. 015, suspended sediments and transmissometry, late spring season (5/21/76-5/26/76). Chief scientist for the cruises were as follows:

006 - - - - - - Gerald Shideler

007 - - - - - - Gary Hill

010 - - - - - - Gerald Shideler

014 - - - - - - Charles Holmes

015 - - - - - - Ronald Miller

Navigation and positioning for occupying field stations were carried out in part by precision navigation and in part by LORAN A. Precision navigation and station location for cruises 006 and 007 in November 1975 were provided by LORAC Service Corporation on a contract from USGS. Although precision navigation is not a requirement for positioning stations sampled for suspended sediments, precision navigation was used during Cruise 006 in November 1975 because the cruise period fell within the month of time leased by USGS from LORAC to cover both BLM and non-BLM sponsored work.

The precision system used was LORAC, operating in a Hyperbolic Mode with a lane transmitting separation of 50 feet and a navigation range of 100 miles. The system included a master transmitting station, two slave stations and a shipboard receiving system consisting of two receivers and an antenna. Lane counts were acquired at specified petroleum production platforms of known position and at the UTMSI Biological Pier at Port Aransas and were tracked on an analog recorder. All station locations were pre-plotted, and post-plot maps and computer readout sheets listing all fixes and allied data were prepared and transmitted to USGS.

During the suspended sediments cruise, 3/2/76-3/6/76, navigation and positioning were provided by the LORAN A equipment aboard the R/V FAY.

INVENTORY OF FIELD DATA

Two general types of samples were collected under the 1976 work plan: cores of benthic sediments of two types; and samples of water at three depths, near surface, mid depth, and near bottom, for extraction of suspended particulate matter.

Cores for the textural stratigraphy and sediment transport studies were obtained by use of a standard gravity fall pipe, employing a 500 pound weight stand and removable plastic liners of 3 inch ID. It was intended originally that a specially designed hydraulically dampened corer be used to collect the 20 cores specified in the work plan for determining rates of sedimentation across the shelf so that disturbance of the surficial sediments could be kept to a minimum during sampling. However, the benthic sediments over much of the South Texas OCS are so soft that the tripod housing the corer, despite its light-weight aluminum construction, repeatedly sank so deeply into the soft sediments that the core triggering mechanism would not activate and no core could be obtained. The remaining cores were taken with a gravity corer and the core was handled with special care during retrieval to keep disturbance of the sediments to a minimum. As the ^{210}Pb dating in the laboratory progressed, the results were so successful that the initial 10 cores were supplemented by 34 box cores collected during the first year. The additional cores were selected for subsampling and dating to provide a better regional coverage than had been planned initially. The dating of the additional box cores was done as a research contribution of the USGS at no cost to the BLM.

During the sampling for the suspended sediments studies by NISKIN casts, the following subsamples were prepared: particulate grain size at all three

levels for three seasons; and trace metals content and clay mineralogy at surface and near bottom for the winter and spring seasons for 12 of the 26 stations. As a supplement to the sampling for suspended sediments analysis, turbidity levels or amounts of particulate concentration in the water were measured with a MARTEK transmissometer. A top-to-bottom profile was recorded at each station for each of the three seasons.

A summary listing of the samples collected by category follows. In part A of the table, column 1 lists the number of samples specified in the work plan; column 2 lists the number of samples actually collected; and column 3 indicates the deviations from the numbers specified. In all cases where a larger number of samples were collected than specified, the work was done at no extra cost to the BLM.

A. Summary listing of samples by type and number:

	1	2	3
Suspended sediments for textural analysis - - - - -	230	230	0
Supended sediments for trace metal analysis - - - -	44	44	0
Suspended sediments for determination of clay mineralogy - - - - - - - - - - - - - - - - -	44	44	0
Gravity cores of benthic sediments for textural stratigraphy, transport and bioturbation studies - - - - - - - - - - - - - - -	63	69	+6
Gravity cores for determining rates of sedimentation by ^{210}Pb - - - - - - - - - - - - - -	20	43	+23
Gravity cores for relating concentrations of trace metals in benthic sediments to natural gas seeps - - - - - - - - - - - - - - -	10	10	0
Turbidity profiles by transmissometer - - - - - - - -	228	228	0
Totals - - - -	639	668	+29

B. Summary listing of samples collected by other elements of the STOCS Project and transmitted to USGS for analysis

1. Topographic highs:
   Samples collected by Texas A&M University during 1975 and submitted for trace metals analysis - 25

2. OCS monitoring, 1976:
   a. Subsamples collected at biological benthic stations by the University of Texas and transmitted for textural analysis - - - - - - - 150

   b. Subsamples collected at biological benthic stations by the University of Texas and transmitted for trace metals analysis and clay mineralogy. Four subsamples for each of 29 stations seasonally - - - - - - - - - - - 116

3. Drill rig monitoring:
   (Samples collected by the University of Texas in three suites: one pre-drilling, a second during drilling and a third post-drilling)

   a. Suspended sediments for trace metals and clay mineralogy, pre-drilling - - - - - - - 5

   b. Suspended sediments for trace metals and clay mineralogy, during drilling - - - - - - 10

   c. Suspended sediments for trace metals and clay mineralogy, post-drilling - - - - - - - 5

   d. Benthic sediments for texture, pre-drilling - - - - - - - - - - - - - - - - - - - 24

   e. Benthic sediments for texture, post-drilling - - - - - - - - - - - - - - - - - - 14

   f. Benthic sediments for trace metals, pre-drilling - - - - - - - - - - - - - - - - - - 7

   g. Benthic sediments for trace metals, post-drilling - - - - - - - - - - - - - - - - - - 7

Total - - - 401

Grand Total - - - 1356

C. Additional samples and data included in project by USGS as research contribution

Cores in transects across selected reefs for sediment transport studies	32
High resolution seismic reflection profile gathered as a part of coastal zone studies, (track miles)	650

The locations of all stations by geographic coordinates are listed in the tables in the appendices at the end of the report.

PRINCIPAL INVESTIGATORS

Element leader for the geologic investigations was Henry Berryhill, Jr., who also assembled and edited the geologic report for 1976. Assistance in the assembling and editing of the report was provided by Anita Trippet.

Principal investigators delegated responsibility for carrying out the laboratory analysis, interpretation, compilation and reporting of data for specific topics of the geologic investigations were:

Suspended sediments, texture, and transmissometry	Gerald Shideler
Suspended sediments, clay mineralogy	Charles Holmes
Suspended sediments, trace metals	Steven Barnes
Benthic sediments, texture	Gerald Shideler
Benthic sediments, textural stratigraphy, and patterns of transport	Henry Berryhill, Jr.
Benthic sediments, biogeology	Gary Hill
Benthic sediments, trace metals	Charles Holmes and Ann Martin
Benthic sediments, trace metals in area of gas seeps	Charles Holmes
Benthic sediments, rates of sedimentation	Charles Holmes and Ann Martin
Late Quaternary geologic history and Holocene geology	Carroll Pyle and Henry Berryhill, Jr.

SUSPENDED SEDIMENTS

PHYSICAL CHARACTERISTICS

by

Gerald L. Shideler

Methods

Field Techniques

The regional dispersal patterns for the suspended sediments were determined seasonally on the basis of both the turbidity and the textural composition at 26 stations during November, March and May. (See figure 3 for station locations.) The 26 stations were located to provide optimum geographic coverage of the region and to provide concentrated coverage of three coastal inlets that serve as major sources of sediment (Pass Cavallo, Aransas Pass, Rio Grande-Brazos Santiago). The inlet stations were located along 2 mile radii from the center of the respective inlets and were occupied during ebb tides as close as possible to the time of maximum current flow. Water column measurements for each cruise were obtained over a maximum period of 5 days, thus providing quasi-synoptic regional coverage. Radar navigation was used for inlet station positioning. Deeper stations were located and repositioned by LORAN-A, except for the fall cruise in November 1975 when LORAC precision navigation was used.

During each of the three seasonal cruises, regional wind conditions and surface drift patterns were recorded. Daily wind speed and azimuth data compiled by the National Weather Service at Corpus Christi were considered to be representative of the OCS region, although it is recognized that wind velocity can vary from offshore to onshore. The wind data were added

vectorially over a 15 day interval that was centered on the cruise period in order to determine the resultant wind directions during each cruise. Quasi-synoptic surface drift patterns were determined by releasing ballasted surface drifter bottles at each station during the cruise. Only drifters recovered within 30 days of the release date were used to determine net drifter trajectories between release and recovery points. Drifters recovered within 15 days from the date of release also were used to calculate net minimum drift velocities, based on straight-line trajectory distances and the corresponding elapsed release-recovery time intervals.

Vertical in situ transmissivity/temperature profiles were recorded at each station. Processing of the profiles consisted of manually digitizing the field analog recordings at selected depth intervals, tabulating the corresponding transmittance and temperature values, and reducing the profiles to a common scale. The recorded transmittance values (percent T per 25 cm optical path) were converted to values corresponding to a 1 m optical path, a more commonly used mode of comparison. Time-series profiles from the 3 cruises were then prepared for each of the 26 monitoring stations to document the variability of turbidity and temperature within the water column. The transmissivity and temperature values are tabulated in Appendix 1.

At each of the 26 stations, water samples were obtained at three levels: top, mid depth, and approximately 2 m above the bottom. Water samples were collected in 30 liter NISKIN bottles and were immediately transferred to particle-free amber polypropylene storage bottles. As a means of inhibiting organic growth, a sufficient quantity of formalin was added to the storage bottles to result in a 5 percent concentration. Sediment dispersal patterns were established on the basis of suspended sediment textural and turbidity gradients observed at the 26 monitoring stations.

Laboratory Techniques

The suspended sediment from the 230 water samples collected during the 3 cruises was analyzed for both texture and total particle concentrations using the following procedures:

Textural analyses

1. The field samples were brought to room temperature and thoroughly agitated; a representative split was taken.
2. The work sample was then filtered through a 125 μm sieve to remove particles capable of blocking the COULTER COUNTER 200 μm tube aperture.
3. Grain-size distributions were determined at a 0.5 Ø interval electronically, employing a 16 channel model TA COULTER COUNTER. Duplicate analyses were conducted with 200 μm and 30 μm tube apertures, providing an effective analytical range from 0.63 μm to 81 μm. All COULTER analyses were conducted using the following standard procedures:
   a. The sample concentrations were maintained at a level sufficiently low to produce less than 5 percent coincidence error. If dilution was required, a particle-free sea water diluent, passed through 0.2 μm filter, was used.
   b. The 200 μm tube analysis was conducted first to determine the coarser half of the size distribution; the sample was agitated during analysis at a standard speed.
   c. The residual sample from the 200 μm tube analysis was passed through a clean 20 μm sieve and was analyzed with the 30 μm tube to determine the finer half of the size distribution. No agitation was used during the 30 μm tube analysis.
   d. The results from both 200 μm and 20 μm tube analyses were combined to obtain the total size distribution, using standard two-tube overlap techniques.

4. The textural data were processed by computer to derive statistical grain size parameters over a 3.5-11.0 Ø analytical range. Derived parameters include the silt/clay ratios and the four moment measures (mean diameter, standard deviation, skewness, and kurtosis). These parameters are tabulated in Appendix 1.
5. The areal variability of selected size parameters was then mapped for both surface and bottom water sediments.

Particle concentration analyses

Suspended sediment particle concentrations in the size range of 0.63 to 81 μm also were determined for each water sample. The particle concentrations (counts/cc), as determined by COULTER COUNTER, were used as the index of relative water turbidity. Particle counts were made using the following procedures:

1. The water sample was brought to room temperature and thoroughly agitated.
2. Counts were made first with the 200 μm tube, running the sample full strength after passing it through a 125 μm sieve. A standard 150 ml sample volume was agitated at a standard speed. Duplicate counts were made; if they agreed within ±10 percent, the average value was used. If the deviation was greater than ±10 percent, additional counts were run until the value spread was within the ±10 percent limits. The 200 μm tube analysis counted particles within the range of 12.7 to 81 μm.
3. The residual sample from the 200 μm tube analysis was passed through a 20 μm sieve and then used for the 30 μm tube analysis to obtain the particle count within the range of 0.63 to 12.7 μm. The sample was diluted to produce less than 3 percent coincidence error. The particle

count was determined and adjusted by the dilution factor. Duplicate counts were made using a ±10 percent value spread, as described in the 200 μm analyses.

4. Particle counts from both the 200 μm and 30 μm tube analyses were arithmetically combined to provide total particle counts/cc. Particle count data are tabulated in Appendix 1. The areal variability of total particle counts was then mapped for both surface water and bottom water sediments.

Patterns of Movement for the Surface Drifters

Wind drift currents appear to be the major sediment dispersal agent within the South Texas OCS region. Consequently, the general nature of the surface drift patterns and the corresponding wind vectors were determined during each of the three cruise periods (figs. 9-11).

November 1975 Cruise

During the November 15-21 cruise the wind generally was from the southeast (fig. 9), shifting to the northwest during the latter part of the cruise (November 20). The shift in wind direction was associated with the passage of a cold front, a storm period of increased sea state and strong southward ship drift. Wind speeds during the cruise were within the 16-25 km/hr range. Immediately preceeding (Nov. 11-14) and following (Nov. 22-25) the cruise, the wind was predominantly from the northeast; the resultant wind vector for the entire 15-day period was southwestward (254°).

A total of 148 surface drifters were released during the cruise, and 11 percent were recovered within 30 days: 7 percent within the 0-15 day interval, and 4 percent within the 16-30 day interval. Drifter recovery sites ranged

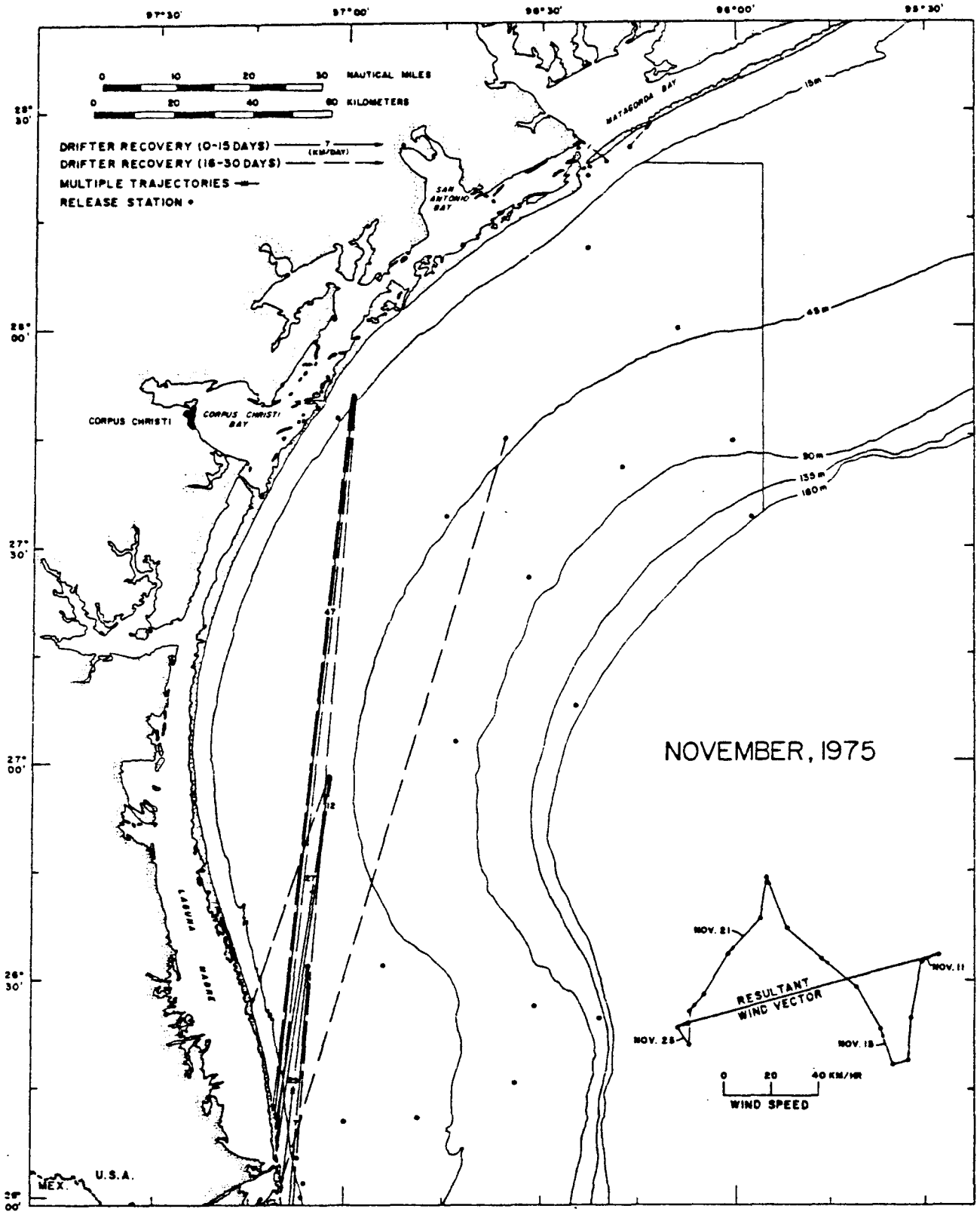


Figure 9. Results of surface drifter releases, November cruise.

from Matagorda Bay southward to beaches in northern Mexico; the highest concentration of recoveries was in the sector along the U.S.-Mexico border. The regional direction of drift was toward the south/southwest, except near the entrance to Matagorda Bay where the tidal current regime apparently was reflected in local variations. Net minimum drift velocities based on drifters recovered during the first 15 days ranged from 1-47 km/day, with an overall mean velocity of 24 km/day. Strong regional southerly drift during the November cruise may partially explain the relatively poor drifter recovery, especially from the outer and the more southerly stations. Drifters released from these stations probably reached remote Mexican beaches farther to the south.

March 1976 Cruise

Daily wind directions during the March 2-6 cruise were predominantly from the southeast with a shift to the northeast during the last day (fig. 10); resultant daily wind speeds were within the 16-40 km/hr range. Preceeding the cruise (Feb. 26-March 1), the daily wind was from the southeast with wind speeds within the 12-29 km/hr range. Following the cruise (March 7-11) the daily winds were from the northeast shifting to the southeast; wind speeds were within the 1-28 km/hr range. The resultant wind vector over the 15 day period was oriented northwestward (319°).

A total of 192 surface drifters were released, and 28 percent were recovered within 30 days: 23 percent within the 0-15 day interval and 5 percent within the 16-30 day interval. Recovery sites ranged from Matagorda Bay inlet southward to northern Mexico beaches. The highest concentration of recovered drifters was in the southern coastal sector near the U.S.-Mexico border. The regional surface drift direction was to the southwest except

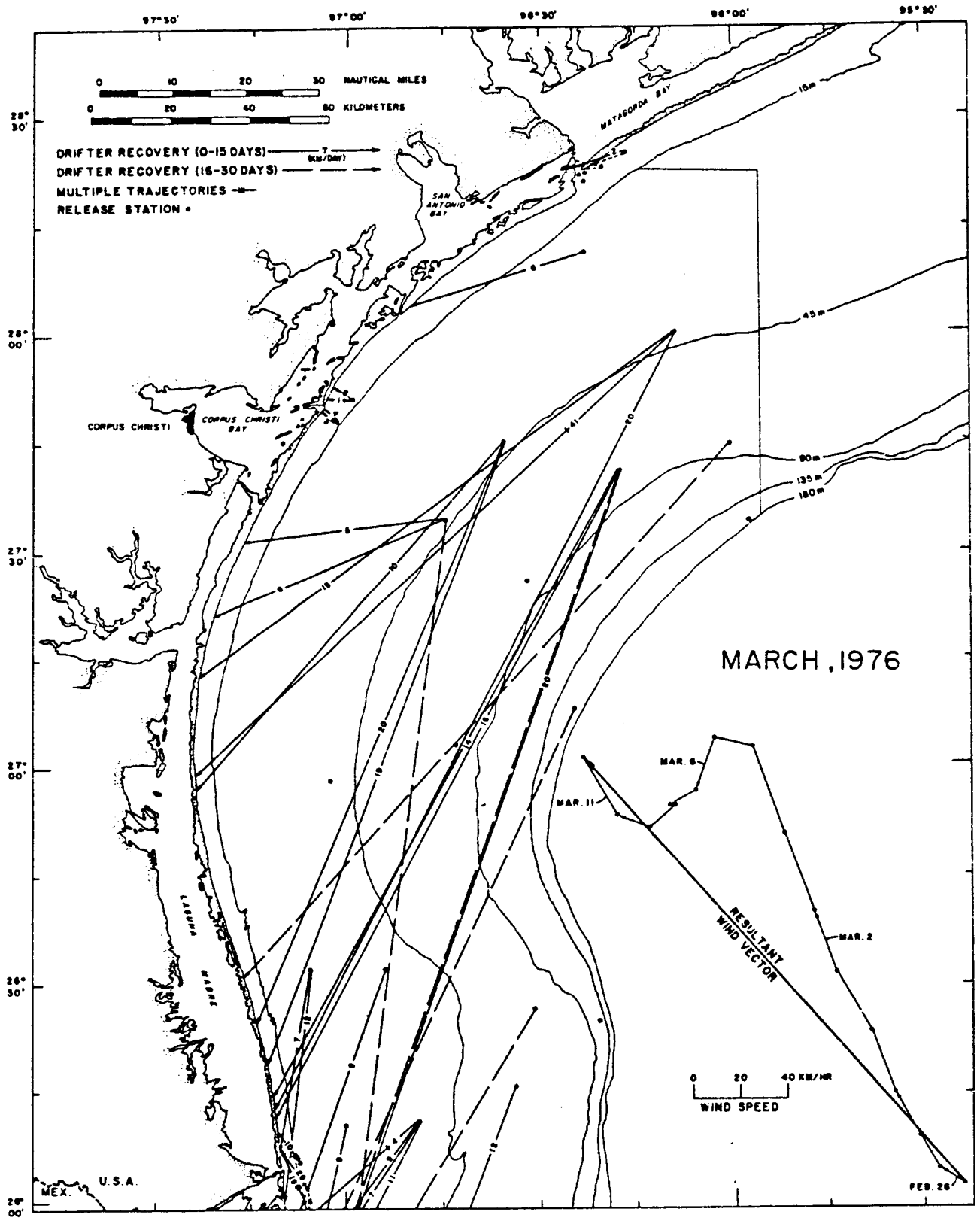


Figure 10. Results of surface drifter releases, March cruise.

in the vicinity of the coastal inlet stations where surface drift generally was to the west/northwest, apparently reflecting a flood-dominated tidal current regime associated with the inlets. Net minimum drift velocities ranged from 1-41 km/day with an overall mean velocity of 12 km/day.

If the non-tidal offshore circulation pattern reflects mainly wind drift currents, the regional southwestward drift is not in agreement with the 15 day resultant wind vector, which is oriented northwestward. The discordance probably indicates that the surface drift during the March cruise reflects either residual wind drift currents generated under earlier winter conditions, possibly by northerly winds associated with passing cold fronts or post-cruise hydraulic conditions. Another possibility is that the March drift pattern is not primarily a wind drift pattern, but may be a density-induced current pattern reflecting either the shelfward intrusion of deeper gulf water or water coming from the northern gulf shelf.

May 1976 Cruise

During the May 21-25 cruise, daily wind direction initially was from the northeast, shifting to the southeast for the remainder of the cruise (fig. 11); resultant daily wind speeds were within the 6-20 km/hr range. Preceding the cruise (May 16-20), wind vectors were to the west/southwest within the 6-18 km/hr speed range; following the cruise (May 26/30), wind vectors were predominantly northwestward and within the 8-27 km/hr range. The resultant wind vector for the 15 day period was northwestward (297°).

Of the 217 drifter bottles released, 37 percent were recovered within 30 days: 27 percent recovery within the 0-15 day interval and 10 percent within the 16-20 day interval. Drifter recovery sites ranged from northern Matagorda Bay southward to near latitude 26°30' N. The directions of

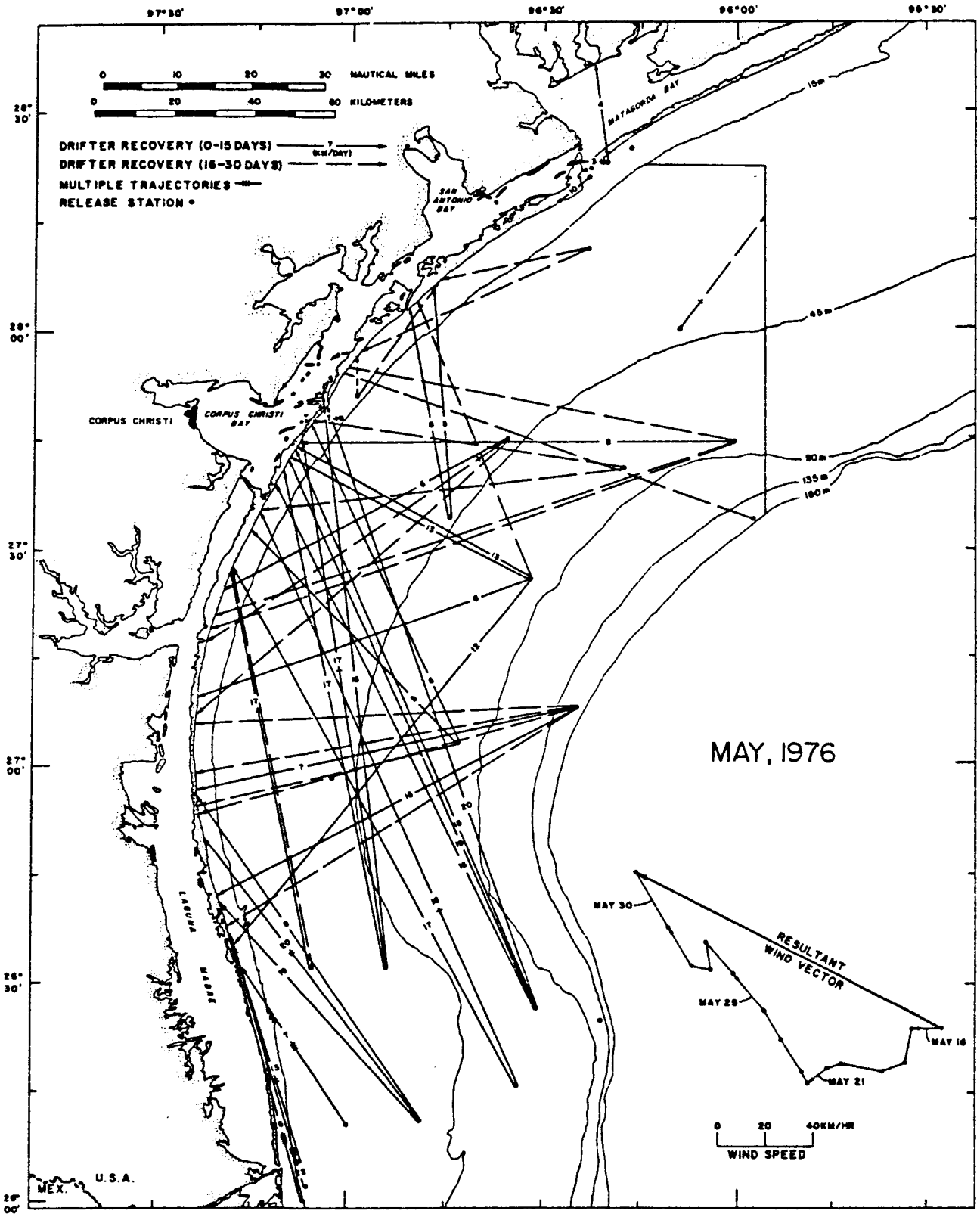


Figure 11. Results of surface drifter releases, May cruise.

regional surface drift were variable and had a distinct bimodal pattern of distribution that indicated a very broad regional convergence toward the central sector. Drift in the northern half of the OCS was predominantly toward the west/southwest; drift in the southern half was predominantly toward the northwest. As drifters were released at the northern stations during the first half of the cruise period, they may largely reflect wind drift currents generated by the west/southwest-oriented wind vectors of the precruise and early cruise periods. In contrast, the drifters released at the southern stations during the latter half of the cruise probably reflect currents generated by the predominantly northwest-oriented wind vectors that occurred within the May 22-30 period. In essence, the bimodal pattern could reflect a shifting wind drift current regime. Net minimum drift velocities during the May cruise ranged from 3-25 km/day with an overall mean velocity of 14 km/day.

Water Turbidity Patterns

One method of evaluating the suspended sediment transport system is by determining on a time-series sequence basis the regional turbidity gradients as indicators of temporal sediment dispersal patterns. Lateral and vertical turbidity gradients were determined for each cruise period in terms of both water transmissivity and particle concentrations.

Transmissivity and Temperature

Measurements of water transmissivity (percent T/m) using a light beam transmissometer system are influenced by a number of variables that affect the optical properties of seawater (Jerlov, 1968; Gibbs, 1974). Obviously, the most influential variable is the amount of sediment in suspension at a

given place and time. Consequently, in situ transmissivity measurements can be used as approximations of the relative amounts of turbidity. The transmissometer measurements were used to determine the seasonal variability of lateral transmissivity gradients in the surface waters, as well as the vertical gradients within the water column and to relate the variations in turbidity to the thermostructure of the water. For descriptive purposes, an arbitrary verbal scale of relative turbidity based on water transmissivity values was defined as follows: 1) highly turbid (opaque) = <5 percent T/m; 2) turbid = 5-30 percent T/m; 3) moderately turbid = 30-70 percent T/m; 4) nonturbid (transparent) = >70 percent T/m.

Surface patterns

November 1975 pattern (fig. 12)--Transmissivity (percent T/m) of surface waters during the November cruise ranged from opaque or highly turbid (0 percent) near some coastal inlet stations to transparent or nonturbid (99 percent) near the shelf edge at the 180 m isobath (station 12). Two general trends were indicated: a progressive seaward decrease in turbidity to mid shelf and only moderate turbidity (>60 percent) and a relatively low transmissivity gradient with turbidity isopleths largely discordant to the bathymetry over the outer half of the shelf. On the inner half of the shelf where turbidity was higher, transmissivity gradients were steeper and the isopleths concordant to the bathymetry. The pattern over the inner shelf of progressively increasing turbidity with decreasing water depth parallels the coastline and probably is attributable to both proximity to coastal sediment sources and a progressive shoreward increase in wave surge intensity that tends to maintain sediment in suspension. In contrast, the discordant pattern over the outer shelf shows an apparent absence of depth control and may reflect the shelfward incursion of

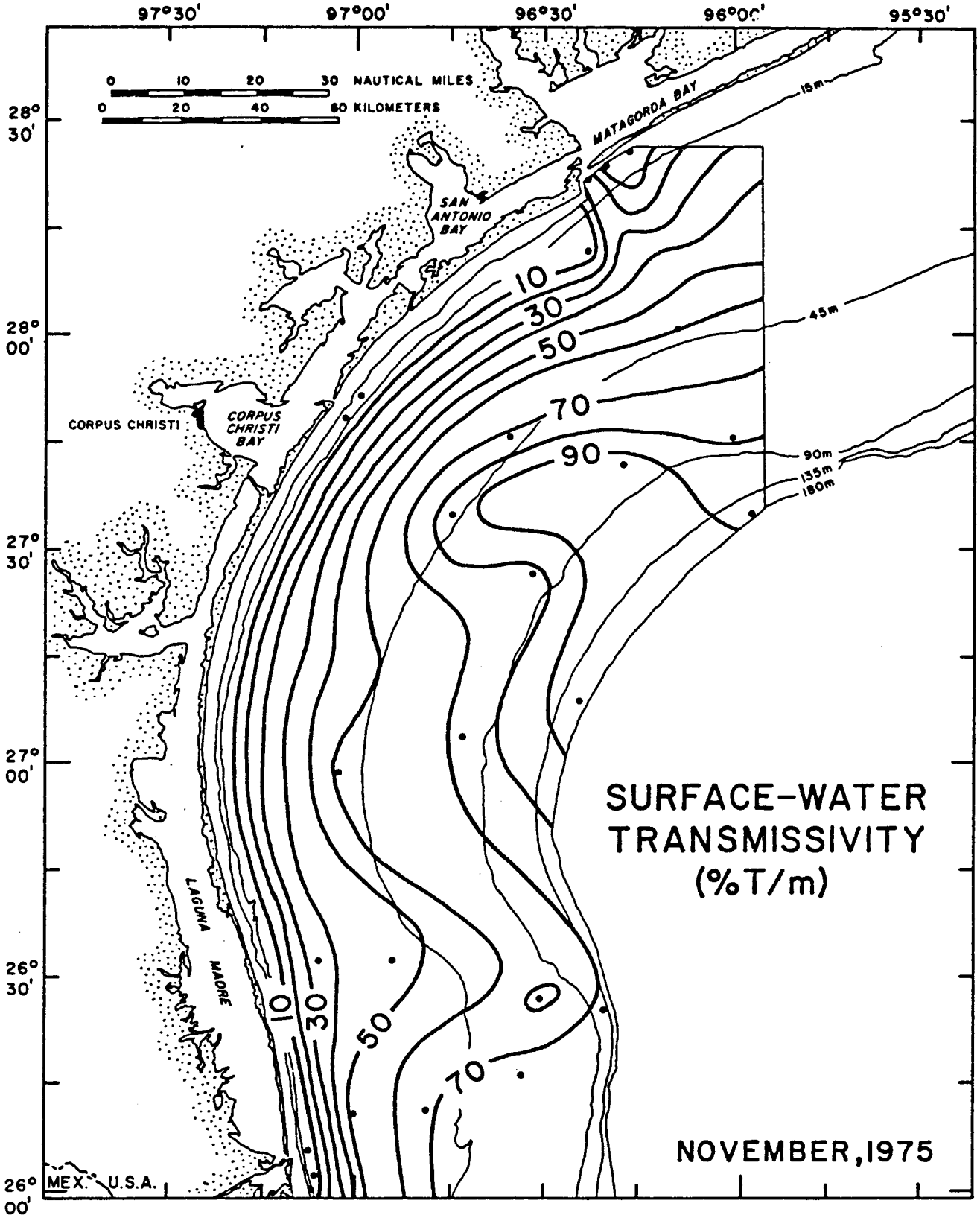


Figure 12. Surface water transmissivity, November cruise.

relatively transparent water from the deeper part of the gulf. An incursion is suggested by the prominent shoreward-trending salient of transparent and relatively warm (percent T >70) surface water centered near latitude 27°30' N. in the central sector and by the subordinate salient centered near latitude 26°00' N. in the southern sector.

March 1976 pattern (fig. 13)--Surface water transmissivity during the March cruise ranged from opaque highly turbid (0 percent) near some inlet stations to transparent nonturbid (90 percent) in the northeastern sector (station 7). The basic regional pattern was similar to that for November and indicated a progressive shoreward increase in turbidity, as well as the same two-fold shelf division in terms of transmissivity characteristics.

A comparison of the March turbidity pattern with the November pattern near coastal inlets shows minor local differences that may be related to differences in the tidal phase during field measurements. Minor changes also occurred in the configurations and locations of the two prominent salients of transparent water; however, the similarity in the positions of the two salients during both seasons suggests that they are relatively persistent.

May 1976 pattern (fig. 14)--Transmissivity of surface waters during the May cruise ranged from a minimum of 7 percent near the Rio Grande-Brazos Santiago inlet (station 23A) to a maximum of 90 percent near the central sector (station 11). The basic two-fold division in shelf transmissivity structure indicated by the patterns for November and March also was evident in the pattern for May, with some modifications. The transparent water of the outer shelf (percent T >70) with low transmissivity gradients and bathymetrically discordant isopleths appears to have expanded shoreward

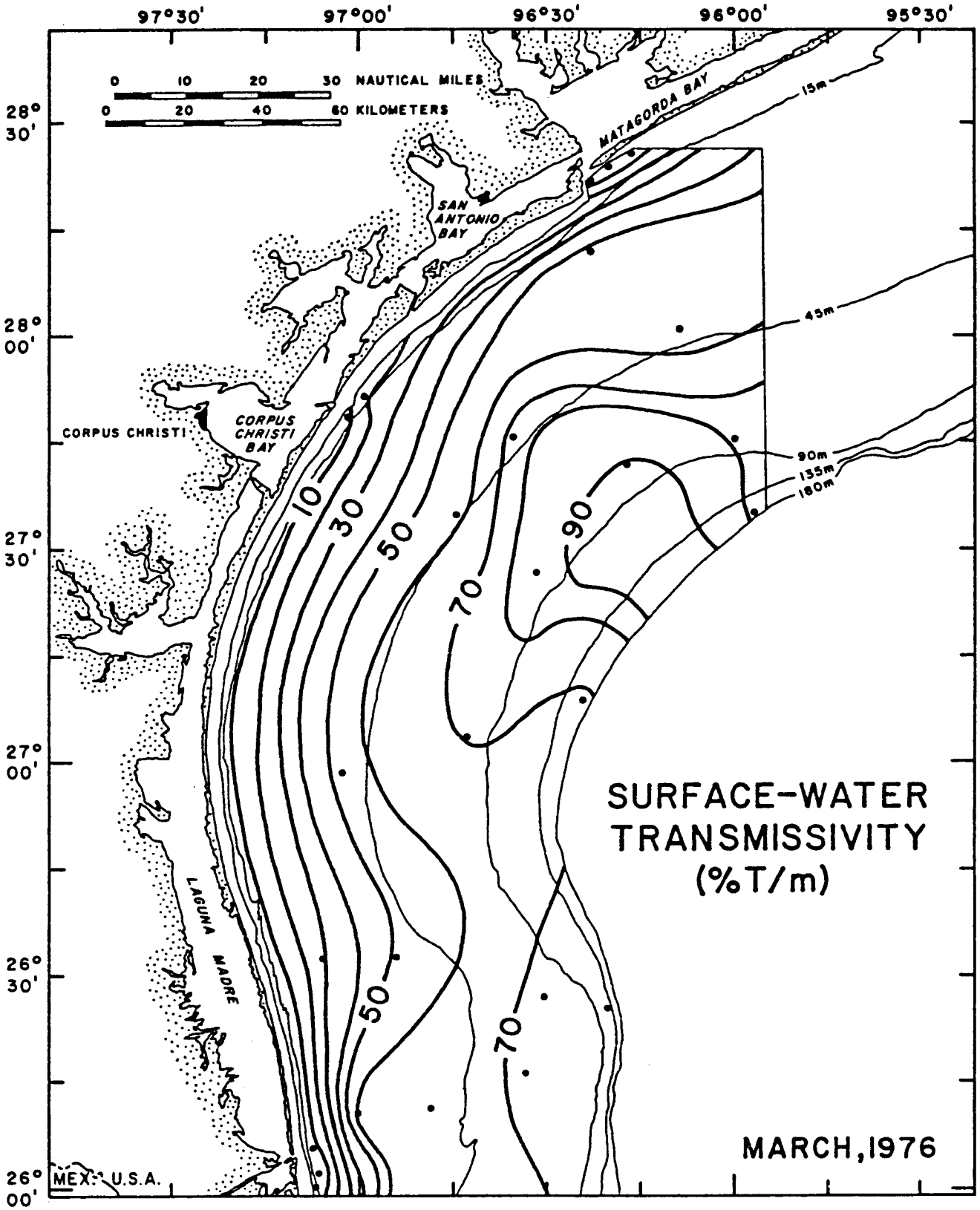


Figure 13. Surface water transmissivity, March cruise.

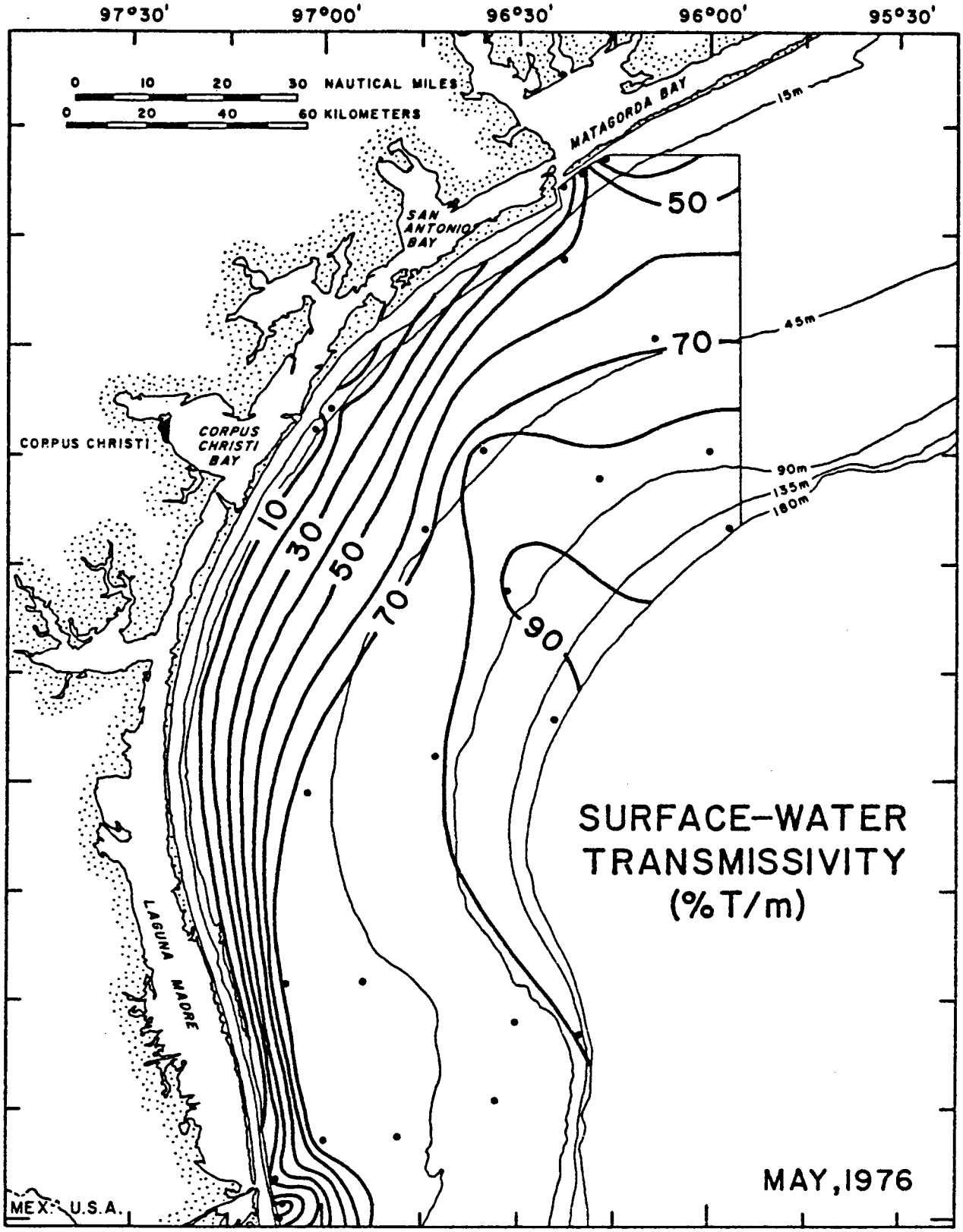


Figure 14. Surface water transmissivity, May cruise.

onto the inner shelf sector within the southern half of the OCS, possibly reflecting the maximum incursion of deeper gulf waters among the three cruises. This incursion appears to have reinforced the bathymetrically concordant turbidity gradients of the southern inner shelf, resulting in relatively high gradients compared with the northern inner shelf gradients where encroachment was less pronounced.

A comparison of the three time-series patterns suggests a temporal variation in OCS surface water turbidity caused by the interaction of two separate dispersal mechanisms. The dispersal mechanism over the inner shelf appears to be regulated by depth, but also is influenced by the locations of coastal sediment sources and by regional wave surge intensity. Temporal turbidity variability along the inner shelf probably is induced mainly by seasonal variations in coastal sediment inflow from adjacent estuaries and by variations in the ambient wave climate. In itself, the seaward dispersion of coastal sediment by advection and diffusion would produce a regional seaward-decreasing turbidity gradient concordant with bathymetry. However, a discordant transmissivity structure on the outer shelf suggests a second dispersal mechanism that involves seasonal variations in the degree of shoreward incursion of transparent water from the deeper gulf. The incursion seems to have been most pronounced during May. The incursion effect, if real, may inhibit the gulfward escape of shelf sediment, thus accentuating the coast-normal turbidity gradients over the inner shelf.

Vertical transmissivity/temperature gradients

Vertical transmissivity/temperature profiles for the monitoring stations are illustrated by figures 15 to 28. Transmissivity (percent T/m) is indicated by the relatively broad graph line; temperature (°C) is indicated by the

thin line. The sea floor position is represented by the hachured surface. Precision limitations of the LORAN-A navigation system made it impossible to occupy the exact same spot for each station on each cruise. Therefore, water depth varied among the three profiles for some stations.

Matagorda Bay Inlet, Stations 1, 1A, 2 (fig. 15)--The purpose of monitoring these three inlet stations was to ascertain the sediment dispersal pattern associated with Matagorda Bay, a source of sediment for the South Texas OCS. All three stations are at depths of less than 15 m. Stations 1 and 1A are located respectively northeast and southwest of the Matagorda ship channel; station 2 is located south of the bay's natural inlet (Pass Cavallo).

In November station 1 had a homogeneously high turbidity (<5 percent T/m) and a positive temperature gradient with depth; station 1A had homogeneously high turbidity and isothermal conditions. Station 2 had a stratified turbidity and thermal structure consisting of a turbid surface water layer, a moderately turbid, warmer intermediate layer, and a highly turbid bottom layer. The comparative November profiles of these inlet stations suggest that the Matagorda ship channel was a more prolific source of sediment than the natural inlet (Pass Cavallo). The variable turbidity and thermal structures of the three inlet stations indicate varying degrees of coastal water homogenization: station 1A exhibits the most thoroughly mixed water column; station 2 is least homogenized. The station 2 profile suggests that an ebb sediment plume maintained its entity as a relatively low density surface flow.

In March all three stations had homogeneously high turbidity. Stations 1 and 2 were nearly isothermal to within a few meters from the bottom, whereas

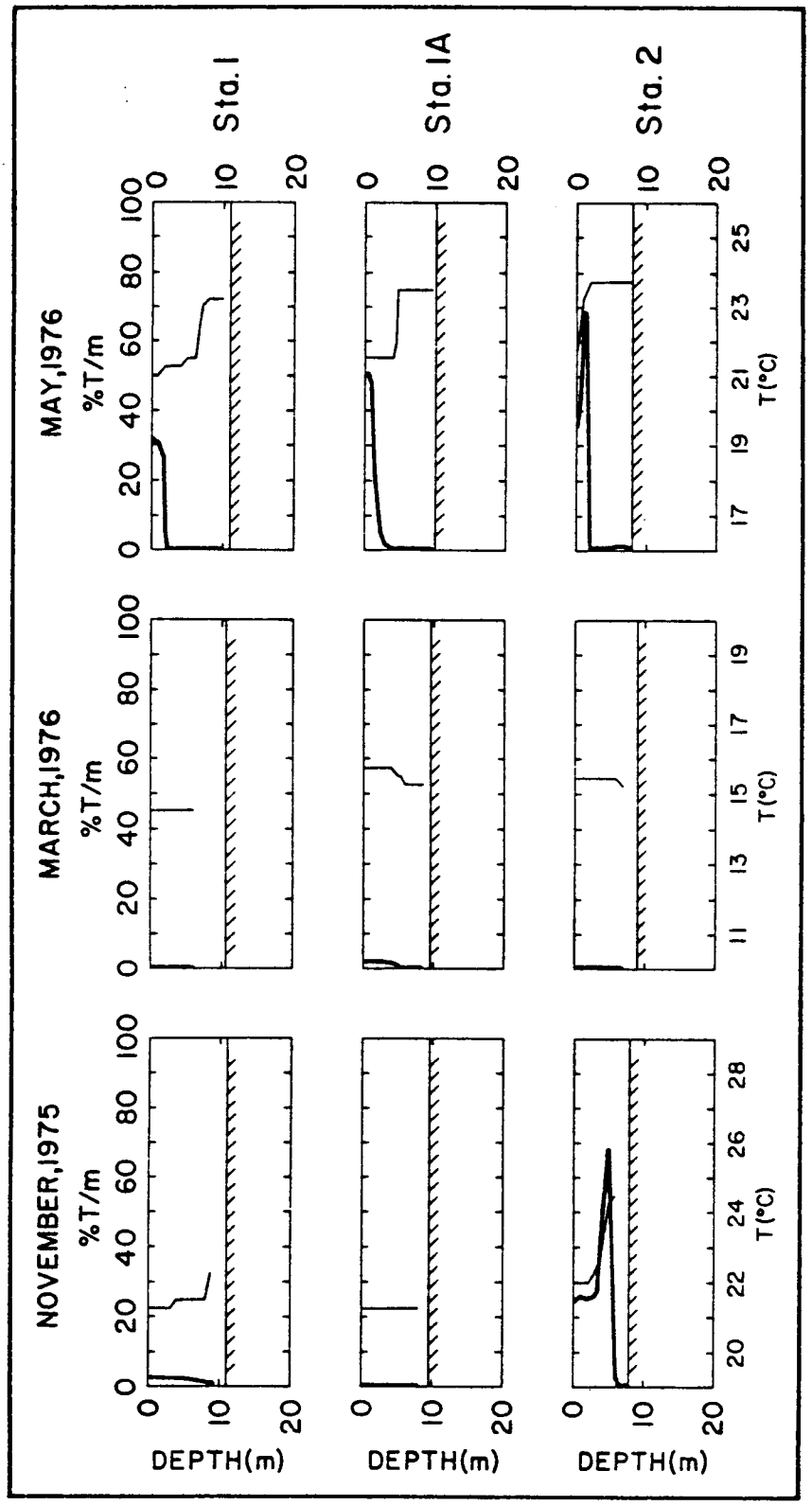


Figure 15. Transmissivity/temperature profiles, Matagorda Bay inlet (Heavy line indicates transmissivity; thin line indicates temperature.)

station 1A had a minor thermocline near a depth of 5 m associated with a small increase in turbidity. The pattern suggests prolific sediment outflow from both the Matagorda ship channel and Pass Cavallo.

In May, all three stations had stratified turbidity and thermal structures. Stations 1 and 1A had a turbid surface layer (upper 3 m) overlying a highly turbid bottom layer. Their thermal structure had a mid-depth temperature inversion. Station 2 had a moderately turbid surface water layer (upper 1 m), a less turbid intermediate layer, and a highly turbid bottom layer. The surface and intermediate layers had a positive temperature gradient with depth, and the bottom layer was a relatively warm isothermal layer. The inlet pattern suggests that both Matagorda ship channel and Pass Cavallo were prolific sediment sources.

Several conclusions can be drawn from the entire suite of time-series profiles from the Matagorda Bay inlet area. 1) Sediment outflow from the inlet area was least during the May cruise. 2) Away from the inlet area proper, dispersal of sediment was uniformly seaward during the three cruises without any dominating longshore transport component. 3) Mixing of coastal water was most thorough during the March cruise, a period of relatively homogeneous turbidity-thermal structure. In contrast, the least mixing was encountered during the May cruise, a period characterized by a well-stratified turbidity thermal structure. 4) Turbidity appeared to be related to water thermostructure although the relationship is variable; isothermal water layers tend to be uniformly turbid.

Station 3 (fig. 16)--For the three cruises, the recorded depths at this inner shelf station varied from 19 to 24 m. The November profile indicated an isothermal water column. The turbidity structure consisted of turbid (5-10

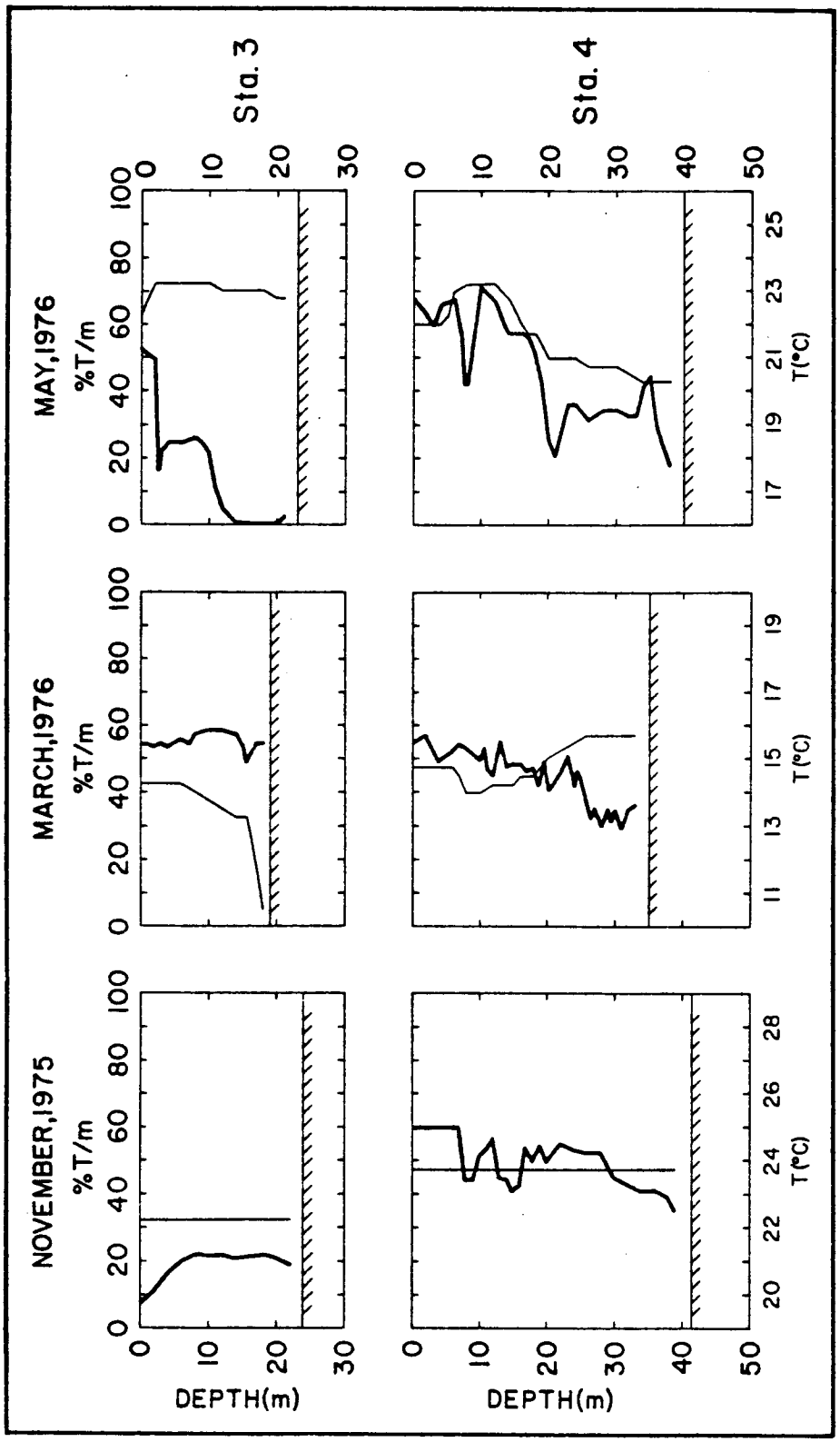


Figure 16. Transmissivity/temperature profiles, stations 3 and 4. (Heavy line indicates transmissivity; thin line indicates temperature.)

percent T/m) surface waters and an increasing turbidity gradient to 8 m and homogeneous turbidity below. The March profile indicated a nearly uniform column of moderately turbid water and a negative temperature gradient. The May profile showed a moderately turbid layer of surface water (upper 2 m), a turbid intermediate layer (2-10 m), and a nepheloid layer 10 m thick. The May thermal structure had a slightly positive temperature gradient in the surface layer, an isothermal intermediate layer, and a slightly negative gradient within the bottom layer. Thermal and turbidity structures appeared to correlate.

The suite of time-series profiles indicated substantial temporal variation in the turbidity/thermal structure, apparently reflecting the shallowness of the station. Overall turbidity was least during March, when the water was coolest. A stratified structure was recorded during May, indicating inefficient mixing and the possible presence of a nepheloid layer approximately 10 m thick. In contrast, the water column during November and March was relatively homogeneous, indicating substantial mixing.

Station 4 (fig. 16)--The depths recorded during the three seasonal cruises at this inner shelf station ranged from 35 to 41 m. The November profile indicated an isothermal water column having moderate turbidity that increased slightly with depth. The March profile also showed moderate turbidity increasing with depth; however, the associated thermal structure showed a negative temperature gradient. The May profile also showed moderate turbidity increasing with depth but with a tendency toward a two-layer structure. A conspicuous turbidity interface was recorded at a depth of about 20 m. The lower, more turbid layer possibly reflected an incipient nepheloid layer. The thermal structure in May essentially was opposite to that in March.

The time-series profiles for station 4 indicated seasonally consistent turbidity structure except for a tendency toward transition from homogeneous to stratified structure from November to May. The transition may have been induced by changes in water temperature from isothermal, to negative, to positive during the period November to May.

Station 5 (fig. 17)--Recorded depths at this outer shelf station ranged from 75 to 81 m. The November and March profiles both showed essentially nonturbid (>70 percent T/m) waters to a depth of 75 m. Below 75 m the turbidity gradient increased abruptly, indicating a nepheloid layer that was 3 m thick in November and 6 m thick in March. The March thermal structure had a negative gradient; the November thermal structure had isothermal waters to a 60 m depth, followed by a temperature inversion and gradient reversal. The May profile also had a nonturbid upper layer that was slightly more transparent than during November and March. The nonturbid water extended to a depth of approximately 68 m and was underlain by a nepheloid layer 7 m thick. The May thermal structure consisted of essentially isothermal surface and bottom waters and a broad thermocline within the depth range of 20 to 55 m.

The time-series profiles indicated only a slight seasonal variation (<10 percent T/m) in overall station turbidity. The two-layer turbidity structure persisted regardless of the large variations in water thermostructure.

Station 6 (fig. 18)--Recorded depths at this outer shelf station ranged from 174 to 184 m. Strong currents along the edge of the shelf during all three cruises prevented the transmissometer sensor from reaching bottom, resulting in partial profiles. Within the zone of measurement, the profiles for all three seasons indicated generally nonturbid water (percent T/m >70 percent). The deepest profile (110 m) was obtained during March. The

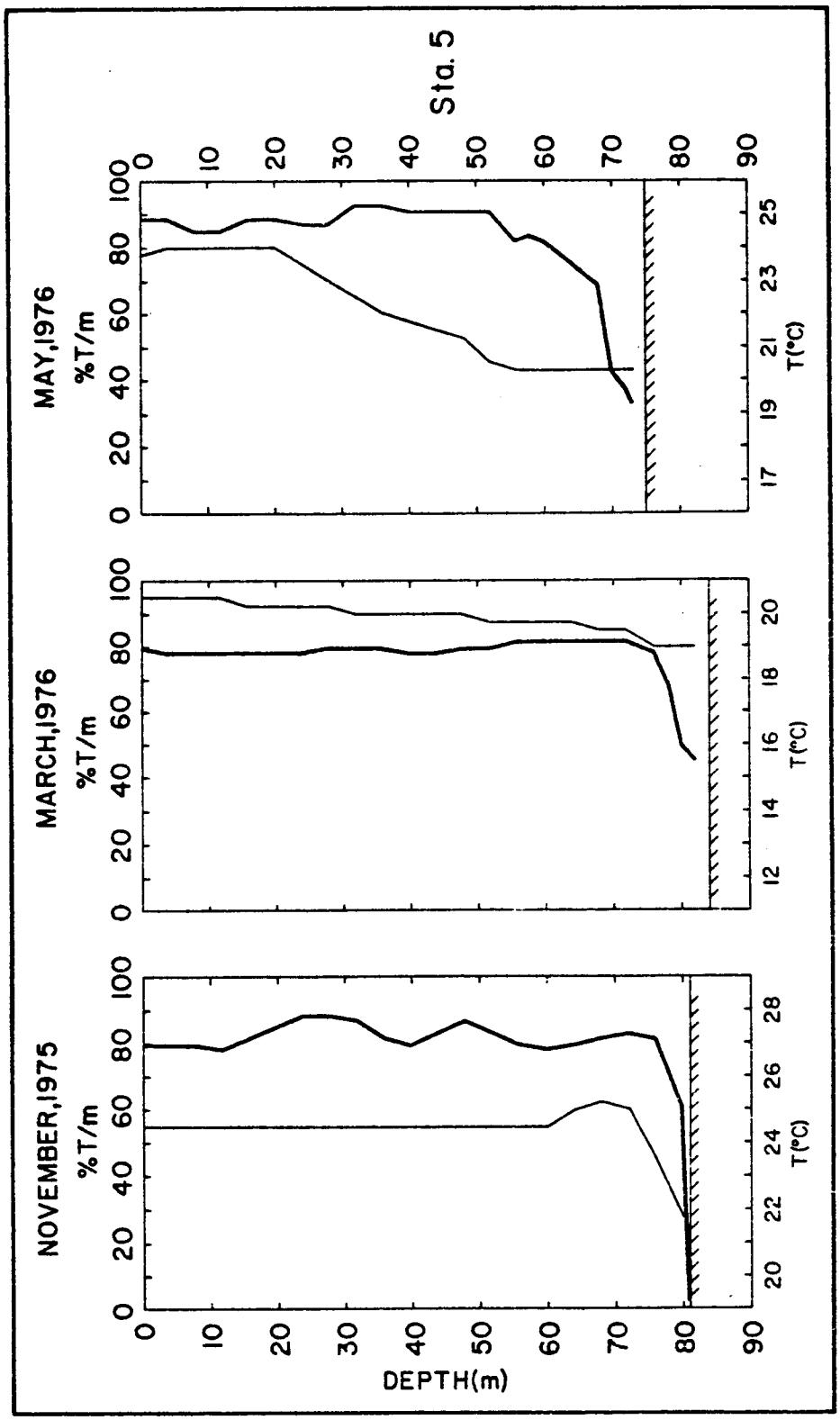


Figure 17. Transmissivity/temperature profiles, station 5. (Heavy line indicates transmissivity; thin line indicates temperature.)

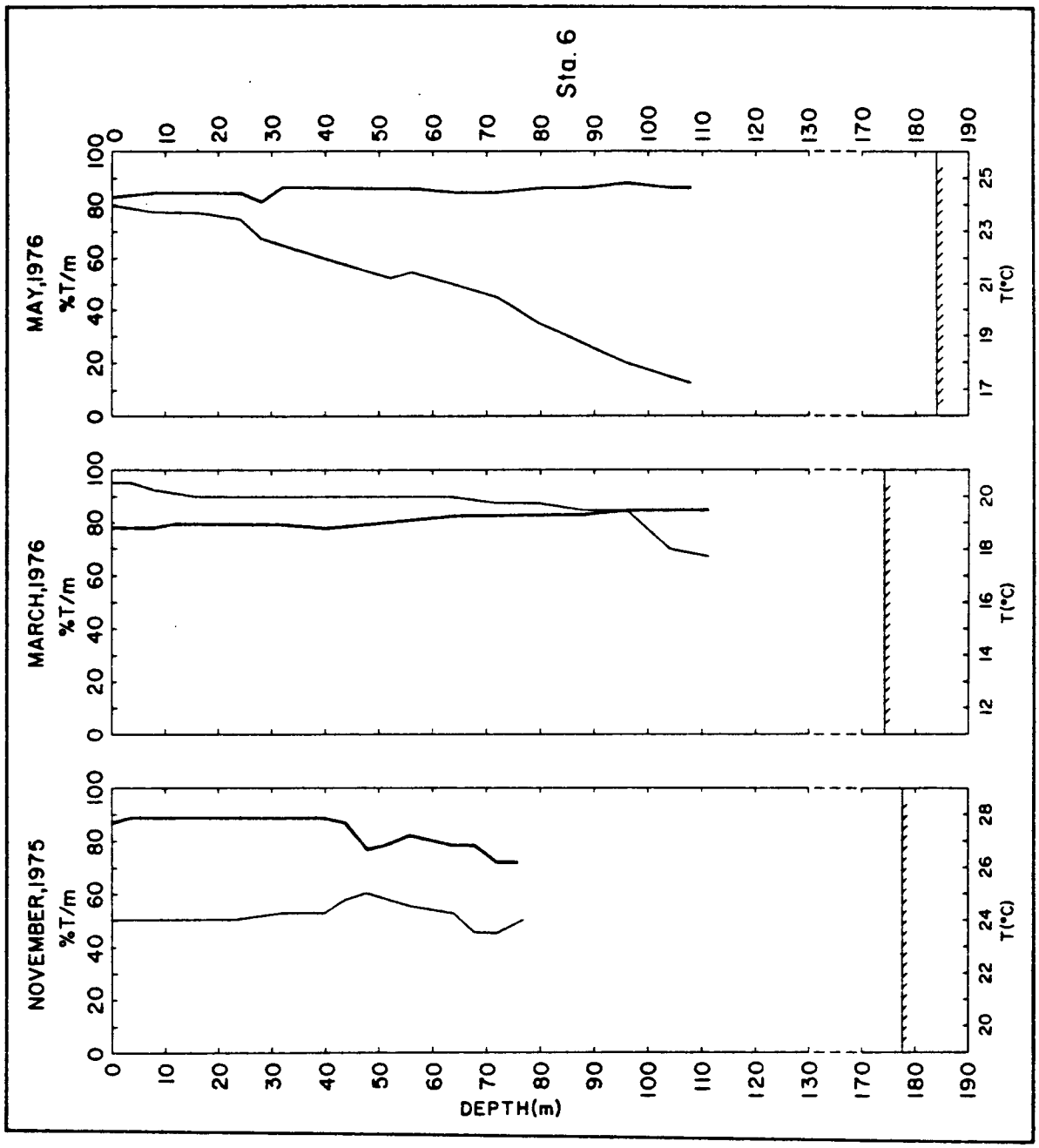


Figure 18. Transmissivity/temperature profiles, station 6. (Heavy line indicates transmissivity; thin line indicates temperature.)

thermal structures were variable seasonally; in March and May the water had respectively low and high negative temperature gradients with depth; in November the water was essentially isothermal.

The time-series profiles show that overall station turbidity was least during November. The water had relatively constant and uniform turbidity structure with depth despite substantial seasonal variation in the thermal structure.

Station 7 (fig. 19)--Recorded depths at this outer shelf station ranged from 67 to 81 m. In November the water was isothermal and relatively non-turbid with a slightly increasing turbidity gradient. In contrast, during the sampling in March and May, the water was stratified, consisting of non-turbid water to respective depths of 62 m and 52 m, above a nepheloid layer that was 17 m thick in March and 21 m thick in May. The thermal structure in March was a slight negative temperature gradient to a 64 m depth, above an isothermal layer; the thermal structure in May was a higher negative gradient to a 56 m depth, above an isothermal layer.

The time-series profiles indicate that from November to May, the thermal structure changed from isothermal to progressively greater negative temperature gradients, accompanied by an isothermal nepheloid layer that was absent in November. The profiles further suggest a general inverse relationship between temperature and turbidity. The nepheloid layer did not develop until near-bottom temperatures decreased from a November high of 24.5°C to a low of 19.5°C in March and May. The presence and thickness of a nepheloid layer at this locality appear to be controlled seasonally by the thermal structure of the water.

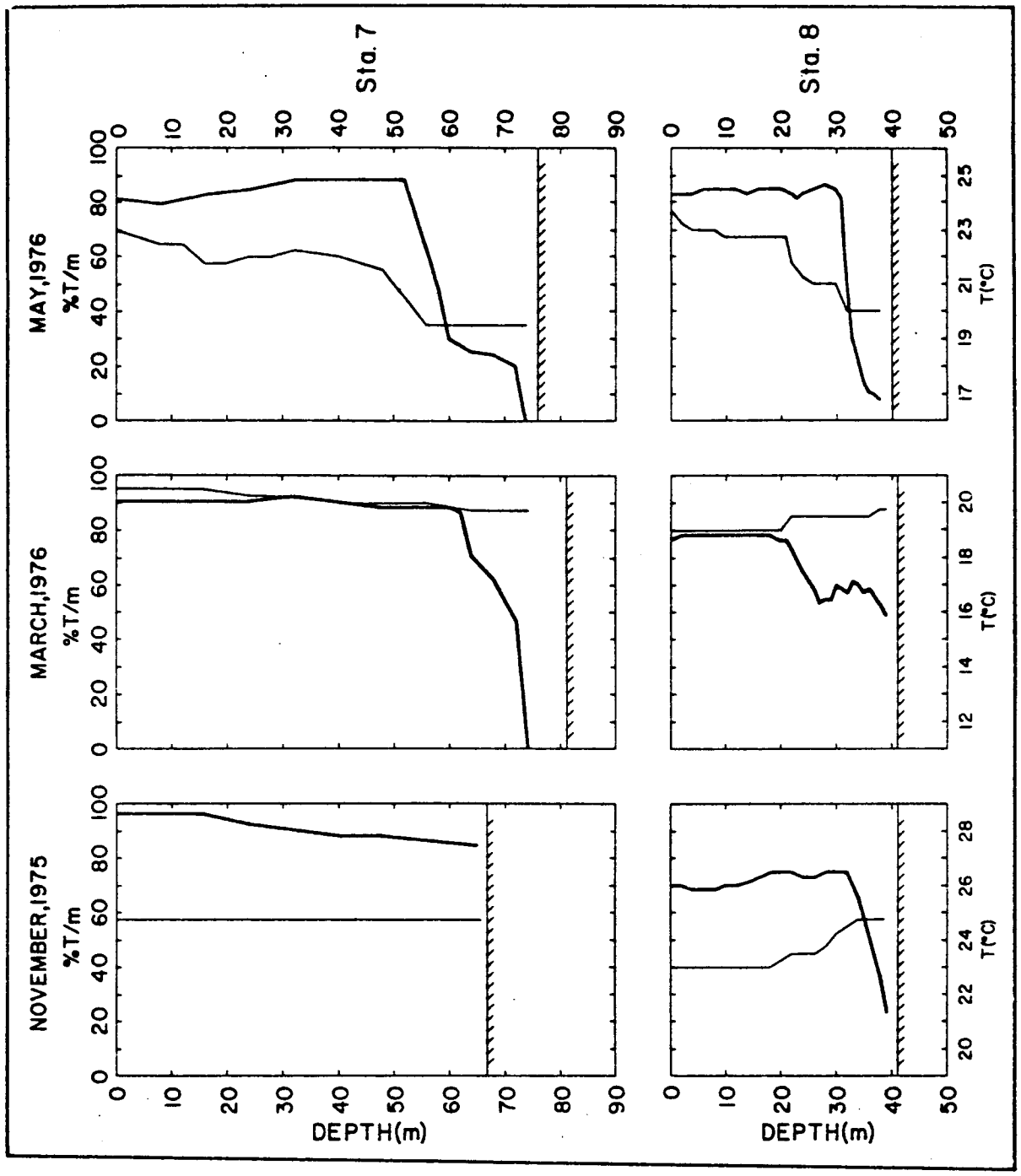


Figure 19. Transmissivity/temperature profiles, stations 7 and 8. (Heavy line indicates transmissivity; thin line indicates temperature.)

Station 8 (fig. 19)--This inner shelf station is 41 m deep. The turbidity profiles for all three seasons showed two layers: a nonturbid (percent T/m >70) upper layer overlaying a nepheloid layer whose thickness varied (8m in November and May; 20 m in March). The thermal structure of the water during November and March indicated temperature inversions; in May an intermittently negative temperature gradient was indicated.

No systematic relationship between thermal structure and turbidity was apparent other than a tendency for a nepheloid layer to be essentially isothermal.

Aransas Pass Inlet: Stations 9, 9A (fig. 20)--The comparative time-series profiles from this pair of stations were used to evaluate sediment dispersal associated with Aransas Pass. Stations 9 and 9A are located respectively northeast and southwest of the inlet and ranged in depth from 10 to 15 m.

In November the water at both stations was isothermal and highly turbid (<5 percent T/m), indicating thorough mixing and a relatively uniform radial dispersion of sediments from the inlet. In March, the water at station 9 was stratified, indicating an absence of effective mixing. The structure consisted of a turbid (20 percent T/m), isothermal layer 8 m thick overlying a highly turbid and slightly cooler layer. In contrast, the water at station 9A had high turbidity (<5 percent T/m) and isothermal structure, indicating thorough mixing. In May station 9 had turbid (15-20 percent T/m) surface water and an increasing turbidity gradient with depth, indicating partial mixing. The thermal structure showed a negative temperature gradient to a depth of 5 m, below which isothermal waters occurred. Station 9A had high turbidity (<5 percent T/m) and a variable thermal structure.

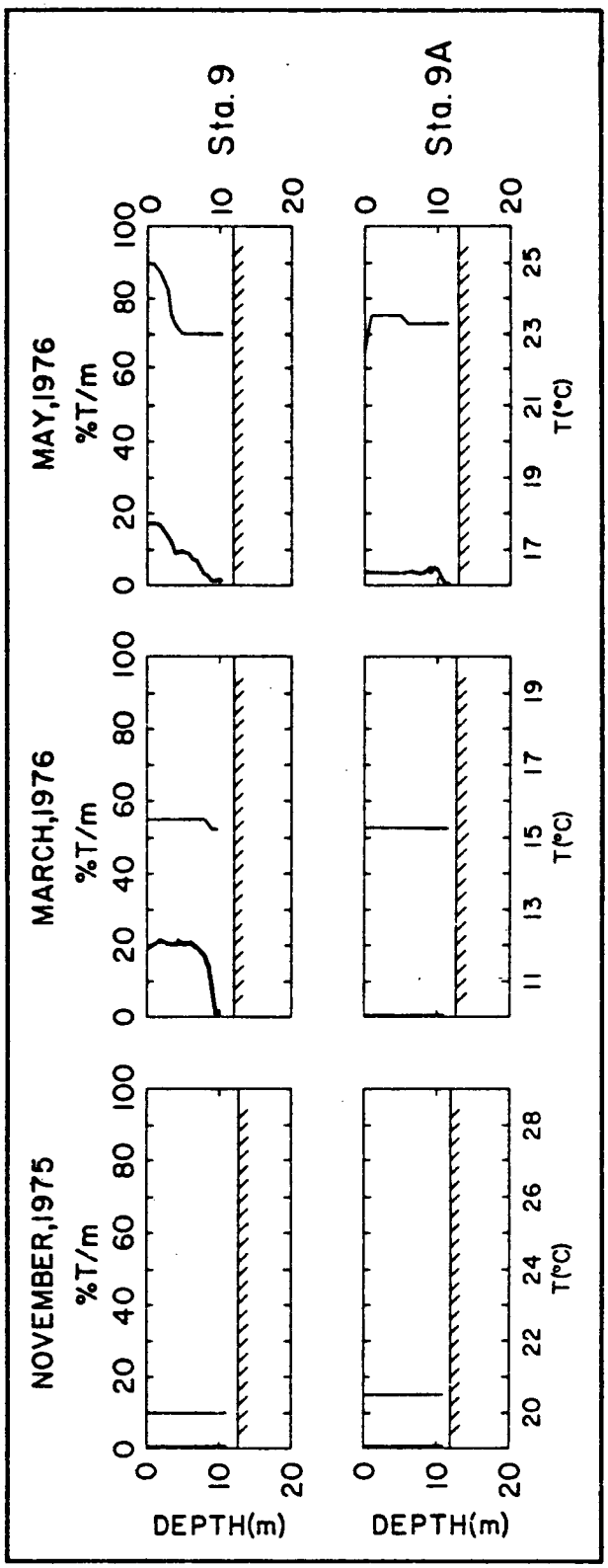


Figure 20. Transmissivity/temperature profiles, Aransas Pass Inlet. (Heavy line indicates transmissivity; thin line indicates temperature.)

The complete suite of time-series profiles from Aransas Pass suggests: 1) southward-trending ebb-tidal sediment plumes during March and May cruises; 2) most efficient mixing of coastal water during the November cruise; 3) generally isothermal waters were uniformly turbid.

Station 10 (fig. 21)--The depth of this inner shelf station is 43 m. The water column for all three seasonal profiles generally had a two-layer turbidity structure: an upper layer of moderately turbid to nonturbid water with substantial local variability above a nepheloid layer that ranged in thickness from 8 m in November and March to 15 m in May. The thermostructure in November and March was similar: isothermal near-surface waters (upper 18-20 m) above a zone of reversing temperature gradients. The thermostructure in May had an intermittently negative temperature gradient.

The time-series profiles indicate a complex, seasonally variable thermal structure, but a persistent, two-layer turbidity structure and a well-defined nepheloid layer. Although temperature variations may have been associated with local variations in the turbidity, no systematic relationship was apparent.

Station 11 (fig. 21)--Depths recorded at this station ranged from 71 to 81 m. The turbidity structure for all three seasons was well-defined two-layer stratification: a nonturbid upper water layer with minor local variations above a nepheloid layer of variable thickness (7 m in May, 15 m in March, and 30 m in November). The thermostructure in November and March was essentially isothermal. In contrast, the thermal structure in May had a negative temperature gradient.

The time-series profiles indicated seasonally persistent turbidity stratification and a well-defined nepheloid layer that was most extensively developed in November but most sharply defined in May. The degree of

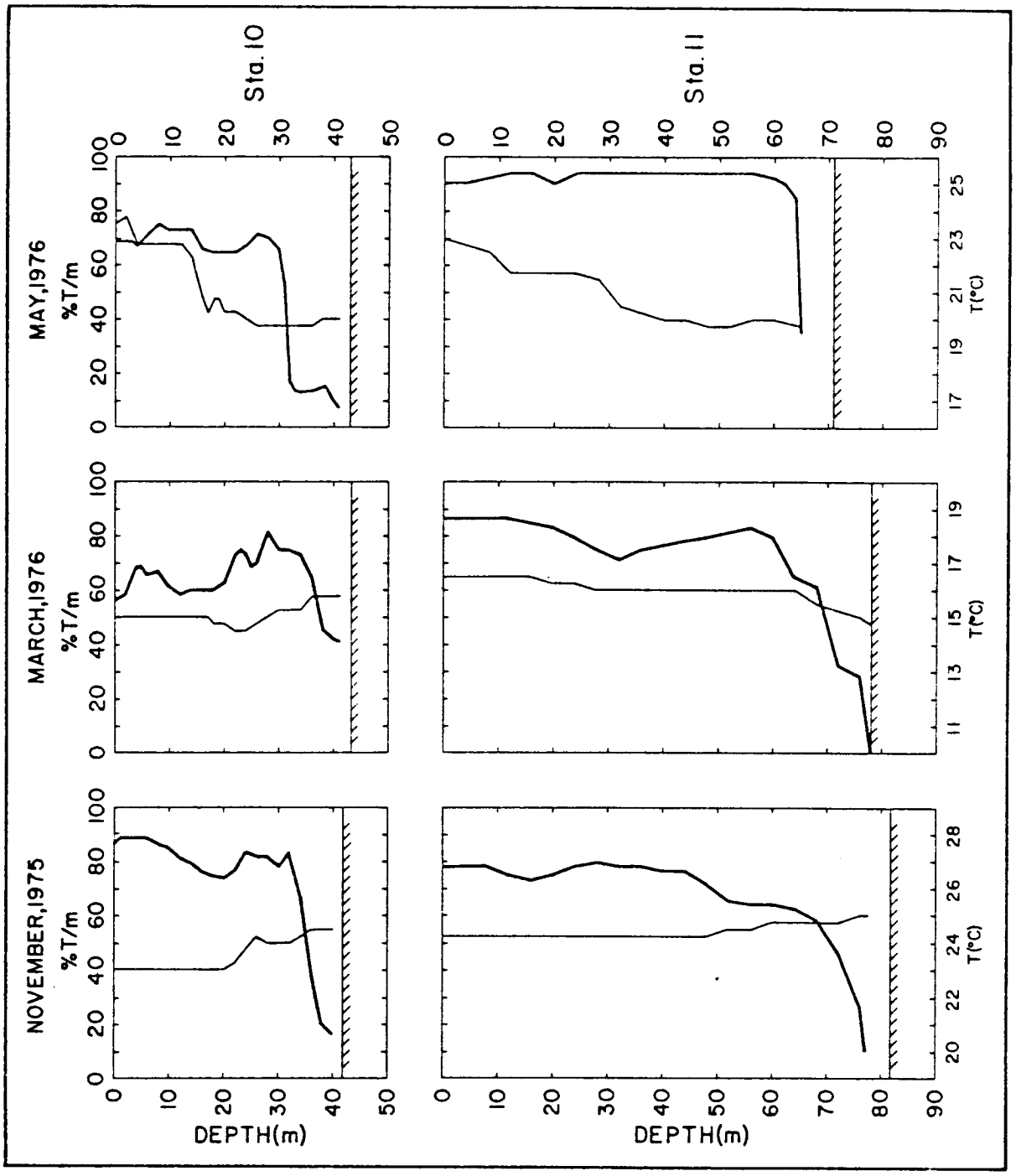


Figure 21. Transmissivity/temperature profiles, stations 10 and 11. (Heavy line indicates transmissivity; thin line indicates temperature.)

stratification apparently was most influenced by a negative temperature gradient.

Station 12 (fig. 22)--The depths recorded at this outer shelf station during the three times of occupancy ranged from 165 to 182 m. Because of strong shelf-edge currents, only partial profiles were obtained. Within the depth interval measured, the turbidity during each sampling was essentially homogeneous. In November the water was transparent (99 percent T/m); the thermal structure showed a near-surface temperature inversion, an underlying isothermal zone, and a bottom layer with a negative gradient. The March profile showed moderately turbid (60-70 percent T/m) water and a negative temperature gradient. The May profile also showed a negative temperature gradient, but with less turbid water (percent T/m >90) than the March profile.

The profiles indicated a seasonally homogeneous turbidity structure within the upper water column, although overall turbidity varied from a maximum in March to a minimum in November. The increased turbidity was associated with a negative temperature gradient.

Station 13 (fig. 23)--Depths recorded at this outer shelf station ranged from 77 to 83 m. The November profile indicated a turbidity gradient that increased downward from nonturbid upper waters to moderately turbid deeper waters. The profile did not reach the sea floor and no nepheloid layer was indicated within the depth recorded. The thermal structure showed a positive temperature gradient. Both the March and May profiles showed two-layer turbidity stratification that consisted of a nonturbid layer above a nephloid layer that was 26 m thick in March and 15 m thick in May. The reduction in thickness of the nepheloid layer was associated with a seasonal difference in thermostructure that changed from nearly isothermal conditions in March to a negative temperature gradient in May.

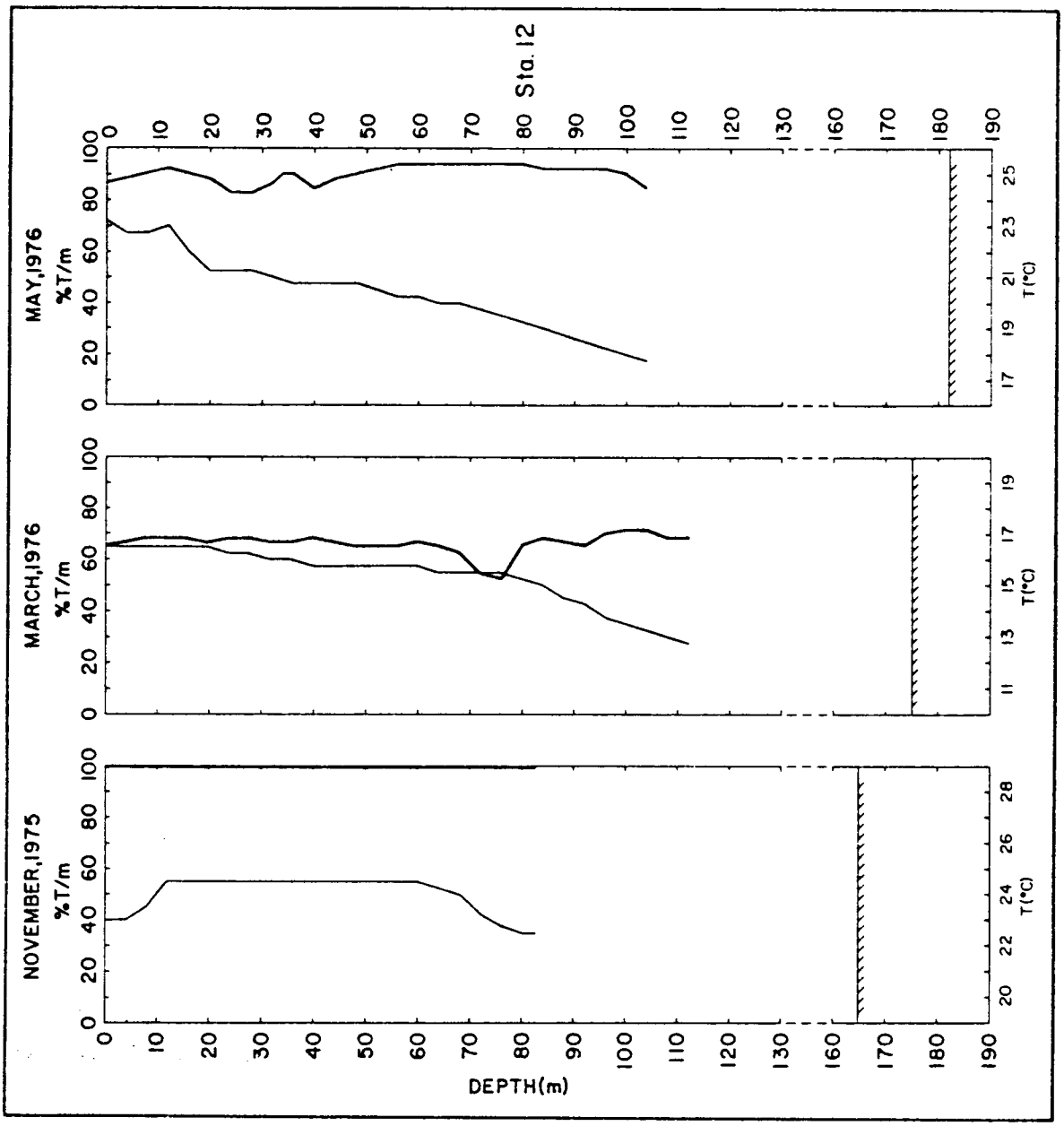


Figure 22. Transmissivity/temperature profiles, station 12. (Heavy line indicates transmissivity; thin line indicates temperature.)

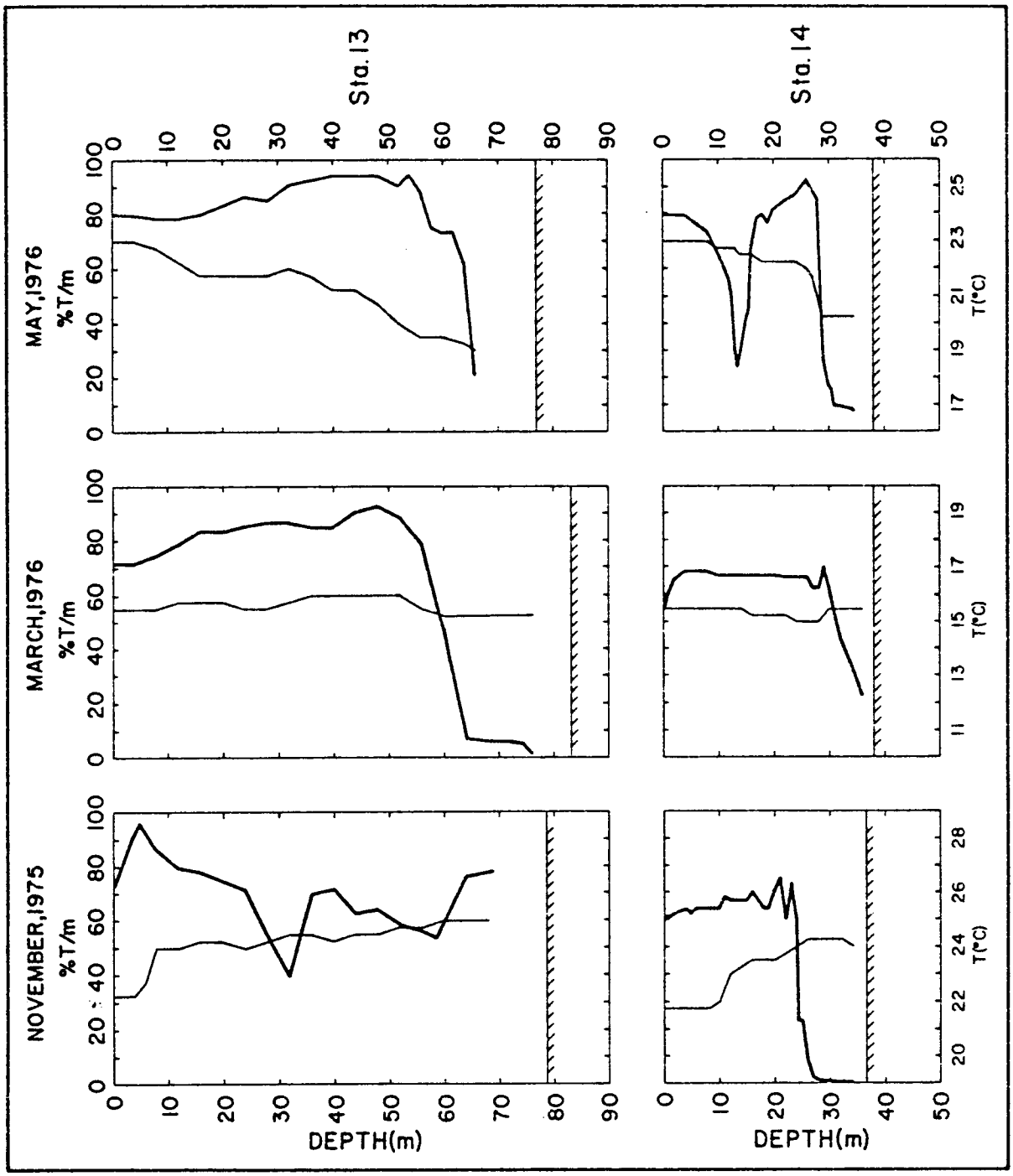


Figure 23. Transmissivity/temperature profiles, station 13 and 14. (Heavy line indicates transmissivity; thin line indicates temperature.)

The time-series profiles suggested a nepheloid layer that was best developed in the early spring and was minimal or absent in the late fall. The seasonal change in turbidity possibly was caused by a change in the thermal structure with maximum development of a nepheloid layer during nearly isothermal conditions.

Station 14 (fig. 23)--This inner shelf station has a depth of 38 m. The turbidity structure in November and March consisted of a moderately turbid upper layer overlying a nepheloid layer that was respectively 13 m and 9 m thick. The thermal structure in November consisted of isothermal surface waters and an underlying positive temperature gradient, as contrasted with a nearly isothermal structure in March. The water had a more complex four-layer turbidity structure in May: a nonturbid surface water layer (upper 9 m), an intermediate moderately turbid layer, a lower nonturbid layer, and a nepheloid layer 10 m thick. The thermostructure in May consisted of isothermal surface waters above a negative temperature gradient; the nepheloid layer was isothermal.

The time-series profiles indicated turbidity stratification of either two or four layers including a persistent nepheloid layer. As at station 13, the thermostructure indicated a seasonal transition from a positive gradient in the late fall to isothermal conditions in early spring and to a negative gradient in late spring. Thermostructure changes may have been related to the changing turbidity structure.

Station 16 (fig. 24)--The depth at this inner shelf station is 23 m. In November the water had a two-layer turbidity structure consisting of an upper moderately turbid layer overlying a nepheloid layer 12 m thick. The upper layer was isothermal, but the nepheloid layer had a positive temperature

gradient. The March water column had a three-layer turbidity/thermal structure consisting of an isothermal, turbid surface layer, a slightly cooler and less turbid intermediate layer, and an isothermal nepheloid layer 7 m thick. The development of the intermediate layer was associated with a small thermal discontinuity. The May water column was essentially isothermal with a two-layer turbidity structure consisting of an upper nonturbid layer and a moderately turbid nepheloid layer 3 m thick.

The time-series profile for station 14 showed seasonally variable thermostructure and stratified turbidity. The nepheloid layer was best developed during the late fall and diminished through late spring.

Station 17 (fig. 24)--This inner shelf station is 39 m deep. In November the water had a two-layer turbidity structure consisting of a variable, moderately turbid layer above a nepheloid layer 11 m thick. The upper water layer contained two isothermal zones separated by a temperature inversion; the nepheloid layer was isothermal. The turbidity structure in March consisted of a moderately turbid to nonturbid upper layer overlying a nepheloid layer 5 m thick. The upper layer also had a slightly variable thermostructure. The water column in May had a negative temperature gradient and appeared to have a two-layer turbidity structure consisting of a nonturbid upper layer (uppermost 22 m) above a nepheloid layer 17 m thick.

The comparative profiles indicated a seasonally persistent, two-layer turbidity structure with a variable nepheloid layer that seems to have been best developed during May when there was a negative temperature gradient.

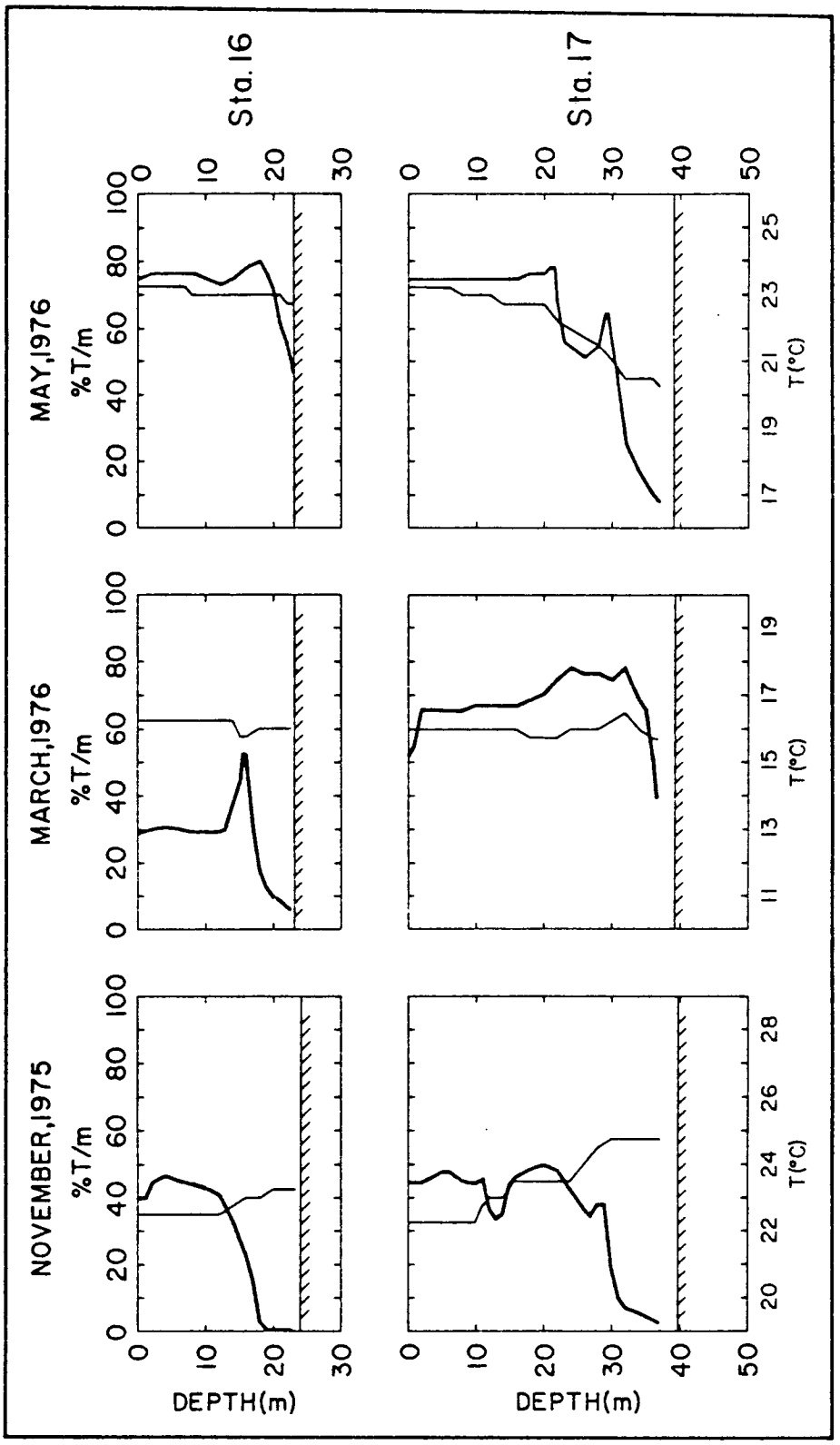


Figure 24. Transmissivity/temperature profiles, stations 16 and 17. (Heavy line indicates transmissivity; thin line indicates temperature.)

Station 18 (fig. 25)--This outer shelf station is 69 m deep. All three seasonal profiles exhibit a two-layer turbidity structure consisting of a variable layer of moderately turbid (November) or nonturbid (March, May) water above a nepheloid layer which was 6 m thick in November, 13 m in March, and 5 m in May. Thermal structures consisted of an upper positive temperature gradient followed by a gradient reversal in November, a low negative gradient in March, and a highly negative gradient in May.

The profiles showed seasonal variations in thermostructure, but a persistent two-layer turbidity structure including a nepheloid layer. Local variations in turbidity appear to be minimal when the water column has a relatively high negative temperature gradient and maximal when the gradient is reversed.

Station 19 (fig. 26)--Depth at this outer shelf station ranged from 109 to 111 m. Strong shelf-edge currents did not permit measurement to the sea floor. The November profile showed a relatively homogeneous, nonturbid layer above a nepheloid layer approximately 36 m thick, which was the thickest nepheloid layer observed during the year. The slight increase in turbidity in the surface water was associated with a temperature reduction, whereas the underlying homogeneous zone of the upper layer was essentially isothermal. The increasing turbidity of the nepheloid layer was associated with a negative temperature gradient. The profile at this station showed an excellent correlation between turbidity and temperature. The March profile showed essentially nonturbid water and a negative temperature gradient. The presence of a nepheloid layer is somewhat conjectural because of the incomplete profile that resulted from the strong shelf-edge currents. The May water column had a relatively high negative temperature gradient and an apparent two-layer turbidity structure

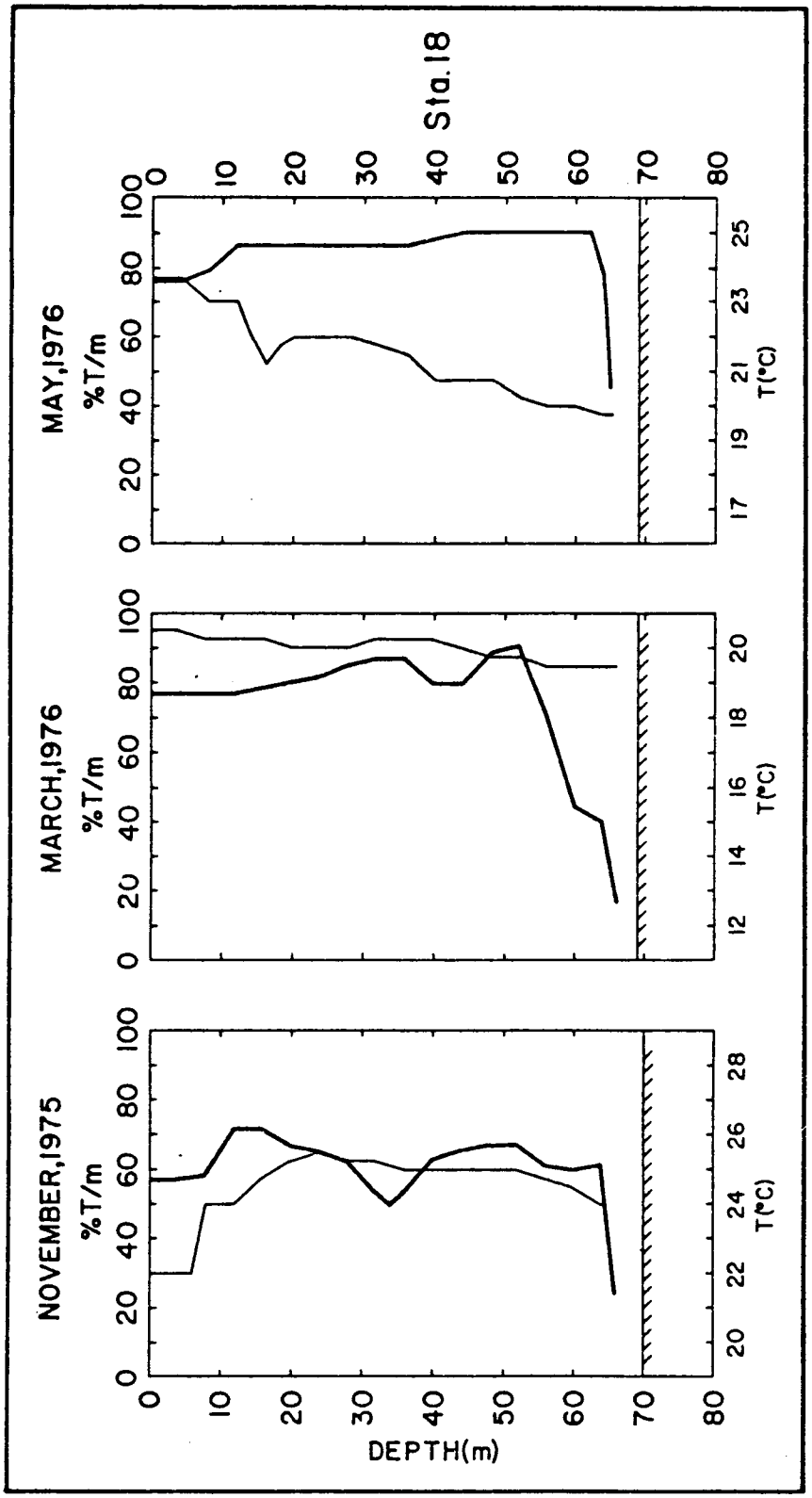


Figure 25. Transmissivity/temperature profiles, station 18. (Heavy line indicates transmissivity; thin line indicates temperature.)

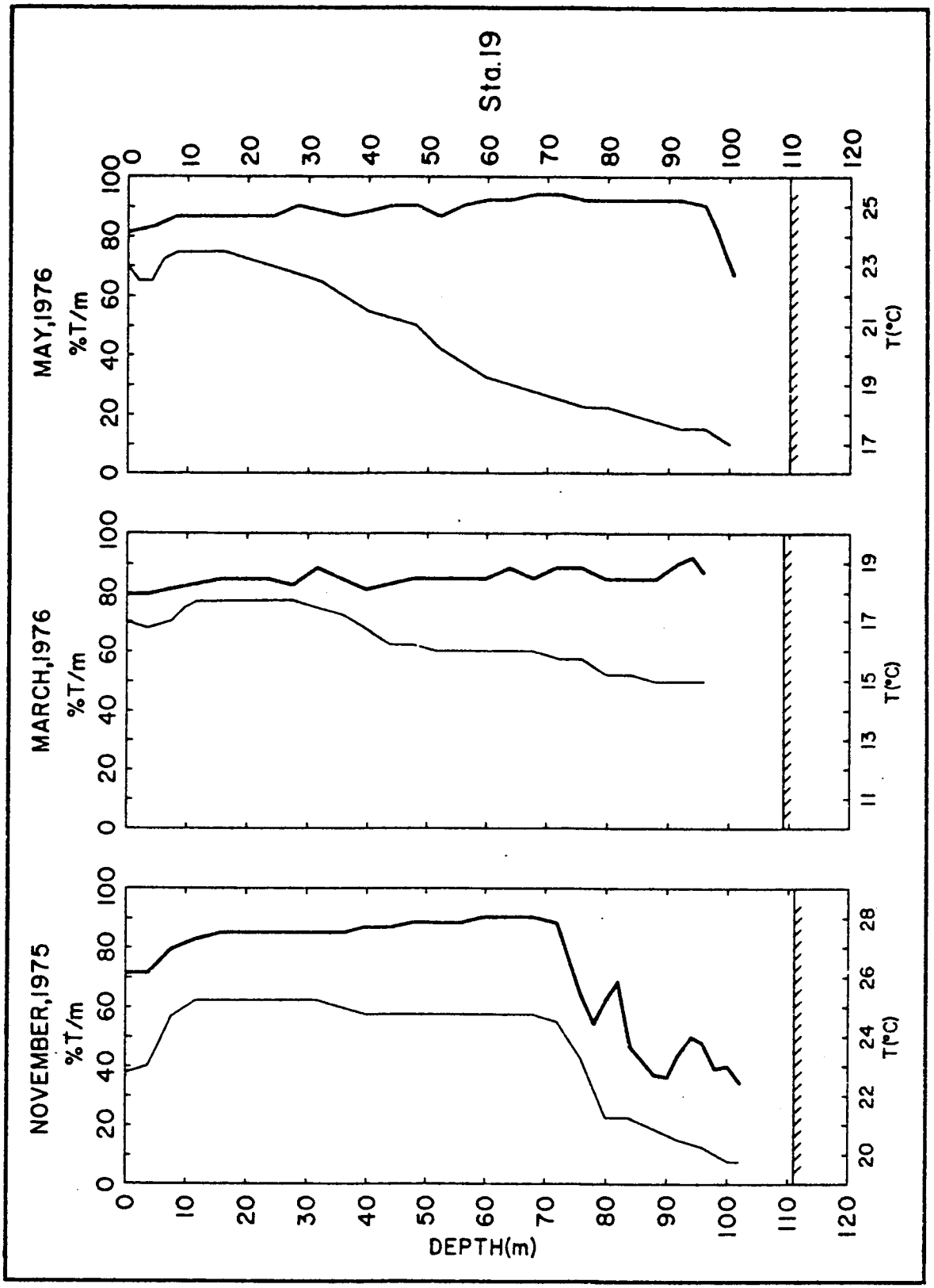


Figure 26. Transmissivity/temperature profiles, station 19. (Heavy line indicates transmissivity; thin line indicates temperature.)

consisting of a nonturbid upper layer and a probable nepheloid layer approximately 10 m thick.

Although complete measurements could not be made, the profile showed two-layered turbidity that probably is perennial. The nepheloid layer was best developed during November. Seasonal variations in thermal structure may have some influence on this development.

Station 20 (fig. 27)--Depths at this station ranged from 49 to 51 m. The profiles for all three seasons showed a two-layer turbidity structure: a nonturbid layer above a nepheloid layer that varied in thickness (13 m in November, 9 m in March, 8 m in May). The thermal structure in November showed a good correlation with turbidity: the upper layer had an isothermal surface zone (upper 14 m) and a lower zone consisting of temperature inversions; the nepheloid layer had a slightly negative temperature gradient. In March the water was largely isothermal with only slightly cooler waters within the nepheloid layer. The thermal structure in May had a negative temperature gradient.

The profiles indicated a substantial seasonal change in thermal structure but a persistent two-layer turbidity structure. The nepheloid layer was best developed in November when the thermal structure showed a substantial temperature inversion.

Station 21 (fig. 27)--Recorded depth at this station for the three cruises ranged from 38 to 40 m. The seasonal profiles showed a two-layer turbidity structure consisting of a moderately turbid to nonturbid upper layer above a nepheloid layer. The nepheloid layer was most distinct in May, when it was 8 m thick; in March it was 9 m thick and in November, when internal turbidity variations were substantial, it was 16 m thick. The seasonal thermal structures

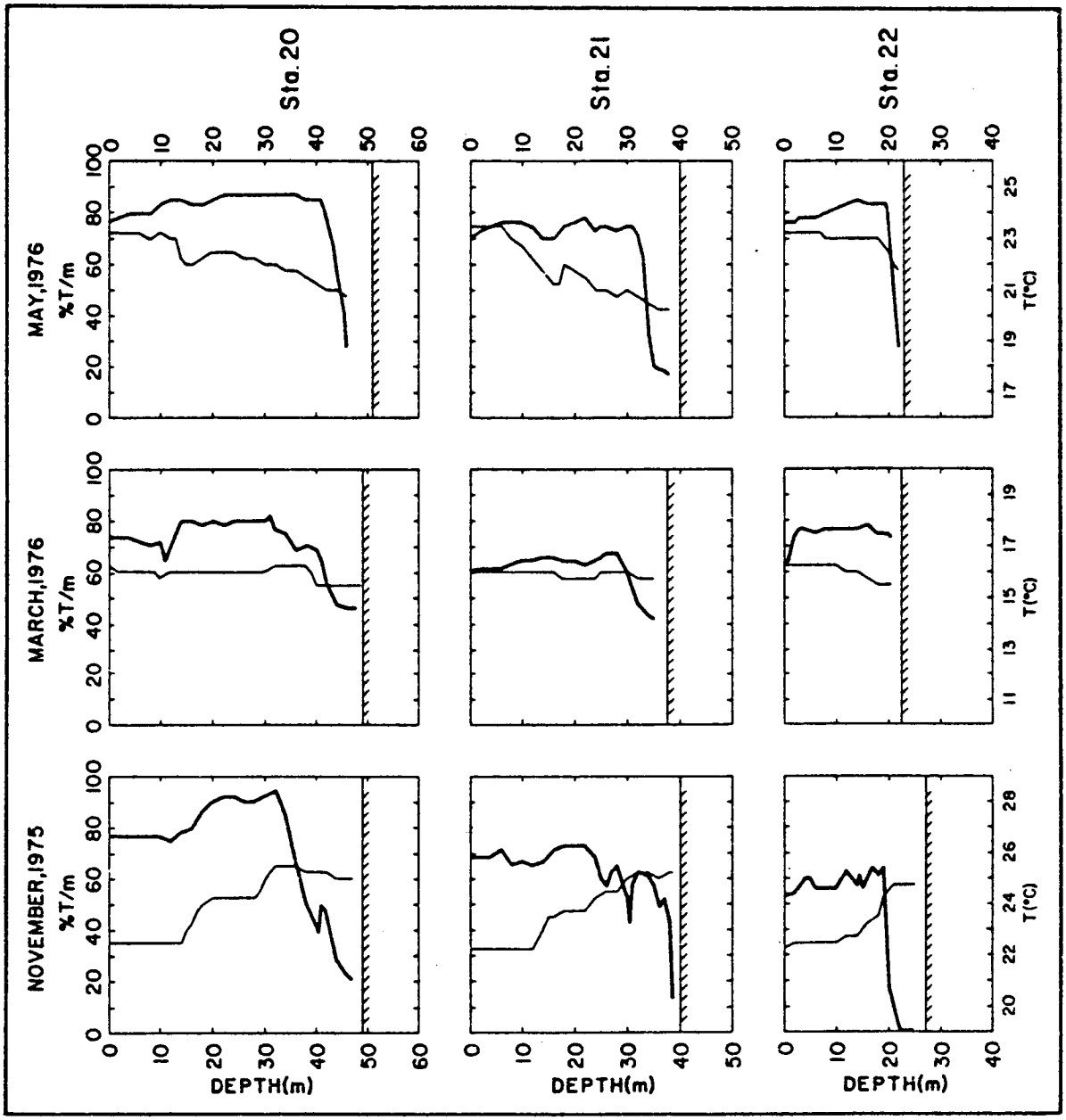


Figure 27. Transmissivity/temperature profiles, stations 20, 21, and 22. (Heavy line indicates transmissivity; thin line indicates temperature.)

ranged from a temperature inversion in November and nearly isothermal conditions in March to a negative temperature gradient in May.

The profiles indicated the same seasonal variability in thermal and turbidity structures as further seaward at station 20, except for slightly higher overall turbidity and a more heterogeneous nepheloid layer during November.

Station 22 (fig. 27)--Depths at this station ranged from 22 to 27 m. The turbidity structure in November consisted of a moderately turbid layer above a nepheloid layer 8 m thick; the associated thermal structure was a temperature inversion. The turbidity structure in May showed a nonturbid layer above a nepheloid layer 3 m thick; the thermal structure was a negative temperature gradient. The profile for March showed a thin, moderately turbid surface layer overlying a nonturbid layer; no nepheloid layer was indicated. The thermal structure in March consisted of a negative temperature gradient.

The profiles indicated seasonal variability in thermal structure and an intermittent nepheloid layer. Except for March, the seasonal patterns were similar to those for the more seaward stations, 20 and 21.

Rio Grande-Brazos Santiago Inlet: Stations 23, 23A, 24 (fig. 28)--The time-series profiles for the three stations were taken to evaluate the sediment dispersal patterns associated with the Rio Grande-Brazos Santiago inlet. Stations 23 and 23A are located respectively northeast and southeast of the Brazos Santiago navigation channel; the southernmost station (24) is northeast of the mouth of the Rio Grande near the U.S.-Mexico international boundary. Depths for the three stations ranged from 10 to 20 m.

In November, all three stations had a well-stratified three-layer turbidity structure: a highly turbid (<5 percent T/m) surface layer (upper 5 m),

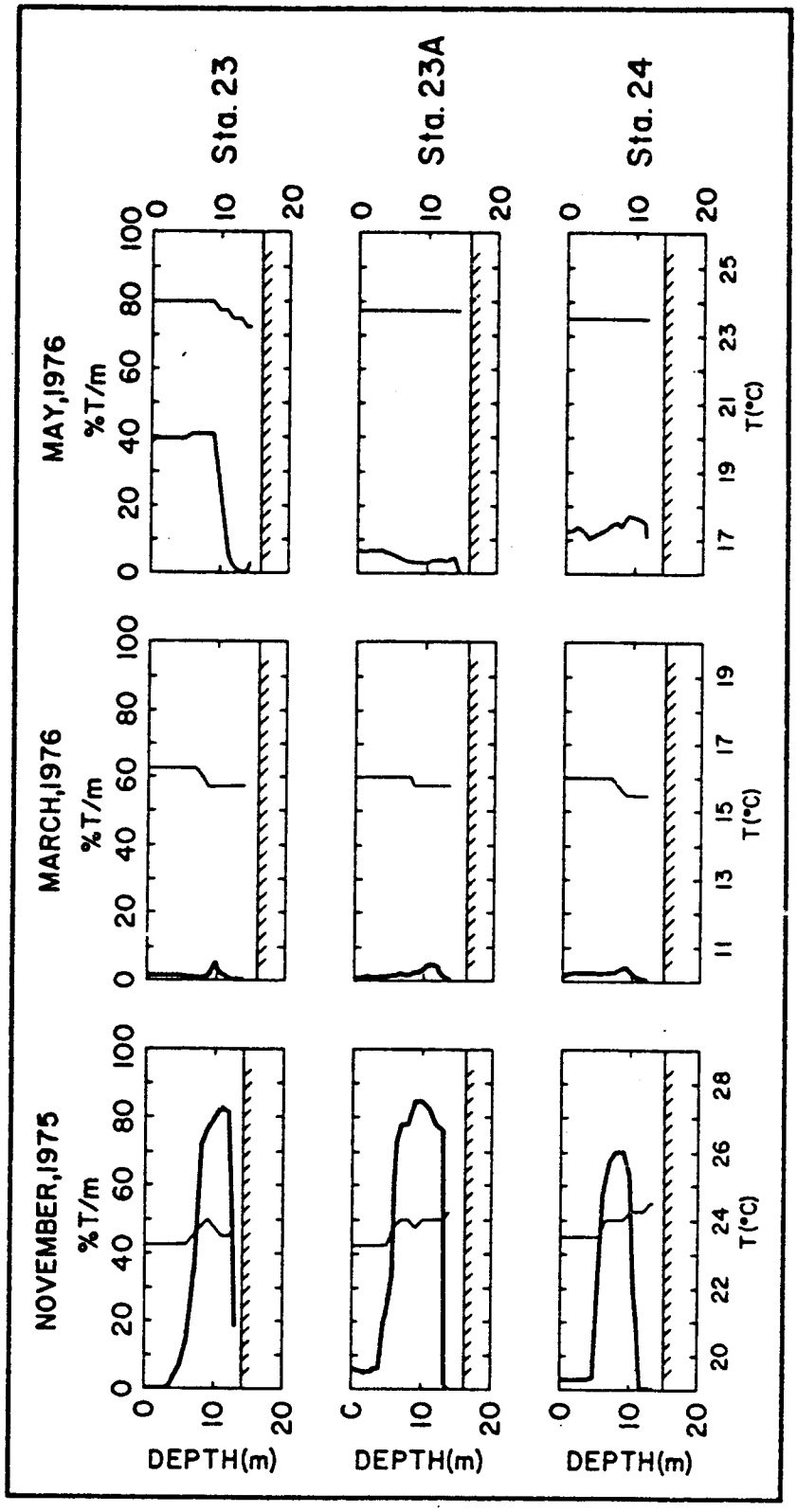


Figure 28. Transmissivity/temperature profiles, Rio Grande-Brazos Santiago Inlet. (Heavy line indicates transmissivity; thin line indicates temperature.)

a relatively transparent intermediate layer, and a highly turbid bottom layer. Also, some thermal stratification was indicated: an isothermal surface layer above a layer in which the temperature gradient increased with depth. The uppermost turbidity interface was associated with a temperature discontinuity. The inlet pattern appeared to reflect the seaward dispersal of an ebb-tidal sediment plume that had maintained its identity as a relatively low density surface-water mass, probably reflecting lower salinities due to coastal runoff. The turbid bottom water probably was caused by resuspension of sea floor sediment by wave surge.

The similarity in turbidity of the surface waters at all three stations suggested that the Rio Grande and Brazos Santiago channel were both prolific sources of sediment; dispersal of the sediment seaward was radial and fairly uniform.

In March, the water at all three stations had high turbidity (<5 percent T/m) and a minor thermocline near a depth of 8 m, below which a slight reduction in turbidity was suggested.

In May, the turbidity/thermal structure at station 23 consisted of a moderately turbid, isothermal surface layer above a cooler, highly turbid bottom layer. Both stations 23A and 24 had isothermal water with uniformly turbid to highly turbid conditions; station 23A was both slightly warmer and slightly more turbid. The stratification at station 23 possibly reflected the northerly transport of a less turbid and lower density sediment plume, which maintained its identity as a surface flow above more turbid inner shelf waters. The turbidity interface at station 23 was associated with a thermocline.

The entire suite of time-series profiles in the area suggests the following: 1) coastal water mixing was most efficient during the March

cruise when relatively homogeneous conditions were indicated; mixing was least efficient during the November cruise when the structure was highly stratified; 2) isothermal waters tended to be more uniformly turbid, although no systematic relationship was indicated between turbidity and thermal structure.

Summary

Vertical transmissivity/temperature gradients of the water at the coastal inlet stations showed complex and variable relationships, both in time and space. The ebb-tidal sediment plumes from inlets suggest either a uniform seaward radial dispersal pattern or a coastwise-oriented pattern caused by an influential longshore transport. No systematic seasonal or spatial dispersal pattern is apparent among the three major inlets.

As the surface water near the inlet had both relatively high turbidity and low temperature, the low density of the plumes must be attributed to lower salinity resulting from coastal runoff. Bottom water turbidity probably is caused by the resuspension of sediment by wave surge. The turbidity and thermal structures in the water appear to be related, but the relationship is not systematic. The apparent absence of a direct cause-and-effect relationship probably can be attributed to the complex diurnal mixing processes associated with coastal waters under tidal influence. Under these conditions, salinity variations and the rate of dispersion by the hydraulic regime are major variables influencing density stratification within the water column.

The inner and outer shelf water away from tidal inlets also had variable turbidity and thermal structures, both in time and space. The most prevalent turbidity structure was a two-layer stratification consisting of

a nepheloid layer below a less turbid layer. The nepheloid layer varied substantially in both thickness and distribution. It seemed to be perennial at most stations but was seasonal at others. In general, the nepheloid layer was thickest toward the outer shelf. The thermal structures of water over both the inner and outer shelf were widely variable. The relationship between turbidity and thermal structure is being studied further as a part of the 1977 program.

Particle Concentrations

Measurements of suspended sediment particle concentrations were made on the quasi-synoptic water samples as a second method of determining lateral variations in turbidity. Regional variations were determined for both surface and bottom waters for each of the three seasonal cruises. Particle concentrations within the 0.63 to 81 μm size range were determined by COULTER COUNTER, in terms of total particle counts/cc of water sample. This information formed the basis for determining relative turbidity patterns.

November 1975

Surface water (fig. 29)--Particle concentrations in surface waters at individual stations ranged from a minimum of $12x10^4$ at station 5 in the northern outer shelf sector to a maximum of $224x10^4$ at Aransas Pass, station 9. The greatest concentrations of suspended material ($>130x10^4$) were at the three coastal inlets: Matagorda Bay, Aransas Pass, and Rio Grande-Brazos Santiago. Particle concentrations at the Matagorda Bay stations ($91x10^4$ at station 1, $186x10^4$ at station 1A, and $133x10^4$ at station 2) suggest the predominantly southward dispersal of an ebb sediment plume from the Matagorda ship channel, which appeared to be a more prolific source of sediment than the natural Pass

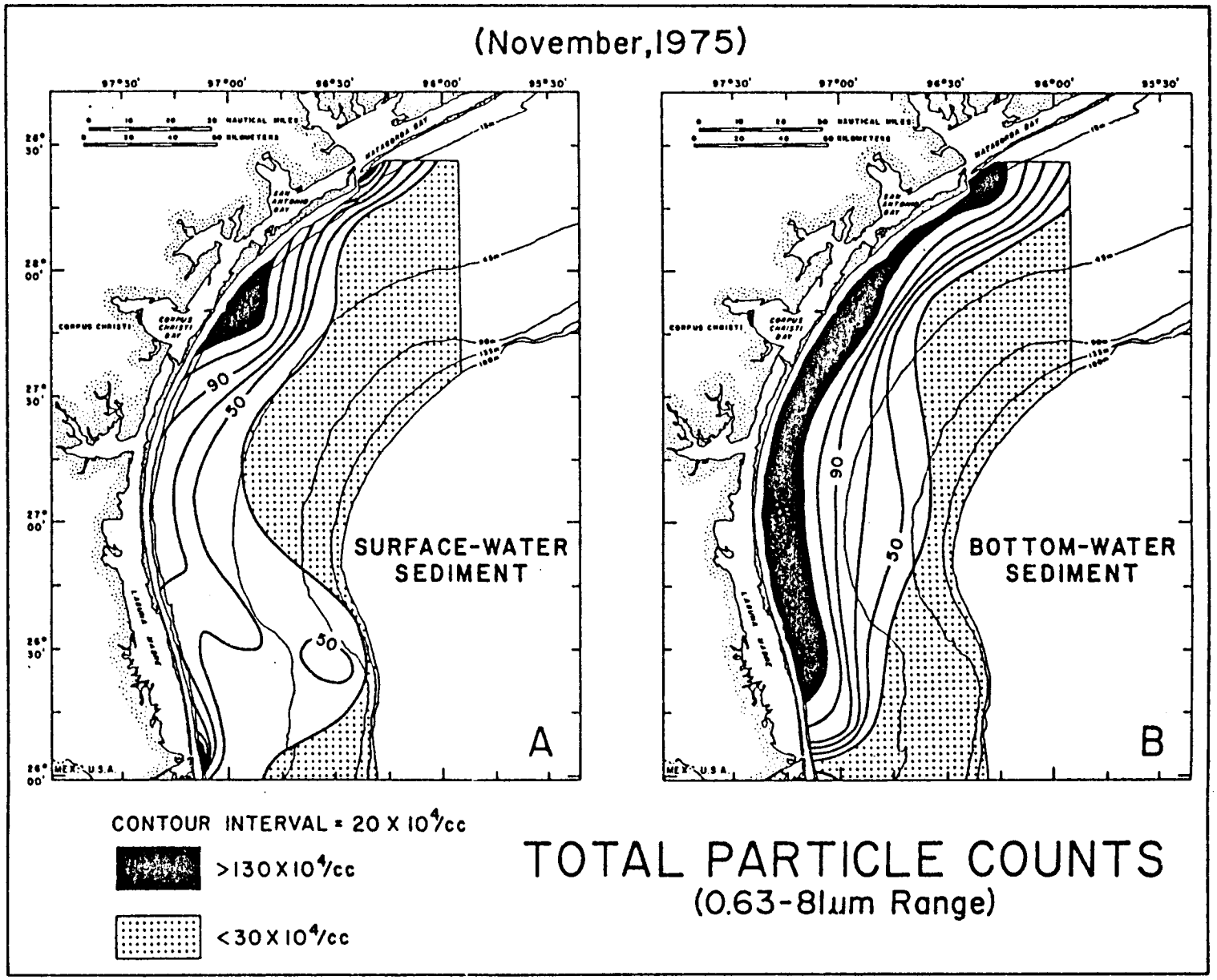


Figure 29. Distribution of suspended sediments based on numbers of particles.

Cavallo. Dispersal southward was attributed to a dominant south-trending longshore current. Particle concentrations at Aransas Pass ($224x10^4$ at station 9 and $188x10^4$ at station 9A) suggested predominantly radial dispersion of an ebb sediment plume seaward, perhaps with some minor northerly longshore transport. Particle concentrations at the Rio Grande-Brazos Santiago inlet ($182x10^4$ at station 23, $69x10^4$ at station 23A, and $55x10^4$ at station 24) suggested the dominantly northward dispersal of an ebb sediment plume emanating from the Brazos Santiago channel, which appeared to be a more prolific source of sediment than the Rio Grande.

The regional pattern of particle concentration showed a shoreward increase in turbidity throughout the OCS, with relatively high concentration gradients along the inner shelf. The pattern also indicated the regional influence of sediment dispersion from the three coastal inlets which serve as prominent sediment sources; Aransas Pass appeared to be the most prolific source. The concentration isopleths along the inner shelf were largely subparallel to the isobaths. A conspicuous area of relatively low concentrations ($<30x10^4$) formed a broad shoreward-directed salient north of latitude 26°45' N. A second subordinate salient was centered near latitude 26°00' N. This regional concentration pattern correlates well with the surface water transmissivity pattern (figure 12), in which the areas of lowest particle concentrations are also characterized by highest water transmissivity.

Bottom water (fig. 29)--Particle concentrations in bottom waters at individual stations ranged from a minimum of $7x10^4$ at station 12 near the central shelf edge to maximum of $248x10^4$ at Aransas Pass, station 9. Greatest concentrations of sediment ($>130x10^4$) occurred in a zone along the inner

shelf from Matagorda Bay southward to latitude 26°15' N. The concentrations at inlet stations were substantially greater than corresponding surface concentrations. In addition, patterns of concentrations at the inlets support the inferences of predominantly southward sediment dispersion from the Matagorda ship channel and uniform to slightly northward dispersion from Aransas Pass. Sediment dispersion from the Rio Grande-Brazos Santiago inlet appears to have occurred mainly as surface flow, as indicated by the conspicuous absence of bottom turbidity.

As in the pattern for the surface water, the pattern for the bottom water showed a general shoreward increase in turbidity and relatively steep concentration gradients along the inner shelf, largely subparallel to the isobaths. The pattern for the bottom water reflected the regional influence of Matagorda Bay and Aransas Pass as prominent sediment dispersal centers. The curvilinear high turbidity zone (>130×10^4 counts/cc) along the inner shelf suggested that resuspension of sea-floor sediment by wave surge in the coastal sectors between the inlets was an additional source of bottom-water sediment. In contrast, surface sediment appears to have been derived mainly from inlet tidal waters. In general, the bottom and surface waters do exhibit some differences in regional concentration patterns, possibly reflecting differences in transport mechanisms.

March 1976

Surface water (fig. 30)--Concentrations of particles in surface water at individual stations ranged from a minimum of 4×10^4 at station 12 near the central shelf edge to a maximum of 203×10^4 at Pass Cavallo (station 2). Greatest concentrations of sediment (>130×10^4 counts/cc) occurred at Matagorda Bay (Pass Cavallo). Concentrations at the Matagorda Bay inlet

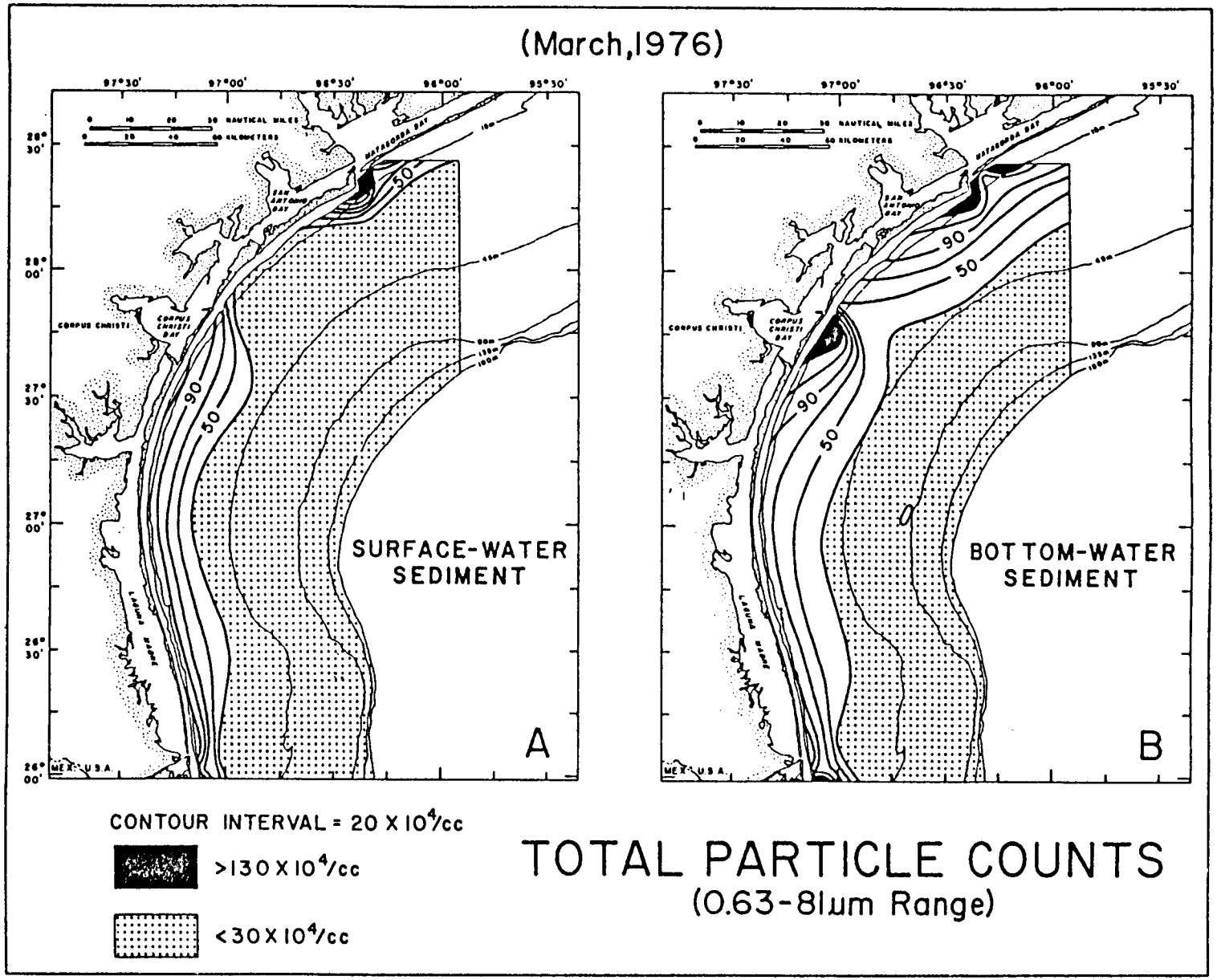


Figure 30. Distribution of suspended sediments based on numbers of particles.

stations ($110x10^4$ at station 1, $85x10^4$ at station 1A, and $203x10^4$ at station 2) suggested the predominantly southward dispersion of an ebb-sediment plume derived primarily from Pass Cavallo and secondarily from the Matagorda ship channel. Concentrations at Aransas Pass (station 9 = $32x10^4$, station 9A = $84x10^4$) suggested southward sediment dispersion; the concentration pattern at the Rio Grande-Brazos Santiago inlet (station 23 = $118x10^4$, station 23A = $71x10^4$, station 24 = $98x10^4$) was inconclusive.

The regional pattern showed increasing turbidity shoreward with the greatest increase in the vicinity of Matagorda Bay inlet, the dominant sediment dispersal center. Concentration isopleths were largely parallel to isobaths. The entire outer shelf (>45 m depth) and much of the inner shelf had relatively nonturbid waters (<$30x10^4$ counts/cc); turbid waters were restricted mainly to the shallower part of the inner shelf. A general correlation existed between areas of low particle concentrations and areas of relatively high surface water transmissivity.

Bottom water (fig. 30)--Concentrations of particles in bottom waters at individual stations ranged from a minimum of $5x10^4$ at station 19 along the southern shelf edge, to a maximum of $329x10^4$ at Pass Cavallo (station 2). Greatest concentrations of sediment (>$130x10^4$ counts/cc) were at the three inlets; Matagorda Bay inlet was the most prolific source of sediment during March. Bottom water concentrations at the Matagorda Bay inlet stations (station 1 = $162x10^4$, station 1A = $107x10^4$, station 2 = $329x10^4$) confirm the inference based on the concentrations of particles in the surface water: predominantly southward sediment dispersion, with Pass Cavallo being a more prolific sediment source than the Matagorda ship channel. Concentrations in the bottom water at Aransas Pass (station 9 = $50x10^4$, station 9A = $184x10^4$)

also indicated predominantly southward dispersion, as did the surface concentrations. The concentrations at the Rio Grande-Brazos Santiago inlet (station 23 = 117×10^4, station 23A = 84×10^4, station 24 = 250×10^4) indicated that the Rio Grande was a more prolific source than the Brazos-Santiago channel.

The regional pattern indicated increasing turbidity shoreward, with highest gradients near the three inlets that functioned as centers for sediment dispersion. Concentration isopleths were parallel to subparallel to the isobaths. The area of relatively nonturbid bottom water ($<30 \times 10^4$ counts/cc) was localized largely along the outer shelf (depth >45 m). Consequently, the area of nonturbid bottom waters was somewhat more restricted than the area of nonturbid surface waters.

May 1976

Surface water (fig. 31)--Concentrations of particles in surface water at individual stations ranged from a minimum of 11×10^4 at station 5 along the northeastern outer shelf to a maximum of 192×10^4 at Matagorda Bay inlet (station 1A). Concentrations at the Matagorda Bay stations (185×10^4 at station 1, 192×10^4 at station 1A, and 132×10^4 at station 2) suggested radial to slightly southward dispersion of an ebb-sediment plume, with the Matagorda ship channel being a more prolific source than Pass Cavallo. Concentrations at Aransas Pass stations (station 9 = 69×10^4, station 9A = 100×10^4) also indicated predominantly southward dispersion. The concentrations at the Rio Grande-Brazos Santiago inlet (station 23 = 75×10^4, station 23A = 40×10^4, station 24 = 39×10^4) suggested predominantly northward dispersion, with the Brazos Santiago ship channel being a more prolific sediment source than the Rio Grande.

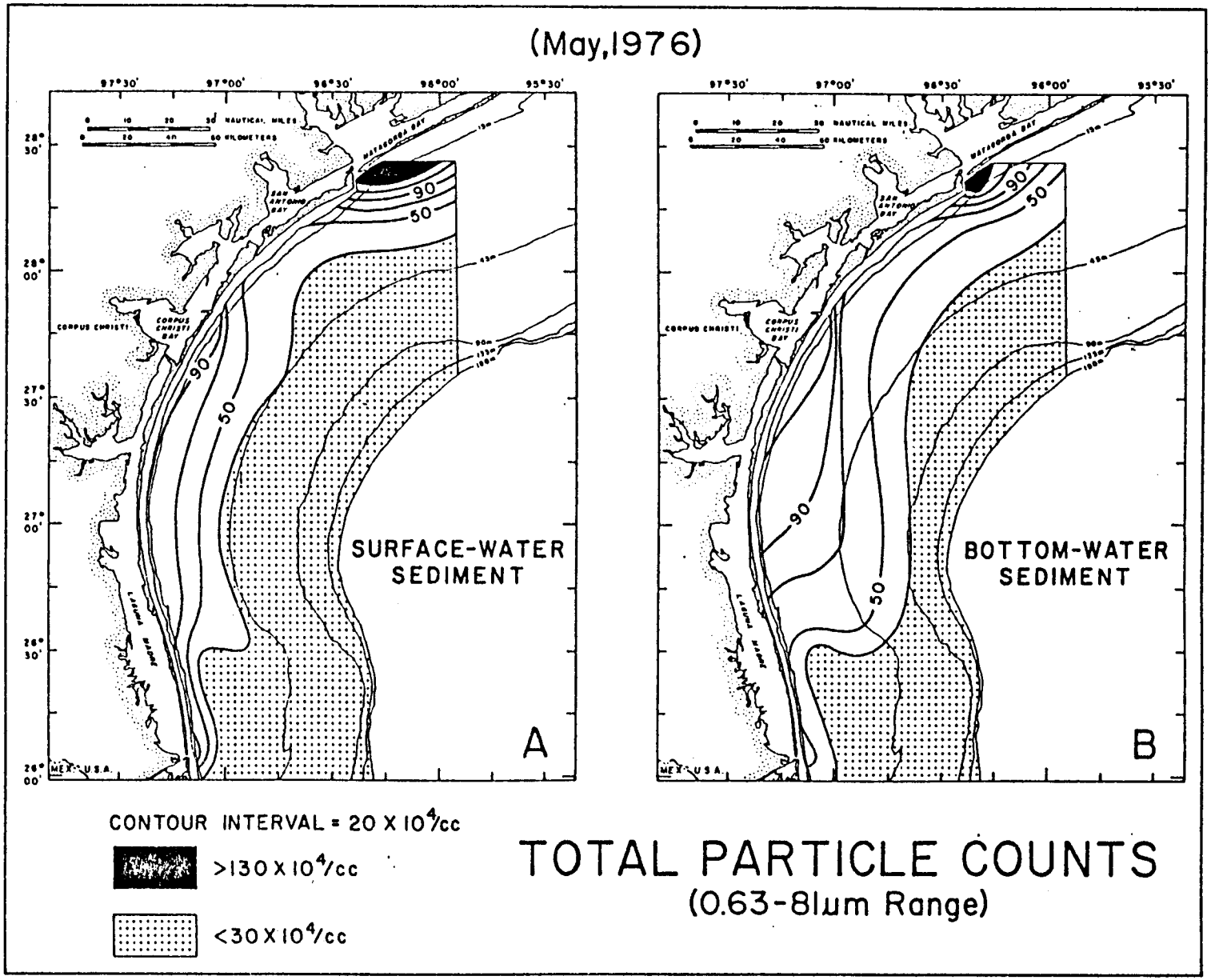


Figure 31. Distribution of suspended sediments based on numbers of particles.

The regional pattern of particle concentrations indicated a general shoreward increase in turbidity, with highest gradients near the inlet to Matagorda Bay which was the dominant dispersal center for surface sediments in May. Concentration isopleths were parallel to subparallel relative to the orientation of the isobaths. Relatively nonturbid waters ($<30 \times 10^4$ counts/cc) cover all of the outer shelf (depth >45 m) and parts of the inner shelf. The areas of low particle counts show a good general correlation with areas of high surface water transmissivity. (Compare figs. 31 and 14.)

Bottom water (fig. 31)--Particles in bottom water at individual stations ranged from a minimum of 6×10^4 at station 6 along the northeastern shelf edge, to a maximum of 234×10^4 at Matagorda Bay inlet (station 1A). As with the surface pattern, the highest concentrations were at the Matagorda Bay inlet. Bottom concentration patterns at individual Matagorda Bay inlet stations were similar to surface concentration patterns, indicating predominant dispersal southward and the dominance of the Matagorda ship channel over Pass Cavallo as a sediment source. Relative concentrations at Aransas Pass and the Rio Grande-Brazos Santiago inlets respectively indicated predominantly southward and northward sediment dispersion, as did the surface concentrations.

The regional pattern showed a general shoreward increase in turbidity with highest gradients in the Matagorda Bay inlet area. However, the bottom concentration isopleths were more discordant with isobaths than were the surface isopleths, and the area of nonturbid ($<30 \times 10^4$ counts/cc) bottom waters was slightly more restricted than the area of nonturbid surface waters. A notable feature of the pattern for bottom water is a prominent southeastward-trending turbid salient near latitude 26°30' N., a feature that is relatively subdued in the pattern for surface water.

Summary

The regional turbidity patterns based on sediment particle concentrations show that shelf waters generally were most turbid during the November cruise. During all cruises, the pattern for turbidity appeared to represent a composite response to both regional and local factors. A well-defined regional gradient of increasing turbidity shoreward appears to have resulted from increasing proximity to coastal source areas and a shoreward increase in wave surge intensity that maintained sediment in suspension. Superimposed on this regional gradient were the local concentrations at the coastal inlets. Regarding the relative contributions of sediment from individual inlets, Aransas Pass appears to have been the most prolific source during November, and Matagorda Bay inlet was the most prolific source during March and May. The relatively nonturbid waters over the outer shelf suggested the possible shelfward incursion of a water mass from deeper parts of the Gulf of Mexico. In general, bottom waters tended to show a somewhat higher degree of turbidity than surface waters. All temporal patterns indicated net offshore transport. In addition, some November and May patterns further indicated a net southward transport component.

Textural Patterns

A second approach for delineating regional sediment dispersal patterns was to establish lateral textural gradients in both surface and bottom suspended sediments for each of the three cruises. The textural parameters investigated include: silt/clay ratios, which provide a general overview of suspended sediment composition; mean grain size (first moment), which provides an indication of dispersal gradient; and standard deviation (second moment),

which provides an indication of sediment sorting or uniformity. All size terminology is in accordance with the Udden-Wentworth grade scale and is expressed in terms of Krumbein's (1934) phi (Ø) transformation.

November 1975 Textural Patterns

General composition

The general textural composition of suspended sediments in surface waters is shown by the silt/clay ratio isopleth map (fig. 32A). Surface sediment ratios at individual stations ranged from a maximum of 2.28 at station 16 to a minimum of 0.46 at station 23A. The regional pattern of distribution indicated that the sediment was predominantly silt (ratios >1.0) within the northern and central sectors of the region, and predominantly clay (ratios <1.0) within the southern sector. The regional pattern also indicated a general trend of increasing silt content toward the shoreward part of the central sector. Textural salients near the coastal inlets indicated predominantly clay dispersal from the Rio Grande-Brazos Santiago inlet and predominantly silt from Matagorda Bay.

The suspended sediments in bottom waters showed a substantially different pattern of silt/clay ratios (fig. 32B). Ratios at individual stations ranged from a maximum of 3.10 at station 16 to a minimum of 0.69 at station 22. The regional pattern indicated that bottom sediments were predominantly silt sized throughout the OCS, except for two small isolated areas in the southern sector where clay predominated. The pattern showed no systematic trend other than a general increase in clay content toward the south-central sector. A comparison of the patterns for bottom and surface water shows that the bottom suspended sediments generally were more silty or coarser-textured than surface sediments, a condition that would be suspected on empirical grounds.

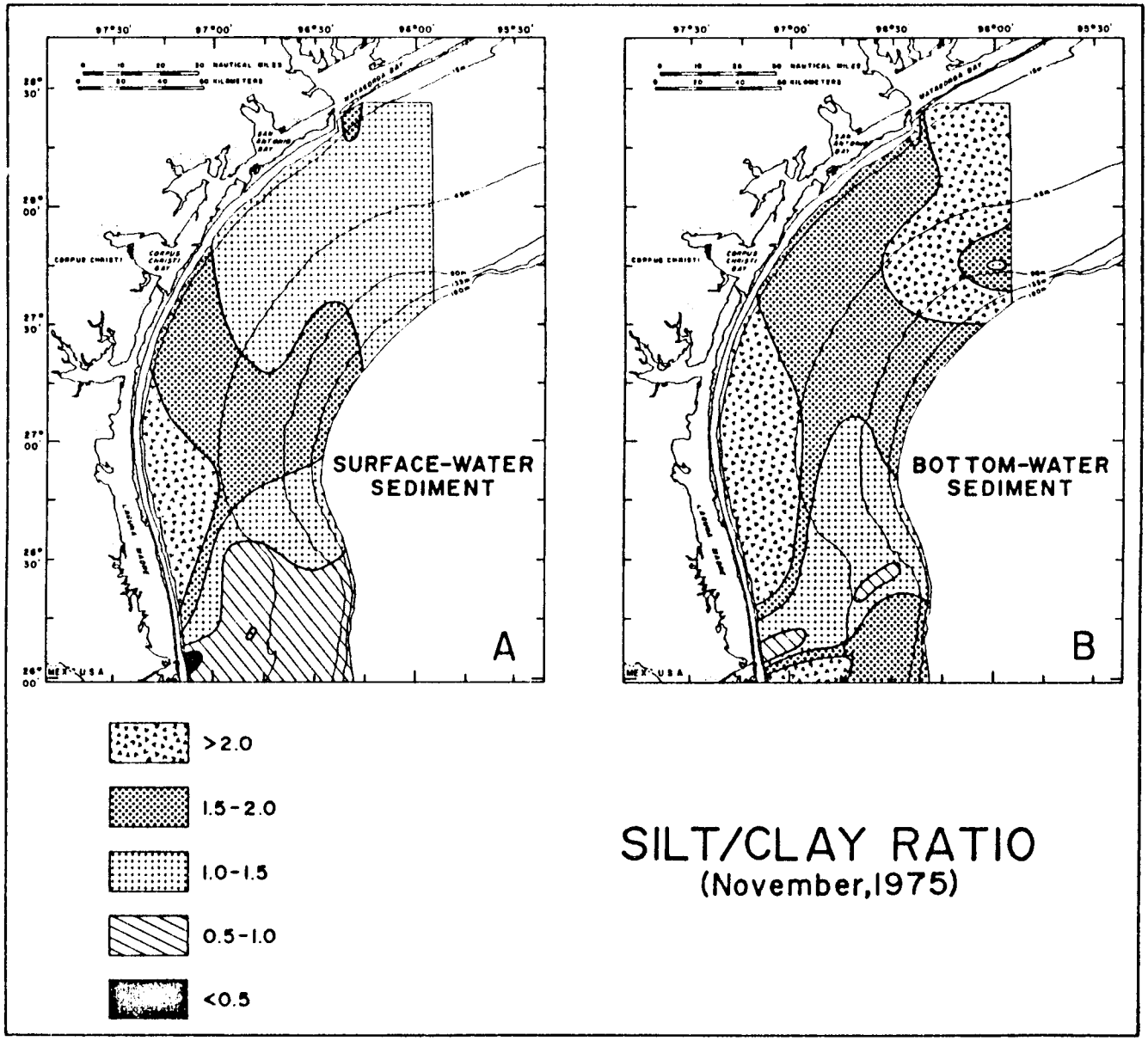


Figure 32. Silt/clay ratios for suspended sediments.

Mean grain size

The regional distribution of suspended sediment by mean grain size (first moment) in surface waters is shown by the mean diameter isopleth map (fig. 33A). Mean diameters are thought to provide a more sensitive indication of dispersal gradients than the more general silt/clay ratios. Mean grain size at individual stations ranged from clay (8.33 Ø) at station 23A to fine silt (6.89 Ø) at station 16. The regional pattern of distribution showed that the suspended sediments were mainly very fine silt (7.0-8.0 Ø range), with only two small local areas of clay (8.0-9.0 Ø) and one area of fine silt (6.0-7.0 Ø). The regional trend for surface waters consisted of a generally increasing coarseness from peripheral areas toward the interior of the shelf. Local textural gradients indicate predominantly silt dispersal from the Aransas Pass inlet.

The pattern of distribution for mean grain size of sediments in bottom waters was substantially different from that of the surface sediments (fig. 33B). The grain size of bottom water ranged from clay (8.17 Ø) at station 22 to fine silt (6.84 Ø) at station 23A. Except for two isolated areas of clay and one area of fine silt within the southern sector, the suspended sediments in bottom waters were very fine silt. The regional trend consisted of general southward reduction in coarseness. Local silt salients were associated with bottom waters at the three coastal inlets.

Sorting characteristics

The standard deviation isopleth map (fig. 34A) provides an indication of the textural uniformity of surface water sediments. When compared to Folk's (1965) verbal scale, the sediments ranged from poorly sorted (1.09 Ø)

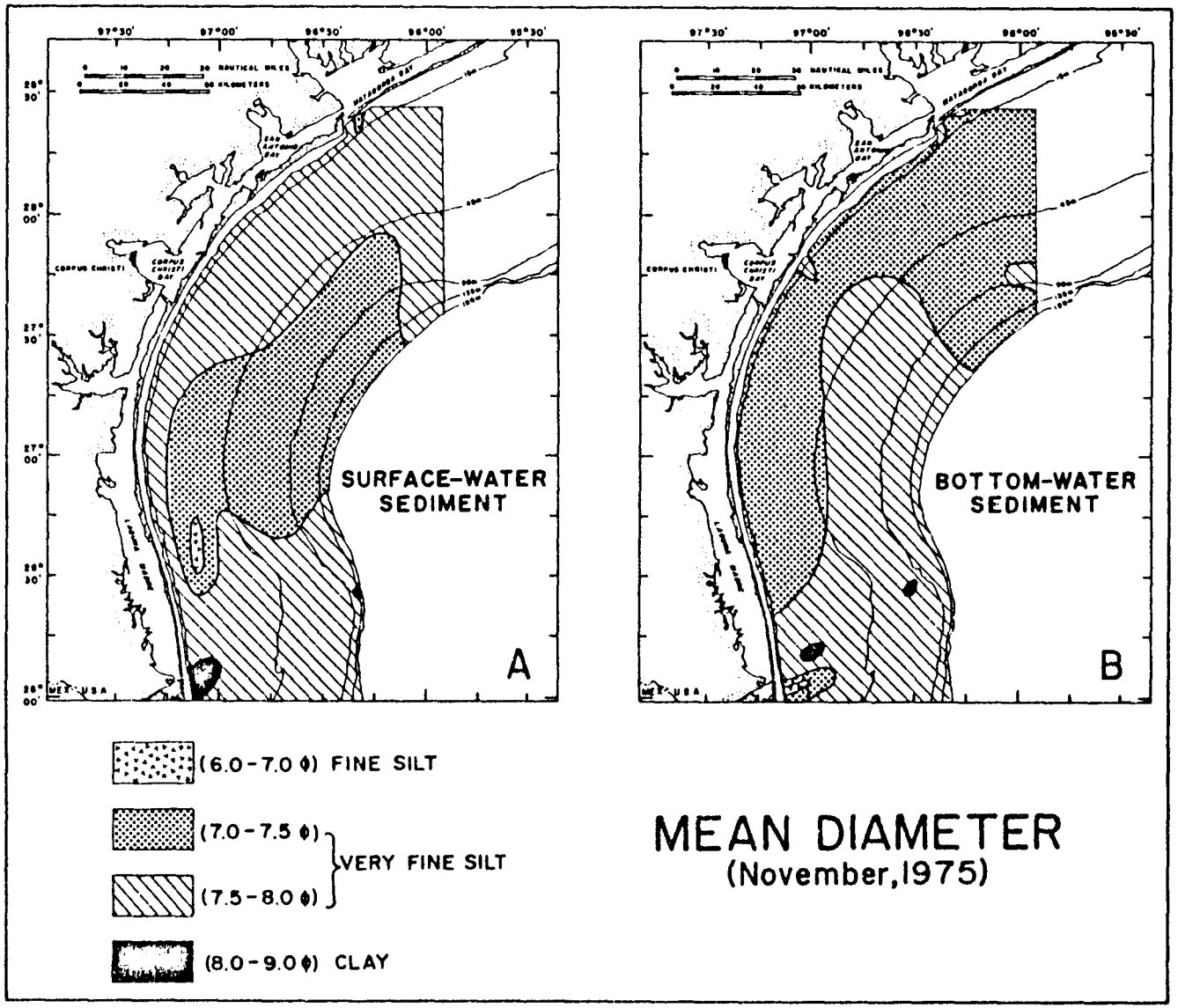


Figure 33. Mean diameters for suspended sediments.

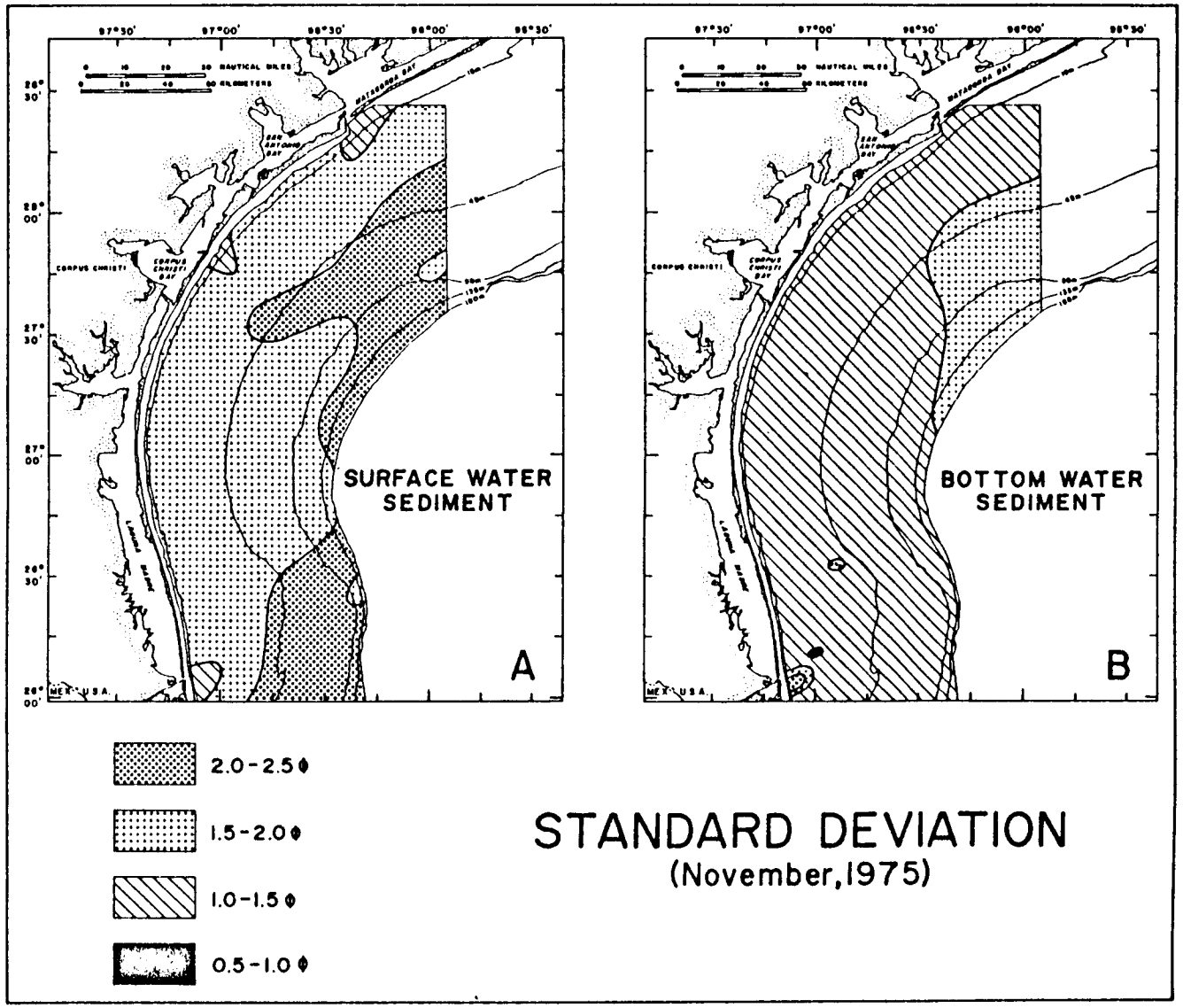


Figure 34. Standard deviations for suspended sediments.

at stations 23 and 23A, to very poorly sorted (2.18 Ø) at station 20. The best sorted sediments (1.0-1.5 Ø range) were in local salients associated with the three coastal inlets; the suspended sediments over the remainder of the OCS were poorly sorted (1.5-2.5 Ø). The regional trend was a general seaward decrease in sorting (increasing standard deviation), with the poorest sorted sediments occurring along the outer shelf.

The sorting values of bottom water sediments ranged from moderately sorted (0.88 Ø) at station 22, to very poorly sorted (2.12 Ø) at station 23A (fig. 34B). The sediments over most of the region were poorly sorted (1.0-1.5 Ø range), with somewhat poorer sorting (1.5-2.0 Ø) in the northeastern sector. A comparison of the bottom and surface patterns indicates that the bottom sediments were more homogeneous and better sorted throughout most of the region.

March 1976 Textural Patterns

General composition

The general textural composition of suspended sediments in surface waters is shown by the silt/clay ratio isopleth map (fig. 35A). The surface sediment ratios at individual stations ranged from a maximum of 2.15 at station 9A to a minimum of 0.45 at station 23. The regional pattern indicates that silt and clay sediment were approximately evenly distributed. In addition, the regional trend is a general reduction in silt content (coarseness) toward the south and southeast.

The suspended sediments in bottom waters showed a substantially different pattern of silt/clay ratios (fig. 35B). Ratios at individual stations ranged from a maximum of 3.02 at station 9 to a minimum of 0.53 at station 23A.

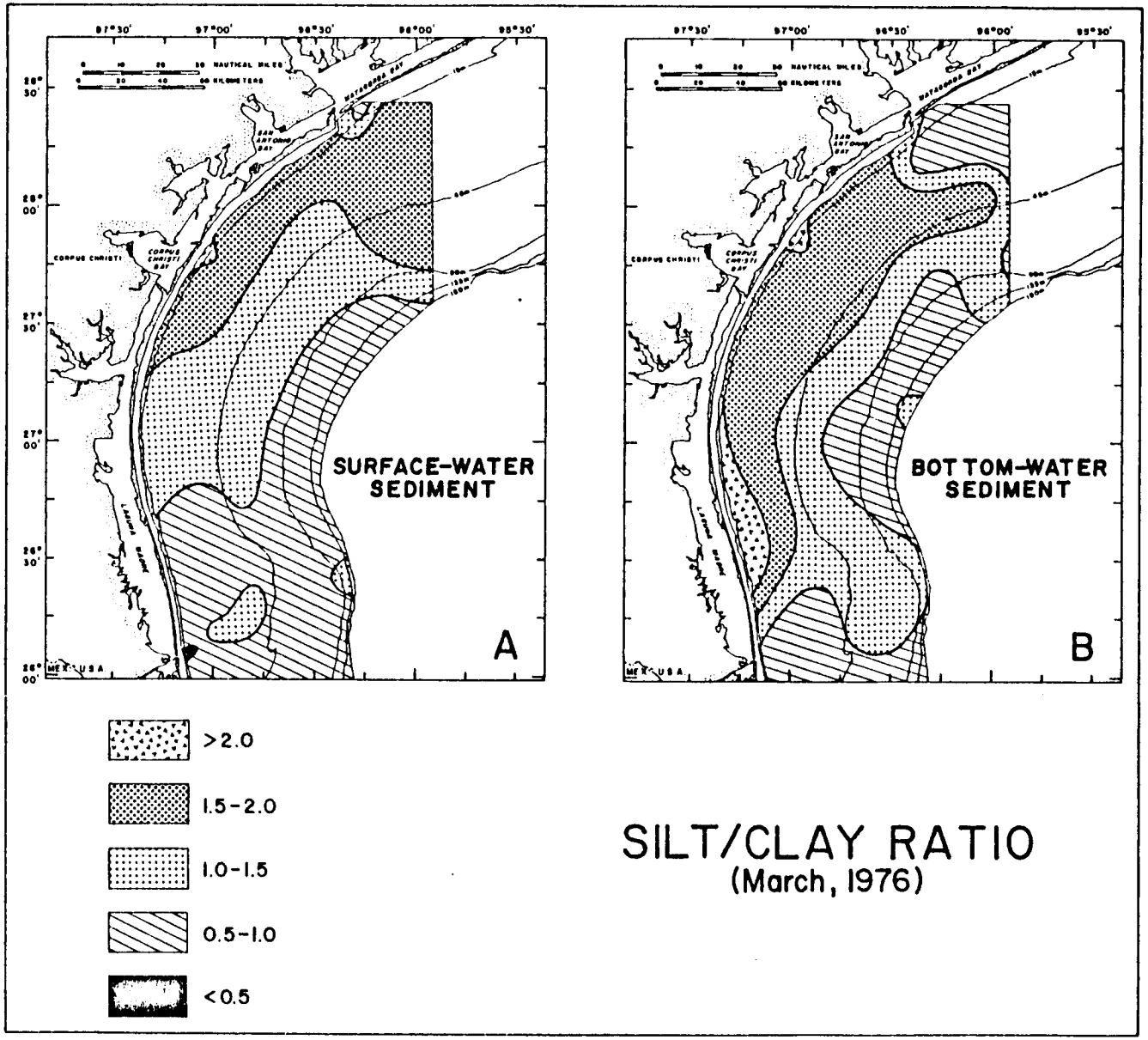


Figure 35. Silt/clay ratios for suspended sediments.

Over most of the OCS, the suspended sediments in bottom water were silt sized. The regional trend was a general seaward reduction in the silt-sized component. Suspended sediments predominantly of clay size were associated mainly with the Matagorda Bay and Rio Grande-Brazos Santiago inlets; the sediments from Aransas Pass were largely of silt size. Comparison of the bottom and surface patterns suggests somewhat different sediment dispersal directions; textural gradients suggest that surface sediments appeared to be moving both seaward and southward, whereas bottom sediments appeared to be moving seaward.

Mean grain size

The variations of mean grain size in the surface waters are shown by the mean diameter isopleth map (fig. 36A). Mean grain size at individual stations ranged from clay (8.36 Ø) at station 23 to fine silt (6.95 Ø) at station 5. Sediment throughout most of the area fell within the size range of very fine silt (7.5-8.0 Ø). Locally, the clay-sized sediment was derived principally from the Matagorda Bay and Rio Grande-Brazos Santiago inlets. The regional pattern shows that the surface sediments were relatively uniform in grain size, except for finer sediments near the two noted inlets and somewhat coarser sediments in the northeastern sector.

The mean grain size of sediments in bottom waters at individual stations ranged from clay (8.29 Ø) at station 23A, to very fine silt (7.20 Ø) at station 10 (fig. 36B). Most of the sediment was very fine silt (7.0-8.0 Ø) with only isolated local areas of clay size. Clay was derived, at least partially, from the Matagorda Bay and the Rio Grande-Brazos Santiago inlets; silt was the principal component at Aransas Pass. A comparison of the bottom and surface patterns indicates general similarities with only local variations,

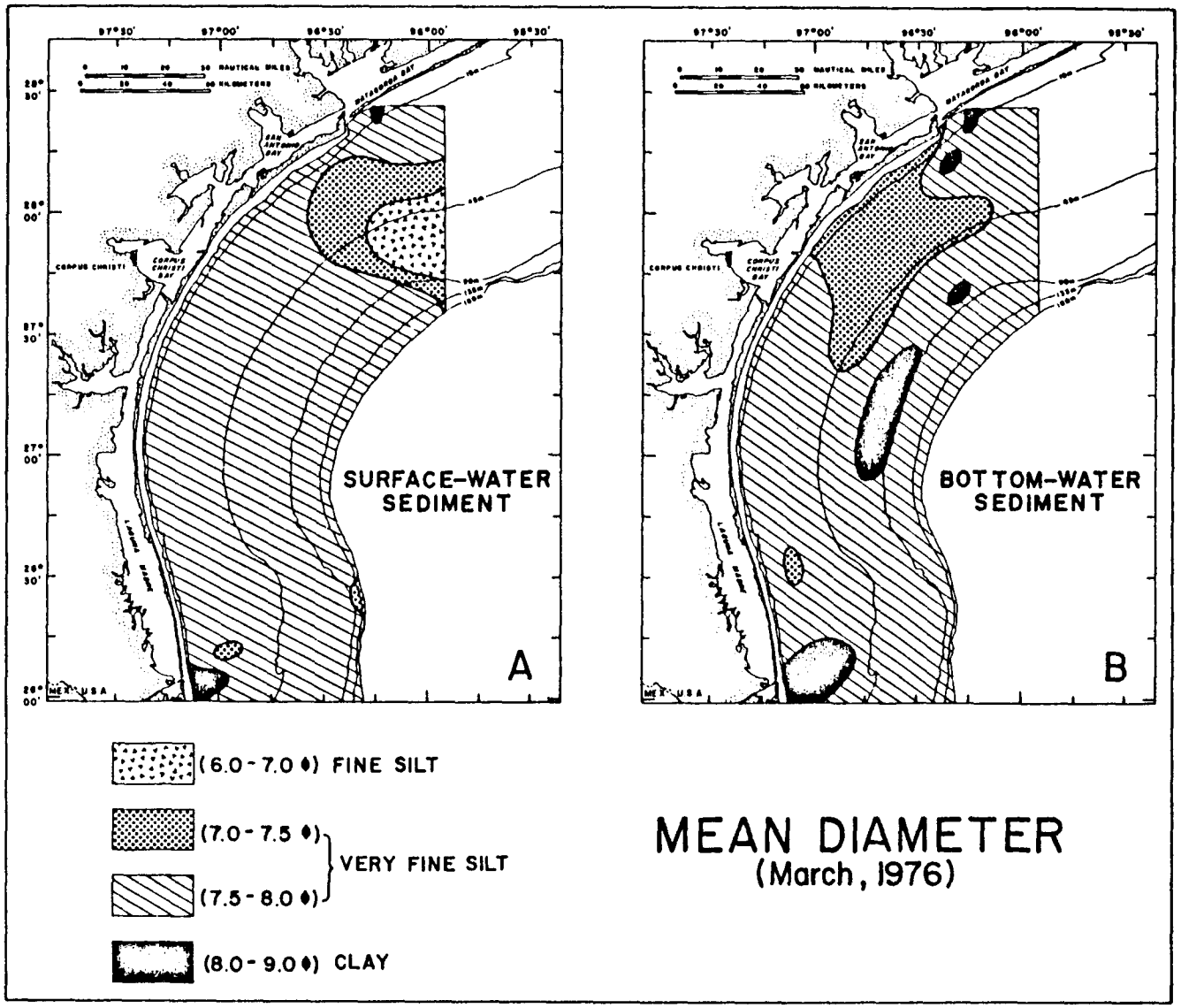


Figure 36. Mean diameters for suspended sediments.

such as locations of clay areas and the location of the coarser area within the northern sector.

Sorting characteristics

The standard deviation isopleth map (fig. 37A) indicates that sediments in surface waters ranged from poorly sorted (1.12 Ø) at station 9A to very poorly sorted (2.33 Ø) at station 20. The best sorted sediments (1.0-1.5 Ø) were near the coastal inlets, and the poorest sorted sediments (2.0-2.5 Ø) generally were along the outer shelf.

The sorting of sediments in bottom water ranged from moderately sorted (0.89 Ø) at station 13 to very poorly sorted (2.00 Ø) at station 19 (fig. 37B. Sorting was generally poor for the entire region with the poorest sorted sediments occurring along the outer shelf.

The regional trend of both surface and bottom water sediments was seaward reduction in sorting, although bottom water sediments tended to be better sorted than surface water sediments as a whole.

May 1976 Textural Patterns

General composition

The general textural composition of suspended sediments in the surface waters is shown by the silt/clay ratio isopleth map (fig. 38A). The ratios at individual stations ranged from a maximum of 7.52 at station 23A to a minimum of 0.75 at station 7. Silt was the dominant grain-size component throughout most of the region; clay was dominant in only a few isolated localities along the outer shelf and at the Matagorda Bay inlet. Local textural salients at inlets indicate predominantly silt dispersion from

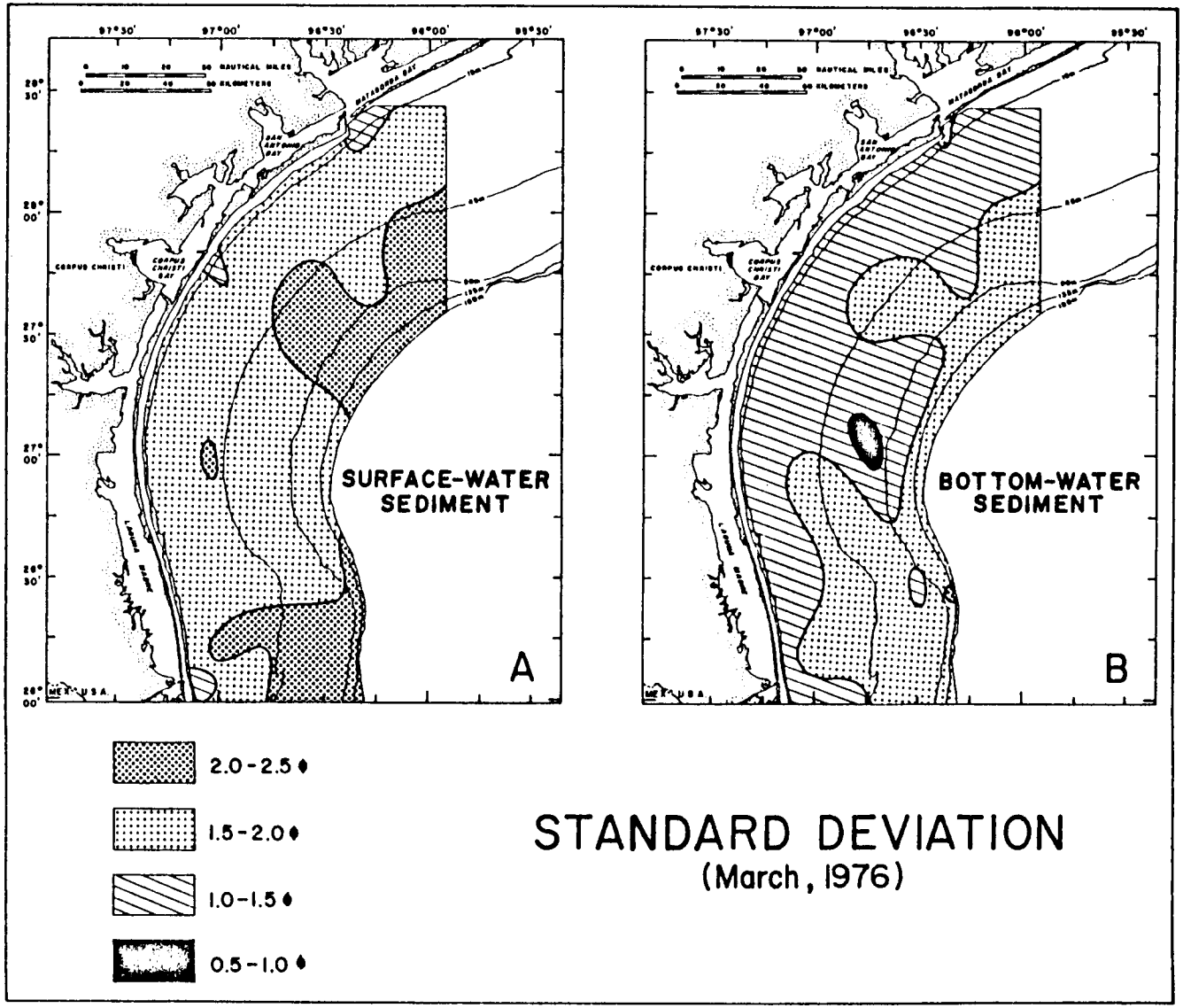


Figure 37. Standard deviations for suspended sediments.

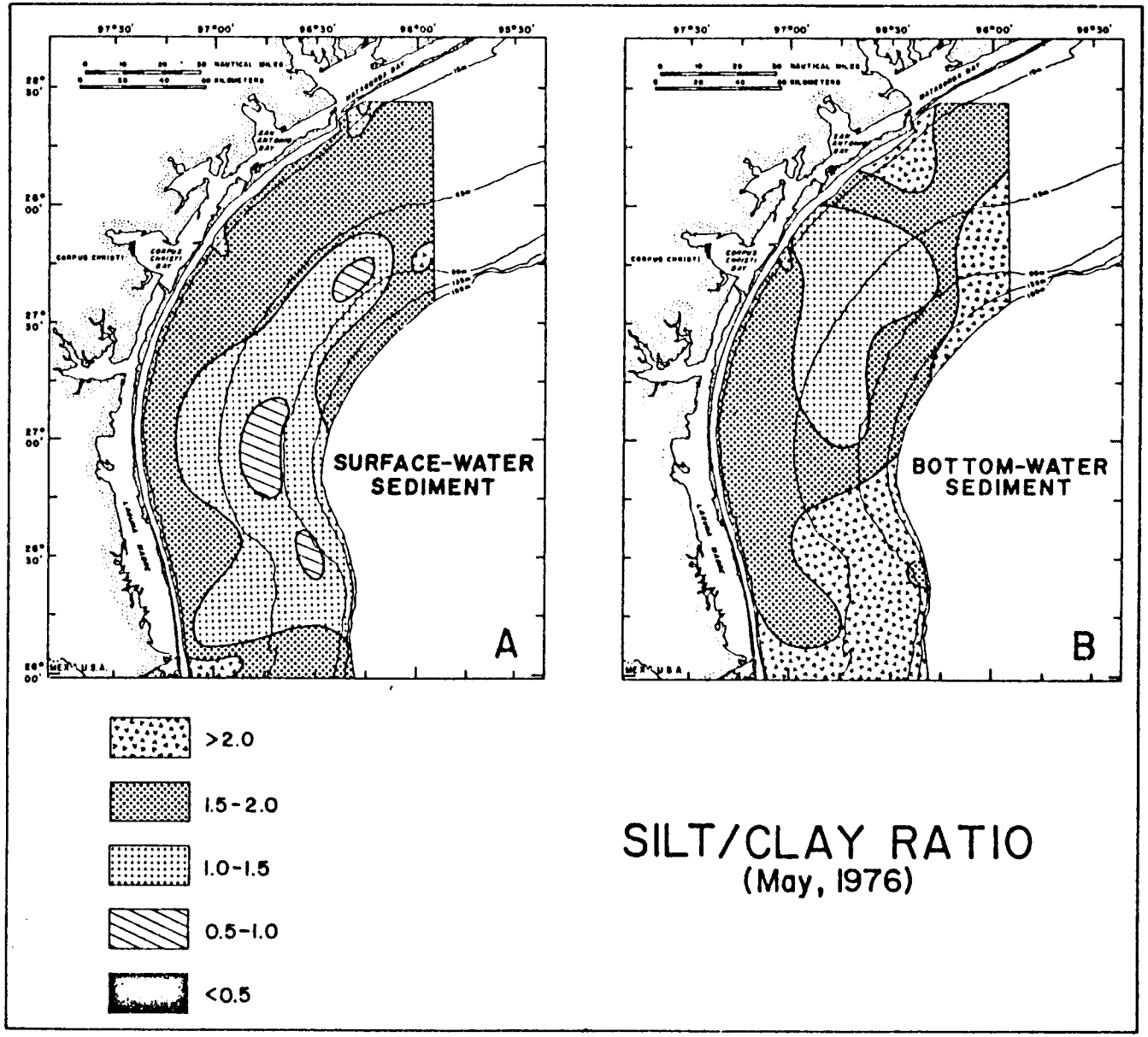


Figure 38. Silt/clay ratios for suspended sediments.

Rio Grande-Brazos Santiago and Aransas Pass, and predominantly clay dispersion from Matagorda Bay.

Suspended sediments in bottom waters had a substantially different pattern of silt/clay ratios than did those in the surface water (fig. 38B). Ratios at individual stations ranged from a maximum of 8.85 at station 23A to a minimum of 1.05 at station 8. Silt was the dominant size component throughout the entire OCS.

The regional trend in both surface and bottom water sediments is a general reduction in silt content (coarseness) from peripheral areas toward the interior, although the closure is in opposite directions.

Mean grain size

Mean grain size of surface water sediment at individual stations ranged from clay (8.10 Ø) at station 13 to fine silt (6.98 Ø) at station 12. The range in mean grain size for the region is shown by figure 39A. The surface sediments are largely very fine silt. In general, mean grain size decreased toward the central interior; this correlates with the silt/clay ratio pattern and suggests net transport toward the interior of the shelf.

The mean grain size of bottom water sediment at individual stations ranged from very fine silt to fine silt (fig. 39B). Bottom sediments were largely very fine silt except for three small isolated coarser areas of fine silt. The fine silt in the northeastern part of the OCS is associated with the flank of the ancestral Brazos-Colorado delta, which is made up of relatively coarse benthic deposits. The regional trend in grain size for sediments in bottom waters was different from the trend shown by sediments in the surface water, suggesting a somewhat different dispersal pattern.

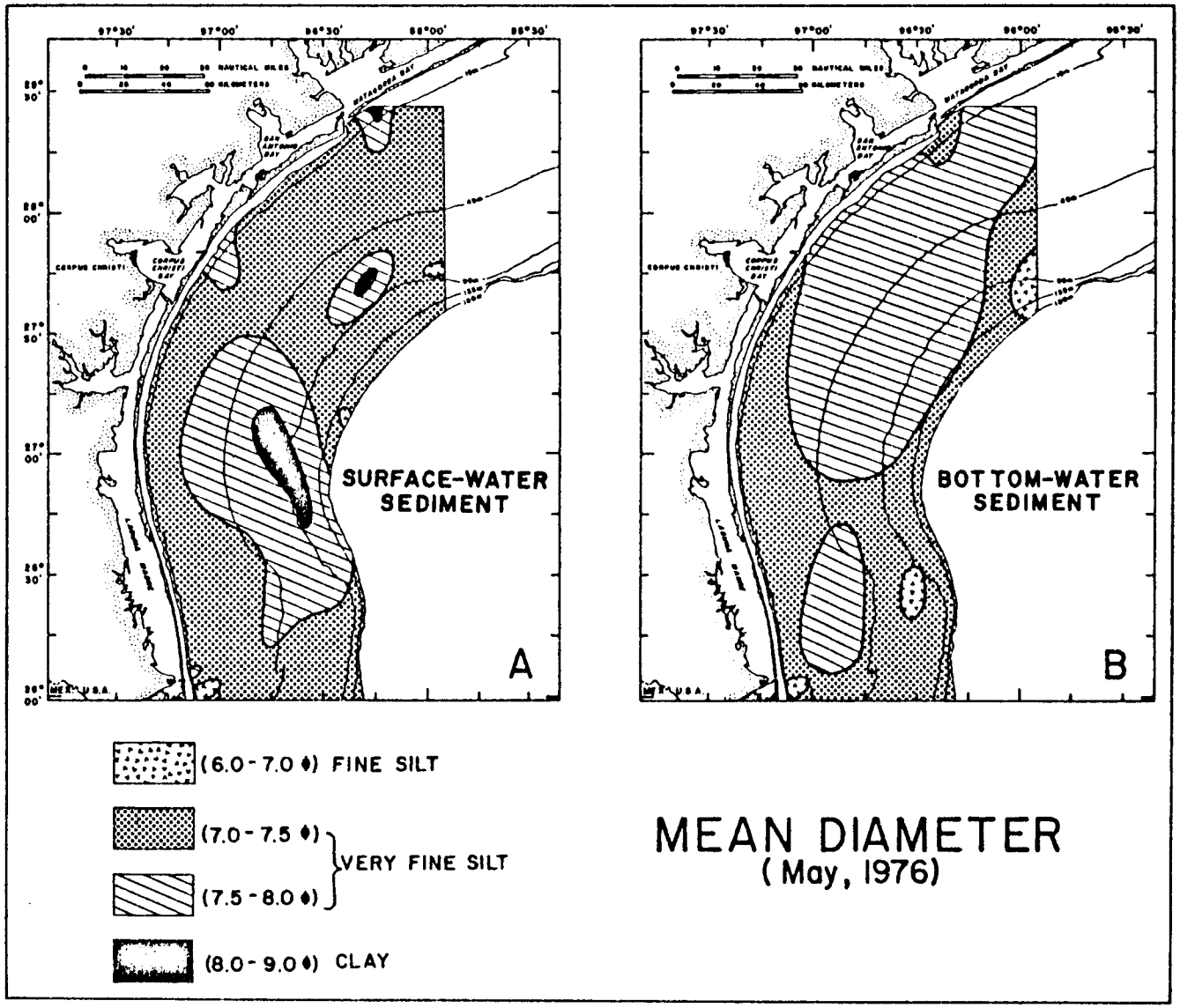


Figure 39. Mean diameters for suspended sediments.

Sorting characteristics

The sediments in surface waters at individual stations ranged from poorly sorted (1.8 Ø) at station 23A to very poorly sorted (1.18 Ø) at station 17 (fig. 40A). The distribution pattern indicated that poorly sorted and very poorly sorted sediments occurred in nearly equal proportions. Sorting decreased seaward with the best sorted sediments (1.0-1.5 Ø) occurring at the coastal inlets.

The standard deviations for sediments in the bottom water ranged from 1.00 Ø at station 13 to 1.98 Ø at station 18 (fig. 40B). Sorting was generally poor throughout the region and decreased seaward. However, the bottom sediments were better sorted than the surface sediments.

Summary

Suspended sediment textural composition, in terms of both mean grain size and silt/clay ratios, showed substantial temporal and spatial variability. Surface waters tended to be coarsest or most silty during May. Temporal variations in the surface patterns apparently reflected differences in the size of sediments entering the shelf from the coastal inlets, differences in hydraulic conditions, differences in the plankton populations, and differences in the degree of shelfward incursion by deeper gulf waters. The patterns of sediment grain size for bottom waters differed substantially from those for surface waters. These differences may indicate hydraulic size fractionation within the water column, as well as possible variations in surface and bottom water sediment dispersal patterns.

The sorting characteristics of suspended sediments in both surface and bottom waters also exhibited some temporal and spatial variability. Generally,

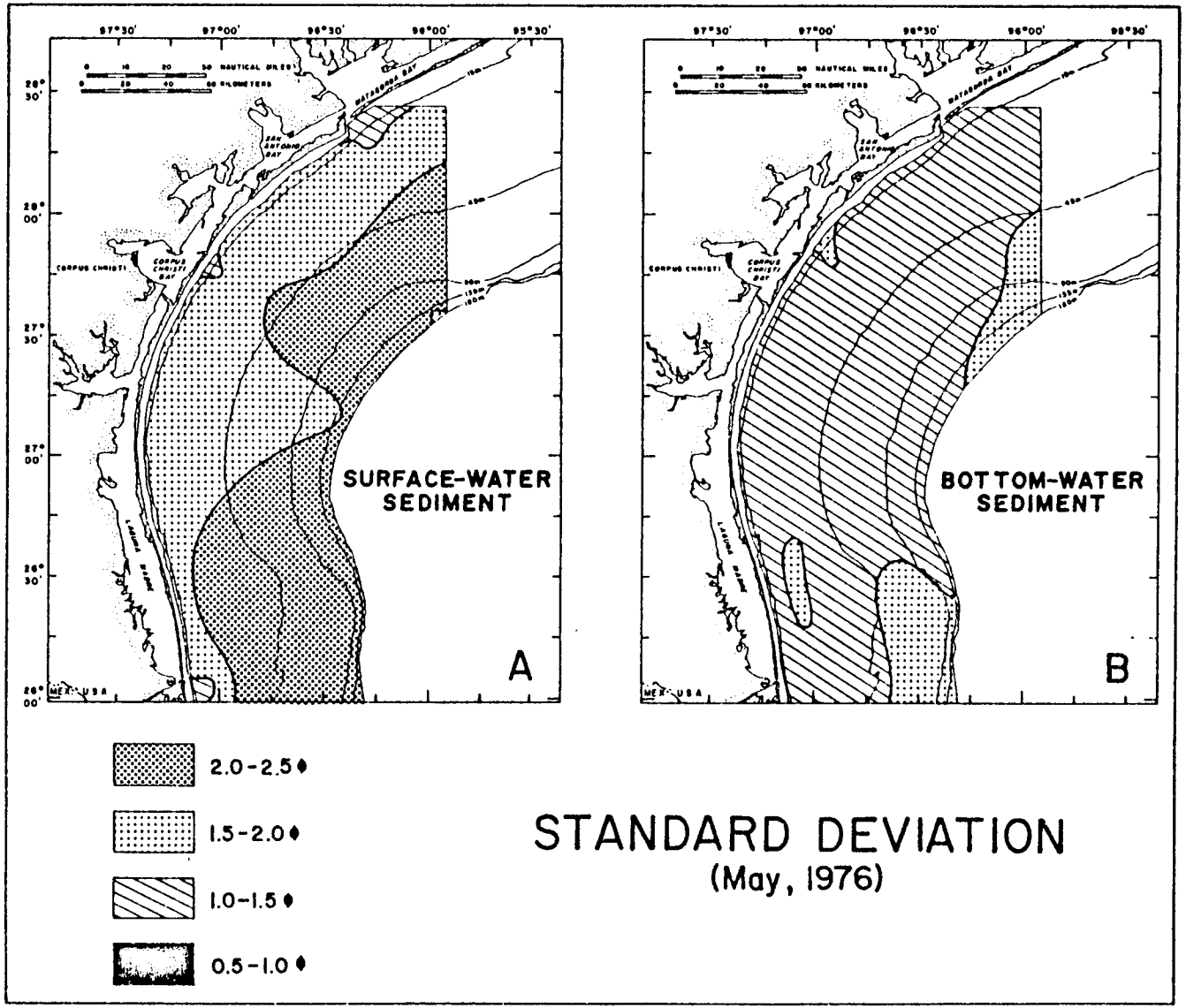


Figure 40. Standard deviations for suspended sediments.

sorting decreased seaward, a trend possibly related to a progressive seaward mixing of terrigenous and biogenic sediment. Generally sediments near the bottom were better sorted than sediments near the surface.

CHEMICAL CHARACTERISTICS

Clay Mineralogy

by

Charles W. Holmes

Introduction

Variation in the nature of suspended matter may significantly affect the transportation of trace substances in a marine environment (Gibbs, 1973). The degree of chemical activity of the substance, whether organic or inorganic, is the most important factor in defining its role in the transportation of trace substances. The organic matter in a particular area is composed of organisms, fragments of organisms and macromolecules of uncertain origin. Little is known about the precise role that organic material plays in the transportation of trace substances. It may be surmised, however, that because this material can be very active chemically, it may play a catalytic role in absorbing and transporting dissolved ions to the inorganic substrate.

The negative surface charge of particulate matter is important in the transport of trace metals because most metals or metal complexes possess a positive charge (Goldberg, 1965; Neihof and Lock, 1972). Laboratory experiments have shown that the expandable clay minerals (e.g. smectite) have the highest potential surface activity (Neihof and Lock, 1972) and are the most chemically active of the inorganic substrates. Measurement of the relative proportions of such substances in time and space is necessary to assess their environmental significance.

The inorganic fraction, and to some extent the organic fraction, inherits its composition from the source environment. Recognition of the sources for suspended particulate matter is essential in deriving a dispersal model for the trace substances.

Methods of Study

Samples were taken during three cruises: one in October-November 1974, one in November of 1975, and one in May 1976. During the fall 1974 cruise, samples were taken at 24 stations (Berryhill and others, 1975, fig. 8). For the fall 1975 and spring 1976 cruises, samples were taken at 12 stations which correspond to some of the same sites occupied for transmissometry (fig. 41). At each site, the samples were taken approximately 1 m below the water surface and 1 m above the benthic sediment-water interface with a 30 liter top-drop bottle. From each sample aliquots were taken for mineralogical analysis (≈2 liters), total organic carbon analysis (≈7.5 liters), and gravimetric mass determinations (≈2 liters). During the 1974 cruises all samples were filtered immediately; during the two subsequent cruises only the samples for trace metal determinations were filtered immediately. The remaining samples were frozen and returned to the laboratory for further processing.

In the laboratory, the aliquots assigned for mass determinations were thawed, filtered through a preweighed 27 mm diameter NUCLEPORE filter with a nominal 0.45 μ pore diameter, were dried and weighed on a PERKIN-ELMER autobalance, model AD-2 in a desiccated environment. For total organic carbon, the sample aliquot was filtered through an acid-washed and fired glass filter (47 mm type AE, GELMAN) and was sent to a commercial laboratory for analysis.

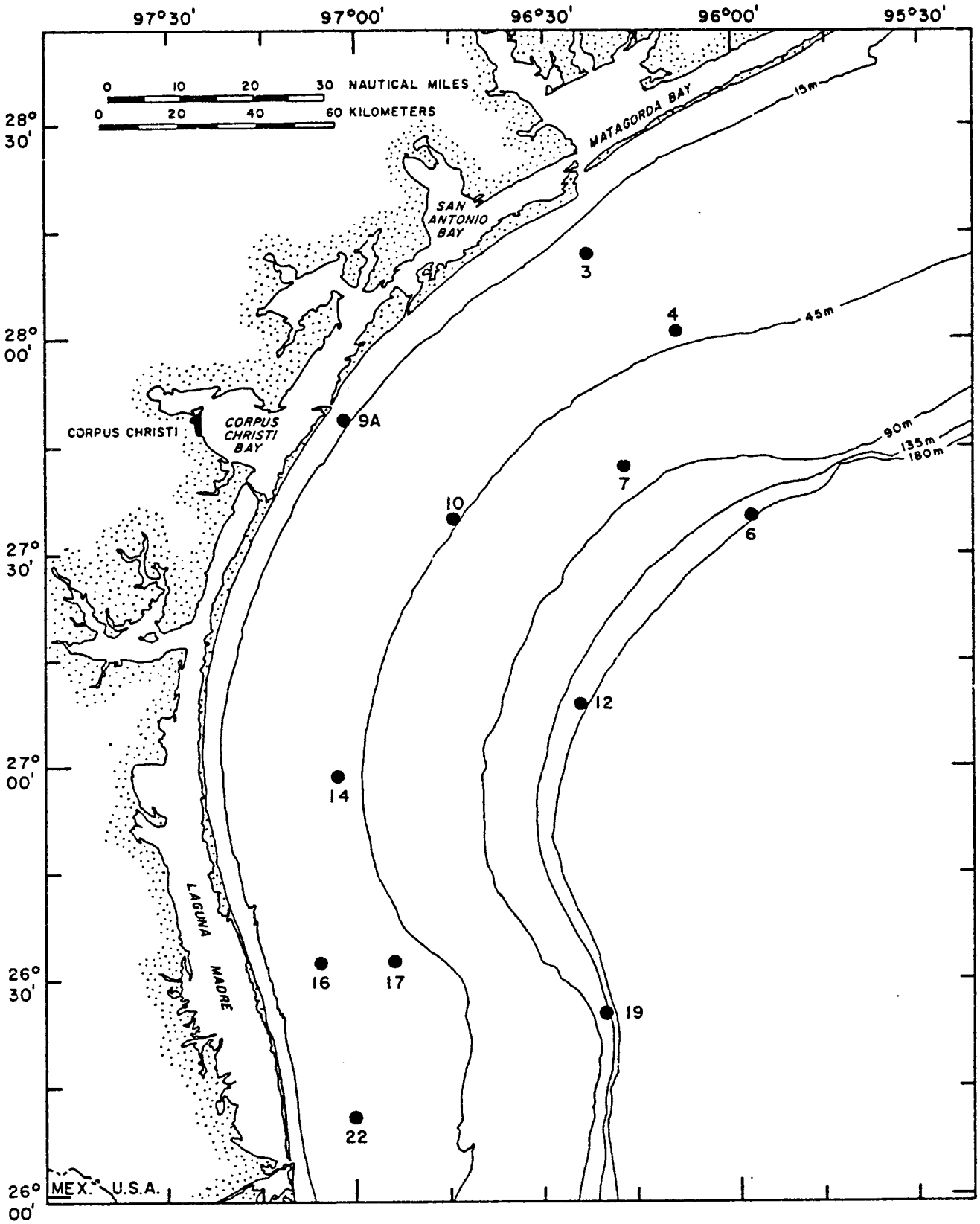


Figure 41. Location of suspended matter samples for both November 1975 and May 1976.

The mineralogical samples were filtered through a 27 mm silver filter with a nominal pore diameter of 0.4 μm (SELAS FLOTRONICS). The mineralogy was then determined by X-ray diffraction techniques. The samples for the fall cruise of 1974 were analyzed on a PICKER diffractometer, and the analyses were made by subjective measurements of "d" spacings and areas under peaks. For the fall 1975 and spring 1976 cruises the samples were analyzed using a DIANO automatic diffraction X-ray system (SRD-8300AD), which allows for greater precision in the determination of peak areas and "d" spacings used to identify the minerals present. The procedure used for mineralogical identification was the same as outlined by Carroll (1970); the method of quantification was a modification of the procedure used by Biscaye (1965). The 3.34 Å peak may indicate the presence of quartz and/or "illite" (Biscaye, 1965). However, there was very little clay material in the samples from the 1975-1976 sampling period. The minor amount of crystalline material produced very broad peaks which made positive identification of clay mineral specks extremely difficult. As a result, the "d" spacings that cluster about certain values are interpreted to be representative of the four reported clay minerals (the 3.34 Å peak is assumed to be quartz). The amount of clay minerals present was then assumed to be a function of the peak area, and appropriate factors and relative proportions of each type were calculated. (See Appendix 2 for original data.)

Summary and Conclusions

During two sampling periods (November 1975 and May 1976), the amount of material in the shelf waters was relatively small as compared

to the previous November 1974. The variation in the amount of suspended material apparently was the result of the relatively mild winter and spring during the 1975-1976 period compared to the fall of 1974. The variations in the amounts of suspended material are shown quantitatively by figures 42, 43 and 44.

In the fall of 1974, the suspended material varied from 140 mg/l in the bottom waters to less than 0.5 mg/l in the surface samples. Three areas of heavily concentrated sediment were apparent: one on the inner shelf between Matagorda and Corpus Christi bays, a second in the vicinity of the East Breaks over the northeastern part of the South Texas OCS and a third immediately seaward of the mouth of the Rio Grande (fig. 42). The two inner shelf areas are attributable to the influx of material from the land and to higher hydraulic energy in the coastal areas. The concentration of material on the outer shelf may be due to a combination of factors, including resuspension of bottom material by storm waves and/or internal waves. On the outer shelf the suspended sediment differs compositionally from the sediment in suspension on the inner shelf in that it, along with material in the Rio Grande area, contains few detectable expandable clay minerals and is largely illitic (Berryhill and others, 1976).

Significant amounts of illitic (micaceous) material in the bottom sediments support the suggestion that illitic-rich sediment is derived from the resuspension of bottom sediments by storms and/or internal waves. The distribution of this illitic material is under investigation.

In contrast to the fall of 1974, the concentration of suspended sediment in the fall of 1975 was low, varying from a maximum of 21 mg/l to less than 0.2 mg/l (fig. 43). A feature of the distribution in November

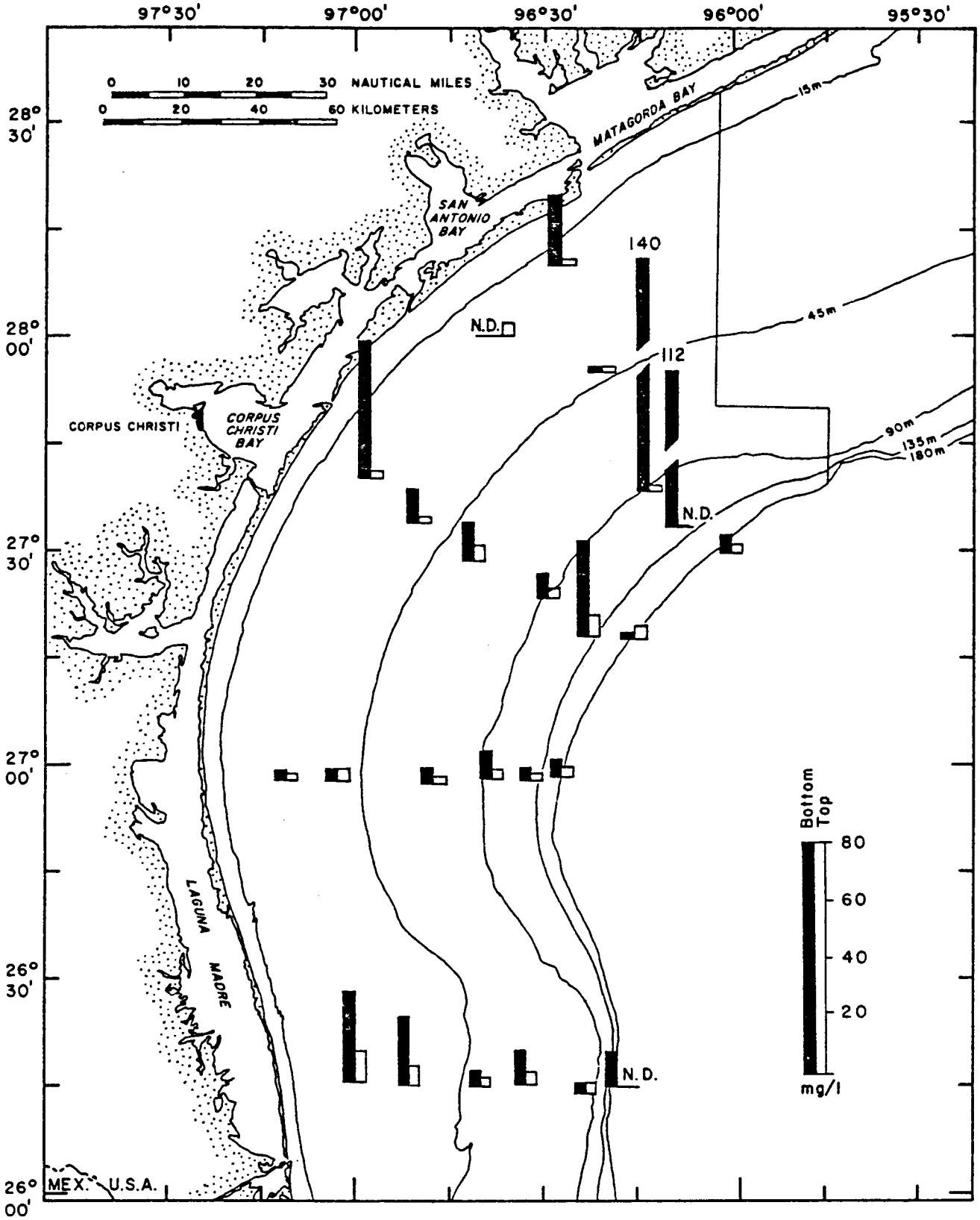


Figure 42. Amounts of suspended sediment, fall 1974.

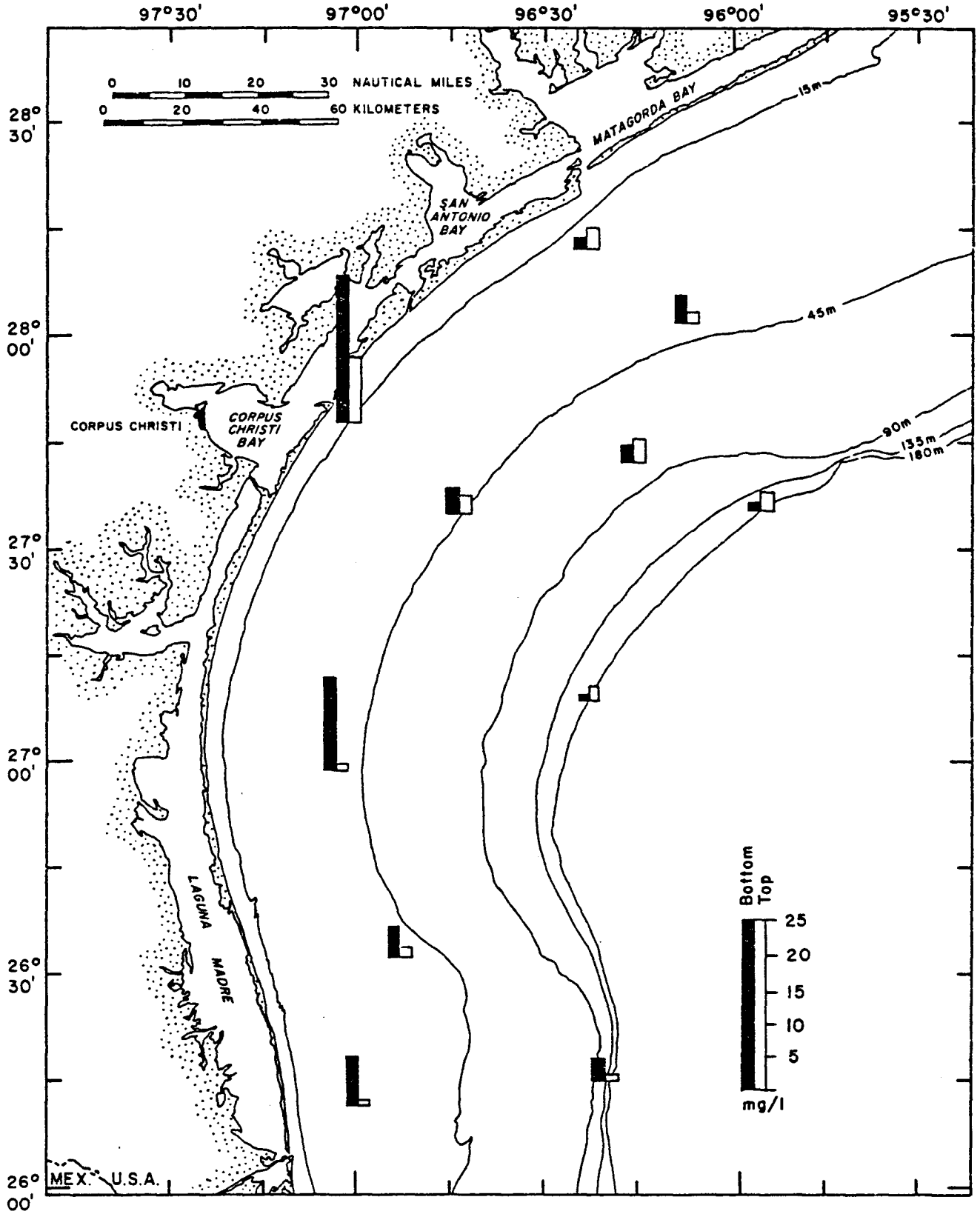


Figure 43. Amounts of suspended sediment, fall 1975.

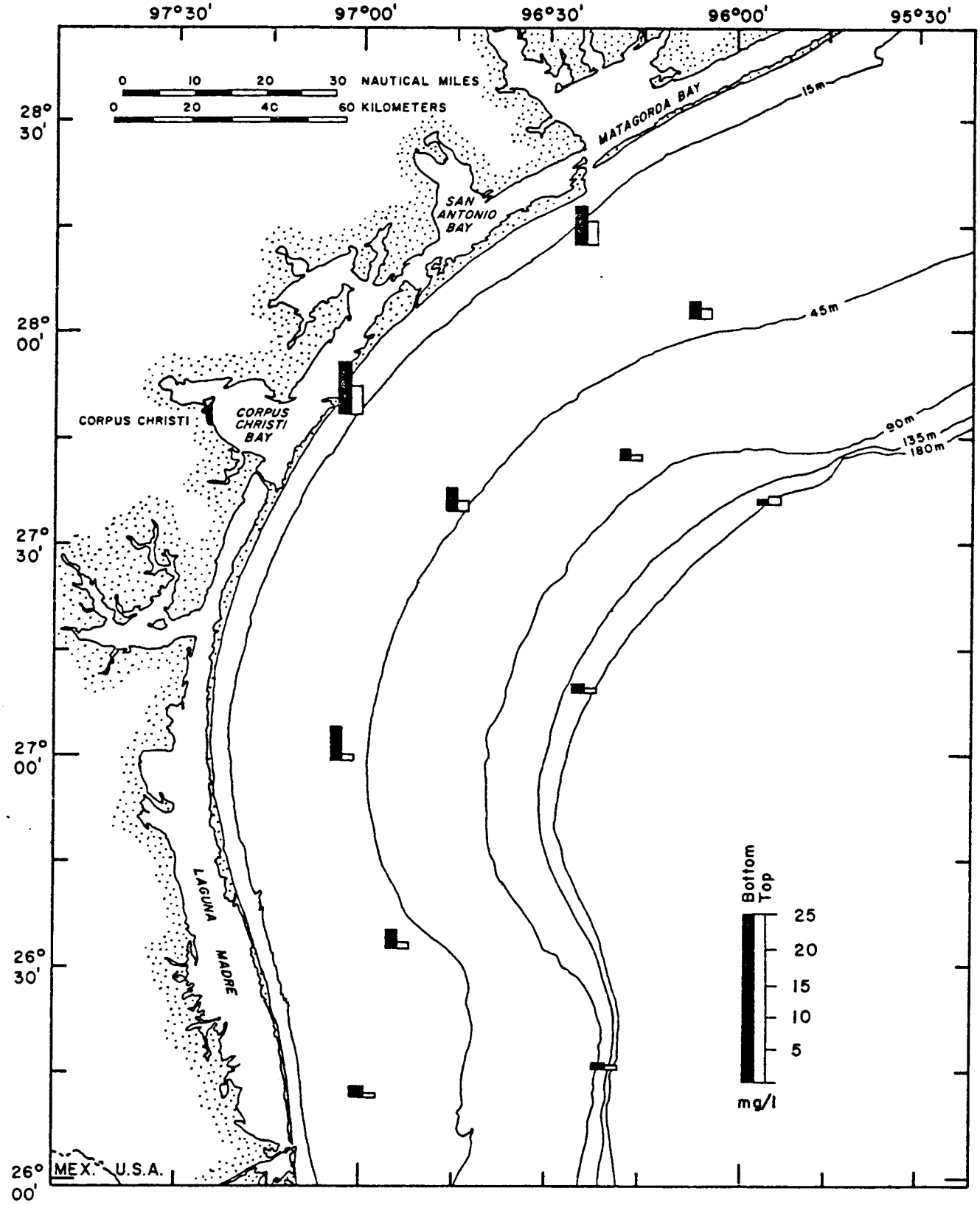


Figure 44. Amounts of suspended sediment, May 1976.

1975 was the larger amount of material in the surficial waters relative to the bottom waters along much of the shelf edge. The material in the surface waters had a significantly larger relative organic carbon content at the inshore sampling sites, probably reflecting the land-derived origin of the material (figs. 45 and 46). Conversely the bottom samples at the shelf edge had the larger carbon values. Mineralogically the samples were dominated by a 3.34 Å substance (quartz) (figs. 47 and 48). The innermost bottom water possessed some 17 Å material as a secondary component, except in the three southernmost samples. Those samples from the bottom waters over the ancestral Rio Grande delta, however, have illitic (10 Å) material as a secondary component. In the surface water at the site nearest the mouth of the Rio Grande, a 17 Å peak represents the only detectable mineral present.

The smallest amounts of suspended matter were measured during the spring of 1976. Amounts ranged from <5 mg/l to <0.2 mg/l. With the exception tion of station 6 at the shelf edge, all of the bottom water samples had larger amounts of sediment than the surface water, and the plot of the distribution by quantities showed a shoreward increase. The samples collected in the spring of 1976 had extremely high percentages of organic carbon (23.7-1.5 percent). At only two sites (station 9 at Port Aransas and station 6 at the shelf edge) are the bottom samples higher in organic carbon than those taken at the surface. Mineralogically, the surface waters in the northern portion of the study area are dominated by a 3.34 Å material; at the shelf edge in the south, 17 Å material dominates. In the bottom waters, the mineralogical composition is more variable, but the 3.34 Å material is dominant. However, the 17 Å material is relatively

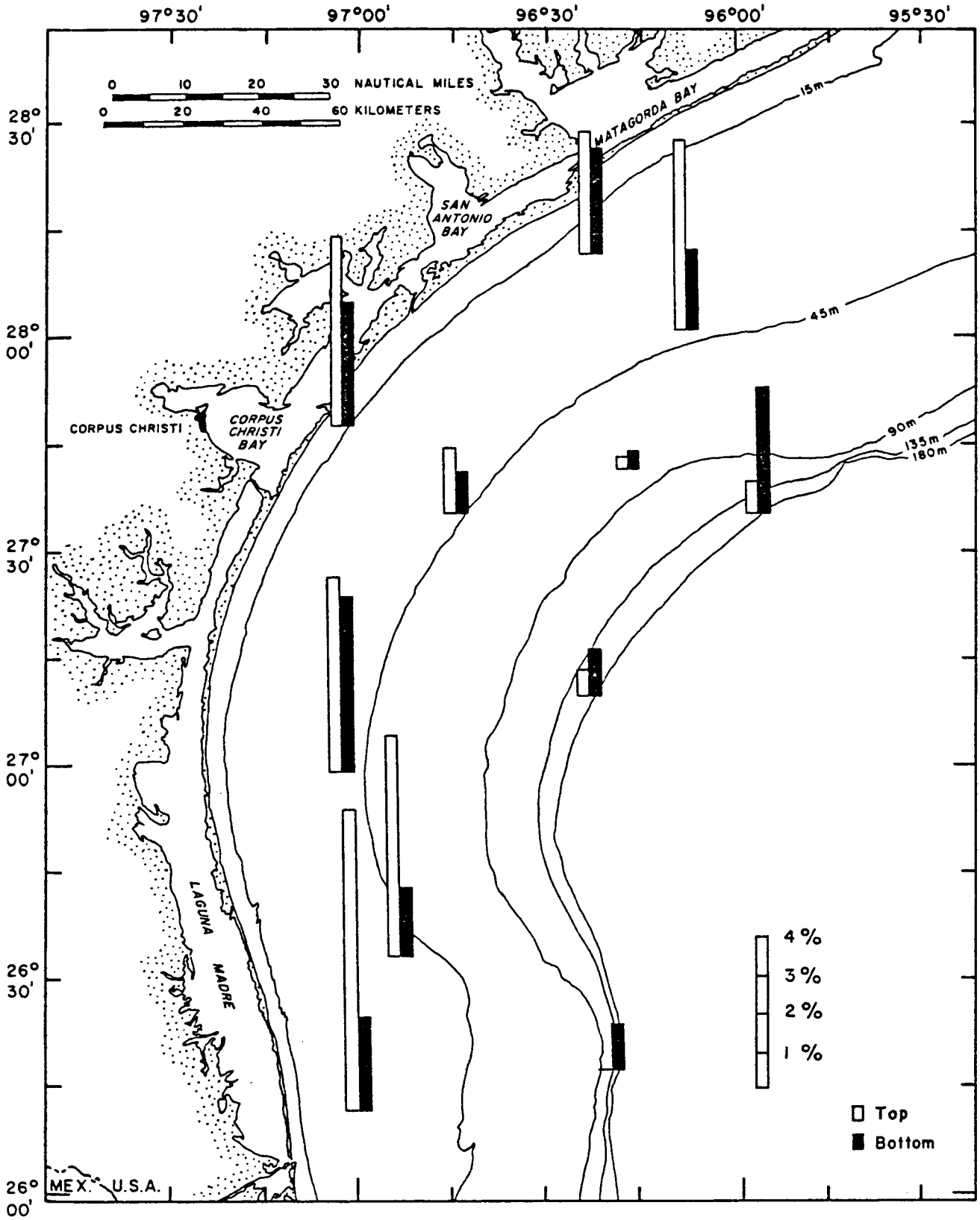


Figure 45. Total particulate carbon in suspended sediments, November 1975.

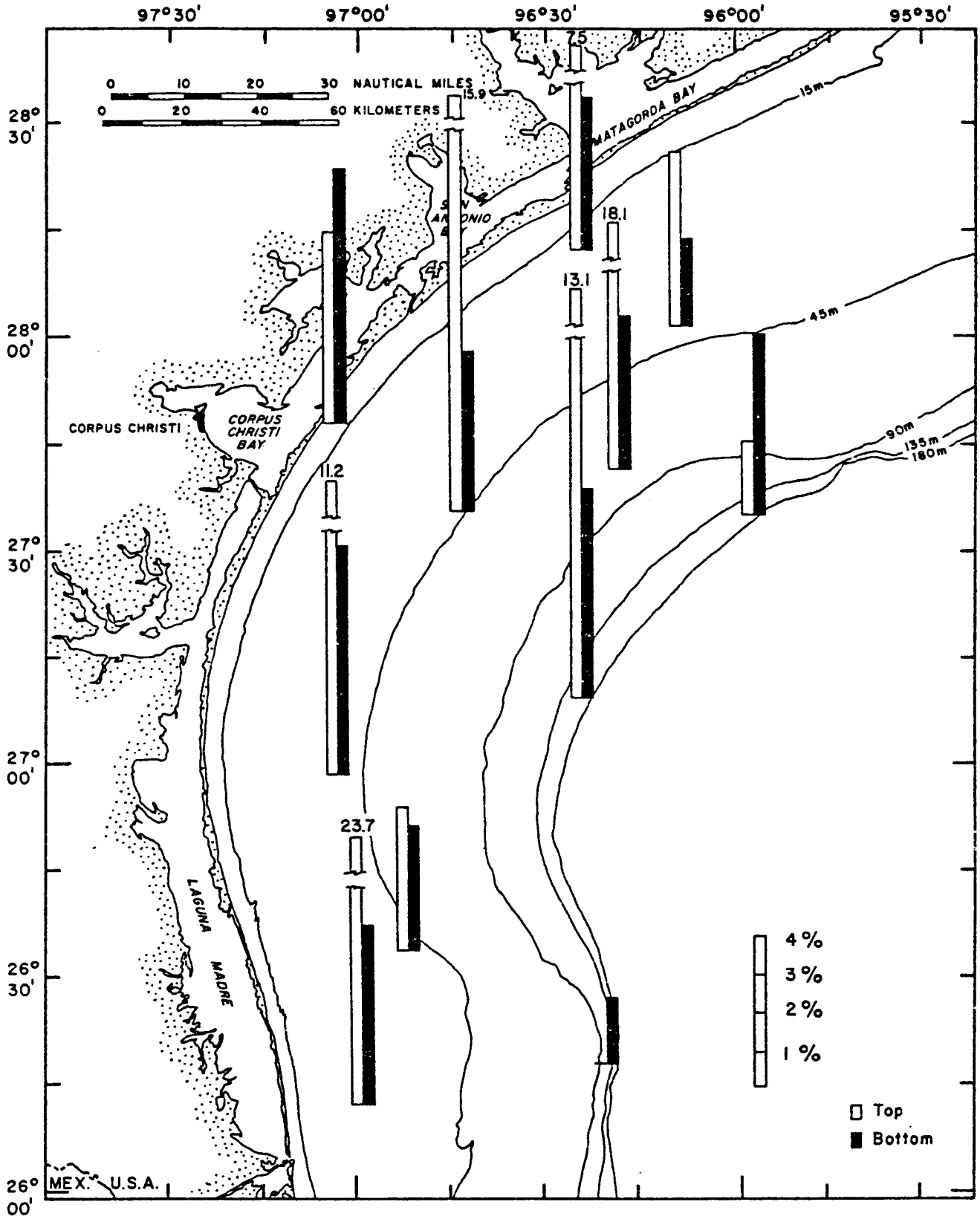


Figure 46. Total particulate carbon in suspended sediments, May 1976.

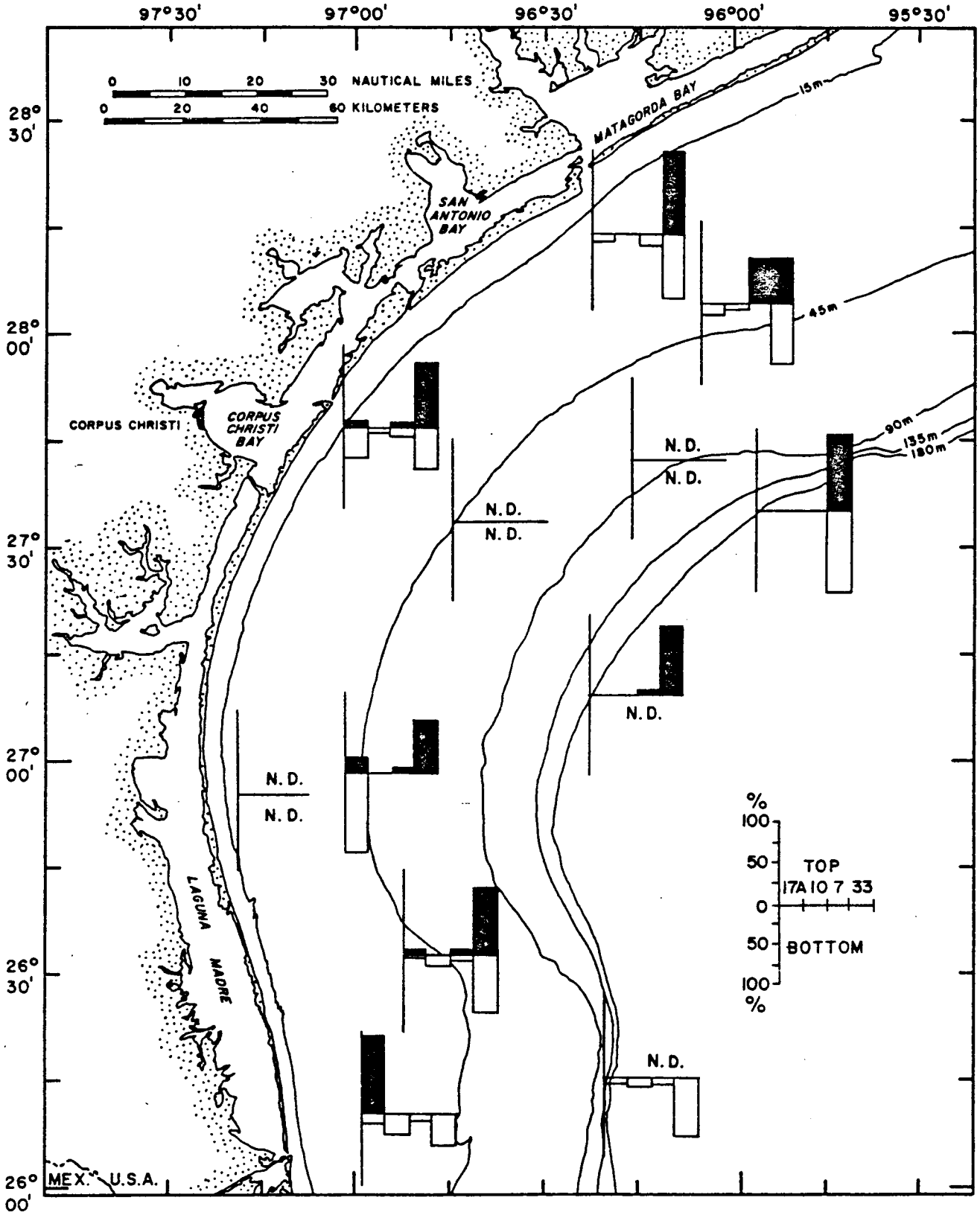


Figure 47. Percentage of clay minerals in suspended sediments, November 1975.

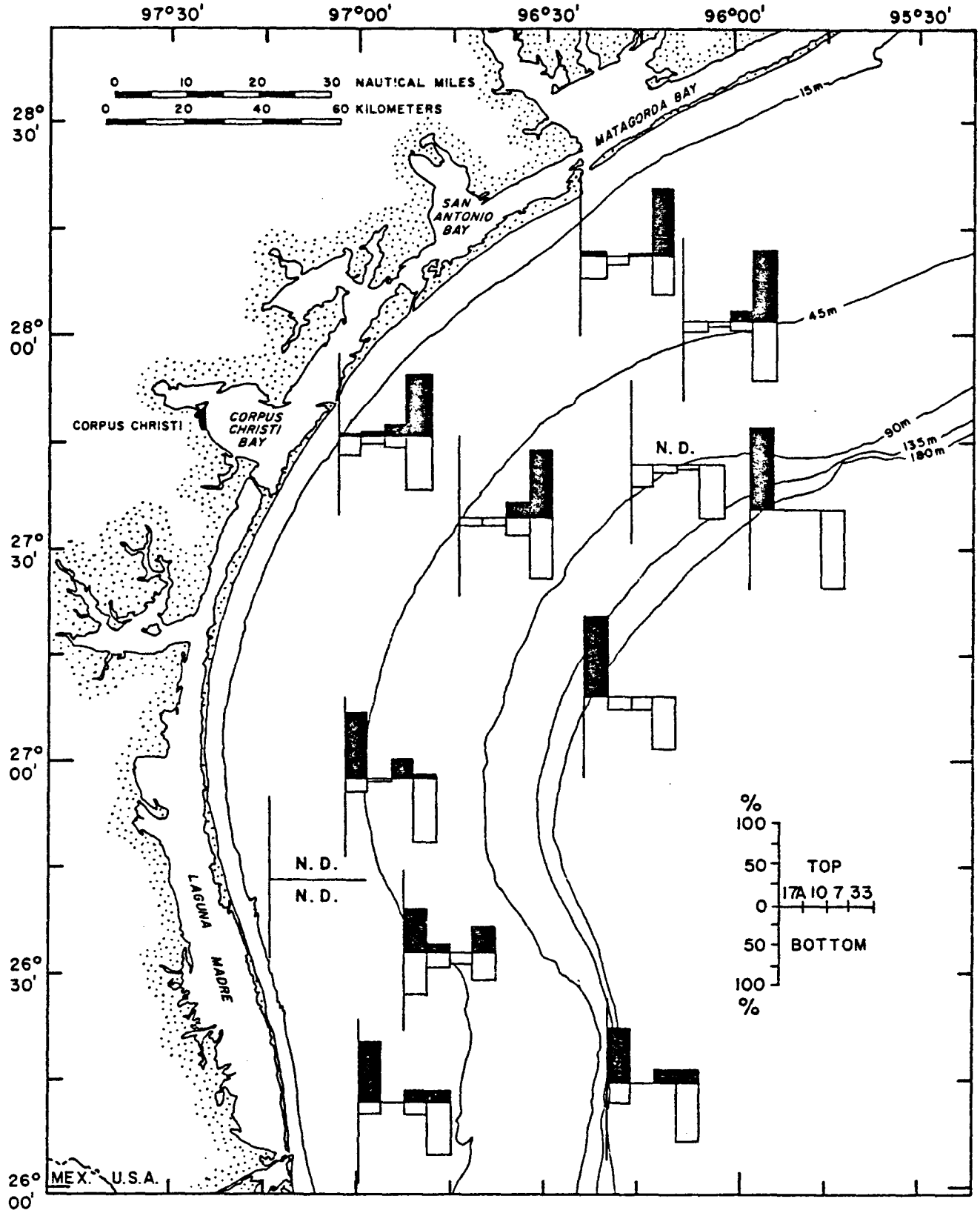


Figure 48. Percentage of clay minerals in suspended sediments, May 1976.

abundant in all locations with the exception of the two northernmost shelf-edge sites, where the 3.34 Å material totally dominates the sample.

A previous study concluded that the size of the sample analyzed exerts a significant influence on the estimation of the clay mineral composition (Tucholke, 1974): the smaller the sample size, the more dominant the illitic material. As a result, analysis of very small samples would indicate an inordinant amount of illitic material as compared to the montmorillonitic substances. As many samples from the study had an apparent illitic dominance, two experiments were conducted to examine this phenomenon. In the first experiment, equal amounts of two clays, a sodium montmorillonite (standard clay, Wyoming) and an illite (Fithian, Illinois) were mixed to form a dispersed slurry. A size analysis by COULTER COUNTER of each clay indicated a modal value of 0.7 μm for the montmorillonite and 1.5 μm for the illite, which mimics the relative sizes of these materials in nature. This mixture was diluted to various concentrations, sedimented by filtration and analyzed in duplicate. Four diffractions (fig. 49) show the decrease in intensity of both the 17 Å and 10 Å peaks, with the 10 Å peak scarcely visible in the graph of the 0.25 mg/cm^2 sample. Figure 50 is a plot of the results of this experiment and is a graph of the relative intensities (area) of the 17 Å and 10 Å peaks, and 4 x the area of the 10 Å peaks. Inspection of this diagram indicates that there is no apparent divergence between the 17 Å and 4 x 10 Å values with decreasing amounts of sample material.

In the second experiment, a bottom sample (the top 1 cm of sediment) from the study area was diluted in filtered sea water, stirred and allowed to settle. An aliquot was taken at 1 hour, 2 hour, and 4 hour

A. 2.5 mg/cm^2 C. 0.75 mg/cm^2
B. 1.25 mg/cm^2 D. 0.25 mg/cm^2

Figure 49. X-ray diffractions of sequential concentrations of 1 to 1 montmorillonite/illite.

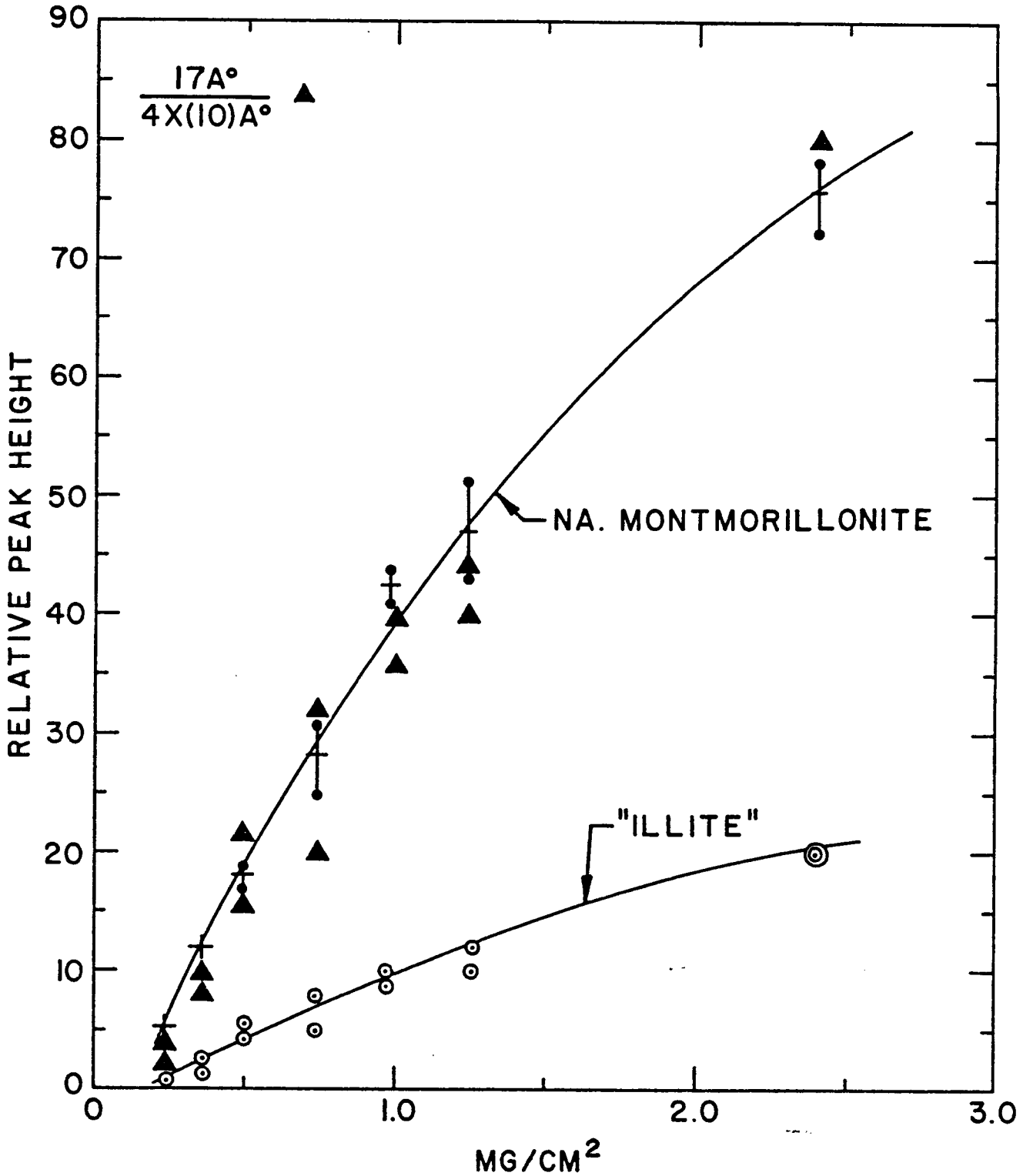


Figure 50. Relative intensities of the peak heights of sequential concentrations of 1 to 1 montmorillonite/illite.

intervals. The material was sedimented on silver filters and X-rayed. This experiment also showed that there was no significant variation in the peak ratios relative to the size of sample analyzed (fig. 51). From these experiments it is apparent that for the material on the South Texas shelf, the dominance of illitic materials is real and not an artifact of sediment loading on the slides.

The samples from the surface waters over the outer edge of the shelf are dominated by 17 Å material, which has two possible sources. One possibility is that the montmorillonitic material may have come from the land and, because of its small size, may have been transported a considerable distance from its source. In order for this to happen, however, the mineral would have to become sheathed with a nonpolar substance that would inhibit its natural tendency to floculate and settle. An alternative explanation is that the material may be diatomaceous. One study has shown that diatoms possess a 17 Å clay layer on the surface of their frustules (van Bennekom and van der Gaast, 1976). This circumstance might account for the 3.34 Å material at depth in this region, both in the November and May periods.

In conclusion, the distribution of clay minerals in the water of the south Texas shelf was very similar during all sampling periods. Although minor differences were evident, such as the presence of the 17 Å substance in the May surface waters on the edge of the shelf, the general trend indicated by the samples collected during the fall of 1974 was confirmed by the later samples: montmorillonitic material is dominant over the northern part of the shelf and illitic material over the southern part. The nature of the 7 Å material is still undefined, but it appears to be chloritic.

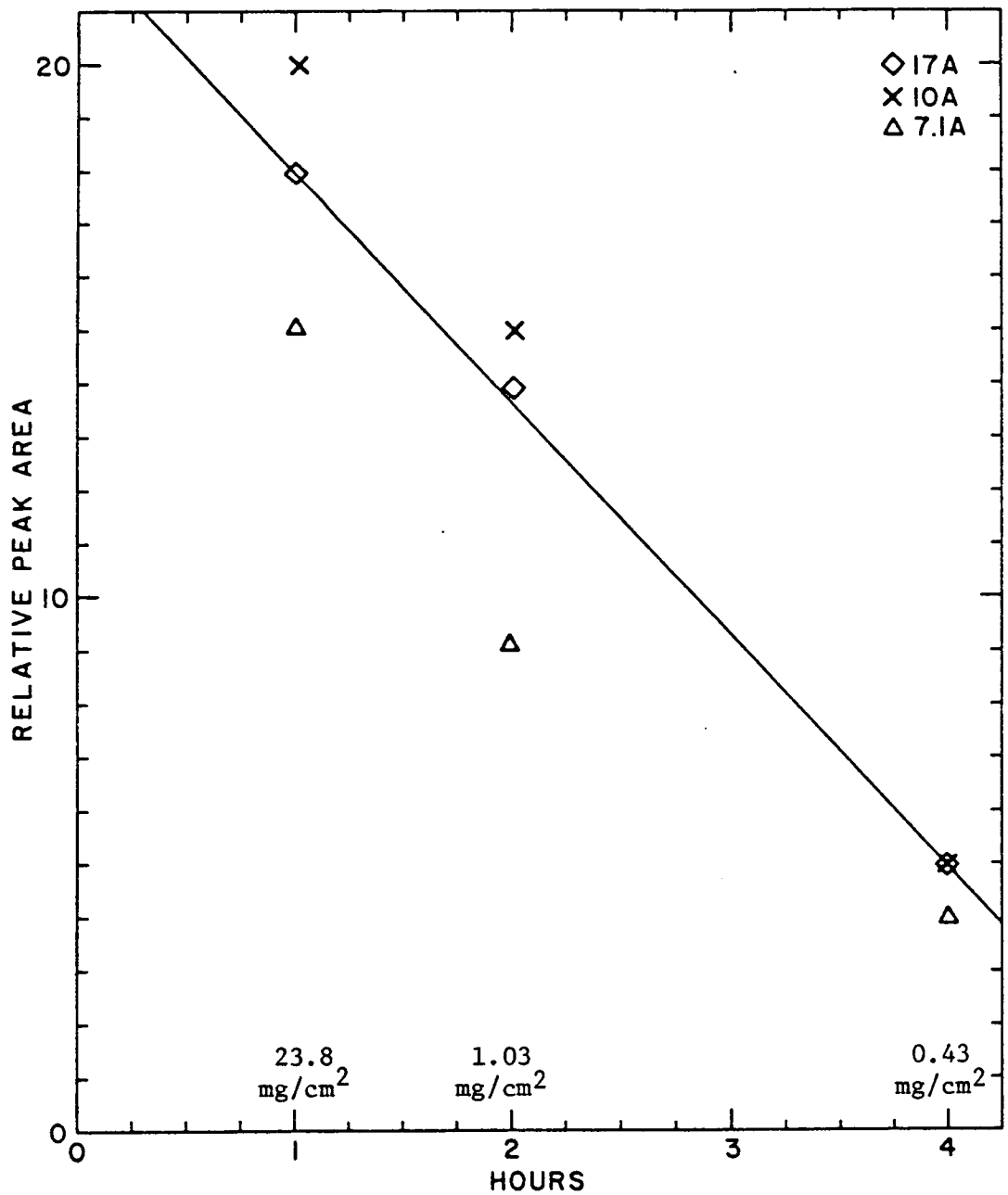


Figure 51. Relative peak area versus settling time for different concentrations.

Trace Metal Content

by

Steven S. Barnes

During the second year changes were made in both the laboratory and the sampling procedures to improve the quality of the data and to provide a more nearly synoptic view of the distribution of trace metals in the suspended sediments.

Sampling was done during November 1975 and May 1976. These two sampling periods were chosen to check on the seasonal variability of suspended sediment composition. The number of stations sampled was reduced to 11, and only top and bottom water samples were taken at each station. Data from the first year program indicated that this sampling pattern should be sufficient to establish an appropriate baseline and would also allow for a shorter total time period for sampling. Time is a very important parameter in sampling of suspended sediment, which varies considerably through time and space.

Methods

Filtration procedures on board ship were essentially the same as those for the first year except for minor modifications in apparatus. Half-gallon samples of water were placed in acid-prewashed polyethylene bottles, were frozen and returned to the laboratory to be used for mass determinations and total carbon analyses. A selected number of samples were also filtered on board for mass and total carbon analysis to check the effect of freezing and storage.

Mass determinations were made by filtering sea water (100 ml for November 1975 or 250 ml for May 1976) through a prewashed, dried, and weighed 0.4 μm

NUCLEPORE filter. Deionized water was forced through the filter behind the sample to remove salt. The sample was then dried over magnesium perchlorate dessicant and reweighed.

As for the first year of study, total carbon analysis was performed by a commercial laboratory (Galbraith Laboratories, Inc., Knoxville, Tenn.) on glass-fiber filter samples. These filter samples were prepared in the following manner. GELMAN type A-E glass-fiber filters with a nominal pore size of 0.6 μm (Feely, 1975) were ashed in a muffle furnace for 2 hours at 400°C. Two of these filters were placed one on top of the other in a vacuum filtering apparatus. Between 1.5 and 2.0 liters of seawater were then filtered. The sample was followed by 100 ml distilled water to remove salt. The filters were dried over magnesium perchlorate dessicant, placed in petri dishes and sealed in polyethylene bags to be shipped to the analytical laboratory for analysis. Particulate carbon was taken as the difference between the carbon values for the two filters, as the top filter should retain the particulate carbon plus some dissolved carbon adsorbed on the glass fibers, and the bottom filter should only contain adsorbed dissolved carbon (Feely, 1975).

Modifications in the trace metal analysis procedure were made to reduce the possibility of contamination. The number of transfers was reduced, and the lucite cups used to hold samples prior to shooting on the atomic absorption spectrophotometer were eliminated. The samples are currently held in teflon beakers. These changes resulted in an acceptable blank. Differences were particularly notable in the zinc content, where the average amounts were two orders of magnitude lower in the second year than in the first year.

Summary and Conclusions

The results of the analyses for the two suites of samples collected during the second year plus those for the first year are listed in table 1.

TABLE 1

Amounts of trace metals in suspended sediments

	11/74	11/75	5/76	Manheim (Gulf of Mexico)	Spencer & Sachs (Gulf of Mexico)	Feely (Gulf of Mexico)	Chester Stover (Atlantic and Indian Oceans)
				Pb			
High	449	272	3350	975			
Low	7	10	20	14			
Mean	115	77	362	186			58
				Cd			
High	100	39.8	45.1	243			
Low	0.1	0.1	0.2	2			
Mean	5.9	3.2	7.2	42			
				Cu			
High	3410	4520	480	898	387		
Low	5	ND	ND	17	34		
Mean	359	217	57	285	236		107
				Ni			
High	4470	268	1828	3609	71		
Low	13	ND	ND	ND	4		
				V			
High	57.0	130	64.8	57			
Low	0.2	ND	ND	ND			
Mean	10	47	17.2				63
				Mn			
High	6910	1420	862		5600		
Low	16	59	29		500		
Mean	797	598	308		2600		529
				Cr			
High	3260	468	81.6				
Low	10	ND	3.1				
Mean	233	73	22				
				Zn			
High	63,400	2970	2070		490		
Low	51	ND	32		114		
Mean	3,100	187	429		235		

	11/74	11/75	5/76	Manheim	Spencer & Sachs	Feely	Chester Stover
				Fe %			
High	6.8	5.88	1.38	4.8	7.7		
Low	0.10	.09	.05	.10	0.1		
Mean	1.77	1.91	.63	.91	4.1	1.85	
				C %			
High		8.3	23.7				
Low		ND	1.8				
Mean		2.8	7.0			44	17
				Total particulate mg/l			
High	22.2	22.2	8.8	1.8	3.7	.09	
Low	0.7	0.7	0.2	.05	.2	.009	
Mean	5.8	4.5	1.8	0.2	1.0	.02	

Also included for comparison are analytical results taken from pertinent literature. The only major anomaly in the data is the one previously noted for zinc. However, an examination of the data station by station reveals that some random contamination probably still occurred. Overall, the data appear to be of sufficient quality to establish a baseline for trace metals in suspended sediments.

The listing of elements according to the amounts in top versus bottom samples in the first year was born out by the analytical results for the second year (table 2). Manganese and iron were definitely enriched in bottom samples compared to top samples. Vanadium showed slightly higher values in bottom waters, but the remainder of the elements had higher average values in the surface samples.

Seasonal variations in the amounts of trace metals in the suspended sediments were indicated by the data collected for the second study year. The differences averaged seasonally for all stations are summarized by table 2. Amounts of cadmium, lead, and total particulate carbon were higher in May than in November. Zinc also fits this pattern if the two extremely high surface values in November 1975 are discounted as being contaminated. The amounts of the other elements were larger in the November samples. The amount of suspended sediment also was larger in November than in May. (Compare figures 52 and 53.) From the data, it appears that manganese, iron, vanadium, chromium, nickel, and copper are associated with the inorganic fraction of suspended sediments. Cadmium, lead, and zinc, on the other hand, appear to be associated with the total particulate carbon. Bostrom and others, (1974) showed that when compared with shale, plankton showed higher concentrations of lead, cadmium, zinc, and copper; nickel, iron, manganese, and vanadium were present in approximately the same proportions in both types of materials. With the exception of nickel,

TABLE 2

Seasonal averages of the amounts of trace metals in suspended sediments

Season	Sample	Mass mg/e	Cd	Cr	Cu	Ni	Pb	Zn	V	Mn	Fe%	C%
Nov. 1975	Top	2.53	6.0	142	505(103)*	85	142	537(123)**	39	209	1.8	3.4
	Bottom	6.43	2.5	67	99	71	78	101	52	758	2.4	2.3
May 1976	Top	0.82	10.5	30	94	53	622	513	18	170	0.5	9.6
	Bottom	2.85	4.0	14	19	25	102	345	16	436	0.7	4.4

All units in ppm unless otherwise designated.

* The value in parentheses is the average when one extraordinarily high value is disregarded.

** The value in parentheses is the average when two extraordinarily high values are disregarded.

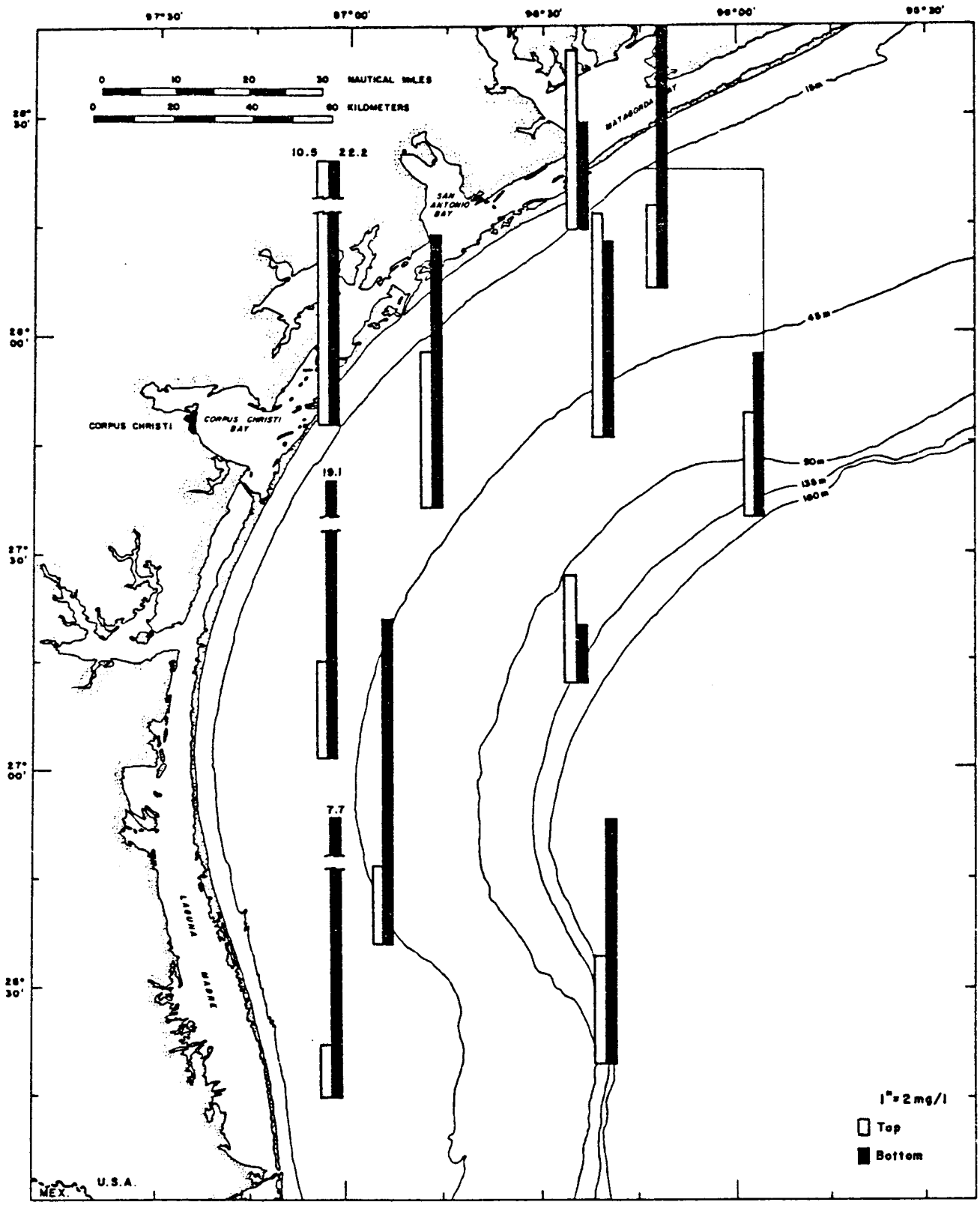


Figure 52. Total suspended sediment, November 1975.

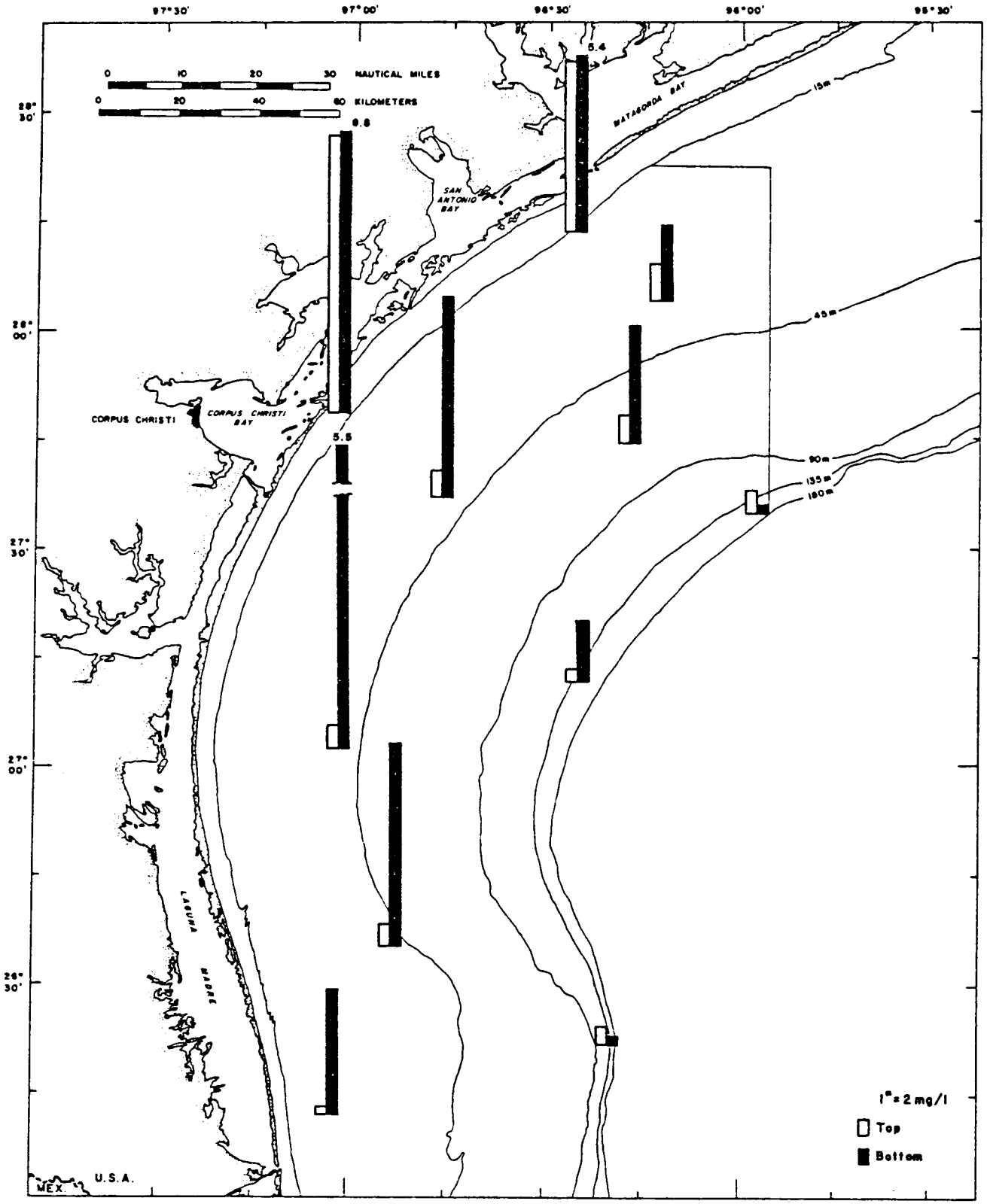


Figure 53. Total suspended sediment, May 1976.

chromium and copper, which fit the manganese/iron pattern, the data for the South Texas OCS follow the pattern obtained by Bostrom. The three metals, nickel, chromium, and copper, behave similarly, but the controlling factor in their behavior has not as yet been determined. Areal patterns of distribution for trace metals in suspended sediments reveal that the northeast section of the study area appears to have higher concentrations of some metals. Chromium, copper, and zinc are most notable, but lead and cadmium showed the same pattern during the November 1975 sampling period. This is essentially the same suite of metals that Bostrom and others (1974) found to be more concentrated in planktonic material than in shale. This is also an area of low total particulate concentrations and, therefore, one where the biological influence on metal concentrations could be of major importance.

Total particulate carbon concentrations are given in figures 54 and 55. The analytical results for each station, indicating the amounts of trace metals determined at each station in both surface and bottom water by season, are shown graphically by the series of maps, figures 56 to 73. The original data from which the graphs were drawn are presented in Appendix 3.

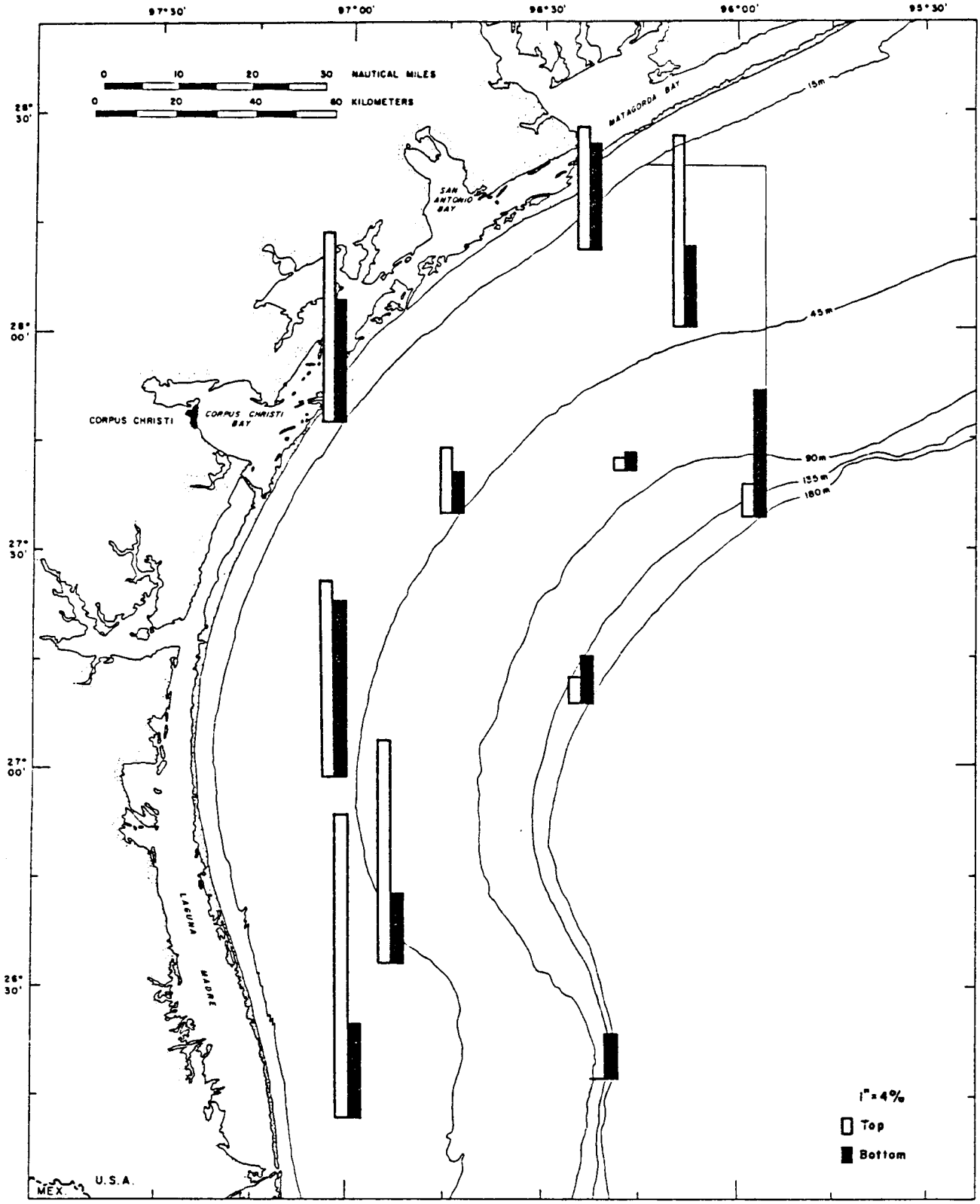


Figure 54. Total particulate carbon, November 1975.

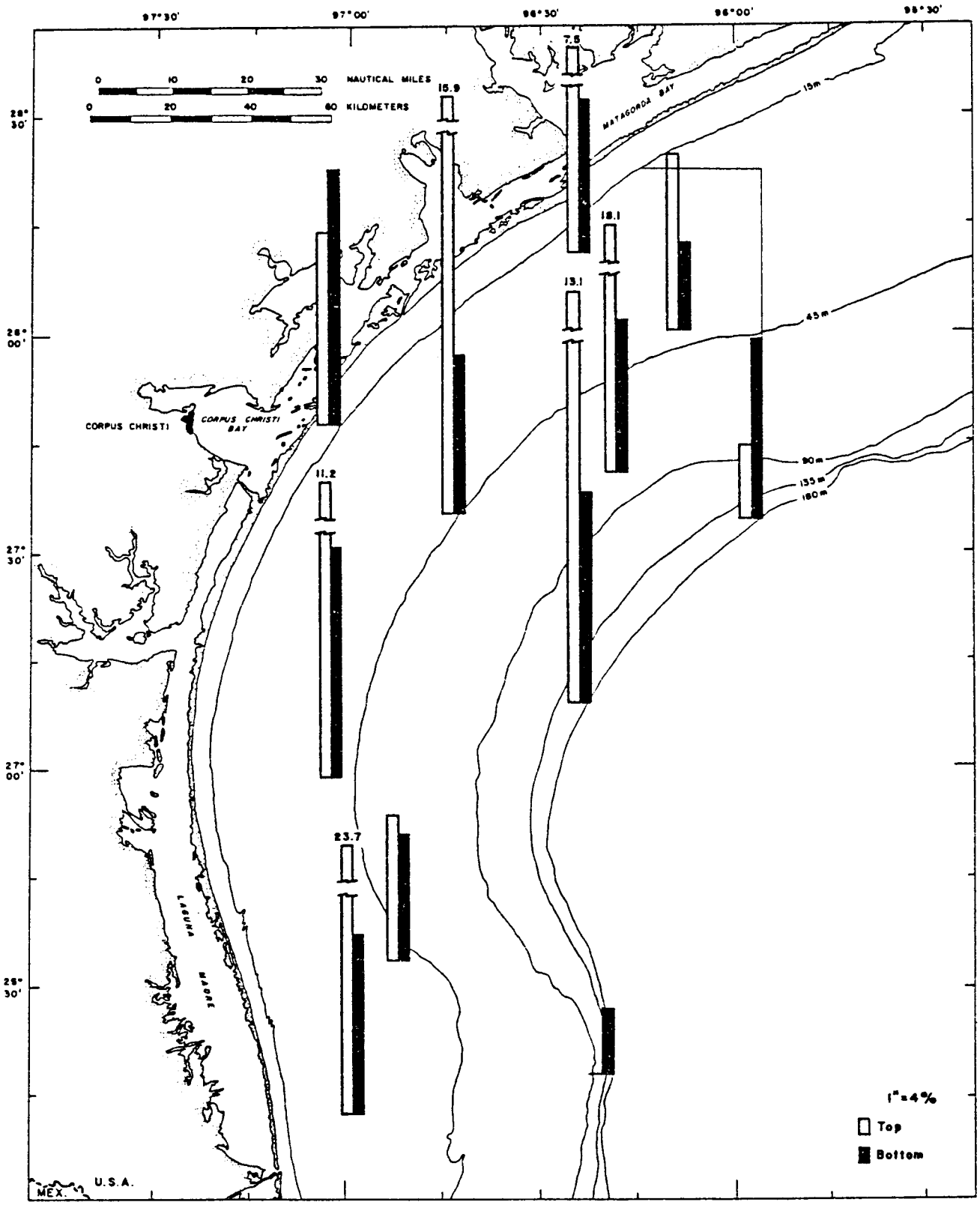


Figure 55. Total particulate carbon, May 1976.

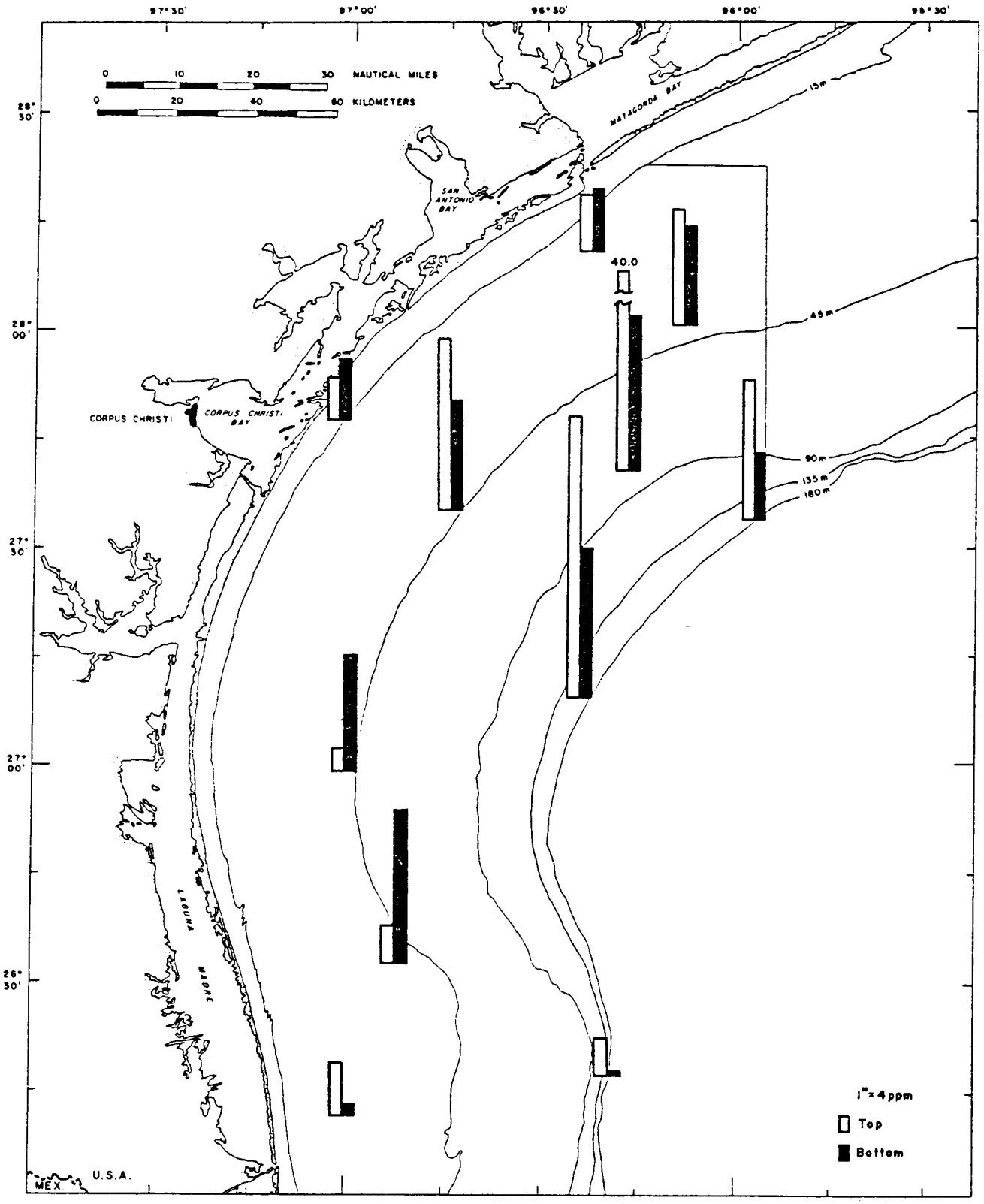


Figure 56. Amounts of cadmium in suspended sediments, November 1975.

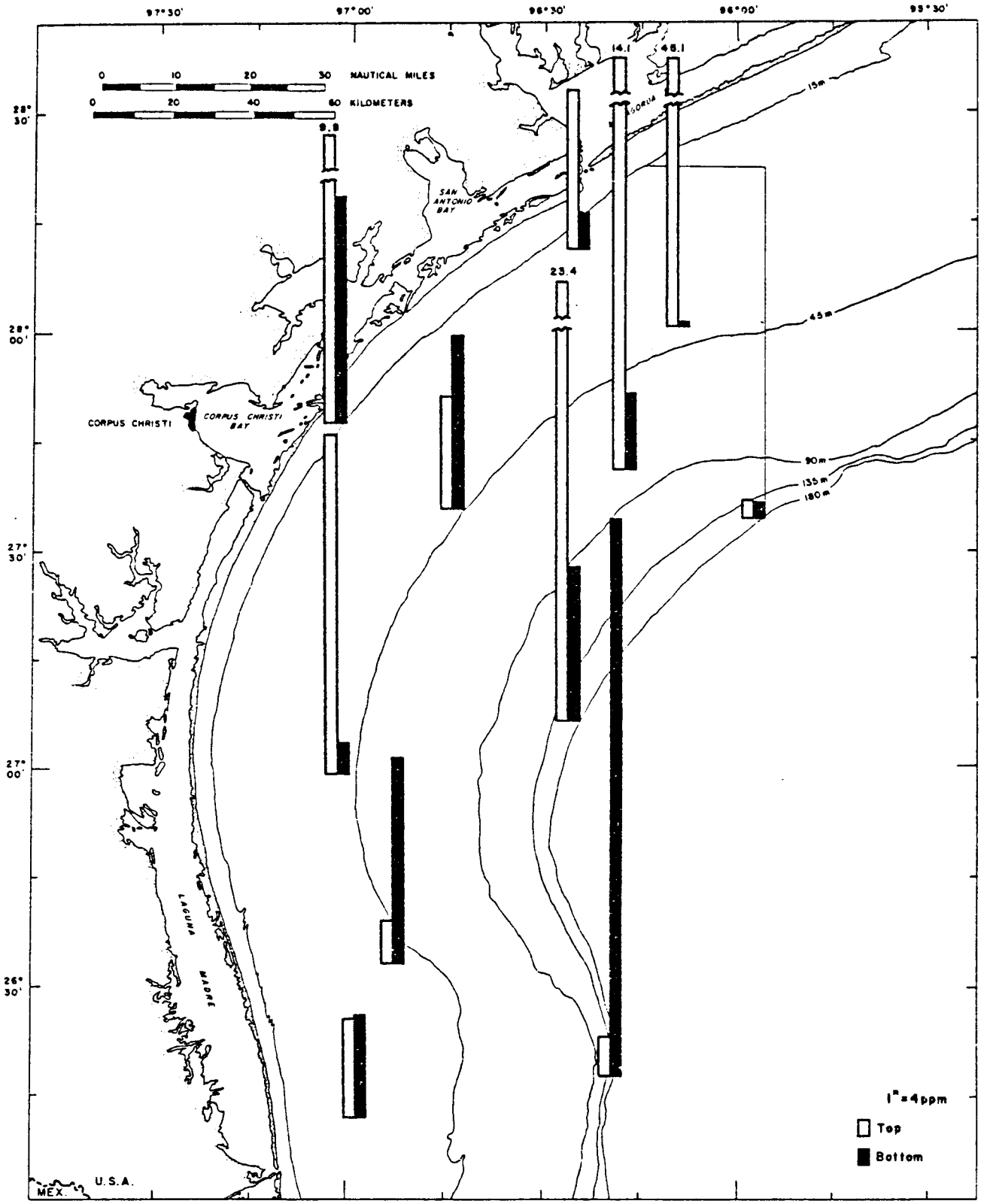


Figure 57. Amounts of cadmium in suspended sediments, May 1976.

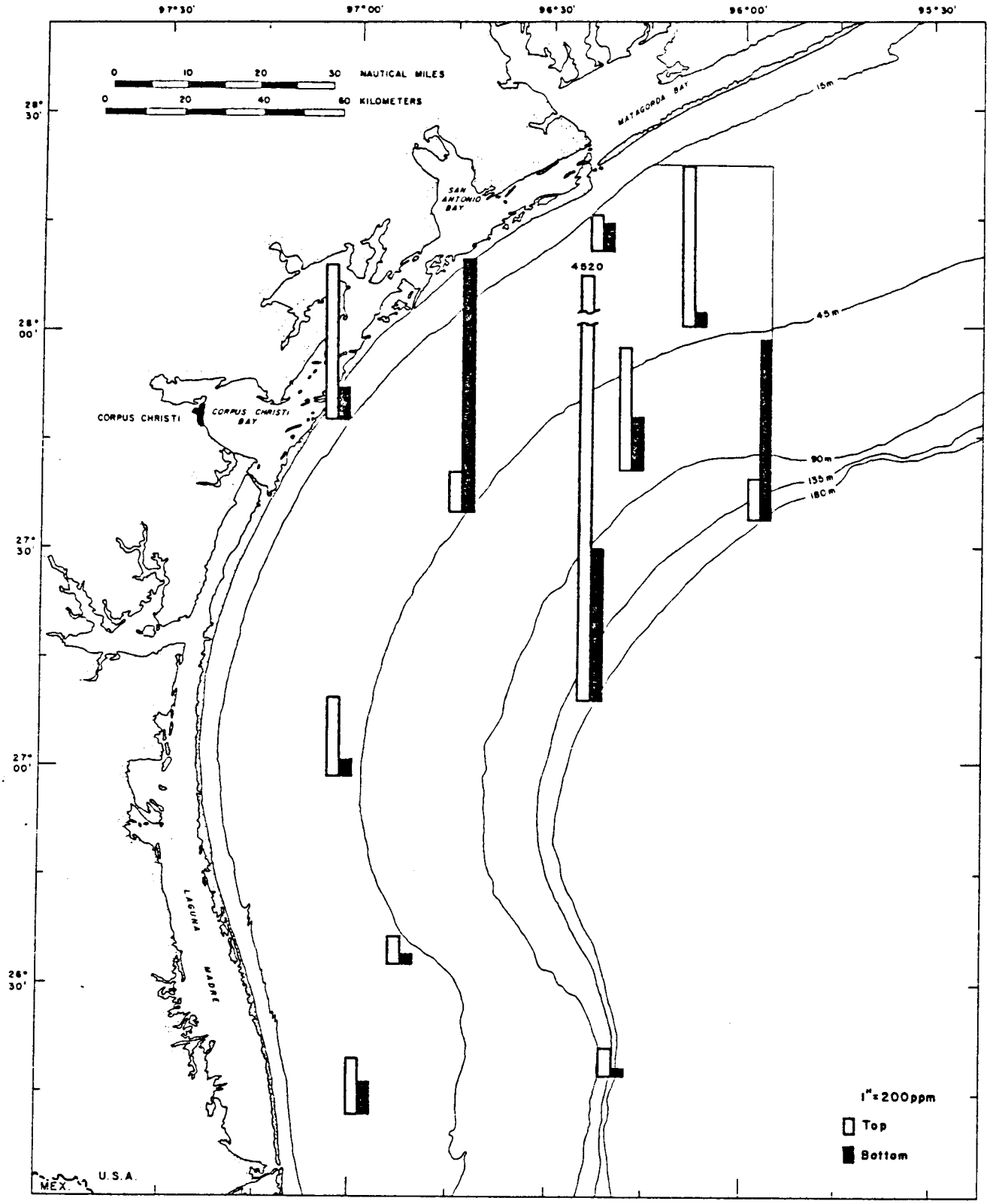


Figure 58. Amounts of copper in suspended sediments, November 1975.

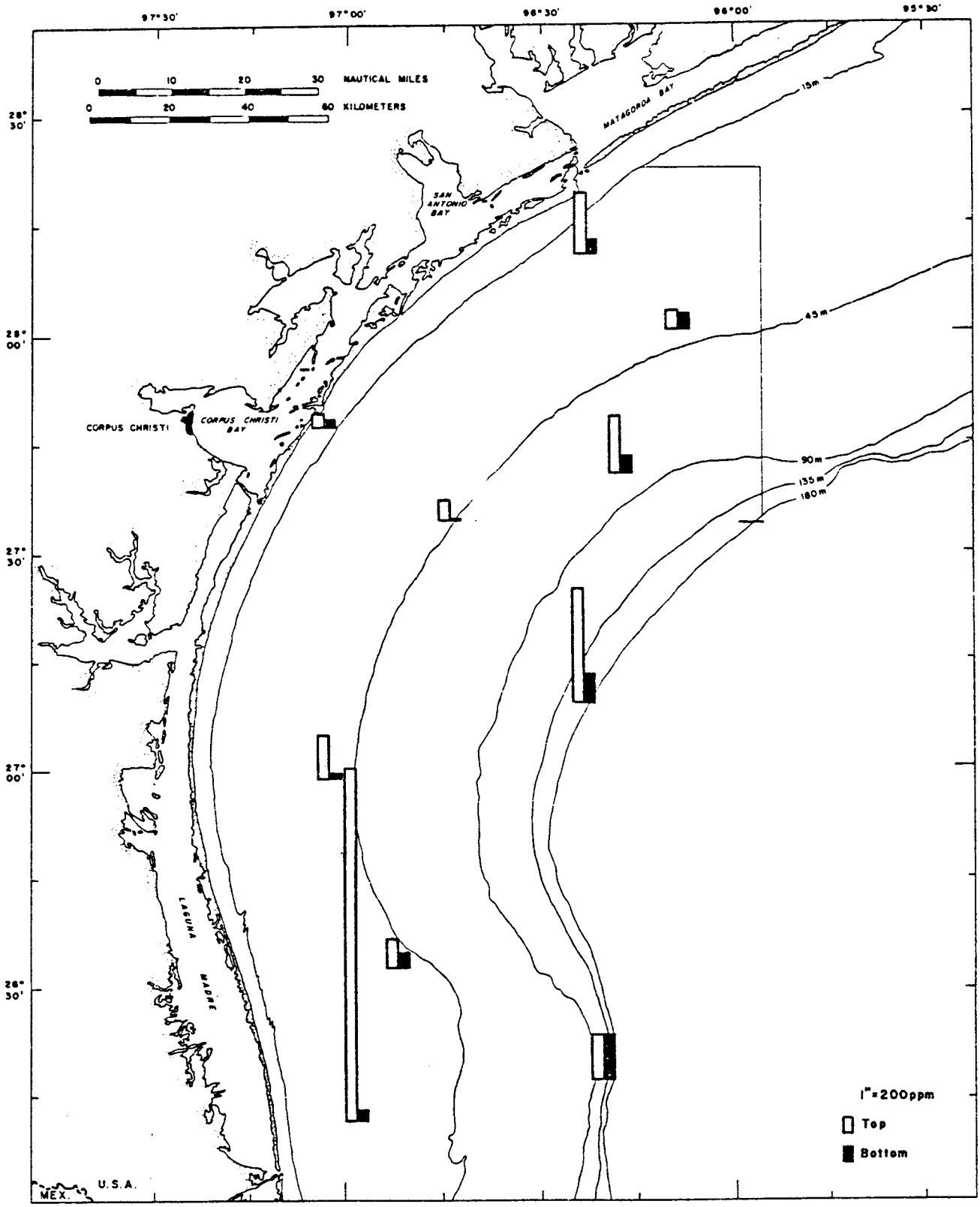


Figure 59. Amounts of copper in suspended sediments, May 1976.

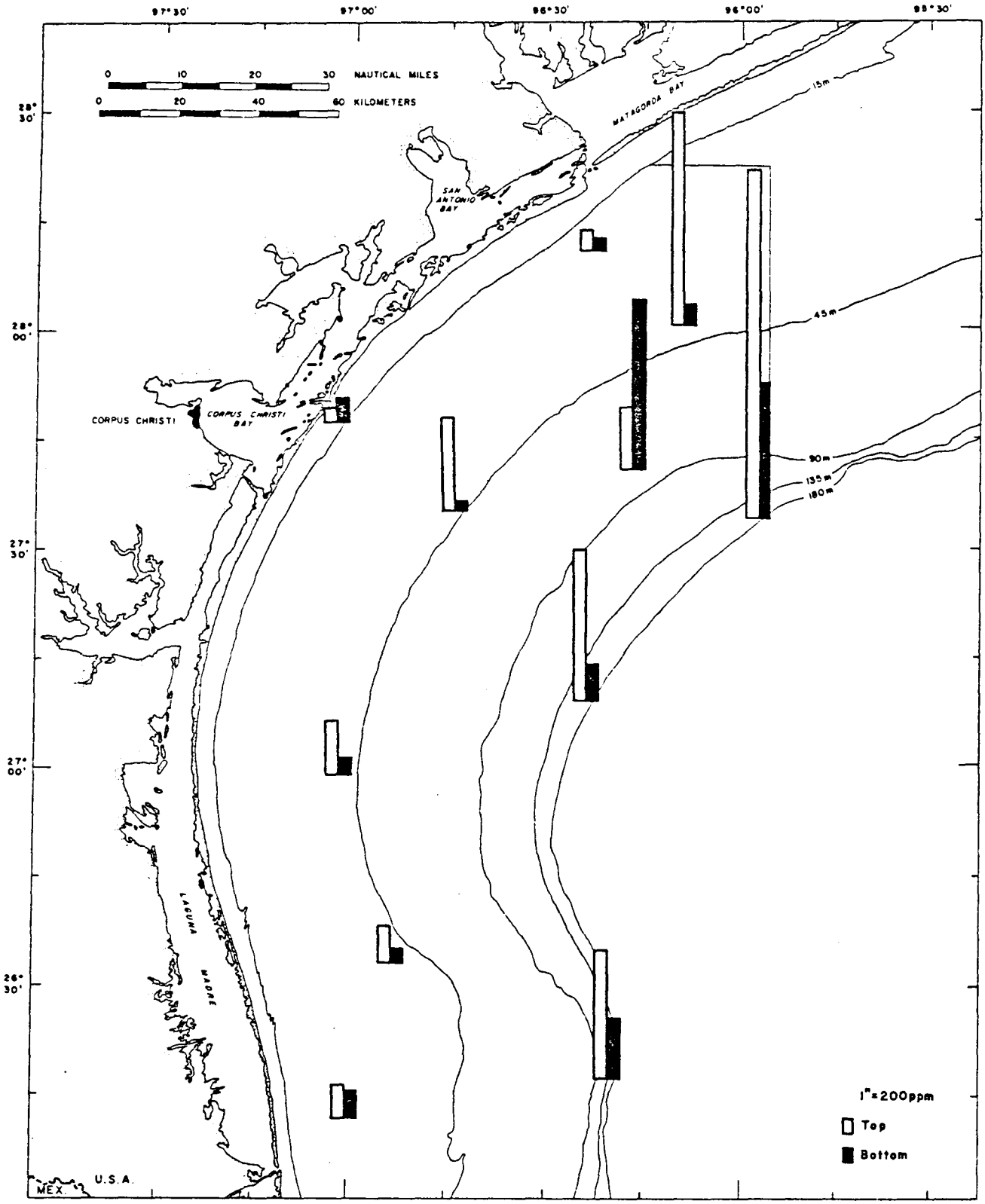


Figure 60. Amounts of chromium in suspended sediments, November 1975.

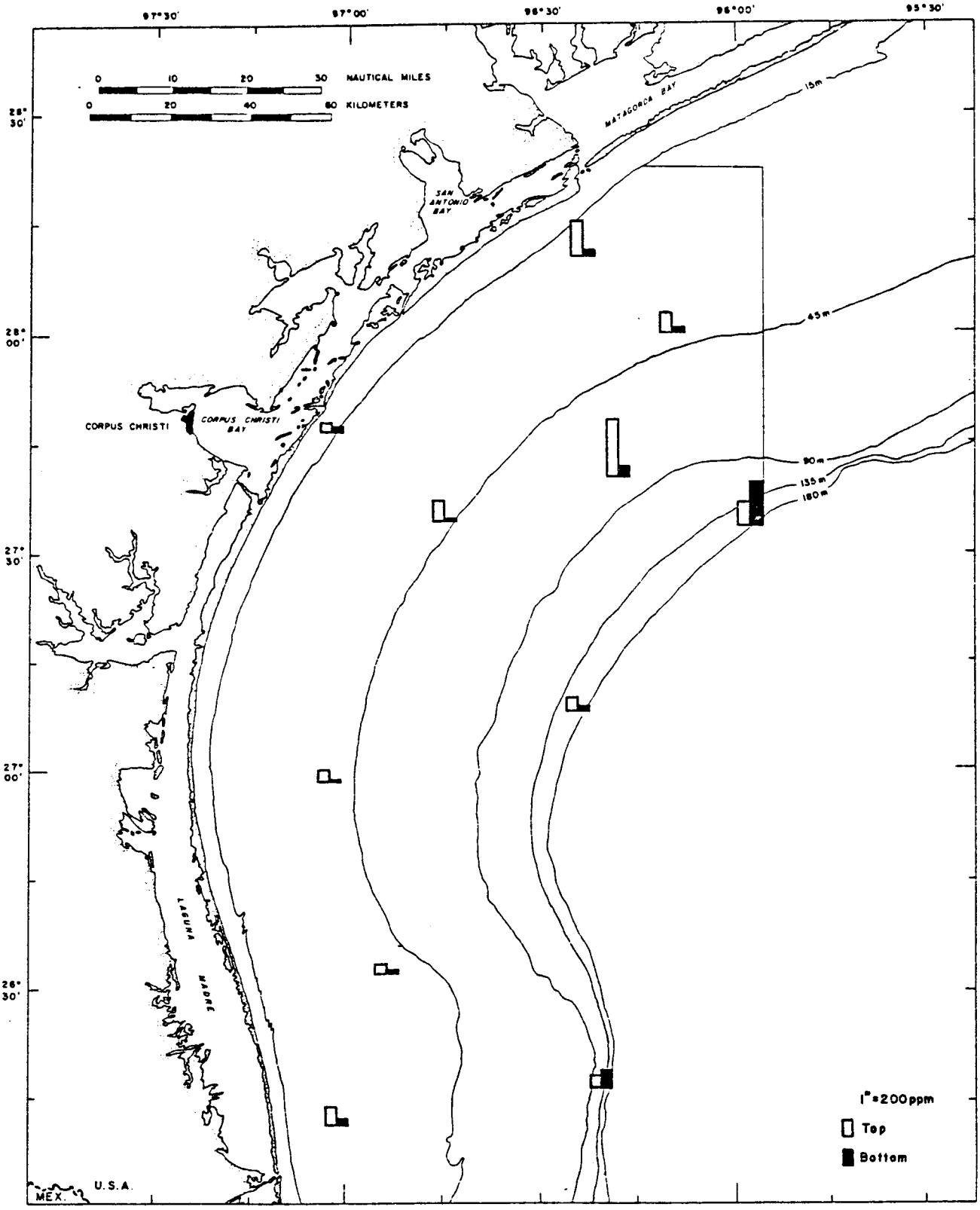


Figure 61. Amounts of chromium in suspended sediments, May 1976.

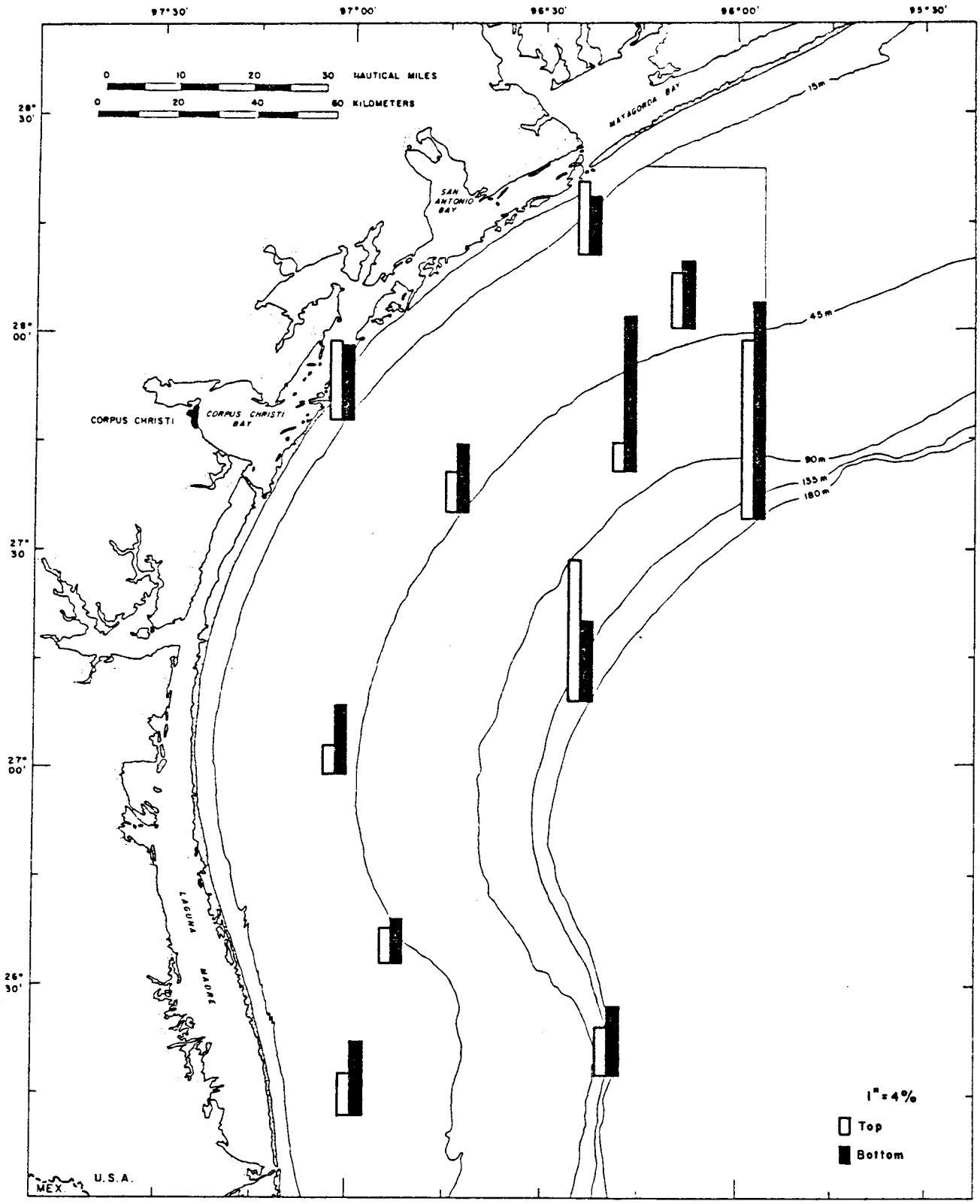


Figure 62. Amounts of iron in suspended sediments, November 1975.

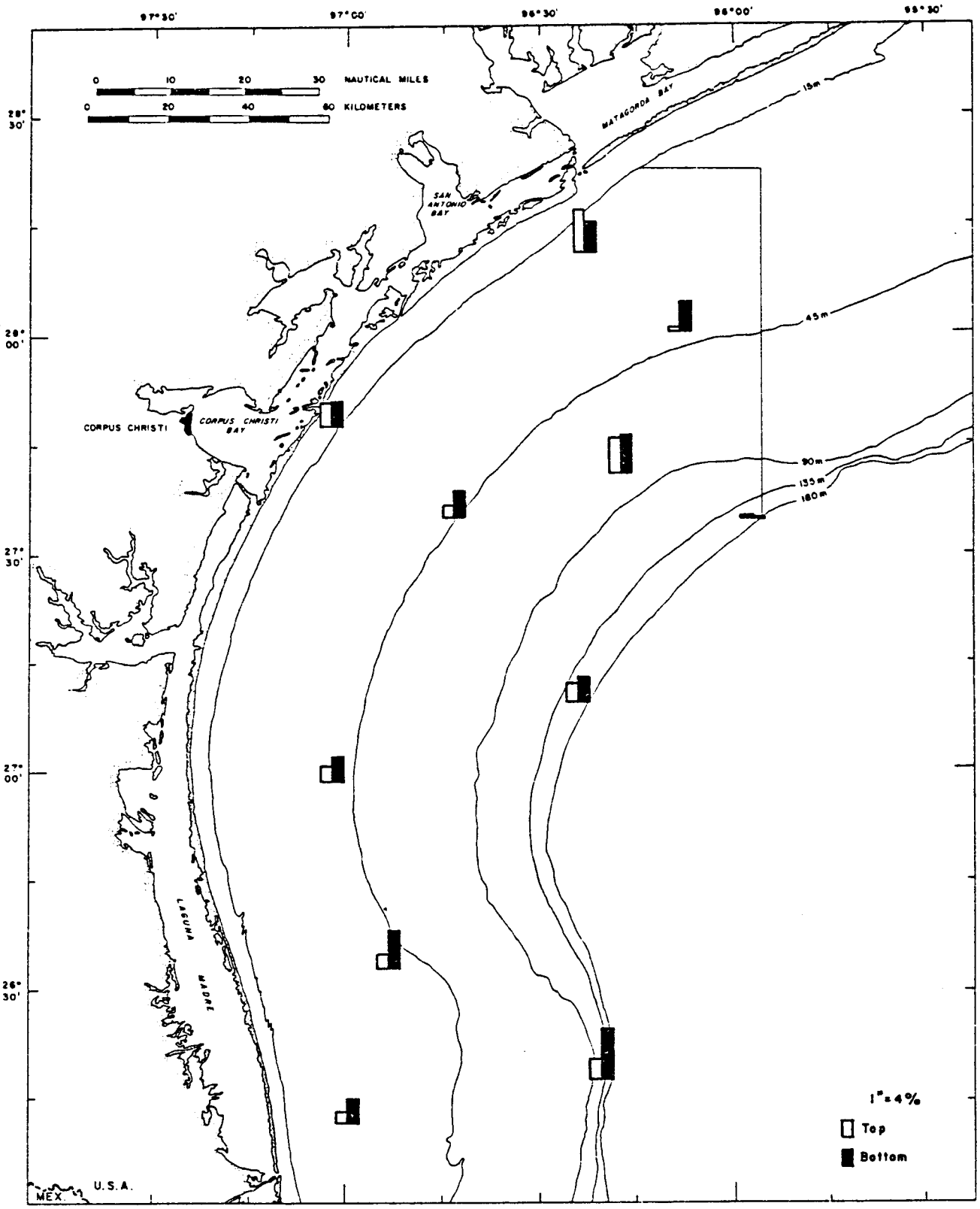


Figure 63. Amounts of iron in suspended sediments, May 1976.

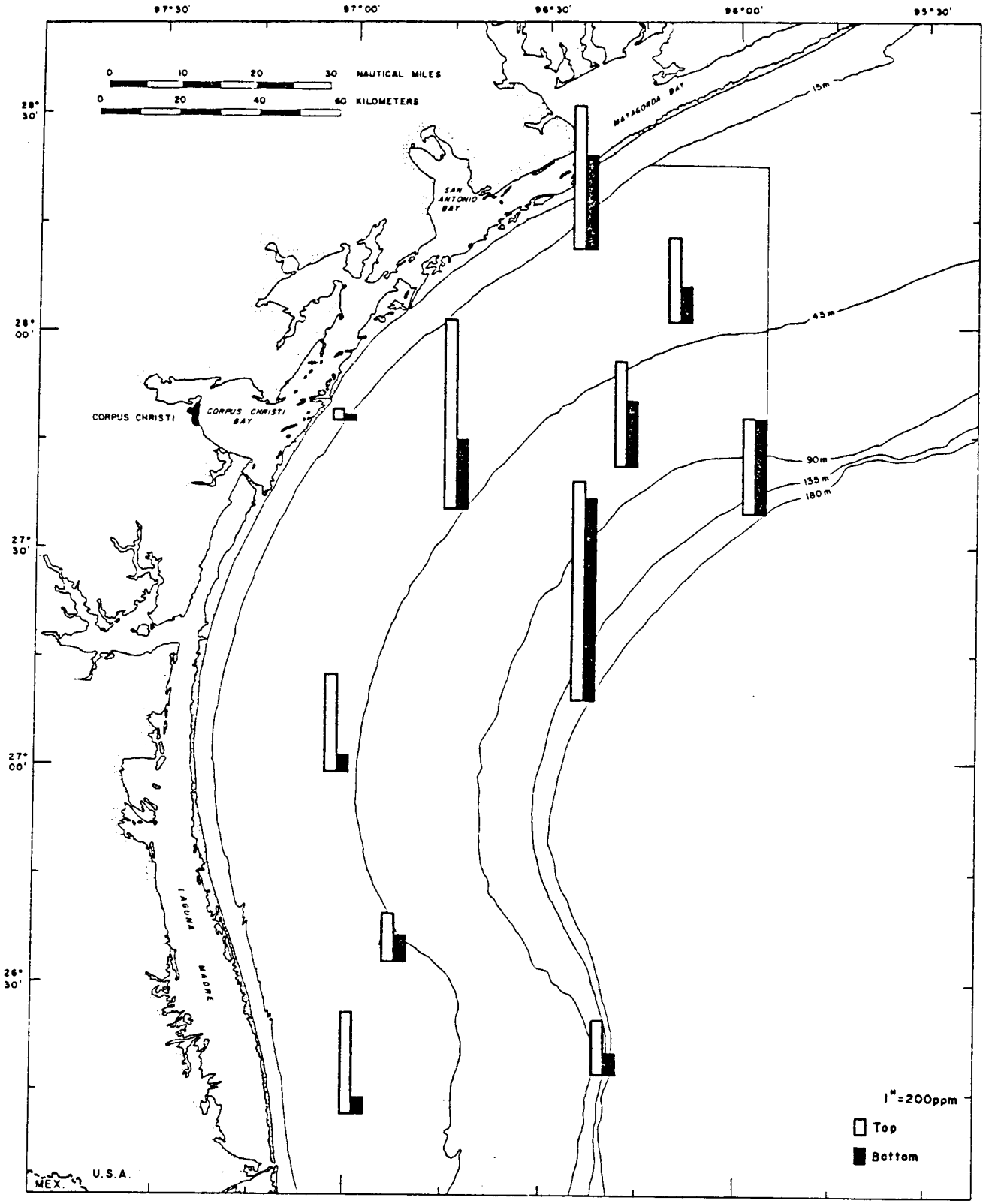


Figure 64. Amounts of lead in suspended sediments, November 1975.

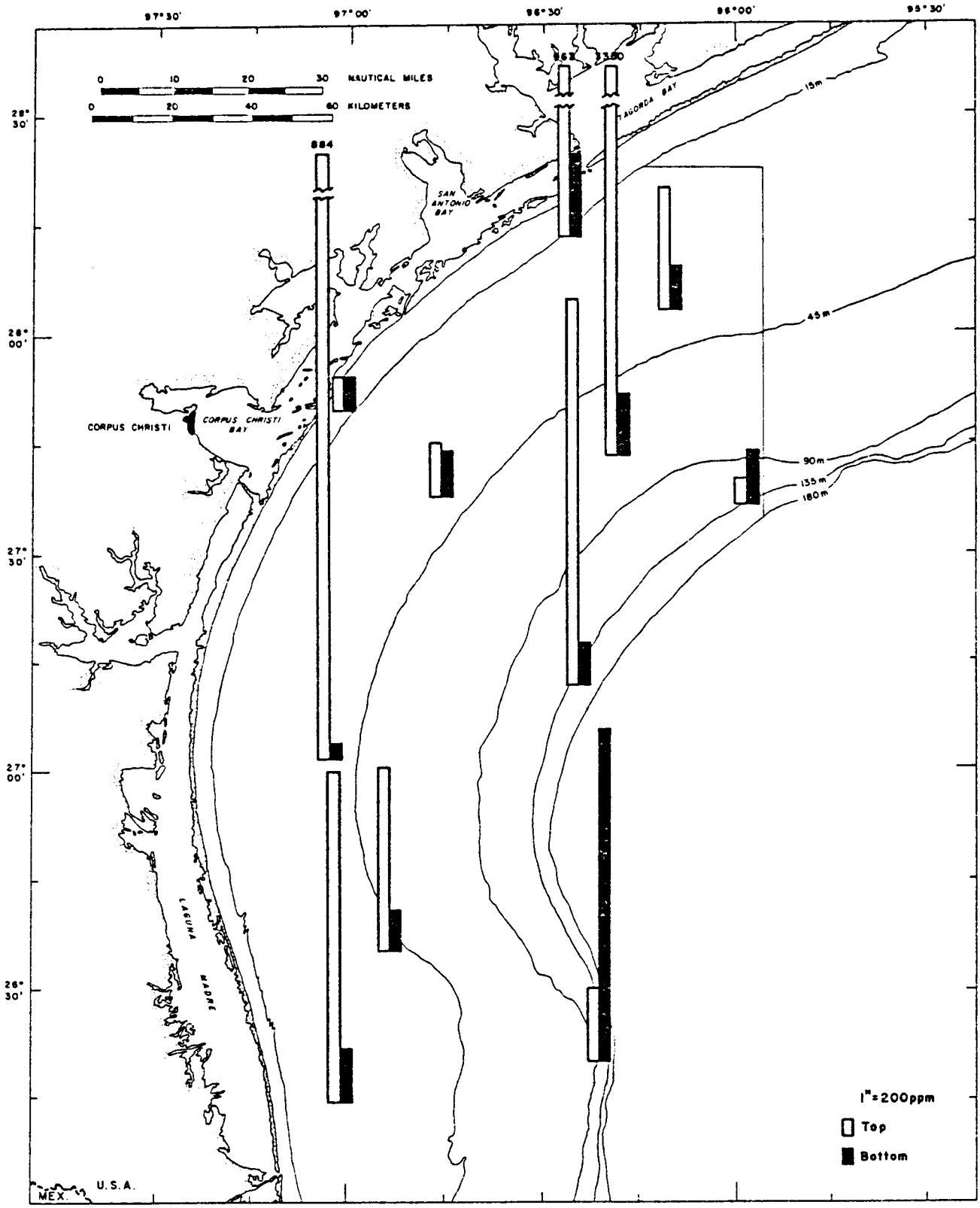


Figure 65. Amounts of lead in suspended sediments, May 1976.

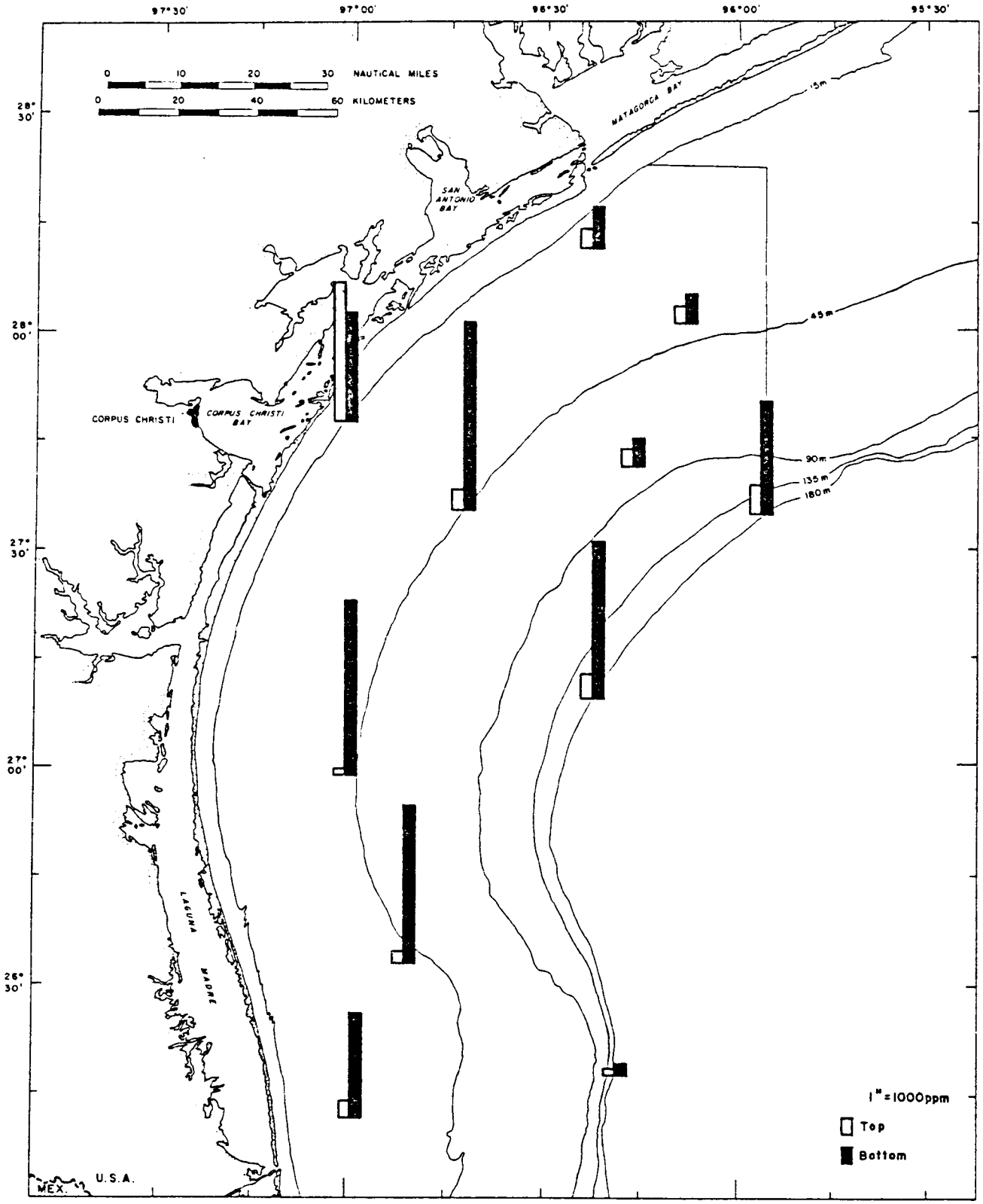


Figure 66. Amounts of manganese in suspended sediments, November 1975.

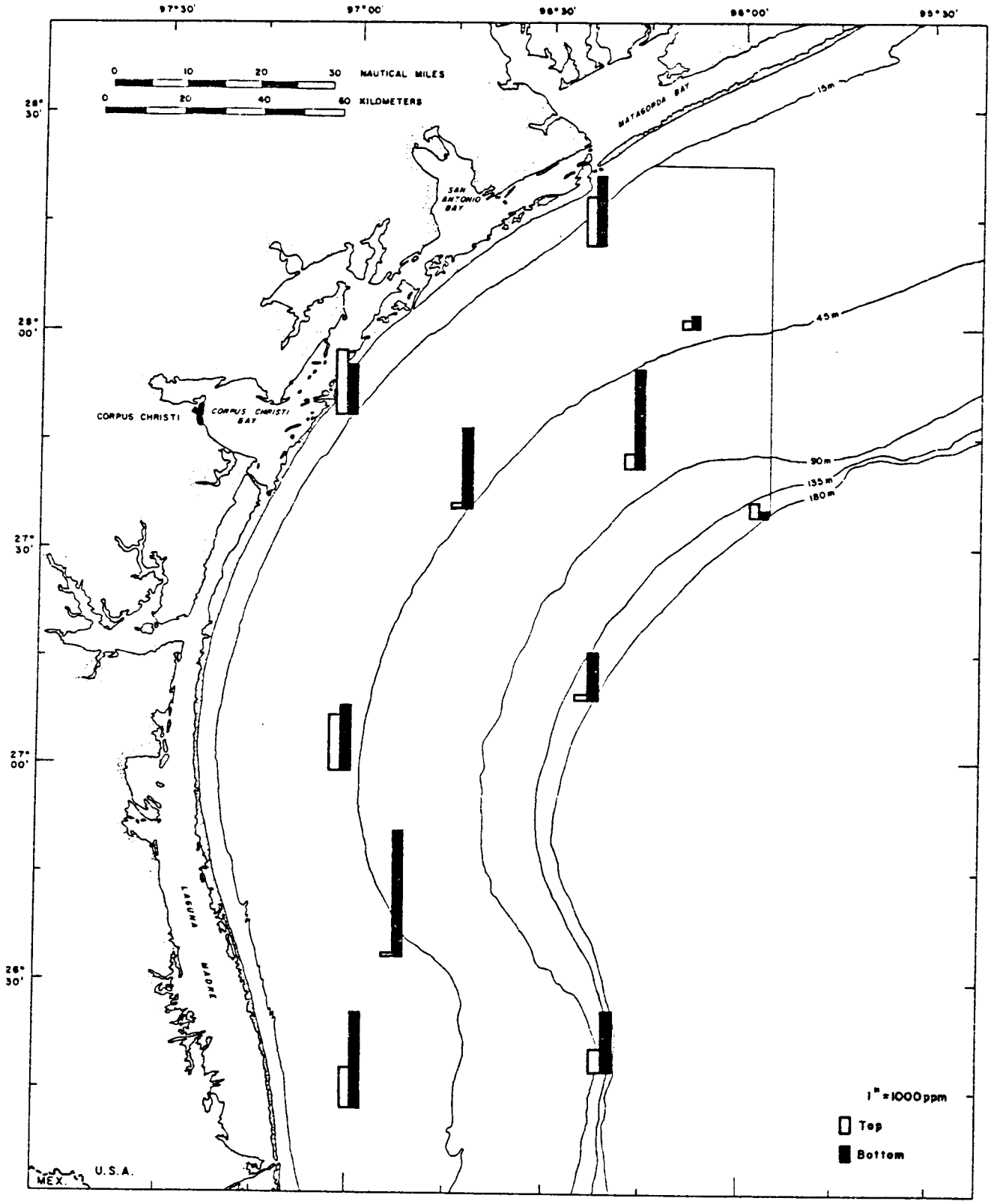


Figure 67. Amounts of manganese in suspended sediments, May 1976.

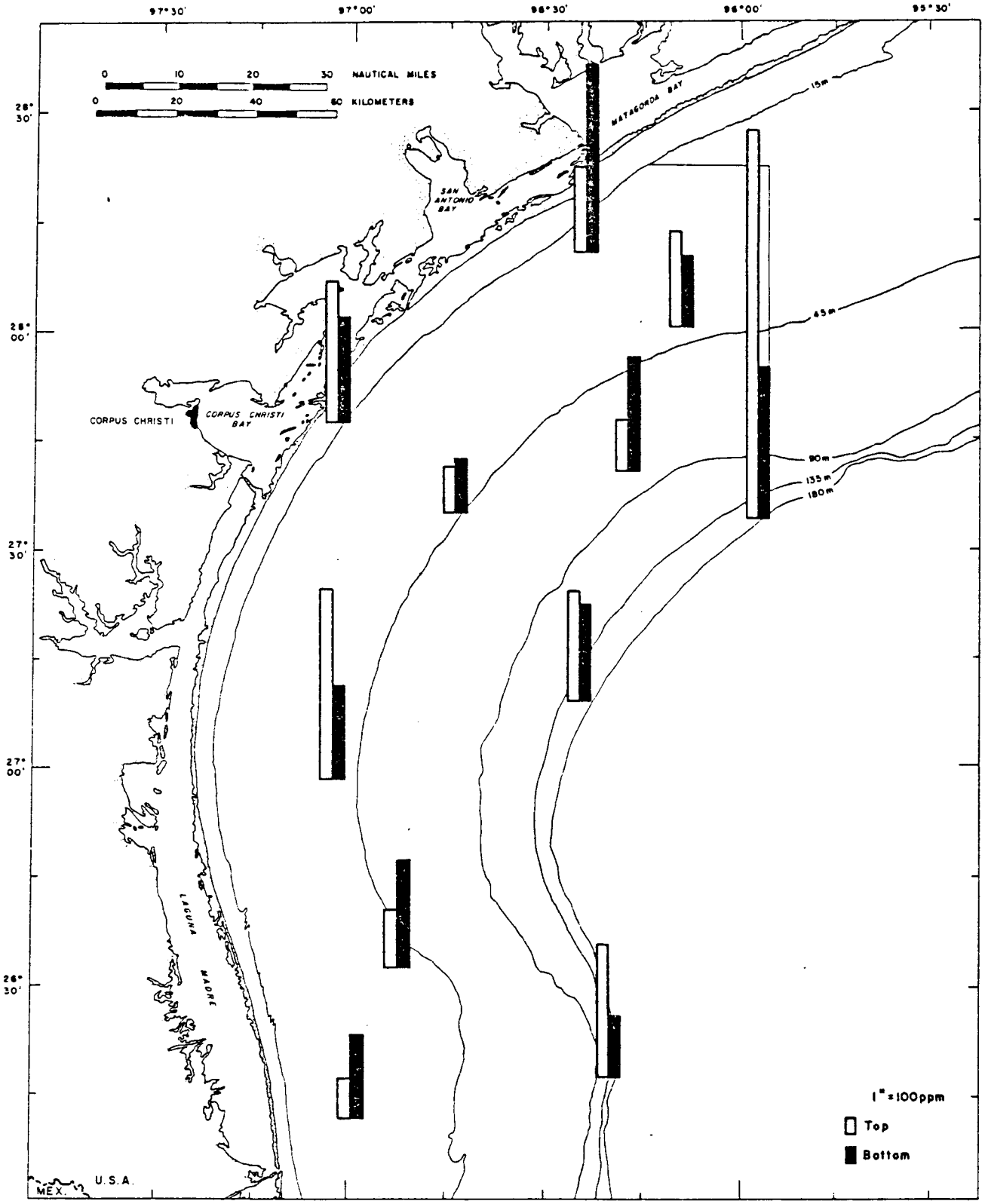


Figure 68. Amounts of nickel in suspended sediments, November 1975.

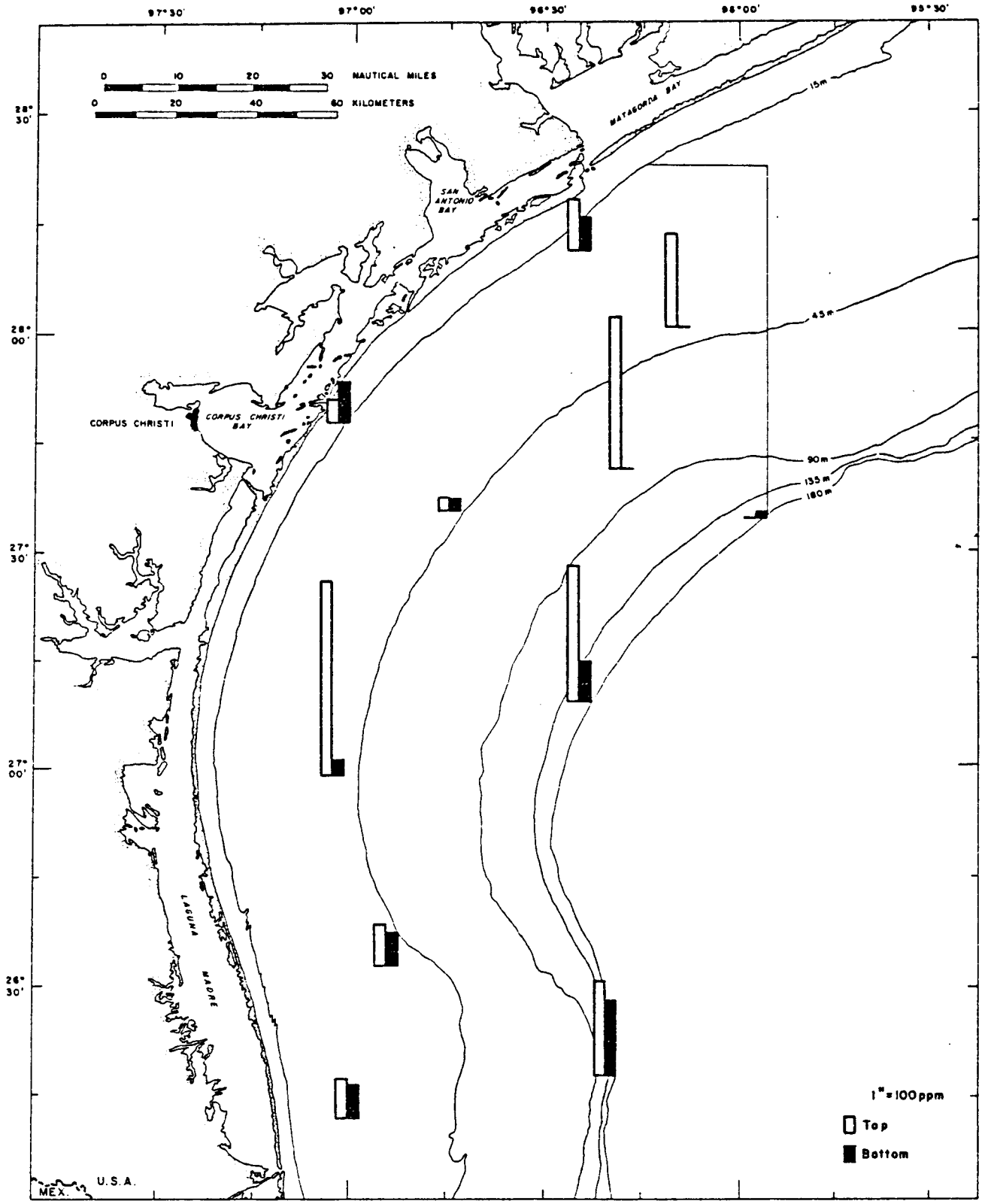


Figure 69. Amounts of nickel in suspended sediments, May 1976.

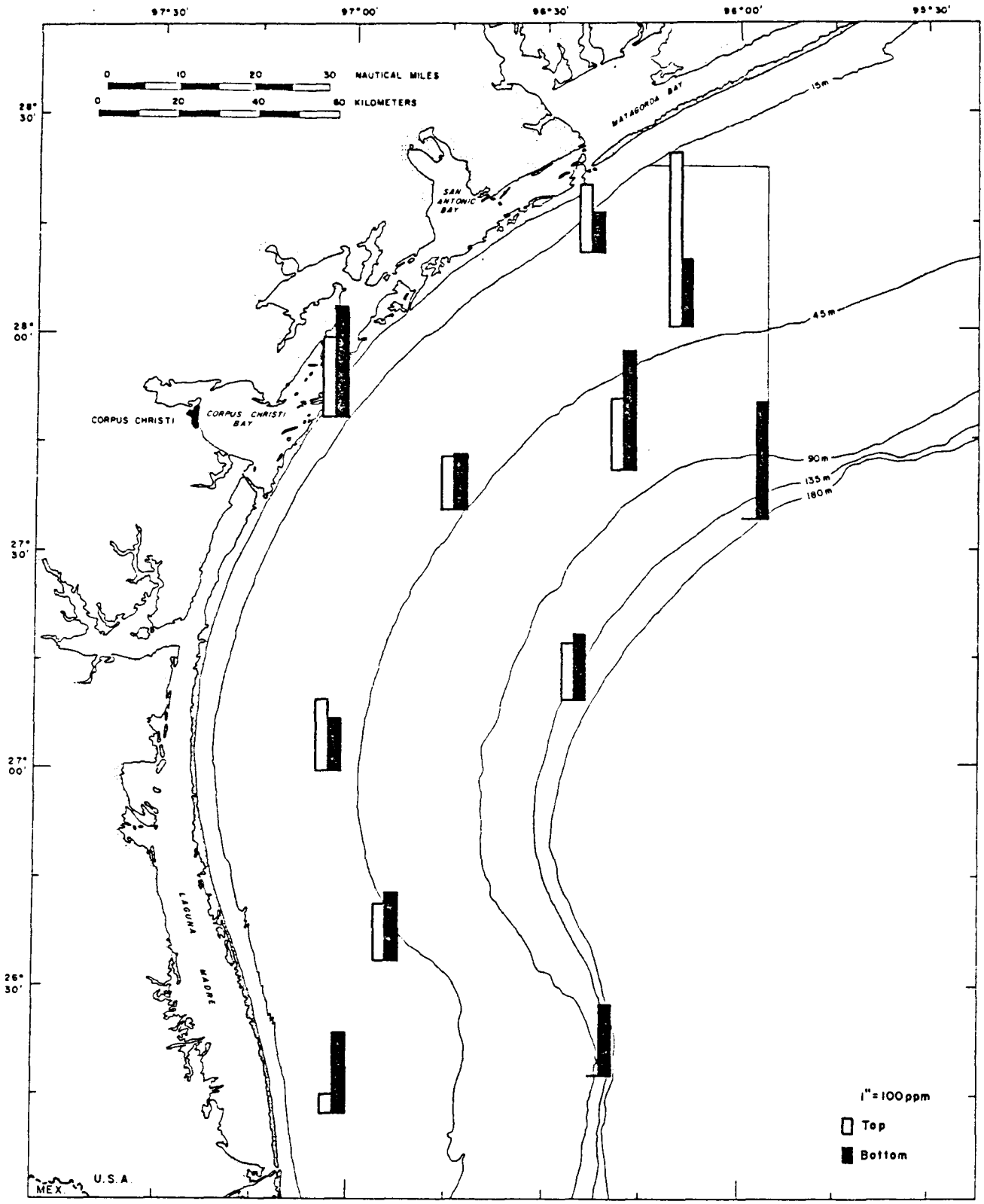


Figure 70. Amounts of vanadium in suspended sediments, November 1975.

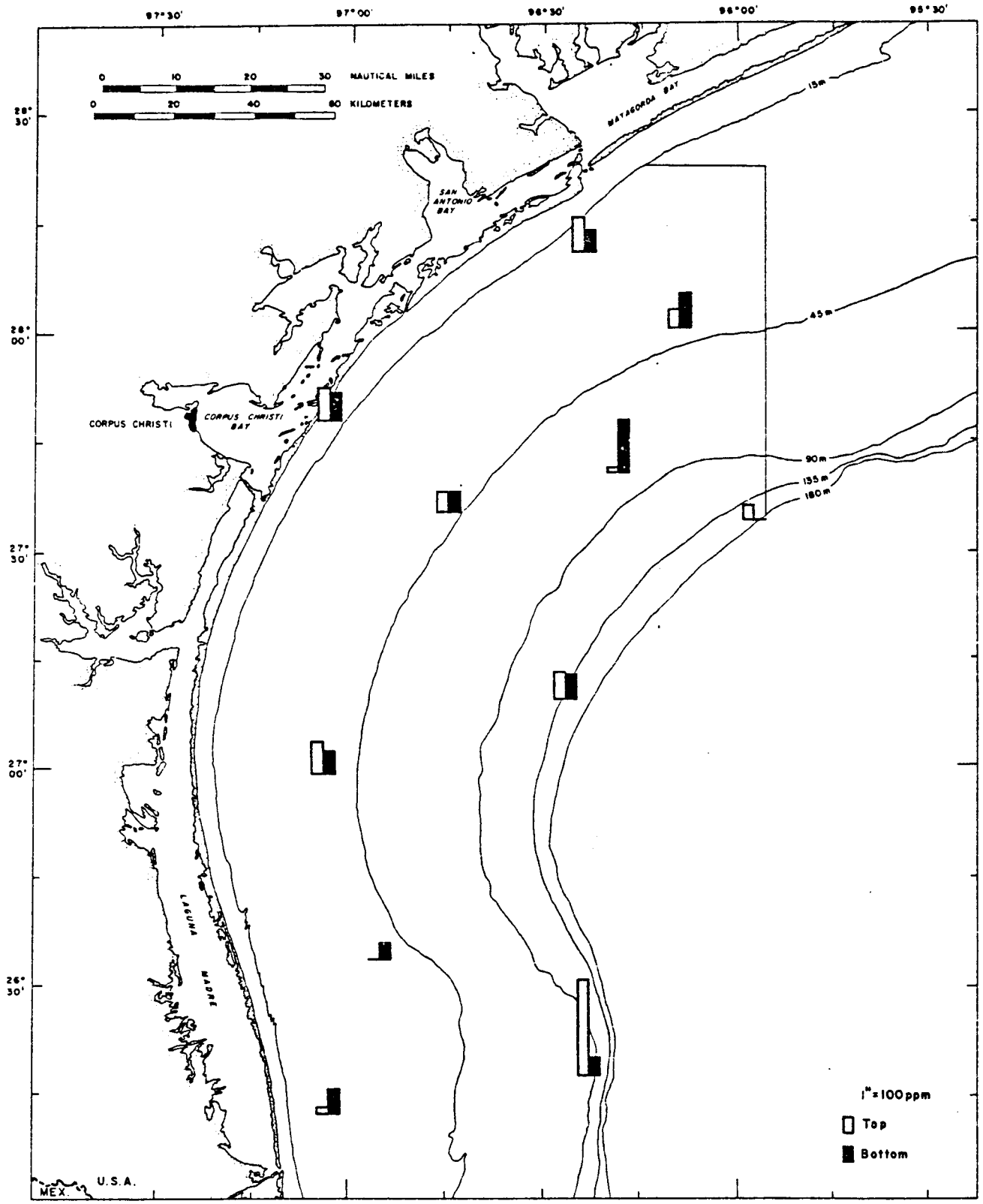


Figure 71. Amounts of vanadium in suspended sediments, May 1976.

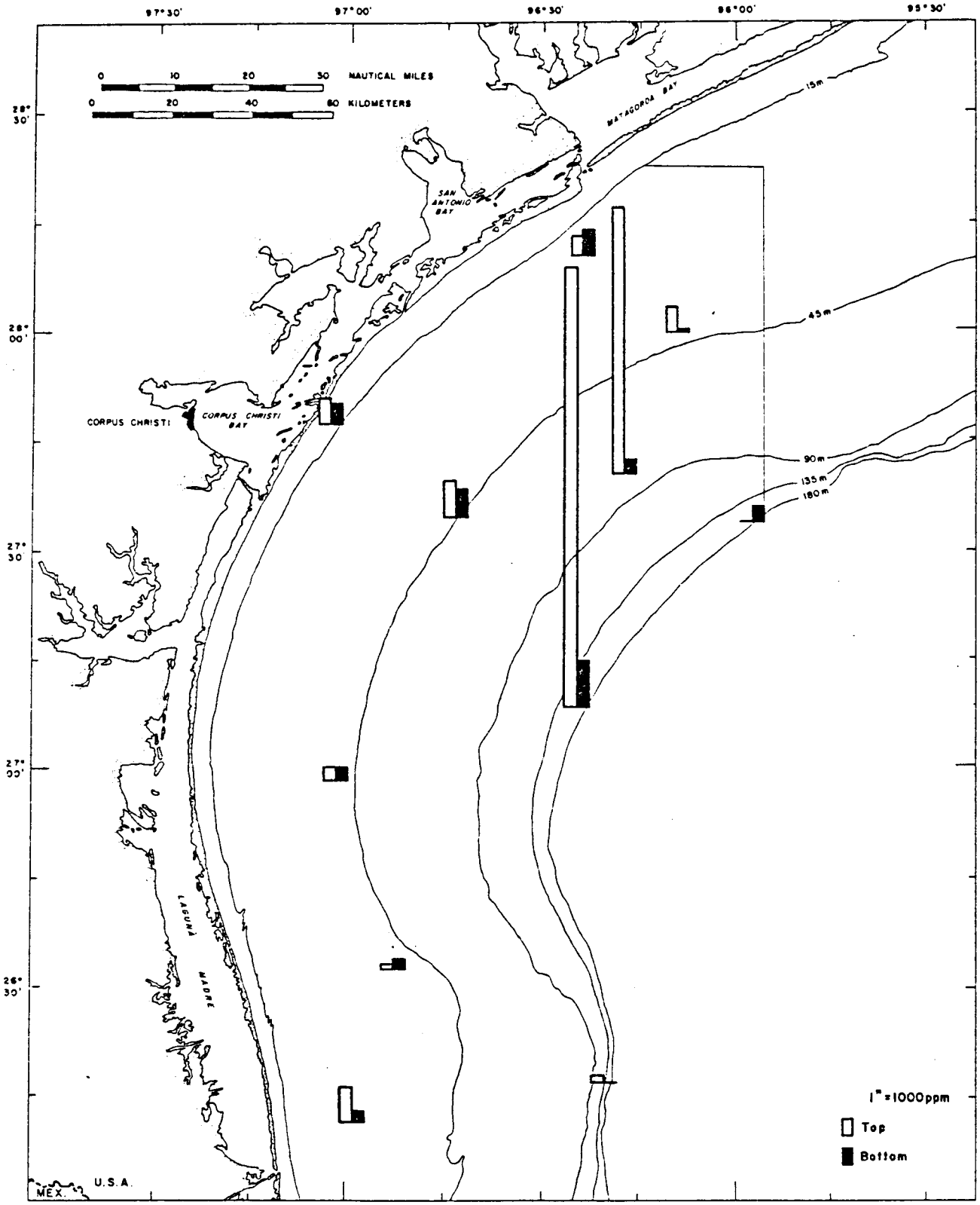


Figure 72. Amounts of zinc in suspended sediments, November 1975.

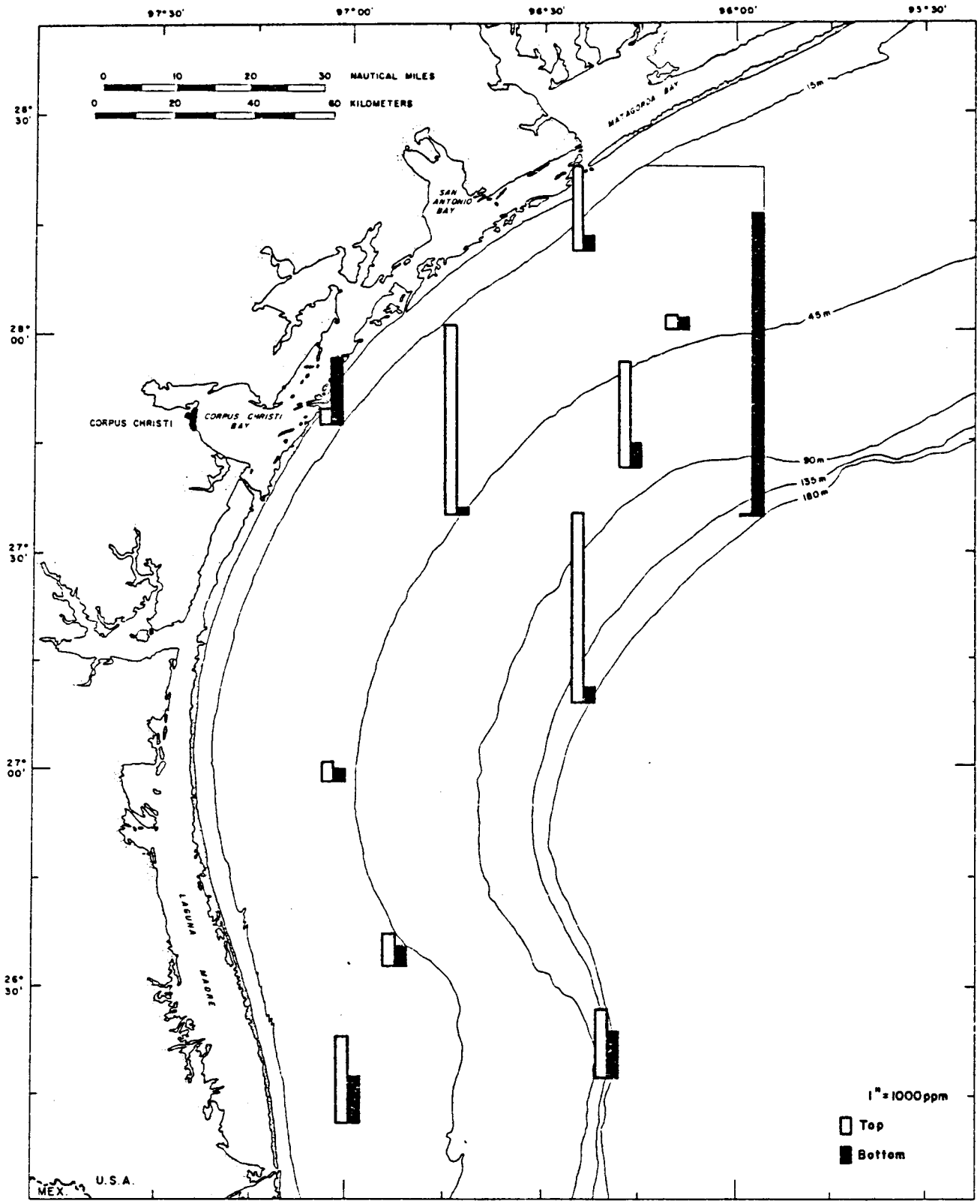


Figure 73. Amounts of zinc in suspended sediments, May 1976.

SEA FLOOR SEDIMENTS

PHYSICAL CHARACTERISTICS

Surface Sediments

by

Gerald L. Shideler

Studies of benthic sediments during 1976 included both continued evaluation of the 1975 baseline samples and textural analysis of samples collected in 1976 as part of the biological monitoring studies. Surficial grab samples obtained during the first year were studied in greater detail in order to provide further insight into regional sedimentary processes. The 1976 benthic surficial samples were studied to determine the seasonal variability of benthic sediment texture along four monitored transects, as supportive evidence for evaluating biological variability.

Linear Correlation Analysis

Selected textural parameters derived from the 264 grab samples obtained during the first year (1975) were subjected to linear correlation analysis in an effort to evaluate interrelationships among textural parameters that could provide further insight into sedimentary processes. A linear correlation analysis was performed on 12 textural parameters by computer, using a U.S. Geological Survey STATPAC program (D0101). Correlated textural parameters included the following: sand percentage, silt percentage, clay percentage, sand/mud ratio, silt/clay ratio, four moment measures (mean, standard deviation, skewness, kurtosis), median diameter, modal diameter and one-percentile values. The results of the correlation analysis are presented in table 3. Only those

Table 3 - Correlation Coefficients of Benthic Sediments (1975 Samples)

	1 Sand%	2 Silt%	3 Clay%	4 Sand/Mud Ratio	5 Silt/Clay Ratio	6 Mean Diameter	7 Standard Deviation	8 Skewness	9 Kurtosis	10 Median Diameter	11 Modal Diameter	12 One Percenti
1. Sand%	1.000	-0.875	-0.731	0.810	0.065	-0.936	0.703	0.620	0.529	-0.914	-0.732	-0.78
2. Silt%		1.000	0.311	-0.745	0.382	0.660	-0.665	-0.252	-0.337	0.636	0.434	0.69
3. Clay%			1.000	-0.542	-0.669	0.910	-0.443	-0.864	-0.565	0.901	0.828	0.55
4. Sand/Mud Ratio				1.000	-0.045	-0.744	0.366	0.423	0.476	-0.720	-0.504	-0.55
5. Silt/Clay Ratio					1.000	-0.358	-0.141	0.622	0.463	-0.346	-0.341	-0.01
6. Mean Diameter						1.000	-0.663	-0.771	-0.566	0.977	0.838	0.76
7. Standard Deviation							1.000	0.186	0.018	-0.598	-0.664	-0.85
8. Skewness								1.000	0.621	-0.824	-0.648	-0.27
9. Kurtosis									1.000	-0.558	-0.246	-0.37
10. Median Diameter										1.000	0.808	0.69
11. Modal Diameter											1.000	0.62
12. One Percentile												1.00

correlation coefficients exceeding an absolute value of 0.700 are considered to be significant.

As sand and mud are the two basic textural end members of the OCS sediments, percentages of sand are directly correlative with sand/mud ratios and inversely correlative with the percentages of silt and clay. Percentages of sand show significant inverse correlation with all three central tendency parameters (mean, median, mode), indicating decreasing Ø values (increasing average size) with increasing percentages of sand. These percentages correlate directly with standard deviation values, indicating poorer sorting with increased sand content. Larger amounts of sand also correlate with coarser one-percentile size fractions.

Percentages of silt are inversely correlative with the sand/mud ratios. However, silt content shows very little correlation ($r = 0.382$) with silt/clay ratios, and only weak correlation with the central tendency measures.

Percentages of clay correlate directly with all three central tendency measures, indicating finer average grain size with increasing percentages of clay, as would be expected. As clay represents detritus at the extreme fine end of the size spectrum, it also has a significant influence on skewness values.

Sand/mud ratios are inversely correlative with both the mean and median diameter Ø values, indicating increasing coarseness with increasing ratios. These ratios do not greatly influence any other parameters. Silt/clay ratios have no significant influence on any of the compared textural parameters.

The mean diameter (first moment) Ø values are directly related to median and modal diameter Ø values, thus showing an agreement among central tendency measures. The mean diameter Ø values are inversely correlative with the skewness values, suggesting increasing fine skewness with increasing coarseness

(decreasing Ø values). The mean diameter values also are directly correlative with the one-percentile values, indicating that both parameters can be used as energy-level indicators.

Standard deviation Ø values correlate inversely with the one-percentile Ø values, indicating a reduction in sorting with an increase in the coarseness of the size distribution's coarse tail. This indicates the important influence of extreme tail segments on overall sorting characteristics.

Skewness is inversely correlative with median diameter Ø values. Kurtosis is not correlative with any other textural parameter. Median and modal diameters are directly correlated, showing agreement between the two central tendency measures.

In summation, the correlation analysis illustrates several readily explainable linear relationships among selected textural parameters. Sediments containing higher percentages of sand tend to have coarser one-percentile fractions and are more poorly sorted. The most unexpected results were the absence of a strong linear influence of silt percentages on silt/clay ratios and the presence of a relatively weak influence on central tendency measures. Since silt is the most abundant detrital fraction within the OCS, the absence of strong linear correlations could suggest nonlinear relationships among these particular parameters.

Seasonal Variability of Texture

The sea-floor surface sediments acquired during 1976 along the four designated transects were analyzed for seasonal variations in texture. The three seasonal sample suites (winter, spring, summer/fall) supplied by the University of Texas Marine Science Institute at Port Aransas were subjected to textural analyses using the same analytical procedures as were

outlined in the USGS element report for the first year (Berryhill and others, 1976). Duplicate samples from each station were analyzed, and the average values of their textural parameters were used to construct transect profiles. Time-series variability profiles based on the three seasonal sample suites were constructed for the following parameters: sand/mud ratios, silt/clay ratios, mean diameters (first moments), and standard deviations (second moments). The results are shown by figures 74 to 77. In addition, the following supplemental textural parameters also were derived: sand percentage, silt percentage, clay percentage, skewness (third moment), and kurtosis (fourth moment). All derived textural parameters are tabulated in Appendix 4.

Sand/mud ratio variability

The sand/mud ratios provide a general overview of textural variability (fig. 74) that is most applicable to the inner shelf where the sand-sized detritus is most abundant.

Transect 1--The seasonal variation of sand/mud ratios was maximum at station 1 (0.72-1.36) and minimum at station 5; the seasonal variation generally was lowest along the outer shelf where sand is scarce. Along the more variable inner shelf (station 4-2 sector), the benthic sediments do not show a systematic seasonal trend; they tended to be coarsest (highest ratios) during the winter in the shallower sector and coarsest during the summer in the deeper sector (station 2).

Transect 2--The sand/mud ratio variability was maximum at station 4 (0.09-0.66); the remainder of the transect showed only minor seasonal variation. At station 4, the sediments were coarsest in the spring and were uniformly finer throughout the remainder of the year.

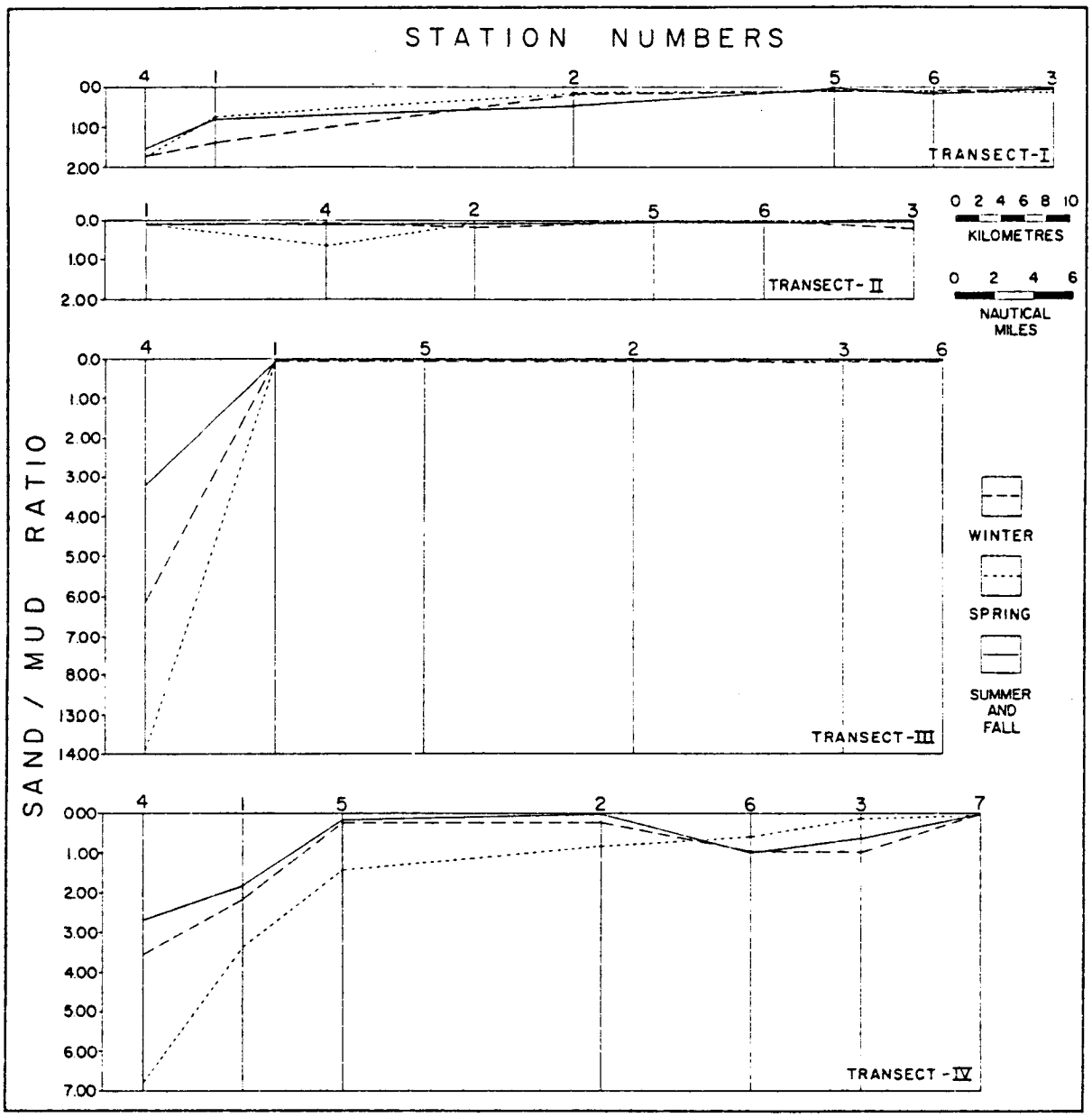


Figure 74. Sand/mud ratios for benthic sediments, biological stations.

Transect 3--The sand/mud ratios showed extremely large seasonal variations at the shallowest station (station 4); grain size ranged from finest in the summer (3.22) to coarsest in the spring (13.95). The remainder of the stations were uniform throughout the year.

Transect 4--The sand/mud ratios showed maximum seasonal variation at the shallowest station (station 4), with sediments being coarsest in the spring (6.81) and finest (2.70) in the summer; variability was minimal at the deepest station (station 7). Sediments along the inner shelf (station 4-2 sector) tended to be coarsest in the spring.

In general, the seasonal variability of sand/mud ratios tended to be largest along the shallow inner shelf. The outer shelf was relatively uniform. This difference probably is caused by two dominant factors: 1) sand is most abundant along the inner shelf; and 2) the range of hydraulic variability is greatest over the inner shelf. When the four transects are compared, the most pronounced variations were along transect 4, which is not surprising considering the wide variety of sediment types across the ancestral Rio Grande delta. No systematic seasonal trends were apparent.

Silt/clay ratio variability

The silt/clay ratios provide a somewhat more sensitive general overview of textural variability than do sand/mud ratios. In addition, silt/clay ratios are more widely applicable to the South Texas OCS, where silt and clay are relatively abundant. The silt/clay ratios are shown by figure 75.

For each transect, the silt/clay ratio variability was maximum at the shallowest station (transect 1, station 4; transect 2, station 1; transect 3,

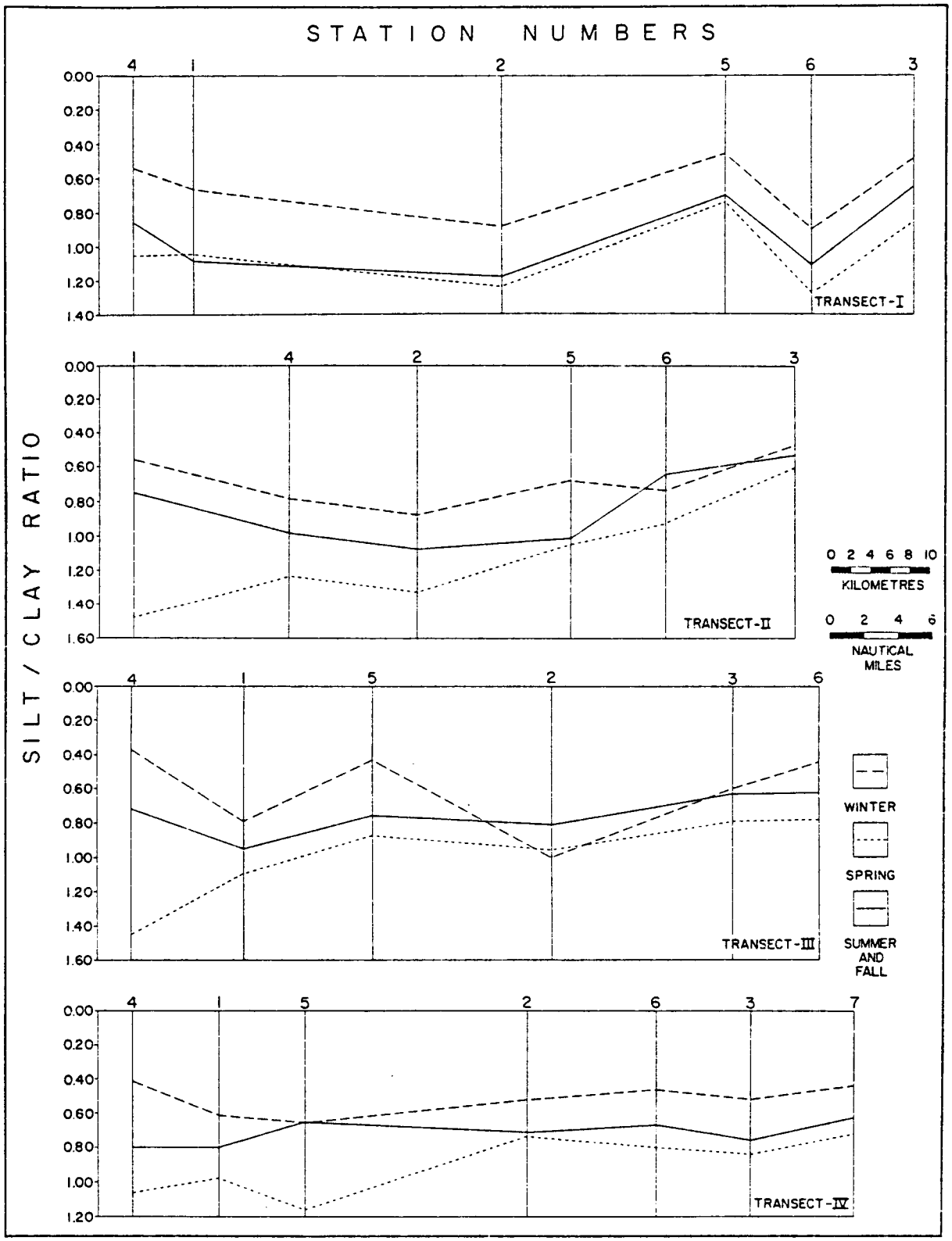


Figure 75. Silt/clay ratios for benthic sediments, biological stations.

station 4; transect 4, station 4). The silt/clay ratios showed substantial seasonal variability throughout the region; they were most variable on the inner shelf, probably because of the more variable hydraulic regime.

In general, the same systematic seasonal trend applied to all transects: the benthic sediments were coarsest (most silty) during the spring and finest (least silty) during the winter.

Mean diameter variability

The mean diameter (first moment) provides a sensitive measure of the average grain size of the sediment and indicates the general levels of energy affecting the environment. Results of the analysis for mean diameters are shown by figure 76.

Transect 1--The seasonal variability of mean diameter was maximum at station 2, with the sediment being coarsest (6.38 Ø) in the summer and finest (7.34 Ø) in the winter. No systematic seasonal trend was evident.

Transect 2--The mean diameter variability was maximum at station 4, with station sediment being coarsest (5.98 Ø) in the spring and finest (7.75 Ø) in the winter. The sediments along this transect were consistently coarsest during the spring.

Transect 3--The variations in mean diameter were maximum at the shallowest station (station 4), ranging from coarsest (3.76 Ø) in the spring to finest (4.63 Ø) in the summer. The sediments were sytematically coarsest in the spring.

Transect 4--The mean diameter variability was maximum at station 5, where the sediments were coarsest (4.50 Ø) in the spring and finest (7.51 Ø) in the

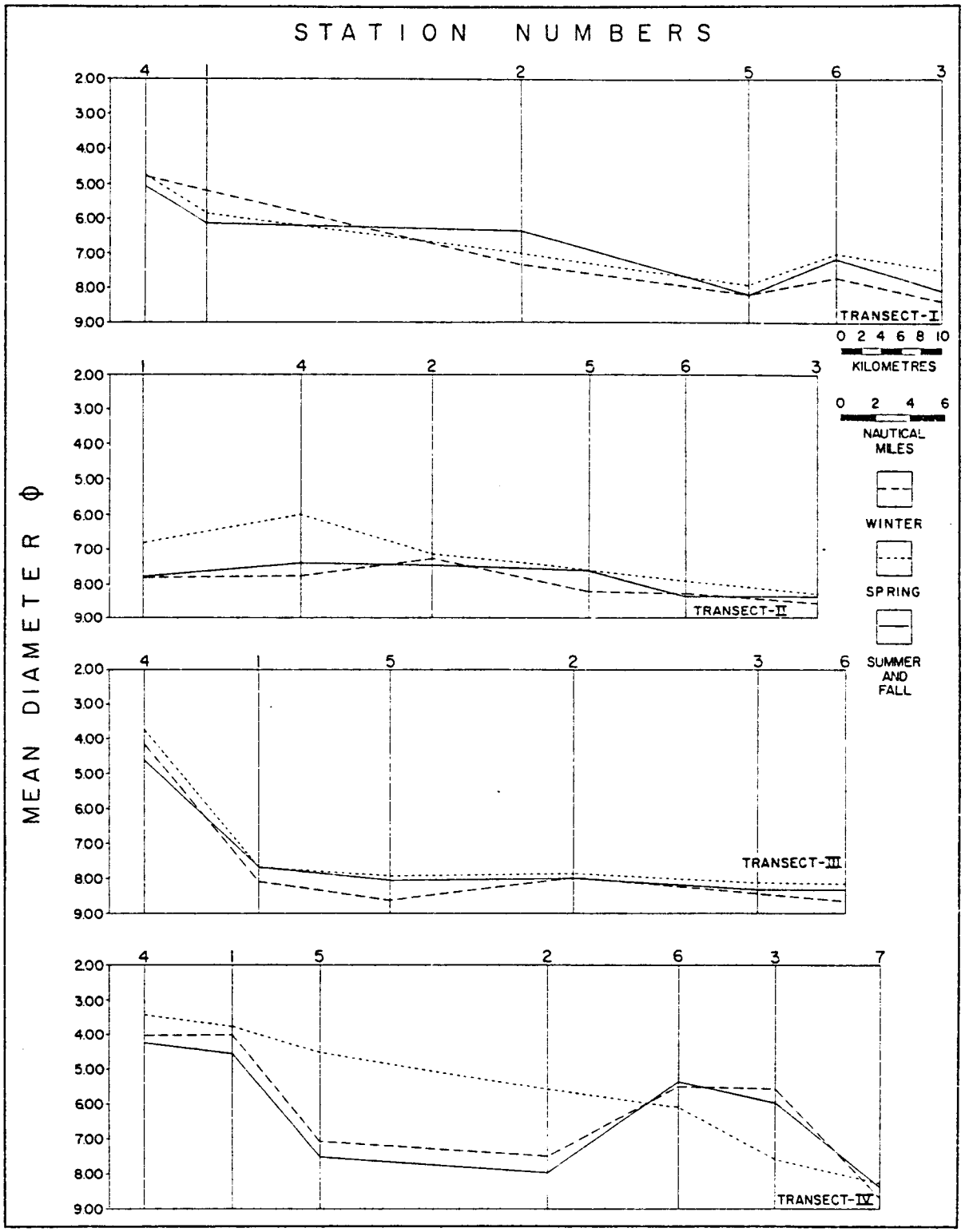


Figure 76. Mean diameters for benthic sediments, biological stations.

summer. No systematic seasonal trend was evident. During the spring, sediments were coarsest at the inner and midshelf sectors and finest at the deeper stations.

The average grain size of benthic sediments, in terms of mean diameters, showed substantial seasonal variability throughout the region. However, the only systematic seasonal trend was within the central sector (transects 2, 3), where the sediments were coarsest during the spring. The shelfwide trend was decreasing grain size seaward, apparently reflecting an offshore transport component.

Standard deviation variability

The standard deviation is a measure of sediment sorting characteristics or homogeneity (fig. 77). This parameter could provide indications of the extent of sediment mixing or of environmental energy consistency.

Transect 1--The seasonal variability of standard deviation was maximum at the shallowest station (2.65-3.15 Ø), with sediments being best sorted (lowest standard deviation) during the spring and most poorly sorted during the winter. No systematic seasonal trend was indicated.

Transect 2--Standard deviation variability was maximum at station 4 (2.08-2.51 Ø); sorting was best during the winter and poorest during the spring. No systematic seasonal trend was apparent.

Transect 3--The standard deviation variability was maximum at the shallowest station (1.16-2.19 Ø). Sorting was best during the spring and poorest during the summer. Except for the shallowest stations (4 and 1), transect 3 had a seasonal trend of best sorting during the winter and poorest sorting during the spring.

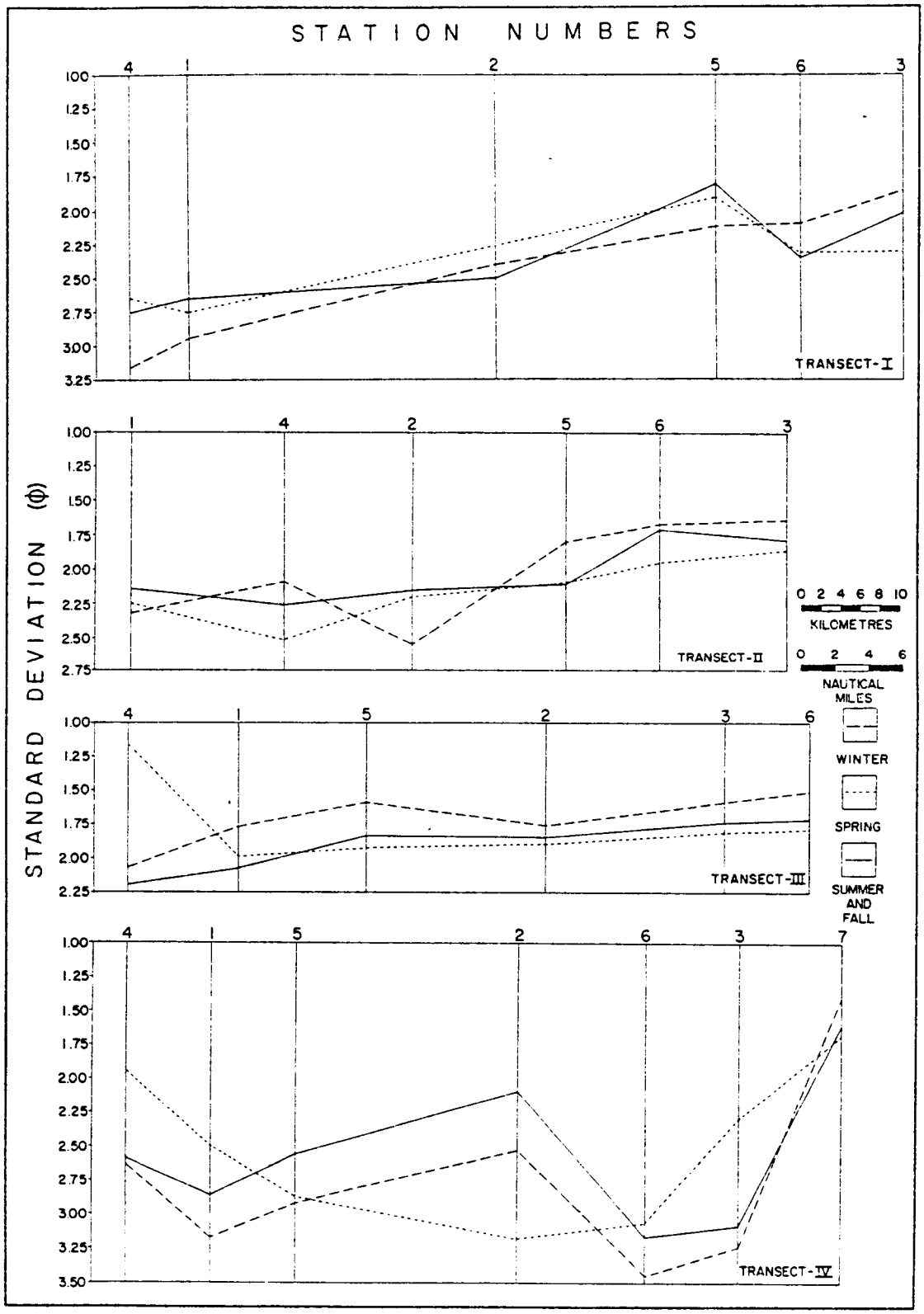


Figure 77. Standard deviations for benthic sediments, biological stations.

Transect 4--Standard deviation variability was maximum at station 2 (2.09-3.17 Ø); sorting was best during the summer and poorest during the spring. No systematic seasonal trend was apparent.

The sorting characteristics of the benthic sediments, as reflected by the standard deviation measure, showed substantial seasonal variability throughout the region. The greatest variability was along transect 4, which crossed the ancestral Rio Grande delta. In general, sorting improved seaward; however, no systematic seasonal trend in sorting was apparent on a regional basis.

Textures in Cored Sediments

by Gerald L. Shideler

Comparative textural analyses were conducted on 7 selected gravity cores obtained during the 1975 sampling program. The cores were representative of what appear to be relict, modern, and palimpsest sedimentary deposits of the South Texas OCS. A general discussion of these genetically distinct types of sediment has been presented by Swift and others (1971). The objective of the present study was to conduct detailed textural analyses of the selected cores to determine if textural criteria could be employed to substantiate genetic differences. Each core was sampled both at 15 cm intervals and at each major change in sediment type, resulting in a total of 84 subsamples. Textural parameters derived consisted of the following: sand/mud ratio, silt/clay ratio, mean diameter (first moment), standard deviation (second moment), skewness (third moment), mode, median diameter, and coarsest one-percentile. On the basis of the sand/mud and silt/clay ratios, a descriptive log also was prepared for each core. Log descriptions and associated textural

parameters for each core are shown by figures 78 to 84. All size terminology is in accordance with the Udden-Wentworth grade scale, and the sorting and skewness verbal scales are in accordance with Folk's (1965) usage. Core locations and size analysis procedures are described in the USGS element report for 1975 (Berryhill and others, 1976).

Descriptions

Core - C238

The core represents probable relict sediments located off the ancestral Rio Grande delta in the southern part of the OCS (fig. 78). The sand/mud and silt/clay ratios indicate that the core is a shelly sand throughout its length (186 cm) but contains a substantial admixture of mud which has a slightly dominant clay component. In terms of central tendency measures, the mode and median diameter parameters both indicate a relatively uniform, fine-grained (2.0-3.0 Ø) sand throughout most of the core; however, the incorporated mud generally results in a coarse silt (4.5-5.0 Ø) mean grain size (first moment). The standard deviation consistently shows a very poorly sorted sand that also is strongly fine skewed, apparently reflecting the mud component. The one-percentile measure largely reflects the large number of molluscan shell fragments and shows a wide range in the sand-sized fraction.

Core - C235

This core also represents probable relict sediments located on the ancestral Rio Grande delta (fig. 79). The sand/mud and silt/clay ratios indicate a thin clay surface layer overlying a shelly, fine sand layer that contains an admixture of mud slightly dominated by clay. The mud

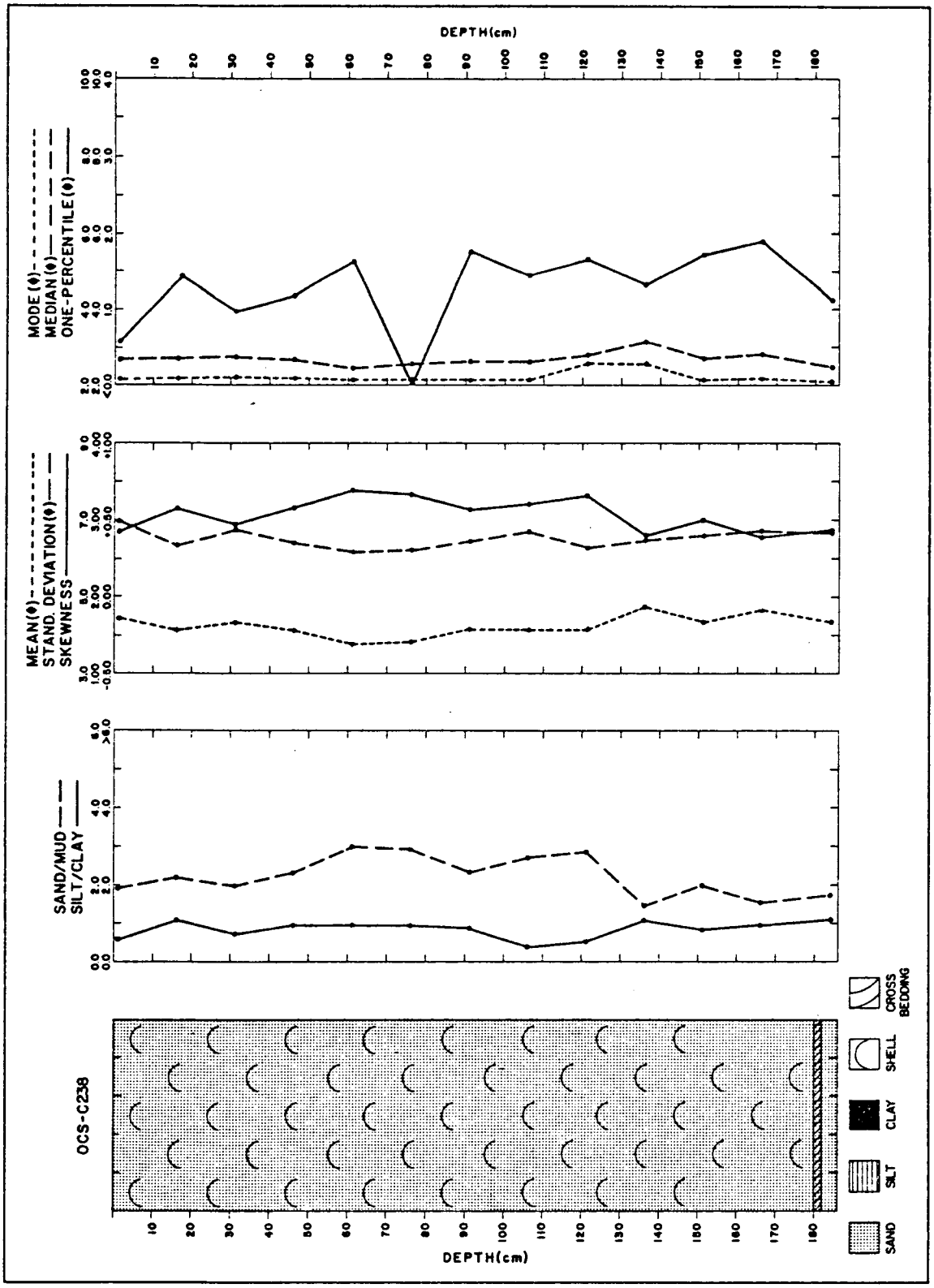


Figure 78. Textural analyses for core C238.

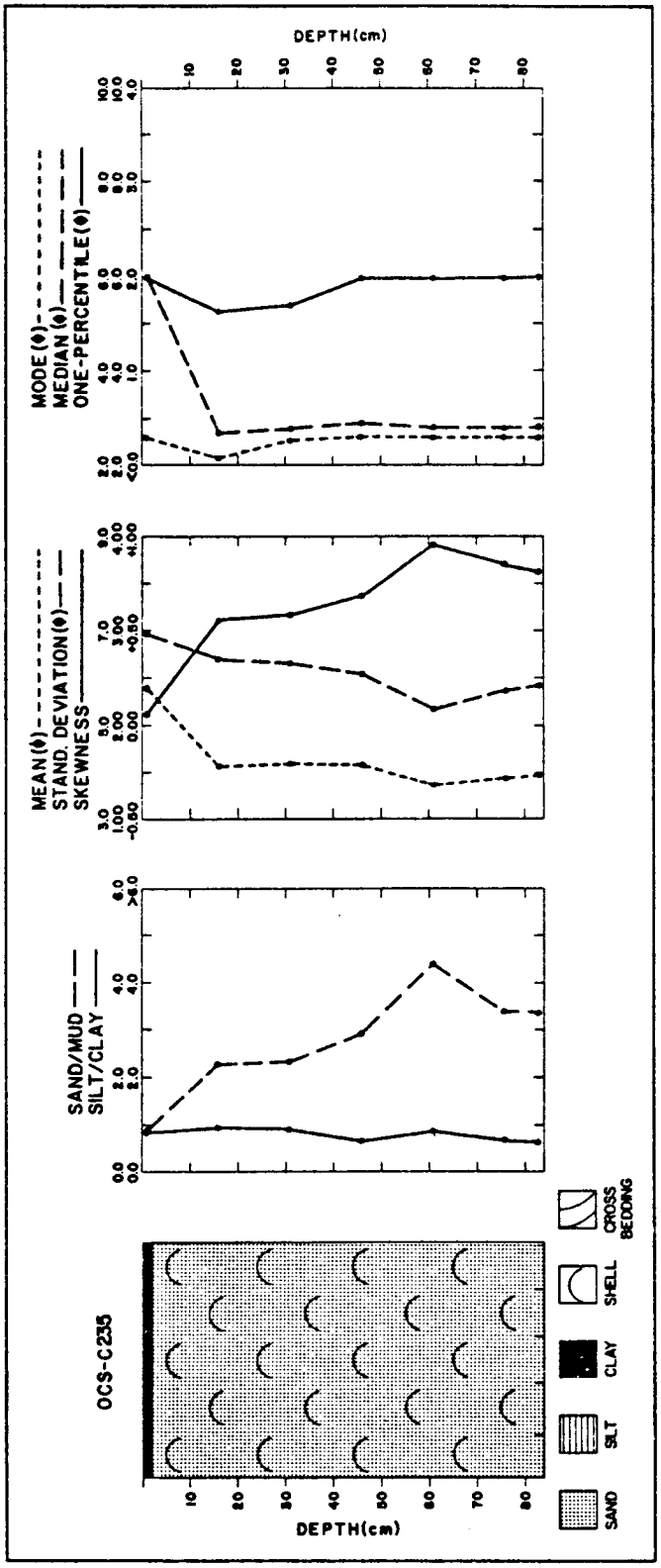


Figure 79. Textural analyses for core C235.

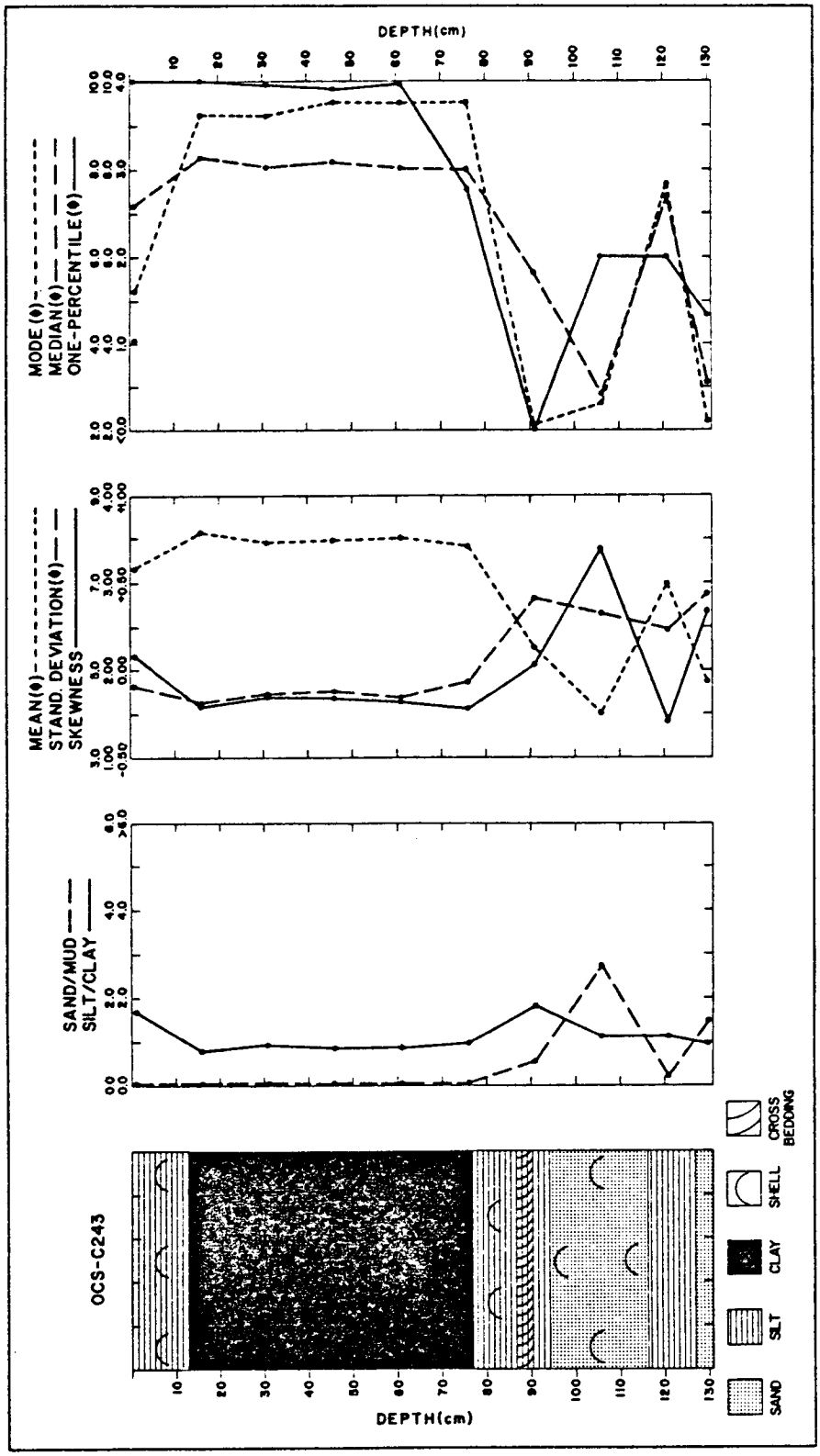


Figure 80. Textural analyses for core C243.

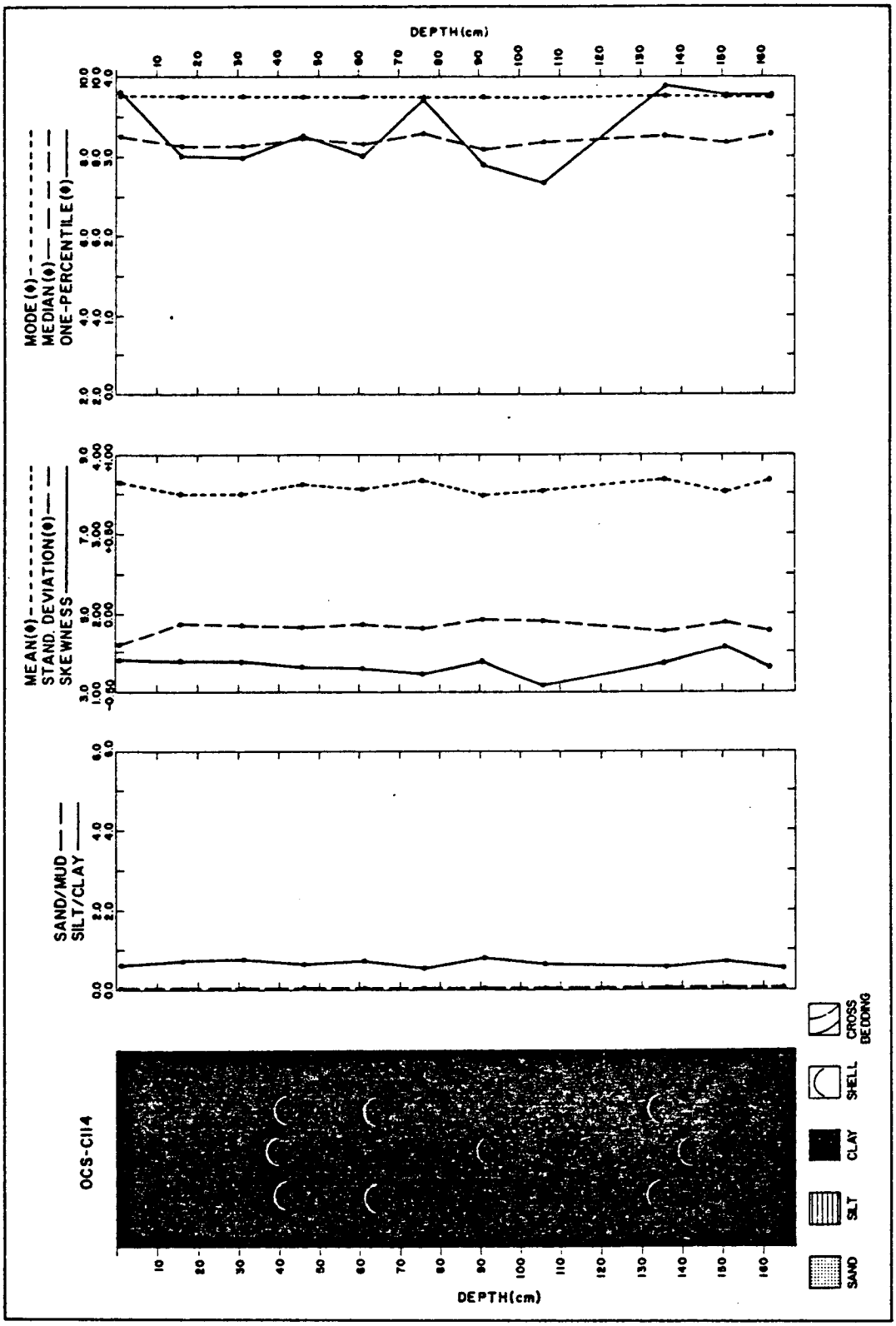


Figure 81. Textural analyses for core C114.

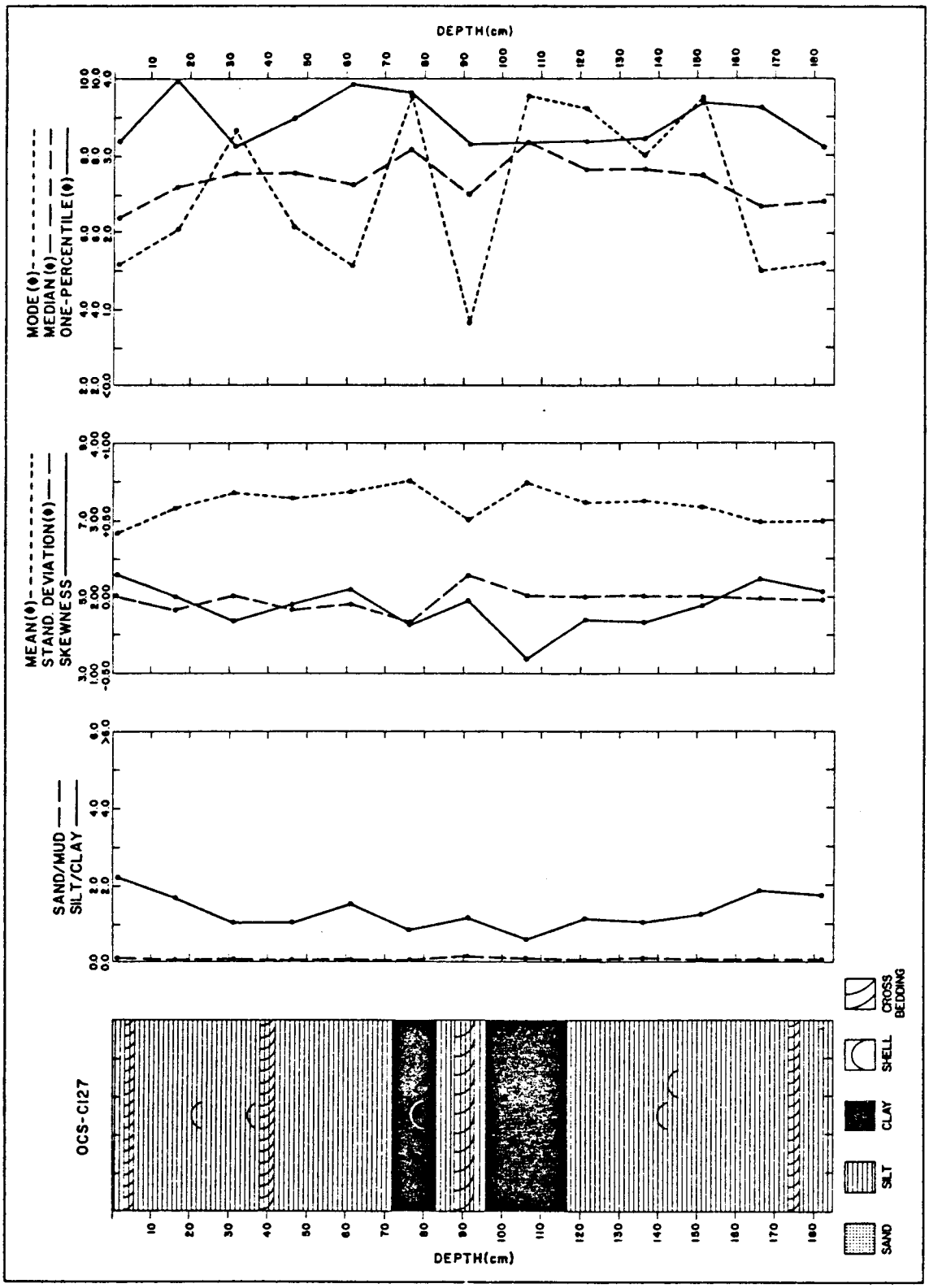


Figure 82. Textural analyses for core C127.

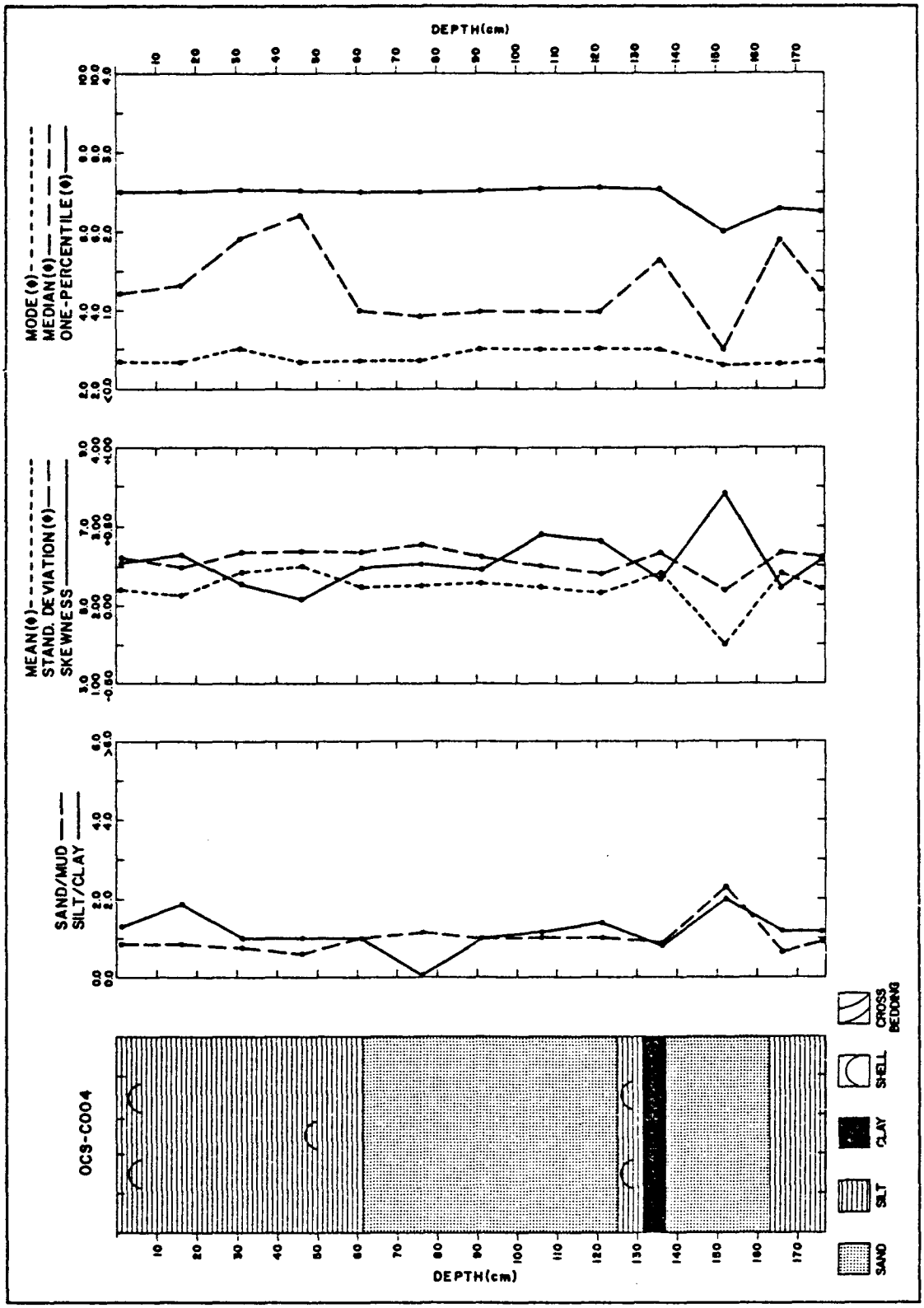


Figure 83. Textural analyses for core C004.

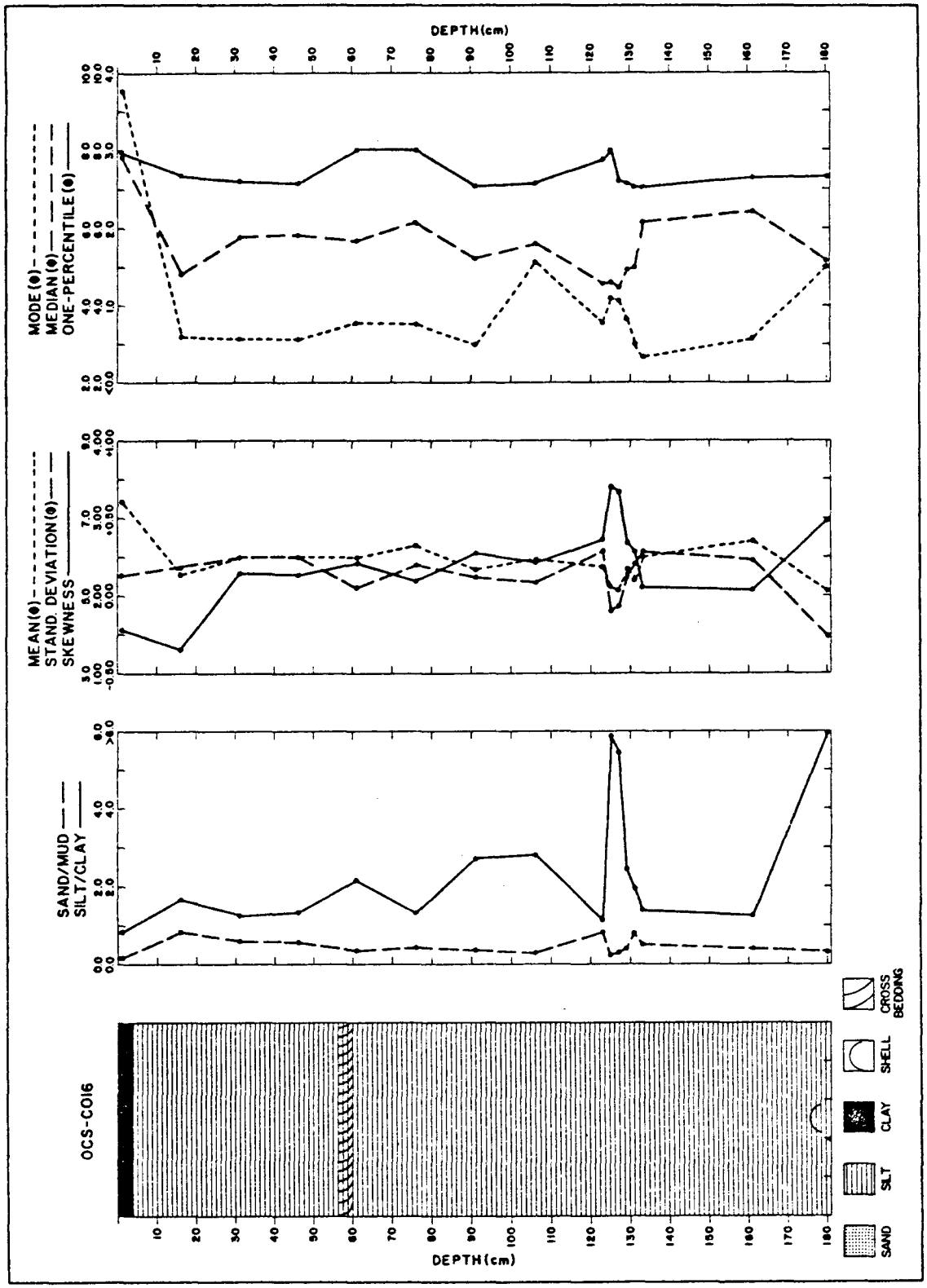


Figure 84. Textural analyses for core C016.

content decreases with depth concurrently with an increase in mean grain size, an improvement in sorting and an increase in fine skewness. The mode and median diameter measures indicate that the sand unit is fine grained. The incorporated mud, however, results in a finer mean grain size that ranges from very fine sand to coarse silt. In terms of general composition, the core is very similar to core C238.

Core - C243

This core was obtained from the shoreward half of the ancestral Rio Grande delta (fig. 80). The core is made up of a mixed sequence of fine-grained sand, silt and clay units. One of the silt units appears to be ripple crossbedded, and shell fragments are scattered throughout the sequence. The lower sandy section may reflect relict ancestral delta deposits that are overlain by modern muddy sediments. The textural variations are reflected in the central tendency measures. A direct association seems to exist between relatively coarse grain size, poor sorting and a high degree of fine skewness. The one-percentile measure shows a wide range of variation, with the clay unit having the finest and most consistent one-percentile fraction.

Core - C114

This core is representative of probable deep water modern deposits along the outer edge of the shelf in the central sector (fig. 81). The core is entirely mud, with clay being the dominant component; sand admixtures are quantitatively insignificant. Minor amounts of shell fragments are scattered throughout the core. The clay texture is reflected by all three central tendency measures. The core has a relatively persistent degree of poor

sorting and coarse skewness. The one-percentile measure exhibits moderate variability and probably reflects the scattered sand-size shell fragments.

Core - C127

This core was obtained from the shoreward half of the central sector (fig. 82). It is representative of probable shallow-water modern deposits and is entirely mud with a dominant silt component. The silt and clay layers are stratified, the silt units commonly are crudely ripple crossbedded, and shell fragments are occasionally present. The mean and median diameters generally are within the very fine silt range (7.0-8.0 Ø); the mode exhibits inconsistent values. The sediments range from finely skewed to coarsely skewed and from poorly sorted to very poorly sorted. The one-percentile measure shows moderate variability within the very fine sand range, probably reflecting shell fragments.

Core - C004

This core (fig. 83) was obtained near the western edge of the ancestral Brazos-Colorado delta in the extreme northern part of the South Texas OCS. It is representative of probable palimpsest or partially reworked relict deltaic deposits. The core contains interbedded sand units, silt units, and a single clay unit. The sand contains large admixtures of mud, and the muddy units similarly contain large admixtures of sand, suggesting substantial homogenization. The mean diameter is mainly within the medium silt (5.0-6.0 Ø) range, but the mode is mainly within the fine sand (2.0-3.0) range. The median diameter, which is based on a single percentile, shows more inconsistent values. The core is very poorly sorted, with size distributions

ranging from nearly symmetrical to strongly fine skewed. The one-percentile measure shows very little variability, all of which occurs within the fine sand (2.0-3.0 Ø) range.

Core - C016

This core (fig. 84) is representative of probable palimpsest sediments along the flank of the ancestral Brazos-Colorado delta. The core is entirely mud with a highly dominant silt component. A thin clay surface is underlain by a thick silt layer that is in part ripple crossbedded. Admixtures of sand are significant. The textural composition is reflected by the mean and median diameter measures, which are within the silt size range; however, modal diameters tend to be somewhat coarser. The core is made up of poorly sorted to very poorly sorted sediments that have a strongly coarse skewed to strongly fine skewed size distribution. The one-percentile measure shows moderate variability within the fine sand-sized range.

Textural Relations in the Cores

The comparative textural analyses of the selected gravity cores suggest some textural distinctions among the probable relict, palimpsest, and modern sediments represented. The modern deposits that are presently in hydraulic equilibrium consist of mud with insignificant admixtures of sand. The shallower water, modern deposits are composed of a heterogeneous mixture of stratified silt and clay units. The dominant silt units frequently have some ripple crossbedding, indicating some tractive transport. In contrast, the deeper water, modern deposits are relatively homogeneous and consist predominantly of uniformly laminated clay that is indicative of transport in suspension.

The probable relict sediments are almost entirely fine grained sand with many molluscan shell fragments and substantial admixtures of mud. The relict deposits are characteristic of much of the ancestral Rio Grande delta and do not appear to be in equilibrium with the present hydraulic regime. Their attributes suggest that they were deposited in shallow water coastal environments during the Holocene transgression. They may represent former littoral lithosomes, possibly developed within a transgressing shoreface environment.

The probable palimpsest sediments reflect an intermediate state of textural adjustment between modern and relict end members. They consist of mixed muddy sand and sandy mud units that suggest substantial homogenization through a combination of hydraulic reworking and bioturbation. These sediments lie along the flank of the ancestral Brazos-Colorado delta and appear to reflect partially reworked relict coastal sediments. They appear to be in partial equilibrium, possibly undergoing transport during storm-intensified hydraulic conditions.

The textural analyses of cored sediments suggest that collective textural differences are present among the genetically different types of sedimentary deposits. However, no single textural criterion can be used to differentiate the genetic sediment types. The study points out the need for future investigations using multivariate discriminant function analysis.

Shallow Subsurface Sediments

by

Henry L. Berryhill, Jr.

Introduction

The 74 core sites selected for the initial year of study, though chosen to provide regional geographic and physiographic coverage for the South Texas OCS, had to be spaced from 10 to 12 miles apart in some areas because of time constraints imposed by the schedule for field investigations. During the second year of study an additional 101 cores were obtained to fill gaps in the geographic coverage for the initial year, to provide data for refining the trends indicated by the results for the first year and to determine the lateral distribution of reef debris in the typically fine-grained sediments around the carbonate topographic features on the outer shelf. Of the 101 cores collected during the second year, 69 came from the shelf proper and 32 from the traverses across 4 reefs.

Although the sites cored during the second year were chosen primarily to fill geographic gaps in the earlier coverage, selection of both the geographic subareas and the specific sites within them was based on the need to confirm suggested patterns of sediment transport and deposition. The 6 subareas, designated A through F, and the location of the 4 reef traverses are shown by figure 85. The specific locations for the core sites are shown by figure 86. The locations for the 74 cores collected during the first year of study also are

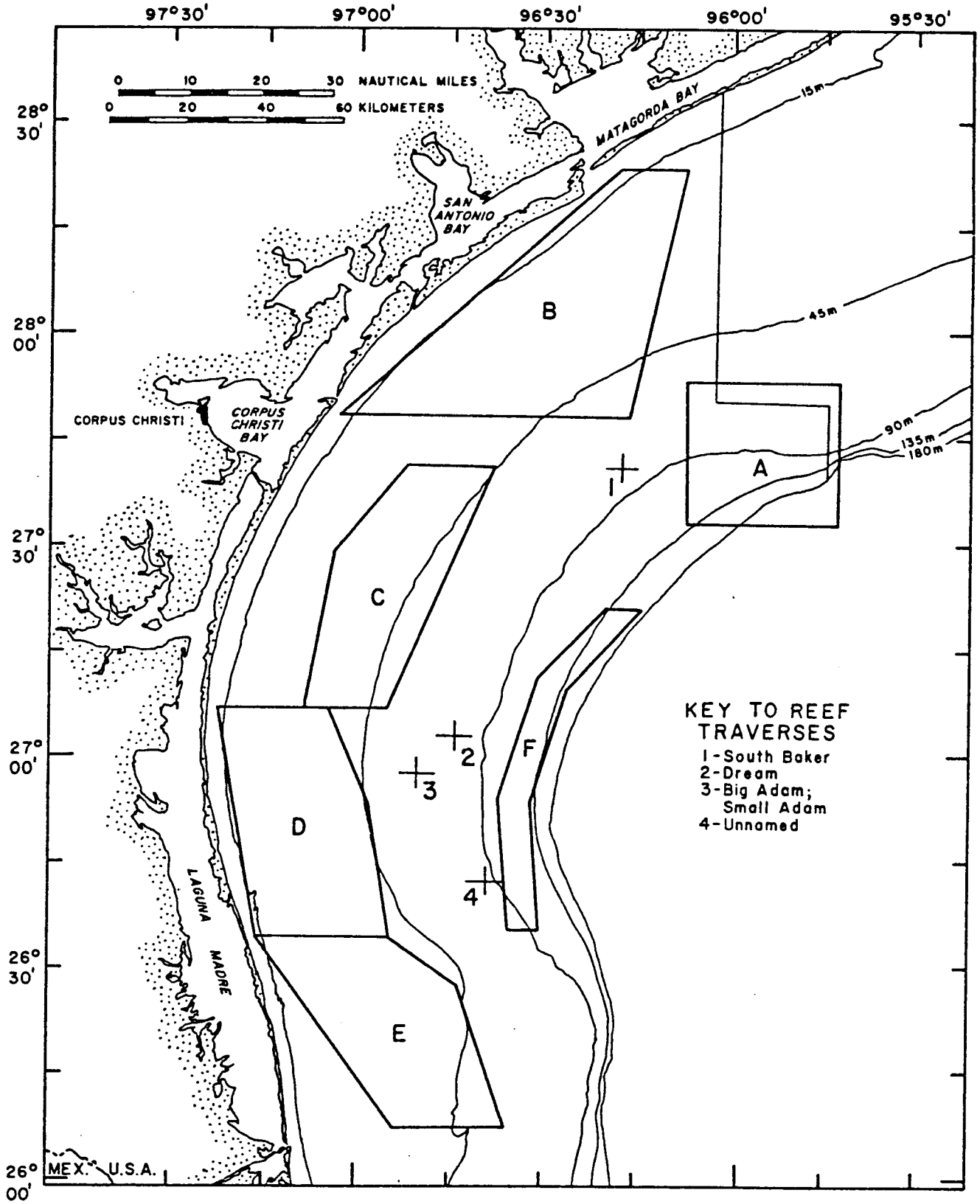


Figure 85. Locations of subareas in which sediments were cored. The locations of the reef traverses are indicated by crosses.

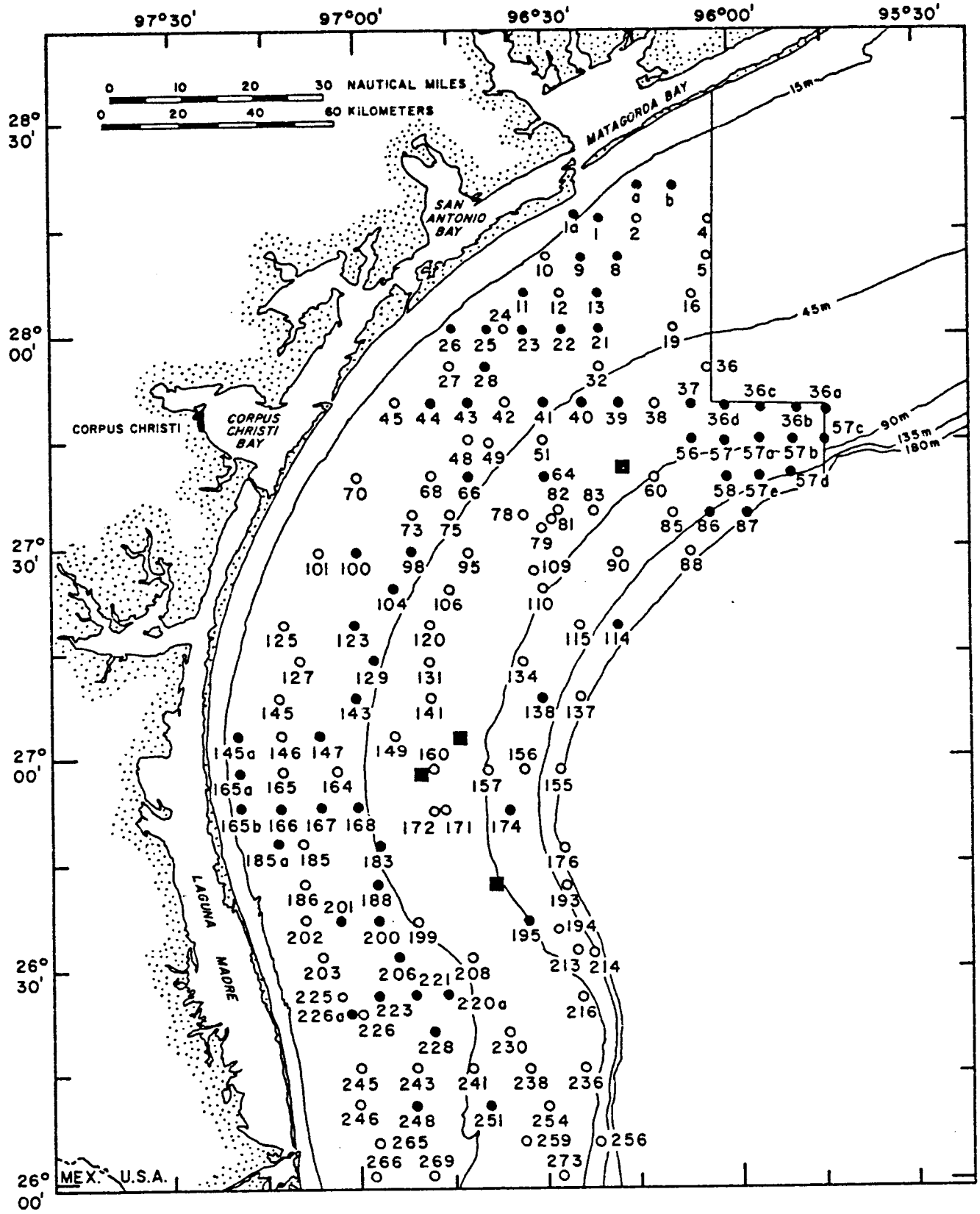


Figure 86. Locations of core sites on the South Texas OCS. Solid dots indicate the cores collected during the second year of study (1975-76); cirles indicate cores collected during the first year of study (1974-75). The squares indicate the location of reef traverses.

included on figure 86 to show the full scope of core data used for the descriptions and interpretations that follow.

The rationale used in selecting the six geographic subareas relative to specific data needs is as follows: A - determine the nature of sediments along the seaward edge of the ancestral Brazos-Colorado River delta where no cores were taken during the first year; B - refine patterns of distribution for the sand-sized sediments over the northwestern part of the OCS where a relatively high rate of sediment influx was suggested by the initial results; C - determine the distribution of discrete sand layers that possibly represent transport and deposition during hurricane passage; D - refine the patterns of sand distribution over the part of the inner shelf where traditional interpretation has placed a current convergence; E - determine the thickness and nature of transgressive sediments over the inner part of the ancestral Rio Grande delta where sedimentary relationships are complex; and F - add supplemental data in an area of low sand content.

The sediments adjacent to the dead carbonate reefs were cored so that the reef debris might be used as a possible indicator in determining the magnitude of bottom water movement over the outer shelf during passage of a hurricane. Determination of the distance to which the debris has been spread away from reefs, at least in the most recently deposited Holocene sediments, might indicate the degree of disturbance to be expected along the bottom in deeper parts of the shelf during extreme weather events. For completeness, the core data in Bright, Rezak, and others, 1976, have been incorporated into the synthesis.

Four reefs were chosen for study: South Baker; Dream; Big Adam, Small Adam Rock; and an unnamed reef that is designated as reef number 8 on figure 87. These four reefs were selected so that representative geographic coverage of the entire reef series would be provided. Morphological differences among the reefs that might affect susceptibility to erosion by moving water are apparent from north to south. The reefs making up the northern half of the series are more mound-shaped and have generally smooth surfaces; those in the southern half, especially the southernmost, are more irregular in shape and have numerous pinnacles. Bathymetric maps of 3 of the 4 reefs, showing the locations of both the USGS and Texas A&M core sites, are shown by figures 88 through 90. The positions of core sites relative to the outer edge of the unnamed reef are shown by figure 91. In addition to the core data reported for the second year of study, the diagrammed descriptions for several cores taken during the first year of study around Hospital and Aransas Reefs are shown by figure 92, taken from Berryhill and others (1976).

The shallow subsurface sediments were collected for study in a stainless steel, gravity fall pipe-corer employing a 500 pound head. The core was retained in a plastic liner 7 cm in diameter.

Methods of Study

In the laboratory, the cores were halved in the plastic core liners and X-rayed at 1 to 1 on a single negative strip. A contact print was made from each radiograph negative. The cores were then described by megascopic examination of the core itself and by use of the

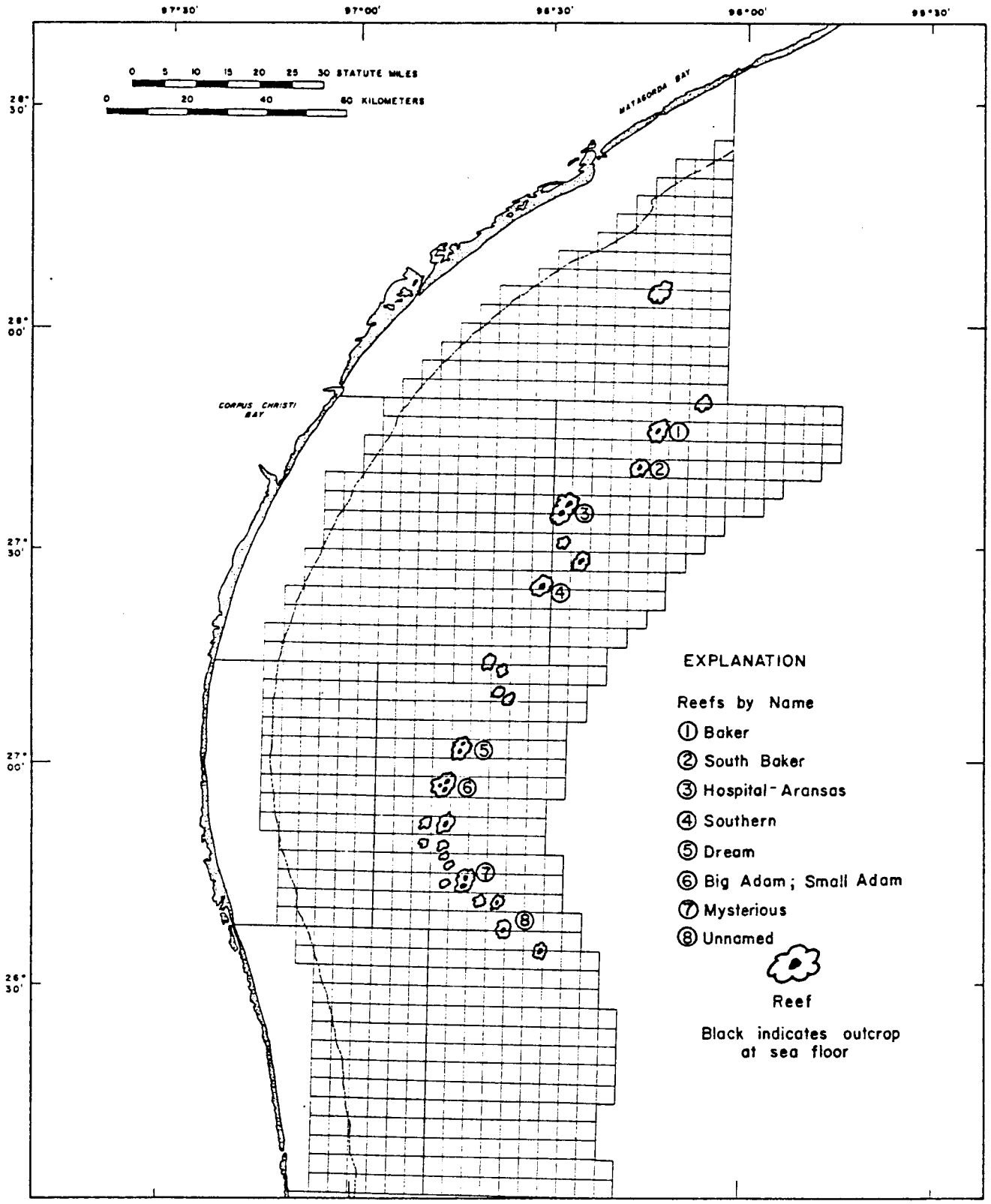


Figure 87. Locations of carbonate reefs on the outer part of the continental shelf.

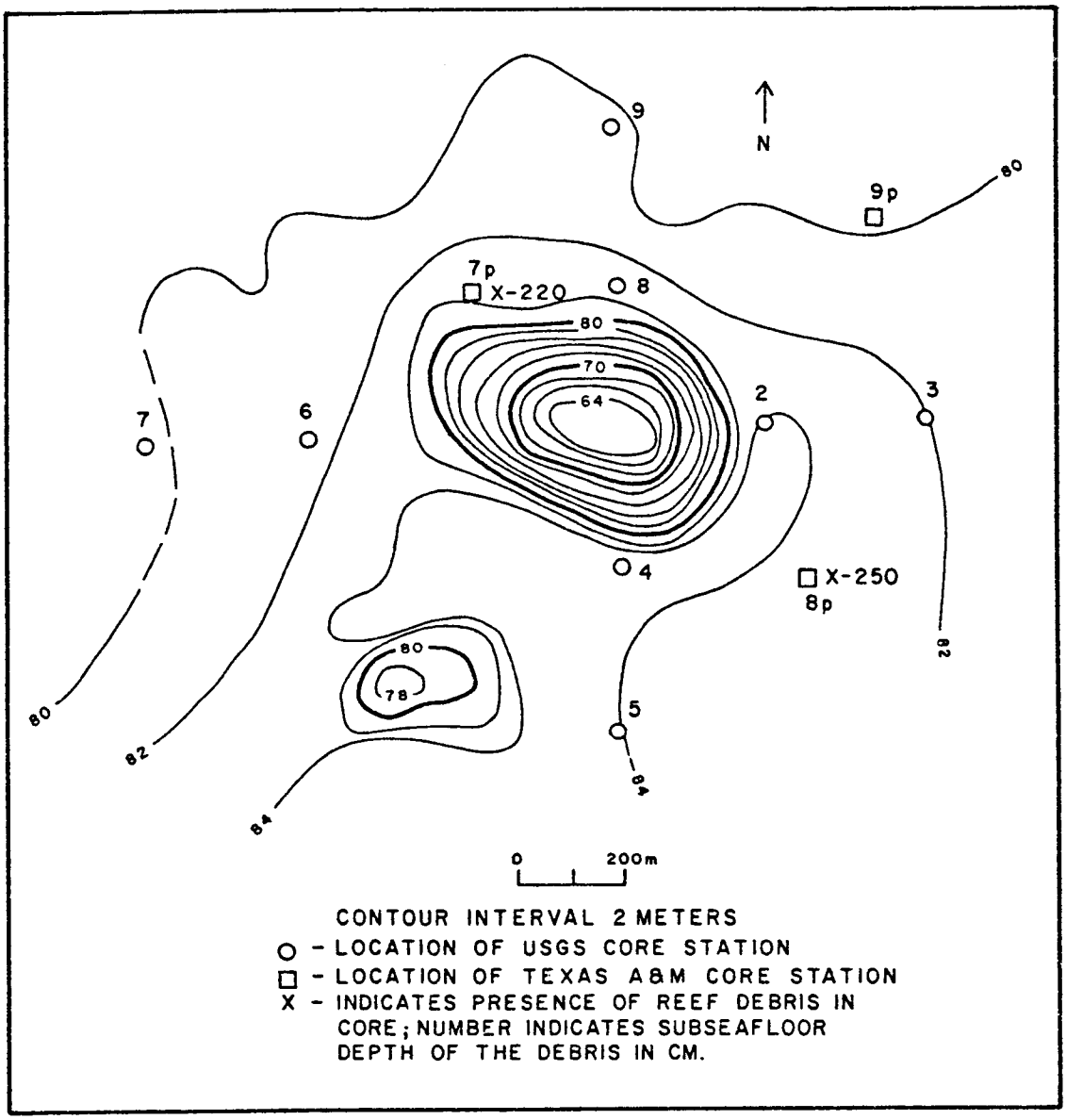


Figure 88. Bathymetric map of South Baker Reef showing the locations of core sites. Depths are in meters. The geographic position of the reef is shown on figure 87. Bathymetry from Bright, Rezak and others, 1976.

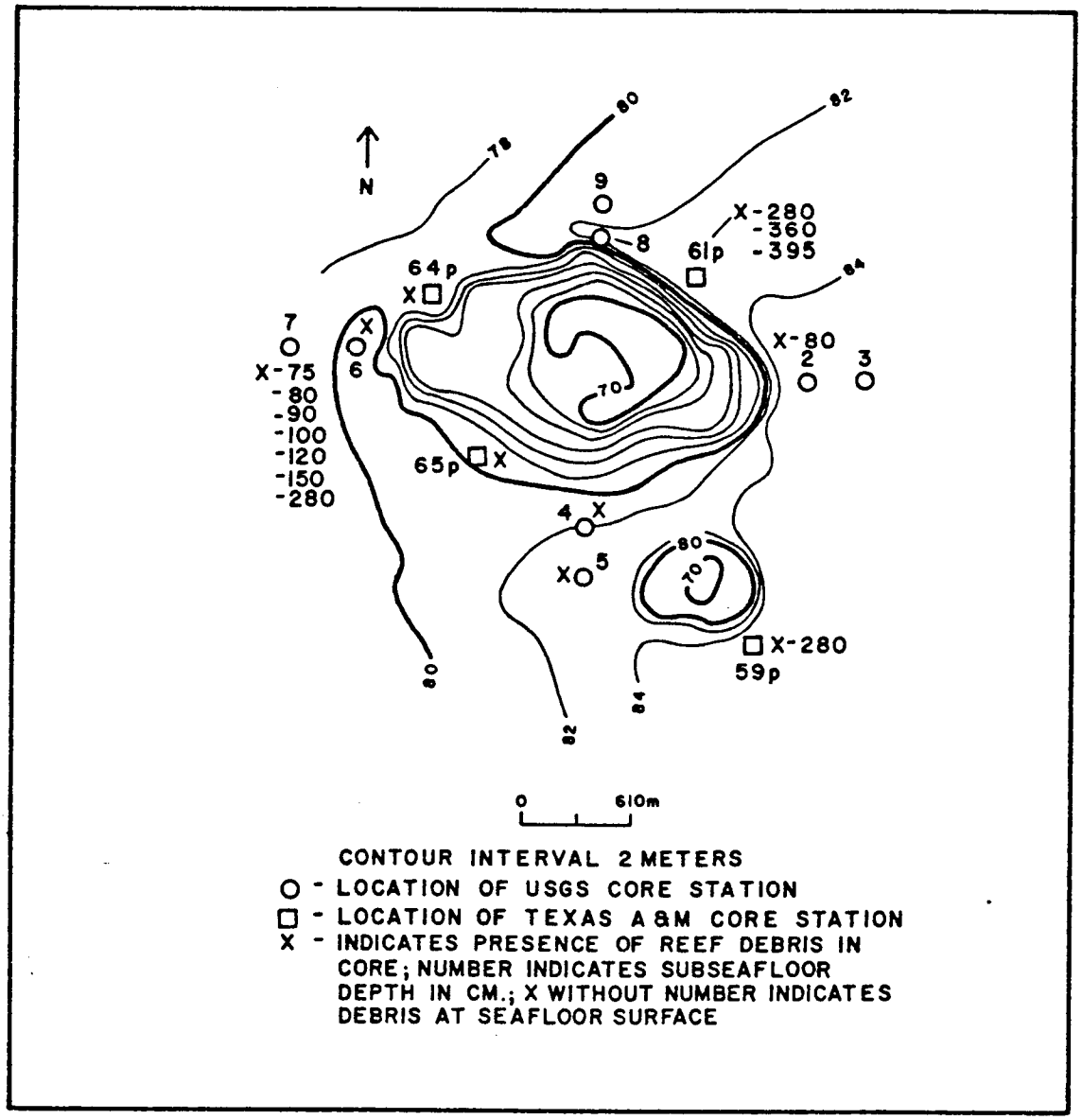


Figure 89. Bathymetric map of Dream Reef showing the locations of core sites. Depths are in meters. The geographic position of the reef is shown on figure 87. Bathymetry from Bright, Rezak and others, 1976.

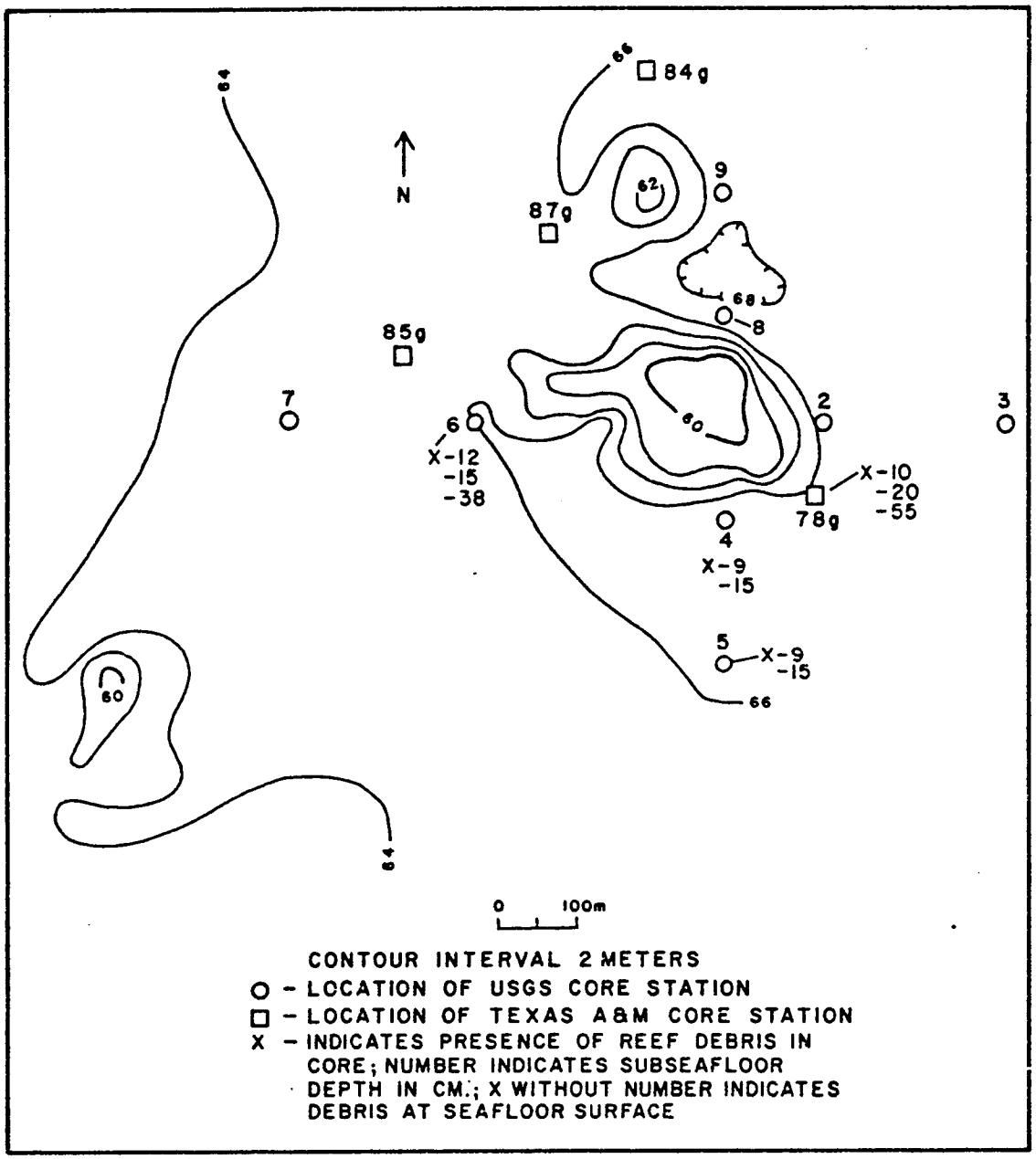


Figure 90. Bathymetric map of Big Adam Reef and Small Adam Rock showing the locations of core sites. Depths are in meters. The geographic position of the reef is shown on figure 87. Bathymetry from Bright, Rezak and others, 1976.

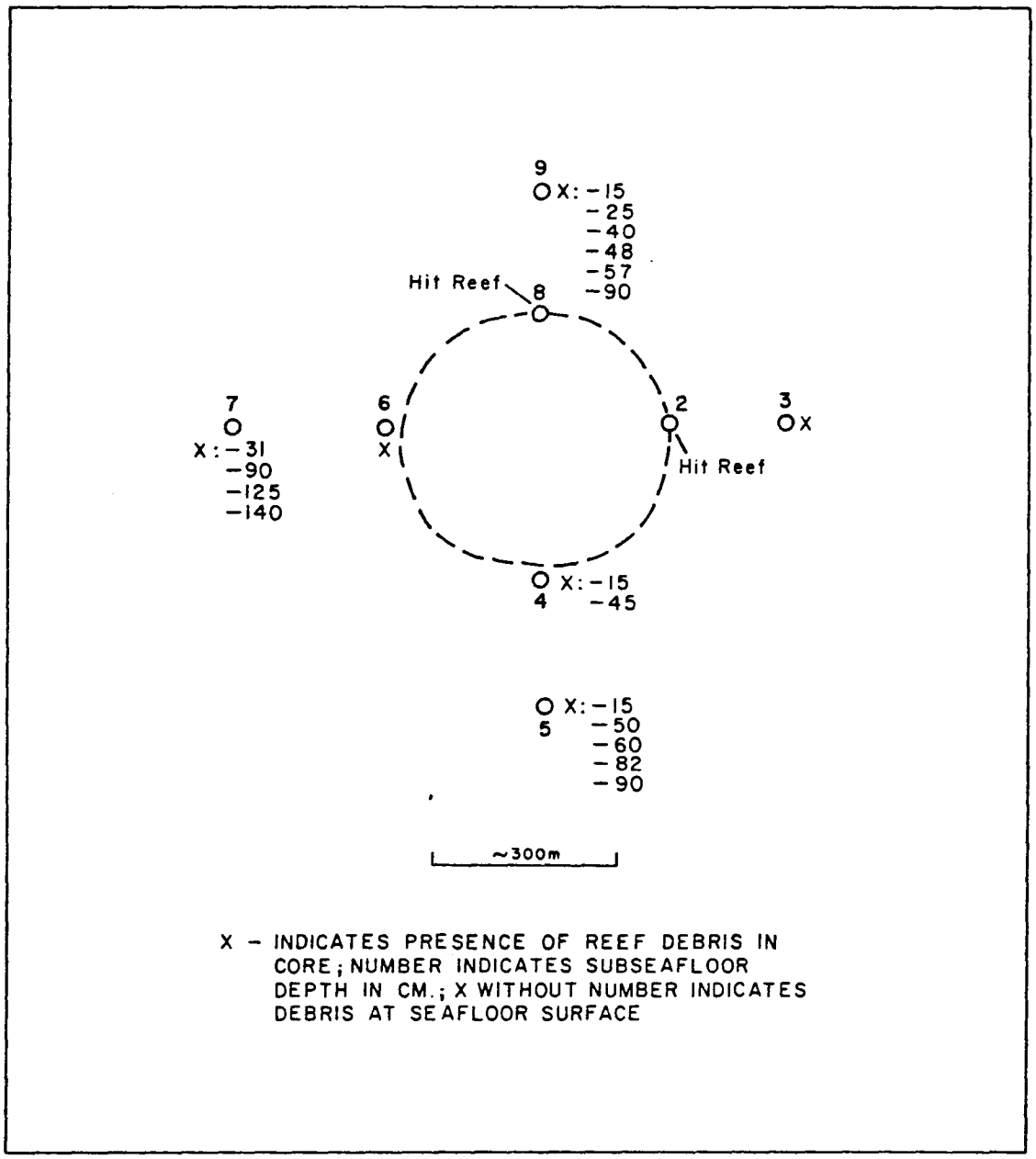


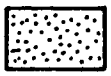
Figure 91. Locations of core stations around the unnamed reef. The approximate depth is 98 m. The geographic position of the reef is shown on figure 87.

EXPLANATION FOR CORE DIAGRAMS
(figures 92-107)

Column 1 — Pipe Core

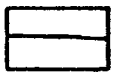
Column 2 — Extent of Bioturbation

Number over bracket is bottom station number

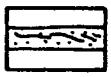


Sand

Number at base of core indicates discrete sands



Prominent Silt laminae



Sand layer having ripple or cross laminae.

Heavy lines at base indicates possible scour during deposition

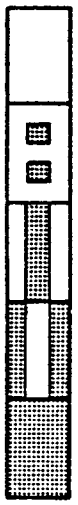
Lithoclasts and shell remains

Reef Debris: Carbonate rubble and coral

Mud

Predominantly mixtures of silt and clay

Bioturbation Coding



Generally absent

Trace

< 30%

30-60%

> 60%

CORES AROUND HOSPITAL-ARANSAS REEF

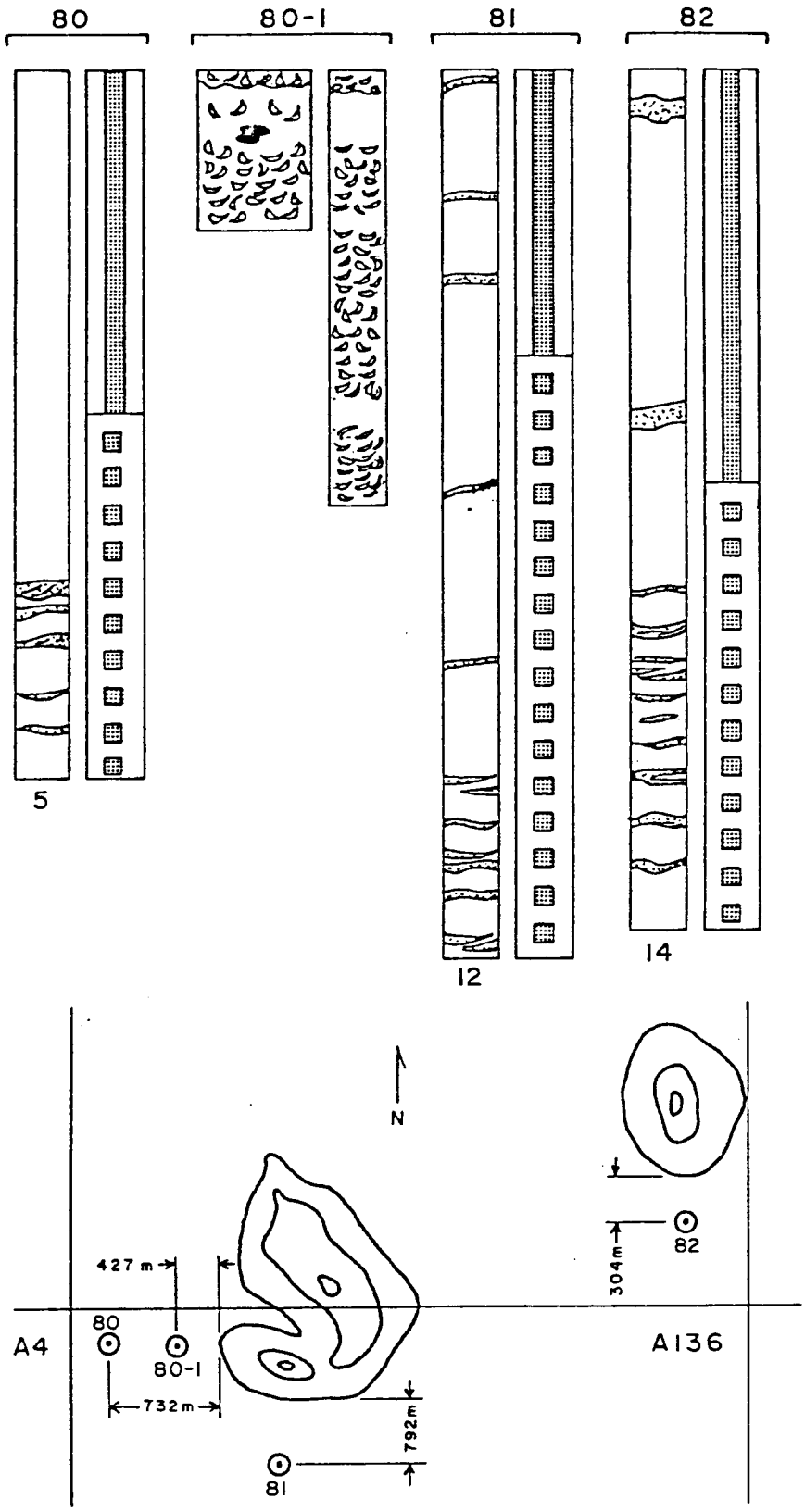


Figure 92. Sketch map showing locations of Hospital-Aransas reefs and logs of cores taken at the localities shown.

X-radiograph film strip. A detailed log, including both diagrammatic and written descriptions, was prepared for each core. Each descriptive log was interpreted and coded as to: 1) number of discrete sand layers; 2) types of sedimentary structures; 3) types and intensity of biogenic structures; 4) degree of sediment modification by bioturbation; 5) types of faunal remains; and 6) estimated total percentage of sand.

As in the 1975 study, primary attention was given to the depositional aspects of the sediments thought most likely to yield significant and quantitative information on the directions and magnitude of sediment transport over the continental shelf as a function of water mass movement. The aspects are: 1) the number and thickness of discrete sand layers in each core; 2) the areal extent of discrete sand layers that seem to be correlative from core to core; 3) amount of sand relative to the finer textured sediments (mud); 4) presence of ripple-type laminae or other depositional structures that indicate extent to which moving water or relatively high energy has been involved in sediment transport; 5) features such as sharp and scour-type boundaries between sediment types, erosional or scour contact at the base of thick sand layers, and geographic distribution of lithoclasts and shell debris in the sand layers, that might indicate the extent of sedimentation over the shelf during hurricanes; and 6) vertical changes in the type and texture of the sediments that record significant and progressive long-term changes in patterns of sediment movement and deposition during latest Holocene time.

During the description and logging of the cores, selected short sections plus some individual sand layers were washed and sieved to

determine general mineralogic composition where megascopic examination suggested significant vertical variations in the type and texture of the sediment. In addition, smear slides of the finer grained sediments in the cores were prepared on a selective basis for estimating the amount of sand-sized grains under the microscope.

The results of the shallow subsurface sediment studies are reported principally in illustrations. The basic descriptions of the sediments cored are in a series of diagrammed logs in which the discrete sand layers and the sedimentary features ancillary to them are emphasized. The syntheses of the basic descriptive data have been plotted on maps to provide synoptic summaries. For convenience in portraying the synthesized data and, as the means of highlighting any significant changes in the general pattern of regional sedimentation through time, the data were plotted and mapped topically in increments of 30 cm, beginning at the sea floor surface. In choosing the incremental approach to the analysis and reporting of the data, it was recognized that the system is somewhat artificial in that it does not account for areal differences in sediment thickness caused by possible variations in rates of sedimentation. As a consequence the increments are not necessarily time synchronous. However, as rates of sedimentation in other than the near-surface sediments are not known and as the emphasis of the study was on defining and determining the seaward extent of discrete sand layers as a possible indication of the extent to which sediments are moved across the shelf during and following hurricanes, the method is valid. As an empirical check on the continuity of individual sand layers within each 30 cm core increment, the layers that are at the

same subseafloor depth in a number of cores were plotted individually and their extent outlined geographically for comparison with the extent of all sand layers mapped in the interval. As the cores vary in length, data below 150 cm were not plotted by increment because the cores longer than 150 cm are too widely spaced for the data to be meaningful when mapped.

Description of Cores, General Shelf

Area A

The cores from area A, as a group, are marked by considerable textural variability and by little regularity in the stratigraphic relations of discrete sand layers to the finer grained mud (<63 μ grains). (See figs. 93 and 94 for diagrammed descriptions of the cores in area A(1) and A(2).) When the cores are compared individually, two general types of sediments are represented, indicating two distinct depositional histories: 1) principally sand deposits that contain abundant mollusc shells; and 2) muds that geographically are peripheral to the sandier sediments.

The sands cored in area A lack internal depositional structures, with only one or two exceptions, and they are the most recent sediment to be deposited in the area of their occurrence. (See core logs 36d; 36c; 36b; 36a; 57a; 57b; and 57c in fig. 93.) The finer grained mixtures of silt and clay (mud) peripheral to the sand contain scattered laminae of sand but few discrete sand layers. The X-radiographs reveal zones of inclined to wavy silt laminae as the most conspicuous depositional features in

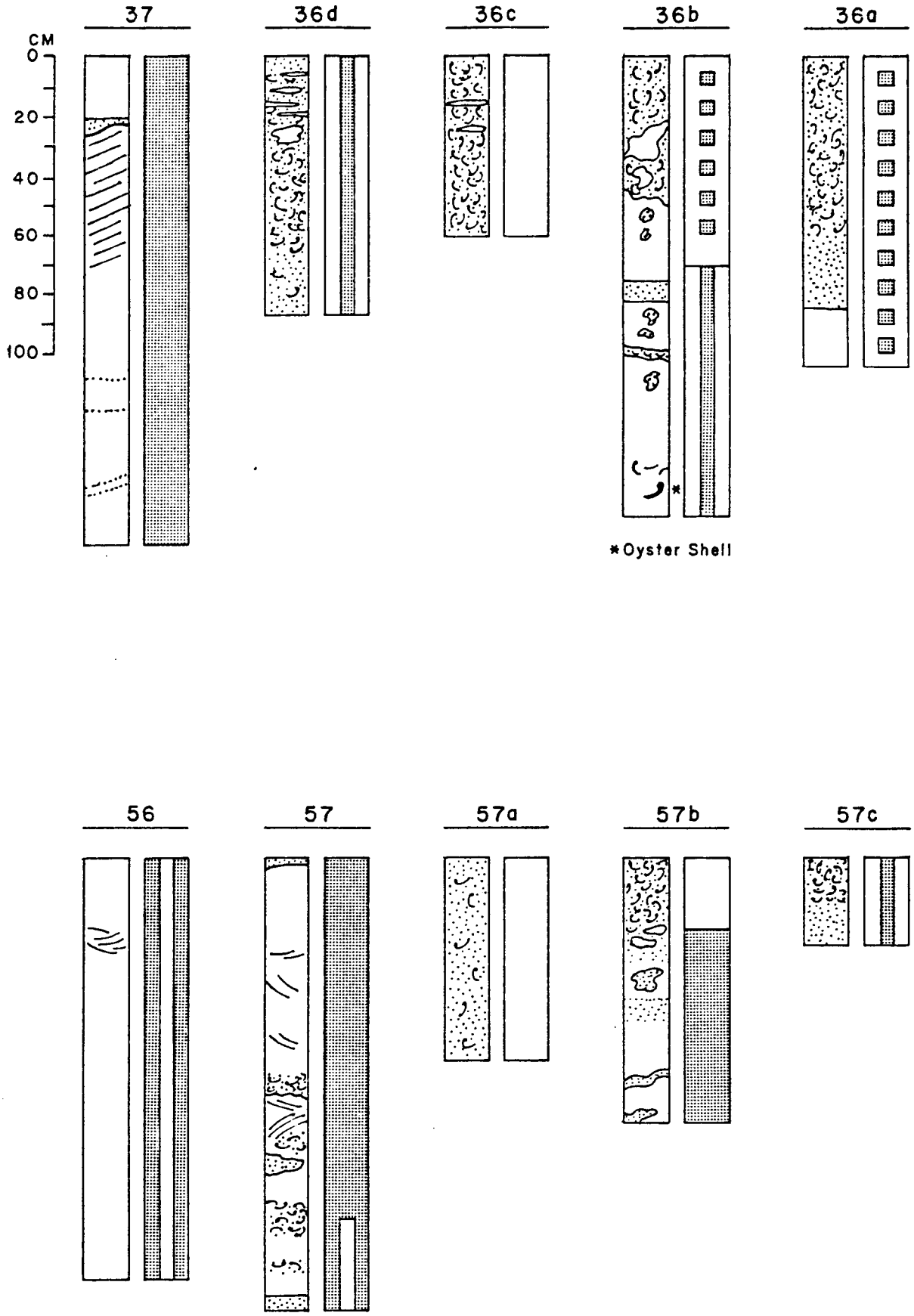


Figure 93. Diagrammed core descriptions, area A(1).

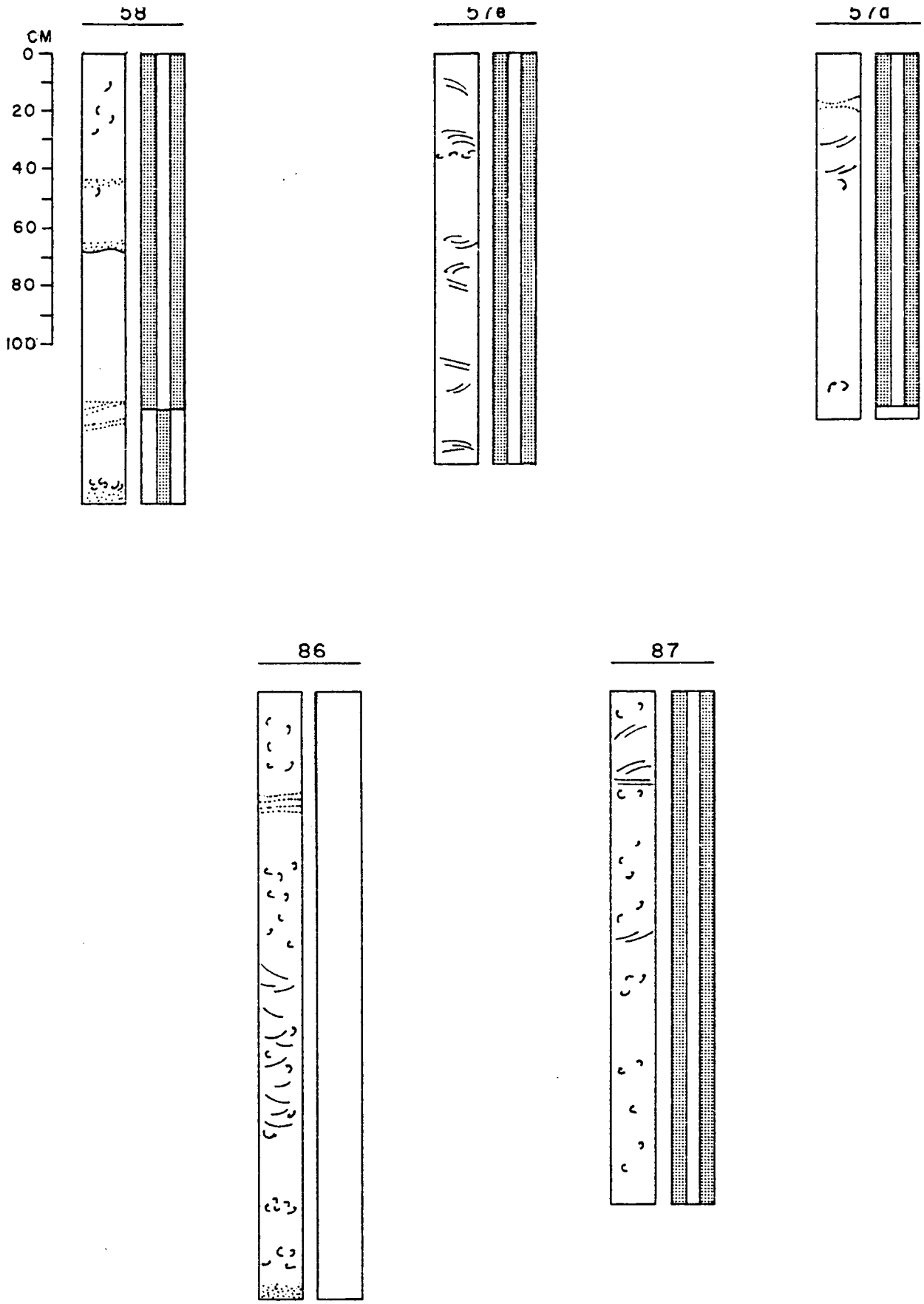


Figure 94. Diagrammed core descriptions, area A(2).

most of the finer grained cores; diminutive mollusc shells are scattered throughout cores 86 and 87 (fig. 94). In core 57 (fig. 93) some 60 cm of mud overlies sandy sediments, demonstrating overlap and encroachment of finer grained sediments onto the sands that lie along the northern part of area A.

Area B

The sediments in area B are relatively sandy, and the sand in the cores is distributed primarily as discrete layers and laminae throughout the cores. (See figs. 95 and 96 for the descriptive logs.) Shell remains are not numerous, but when present are confined almost entirely to the discrete sand layers, usually to the basal part. The mud between the discrete sands contains a predominance of silt over clay.

The principal depositional structure indicated by the cores is the very sharp basal contact of some sand layers with the underlying mud; in some cases, scour is apparent. The X-radiographs indicate both inclined and cross-laminations in some of the sand layers; textural gradation upward from coarse to finer grain size is typical of many layers.

Area C

As in area B, the sediments of area C contain discrete sands throughout. (See fig. 97.) However, the sand layers in area C are thinner, are more widely separated, and tend to be uniformly finer grained than in area B. Shell remains are scarce and the larger shells do not seem to be confined to the sand layers; fine shell

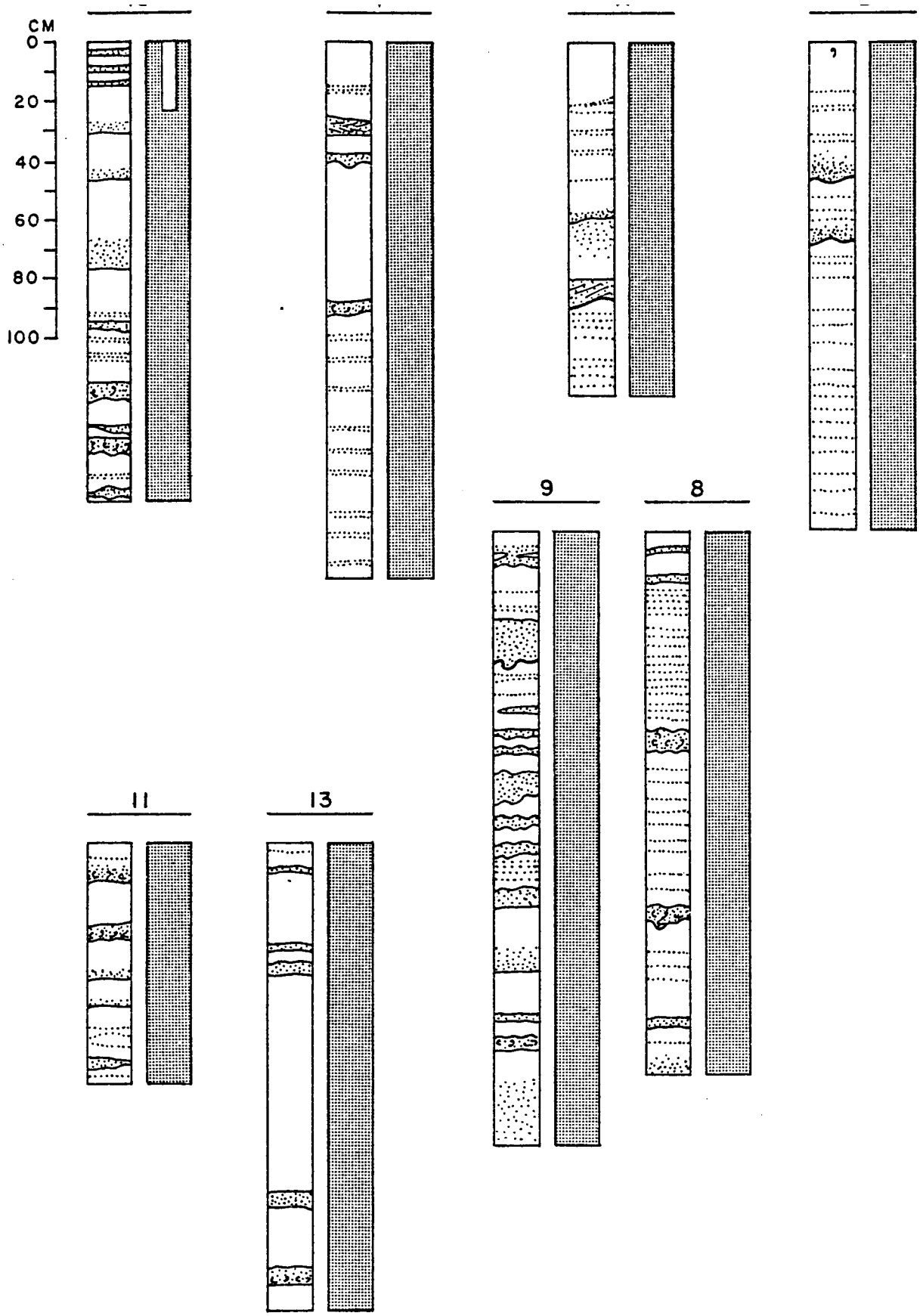


Figure 95. Diagrammed core descriptions, area B(1).

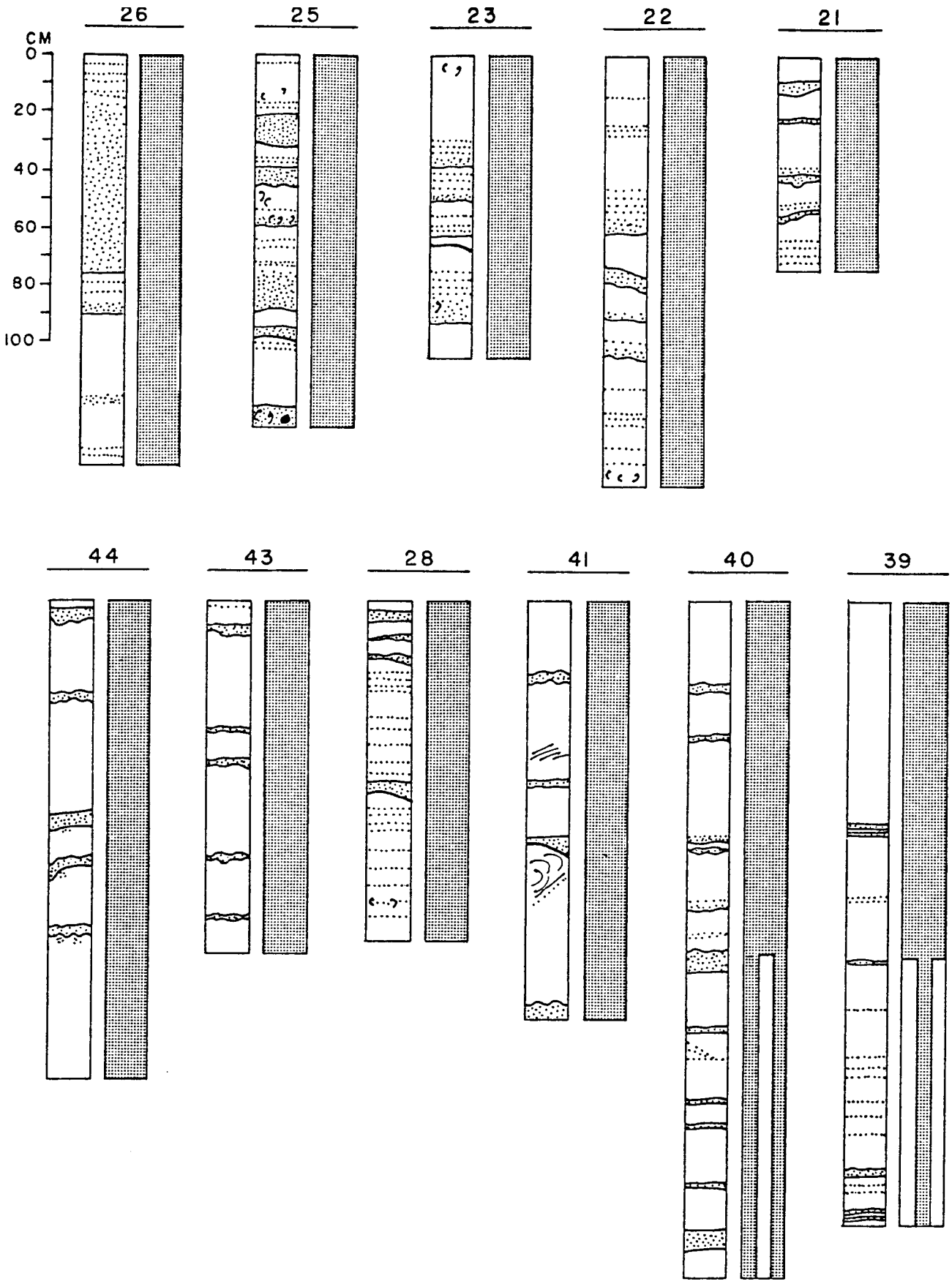


Figure 96. Diagrammed core descriptions, area B(2).

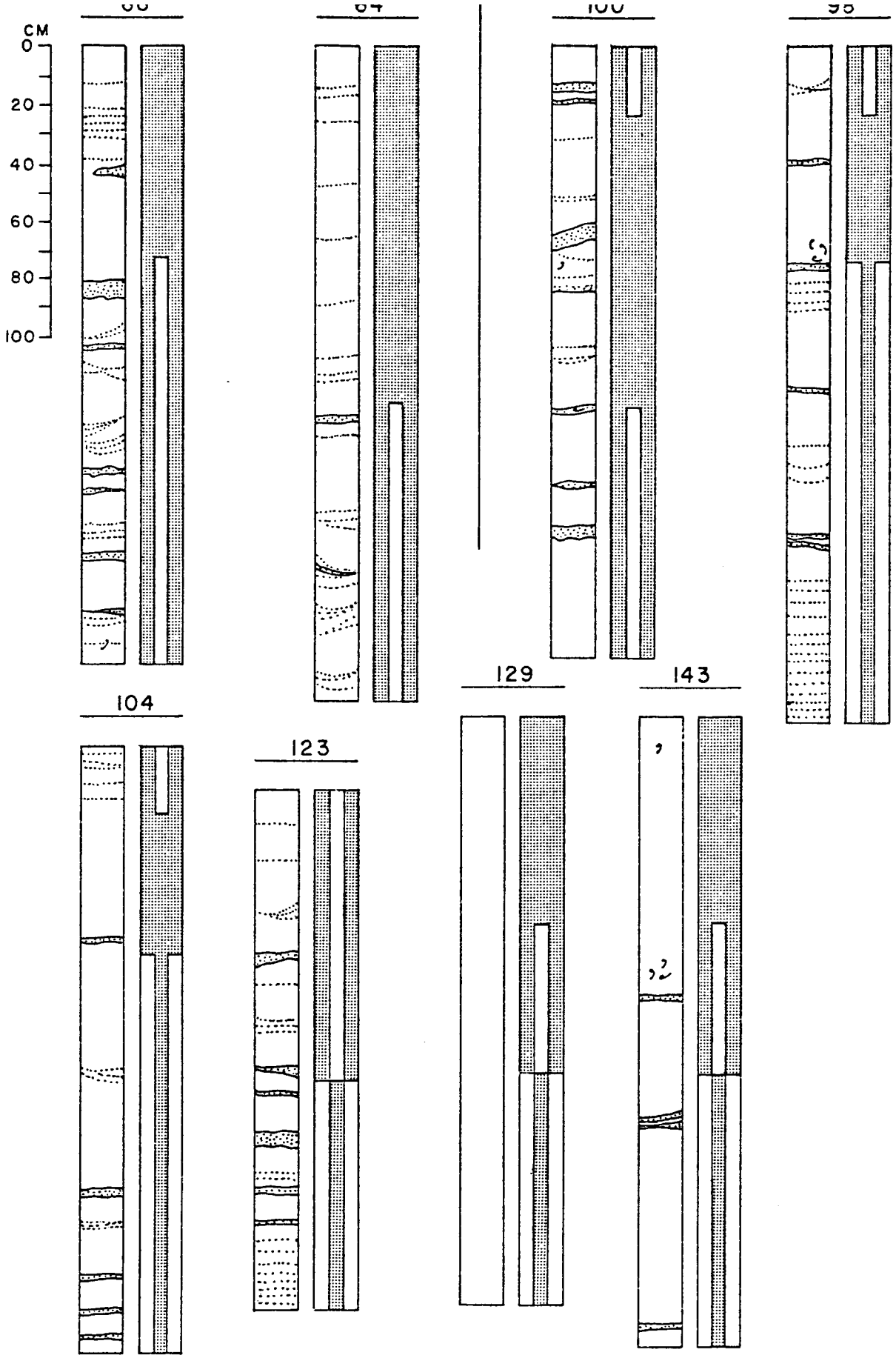


Figure 97. Diagrammed core descriptions, area C.

particles, too small to show on the diagrammed logs, are in some of the discrete sands.

Core penetration in area C generally was more uniform and to a greater average depth than in any other part of the shelf, except along the outer shelf beyond the reefs.

Area D

Two distinct types of deposits are indicated by the cores obtained in area D: predominantly sand along the western or shoreward part, and primarily muds over the eastern or seaward part. The core logs in figure 98 have been arranged geographically to emphasize the difference in the nature of the sediments within the area: those in the upper tier, with the exception of number 147, are the sandier cores from the western edge of the area; those in the lower tier are the muddier cores from farther out on the shelf. The transitory nature of the seaward decrease in the sand content of the sediments is shown by comparison of cores 165b, 166, 167, and 168, which lie along the same traverse.

The sand in the cores from the inner shelf gives little indication of internal depositional structures, but the numerous mollusc shells in the sand are arranged in layers rather than scattered randomly throughout the sand, as in the sand from area A. Also, the thin, discrete layers of mud within the units of sand indicate that the predominant process of sand deposition along the shoreward part of area D is punctuated from time to time by the deposition of finer material. The sand in the cores is, with one exception, very similar in texture and composition. That in the lower part of core 185a is almost totally quartzose, is very even

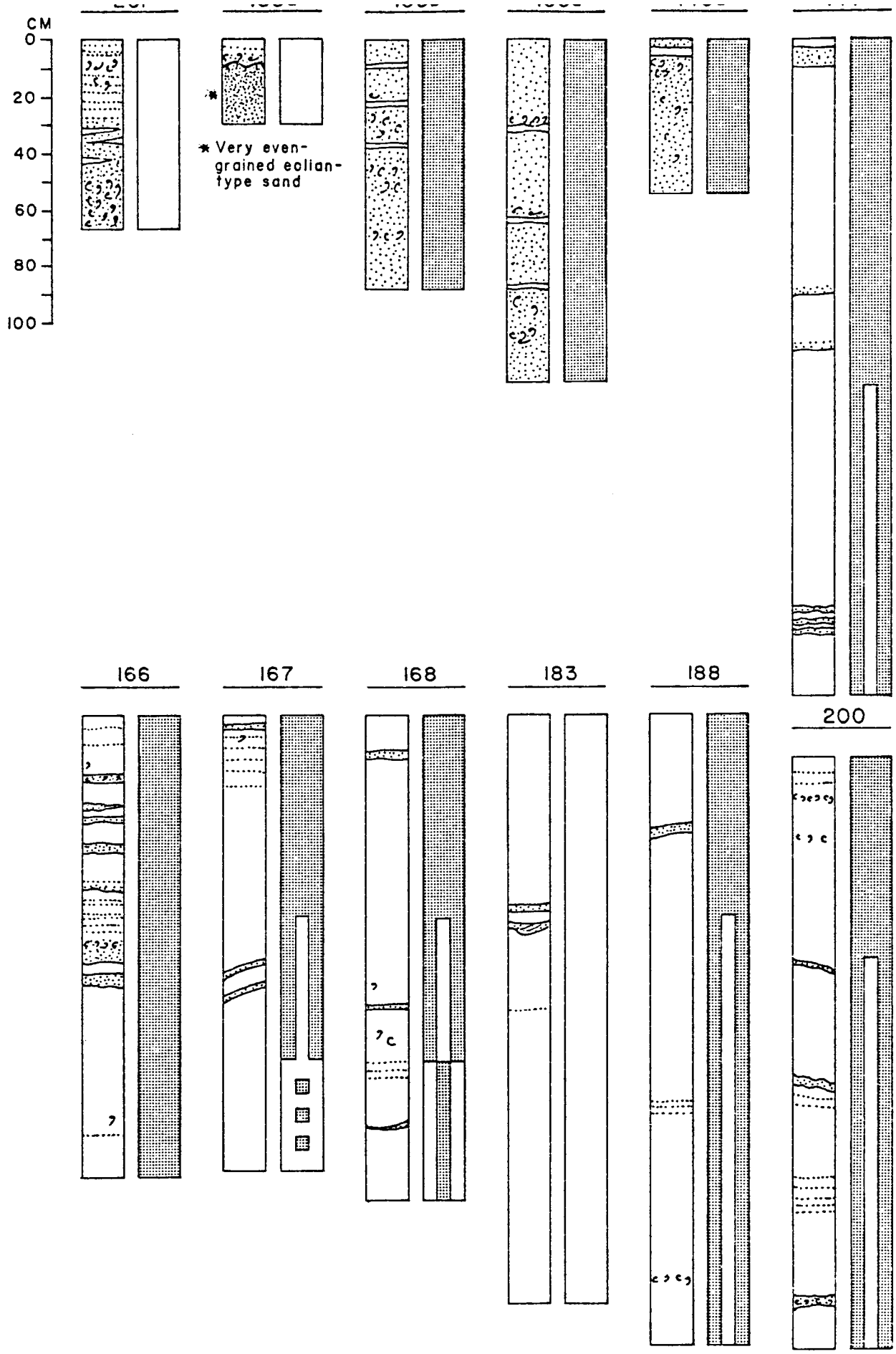


Figure 98. Diagrammed core descriptions, area D.

grained and has no shells. It represents depositional conditions different from those that now prevail in area D.

The cores shown in the lower half of figure 98, which represent the most seaward part of area D, generally have fewer discrete sands than those from area C, but otherwise the sediments are of comparable type, indicating similar conditions of deposition.

Area E

Sand containing abundant shells is the typical sediment in the cores from area E (fig. 99). Only core 248 has no sand. The amount of sand and shells varies considerably from one core to another, but decreases generally upward. Mud is the most recent deposit in all cores except 226a.

Three types of sand are represented in the cores in terms of depositional history. The sand in the basal parts of cores 223, 221 and 226a is highly quartzose, is very even grained, contains no shells, and is compact and firm; some intermixed clay gives the sand a distinctive greenish-gray color. The sand that lies in sharp contact with the basal sand in the cores listed and in the other cores is of less even grain size, contains an abundance of mollusc shells, and contains varying amounts of mud. Depositional structures generally are lacking in the sand, and the shells are randomly scattered; the sand becomes stratified and the shells are crudely layered in the upper parts of a few of the cores. The mud that lies above the main deposits of sand contains a few thin, discrete layers of sand that represent the third type of sand deposit in area E.

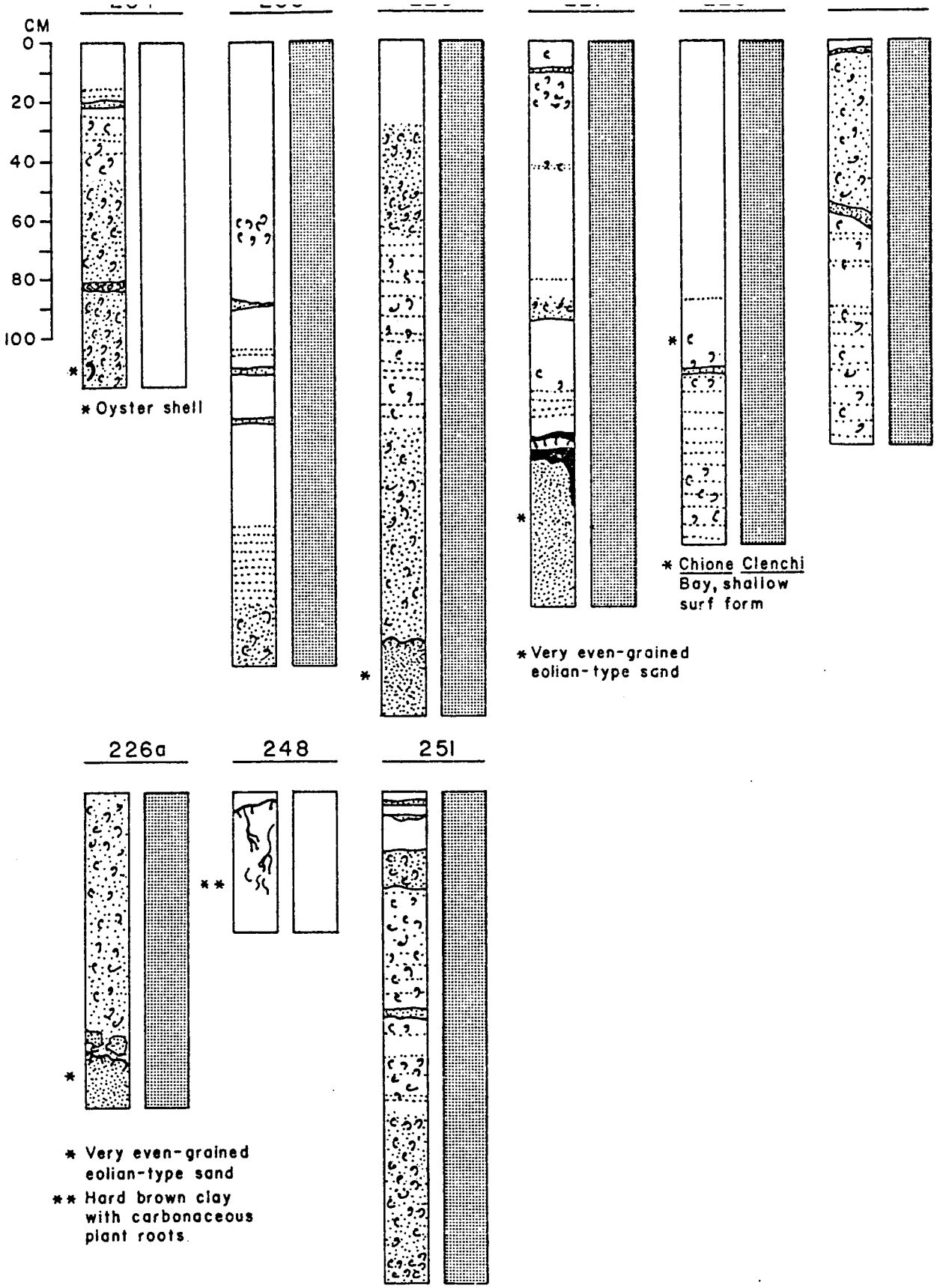


Figure 99. Diagrammed core descriptions, area E.

Area F

The definition of area F as outlined on figure 1 is purely arbitrary. In a broad sense, relative both to the physiographic subdivisions of the shelf and to the types of depositional processes operative from place to place across it, area F is representative of the outermost part of the continental shelf.

The four cores diagrammed in figure 100 are very fine grained mud virtually devoid of any obvious depositional structures. The X-radiographs of the cores reveal faint laminations that represent alternating laminae of clay-sized sediment and silt-sized particles, many of which are tests of foraminifera. Sand-sized grains make up less than 5 percent of the sediment; no discrete sand layers are in any of the cores from the outer shelf, including those on figure 100 and those taken during the first year. Scattered diminutive mollusc shells are a rare component of these sediments.

Summary and conclusions

In terms of depositional history, the cores described confirm the two general types of sedimentary deposits outlined by the first year of study: 1) the finer grained sediments of the central part of the South Texas OCS that contain varying amounts of sand, both as admixtures with the mud and as thin, discrete layers; and 2) the sandy sediments over the southern part of the OCS that contain abundant mollusc shells. In addition, the cores from area A, which was not sampled during the first year, revealed sandy, shelly sediments similar to those that floor the southern part of the South Texas OCS.

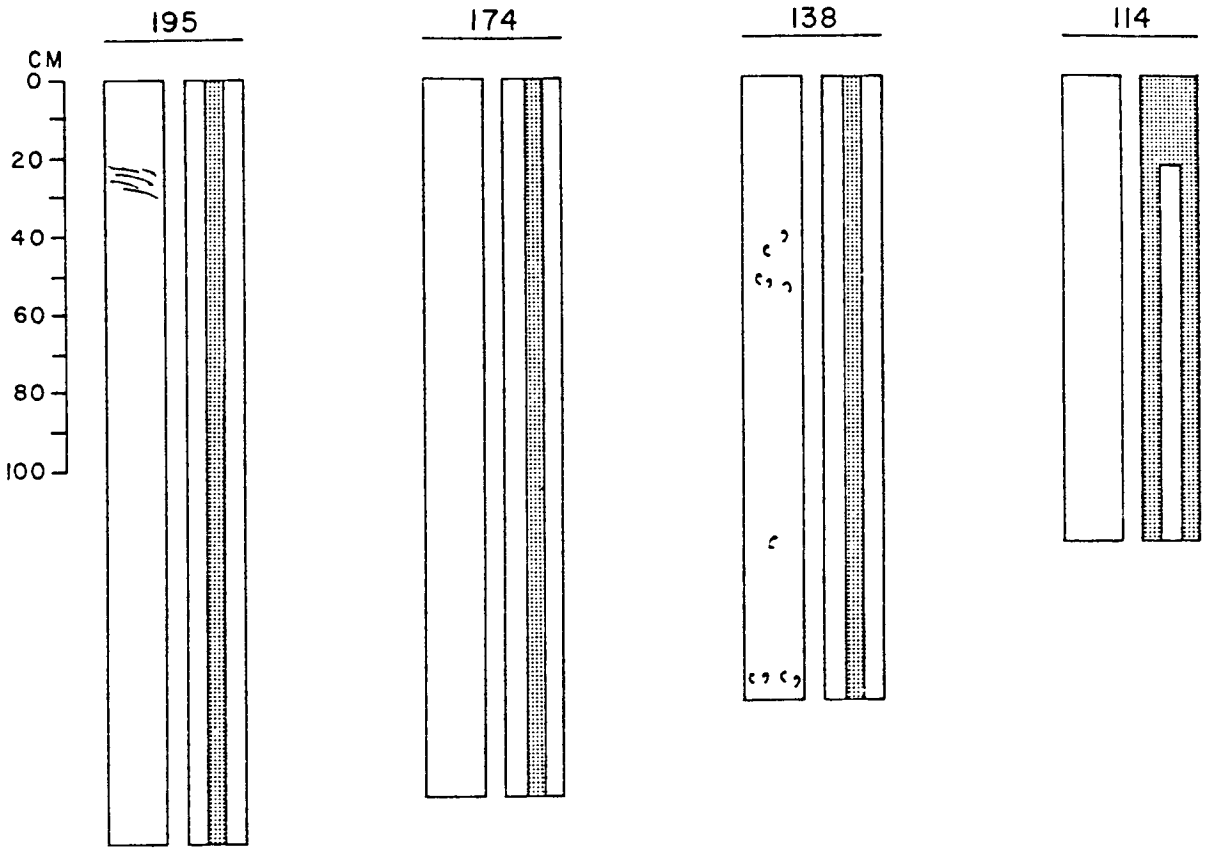


Figure 100. Diagrammed core descriptions, area F.

The 2 general types of sediments indicate not only 2 different depositional processes, but also 2 episodes of deposition: 1) an older period of primarily deltaic or fluvial deposition when the shoreline lay near the outer edge of the continental shelf and sea level was some 100 m lower than now; and 2) subsequent and progressive spreading of open shelf marine sedimentation during the rise of sea level across the shelf from its previous lower position. The sandy, shelly deposits to the north and south are the submerged relict deposits of the earlier episode when both deltaic and shallow marine sediments were spread across the shelf; the generally fine-grained sediments of the central shelf that are beginning to overlap the older sands to the north and south represent the episode of sedimentation now in progress.

Core Descriptions, Reef Traverses

South Baker Reef

The cores from around South Baker Reef indicate sediments of a textural composition similar to the sediments in areas B and C. The sand-sized grains are predominantly quartzose, but foraminiferal tests are common and make up 25 percent or more of the sand fraction in some segments of the cores. Each of the gravity cores contains discrete sand layers, but they are most numerous to the east, west, and south of the reef. (See fig. 101 for the core descriptions and fig. 88 for their locations.) The longer piston cores taken by Texas A&M University reveal that the deeper lying sediments are similar in textural composition to the shallower sediments cored by USGS. (See fig. 102.) Notably, individual sand layers are at a common depth in a majority of

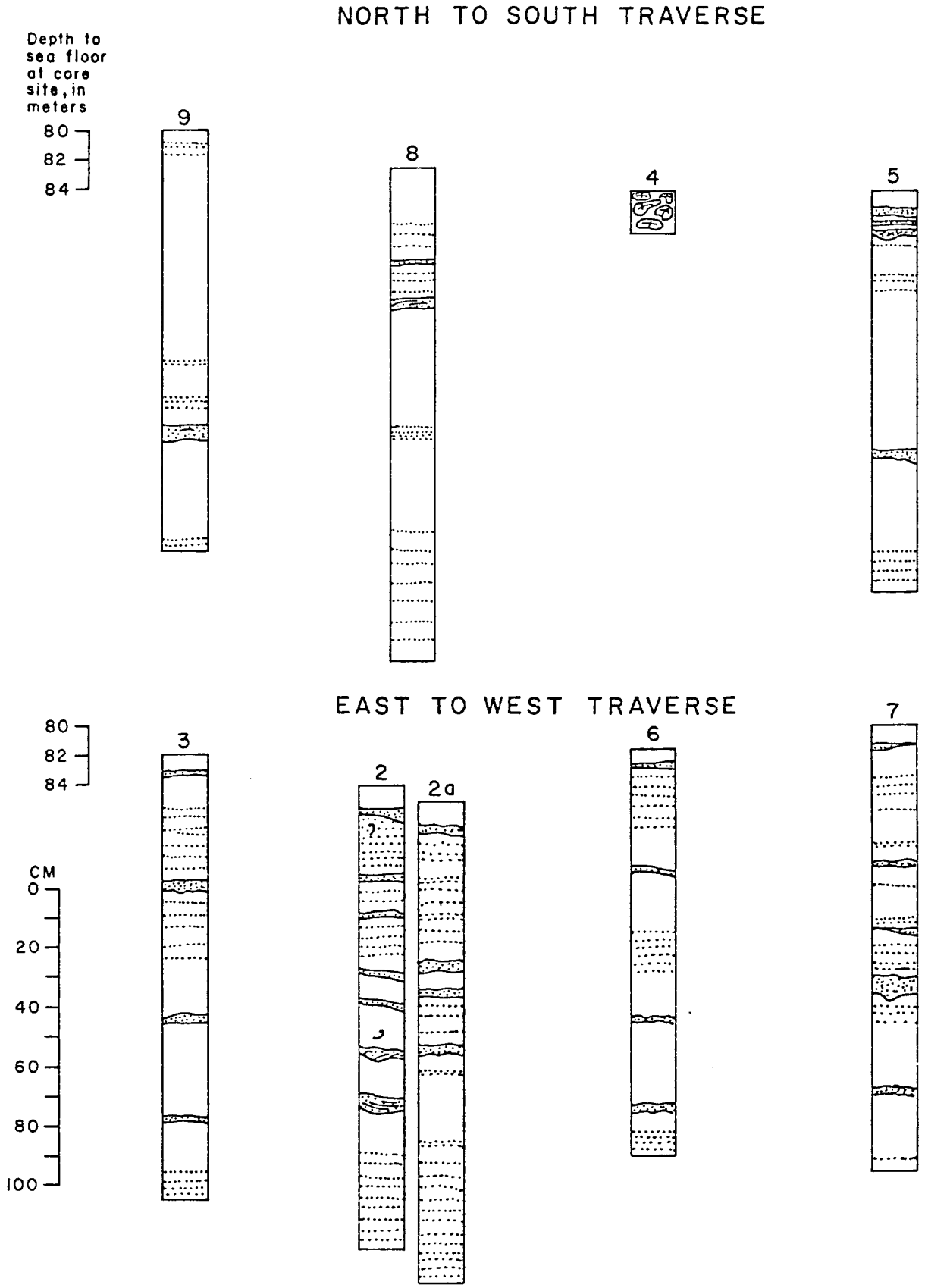


Figure 101. Diagrammed core descriptions, South Baker Reef. Cores collected by USGS. See figure 88 for locations.

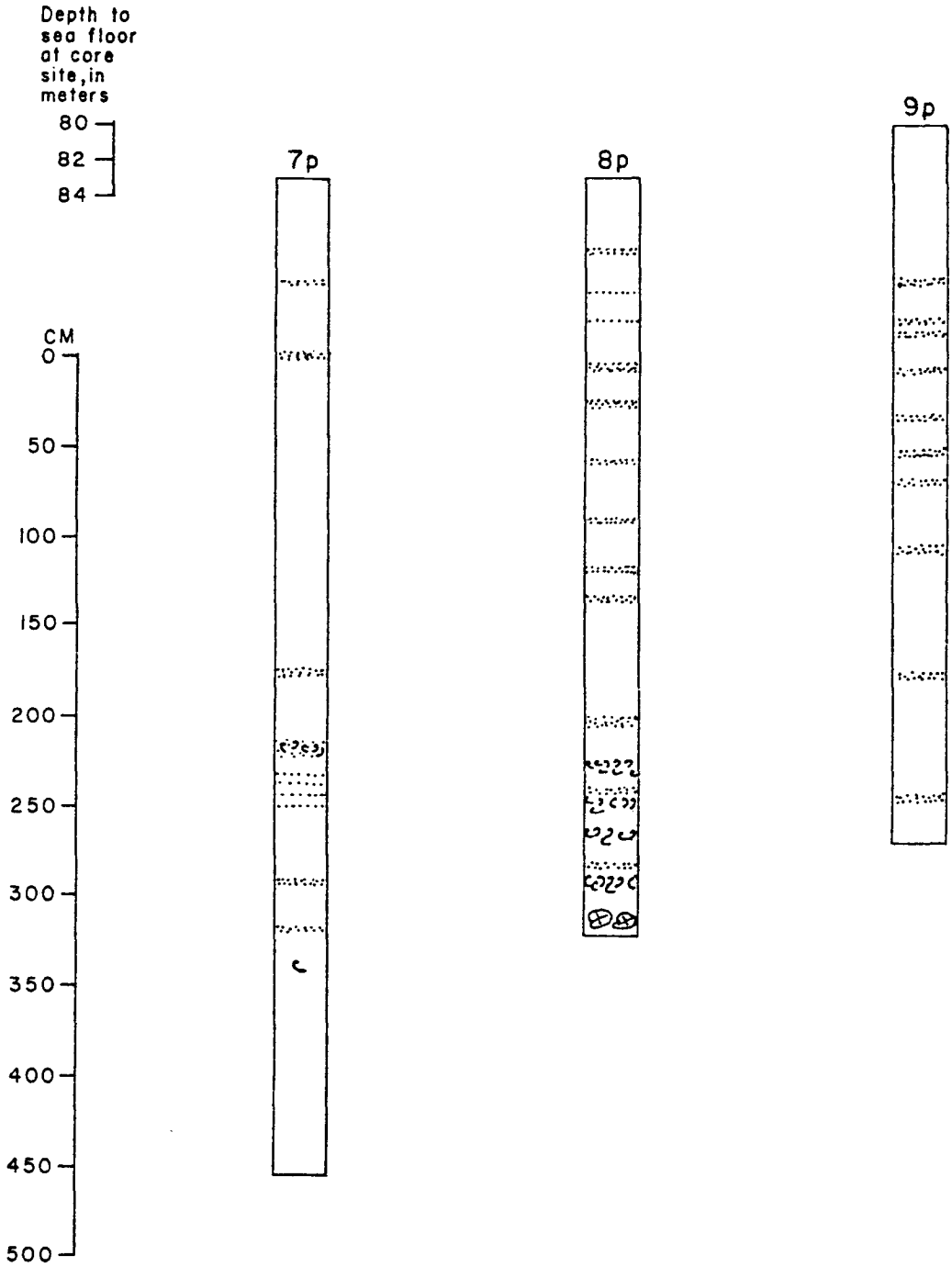


Figure 102. Diagrammed core descriptions, South Baker Reef. Cores collected by Texas A&M University (Bright, Rezak and others, 1976). See figure 88 for locations.

the cores, suggesting correlation from core to core. Those having the highest indices of occurrence at a common depth are at 10 cm, 45 cm, and 90 cm below the sea floor surface.

The principal depositional structure within the sediments, as indicated by the X-radiographs, is fine interlaminations caused by alternations in the size of grains; sand laminae are common. Internally the discrete sand layers have irregular to crude cross-laminae.

The scarcity of reef debris, even to the depths of several meters penetrated by the piston cores, is a characteristic of the cores around South Baker Reef. Coarse surficial reef rubble at site 4, virtually on the edge of the reef, stopped core penetration; at site 7P, which is within a few tens of meters of the edge of the reef, the more than 5 m of sediments cored contained a few shells, concentrated mostly in one layer, but no reef rubble.

Hospital-Aransas Reefs

The cores taken in the vicinity of Hospital-Aransas Reefs provide a somewhat localized indication of sediment types, as they are not arranged systematically in traverses as are the cores from near the other reef sites. The sediment in the four cores diagrammed on figure 92 is principally mud, containing a number of discrete sand layers, which are most numerous in the lower half of the cores. The sediments cored are similar to those around South Baker, both in overall composition and in the general number of discrete sand layers.

Carbonate organic remains from the reefs were collected only in core 80-1, located some 305 m west of the edge of Aransas Reef. The core

consists of a series of crudely cyclic deposits of interlayered reef debris and mud. The reef debris is a mixture of mollusc shells, coral fragments and reef rock particles, in which the shells and reef rock are predominant. The particles of reef debris, though sorted by size internally within a bed to form a sort of crude textural stratification, cannot be classified as well sorted overall; particles range in size from < 2 mm to approximately 1.5 cm. Within the individual beds of reef debris, crude vertical grading of particles is indicated. In some beds, grading is from coarse to fine upward, but in others the grading is reversed.

The geographic positions of cores 80-1 and 80 give a good indication of the distance debris has been carried away from the submerged reefs which lie some 45 km from shore and at a water depth of some 85 m. The sediment deposited under normal conditions of water movement around the reef is fine-grained material (mud); yet core 80-1, 305 m to the west of the reef, is predominantly reef debris that is interlayered with the mud throughout the core. Sediment of a particle size far coarser (gravel size) than the < 63 μ typically transported to the site has been moved a distance of at least 305 m from time to time. As core 80, which is located 732 m west of the reef, contains no reef debris, the actual distance the gravel-sized material is transported exceeds 305 m but is less than 732 m. The layers of coarse debris in otherwise very fine grained sediments indicate that the energy level of water moving across the reefs occasionally has exceeded substantially that normal to the outer part of the shelf. At such times bottom currents have been sufficiently

strong to carry particles of gravel size up a slight gradient for a distance of a least a quarter of a mile over a soft mud bottom.

Dream Reef

The sediment in the cores from Dream Reef is variable, both in type and texture; very fine grained material (mud) and reef debris are the dominant textural components. (See figs. 103 and 104 for the logs and fig. 89 for their locations.) The few discrete sand layers are relatively thin and random; only three cores (sites 3, 7, and 8) have a sand layer at a common depth. The sand at 90 cm in the three cores corresponds in depth to the most prevalent sand layers in the cores from South Baker Reef. Mica makes up as much as 25 percent of some sand layers. Debris from the reef is common in the sediments around Dream Reef, but it is quite variable in coarseness and is not evenly distributed. The cores around the western perimeter have the most debris, except for sites 4 and 5 which may lie on a terrace connecting the two hummocks that make up Dream Reef; site 7, some 610 m west, yielded the debris most distant from the reef. The layers of larger rubble in cores 59P and 61P and at the base of 7 are at the same depth in the three cores, and they are both overlain and underlain by fine-grained material.

Depositional structure, like texture, is variable. The thickest sequences of debris are poorly sorted with no evidence of layering; in other cores, the finer reef fragments are layered. The debris in core 7, the farthest from the reef, is well layered.

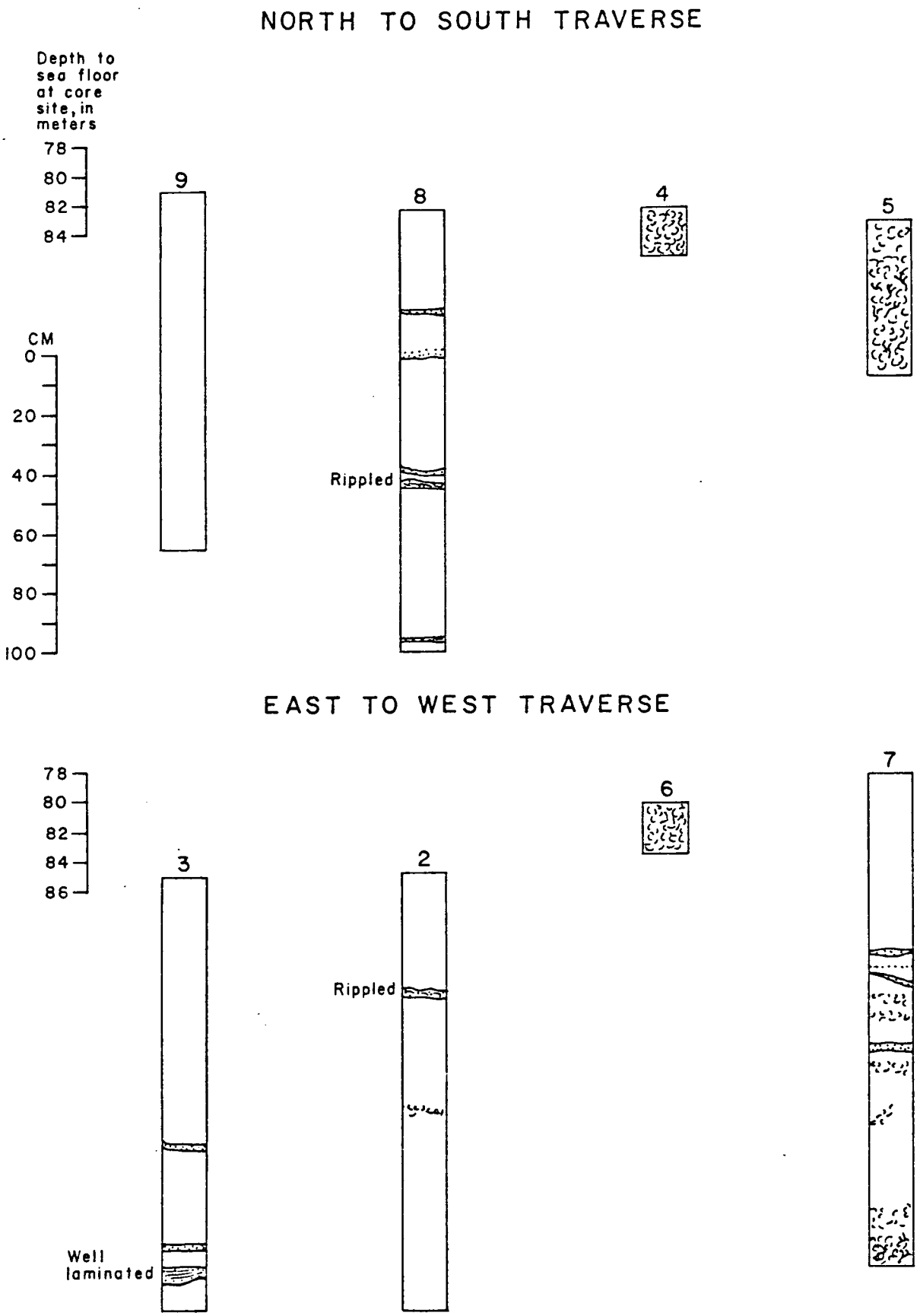


Figure 103. Diagrammed core descriptions, Dream Reef. Cores collected by USGS. See figure 89 for locations.

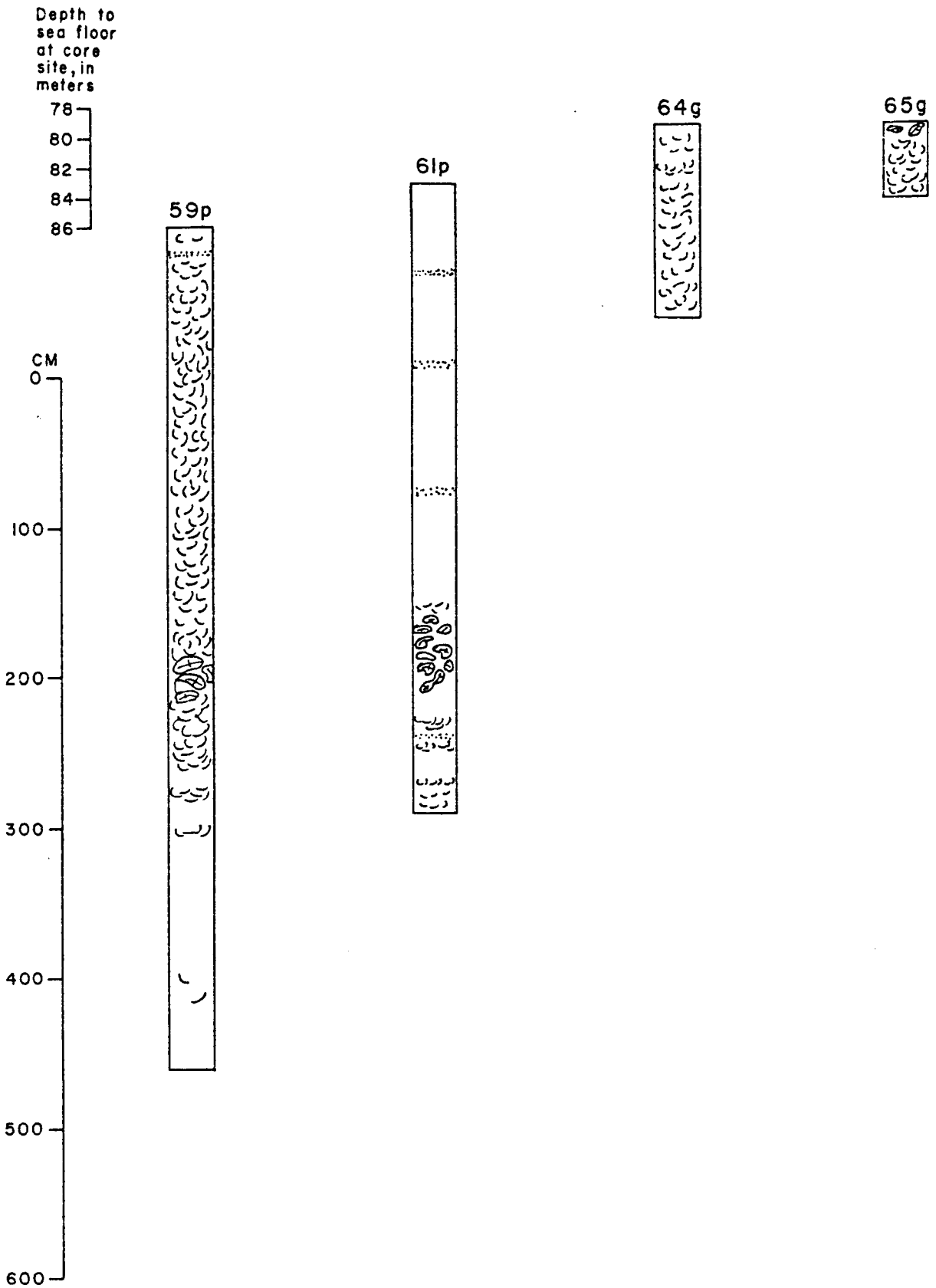


Figure 104. Diagrammed core descriptions, Dream Reef. Cores collected by Texas A&M University (Bright, Rezak and others, 1976). See figure 89 for locations.

Big Adam Reef and Small Adam Rock

Very fine grained sediment or mud is the predominant component in the cores around Big Adam Reef and Small Adam Rock. (See figs. 105 and 106 for the core logs and fig. 90 for their locations.) Sediment particles coarser than silt size are principally reef and shell debris. Discrete sand layers were encountered at only two sites: cores 9 and 7 have one layer each but not at the same depth. A distinctive mineralogical component of both the silt and sand-size fractions in the sediments around Big Adam Reef is mica; it makes up about one-third of the sand layer near the top of core 9 (fig. 105).

Reef rubble was cored at 3 sites, and layers of shell and shell debris were cored at 7 sites. Little if any correlation of layers can be made from core to core, except perhaps between cores 4 and 5, which came from south of Big Adam Reef. Fragments of coral are in several cores, and oyster shells are in core 5.

Unnamed reef

The typically fine-grained sediments around this reef contain an abundance of reef debris and shells, significantly more so than the sediments around the other reef sites described. Very coarse carbonate rubble is in three cores. (See fig. 107 for the logs and fig. 91 for their locations.) The material shed from the reef seems to be almost equally abundant in all directions from the reef and is in each of the outermost cores some 300 m from the edge of the reef.

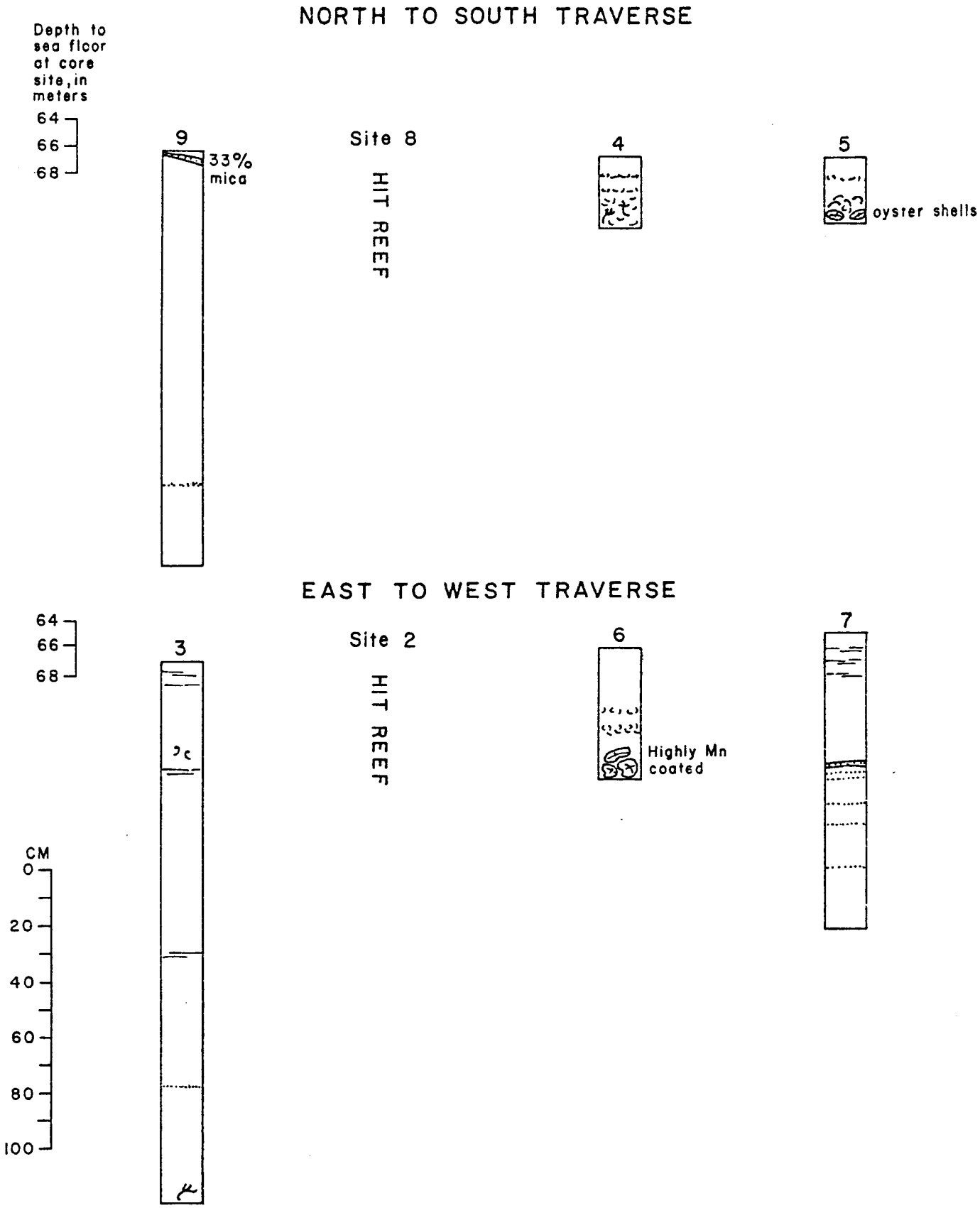


Figure 105. Diagrammed core descriptions, Big Adam Reef and Small Adam Rock. Cores collected by USGS. See figure 90 for locations.

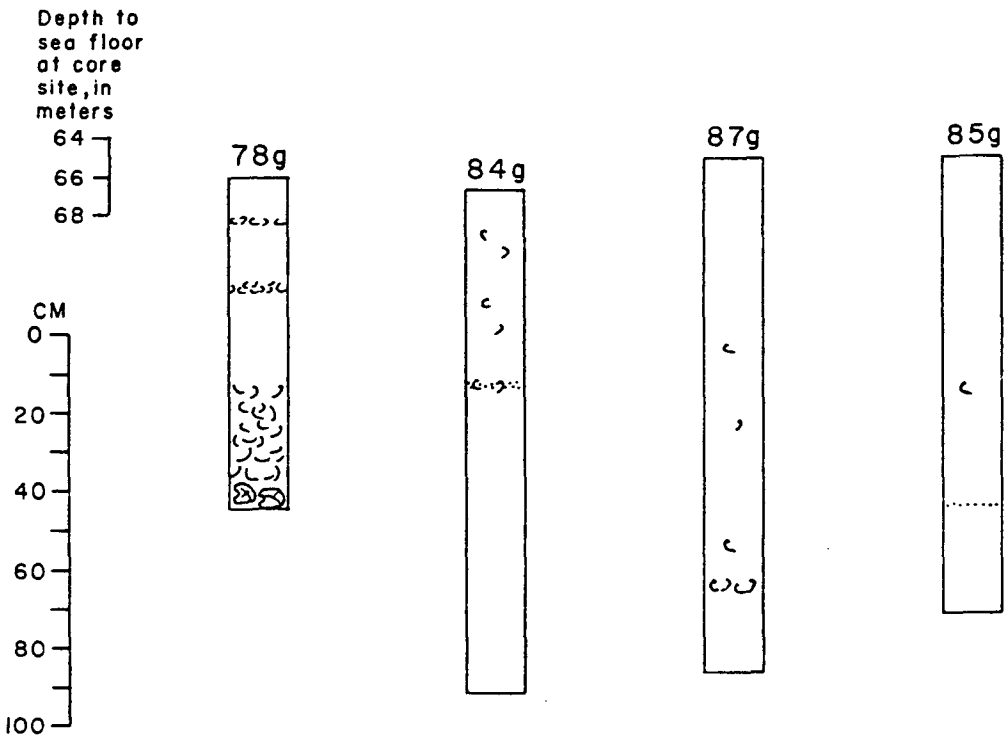


Figure 106. Diagrammed core descriptions, Big Adam Reef and Small Adam Rock. Cores collected by Texas A&M University (Bright, Rezak and others, 1976). See figure 90 for locations.

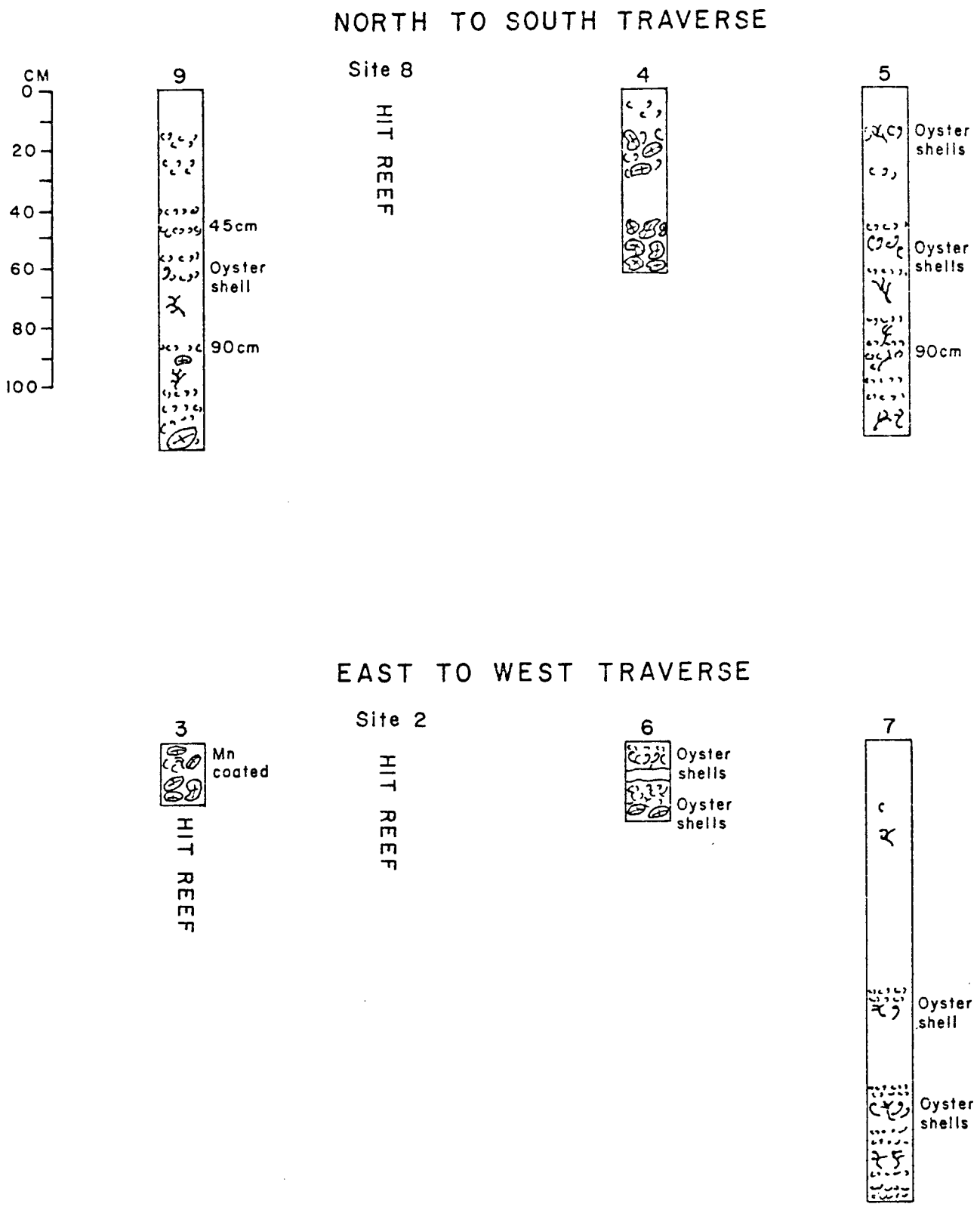


Figure 107. Diagrammed core descriptions, unnamed reef. Cores collected by USGS. See figure 91 for location. No accurate bathymetry data available for reef proper.

The reef debris, except for the very coarse rubble, is well layered, indicating transport and deposition by water moving with some speed. The shells and debris are interlayered with mud, and massive, incoherent dumping of material around the reef is not indicated. The unnamed reef, near the southern end of the group of reefs along the South Texas OCS, is noteworthy for the large amount of both coral fragments and oyster shells. Four species of coral have been tentatively identified: Madracis asperula; Madracis cf. myricaster; Madracis cf. mirabilis; and Eusmilia fastigrata. Two species of oysters have been tentatively identified, Ostrea equestris and Ostrea sp.

Summary and conclusions

On the outer part of the South Texas OCS, the submerged reefs that now lie in water depths of about 90 m are relicts that formed and grew in a shallow water environment. They document the general geographic position of the shoreline during the last low stand of sea level at the end of Pleistocene time. Because some of the reefs have not as yet been completely buried by the Holocene sediment deposited during the latest rise in sea level, they still are potential sources of erosional debris. Consequently, the extent to which the debris is distributed in the uppermost sediments around the reefs offers a possible clue to the maximum energy level reached by the bottom waters over the outer shelf. The cores from around the reefs indicate that reef debris up to 1.5 to 2 cm in diameter is interlayered with the very fine grained mud at least to the depths penetrated by the cores. High resolution seismic reflection profiles indicate that the average maximum thickness of sediment above the distal edges of the buried reef platforms is about 12 m. The bases

of the reef platforms are coincident with the angular unconformity that marks the base of the Holocene deposits, thus the full thickness of sediments deposited on the outer shelf around the reefs during the transgressive rise in sea level is well established. The nature of the sedimentary processes involved is as follows:

1. Deposition of fine-grained material of less than 63 μ particle size is the prevailing process. The fine-grained mud now reaching the outer shelf seems to come primarily from terrestrial sources and is carried in suspension seaward across the shelf. The regional patterns of dispersal for the suspended material on a seasonal basis are described by Shideler in another section of this report. The relatively large numbers of microzooplankton tests in some of the cores indicate some pelagic sedimentation as well. The rates of accumulation for the mud could not be established from the cores described. A special study by Holmes of rates of sedimentation over the past 200 years, using ^{210}Pb as a dating agent, is described in another section of this report. His dating analyses indicate that the most recent sediments are accumulating at a rate of a little more than 1 mm per year along the part of the outer shelf in which the reefs lie. The rate determined by Holmes for the most recent sediments is essentially the same as the 0.9 mm per year average for the overall Holocene sequence, assuming that the elapsed time has been 13,000 years.

2. Quartzose sediment particles of sand size (> 63 μ) are subordinate in quantity to both mud and reef debris in the deposits around most of the reefs, yet thin, discrete sand layers are in most of the cores. Regionally these discrete sand layers are most numerous around the northernmost reefs where they predominate over reef debris; they decrease in number progressively southward and are absent around the unnamed reef near the southern end of the series. The abundance of quartzose sand in the northern part of the outer OCS suggests that the sand is more prevalent there because that part of the shelf is closest to the main sources for the sediment now being carried onto the South Texas OCS. However, the significant amounts of mica and foraminiferal tests mixed with the quartz grains, plus the very intricate interlamination of the textural components in most of the discrete layers, suggest that the sands also may represent in part lag deposits that accumulate as a result of stirring of the bottom by fairly persistent currents. The persistence of a prominent nepheloid layer around the reefs has been documented. Thus two processes seem to be involved in the accumulation of discrete sands around the reefs: normal sediment transport across the shelf, plus some redistribution and reconcentration by bottom currents. As the sand layers seem to be more numerous in the sediments peripheral to the reefs than in the midshelf sediments to the west of the reefs, the assumption can be made that the currents which winnow and redeposit the sands around the reefs are moving onto the outer shelf from the deeper gulf. The sand-sized particles, being slightly coarser than the predominantly finer grained particles carried

by the bottom currents, may tend to accumulate around the reefs because the reefs disrupt and decrease the velocity of water moving over and around them.

3. The presence of reef debris as interlayers in the mud that surrounds the reefs indicates that seawater of an increased velocity has moved intermittently across the reefs and has swept the debris onto the adjacent sea floor. The maximum distance the debris has been carried from the reefs, on the basis of the cores studied, is between 300 and 500 m. The spreading of the debris in individual layers or beds within an otherwise muddy sedimentary environment and the crudely layered arrangement of some of the debris itself within the beds indicate the episodic nature of the process. Viewed within the context of the known transgressive rise in sea level during the Holocene, the logical conclusion for the presence of debris in the muds around the reefs is that the debris was swept off the reefs during storms when the water depth over the reefs was much shallower. It seems doubtful that even hurricanes could cause increased bottom water velocities at depths of 90 m sufficient to carry reef debris up to 2 cm in diameter for distances of 300 m or more. The evidence from the cores suggests that fine sand is the maximum particle size now being transported by bottom currents moving around the reefs during the period of highest velocity. Furthermore, the depth of burial of the uppermost layers of debris in the cores increases progressively in a south to north direction, indicating: 1) that the rates of most

recent sediment deposition are higher to the north and that the primary source of sediment reaching the South Texas OCS is to the north or northwest; and 2) that the southernmost reefs probably are not only younger than the northernmost but have had a different history of growth as well.

Incremental Analyses of the Cores

General statement

The incremental analyses of the cores in segments of 30 cm included: estimated percent of sand-sized particles; number of discrete sand layers, and areal extent of individual discrete sand layers that are at the same subseafloor depth in a significant number of cores. As relict deltaic deposits are at shallow subseafloor depths over the extreme northeastern and the southern parts of the South Texas OCS, the thickness of the late Holocene shelf transgressive deposits in those areas, as indicated by the cores, is shown by figure 108.

The results of the incremental analyses, which include all cores collected during the first year as well as those collected during the second, are shown by the series of maps in figures 109 through 113. As the incremental analyses included 3 types of syntheses, each figure covering the 4 increments from 0 to 120 cm includes 3 maps that are labelled a, b, and c: a) the percentage of sand; b) the number of discrete sands; and c) the distribution of individual discrete sand layers that are at the same depth in a number of cores. As some of the cores did not penetrate an additional full 30 cm increment below a depth of 90 cm, maps showing sand layers at a common depth in the

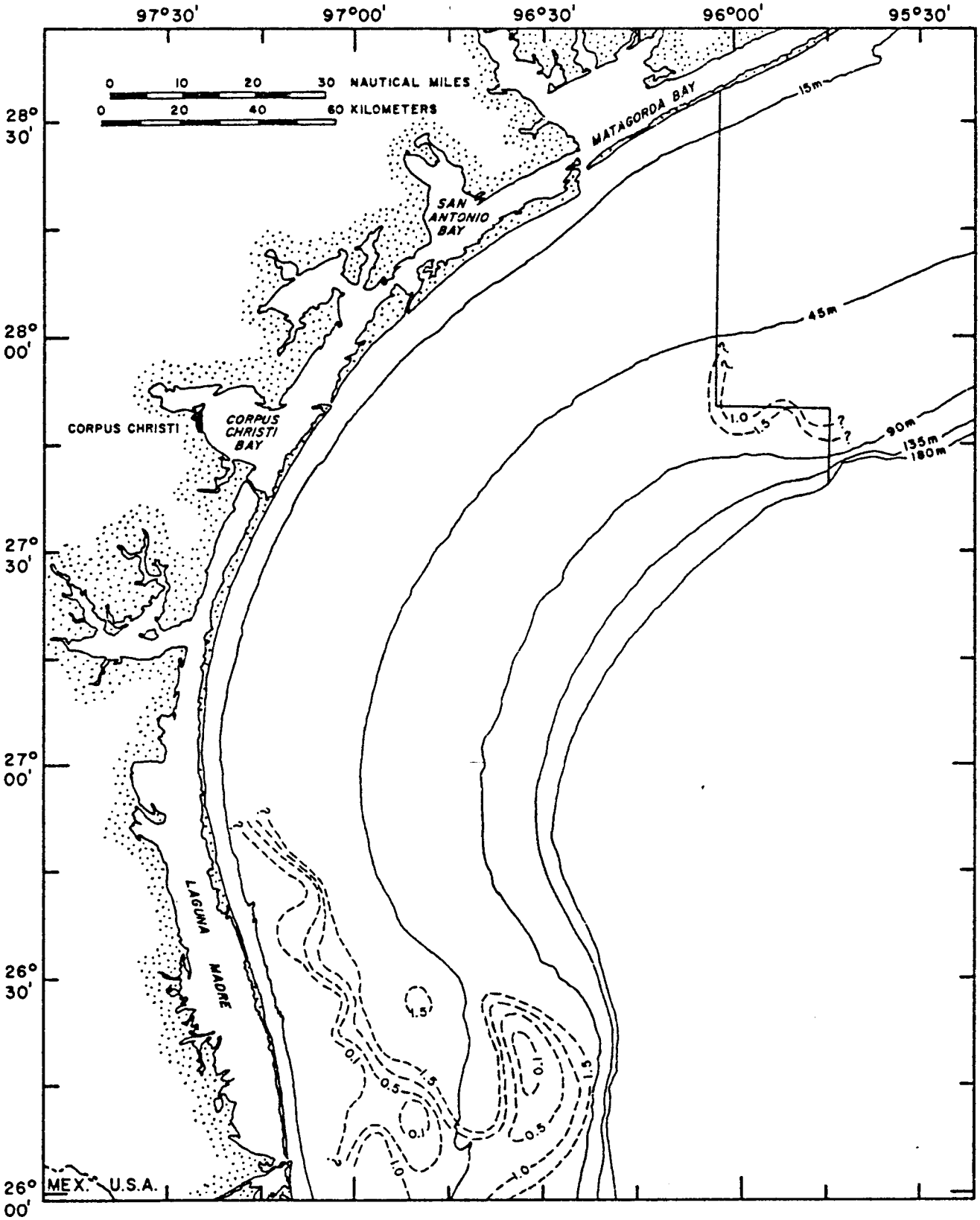


Figure 108. Thickness of Holocene shelf transgressive sediments that overlie relict deltaic deposits, as indicated by cores. Thickness in meters.

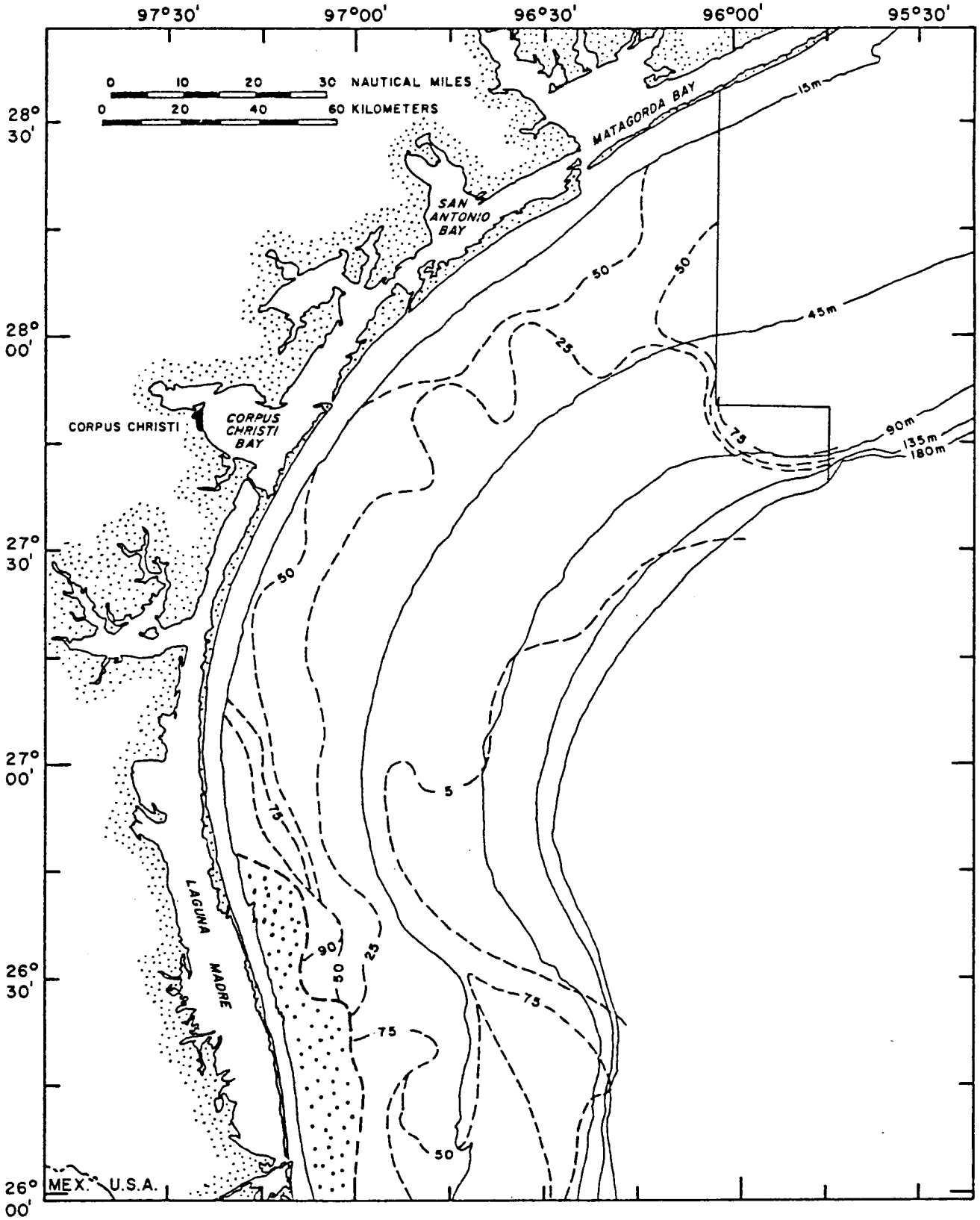


Figure 109a. Estimated percentage of sand-sized detritus in the core depth interval, 0-30 cm. Stippling indicates area of relict deltaic deposits generally not penetrated to a full depth of 30 cm.

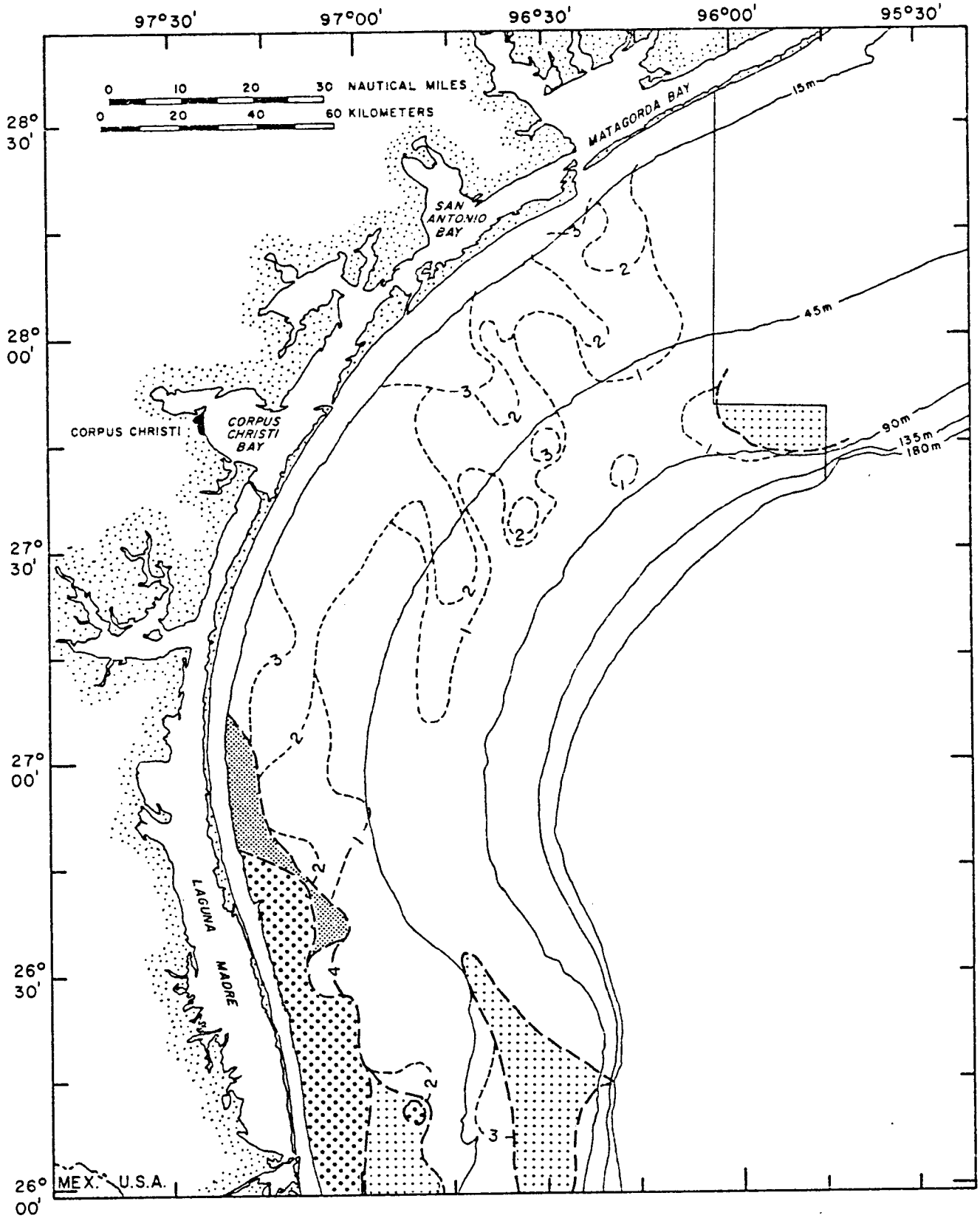


Figure 109b. Number of discrete sand layers in the core depth interval, 0-30 cm. The areas outlined contain the number of sand layers indicated along the dashed lines. The fine stippling indicates that transported sand makes up 90 percent of the interval. The heavy stippling indicates that relict deltaic deposits make up most of the interval; the medium stippling indicates that the interval is primarily reworked deltaic sand.

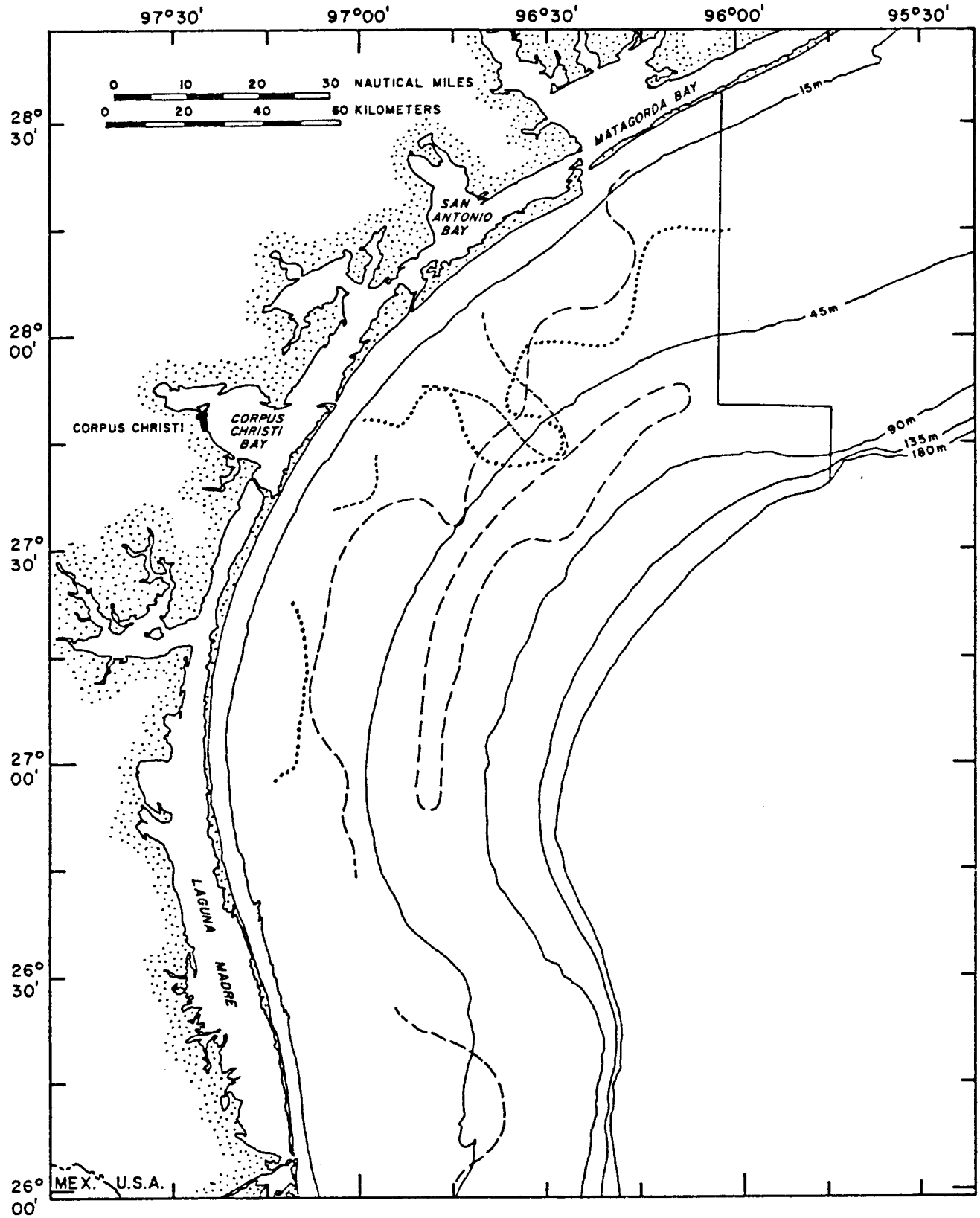


Figure 109c. Distribution of discrete sand layers that lie at the same subseafloor depth in most of the cores in a given area (0-30 cm): 5 cm - dotted line; 10 cm - long dashed line; and 20 cm - short dashed line.

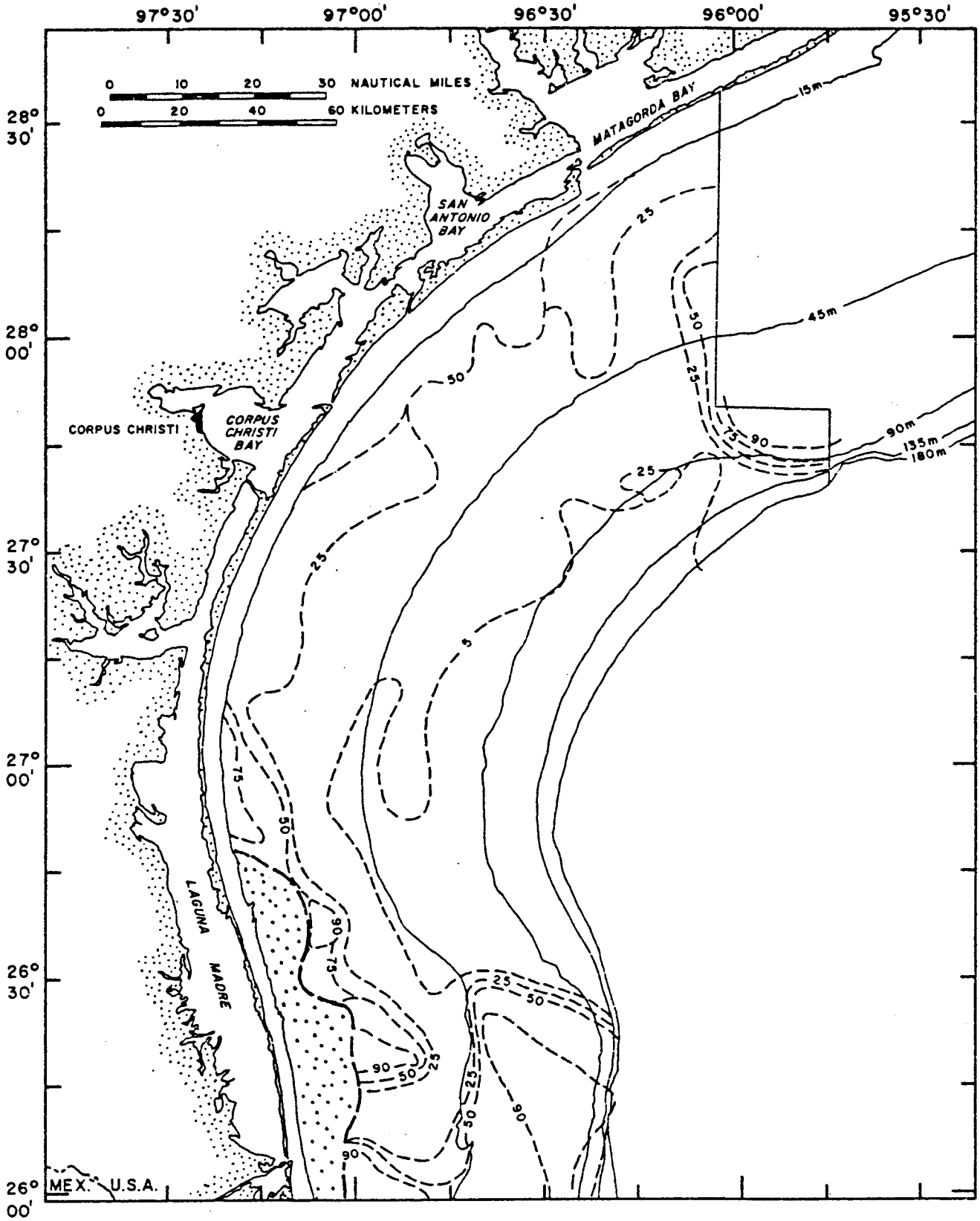


Figure 110a. Estimated percentage of sand-sized detritus in the core depth interval, 30-60 cm. Stippling indicates area of relict deltaic deposits not penetrated to full depth of interval.

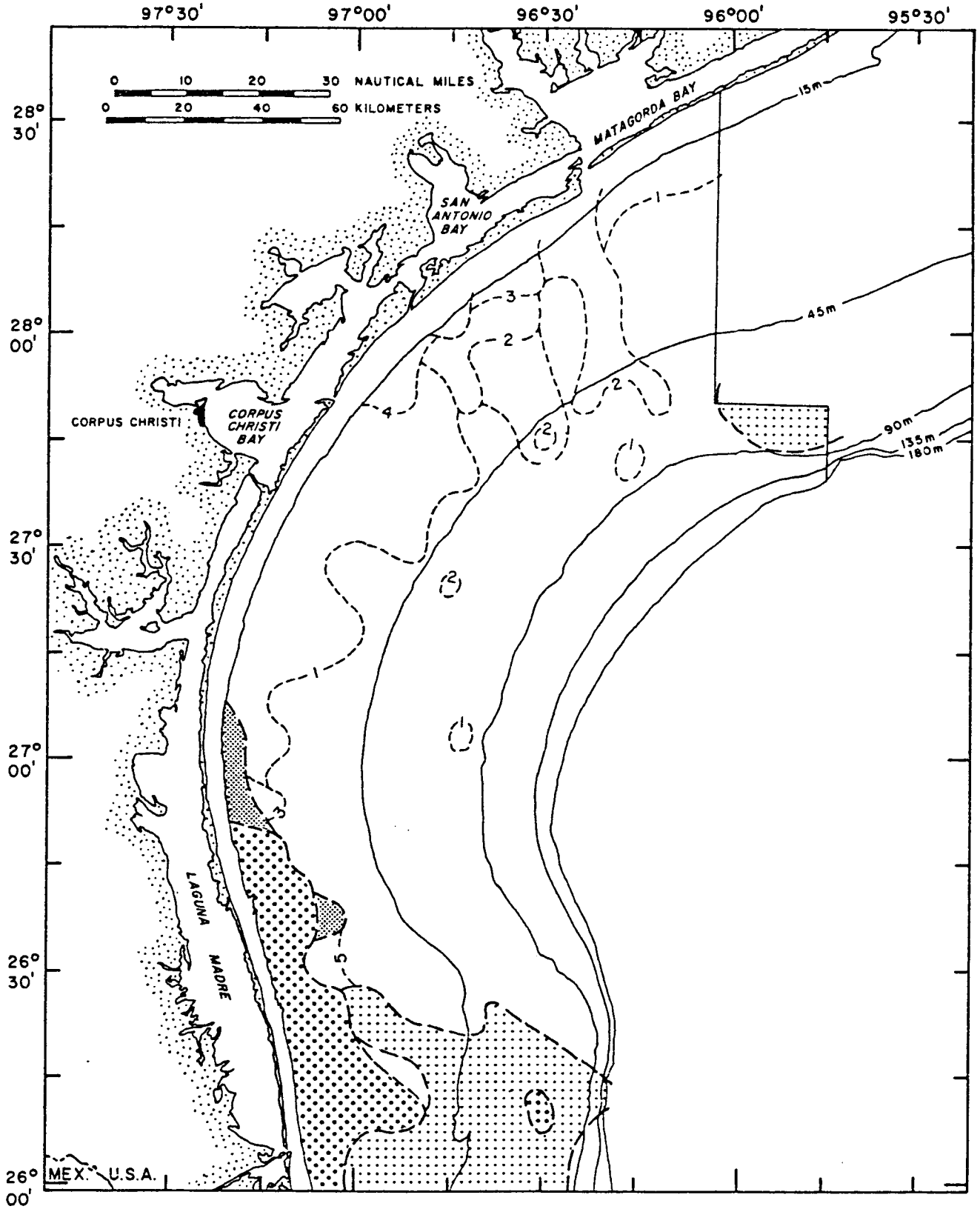


Figure 110b. Number of discrete sand layers in the core depth interval, 30-60 cm. The areas outlined contain the number of sand layers indicated along the dashed lines. The fine stippling indicates that transported sand makes up 75 percent or more of the interval; the heavy stippling indicates that relict deltaic deposits make up most of the interval; the medium stippling indicates that the interval is primarily reworked deltaic deposits.

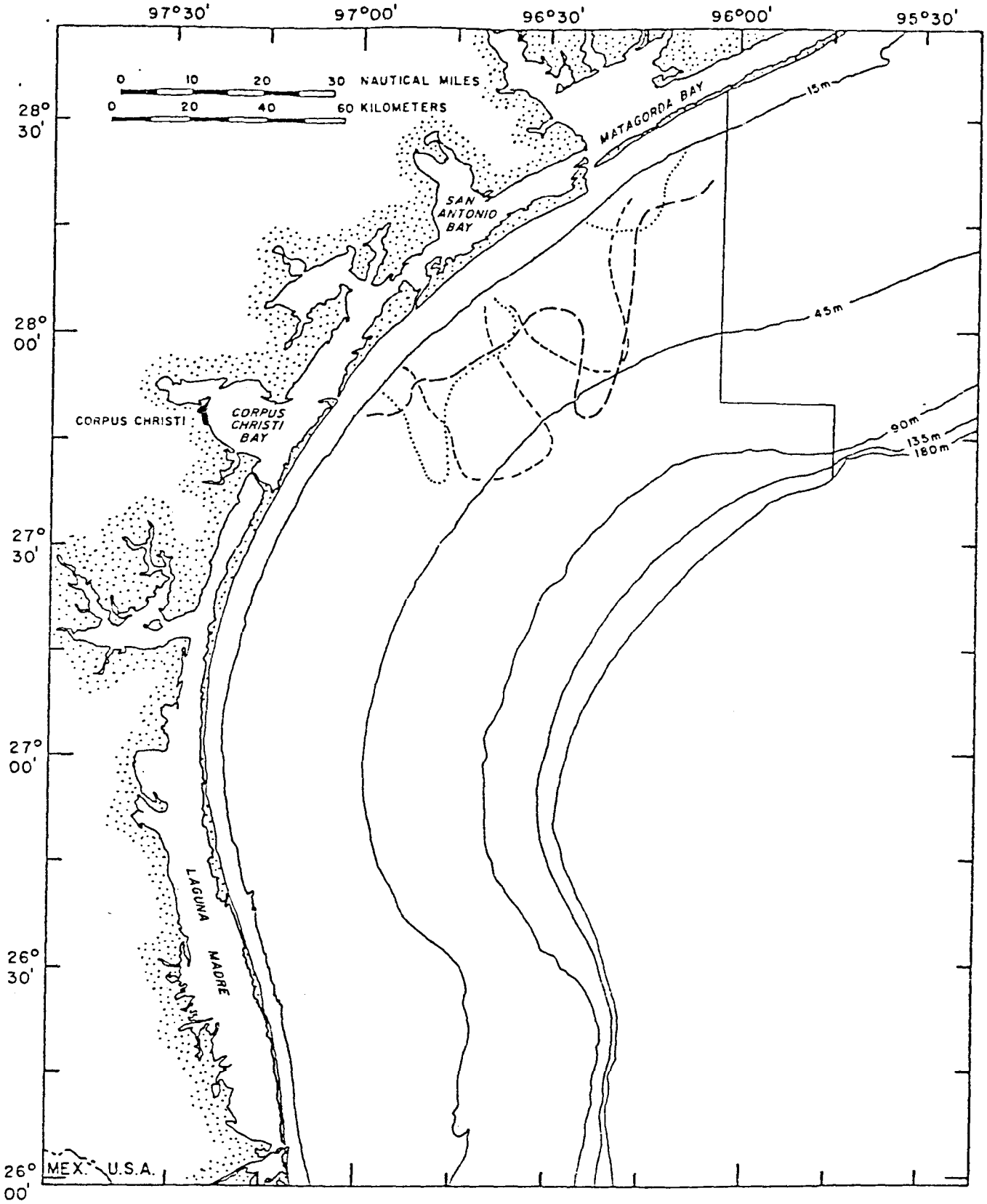


Figure 110c. Distribution of discrete sand layers that are at the same subseafloor depth in most of the cores in a given area (30-60 cm): 30 cm - dotted lines; 45 cm - long dashed line; 60 cm - short dashed lines.

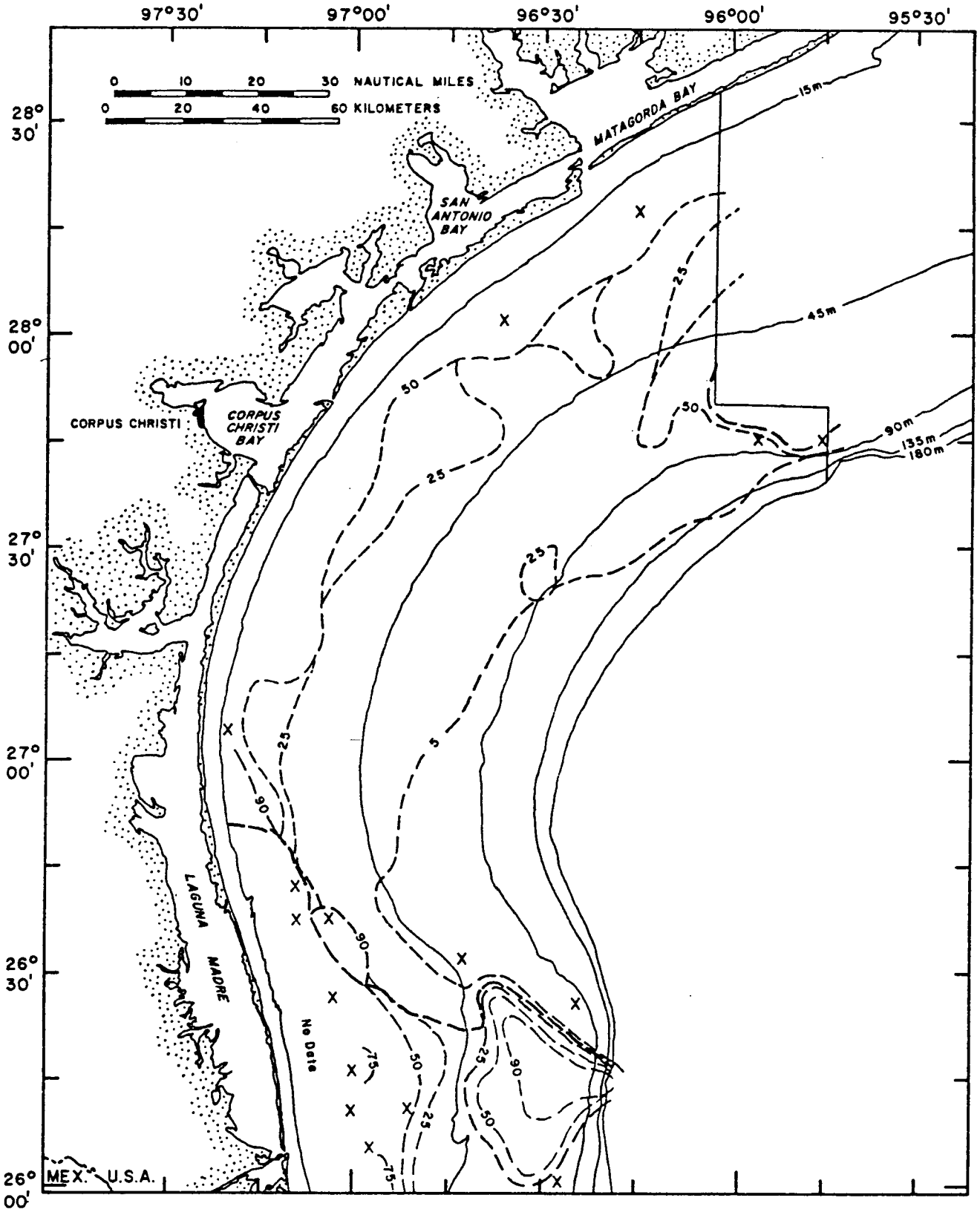


Figure 111a. Estimated percentage of sand-sized detritus in the core depth interval, 60-90 cm. An X indicates that the complete interval was not penetrated by the corer. Heavy dashed lines indicate approximate limits of the two ancestral deltas.

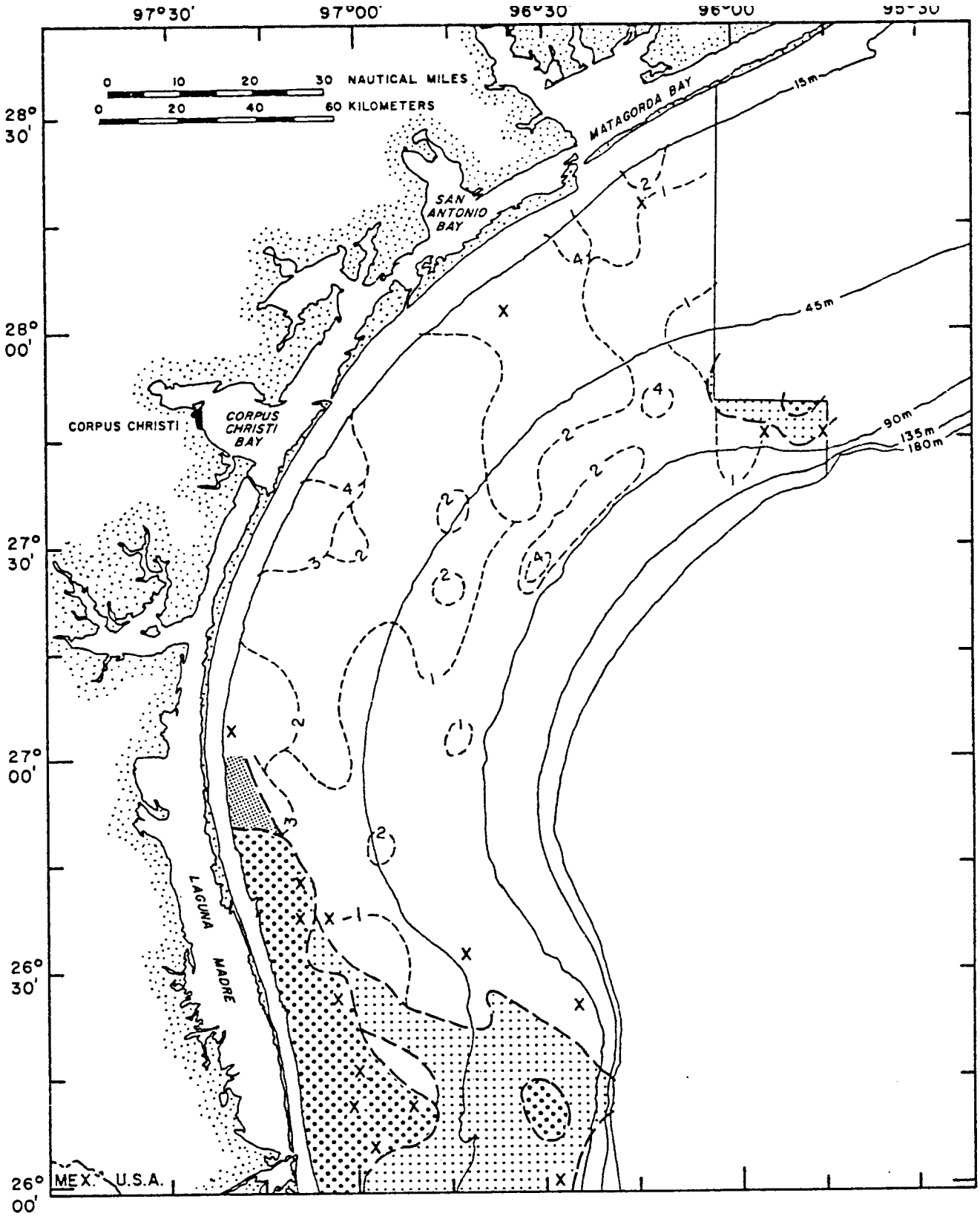


Figure 111b. Number of discrete sand layers in the core depth interval, 60-90 cm. The areas outlined contain the number of sand layers indicated along the dashed lines. The fine stippling indicates that transported sand makes up 90 percent of the interval; the heavy stippling indicates that relict deltaic deposits make up the interval. The medium stippling indicates that the interval is made up of reworked deltaic sediments.

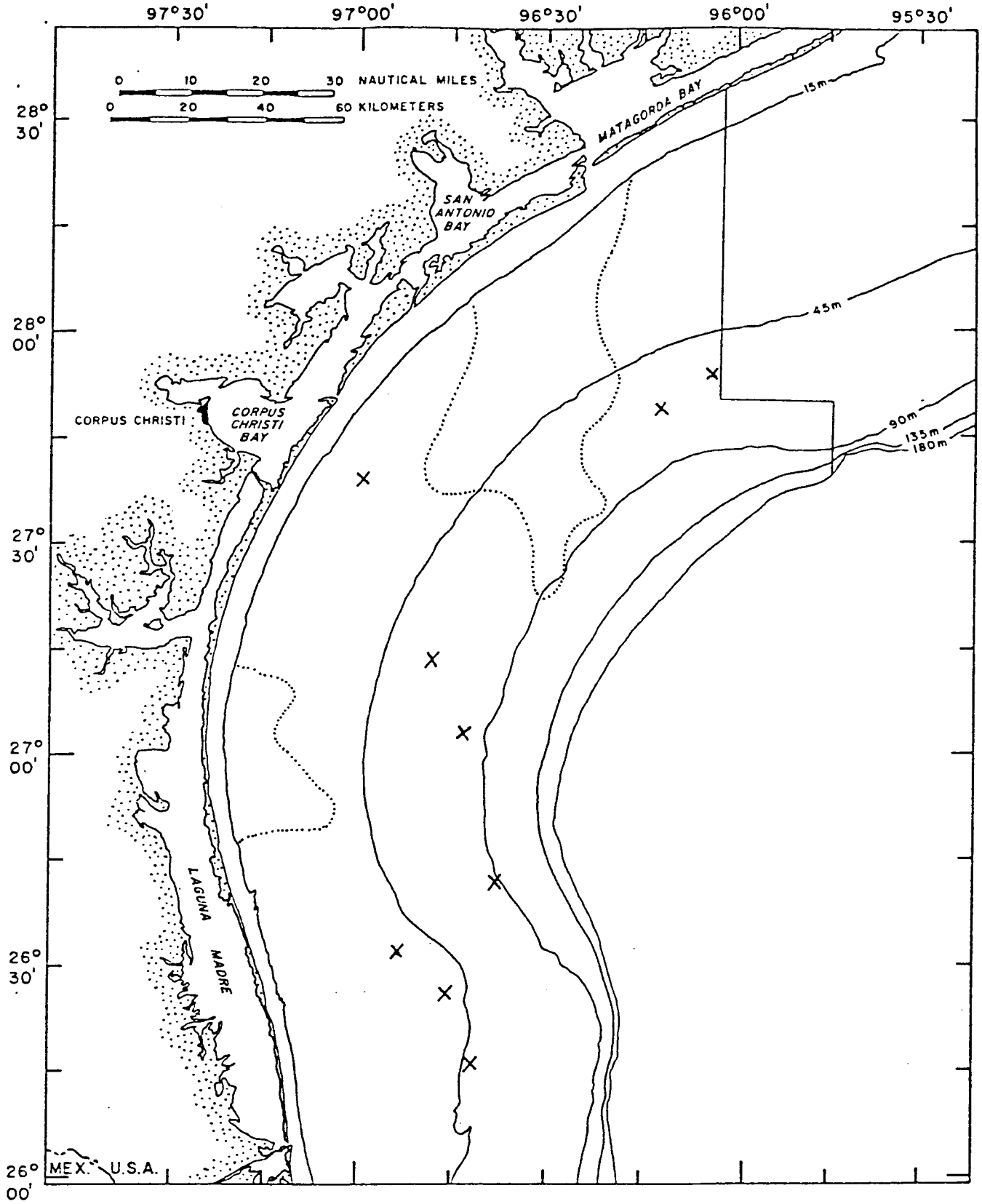


Figure 111c. Distribution of the discrete sand layer that is at a subseafloor depth of 90 cm in most of the cores in the areas outlined on the map. X's indicate isolated stations where the sand layer is at 90 cm.

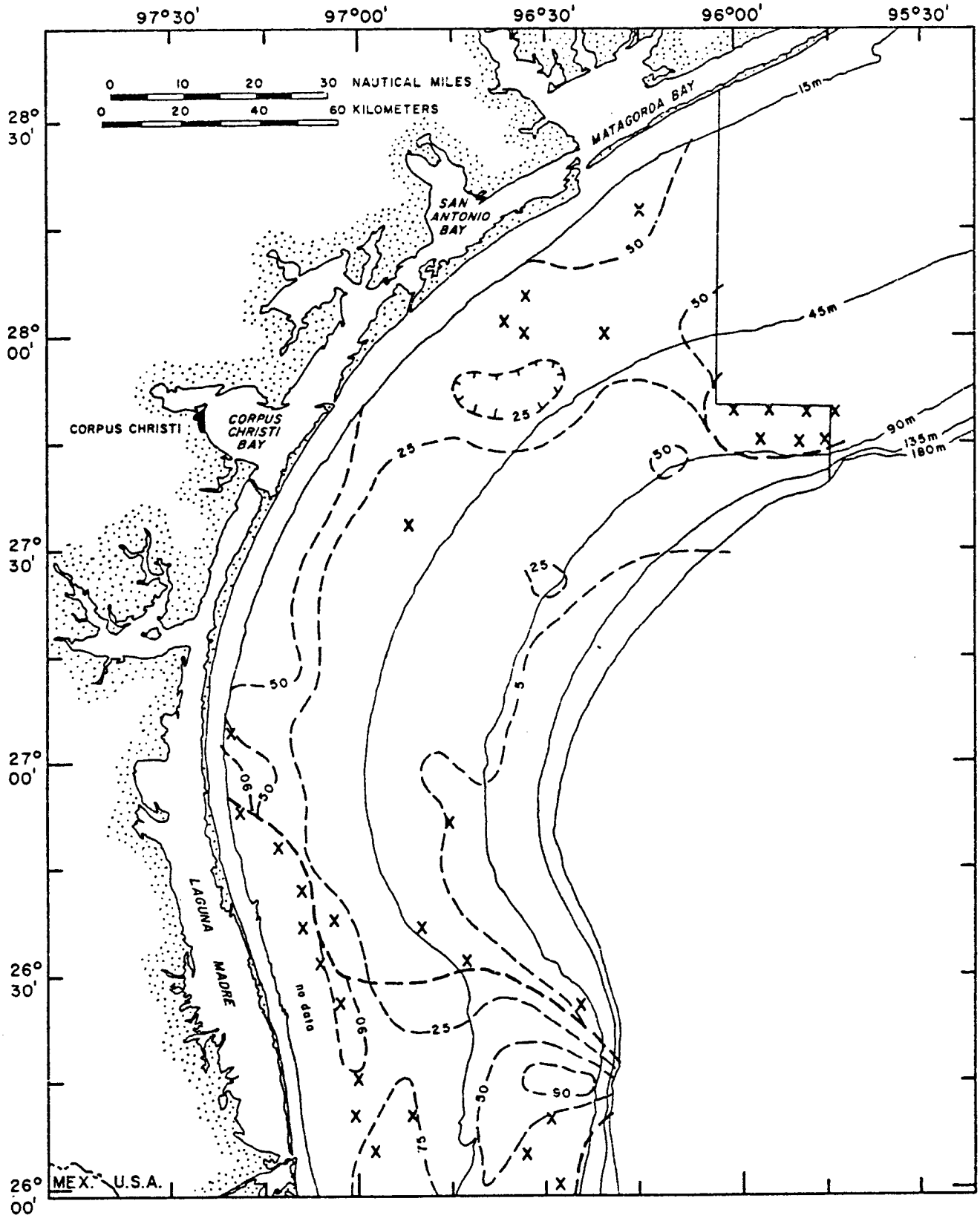


Figure 112a. Estimated percentage of sand-sized detritus in the core depth interval, 90-120 cm. An X indicates that the complete interval was not penetrated by the corer. Heavy dashed lines indicate approximate limits of the ancestral deltas.

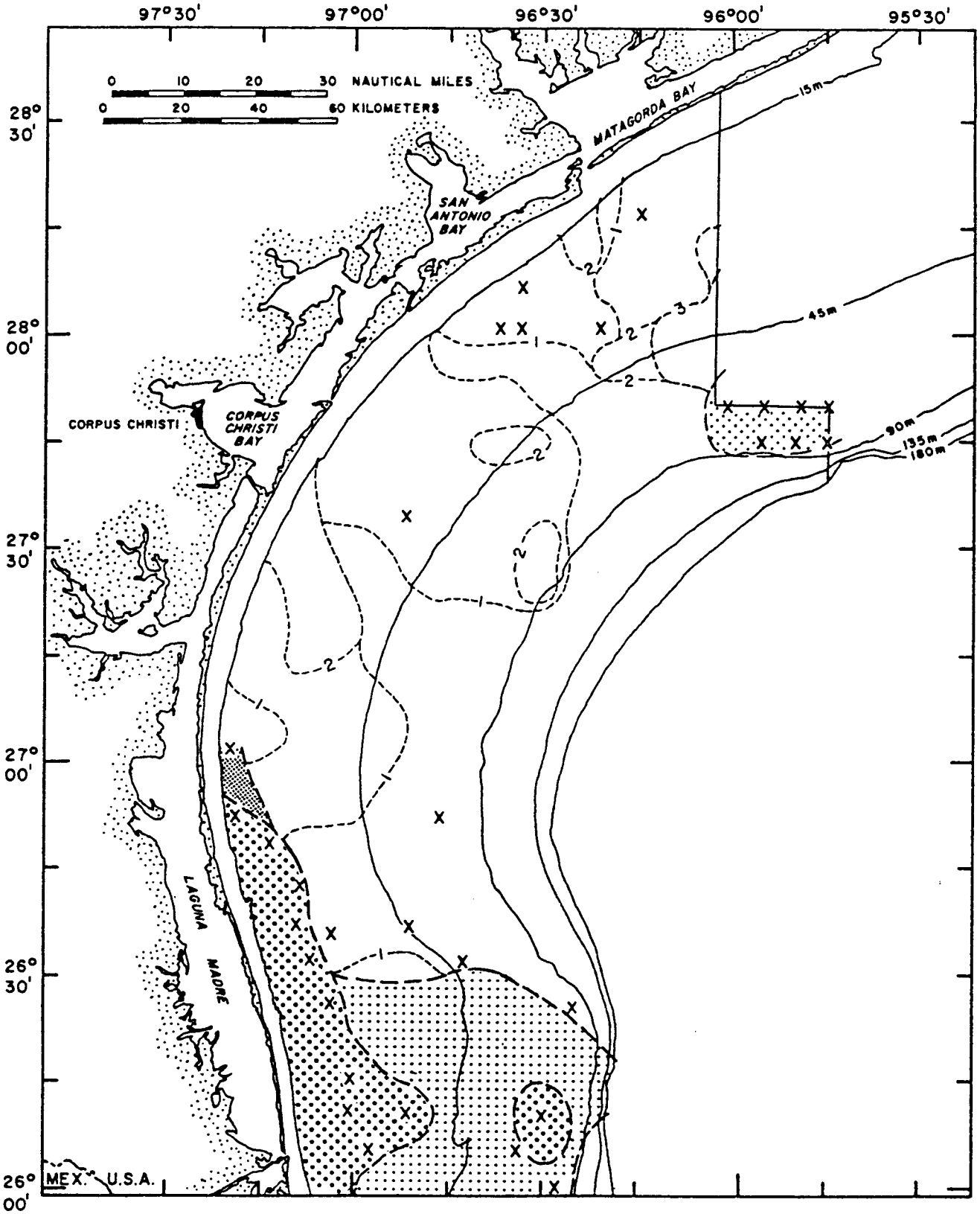


Figure 112b. Number of discrete sand layers in the core depth interval, 90-120 cm. The areas outlined contain the number of sand layers indicated along the dashed lines. The fine stippling indicates that transported sand makes up 90 percent of the interval; the heavy stippling indicates that relict deltaic sediments make up the interval; the medium stippling indicates the interval is made up of reworked deltaic sediments. An X indicates the interval was not penetrated by the corer.

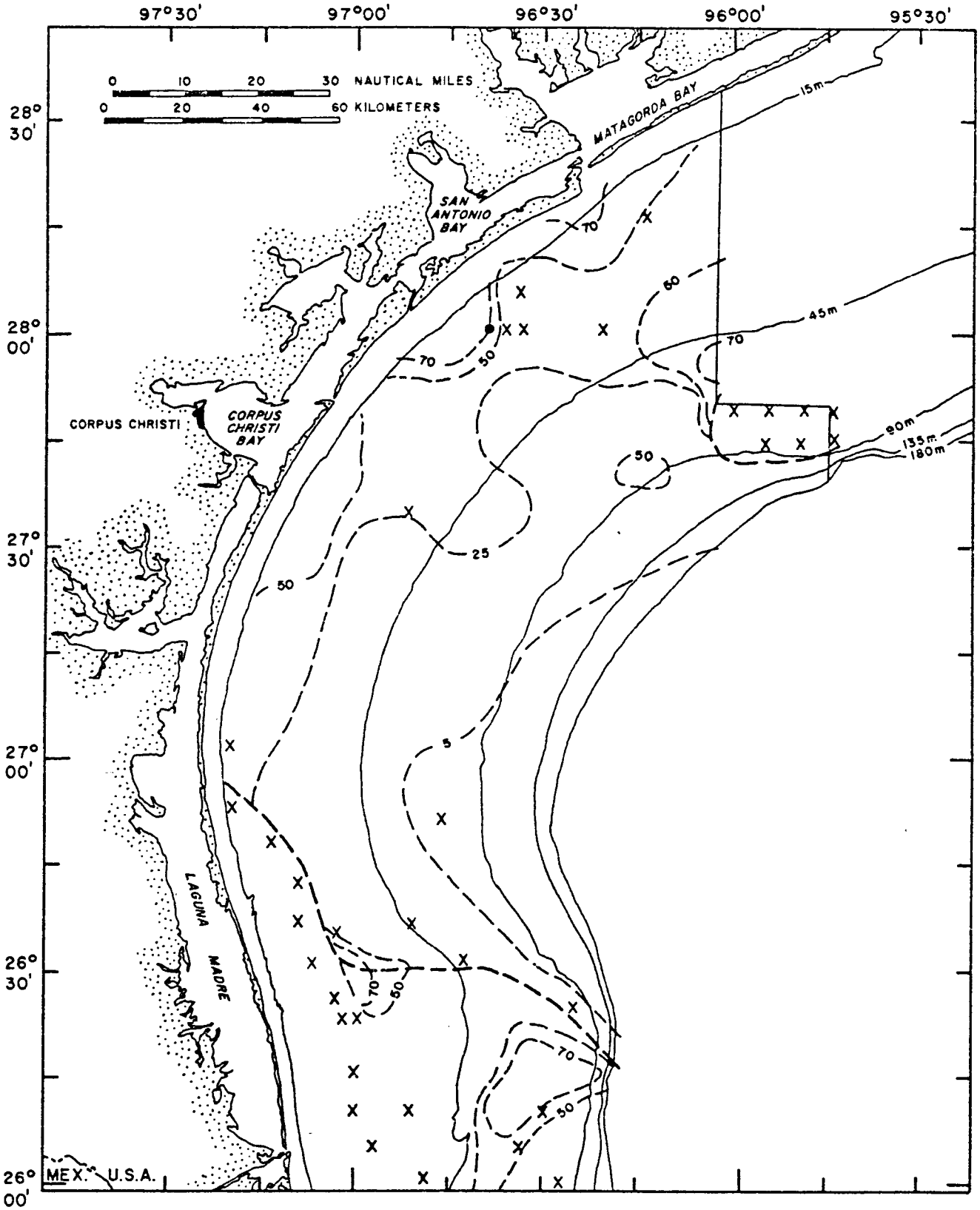


Figure 113a. Estimated percentage of sand-sized detritus in the core depth interval, 120-150 cm. An X indicates that the interval was not penetrated by the corer. Heavy dashed line is approximate northern edge of the ancestral Rio Grande delta.

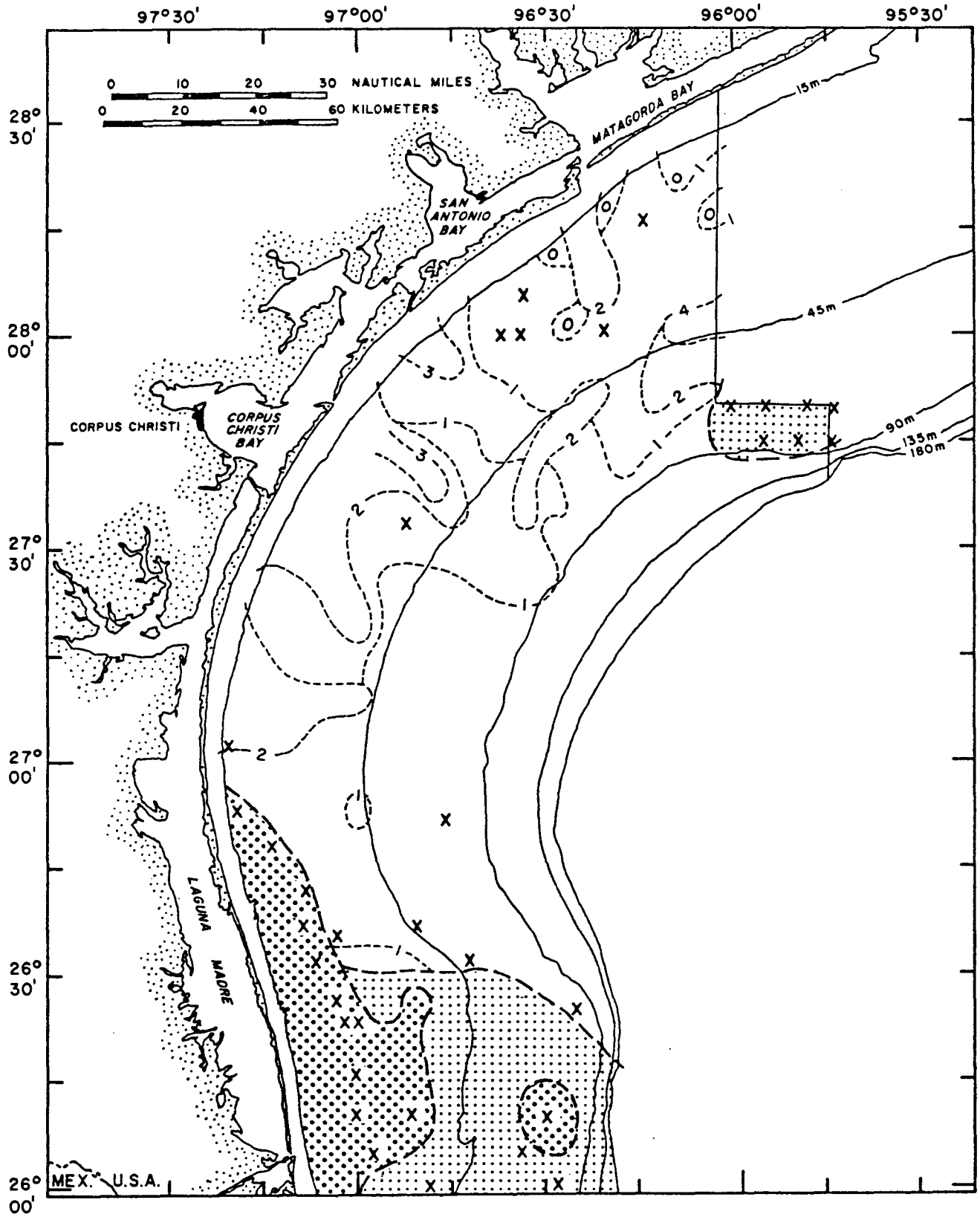


Figure 113b. Number of discrete sand layers in the core depth interval, 120-150 cm. The areas outlined contain the number of sand layers indicated along the dashed lines. The heavy stippling indicates that relic deltaic sediments make up the interval; the light stippling indicates that reworked deltaic sediments make up the interval. An X indicates that the interval was not penetrated by the corer.

90-120, and 120-150 increments were not constructed. The synthesized data have been presented in a form that is largely self-explanatory. The areas of older deltaic deposits are indicated on each map.

Summary and conclusions

As pointed out in the introduction to this section of the report, the incremental approach to data synthesis is stratigraphically artificial in that it does not account for any geographic differences in rates of sedimentation from one part of the shelf to another. Nevertheless, as the sequence of sediments represented in the cores is both relatively thin and recent in age, and, as no part of the STOCS seems to have received great thicknesses of sediments such as those parts of the continental shelf peripheral to the Mississippi Delta, the approach used adequately fulfills the purpose intended. The syntheses indicate the following characteristics of sediment movement over the South Texas OCS:

1. The geographic patterns of sand occurrence, whether as a percentage of the total segment or as discrete layers, vary only slightly from one increment to another. Minor variations in the areal distribution of discrete sands are evident when increments are compared, but no significant geographic changes in either source of the sediment or directions of transport across the shelf are indicated.

2. The source for most of the sediment that has entered the South Texas OCS during the latest Holocene has been to the northwest and north. The numbers of discrete sand layers are most numerous and most widespread in the northwestern part of the OCS, both incrementally and in aggregate.

3. The principal mechanism responsible for spreading sand in discrete layers to midshelf and beyond probably has been hurricane-generated turbidity currents. Graded grain size, together with other depositional structures such as laminae flow and crude, cut-and-fill structures in the layers, attest to relatively rapid transport; however, as individual layers cannot be correlated with absolute certainty from core to core, the interpretation must rest on empirical evidence.

4. The principal depocenter at the present time for sediments now reaching the South Texas OCS, as suggested by the incremental analyses, is the north central part of the shelf. The general area is shown by the map in figure 114.

5. Five subprovinces of the shelf can be outlined on the basis of the sediment characteristics and the processes involved in sediment transport and deposition (fig. 115):

   I - Relict deltaic deposits of an older sedimentary regime that include both complexly and intricately interstratified intermixed sand, shells and hard clays. The upper part of these deposits is in part reworked. They are relatively compact and firm, and they are overlain disconformably by relatively thin deposits of soft mud and sand of variable thickness;

   II - Inner shelf, characterized by both higher percentage of total sand and by more numerous discrete sands;

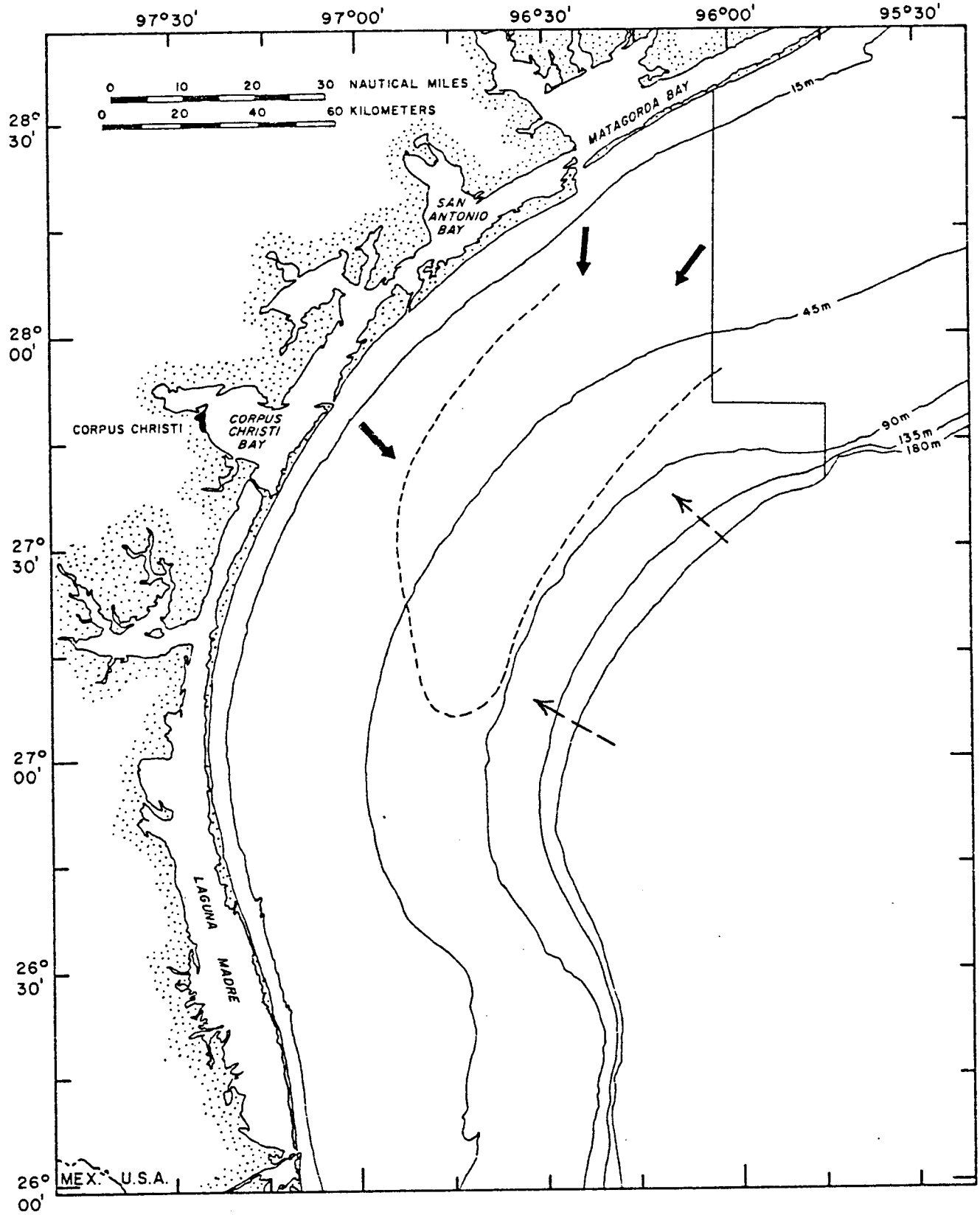


Figure 114. Principal sediment depocenter at the present time on the South Texas OCS, as indicated by the incremental analyses of the cores. Arrows indicate principal directions of bottom water movement, as suggested by the sedimentary patterns; the broken arrows are based on less firm documentation than the solid arrows.

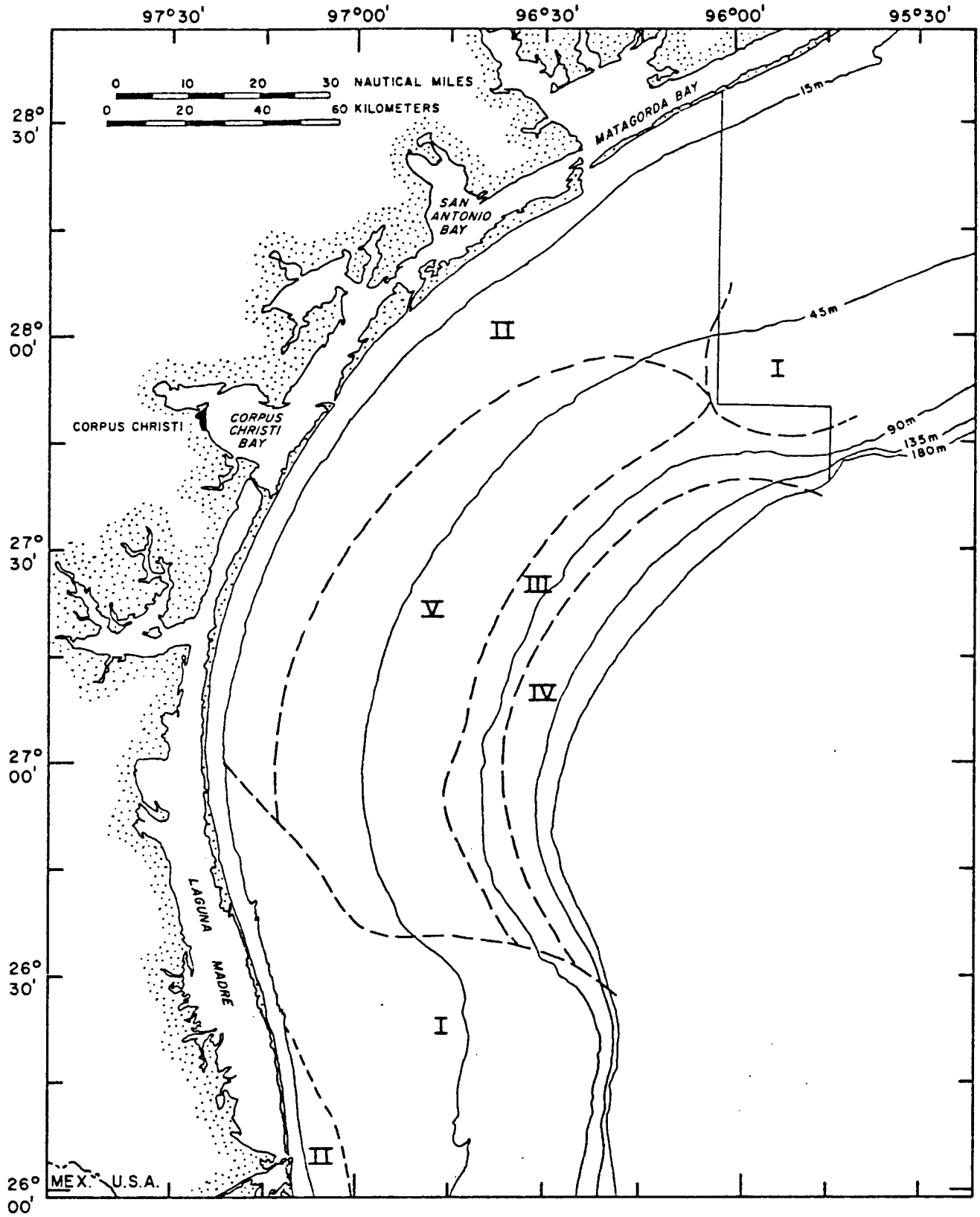


Figure 115. Principal subdivisions of the South Texas OCS based on sedimentary processes.

III - Outer shelf, narrow area containing relict reefs that lie roughly along the 90 m isobath. Sediments reaching the area are principally of silt and clay size; sand possibly is carried in occasionally by hurricane-generated turbidity flows, and some sand may be concentrated as lag deposits by bottom currents moving onto the shelf from the deeper Gulf;

IV - Outermost shelf, an area of slow sedimentation relative to other parts of the South Texas OCS where pelagic raining of microscopic organic remains appears to be the principal process;

V - Central shelf, an area of relatively high sedimentation but of progressively decreasing rate from north to south; receives some sand-sized particles under normal conditions and probably thin layers of discrete sand in the aftermath of hurricanes.

Rates of Sedimentation

by

Charles W. Holmes and E. Ann Martin

Variation in the rates at which sediments accumulate within a sedimentary basin is an important aspect in the understanding of the physical and chemical processes involved both during and after deposition. To obtain some estimate of rates of deposition, many investigators have relied on extrapolations from a time datum based on paleontological evidence, radiocarbon dating, or stratigraphic relations. On the other end of the spectrum, many investigators tacitly assume that the upper few centimeters or so are "modern" and are thus a picture of the processes now active. In reality sedimentation rates may vary by more than an order of magnitude within a basin, and such an assumption can lead to erroneous conclusions.

During the past decade, a method has been developed that permits measurement of the age of sediments that have been deposited within the past century or so. The method is based on the discovery that an excess of a radioactive species of lead (^{210}Pb) exists in the atmosphere. First used to determine snow accumulation in the permanent snow fields of Greenland (Goldberg, 1963), the method has been successfully applied to studies of Alpine glaciers (Windom, 1969) and to age dating of the Antarctic ice sheet (Crozaz and others, 1964). Recently the method has been applied to accumulation rates of sediments in lakes (Koide and others, 1973; Edgington and Robins, 1976), in marshes (Armentano and Woodell, 1975), and in coastal and shelf regions (Bruland, 1974; Shokes, 1976; Thomson and others, 1976). Reported herein are the results of a similar study on the shelf of the northeastern Gulf of Mexico.

Geochemical Considerations

Excess radioactive lead (^{210}Pb) is produced and accumulated in the atmosphere and waters of the world as a result of a series of favorable nuclear and chemical properties of the elements in the uranium-238 radioactive family. The lead isotope (^{210}Pb), with a half life of 22.26 years (Hohndorf, 1969), is formed from the decay of its radon grandparent (^{222}Rn), which diffuses into the atmosphere because of its properties as a noble gas. After its formation, the lead is precipitated into the hydrosphere. Its mean residence time has been measured in southern Wisconsin as about 3.8 days (Francis and others, 1970). Other sources are apparently insignificant when compared to the atmosphere (fig. 116) (Benninger, 1976).

Once in the hydrosphere, the chemically active lead is adsorbed onto particulate material and thus becomes entrained in the sedimentary processes. The absorption process is very rapid with respect to nonbiogenic material (Scrudato and Estes, 1976). Similar activity could be expected with biogenic particulate material.

The use of any radioactive isotope for estimating the age of a substance requires that certain conditions be met. In disequilibrium procedures, the production or flux of the radioelement must be constant over the dated interval of interest; after deposition of the radioelement, there must be no addition or subtraction of the element from the system.

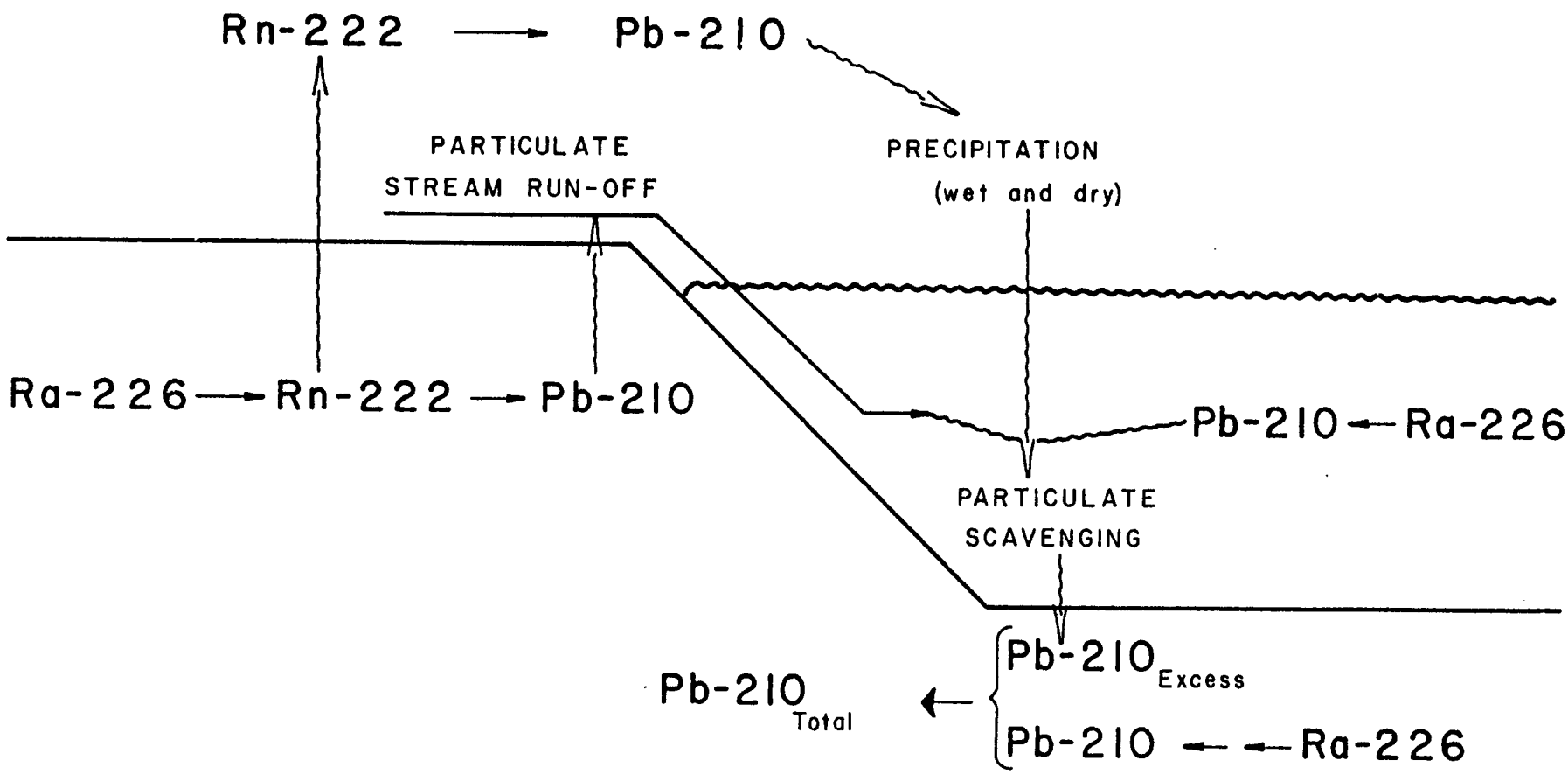


Figure 116. Geochemical cycle for ^{210}Pb (modified from Benninger, 1976).

Lead comes to equilibrium with the particulate material rapidly in the marine environment. Thus this material assumes the lead character of the water mass which surrounded it and from which it was deposited. As water masses keep their integrity for considerable distances, conditions will be met over large regions for a valid method of estimating sedimentation rates. In the zone in which two water masses may become mixed, the zone of mixing would be reflected in the lead distribution in the sediment. There is no evidence of lead migration after deposition (Thomson and others, 1976); the chemical activity of lead tends to immobilize it in the marine environment.

Methodology

The specific activity of ^{210}Pb was measured indirectly by the determination of the activity of the granddaughter isotope ^{210}Po, assuming secular equilibrium between the two species. This assumption has been investigated (Benninger, 1976; Nittrouer and others, 1976), and no evidence was found to negate it. The excess ^{210}Pb was determined by subtracting that lead which was found to be in equilibrium with ^{226}Ra. This value was indirectly determined by assuming that radioactive equilibrium was reached in the lower sections of the core as exhibited by a constant lead value with depth; this value was then subtracted from those values in the upper sections of the same core to yield the excess ^{210}Pb.

Forty-three cores were obtained from every region of the northwestern gulf shelf (fig. 7). Four were obtained with a device designed

to take short, undisturbed cores (hydrostatically dampened cores). The core device proved to be unsatisfactory in the soft mud that covers much of the south Texas shelf. Of the remaining 39 cores, 16 were taken by a large diameter gravity corer and 23 by a large box corer. These cores yielded satisfactory samples with minimal disturbance of the surficial layers and without significant shortening.

The reasoning behind the preceding geochemical and radiochemical assumptions leads to the basis for calculating the age of any level within a sediment column: the age of a sample at a certain depth (x) is related to time by the sediment rate (w) as

$$t_{time} = x/w$$

so that a plot of the log activity of excess ^{210}Pb should yield a straight line over a time interval in which the sediment rate is constant. Graphically displayed in this manner, the steeper the slope, the slower the rate.

If the sediment entrained in the water column is always in equilibrium with ^{210}Pb so that no matter how much sediment is introduced, the activity per gram of sediment will remain constant, then a break in the slope of the decay plot versus depth may represent variances in sediment rates. However, such breaks in the top 10-20 cm in shallow areas where biologic activity may be significant may be the result of bioturbation and/or wave action. In most cases, wave action produces the break in slope noted by many investigators.

In many areas the water content of sediment samples varies significantly both areally and with depth. If this differential is not taken into account, the sedimentation rates are erroneous.

Measurements of water content in cores used in this study show a remarkably uniform interstitial water/sediment ratio. Thus, any correction for sedimentation rates based on water content could be uniformly applied. As sediment rates are usually reported in terms of length per unit time instead of weight per area per year, the rates reported here are in millimeters per year. Original data are listed in Appendix 5.

Dating Procedure

The entire sample was dried and ground to a fine powder. A 5 g representative subsample was weighed into a precleaned porcelain crucible and placed in a muffle furnace at 450°C for 6 hours. The sample was allowed to cool in a dessicator and was reweighed in order to obtain a dry sample weight.

The dry sample was transferred to a 100 ml teflon beaker with 5 ml of concentrated reagent grade nitric acid. The appropriate amount of ^{208}Po spike was added, and the sample was evaporated to dryness under heat lamps. Five ml of 30 percent hydrogen peroxide was added and allowed to react with the sample. The solution was again evaporated to dryness. Hydrochloric acid addition was repeated until all traces of the nitric acid were removed.

The sample was redissolved in 5 ml of concentrated hydrochloric acid and transferred to a 100 ml glass beaker. After the addition of 2 ml of 25 percent sodium citrate, 5 ml of hydroxylamine hydrochloride, and 10 mg of bismuth carrier, the pH of the resulting solution was adjusted to 2.0 with ammonium hydroxide. The beaker was placed on a stirring hot plate and heated to 85°-90°C. Stirring and heating continued for 5 minutes. A silver disc was secured in the teflon plating device and lowered into the solution taking care not to trap air pockets beneath the disc. Heating and stirring

continued for a minimum of 90 minutes. The silver disc was removed from the plating apparatus, rinsed with deionized water and allowed to dry. The disc was counted on an alpha spectrometer.

Results and Conclusions

The ^{210}Pb activity in the sediments of the continental shelf of Texas varied from a high of about 25 disintegrations per minute (dpm) to 1.4-1.0 dpm. The latter rates represent the background values, or that radioactive lead which is in equilibrium with the radium in the sediment. The larger value is representative of the material entering the OCS environment from sources along the Texas coast and beyond. The smaller value appears to be associated with hemipelagic material being deposited on the outer shelf. These values are in line with previously measured radium activity values for delta sediments (Shokes, 1976).

The results of the ^{210}Pb analyses, showing the excess of ^{210}Po in sequential incremental depths in the cores, are in the series of graphs, figures 117 through 120. Of the 43 cores analyzed, 16 showed straight line decreases of the log activity of lead and are indicative of constant sedimentation. Twelve cores had no excess radioactive ^{210}Pb, indicating either little or extremely slow sedimentation. In a number of cores, the individual analyses do not plot as a straight line for the entire segment of core analyzed; instead, breaks or changes in the slope of the line are indicated (see core 32, fig. 117 and core 174, fig. 119). This variation in the distribution of ^{210}Po is thought to be caused by mixing of the sediment after deposition by infaunal activity or bioturbation. Consequently, the slope of this mixed zone is influenced by both the relative rates of deposition and the degree of bioturbation (Guinasso and Schink, 1975):

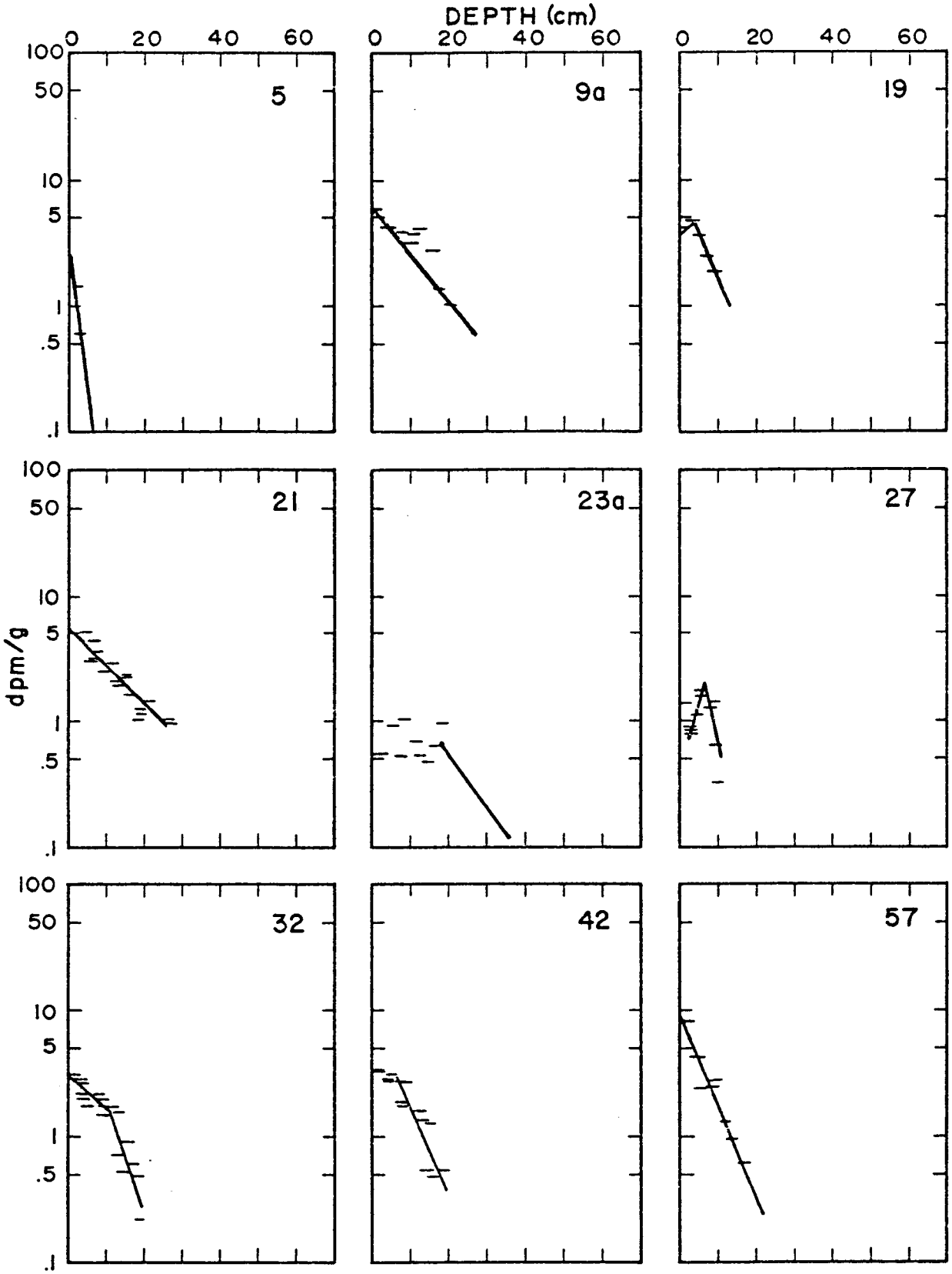


Figure 117. ^{210}Po excess for sequential depths in cores in disintegrations per minute per gram. The core number is in the right hand corner of the graph. Locations for the cores are shown by figure 7.

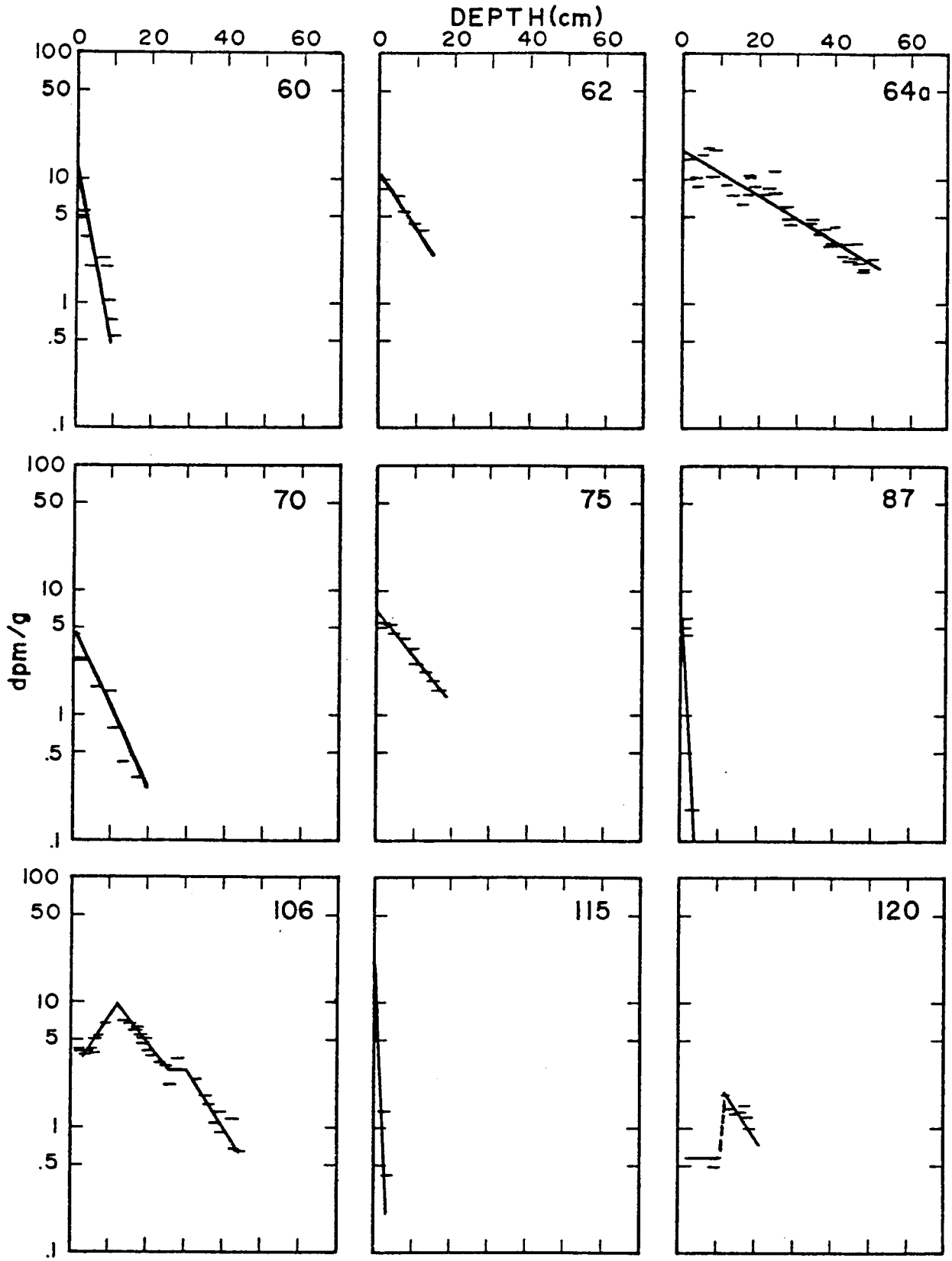


Figure 118. ^{210}Po excess for sequential depths in cores in disintegrations per minute per gram. The core number is in the right hand corner of the graph.

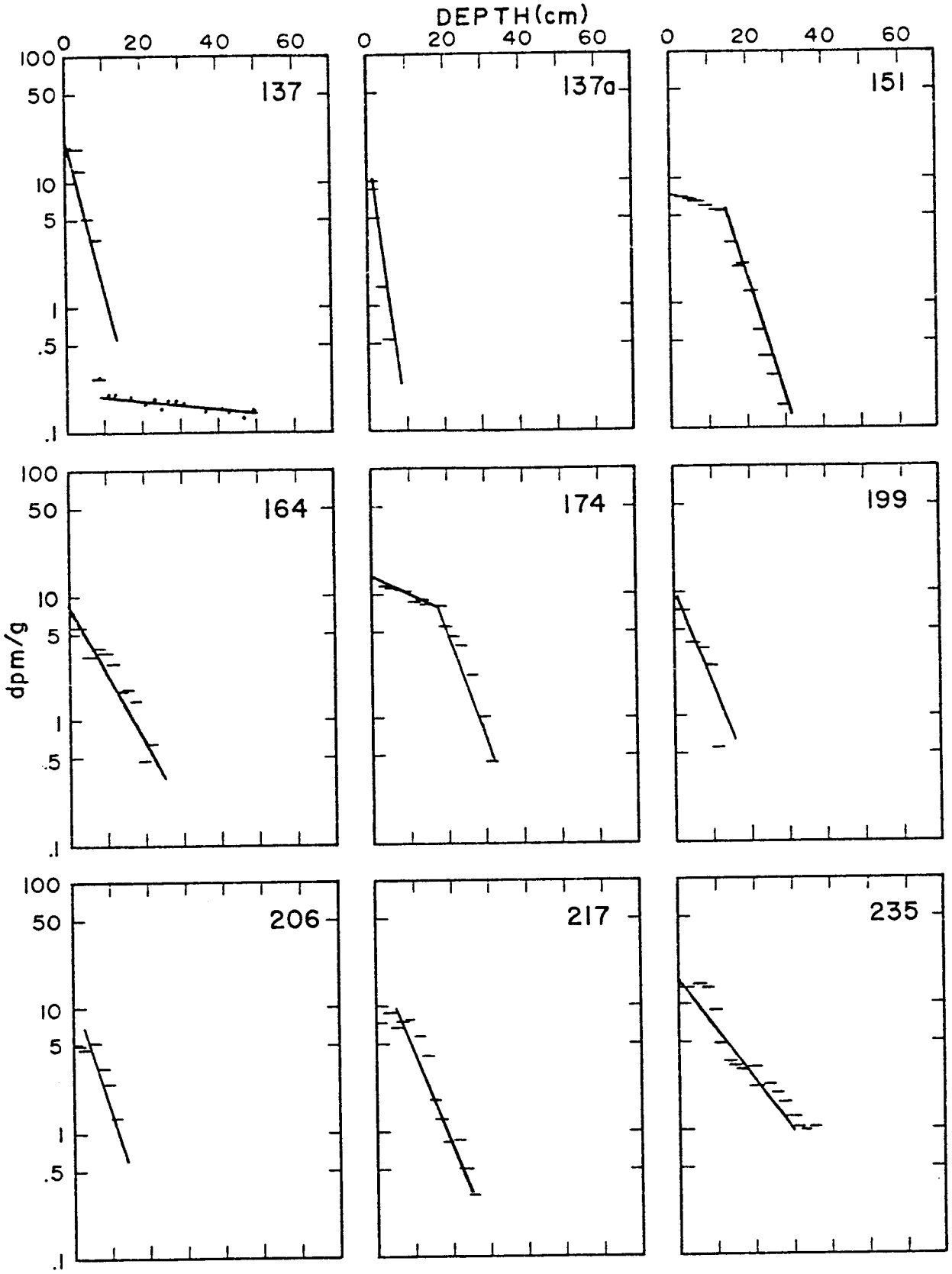


Figure 119. ^{210}Po excess for sequential depths in cores in disintegrations per minute per gram. The core number is in the right hand corner of the graph.

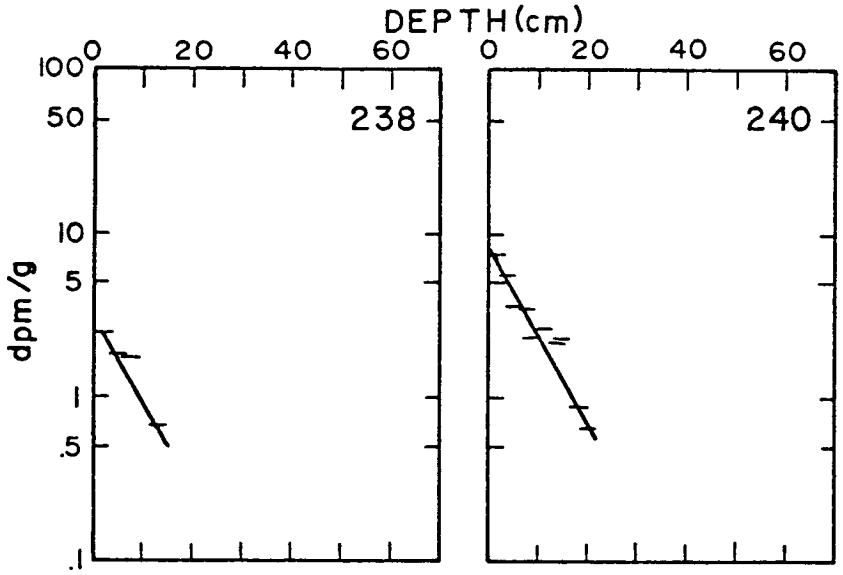


Figure 120. ^{210}Po excess for sequential depths in cores in disintegrations per minute per gram. The core number is in the right hand corner of the graph.

the more the slope of the curve resembles the decay curve, the higher the rate of sedimentation relative to the rate of mixing. Conversely, the flatter the curve, the higher the rate of mixing, with a horizontal zone of radioactivity representing a totally mixed zone. Two cores (19 and 27) show a greater increase in activity with depth in the surface zone than does the normal decay curve. This inverse relationship may be due to a type of bioturbation in which older material is carried upward to the surface by animals and redeposited over the younger sediment. This process may be the result of the activity of worms, especially the filter feeders.

Three cores on the shelf showed unique radioactive ^{210}Pb distributions. Two box cores from the inner shelf (27 and 120) have unusual curves in which the activity of the surface sediment is low, and the normal decay has occurred below a sand layer. In the third core (106), radiometric lead decreases with depth in a sawtooth pattern: in the surface zone, the radioactive material is constant; at a depth of 10 cm the lead radioactivity abruptly increases followed by a normal decrease with depth; again at 30 cm, a similar jump occurs. Each of these discontinuities corresponds to the position of a sand layer in the core. The sand layers appear to represent single sedimentological events of probable short duration that have disrupted the normal decay pattern for ^{210}Pb. Other characteristics of the sediments, as reported by Berryhill elsewhere in the report, strongly suggest that many of the more widespread individual sand layers were transported and deposited during hurricanes. The patterns of decay for ^{210}Pb in cores such as 106 support the other lines of evidence that point to deposition of the discrete sands by storms. Thus the ^{210}Pb dating method may be applicable not only to dating rates of sediment deposition but to identifying and mapping short-lived sedimentary events of regional significance as well.

The ^{210}Pb activity within the surface sediment, calculated by projecting the nonbioturbated curve to the surface, falls into two distinct categories: an inner region with surface activity clustered about 6-7 dpm, and an outer region that clusters about 20+ dpm (fig. 121). Cores near the boundary of these 2 regions have values indicating an apparent mixing of the zones, which suggests either 2 sources of sediment or 2 water masses from which the sediment is deposited. The higher values are in the surface sediment on the outer edge of the shelf and are believed to be associated with hemipelagic deposition. The lower values are in the sediment from an inner shelf source. In some cores, the lower values probably are due to sampling disturbance, with the surface sediment being lost. Cores 238 and 57 were taken as gravity cores, and disturbance is more likely with this method of sampling than with box coring. A similar relationship and range of surface values was noted by Shokes (1976) off the delta of the Mississippi River and by Nittrouer and others (1976) off the Washington shelf.

The average rate of sedimentation on the shelf varied from 0.19 to 9.88 mm/year (figs. 122 and 123). Twelve sites had no measured rates of sedimentation. These lie along the inner shelf and on the central and northern edge of the Rio Grande submerged delta. The highest measured rate was 9.88 mm/year, just off the mouth of the Rio Grande. Further out over the inner half of the submerged Rio Grande delta, no apparent modern sedimentation is taking place. Although most of the material delivered to the gulf by the Rio Grande appears to be deposited on the inner shelf, some of the sediment appears to bypass the inner shelf and is deposited over the outermost part of the shelf. Although the latter possibility seems unique, the source of sediment necessary to produce both the moderately high accumulation rates at the shelf edge and the surface activity values suggests a combination of an onshore

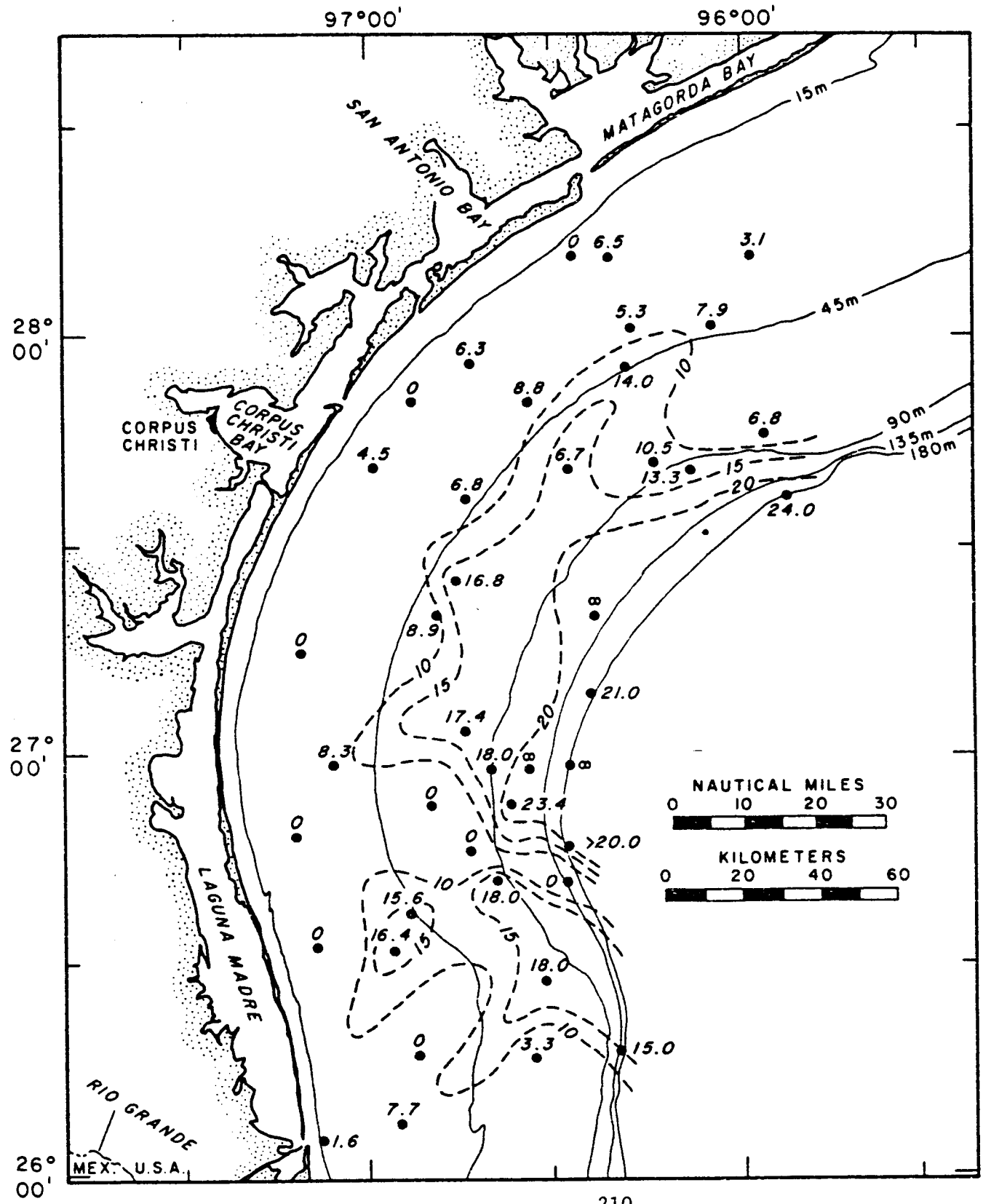


Figure 121. Calculated surface activity of ^{210}Po in disintegrations per minute per gram.

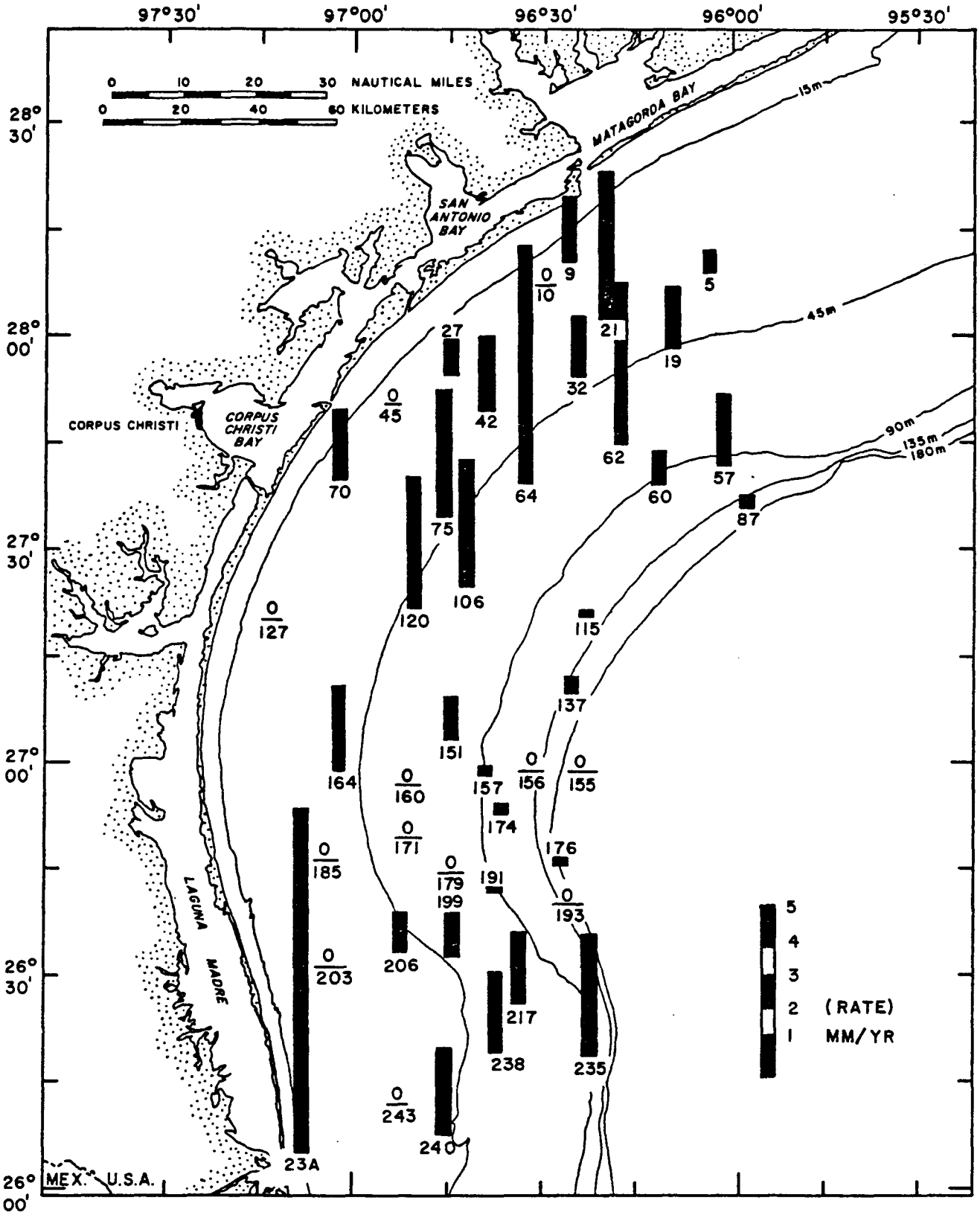


Figure 122. Rates of sedimentation at individual stations. The core number is at the base of the graph bar.

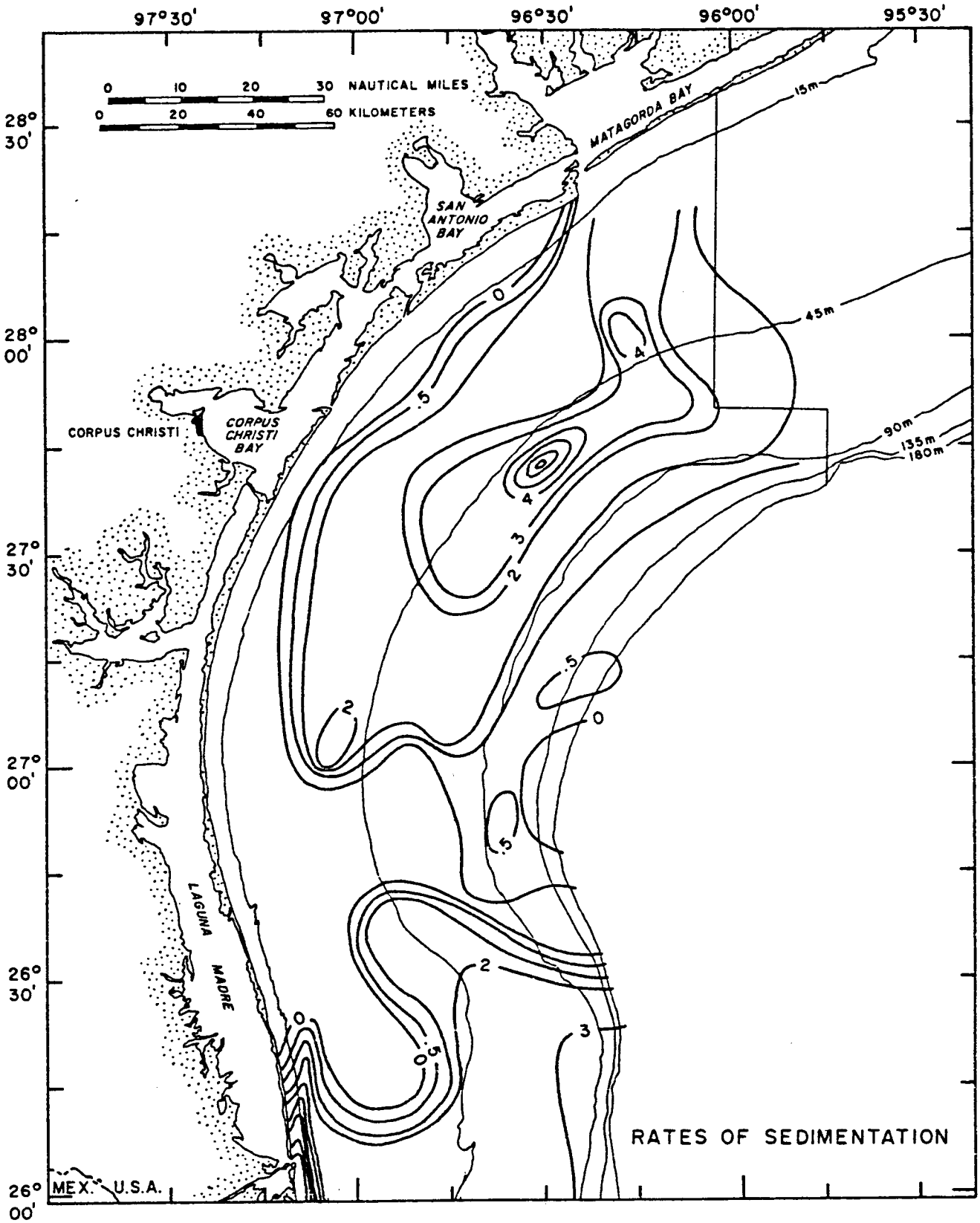


Figure 123. Interpretive contours showing rates of sedimentation (in mm per year).

source of sediment deposited through an offshore water mass. This combination would produce a high rate of sedimentation with a moderate to high surface activity value.

In addition to the high rate of sedimentation near the mouth of the Rio Grande, a high rate of sediment accumulation also is indicated for the central shelf south of Matagorda Bay. From LANDSAT photographs, the source appears to be sediment trailed offshore by winds during the winter season when the energy and sedimentation activity is greatest (Hunter, R. E. 1976, pers. commun.). This physical evidence suggests that the high rate of sedimentation and the relative surface activities may reflect a zone of mixing such as in the model proposed by McCave (1972). His model relates the magnitude of energy in the environment to the concentration of suspended sediment: if the concentration exceeds the amount of energy needed to maintain the material in transport, deposition occurs. Over the northern part of the South Texas OCS, large amounts of suspended material are moved southwestward along the coast to the vicinity of Matagorda Bay where the material is entrained oblique to the coast by a combination of currents and wind stresses. As a result, the suspended material is transported in large amounts from the high energy zone on the inner shelf to the relatively quieter central shelf where rapid deposition occurs. The surface activity values of ^{210}Pb in this area of high sediment accumulation also suggest that there may be some influence from water coming from the north, possibly Mississippi River water (Smith, Ned, 1976, pers. commun.).

CHEMICAL CHARACTERISTICS

Surface Sediments--Seasonal Variability in Trace Metals Content

by

Charles W. Holmes and E. Ann Martin

As a means of testing the seasonal variability of trace metals in the benthic sediments and to provide supportive trace metal data for concurrent biologic and hydrocarbon investigations, subsamples from 26 biologic infaunal stations (fig. 123a) taken during the winter, summer, and fall seasons in 1976 were analyzed. (See table 4 for the geographic coordinates of the stations.) The samples submitted for analysis were composited subsamples obtained by a SMITH-MACINTYRE grab sampler which retrieves an "undisturbed" sample. At each station four grabs were taken, with the subsamples representing both the top 5 cm from each grab and also one subsample pooled from the four grabs. For the summer sampling period, both the individual and the pooled subsamples were analyzed. The sampling scheme used permitted comparisons to be made both areally and seasonally, and the variability to be assessed.

In addition to the sediment samples, interlaboratory calibration and reference samples also were analyzed. These were the standard organic material, Orchard Leaves and Bovine Liver (National Bureau of Standards biological standards), plus four exchange samples from the Texas A&M trace metal laboratory. The marine reference sediment material, USGS MAG I; the USGS standard rock material, G-2; and a composite sediment sample from the study area were also interchanged and analyzed. The results of these analyses demonstrate that the precision and accuracy of the analytical techniques of the laboratories compare favorably.

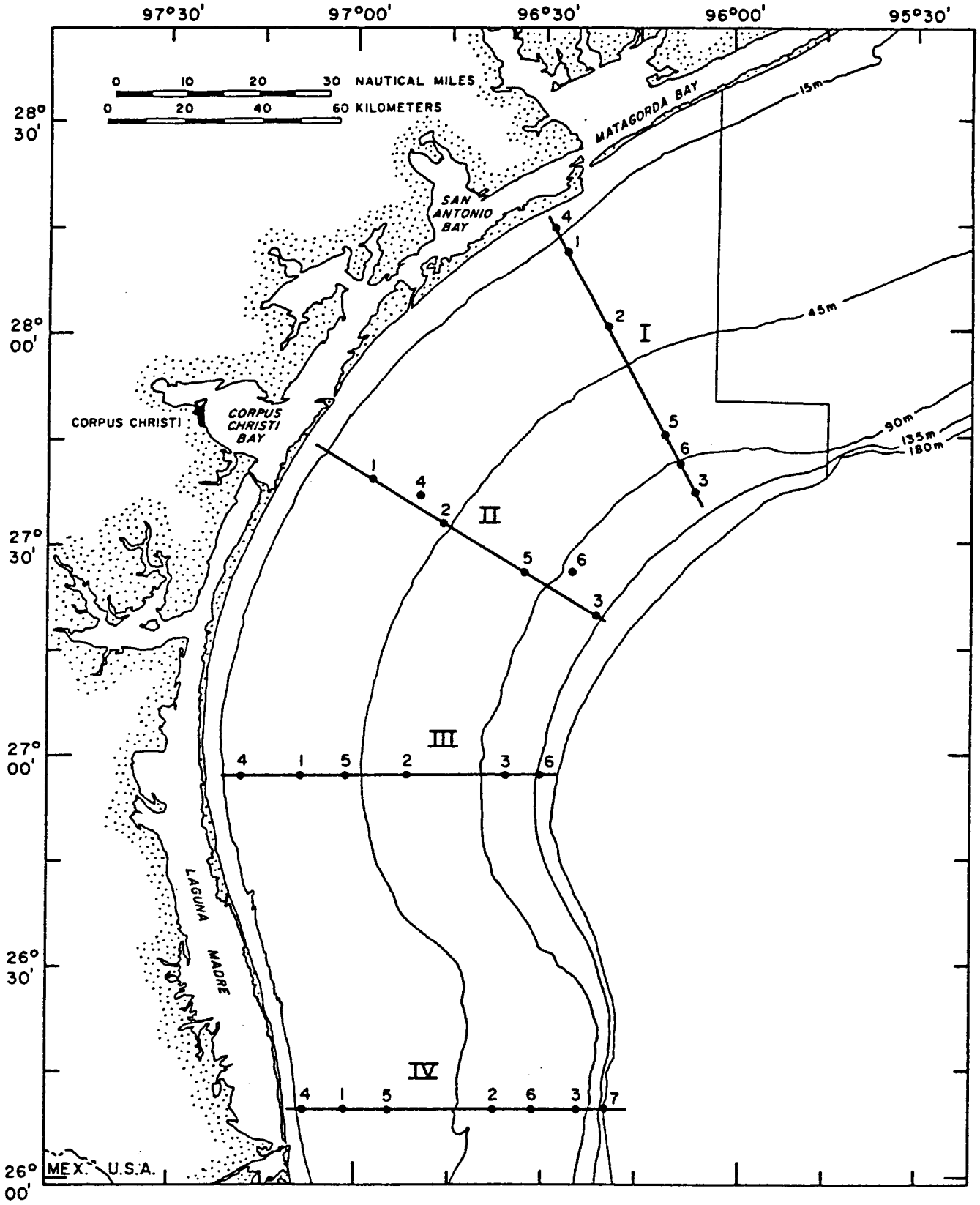


Figure 123a. Biologic infaunal stations from which subsamples were taken for trace metal analyses.

Table 4. Location of stations used for studying the seasonal variability of trace metals in benthic sediments

Transect	Station	Latitude	Longitude	Depth (m)
I	1	28°12'N	96°27'W	18
	2	27°55'N	96°20'W	42
	3	27°34'N	96°07'W	134
	4	28°14'N	96°29'W	10
	5	27°44'N	96°14'W	82
	6	27°39'N	96°12'W	100
II	1	27°40'N	96°59'W	22
	2	27°30'N	96°45'W	49
	3	27°18'N	96°23'W	131
	4	27°34'N	96°50'W	34
	5	27°24'N	96°36'W	78
	6	27°24'N	96°29'W	98
III	1	26°58'N	97°11'W	25
	2	26°58'N	96°48'W	65
	3	26°58'N	96°33'W	106
	4	26°58'N	97°20'W	15
	5	26°58'N	97°02'W	40
	6	26°58'N	96°30'W	125
IV	1	26°10'N	97°01'W	27
	2	26°10'N	96°39'W	47
	3	26°10'N	96°24'W	91
	4	26°10'N	97°08'W	15
	5	26°10'N	96°54'W	37
	6	26°10'N	96°31'W	65
	7	26°10'N	96°20'W	130

Methods

Partial leach (sediment)

For cadmium, chromium, copper, iron, lead, nickel, vanadium, and zinc determination, the entire sample was dried at 90°C and ground in a ceramic mortar to pass through a 200 μ mesh nylon screen. From this sample, duplicate 1 g subsamples were weighed into preweighed and prefired crucibles, and were heated in a muffle furnace at 450°C for 6 hours. After cooling in a dessicator, the samples were reweighed and transferred to precleaned culture tubes; 10 ml of 16N HNO_3 (reagent grade) were added. After heating for 1 hour at 54°C, the solution was transferred to a teflon beaker and evaporated to dryness. The dried sample was brought into solution by the addition of 10 ml of 16N HNO_3, transferred to a culture tube and analyzed by atomic absorption methods. For barium, the method described was modified by the addition of 10 ml of 30 percent H_2O_2 to the sample prior to the addition of the nitric acid. This solution was then mixed well and analyzed for barium. The instrument settings are given in table 5.

Table 5. Instrument Parameters and Mode of Analysis
-303 PE with an HG2100 Graphite Furnace = flameless
-360 = flame

Element	Wave Length	Dilution	Mode	Dry Temp.	Ashing Temp.	Atom. Temp.
Ba	2776	1:40(1:200)	Flameless	100°C	1200°C	2700°C
Cd	2293	1:10	Flameless	100°C	250°C	2100°C
Cu	3262	1:10	Flame	--	--	--
Cr	3589	1:100	Flameless	100°C	1200°C	2700°C
Fe	2483	1:1000	Flame	--	--	--
Mn	2801	1:100	Flame	--	--	--
Ni	2330	1:10	Flame	--	--	--
Pb	2842	1:10	Flameless	100°C	550°C	2000°C
V	3194	1:10	Flameless	100°C	1700°C	2700°C
Zn	2146	1:100	Flame	--	--	--

Totals (sediment)

The sample was ground and homogenized to pass through a 200 mesh nylon screen. Duplicate 0.25 g samples were placed in preweighed and prefired porcelain crucibles and were fired in a muffle furnace at 450°C for 6 hours. The sample was then cooled in a dessicator, reweighed, carefully transferred into a 50 ml teflon beaker and wetted with 12N HCl. Four ml of 16N HNO_3 was added. The sample was then stirred and evaporated to dryness. The residue was redissolved in 2 ml 30 percent H_2O_2, followed by the addition in sequence of 3 ml of 12N HCl, 1 ml HF, 10 ml of 8N HNO_3 and 1 ml 12N HCl. One ml of 16N HNO_3 was added to the residue, and it was diluted to a total volume of 10 ml. This solution was analyzed by atomic absorption. The instrument settings are given in table 5.

Total biological material

Duplicate 0.5 g, freeze-dried, homogenized samples were placed into 50 ml teflon beakers, and 6 ml of 3 to 1 concentrated HCl: HNO_3 mixture were added. The sample was covered with a watch glass and allowed to digest at room temperature overnight or until the sample ceased to foam or bubble. It was then slowly heated for 1 1/2 hours and evaporated to near dryness. To this solution, 30 percent H_2O_2 was added until the resulting solution was clear to yellow. Again the sample was taken to near dryness by repeating the last process. To the residue, 5 ml of 16N HNO_3 was added, and the solution was transferred to a 25 ml volumetric flask, brought to volume with 1 to 1 HNO_3 and filtered through a 0.4 μm NUCLEPORE filter. The solution was analyzed by atomic absorption methods. The instrument settings are given in table 5.

Table 6. Intercalibration samples

Lab	Ba	Cd	Cr	Cu	Fe	Mn	Ni	Pb	V	Zn
MAG I										
USGS, Corpus Christi	540±1	0.27±.07	108±3	29.0±5	51200±300	666±20	64.5±10	19.7±2	128±8	139±8
Texas A&M	-	-	120±5	30.3±0.6	49300±200	762±24	61.5±3	28.8±2.2	-	140±3
Prof. Paper 841	493	-	121±20	48.8	52400	-	50.7	20.4	132	102
G-2										
USGS, Corpus Christi	1434	0.11	10.3	7.5	-	-	4.3	25.8	-	87.1
Prof. Paper 841	1532	-	8.0	9.7	24400	410	2.4	31.3	44.6	68.2
STOCS I/III										
USGS, Corpus Christi	528±80	0.24±.04	64±1	16.4±3	32800	404	35.4±6	16.4±8	99±8	92±2
Texas A&M	-	-	71±5	17.5±.2	32100±200	468±1	30.9±1	25±1	-	87±2
#4922 Starfish										
USGS, Corpus Christi	-	0.34±.08	4.4±1.0	7.3±1.0	223±20	189±70	1.8±0.2	0.74	-	41.8
Texas A&M	-	0.40	0.6	14	273	-	-	0.9	-	-
#4517 Shrimp										
USGS, Corpus Christi	-	0.02±.01	3.6±0.5	17.3±18	104±13	0.8±0.03	2.0±.3	0.1±.03	-	47.7
Texas A&M	-	0.04	-	20	-	-	-	0.1	-	-
#4924 Shrimp										
USGS, Corpus Christi	-	0.05±0.01	3.6±0.2	12.6±0.7	60±8	1.0±.08	2.4±0.3	.29±.16	-	45.4
Texas A&M	-	0.05	-	15	-	-	-	.2	-	-
Zooplankton										
USGS, Corpus Christi	-	0.32±.02	7.8±1.0	28±0.3	170±36	5.50±0.55	3.1±1.1	0.36±14	-	61.2±5
Texas A&M	-	0.40	-	35	-	-	-	0.3		49

Results

Intercalibration

The results of the intercalibration and standardization are given in table 6. For most elements, very good agreement between laboratories is indicated. The only apparent exception is chromium in the organic material. The Corpus Christi laboratory obtained amounts that were higher than those reported by Texas A&M and those certified by the National Bureau of Standards. As these samples were analyzed both by the direct method and by the method of additions with consistent results, we feel our values are valid. The discrepancy may be due to differences in the splits analyzed. The samples exchanged between laboratories (the composite sediment; the shrimp and zooplankton) may have a slightly wider variation because of the lack of stringent homogenization. For example, in the case of the starfish, two individuals were analyzed; some variation would be expected in this case.

Seasonal sediment samples

The results of the analyses from the three seasonal samples are listed in Appendix 6. The samples were analyzed in duplicate and table 7 lists the percent deviation for each element.

Table 7. Percent deviation of duplicate analyses

Ba	9.0	Mn	2.2
Cd	4.6	Ni	6.1
Cr	6.0	Pb	5.4
Cu	5.3	V	6.9
Fe	4.7	Zn	4.3

Discussion

Areal variation

During the summer cruises, subsamples of the four samples taken at each station were analyzed along with a composite of the four samples. This procedure permitted an excellent opportunity to investigate site variability. Figures 124 to 133 show graphically the variability at each site. The graphs were constructed by plotting the average of the four individual samples along the x-axis against the value for each sample and for the composite. In this manner the variability of the elements is visually displayed. If no significant variability exists, all values should fall along or close to a 1 to 1 line. The graphed results show very close agreement, especially with respect to the composite sample. The few individual samples that fall outside the 10 percent envelope (the divergent lines on the graphs) are those taken nearest the shore where the texture of the sediment is highly variable.

Seasonal variability

As discussed above, the composite (the pooled sample from the four grabs taken at each station) was established as a good representative sample for the summer period at each location. As the samples analyzed for the winter and fall sampling period also were pooled from four individual grabs, it follows that these are also representative of the sampling station for the respective seasons.

The plots of a dispersion index (the standard deviation divided by the mean) for seasonal samples against those from a single station (those taken on the summer cruises) are shown by figures 134 to 142. Cadmium was

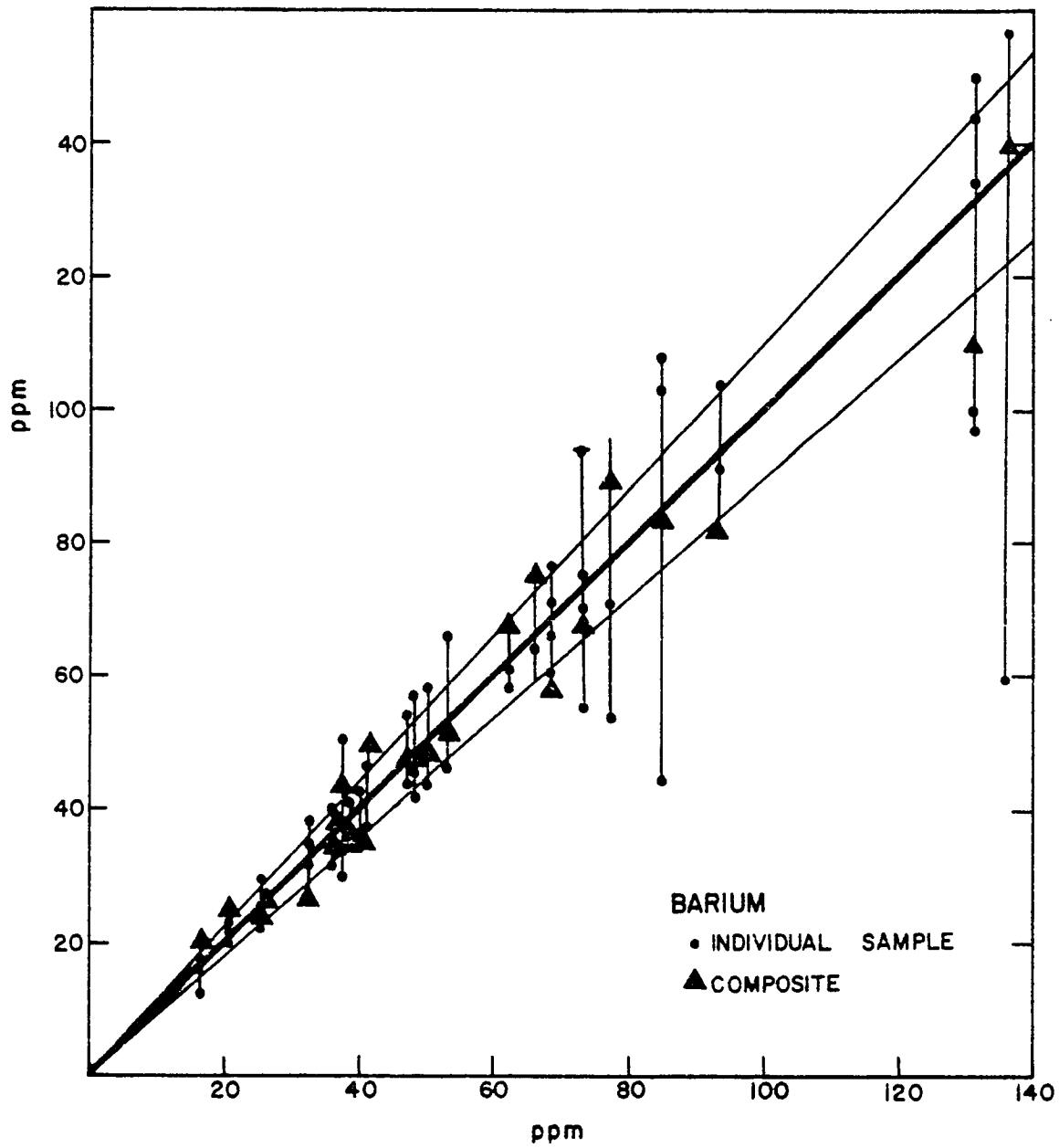


Figure 124. Variations in the amounts of barium in benthic sediments at individual stations, summer sampling period.

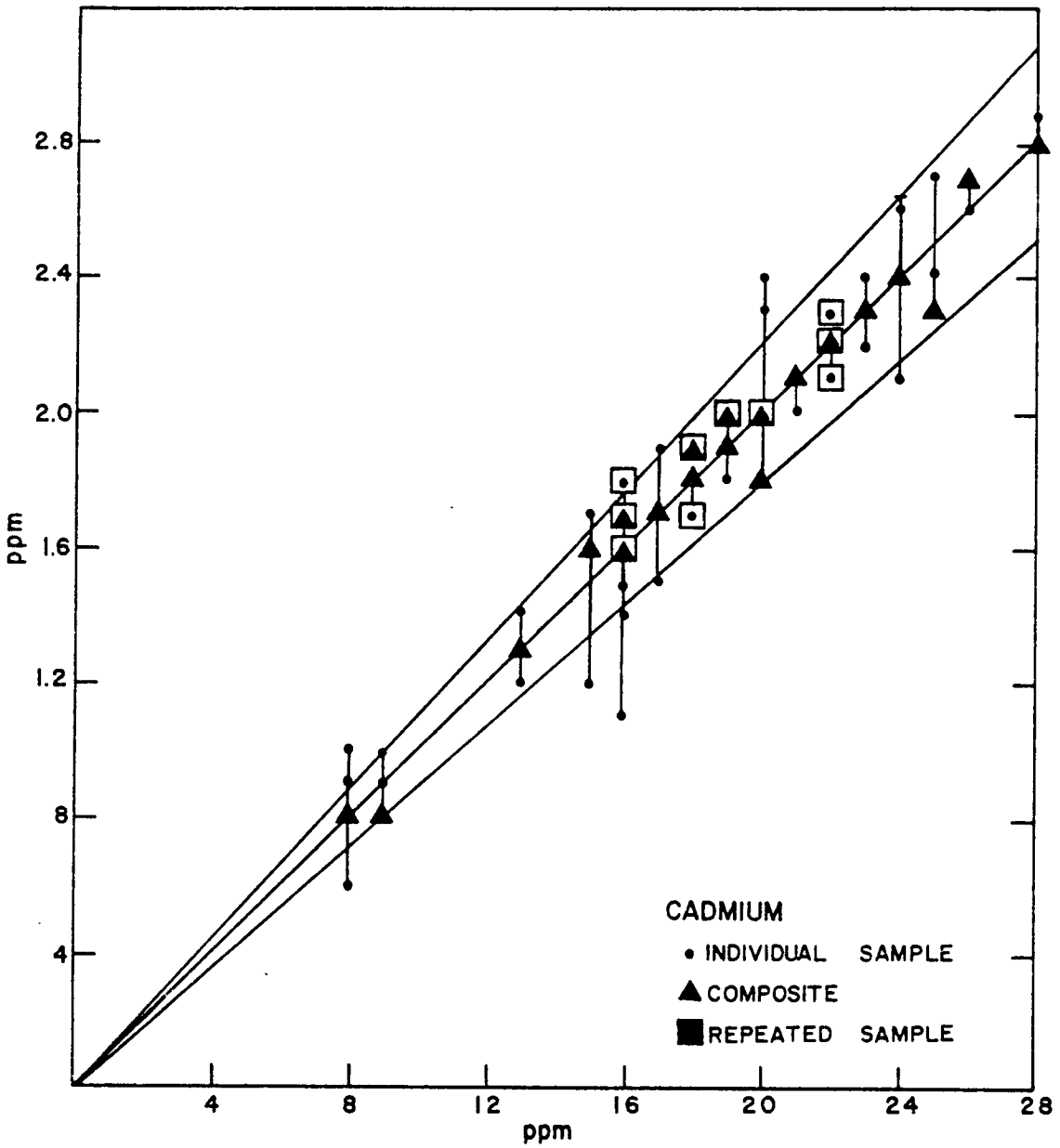


Figure 125. Variations in the amounts of cadmium in benthic sediments at individual stations, summer sampling period.

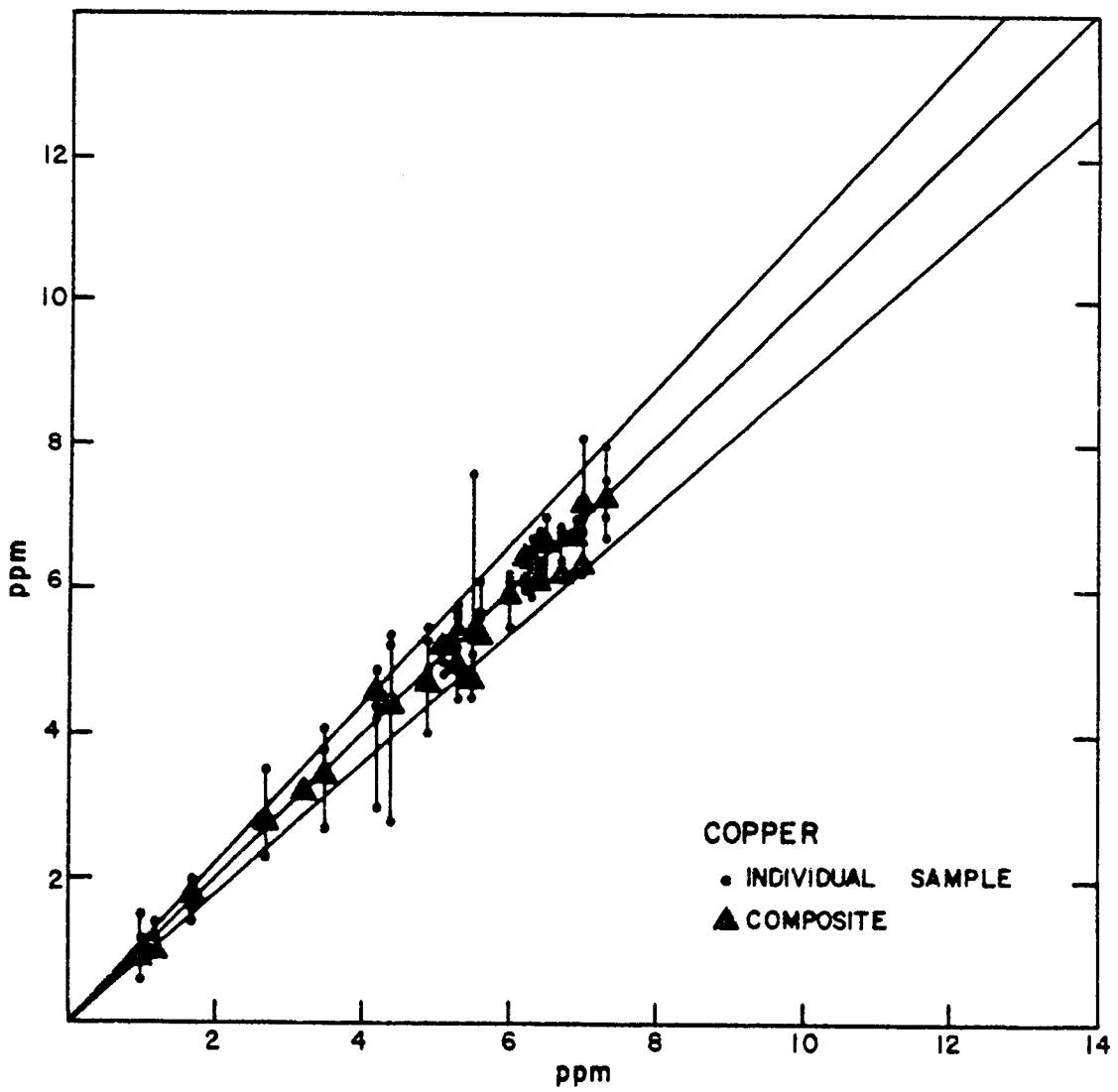


Figure 126. Variations in the amounts of copper in benthic sediments at individual stations, summer sampling period.

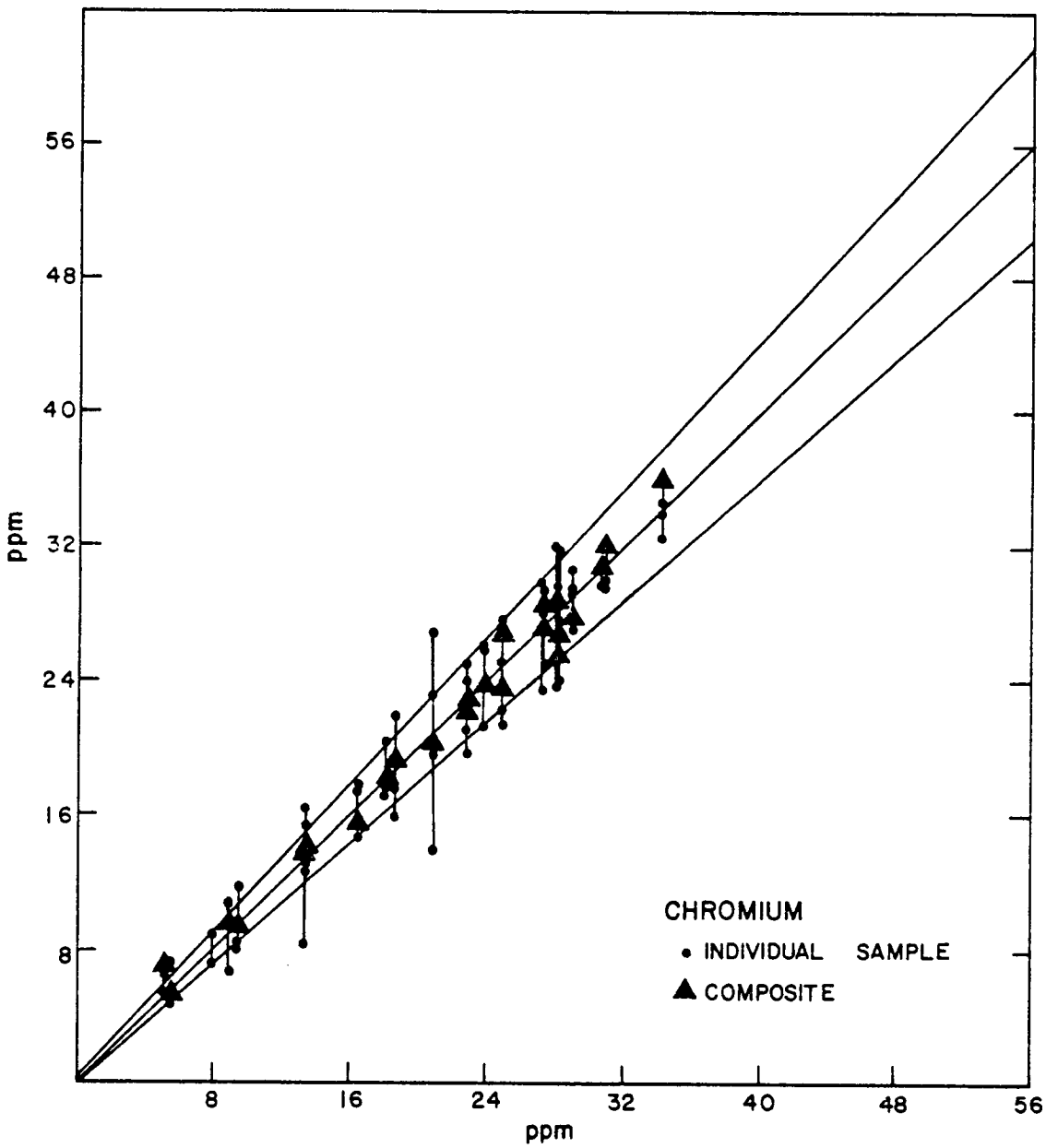


Figure 127. Variations in the amounts of chromium in benthic sediments at individual stations, summer sampling period.

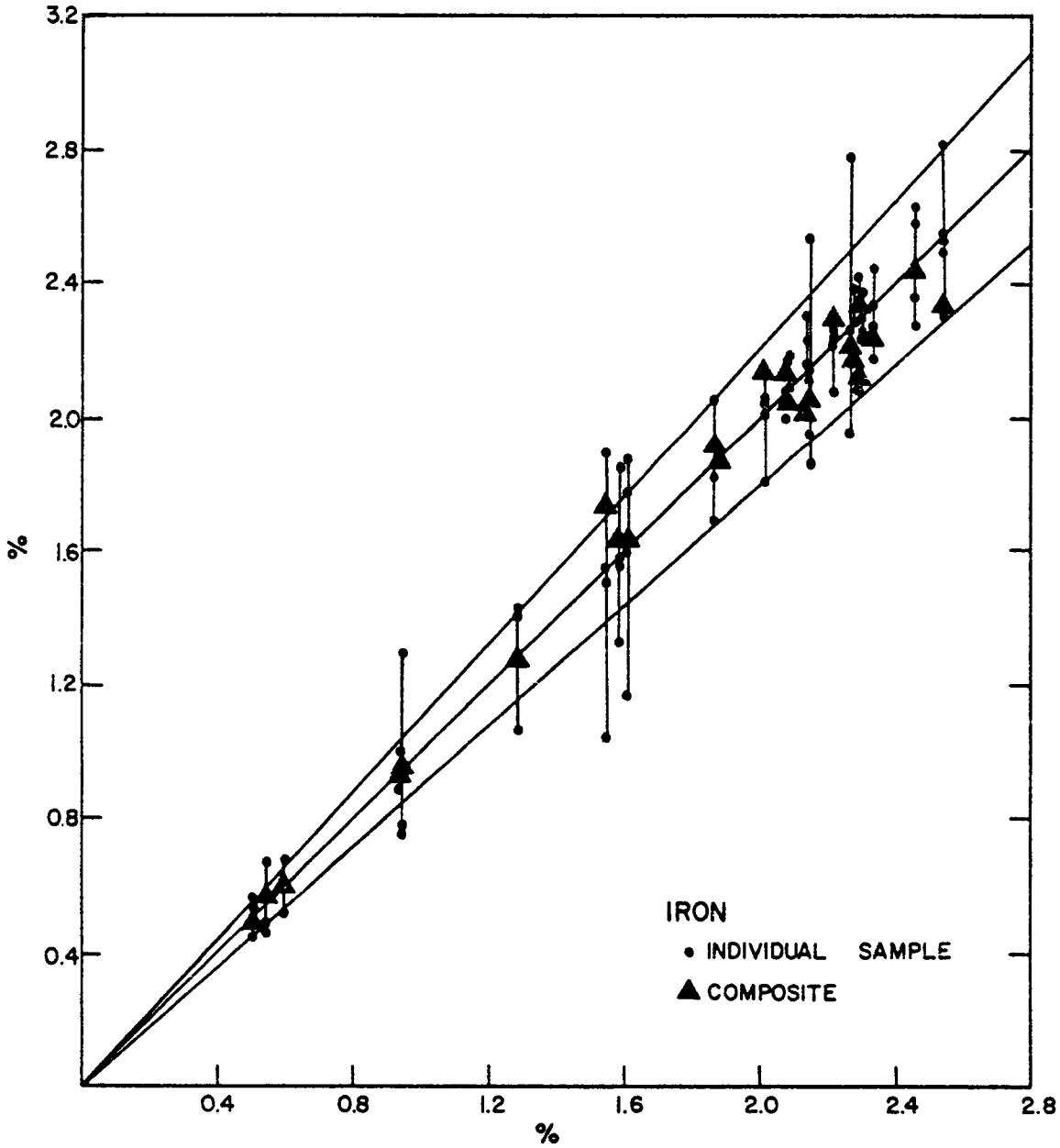


Figure 128. Variations in the amounts of iron in benthic sediments at individual stations, summer sampling period.

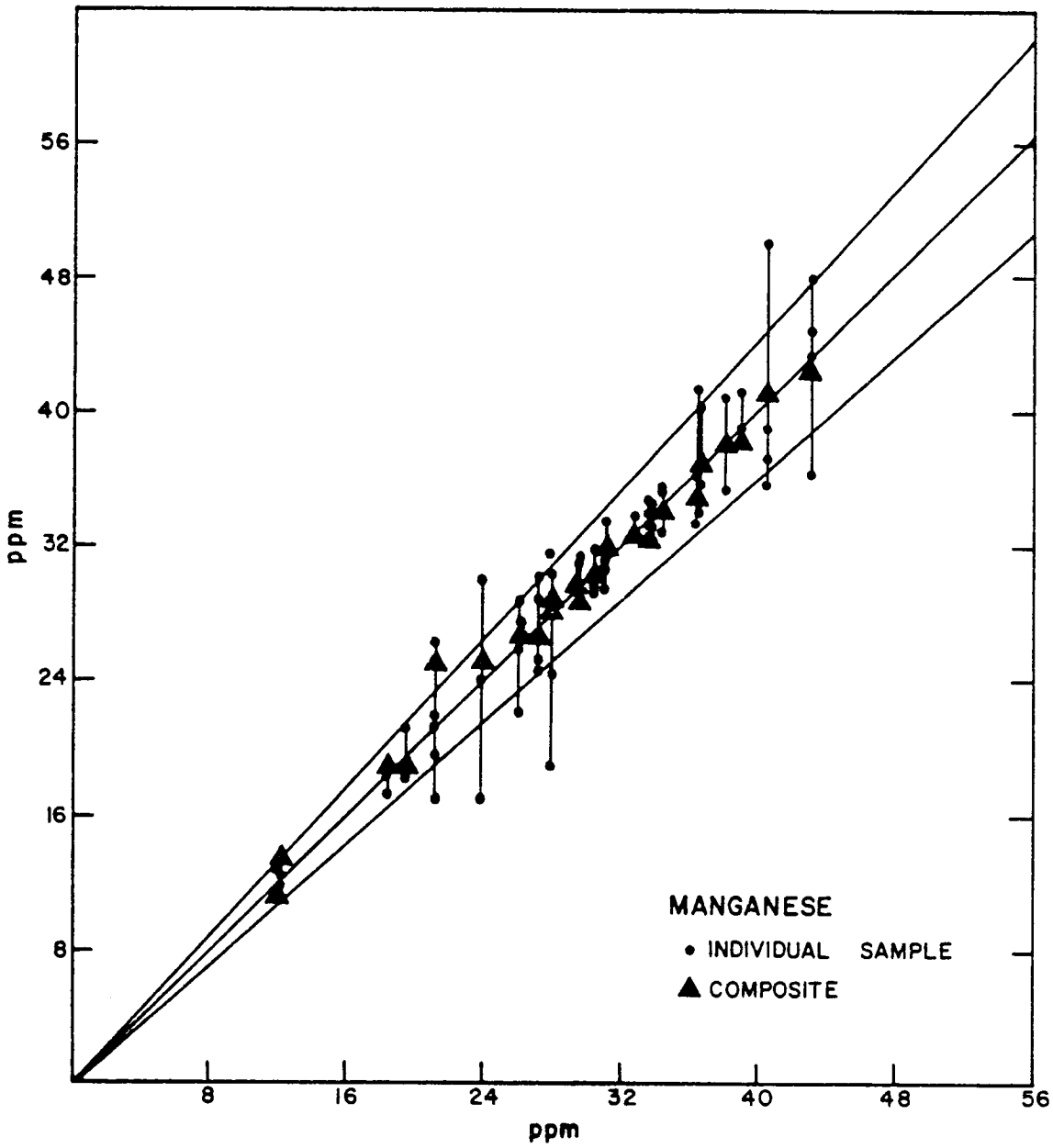


Figure 129. Variations in the amounts of manganese in benthic sediments at individual stations, summer sampling period.

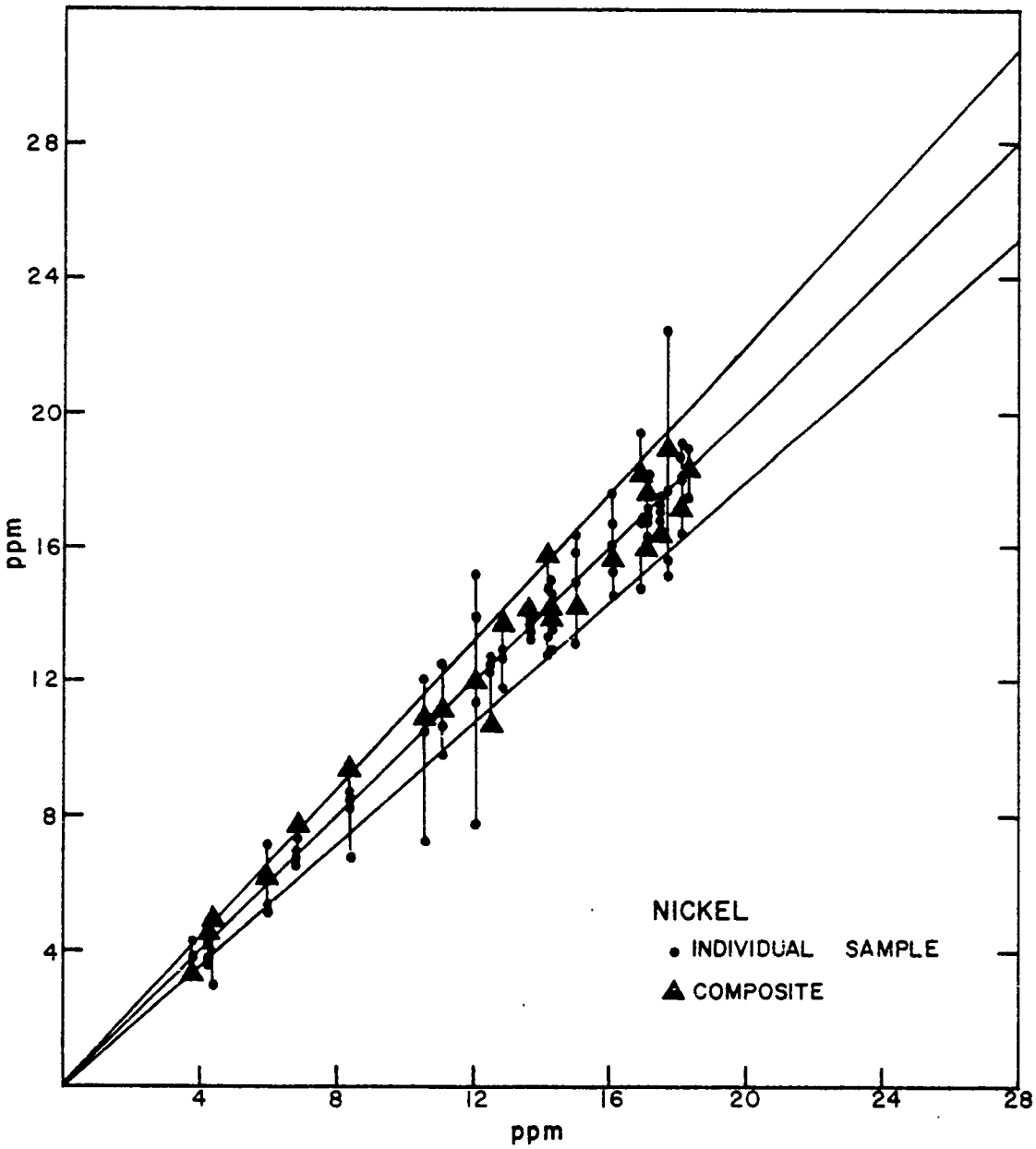


Figure 130. Variations in the amounts of nickel in benthic sediments at individual stations, summer sampling period.

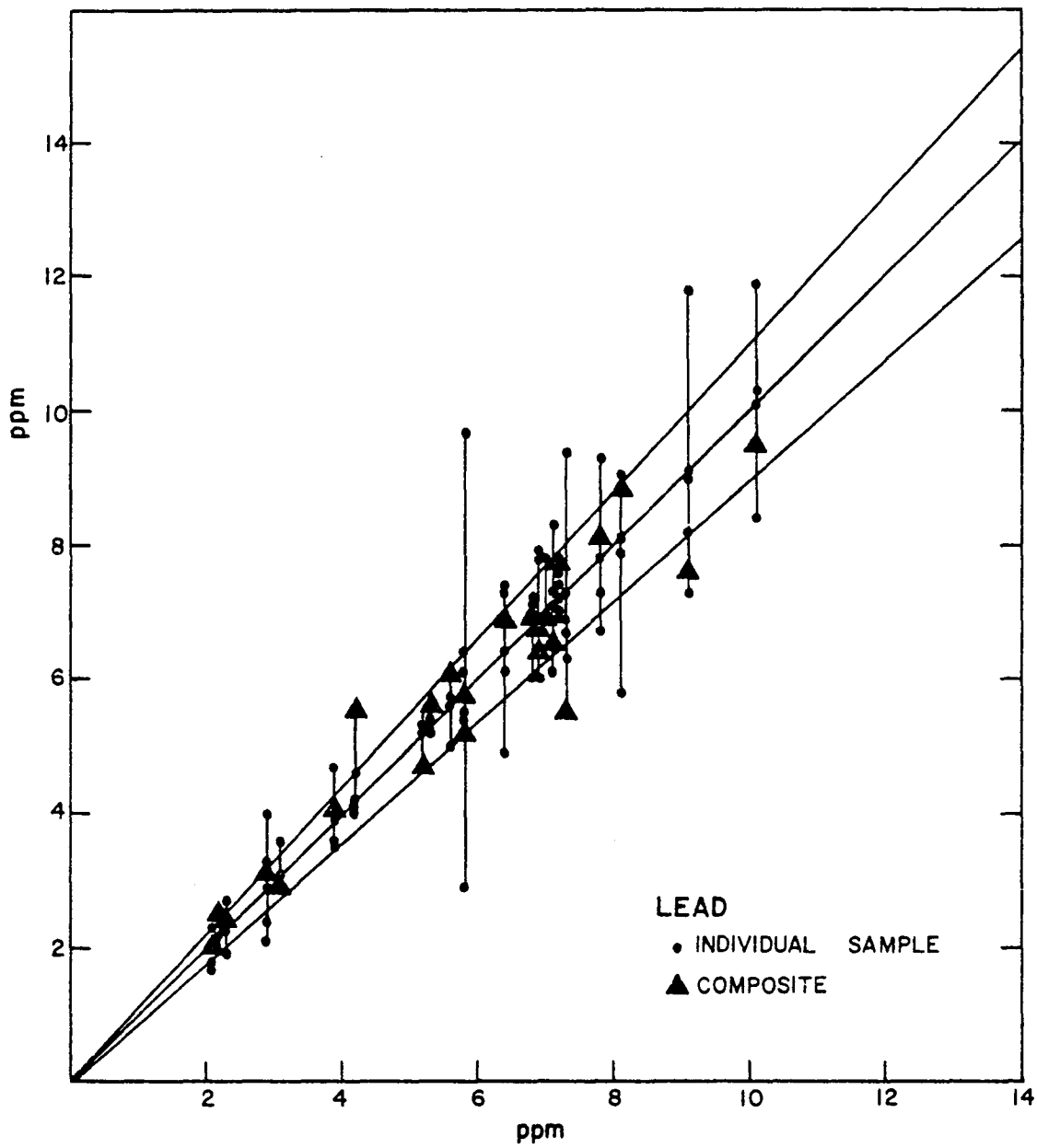


Figure 131. Variations in the amounts of lead in benthic sediments at individual stations, summer sampling period.

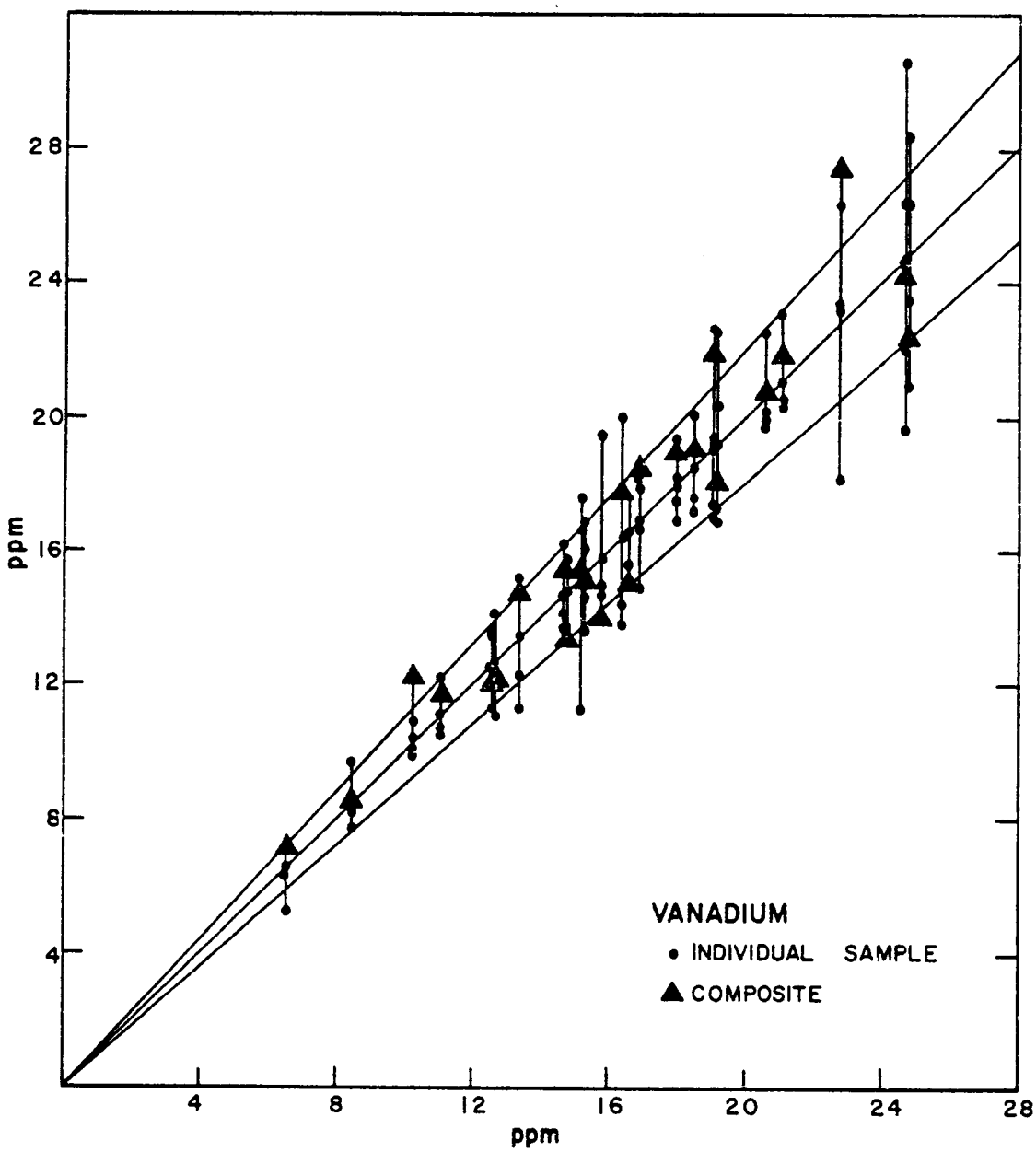


Figure 132. Variations in the amounts of vanadium in benthic sediments at individual stations, summer sampling period.

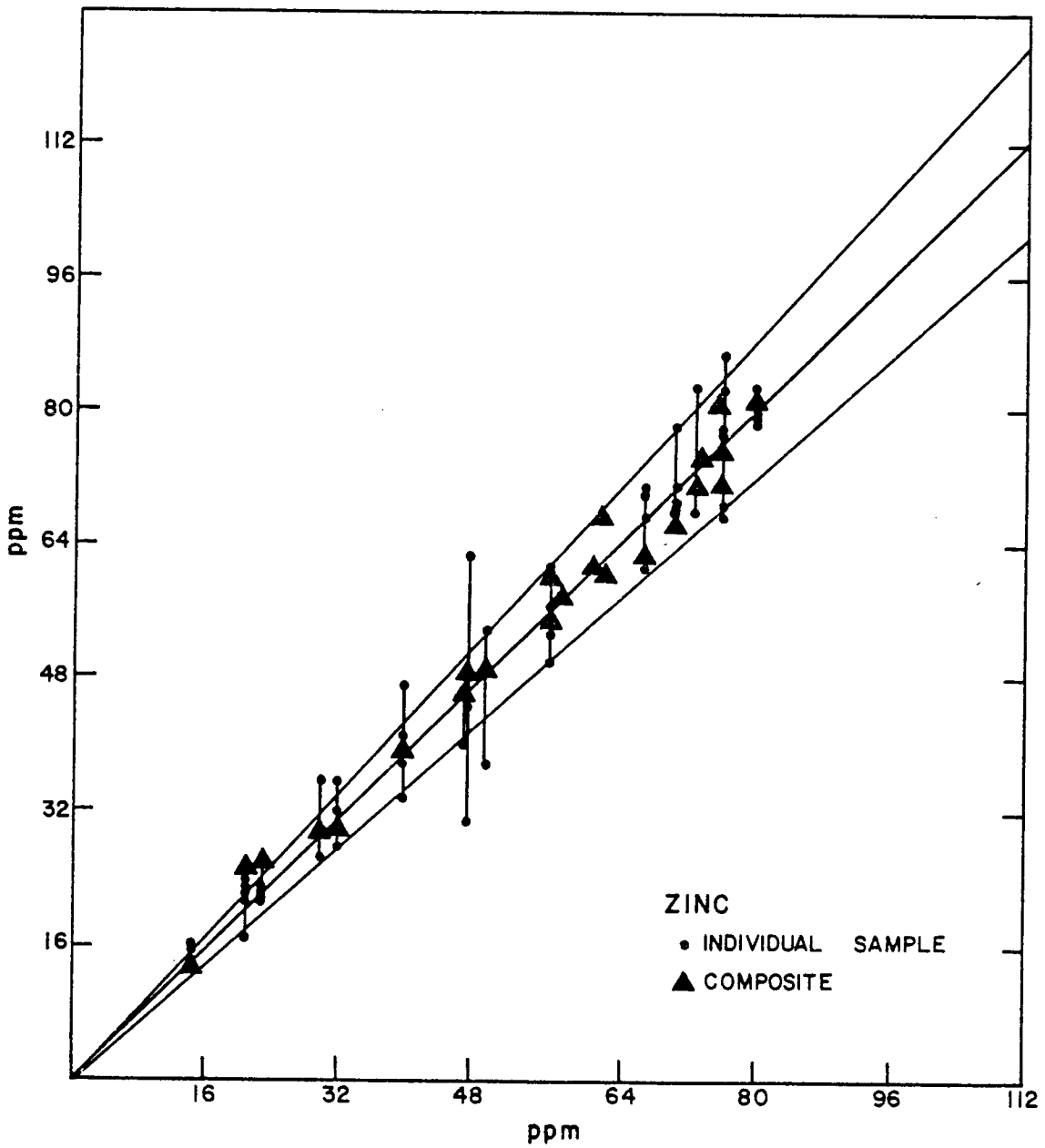


Figure 133. Variations in the amounts of zinc in benthic sediments at individual stations, summer sampling period.

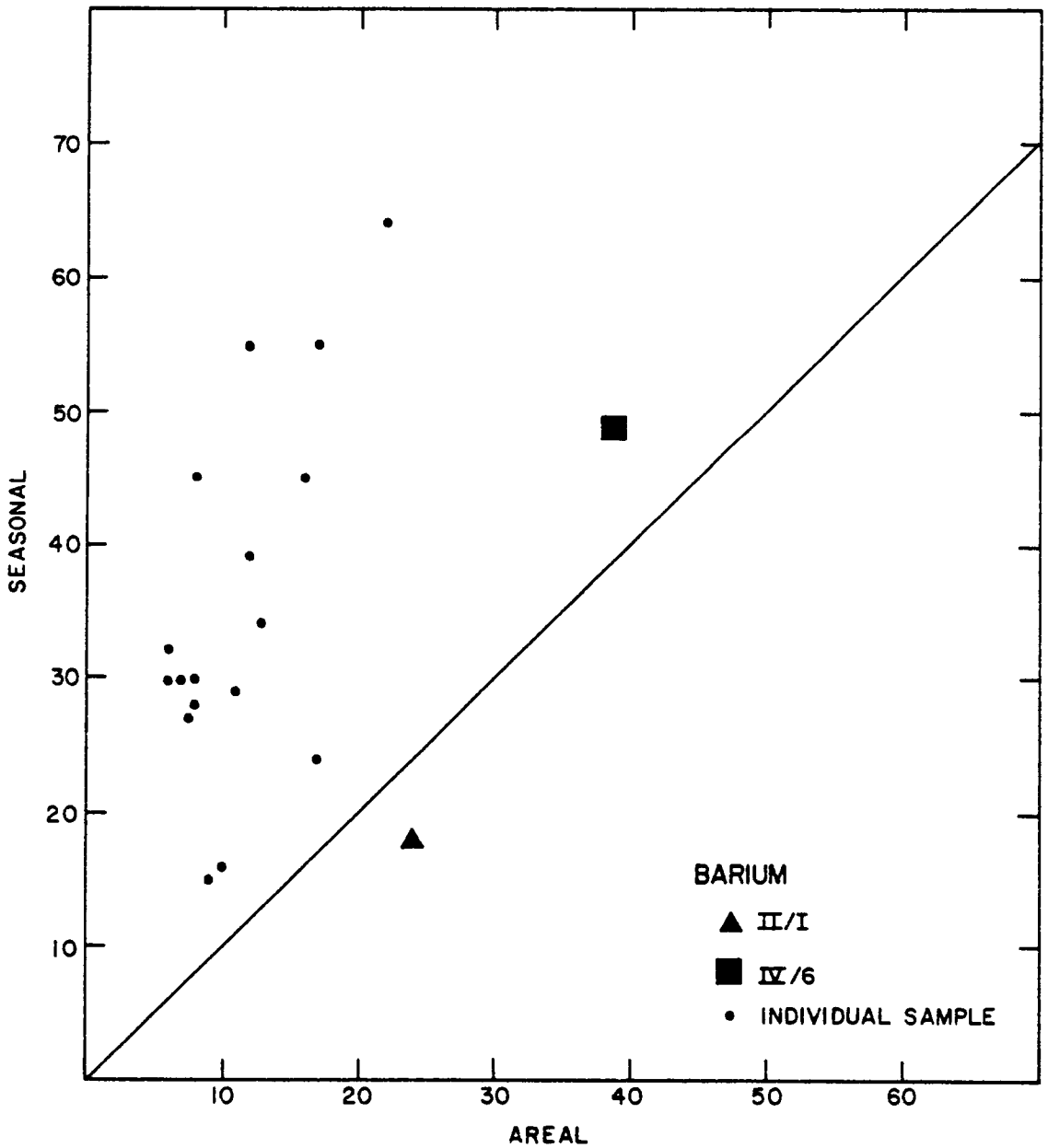


Figure 134. Plot of dispersion indices, seasonal versus areal distribution, for barium in benthic sediments.

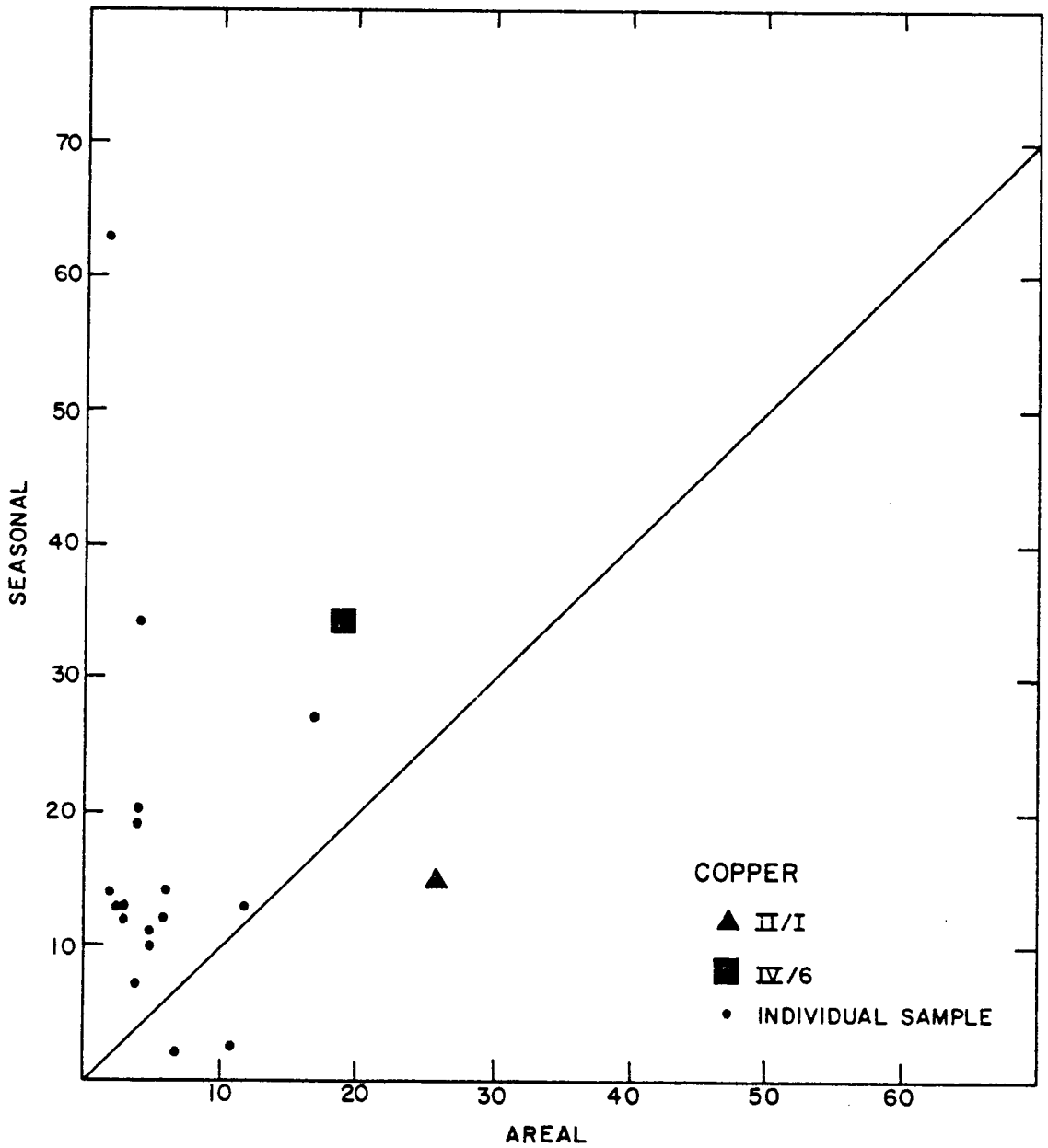


Figure 135. Plot of dispersion indices, seasonal versus areal distribution, for copper in benthic sediments.

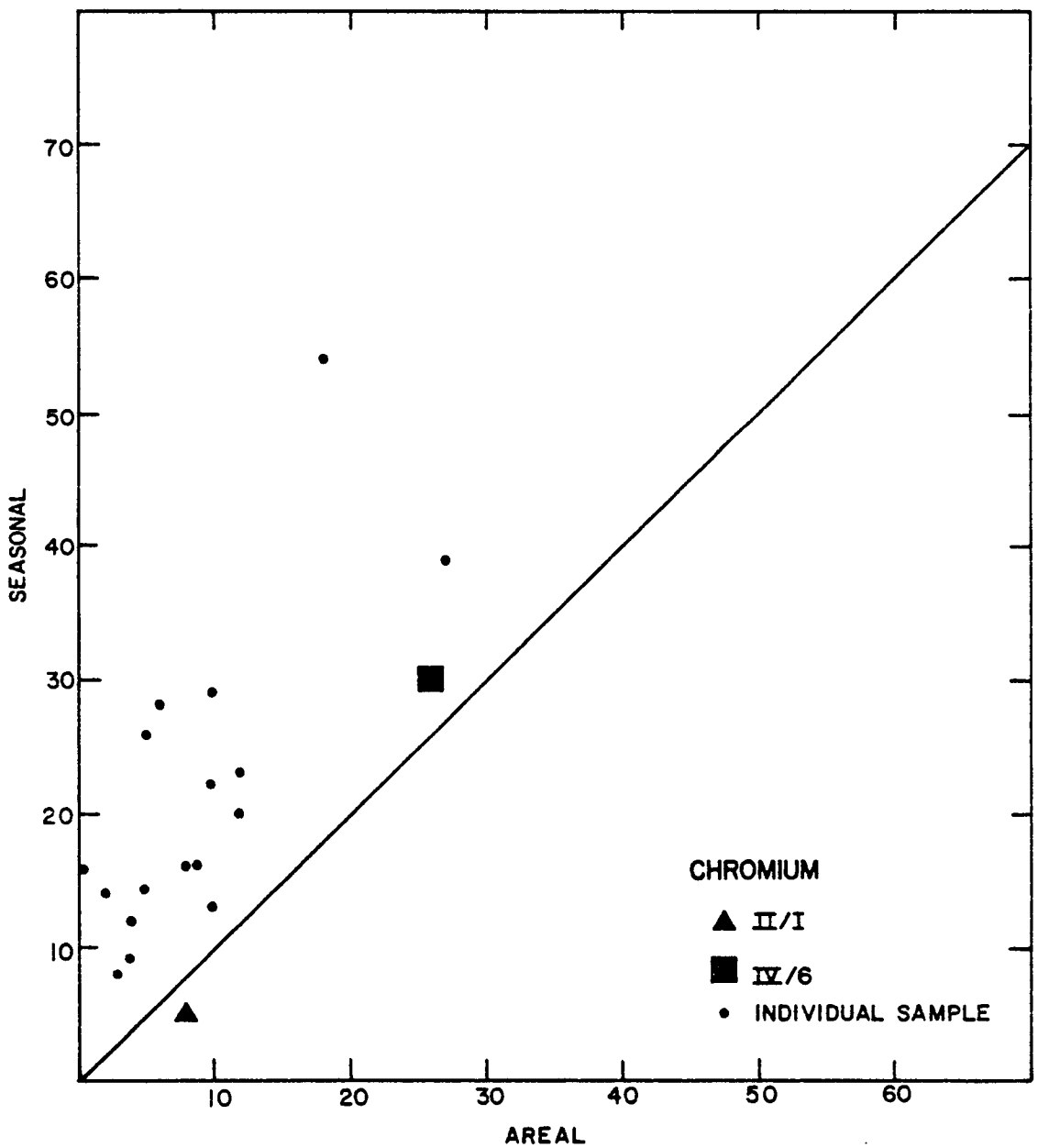


Figure 136. Plot of dispersion indices, seasonal versus areal distribution, for chromium in benthic sediments.

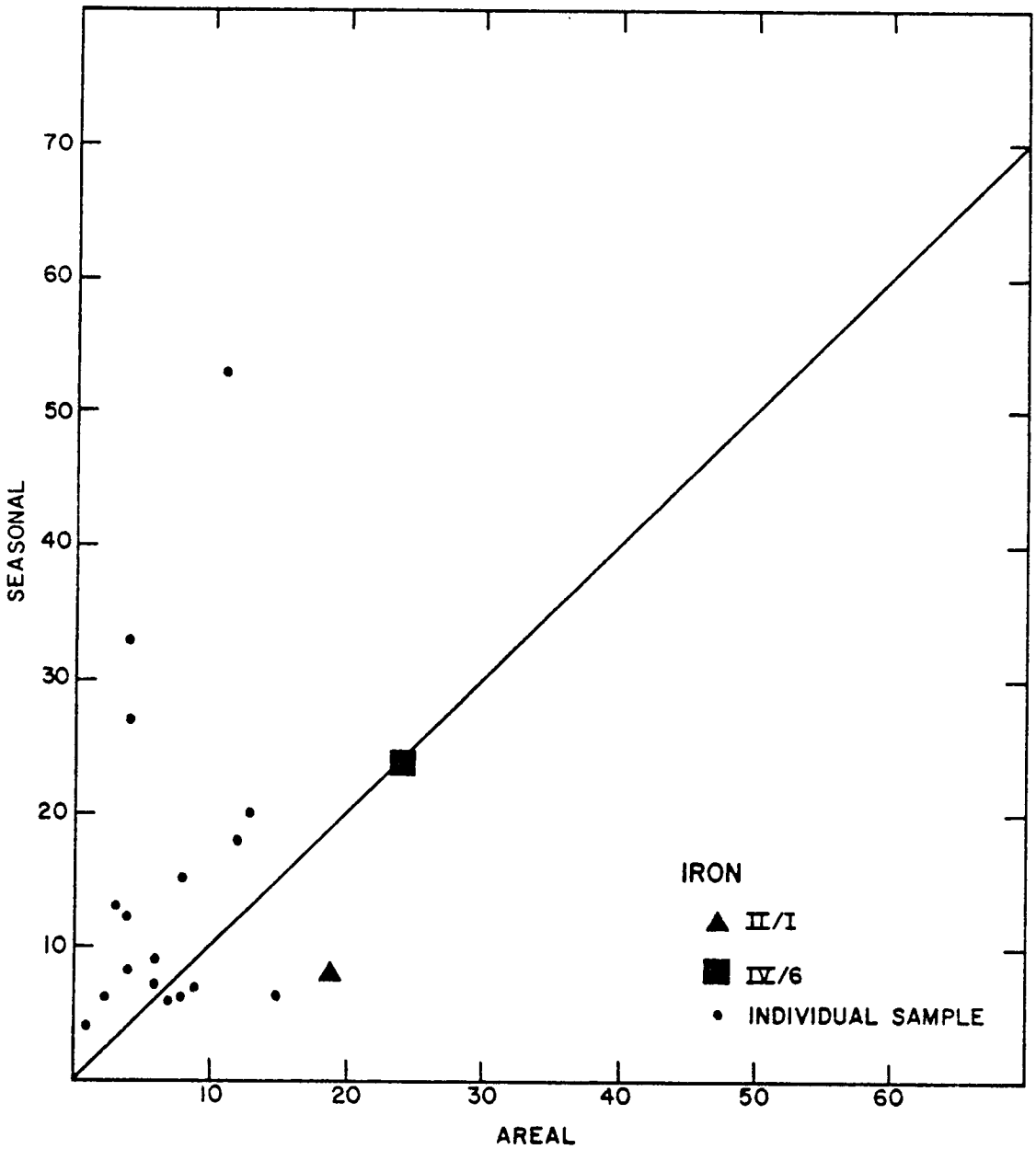


Figure 137. Plot of dispersion indices, seasonal versus areal distribution, for iron in benthic sediments.

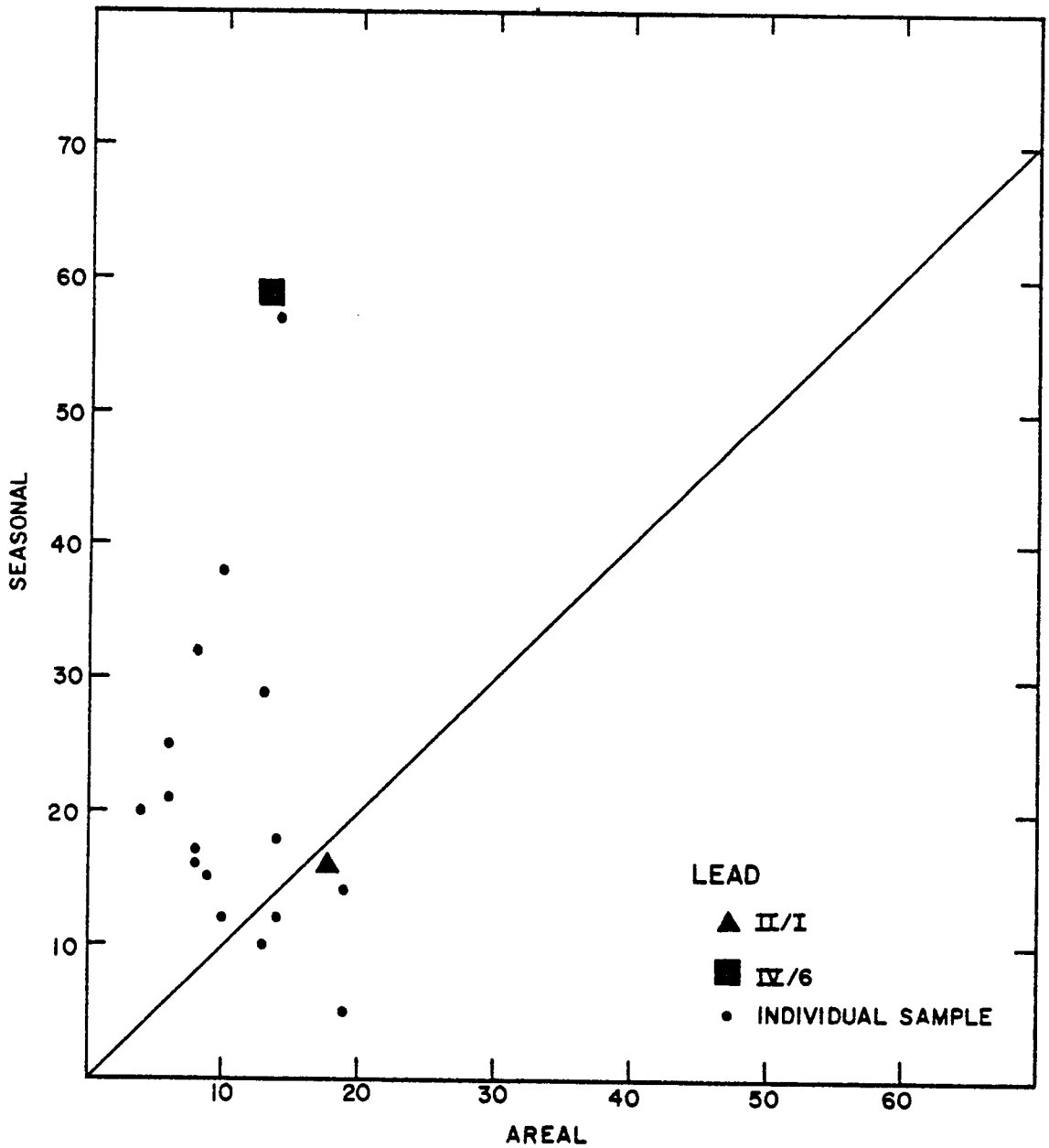


Figure 138. Plot of dispersion indices, seasonal versus areal distribution, for lead in benthic sediments.

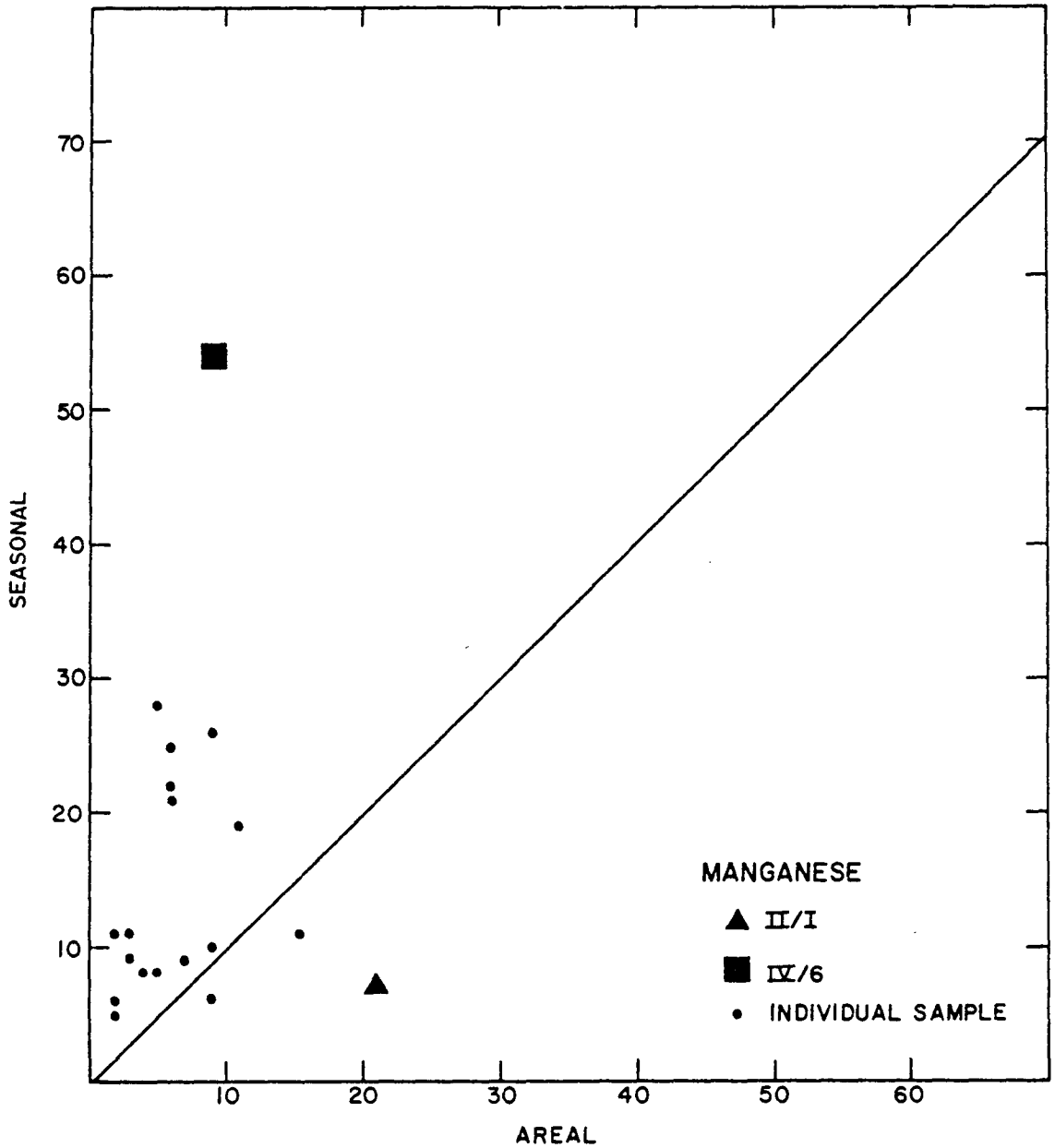


Figure 139. Plot of dispersion indices, seasonal versus areal distribution, for manganese in benthic sediments.

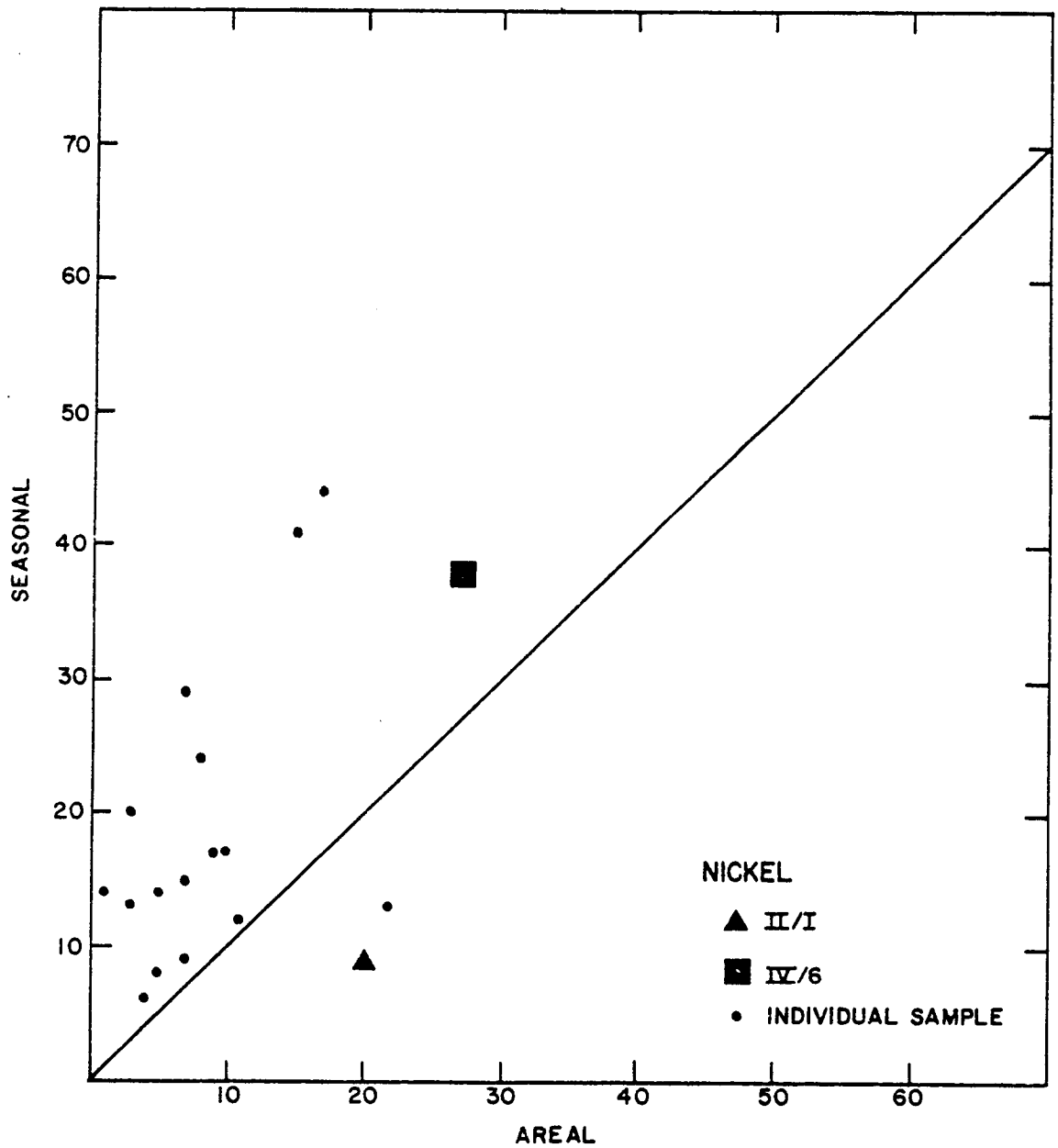


Figure 140. Plot of dispersion indices, seasonal versus areal distribution, for nickel in benthic sediments.

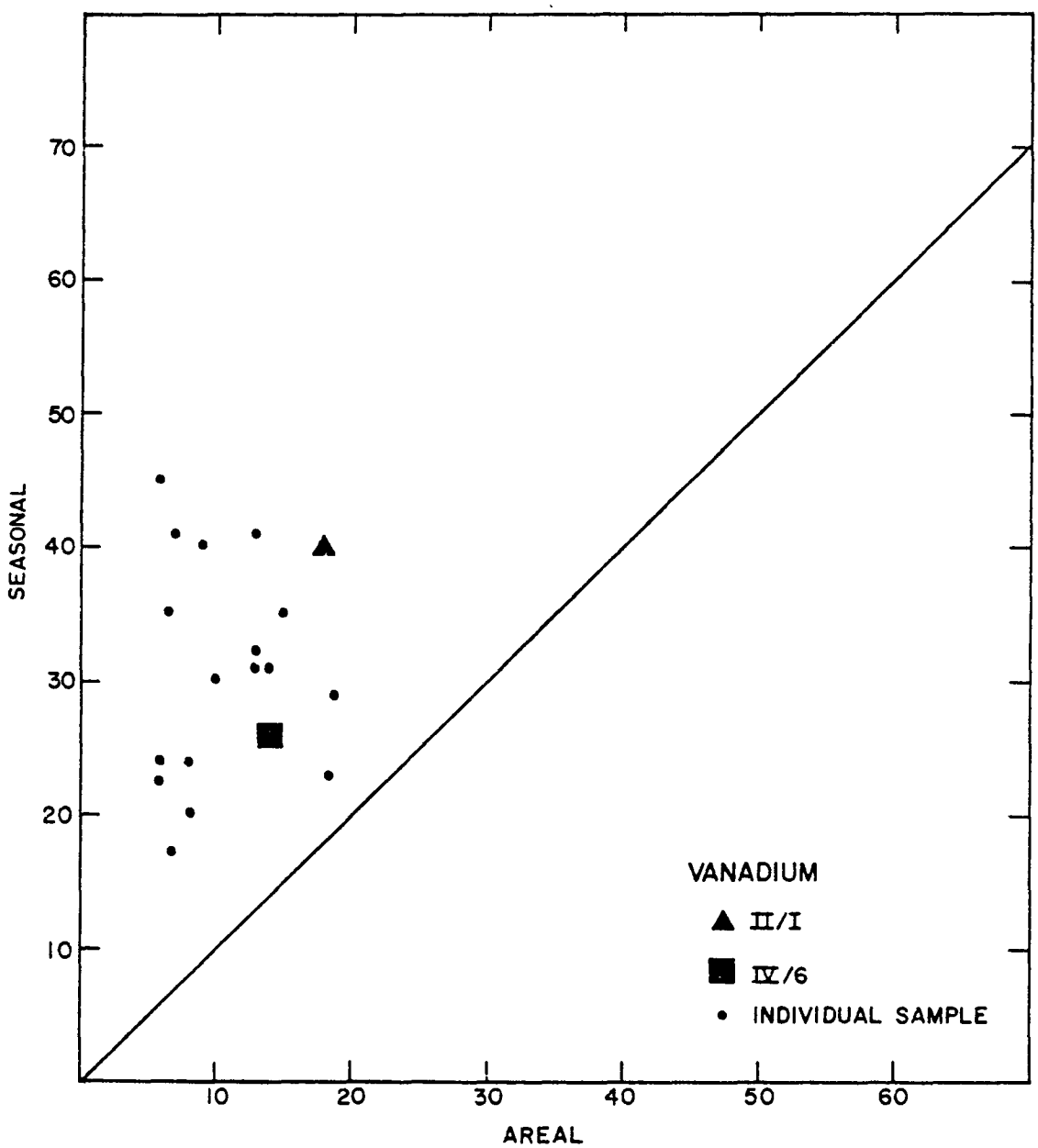


Figure 141. Plot of dispersion indices, seasonal versus areal distribution, for vanadium in benthic sediments.

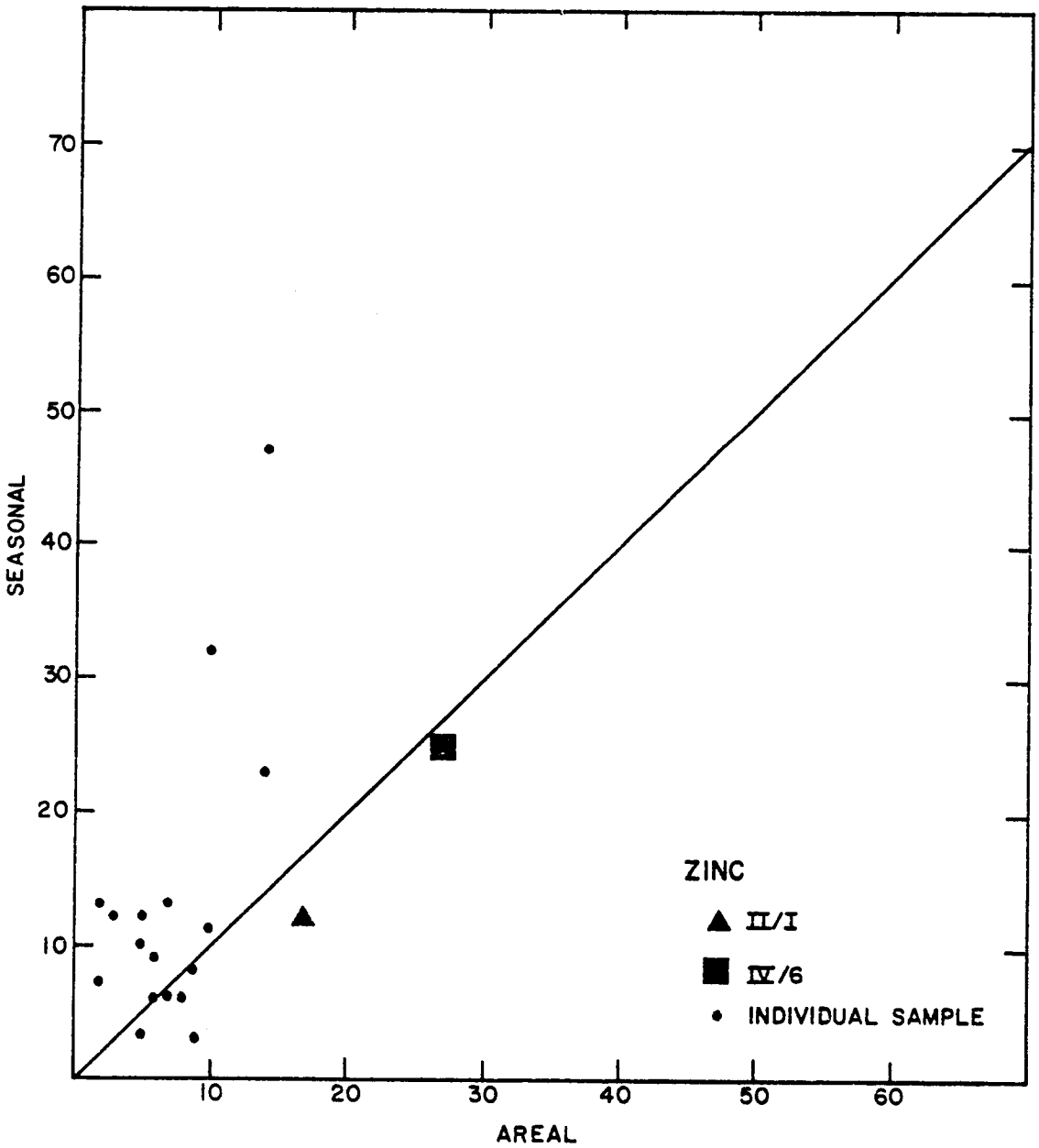


Figure 142. Plot of dispersion indices, seasonal versus areal distribution, for zinc in benthic sediments.

not plotted because of insufficient data for comparison. If no significant differences between the seasonal and areal sampling existed, then the graphed values should fall along or near the 1 to 1 line. The graphs show that for all elements most of the analytical results fall above the line and close to the seasonal axis, indicating that variability on a seasonal basis is greater than the areal variability at a site. The analyses for two stations indicated a significant departure from the pattern of variability common to the other sites. Station II/1, the innermost station on the transect that extends seaward from Port Aransas, had greater site variability than seasonal variability; in contrast, station IV/6, which lies at the outer edge of the ancestral Rio Grande delta, had significantly higher seasonal variability than other stations.

As the samples for each season were analyzed when they were submitted to the laboratory, there was a possibility that the variations indicated were caused by inadvertent variations in laboratory processing and procedures. To test this possibility, 10 samples from the different sampling periods were reanalyzed and the results are listed in table 8. The results document excellent agreement between amounts measured during the seasonal analyses and those measured later during reanalysis (fig. 143).

As a check on the correlativity of the trace metals content of benthic sediments from one year to another within a season, the results for November 1975 were compared with those for November 1974, as reported by Berryhill and others, 1976. Even though a direct comparison was not possible because of the large difference in the number of stations sampled in the two years (264 in 1974; 26 in 1975) the specific amounts on a local basis and ranges in amounts over the region were very similar. Thus, the amounts and the general patterns of distribution indicated by the samples for November 1974

were confirmed by the analyses for November 1975 and may be considered characteristic of the region for that period of the year.

In summary, the seasonal monitoring of variations in trace metals content of benthic sediments indicates that variations between one season and another are greater than those at individual stations within a season. The reason for the pattern of variability indicated is not completely understood, but it may be caused by seasonal variations in biologic activity both along the sea floor surface and within the benthic sediments.

Table 8. Results of reanalysis used to check variations in initial seasonal analytical results that might have been caused by inadvertent changes in laboratory processing. Reruns were in triplicate.

SAMPLE	Cu	Cu*	Mn	Mn*	Pb	Pb*	Zn	Zn*
SEASON I								
4/II	1.6	1.4	227	222	2.6	2.4	27.6	28.1
7/IV	6.6	7.2	623	560	10.5	12.2	95.7	82.6
SEASON II								
3/I	6.0	6.4	327	322	5.4	6.4	70.0	62.6
2/II	5.0	5.3	296	296	6.6	7.7	66.2	54.6
1/IV	2.1	1.9	141	136	2.9	2.7	25.1	22.6
5/IV	3.1	3.3	196	190	3.6	2.9	30.0	30.4
SEASON III								
5/II	5.4	5.5	321	312	8.0	7.3	71.0	70.7
6/II	5.9	6.2	359	305	8.7	7.6	80.2	79.9
I/III	5.7	5.4	306	280	7.4	8.0	61.0	72.5
4/IV	1.6	1.9	167	168	2.3	2.0	19.4	24.1

*Check samples

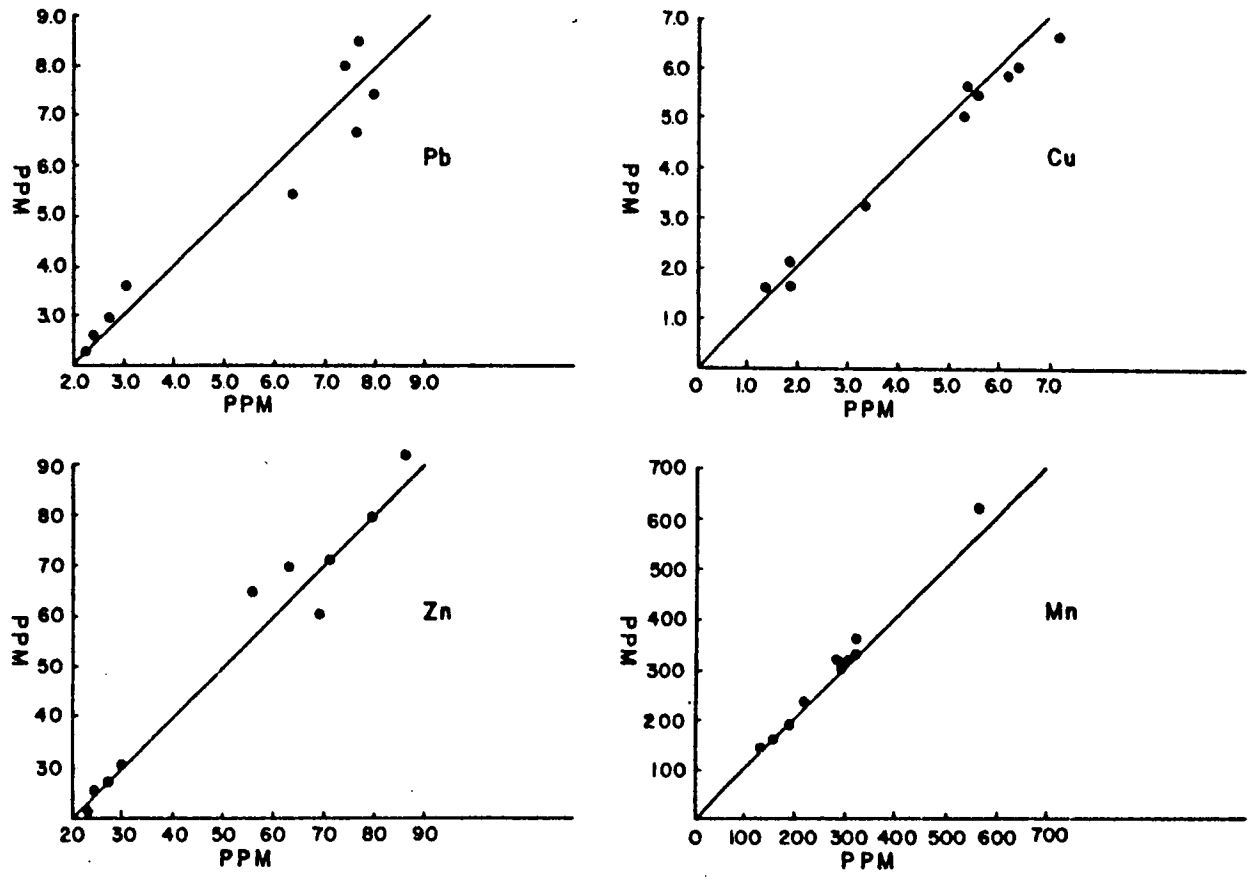


Figure 143. Graphed plots for selected trace metals showing amounts measured during the seasonal analysis versus amounts measured during reanalyzation as a check on the inadvertent variations in laboratory procedures.

Gas Seeps and Trace Metal Concentrations

by

Charles W. Holmes, Bernie Bernard and E. Ann Martin

A geochemical "hot spot" where the amounts of certain trace metals in the benthic sediments are significantly greater than the regional averages, has been mapped in the northeastern part of the south Texas shelf (Berryhill and others, 1976, fig. 27). The amounts of cadmium, chromium, iron, vanadium, and zinc are larger than elsewhere in the South Texas OCS (Appendix 7). The geophysical investigations in 1974-75 suggested that gas seeps are numerous in the area where amounts of the trace metals specified are regionally largest (figure 144). Furthermore, in an investigation of diagenetic changes in argillaceous sediments related to salt intrusives, significantly large amounts of metallics were indicated in marine sediments that overlie a diapiric zone immediately adjacent to the hot spot region (Holmes, 1974). The concentrations of metals were attributed to fluid migration upward into the sediments from the underlying salt mass. The close proximity of the salt mass to the hot spot area suggested that a similar phenomenon might be the cause of the large amounts of metallics in sediments within the suspected gas seep area. The results of an investigation into the possible role that hydrocarbons might play in migration and deposition of metals in benthic sediments follows.

Methodology

Sampling

During May 1975, a detailed high-resolution seismic-reflection survey was made in the hot spot region. Because of malfunctioning of the 3.5 kHz

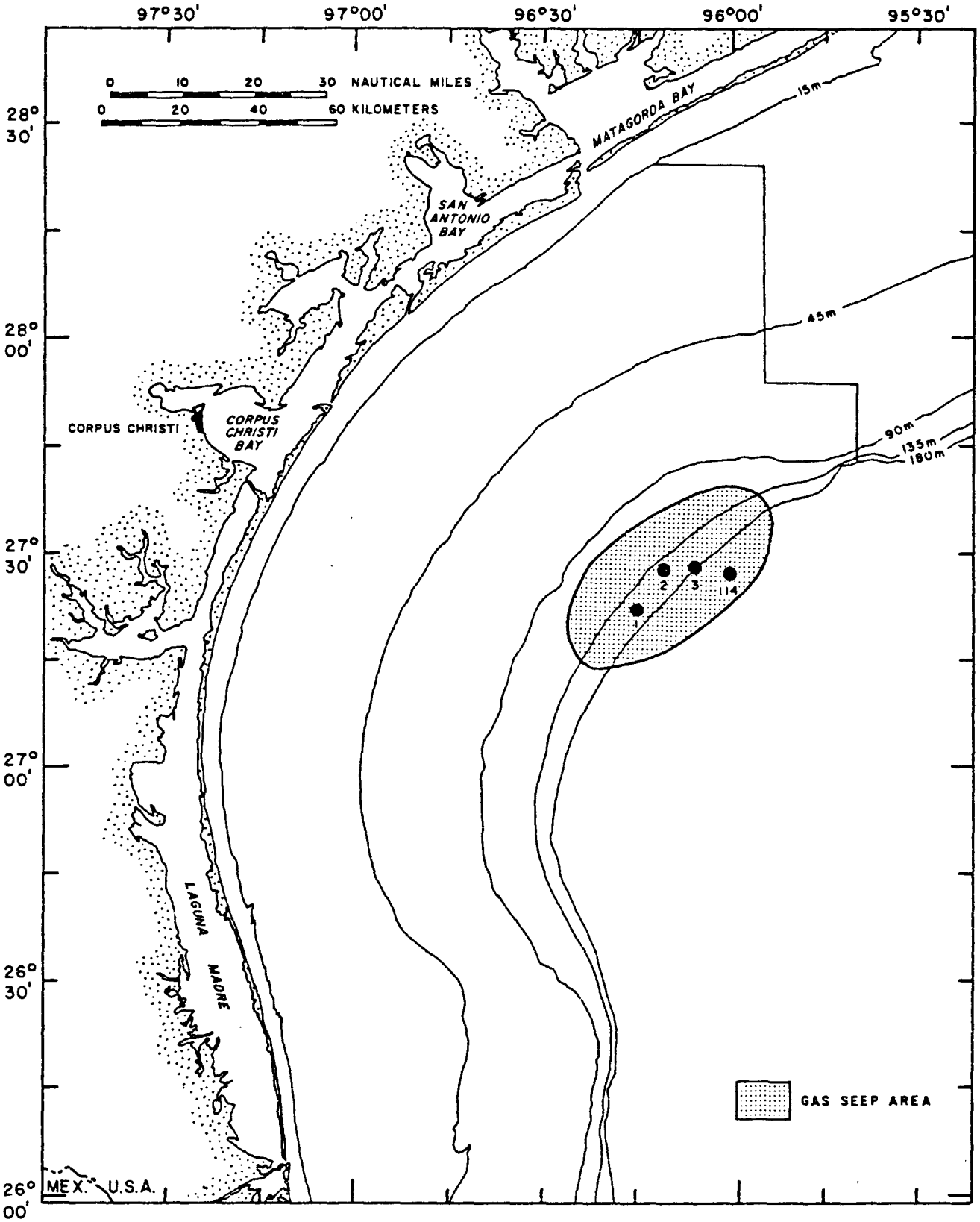


Figure 144. General outline of area suspected of having numerous gas seeps, and locations of cores used for studying concentrations of trace metals in benthic sediments relative to the gas seeps.

seismic profiling system, no gas seeps were observed. However, from the sparker profile data obtained during the survey, three sites were selected for sampling by coring. All three sites were in the vicinity of faults that terminate upward only a short distance beneath the sea floor surface. (See figure 144 for geographic locations.) Site one is located on the flank of an anticline that is oriented northeast-southwest; site 2 is located directly over a fault, also on the flank of the anticline; site 3 is on the crest of the anticline. The locations of the three sites relative to faults are shown by figure 145. Three cores were obtained at each site. At all three sites an attempt was made to recover one of the three cores from as close to the nearest fault as possible. The tenth core (core 114) was taken on the crest of the dome previously studied by Holmes.

After the cores were recovered, they were immediately sectioned into 15 cm lengths. Alternate sections were frozen for gas analysis, and the remaining sections were placed in a cold room for transfer to the laboratory for analysis.

Analysis for gas content

The sealed, frozen sections were placed in a leakproof plexiglass chamber with hydrocarbon-free helium and distilled water. The sediment was allowed to thaw, and the low-molecular-weight hydrocarbons contained in the sediments were allowed to equilibrate and partition into the helium phase, while being agitated on a high speed shaker. The helium phase, containing the low-molecular-weight hydrocarbons, was analyzed by gas chromatograph, equipped with a 1.8 m, 3.0 mm O.D. PORAPAK Q column having a Flame Ionization Detector.

For each section of sediment analyzed, a subsample was taken, weighed, freeze-dried, and reweighed to determine the percent composition of interstitial

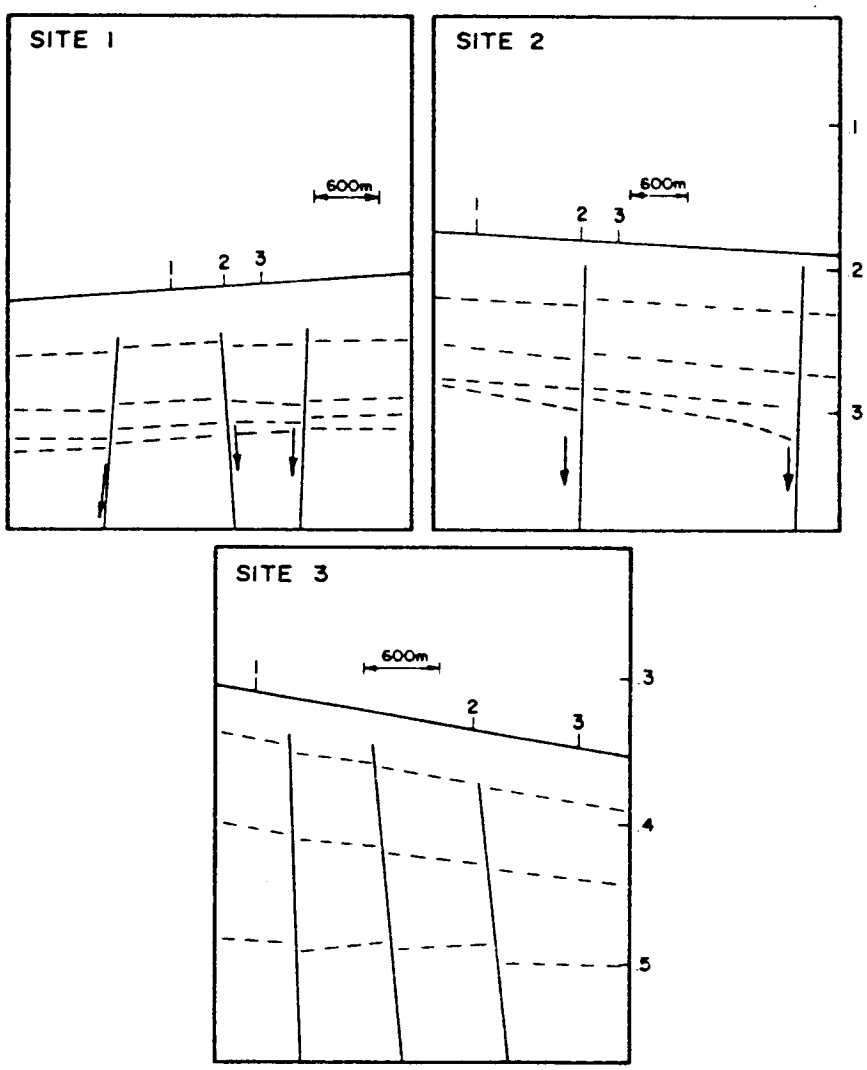


Figure 145. Locations of coring sites used for the gas seep studies relative to faults.

water. The types of low-molecular-weight hydrocarbons detected and the amounts measured are reported in Appendix 8 as liters of hydrocarbon per liter of sediment.

Analysis for trace metals

The interstitial water was extracted by a nylon, gas pressure water-squeezer, with nitrogen as the expressing medium. The sediment and expressed water were kept at the temperature of recovery (20°C). Chlorine, bromine, total sulfate, silicate, calcium, magnesium, sodium and potassium concentrations were determined for the expressed water by basically the same procedure as outlined by Presley (1971). Zinc and manganese were determined directly by atomic absorption, using the method of additions. The amounts of trace metals and the mineralogy of the total sediment were determined by the same procedures as described in Berryhill and others (1976). The analytical data were then synthesized by statistical procedures, specifically by correlation analysis, in an attempt to delineate any geochemical relationships.

Summary

The basic analytical data are presented in Appendix 8. The mean and standard deviation for each measurement for each core are listed in Appendix 9.

The range in the amount of gas within the sediments was about 1 to 2 μl per liter of sediment, increasing slightly with depth. In some cores the maximum amount of gas was at approximately 2/3 the depth of the core, followed by a decrease. For methane, both the concentrations and the gradients of distribution with depth in the sediments are similar to those reported for cores taken previously and elsewhere in shelf sediments. The amounts of gas detected appear to be representative of slow seepage of biogenically-produced

methane from below, and the results are believed to be adequate baseline data for the amount of methane in near-surface sediments of the outer shelf.

The origin of the other low-molecular-weight hydrocarbons is unknown. The variations in amounts, however, are real and may be attributed to in situ generation. The unsaturated hydrocarbons (olefins) are known to be generated by organisms in anoxic environments.

The only core which showed significant differences from the others is core 114, taken on the salt dome. In core 114 the light alkanes formed in older sediments that have been pushed to the surface by diapiric movement of the salt below. The observed gradient of gas distribution in the core may indicate the flux of the hydrocarbons out of the sediment, or it may simply indicate that the more porous and permeable sand in the core allows the gas to migrate more easily.

Correlation analysis of the data reveals no valid correlation between the distribution of the gas and any of the trace metals. The only correlation noted is a fairly strong relation between methane and silicate in the interstitial water.

Statistical analysis among cores and among sites indicates that core 114 differs significantly from all other cores. Cores from sites 1, 2, and 3 are statistically similar to each other.

Overall analysis of the data indicates that the site over the salt dome is completely different from the other sites and that the processes responsible for the concentrations of trace metals differ. Also, it is apparent that seeping gas has little if any direct connection with amounts of the trace metals in the "hot spot" area. The increased amounts of trace metals in the area probably are related to the increased amounts of organic material in the benthic sediment along that part of the shelf.

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Statistical analysis among cores and among sites indicates that core 114 differs significantly from all other cores. Cores from sites 12 and 3 are statistically similar to each other.

Overall analysis of the data indicates that the salt dome site is completely different from the other sites and that the processes responsible for the concentrations of trace metals differ. Also, it is apparent that seeping gas has little if any direct connection with amounts of the trace metals in the "hot spot" area. The increased amounts of trace metals in the area probably are related to the increased amounts of organic material in the benthic sediment along that part of the shelf.

ANIMAL-SEDIMENT RELATIONS

by

Gary W. Hill, Kenneth A. Roberts
Jack L. Kindinger, and George D. Wiley

Introduction

Recent investigations of various Holocene and ancient sedimentary environments have shown that in many instances biogenic processes affecting the substrate subsequent to deposition are equally as important as the physical processes involved during deposition (Howard and others, 1972). Because bioturbation commonly modifies both grain-size relations and depositional structures to a marked degree in some depositional environments, an understanding of benthic biological processes contributed significantly to sedimentological, paleoecological, and overall environmental interpretations. This report describes biological studies designed to identify, classify, and interpret significant benthic (macrobenthic infauna) biological processes as they relate to the sedimentological processes operative on the South Texas Outer Continental Shelf.

The interaction of physical and biological processes on the continental shelves has rarely been studied. In the United States, investigations of animal-sediment relations have been largely restricted to the east coast, particularly off Georgia (Howard and Reineck, 1972). Animal-sediment relations off the Texas coast had received only meager study (Hunter and others, 1972; Hill, 1974) until the first year of environmental studies on the South Texas OCS. The studies were begun as a part of the work undertaken by USGS, and initial results were reported by Hill in Berryhill and others, 1976. The results reported herein represent the continuation and conclusion of those studies.

General Statement

Bottom samples from 264 stations (fig. 146) were analyzed for biological content. Of the total samples used in the study, 81 representing all parts of the shelf were analyzed and reported on in 1975 (Berryhill and others, 1976). The remaining 183 were analyzed in 1976 and the results incorporated into those for 1975. Subsamples were removed from each sample for sedimentological and geochemical studies. A detailed explanation of the investigative steps used in this study is outlined in table 9. The methods of handling, preservation and identification of the sample material followed collection and laboratory processing procedures that are in general use.

The spatial distribution along and normal to shoreline trends were determined by compiling the counts from each traverse. Biomass was determined using a PERKIN-ELMER autobalance AD-2^R, accurate to 1.0×10^{-6} g. For some species, because of their very small size and fragmentation, an average weight per individual was calculated and used in biomass calculations.

A classification type of numerical analysis was utilized to determine macrobenthic infaunal assemblages. The computer program was supplied by Dr. Joseph L. Simon, Department of Biology, University of South Florida. Correlation coefficients were determined using the modified USGS RAS-STATPAC program for correlation analysis (D0101) and general regression analysis (D0095).

The Shannon diversity index, $H' = - \Sigma P_i \log_e$ (P_i is the proportion of the ith species in the collection), was utilized to calculate diversity because it is influenced by two components: the total number of species present (species richness component) and the evenness of distribution of the individuals among the different species (equitability component) (Shannon and Weaver, 1963; Lloyd and Ghelardi, 1964). To apply Shannon's formula to a sample from a population, it must be estimated by the equation,

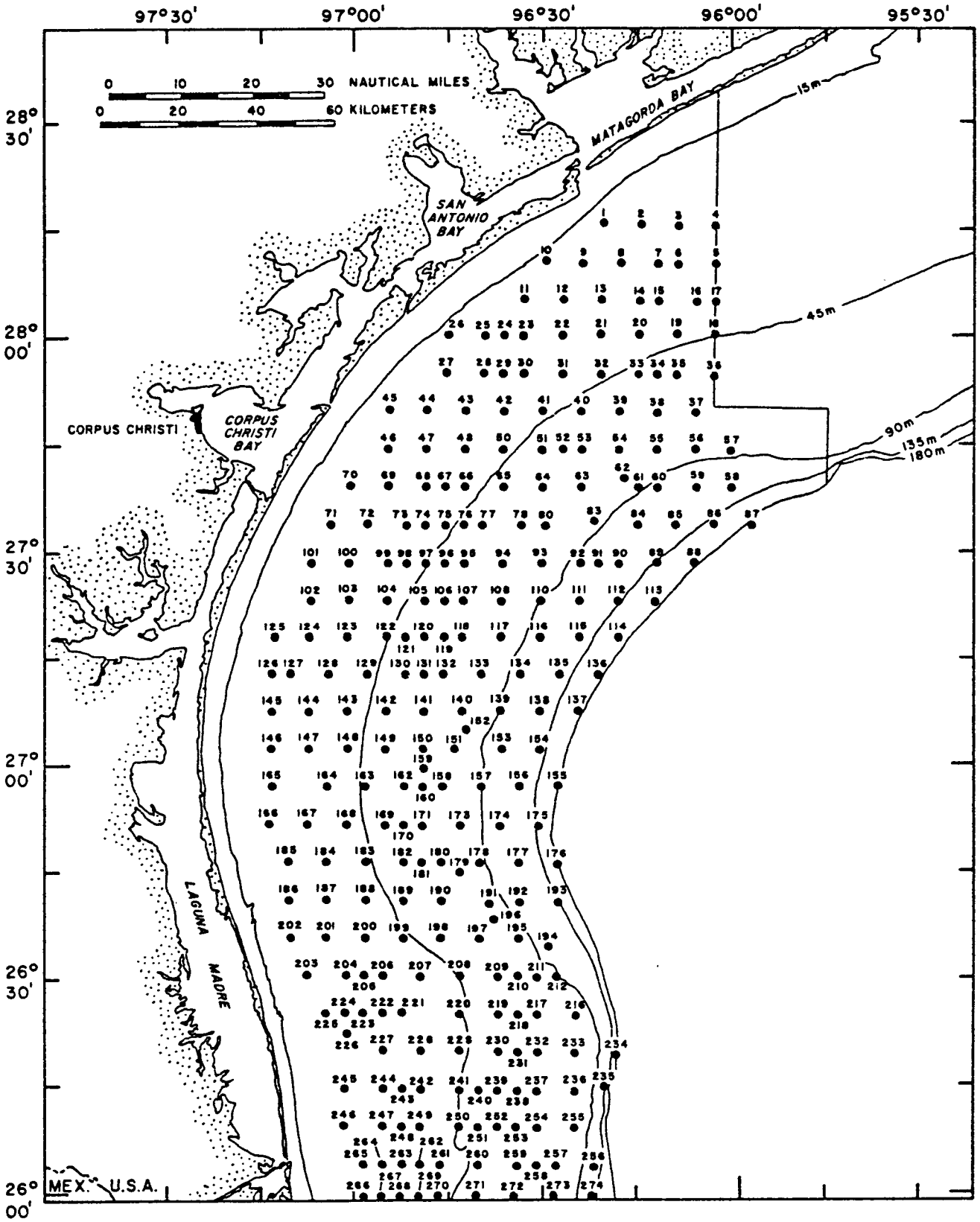


Figure 146. Locations of benthic stations sampled for the study of animal-sediment (biogeologic) relations.

Table 9. General outline of investigative steps used in the biogeologic studies of the South Texas OCS.

Step 1.	Sample collection	1.1	Samples collected
		1.2	Samples washed through 0.5 mm sieve
		1.3	Samples stored in properly labeled glass jars
		1.4	Pertinent sample data entered in master log
		1.5	Sample inventoried on ship and storage location noted
Step 2.	Sample preservation	2.1	Samples fixed in 5 percent formalin solution
		2.2	Samples converted to 45 percent isopropyl alcohol solution for preservation
		2.3	Samples inventoried in lab and storage location noted
Step 3.	Differentiation phase, initial sorting	3.1	Organic versus inorganic separation
		3.2	Identifiable organic material versus unidentifiable organic material separation
		3.3	Separation of identifiable organic material to phyla level
Step 4.	Differentiation phase, final sorting	4.1	Separation of identifiable organic material to species level
		4.2	Cursory description of unidentifiable organic material
		4.3	Cursory description of inorganic material
Step 5.	Identification pahse	5.1	Taxonomic identification of species
		5.2	Biomass calculation
Step 6.	Classification (community level) phase	6.1	Numerical analysis
		6.2	Diversity-equitability analysis
		6.3	Biofacies analysis
Step 7.	Interpretation phase	7.1	Interfacing analytical results
		7.2	Data processing for computer
		7.3	Parameter tabulation
		7.4	Interpretation of results

$$H' = - \Sigma \frac{N_i}{N} \log_e \frac{N_i}{N} \text{ natural bels/individual;}$$

where N_i is the number of individuals in the ith species and

N is the total number of individuals collected.

The species richness component was measured by Margalef's index, $d = (S-1)/\log N$, where s = number of species and N = total number of individuals in the sample (Margalef, 1958). Relative species abundance was measured by Lloyd and Ghelardi's (1964) equitability index, $E = s'/s$, where s' is the number of species predicted for the calculated H' by the "broken-stick" model of MacArthur (1967) and S is the number of species.

Two important points need explanation before proceeding with the discussion and results. First, the entire study area was sampled during October 25 to December 22, 1974. This study, therefore, represents a "snap-shot" picture of the benthic biological conditions that prevailed during the winter of 1974 on the South Texas OCS. Second, it must be stressed that only one grab sample (approximately 0.0125 m^3) was taken at each station because of time and logistical constraints. It has been pointed out by Holland (1975), based on Pk values on a suite of 12 samples, that one grab sample will obtain approximately 30 percent of the species that might be expected to exist at a specific inshore station. He also expressed the opinion that 50 or more samples at an individual site might be needed to sample adequately the total infaunal population. Therefore, large variations may be expected between adjacent stations. This variability affects the contouring of maps for various parameters, particularly derived data. Consequently map contours in this report must be considered approximations.

The raw data relative to biological sampling and data inventory is listed in Appendix 10.

Macrobenthic Infaunal Zonation

In order to identify, classify, and interpret the significant benthic biological processes as they relate to the sedimentological processes operative in the study area, basic descriptive biological and sedimentological studies were conducted. The studies focused on the living macrobenthic infauna because they make the most significant biogenic impact on the sediments. Sediment parameters referred to in the discussions are those determined by Gerald L. Shideler and reported in Berryhill and others (1976).

As a first step toward the interpretation of benthic biological processes, macrobenthic infaunal zonation must be described and the factors controlling such zonation defined. Spatiotemporal variations in macrobenthic infaunal distribution patterns were examined. To determine the significance of variations in the spatial distribution of benthic organisms, the characteristics of macrobenthic infauna are described, first relative to the study area in general and then by specific assemblages.

General Characteristics of the Macrobenthic Infauna

Characteristics of macrobenthic infauna to be discussed include number of species and individuals, biomass, diversity, equitability, and species distribution.

Number of species and individuals

The 264 samples examined yielded 14,313 individuals representing several taxonomic groups (table 10) and 205 species (table 11). The taxonomic groups having the greatest number of species were Polychaeta (48 percent), Crustacea (24 percent), and Mollusca (22 percent). The greatest number of individuals

Table 10. Number of species and individuals collected from 264 stations/samples.

Taxon	No. of Species	No. of Individuals
Polychaeta	98 (48 percent)	8895 (62 percent)
Crustacea	49 (24 percent)	2291 (16 percent)
Mollusca	46 (22 percent)	1629 (12 percent)
Others	12 (6 percent)	1498 (10 percent)
Total	205 (100 percent)	14313 (100 percent)

Table 11. Benthic invertebrates taken during the biologic studies of the South Texas Outer Continental Shelf.

COELENTERATA
- Anthozoa
  - Pennatulacea
    - Renillidae
      - *Renilla mulleri*
  - Actiniaria
    - unidentified anenome

PLATYHELMINTHES
- Turbellaria
  - Polycladida
    - unidentified flatworm

NEMERTINEA
- unidentified nemerteans

ANNELIDA
- Polychaeta
  - Phyllodocida
    - Phyllodocidae
      - phyllodocid
    - Polynoidae
      - *Phyllohartmania taylori*
    - Polyodontidae
      - *Polyodontes lupina*
    - Sigalionidae
      - *Leanira* sp.
      - *Sthenelais* sp.
    - Chrysopetalidae
      - *Paleonotus heteroseta*
    - Glyceridae
      - *Glycera tesselata*
      - *Glycera* sp.
    - Goniadidae
      - *Glycinde* sp.
      - *Goniada* sp.
    - Nephtyidae
      - *Aglaophamus verrilli*
      - *Nephtys picta*
      - *Nephtys* sp. A
      - *Nephtys* sp. B
    - Syllidae
      - *Exogone dispar*
      - *Exogone* sp.
      - syllid A
      - syllid B
      - syllid C
    - Hesionidae
      - *Nereimyra punctata*
      - hesionid

Pilargidae
- *Ancistrosyllis papillosa*
- *Ancistrosyllis* cf. *rigida*
- *Sigambra tentaculata*
- pilargid A
- pilargid B
- pilargid C

Nereidae
- *Nereis* sp. A
- *Nereis* sp. B
- nereid A
- nereid B

Capitellida

Capitellidae
- *Leiocapitella glabra*
- *Notomastus* cf. *hemipodus*
- *Notomastus latericeus*

Maldanidae
- *Branchioasychis americana*
- *Clymenella torquata*
- maldanid A
- maldanid B
- maldanid C

Opheliidae
- *Armandia agilis*
- *Armandia maculata*
- *Armandia* sp.
- *Polyophthalmus pictus*

Sternaspida

Sternaspidae
- *Sternaspis scutata*

Spionida

Spionidae
- *Laonice cirrata*
- *Malacoceros indicus*
- *Malacoceros* sp.
- *Paraprionospio pinnata*
- *Prionospio cirrifera*
- *Prionospio* sp.
- *Scolelepis* sp.
- *Spiophanes* cf. *bombyx*
- *Spiophanes* sp.
- spionid A
- spionid B

Heterospionidae
- heterospionid

Trochochaetidae
- trochochaetid

Paraonidae
- *Aricidea* sp. A
- *Aricidea* sp. B
- *Cirrophorus branchiatus*
- *Paraonides* sp.
- *Paraonis* sp.
- paraonid A
- paraonid B
- paraonid C

Chaetopteridae
chaetopterid
Eunicida
Onuphidae
Diopatra cuprea
Onuphis sp. A
Onuphis sp. B
Eunicidae
Marphysa aransensis
Lumbrineridae
Lumbrineris sp. A
Lumbrineris sp. B
Lumbrineris sp. C
Ninoe nigripes
Arabellidae
Arabella sp.
Drilonereis magna
Lysaretidae
Lysarete brasiliensis
lysaretid
Amphinomida
Amphinomidae
Amphinome rostrata
Chloeia viridis
Pseudeurythoe sp.
Magelonida
Magelonidae
Magelona pettiboneae
Magelona sp.
Ariciida
Orbiniidae
orbiniid
Cirratulida
Cirratulidae
cirratulid A
cirratulid B
Cossuridae
Cossura delta
Oweniida
Oweniidae
Owenia fusiformis
Terebellida
Pectinariidae
Pectinaria gouldii
Ampharetidae
Melinna maculata
Terebellidae
Terebellides stroemi
Flabelligerida
Flabelligeridae
Diplocirrus cf. *capensis*
flabelligerid A
flabelligerid B

unidentified polychaete A
unidentified polychaete B
unidentified polychaete C
unidentified polychaete D

MOLLUSCA
- Gastropoda
  - Rissoinidae
    - *Zebina browniana*
  - Vitrinellidae
    - *Episcynia inornata*
  - Melanellidae
    - *Strombiformis* sp.
  - Naticidae
    - *Polinices duplicatus*
    - *Natica pusilla*
  - Ringiculidae
    - *Ringicula semistriata*
  - Retusidae
    - *Volvulella texasiana*
    - *Pyrunculus caelatus*

    - gastropod
- Scaphopoda
  - Dentaliidae
    - *Dentalium eboreum*
    - *Dentalium* sp. A
    - *Dentalium* sp. B
- Bivalvia
  - Nuculidae
    - *Nucula proxima*
  - Nuculanidae
    - *Nuculana acuta*
    - *Nuculana concentrica*
    - *Yoldia solenoides*
    - *Yoldia* sp.
    - nuculanid A
    - nuculanid B
  - Arcidae
    - *Anadara transversa*
  - Lucinidae
    - *Linga amiantus*
    - *Linga multilineata*
  - Thyasiridae
    - *Thyasira* sp.
  - Diplodontidae
    - *Diplodonta* sp.
  - Carditidae
    - *Cycolcardia* sp.
  - Veneridae
    - *Cyclinella tenuis*
    - *Anomalocardia auberiana*
    - *Chione clenchi*
    - *Chione intapurpurea*
  - Crassatellidae
    - *Crassinella lunulata*

Tellinidae
- *Tellina squamifera*
- *Tellina versicolor*
- *Macoma pulleyi*
- *Macoma* sp.

Semelidae
- *Abra aequalis*

Corbulidae
- *Corbula* sp.

Periplomatidae
- *Periploma* sp.

Verticordiidae
- *Verticordia ornata*
- *Verticordia* sp.

Cuspidariidae
- *Cardiomya perrostrata*
- *Cardiomya* sp.

Leptonidae
- *Mysella* sp.

Lasaeidae
- *Aligena* sp.

- bivalve A
- bivalve B

ARTHROPODA

Crustacea

Nebaliacea
- *Nebalia* sp.

Cumacea

Leuconidae
- *Eudorella monodon*
- *Eudorella* sp.
- leuconid

- unidentified cumacea

Tanaidacea

Apseudidae
- *Leptognatha gracilis*
- apseudid

Tanaidae
- *Pseudotanais oculatus*
- unidentified tanaid A
- unidentified tanaid B

Isopoda

Gnathiidae
- *Gnathia* cf. *prouctatrideus*

Anthuridae
- *Hyssura* sp.
- anthurid

Stomatopoda

Squillidae
- *Squilla empusa*
- *Squilla* sp.

Amphipoda
- Ampeliscidae
  - *Ampelisca cristoides*
  - *Ampelisca* cf. *cucullata*
  - *Ampelisca* cf. *cristata*
  - *Ampelisca* cf. *vera*
- Ampithoidae
  - *Ampithoe* sp.
- Gammaridae
  - *Gammarus* sp. A
  - *Gammarus* sp. B
  - *Gammarus* sp. C
- Lysianassidae
  - *Tmetonyx* sp.
  - *Orchomonella pinguis*
  - lysianassid
- Phoxocephalidae
  - *Heterophoxus* sp.
  - *Proharpina antipoda*
  - *Proharpina tropicana*
  - *Pseudharpina* cf. *dentata*

  - unidentified amphipod A
  - unidentified amphipod B
  - unidentified amphipod C

Decapoda
- Penaeidae
  - *Penaeus aztecus*
  - *Penaeus setiferus*
- Alpheidae
  - *Alpheus* sp.
- Callianassidae
  - *Callianassa* sp.
- Leucosiidae
  - *Myropsis quinquespinosa*
- Xanthidae
  - *Micropanope* sp.
  - xanthid
- Pinnotheridae
  - *Pinnixa retinens*
  - *Pinnixa sayana*
  - *Pinnixa* sp.
- Goneplacidae
  - *Speocarcinus* sp.
  - *Goneplax hirsuta*
  - *Chasmocarcinus mississippiensis*
  - *Euryplax nitida*
- Raninidae
  - *Raninoides louisianensis*

  - unidentified crab A
  - unidentified crab B

SIPUNCULIDA

- sipunculid A
- sipunculid B

ECHIURIDA

echiurid A
echiurid B

BRYOZOA

unidentified bryozoan

ECHINODERMATA

- Echinoidea
  - Spatangoida
    - Schizasteridae
      - *Moira atropos*
- Asteroidea
  - Paxillosida
    - Astropectinidae
      - *Astropecten* sp.
- Ophiuroidea
  - Ophiurida
    - unidentified brittle star

collected belong to Polychaeta (62 percent), Crustacea (16 percent), and Mollusca (12 percent). Other taxonomic groups accounted for 10 percent or less of the total number of species and individuals.

The number of species per sample (0.0125 m^3) ranged from zero to 39 with a mean of 7.6 (table 12). The regional pattern of distribution by number of species (fig. 147) showed two general trends for the South Texas OCS. First, the smallest number of species was in the central sector with numbers increasing radially to the north, south, and shoreward. Second, the number of species decreased generally in a seaward direction. The largest number of species was in the general area of the Brazos-Colorado and Rio Grande ancestral deltas, particularly in the near-shore areas.

The number of individuals per sample (0.0125 m^3) ranged from zero to 810 with a mean of 19.4 (table 12). Two general trends were evident in the regional pattern of distribution for individuals (fig. 148). First, numbers of individuals generally decreased across the shelf as water depth increased. Second, the central part of the area studied had fewer individuals than the northern and southern parts. As with the distribution of species, the largest number of individuals was in the shallower water in the general area of the ancestral Brazos-Colorado and Rio Grande deltas.

In the northwestern Gulf of Mexico, a number of investigators (Parker, 1956, 1960; Boyer, 1970; Stanton and Evans, 1971, 1972) have noted the close relationship between the distribution of macro-invertebrates and variations in depth of water and type of sediment. Comparison of the regional distribution maps for both numbers of species (fig. 147) and numbers of individuals (fig. 148) with a bathymetry map of the study area (fig. 149) suggests a general correlation with depth of water. A similarity in distribution also is evident when the two biological maps are compared to a set of sedimentological maps

Table 12. Biological characteristics of the South Texas OCS by sample (macrobenthic infauna/0.0125 m^3)

Parameter	Mean	Standard Deviation
No. of species	7.6172	4.9825
No. of individuals	19.4490	24.2301
Biomass (g)	0.4364	0.6310
Diversity (H")	1.6323	0.6844
Equitability	0.5906	0.2129

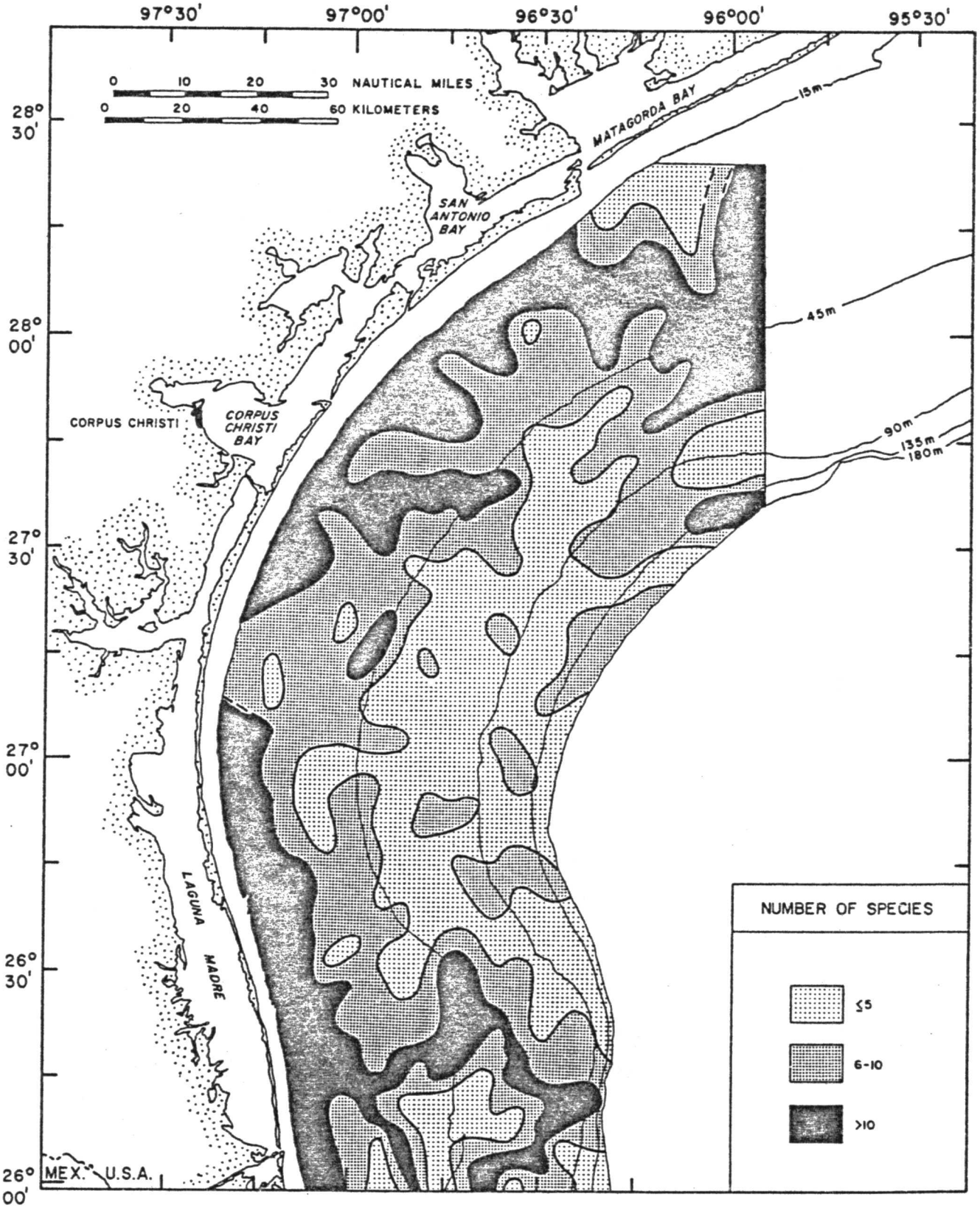


Figure 147. Distribution of total number of species per 0.0125 m^3.

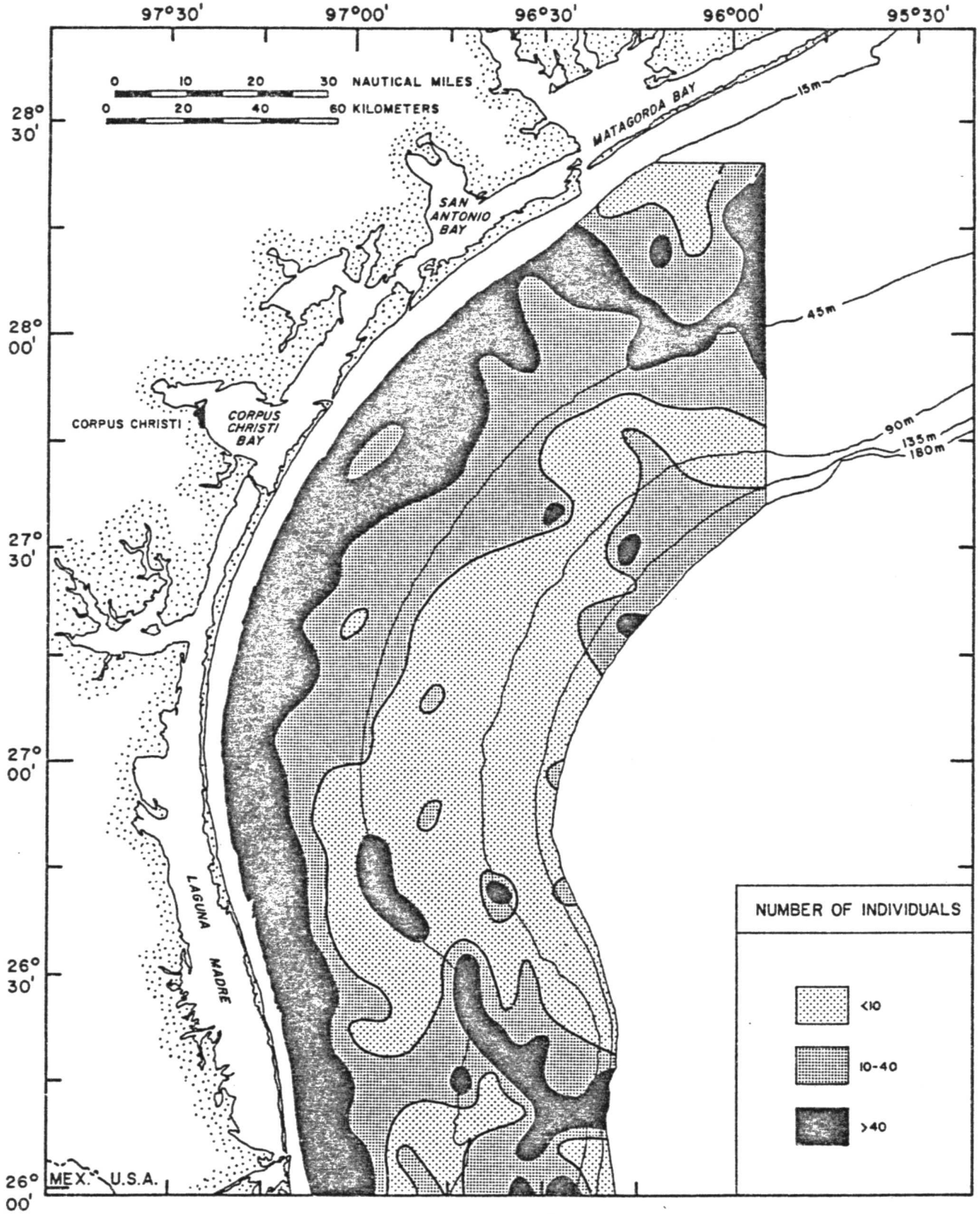


Figure 148. Distribution of total number of individuals per 0.0125 m^3.

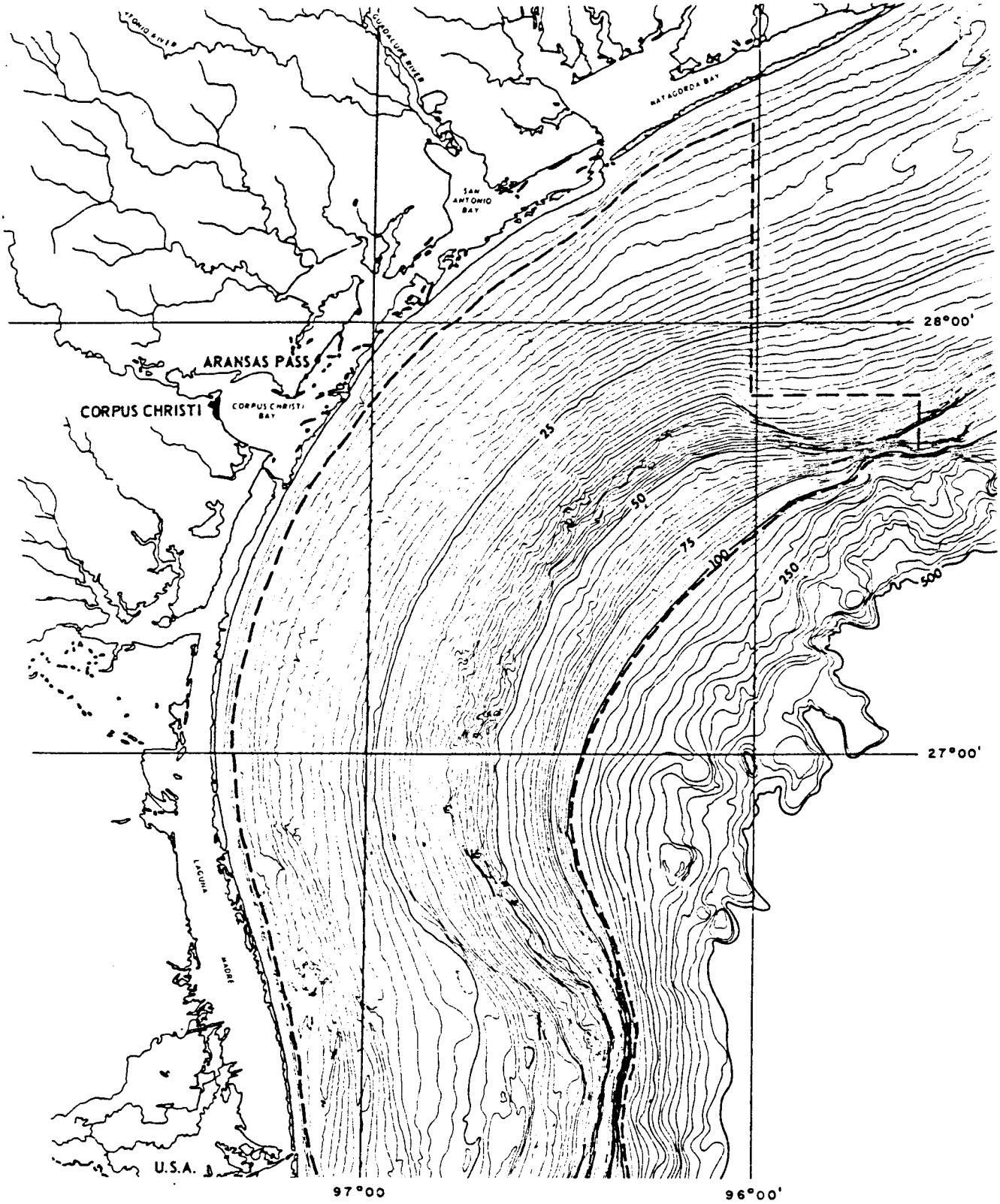


Figure 149. Bathymetry of the South Texas OCS for comparison with infaunal characteristics.

that include sand/mud ratio (fig. 150), mean diameter (fig. 151), and standard deviation (fig. 152).

A good correlation exists between the distribution of species and of individuals. The largest number of species and individuals seems to be in relatively shallow water, and in parts of the shelf having high sand/mud ratios. (A more complete discussion concerning factors controlling faunal distribution is given later in the report.)

Three large anomalous areas contradicted the general trends in the regional patterns of distribution for both numbers of species and individuals just reviewed. Areas of low population density occurred within both the Brazos-Colorado and Rio Grande ancestral deltas, which on the whole had relatively high densities. Both cases probably reflect a biological response to local areas of sand deficiency where prominent mud salients extended southward from the inlet to Matagorda Bay and onto the Rio Grande delta east of 97° W. longitude (fig. 150). An anomalous area of high population density occurred south of the ancestral Brazos-Colorado delta along the eastern edge of the study area. The higher density there probably reflects a response to a sedimentological characteristic not indicated by figures 150, 151, and 152. The bottom sediments in the area contained sizable numbers of foraminiferal tests, among which Orbulina sp. is conspicuous. The numerous forams in otherwise muddy sediments would effectively alter the textural characteristics of the sediment and thus affect the number and types of infauna.

Overall, the density of species and individuals over the South Texas OCS is low compared to the coastal waters adjacent to the OCS and to parts of the continental shelf further north. For example, Holland and others (1974) reported 338 benthic taxa from Corpus Christi, Nueces, and Copano Bays with maximum standing crops reaching as high as 11,896 individuals/0.5 ft^3.

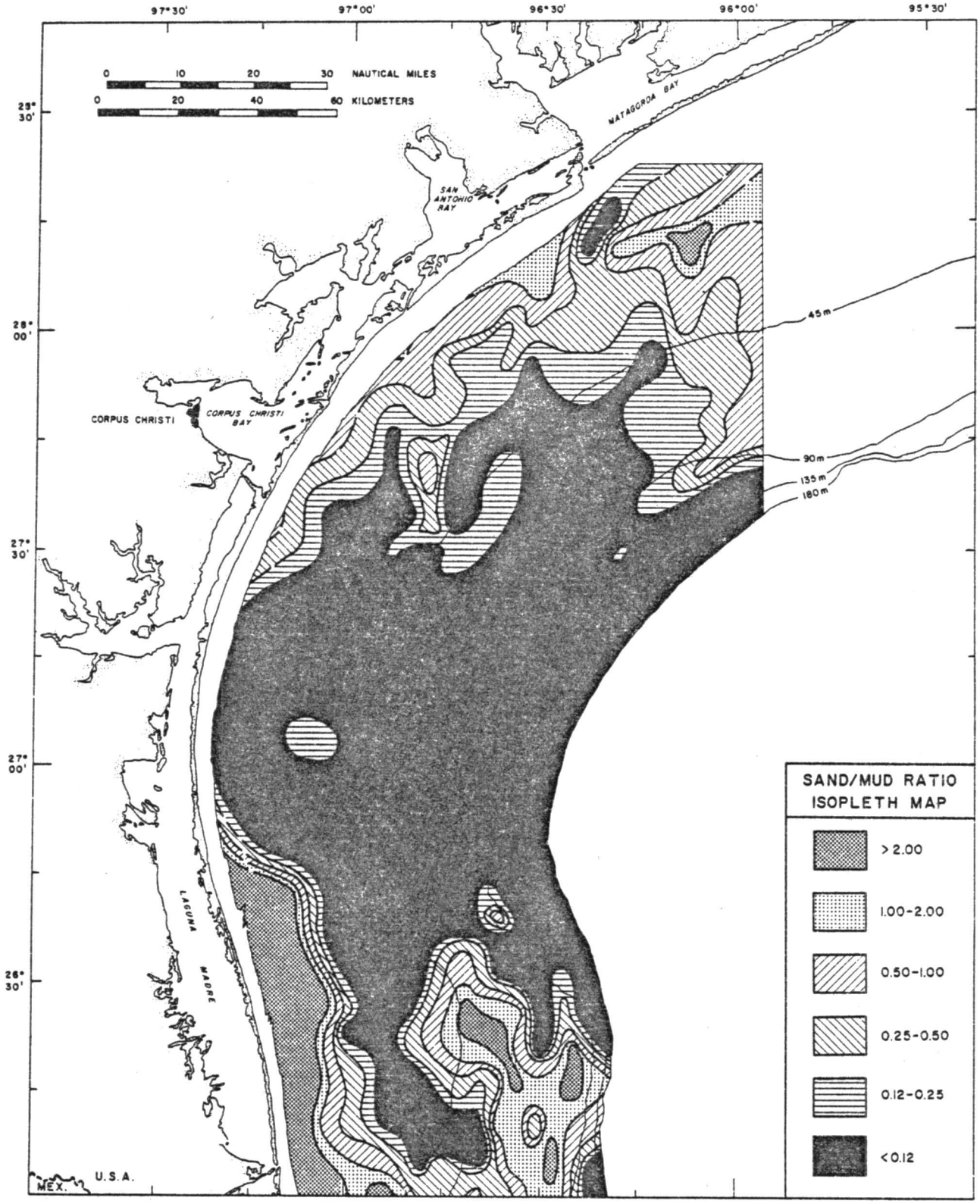


Figure 150. Sand/mud ratios, benthic sediments, from Berryhill and others, 1976.

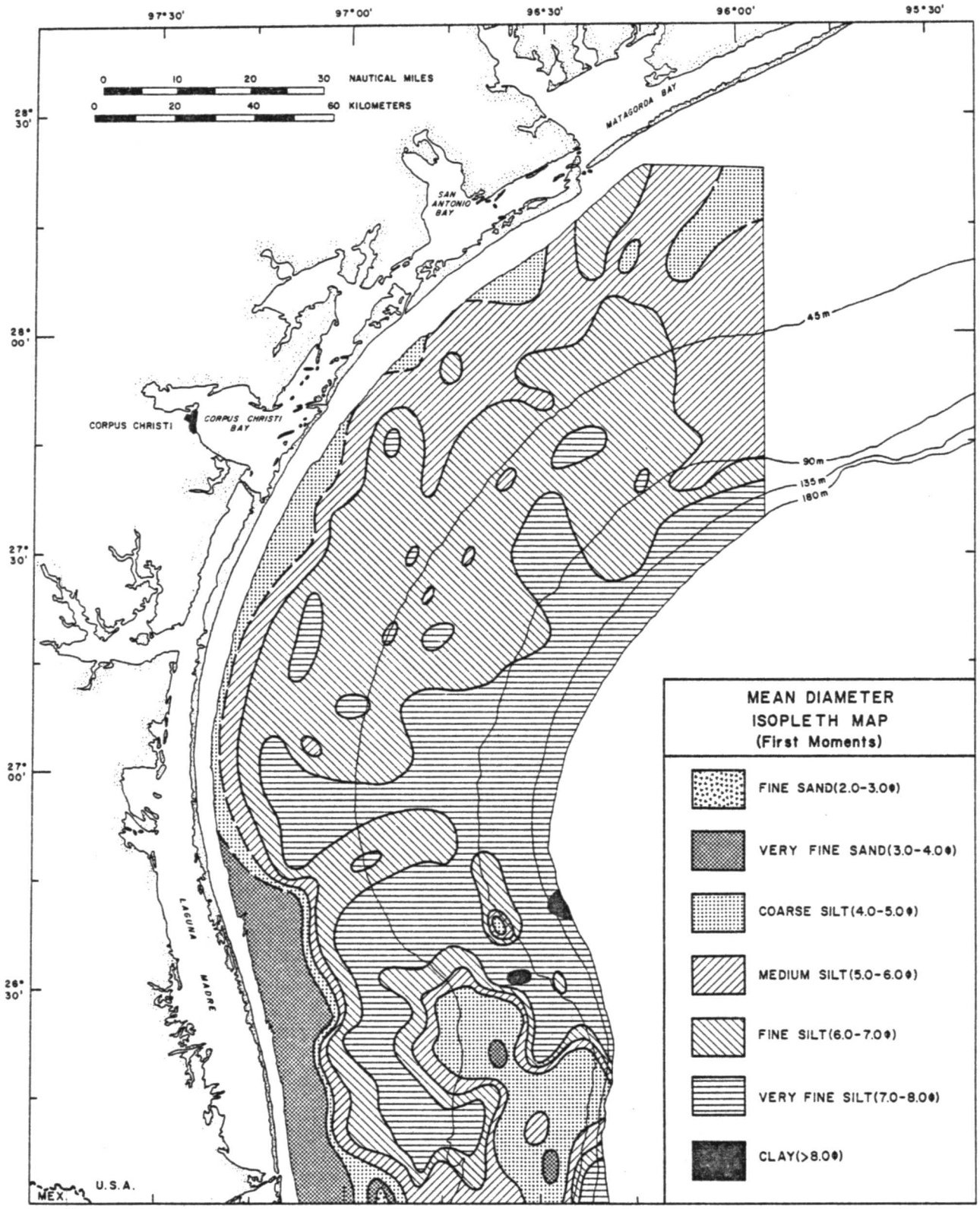


Figure 151. Mean diameters, benthic sediments, from Berryhill and others, 1976.

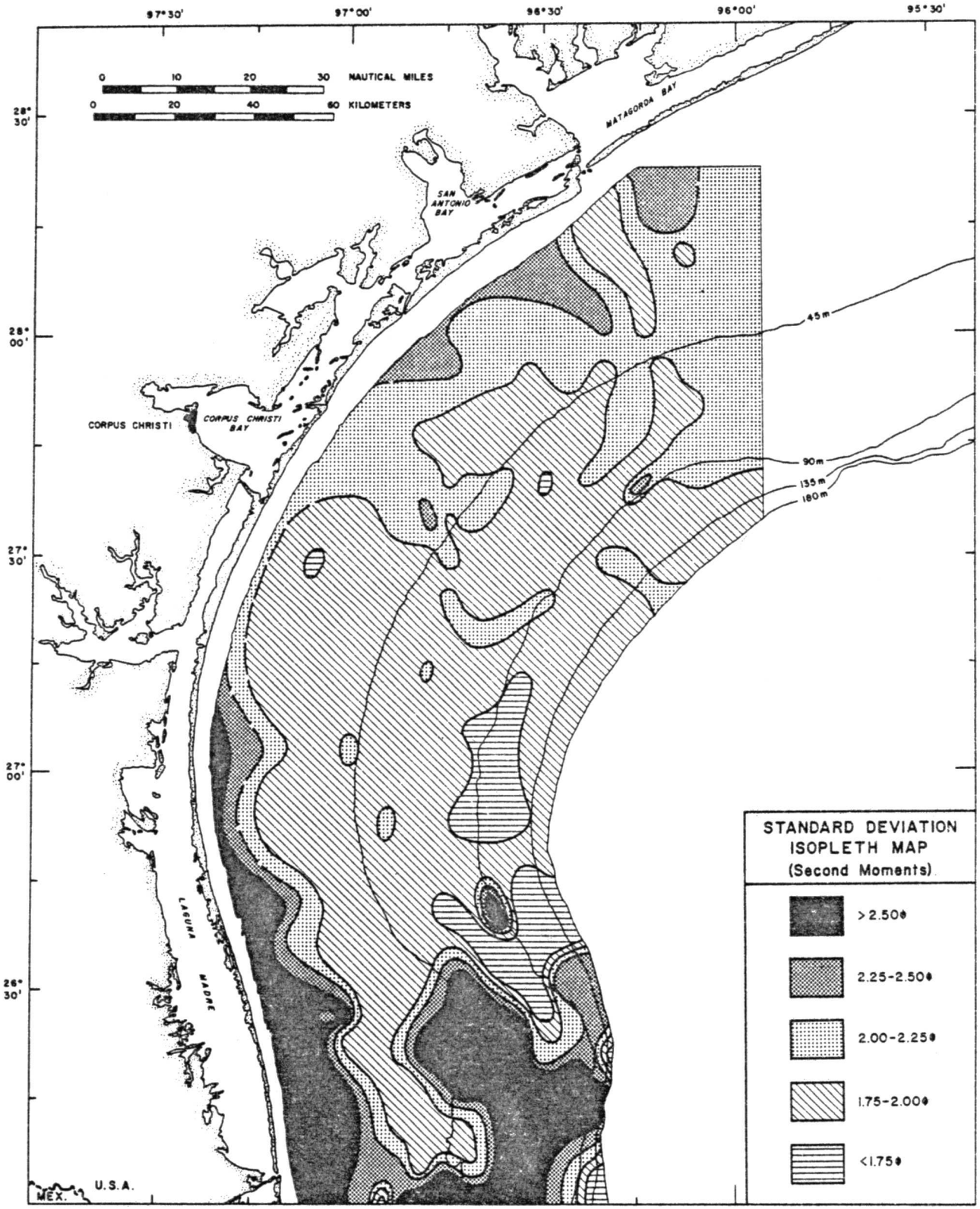


Figure 152. Standard deviations, benthic sediments, from Berryhill and others, 1976.

Manheim (1974) reported 190 species of polychaetous annelids alone from the shelf off Mississippi, Alabama, and the Florida panhandle. The overall low densities on the South Texas OCS probably are the result of the relatively homogeneous fine-grained sediments characteristic of the region and the relatively high sedimentation rates (∿0.1 cm/yr, Berryhill and others, 1976; ∿0.9 mm/yr, Holmes, this report).

Biomass

The biomass, calculated in grams (wet weight, preserved), ranged in weight by sample (0.0125 m^3) from zero to 29.9 g with a mean of 0.4364 g (table 12). The gross biomass data in the study were subject to more sources of error than other aspects of the biological data for two reasons. First, the biomass per sample was generally very small and difficult to measure accurately. Second, biomass data were influenced greatly by chance recovery of unusually large or heavy organisms. Molluscs are particularly troublesome because of their relatively heavy shell.

The regional pattern of distribution for biomass is shown in figure 153. Areas of large biomass (>0.15 g) were in shallow water (generally less than 45 m) and in the extreme northern and southern parts of the region. Only a few isolated areas of biomass <0.05 g existed and these generally were in deep water at the edge of the shelf. The ancestral Rio Grande and Brazos-Colorado deltas had relatively high biomass values (>0.15 g) compared to the central sector of the shelf.

The general decrease in biomass seaward agrees with results from a number of studies on the continental shelves of the United States (Sanders and Hessler, 1969). The anomalous areas of small biomass to the extreme north and large biomass south of the ancestral Brazos-Colorado delta on the shelf

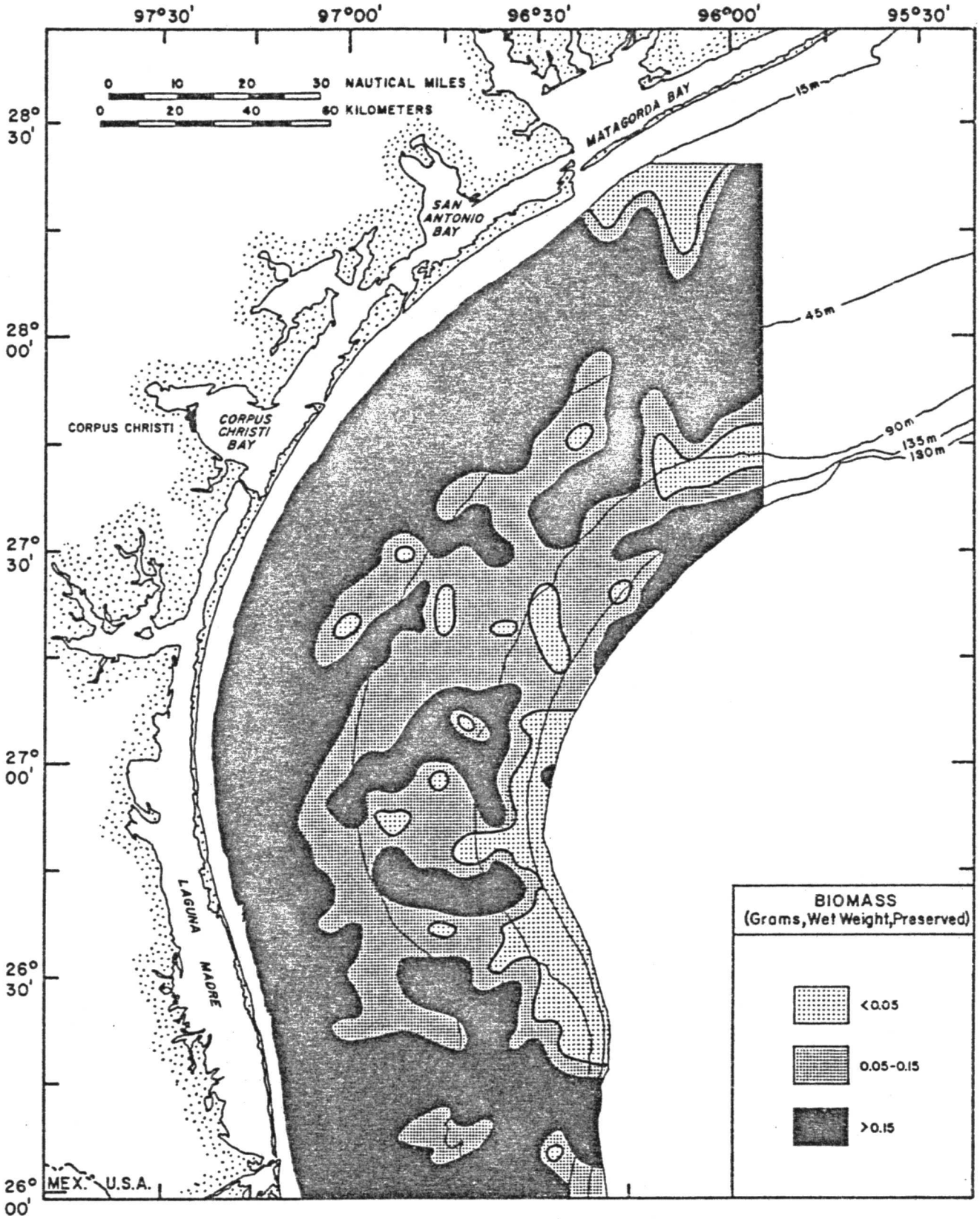


Figure 153. Distribution of biomass, benthic sediments.

edge are similar in location, extent, and trend to the anomalous areas discussed relative to the density of species and individuals. The two areas of large biomass at midshelf in the central part of the study area reflect the chance recovery of large heart urchins (Moira atropos), which are known to occur in a clustered pattern.

Reduction in biomass is normally associated with a decrease in food supply. Based on the quantity (0.2-1.2 percent) and distribution of total organic carbon in the sediment (Berryhill and others, 1976), however, the available food material seems to be adequate to support a larger biomass. Consequently, sediment texture seems to be not only the principal factor controlling the number of species and individuals, as discussed previously, but must be at least partly responsible for the overall small biomass, especially in the outer parts of the shelf between the two ancestral deltas. The conclusion is supported by variations in biomass that appear to be related to changes in the substratum.

Diversity and equitability

Calculated diversity (H") values per sample (0.0125 m^3) ranged from zero to 3.10 with an overall mean of 1.63 (table 12). The regional pattern of distribution (fig. 154) is very irregular, but some broad general patterns seem to exist. The lowest values for diversity (<1.75) are in the central sector of the shelf between the two ancestral deltas; the highest (>2.75) are concentrated mainly in the southern one-third of the study area and are associated with "gravelly" substrates. For the South Texas OCS in general, values for diversity are low.

The range of values for equitability per sample (0.0125 m^3) varied between zero and 1.0 with a mean value of 0.59 (table 12). According to the regional

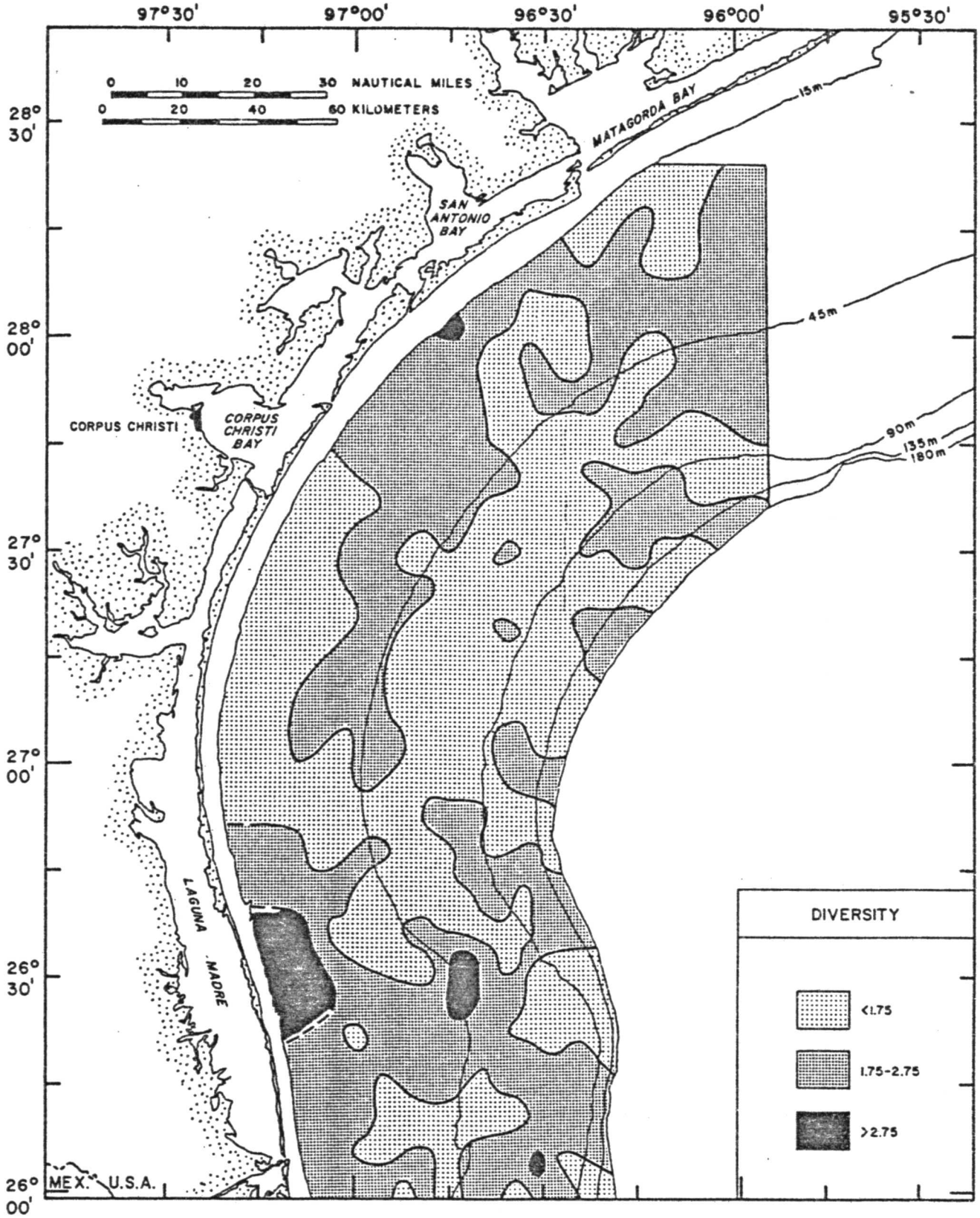


Figure 154. Infaunal diversity (H") per 0.0125 m^3.

pattern of distribution for equitability (fig. 155), most of the study area is characterized by values between 0.4 and 0.7. However, a fairly distinct zonation of values for equitability is evident. Lowest values (<0.4) are prevalent in shallow water along the inner OCS and the highest are concentrated in the outer half of the OCS. Generally, values for equitability increase seaward.

The definition, significance, causes, and uses of various indices for diversity have been widely discussed in the literature (Hulbert, 1971; Hendrickson and Ehrlich, 1971; Margalef, 1957; MacArthur and Wilson, 1967; Sanders, 1968, 1969; Paine, 1966; Klopfer, 1959; Pianka, 1966; Woodwell and Smith, 1969; Johnson, 1970). The Shannon diversity index (H") was chosen because it is based on both number of species and relative abundance, is relatively independent of sample size (Sanders, 1968), is normally distributed (Hutchenson, 1970), and is easily calculated. The large volume of literature that attempts to explain observed patterns of diversity has been reviewed by Valentine (1971) and others. After reviewing the literature, Stanton (1973) stated that "diversity is determined by the interplay of historical factors with the biological and physical factors in the ecosystem of time, stability, and resources." As a measurement of processes operating in an ecologic system, diversity reflects external environmental stresses as well as internal stability and productivity (Beerbower and Jordan, 1969).

The regional patterns of diversity and equitability on the South Texas OCS do not agree completely with what has been found elsewhere. In other studies, both diversity and equitability increased in a seaward direction, away from the more variable and rigorous environments of the inner shelf and coastal waters (Stanton and Evans, 1971). Over the South Texas OCS, diversity generally decreases and equitability increases with increasing water depth.

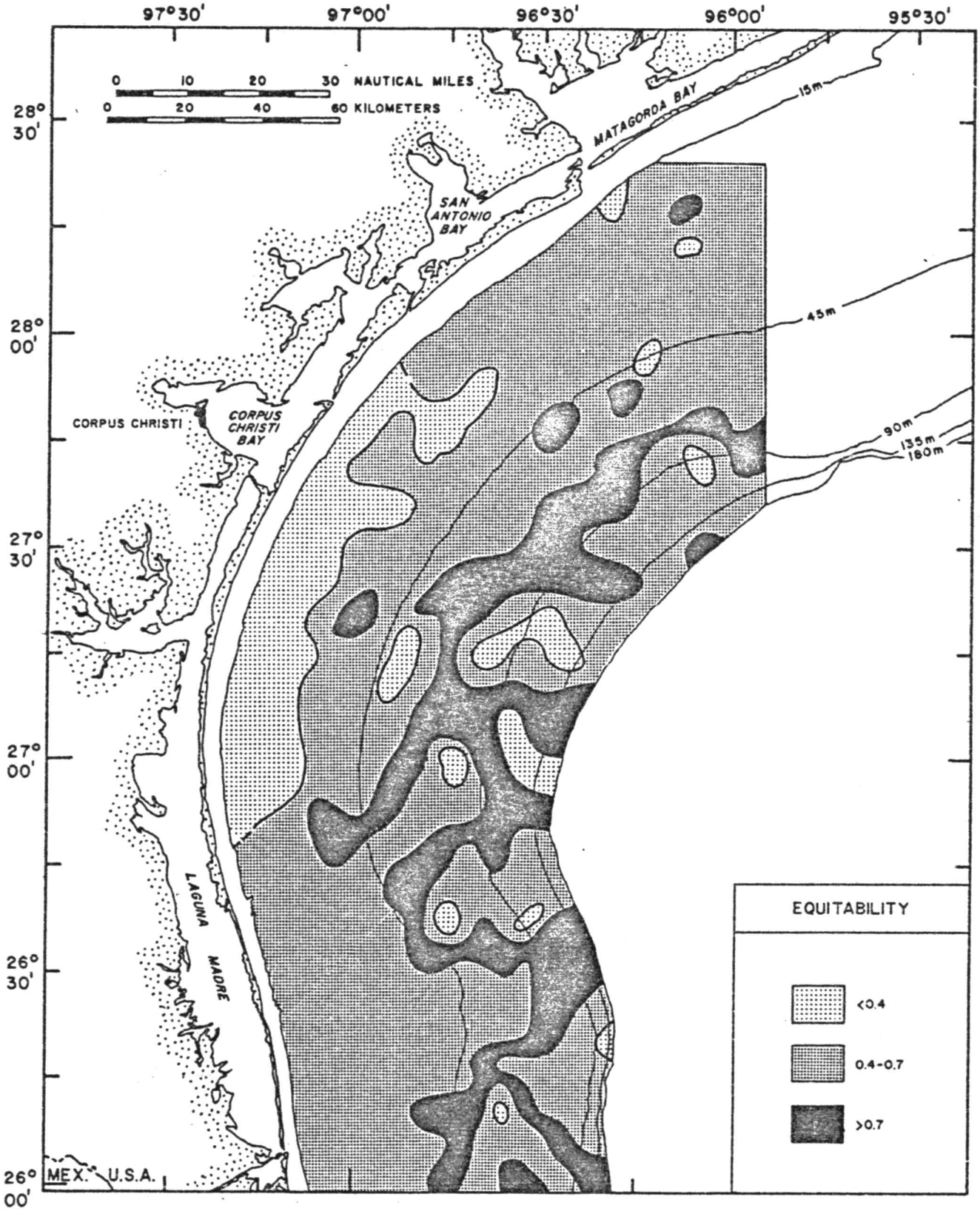


Figure 155. Infaunal equitability per 0.0125 m^3.

At least two explanations are possible for the seemingly anomalous trend. First, as the number of species depends on the structural diversity of the habitat, in contrast to equitability which is more sensitive to the stability of physical conditions (Beerbower and Jordan, 1969), the physical characteristics of the sediments flooring the South Texas OCS might explain the observed regional patterns of distribution for diversity and equitability. The shallow parts of the OCS and the ancestral deltas of the Brazos-Colorado Rivers and the Rio Grande have the greatest sediment diversity, or habitat diversity (fig. 152), and consequently support a more diverse fauna than the relatively homogeneous fine-grained sediments of the central, deeper sector. This possible explanation must be tempered, however, by a second consideration. Because only one grab sample was taken at each station, moderate numbers of one or two very common species and a few individuals from a large group of uncommon or rare species theoretically could be recovered by each sample. If more grabs had been taken at each station, the overall results probably would show that the numbers of individuals of the ubiquitous to very common species increase as do the numbers of common to rare species, although the latter increase at a lower rate. As the number of grabs increases, the domination of the total sample by the ubiquitous to very common group would be much greater, but the equitability and diversity would be diminished. Consequently, the dominance by a few species would reflect less diversity for a given sample. Holland (1976) found through repetitive sampling at each of 12 stations on the South Texas OCS, that inshore stations were dominated by a few species, causing decreased equitability and diversity of the total sample. Taking into consideration the results of previous studies (particularly that of Holland), the regional distribution of equitability values over the study area (fig. 155) and the increasing dominance of a few species relative to the number of individuals

as water depth decreases (discussed later in this report), the regional distribution of diversity values (H") shown in figure 154 probably reflects the exact opposite of the true pattern of diversity (H"). That is to say, diversity (H") increases in a seaward direction and is highest in the central sector, decreasing in the areas of the ancestral Brazos-Colorado and Rio Grande deltas.

General trends in the patterns for equitability are similar to those observed in other areas. As water depth decreases, the physical conditions (temperature, salinity, currents) are more variable and the successional sequence leading to high equitability does not have time to develop fully before the ecosystem is returned to a less mature stage because of environmental change (Gibson, 1966).

Species distribution

The macrobenthic infauna can be divided into three groups based on distribution. Group one consisted of a few common species that were collected in 25 percent or more of the samples. Included in the group were the polychaetes Paraprionospio pinnata, Nereis sp., Magelona spl, Nephtys picta, Cossura delta; the amphipod Ampelisca cf. cucullata; nemerteans; and an unidentified brittle star (Echinodermata, Ophiuroidea). Group two (uncommon species) was not as widely distributed, occurred in 5-25 percent of the samples, and included the polychaetes Ninoe nigripes, unidentified paraonid, Onuphis sp., Lumbrineris sp., unidentified maldanid, Sigambra tentaculata, Armandia agilis, Notomastus latericeus, Sthenelais sp., Diopatra cuprea, unidentified cirratulid, Glycera sp., unidentified spionid, Armandia maculata; the molluscs Corbula sp., Nuculana acuta, Diplodonta sp., Nuculana concentrica, unidentified gastropod; the crustaceans Eudorella monodon, Leptognatha gracilis,

Ampelisca cristoides, Ampelisca cf. cristata, Chasmocarcinus mississippiensis, Speocarcinus sp., Pinnixa retinens; and an unidentified sipunculid (Sipunculida). The majority of the infaunal species were in group three, a group considered rare because each species was found in less than five percent of the samples.

The spatial distribution of most common and uncommon species seemed to be restricted generally (fig. 156-187). By dividing the study area latitudinally into thirds, four broad patterns of distribution by species were indicated:

(1) species which were most common in the north sector and/or south sector at all water depths, as well as the inner half of the central sector (fig. 156-177). This was the most common distribution pattern;

(2) species collected from midshelf stations in all three sectors (figs. 178-180);

(3) species mainly in the central sector and seaward of midshelf in the north and/or south sector (figs. 181-183);

(4) species primarily seaward of midshelf in the central sector, at all depths in the south sector and to a lesser degree in deeper water in the north sector (figs. 184-187).

The remainder of the common to uncommon species were widely distributed and were found more or less equally in most parts of the OCS (figs. 188-190). The listing of the numbers of individuals by species at the infaunal stations indicated on figures 156 through 190 is given in Appendix 11.

Summary

The five biological parameters described shared two common regional trends. First, the number of species, number of individuals, and biomass tended to be highest in the inner shelf and to decrease with increasing water depth. The opposite trend relative to increasing water depth was indicated for

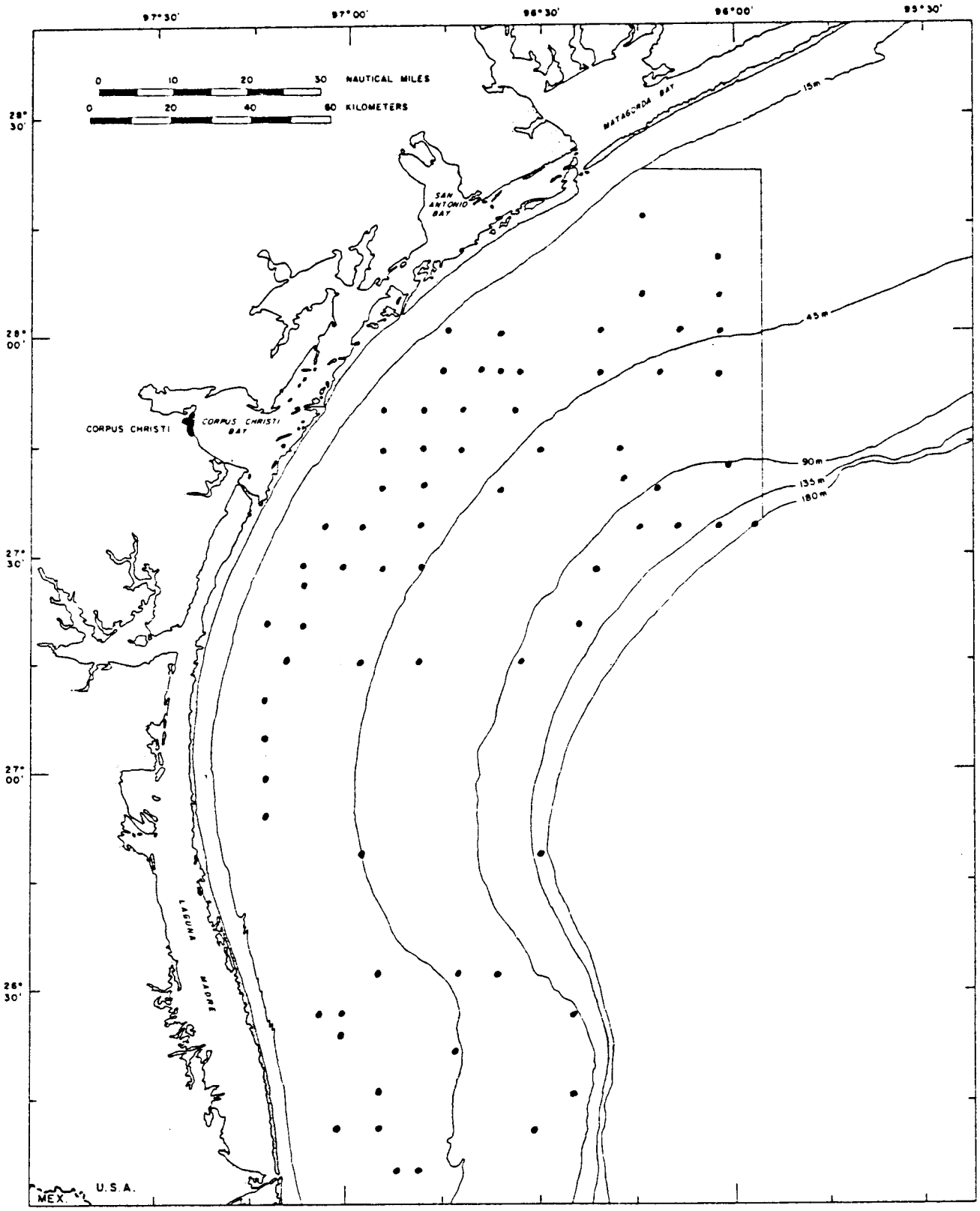


Figure 156. Distribution of Ampelisca cf. cucullata.

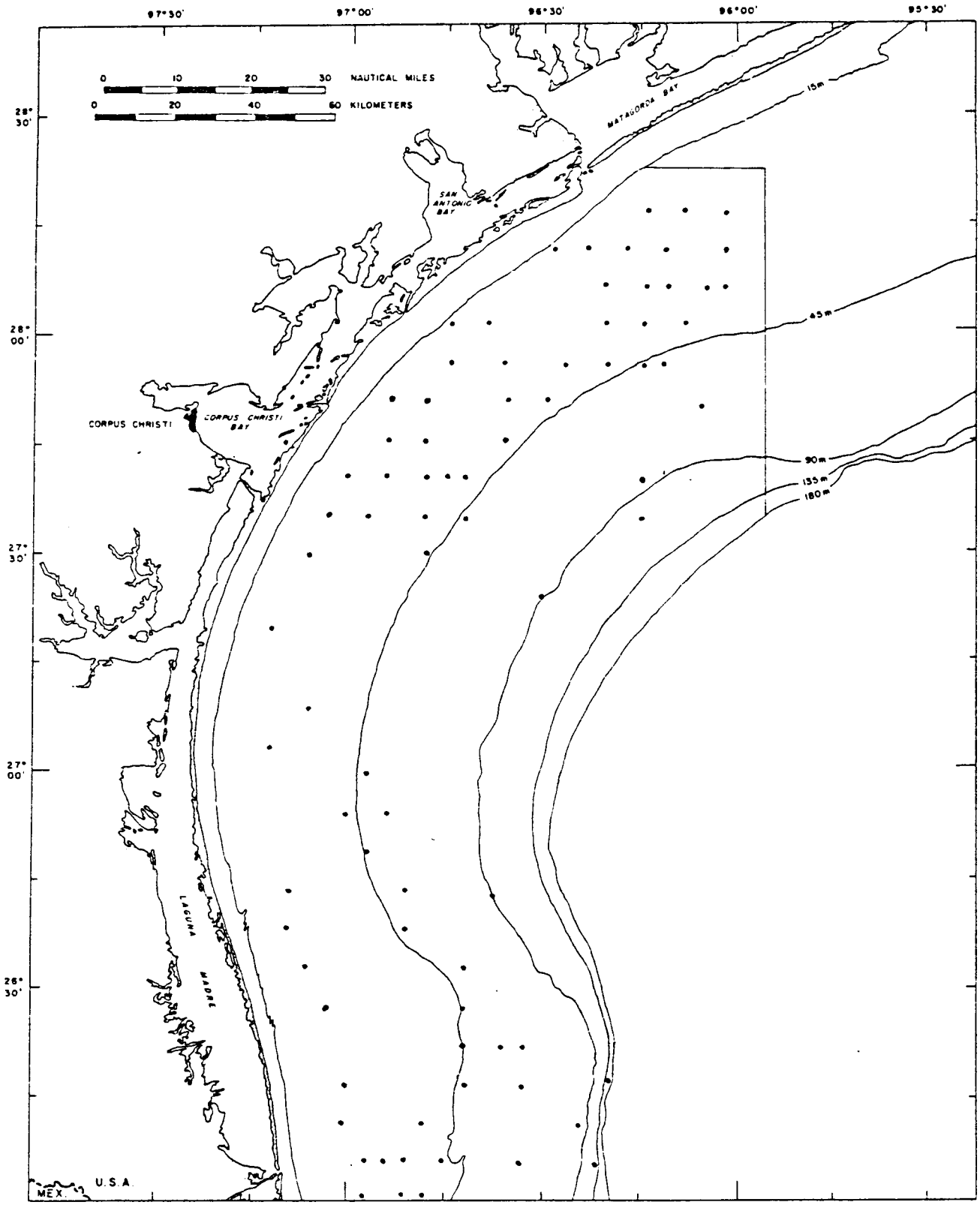


Figure 157. Distribution of Nereis sp.

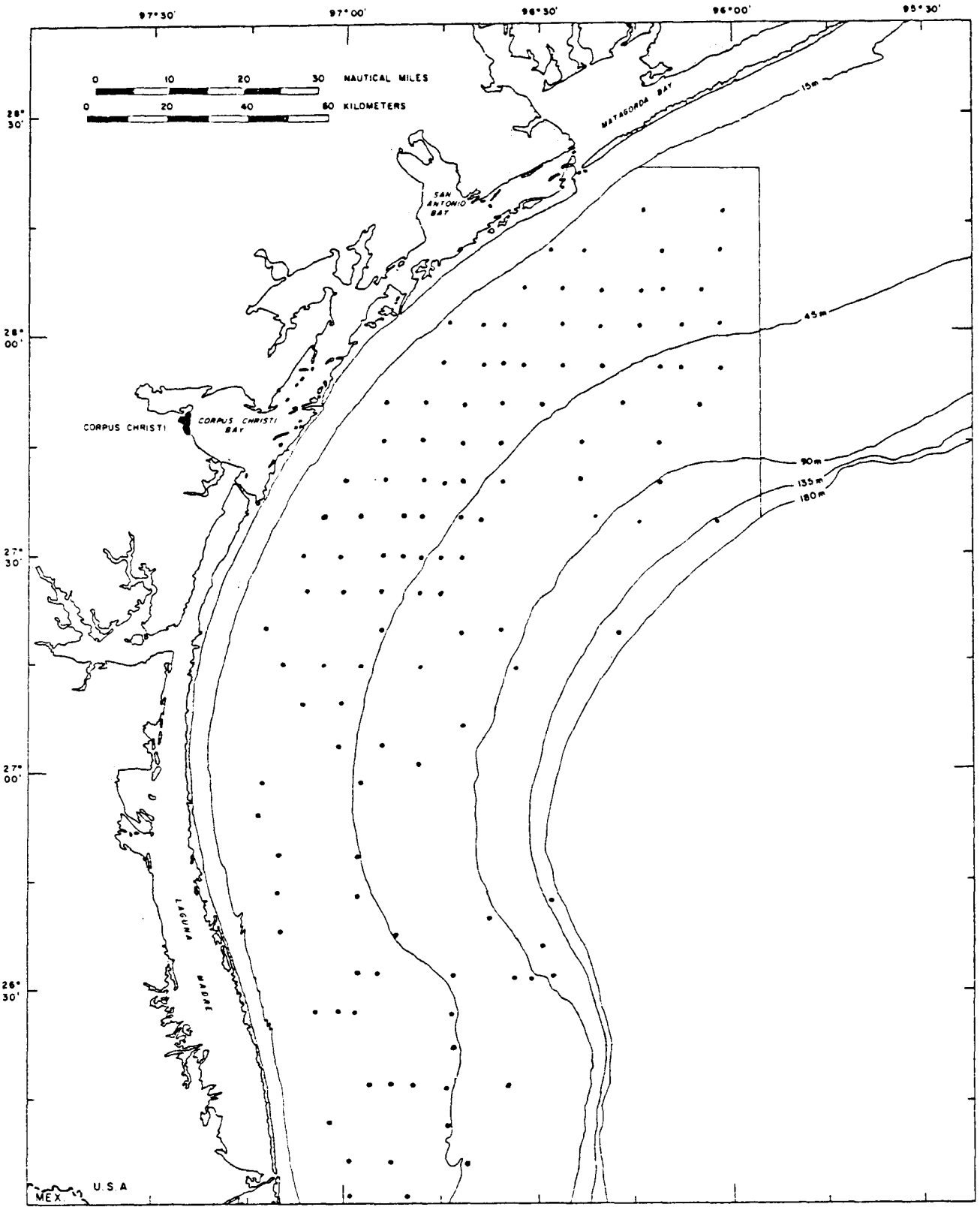


Figure 158. Distribution of Paraprionospio pinnata.

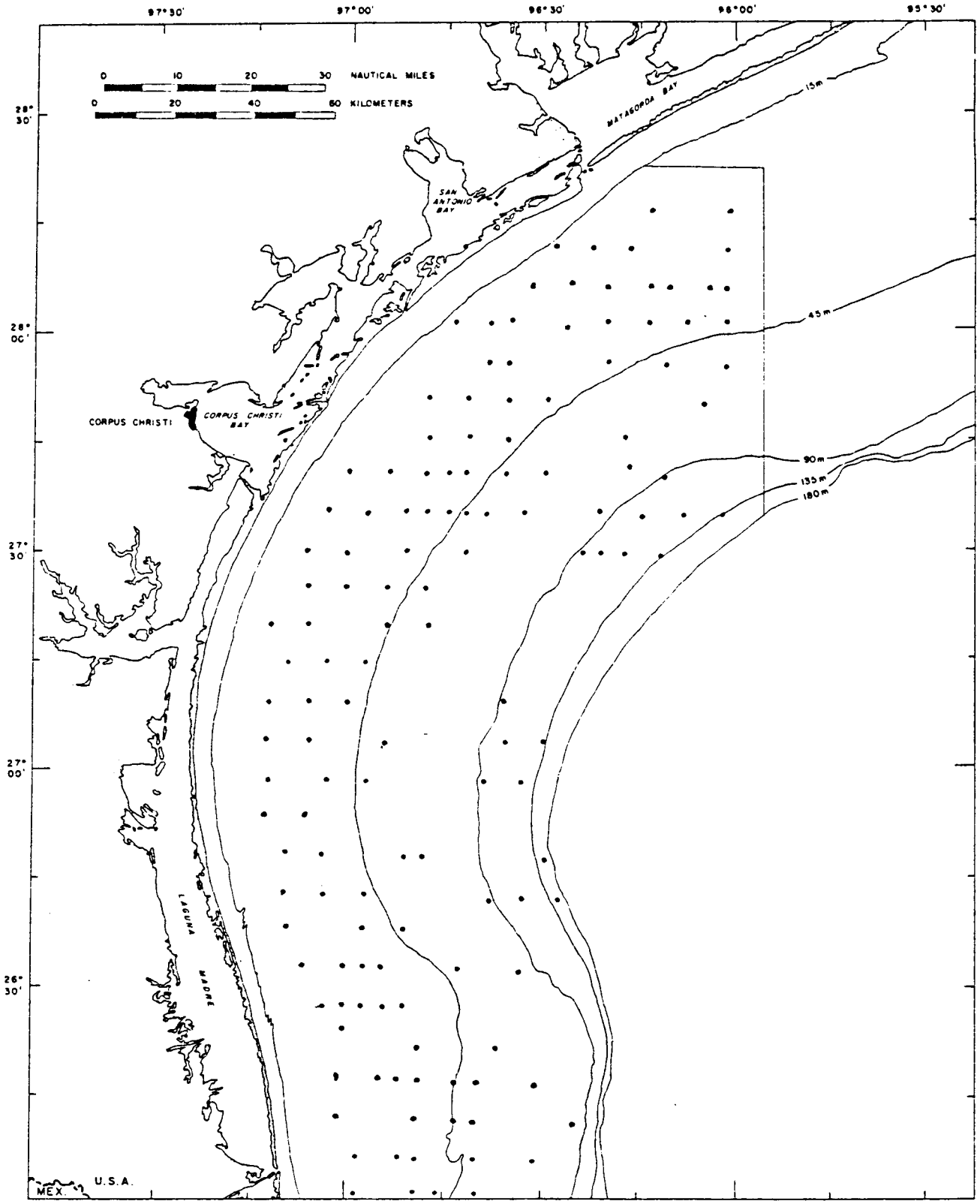


Figure 159. Distribution of an unidentified nemertean.

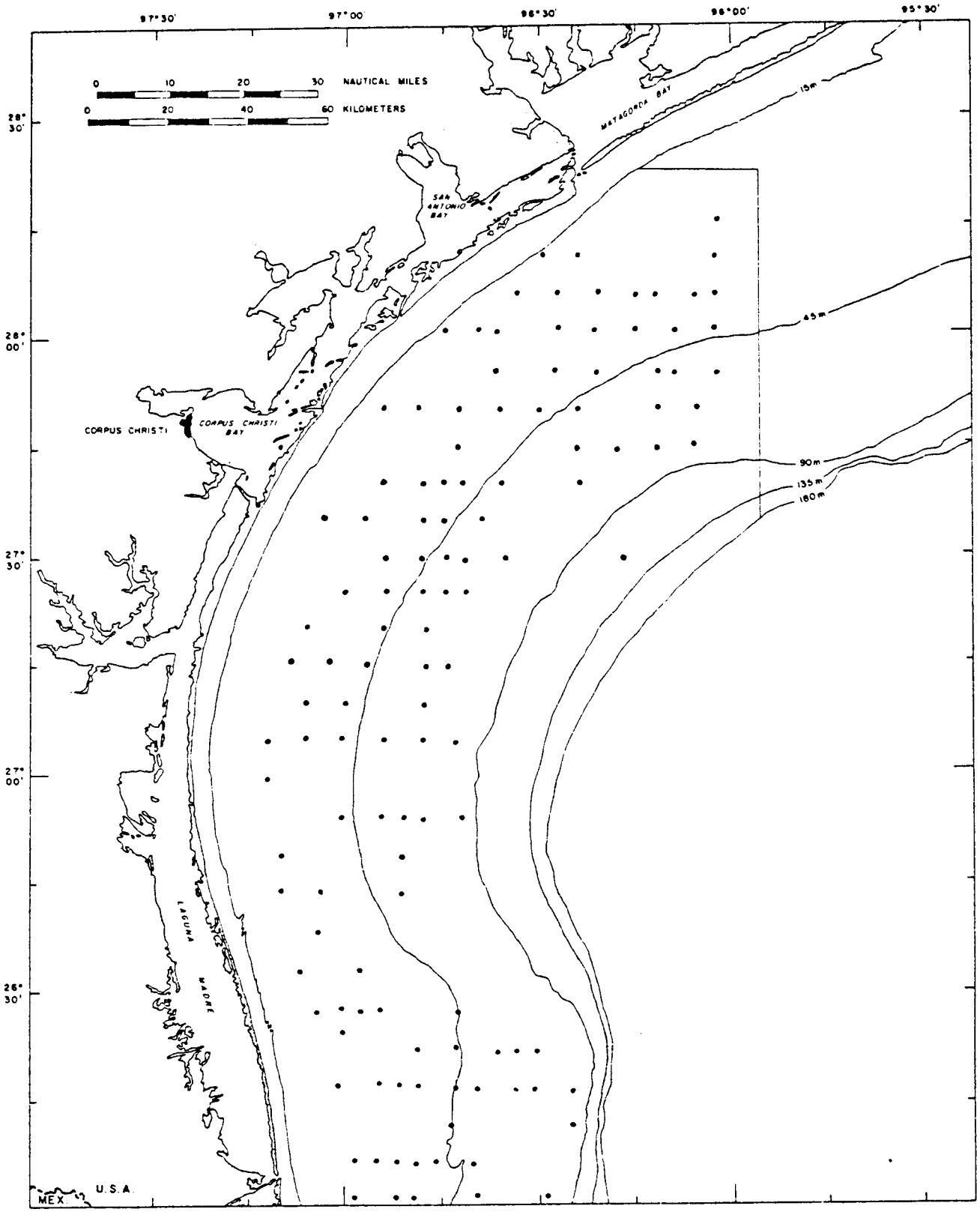


Figure 160. Distribution of Magelona sp.

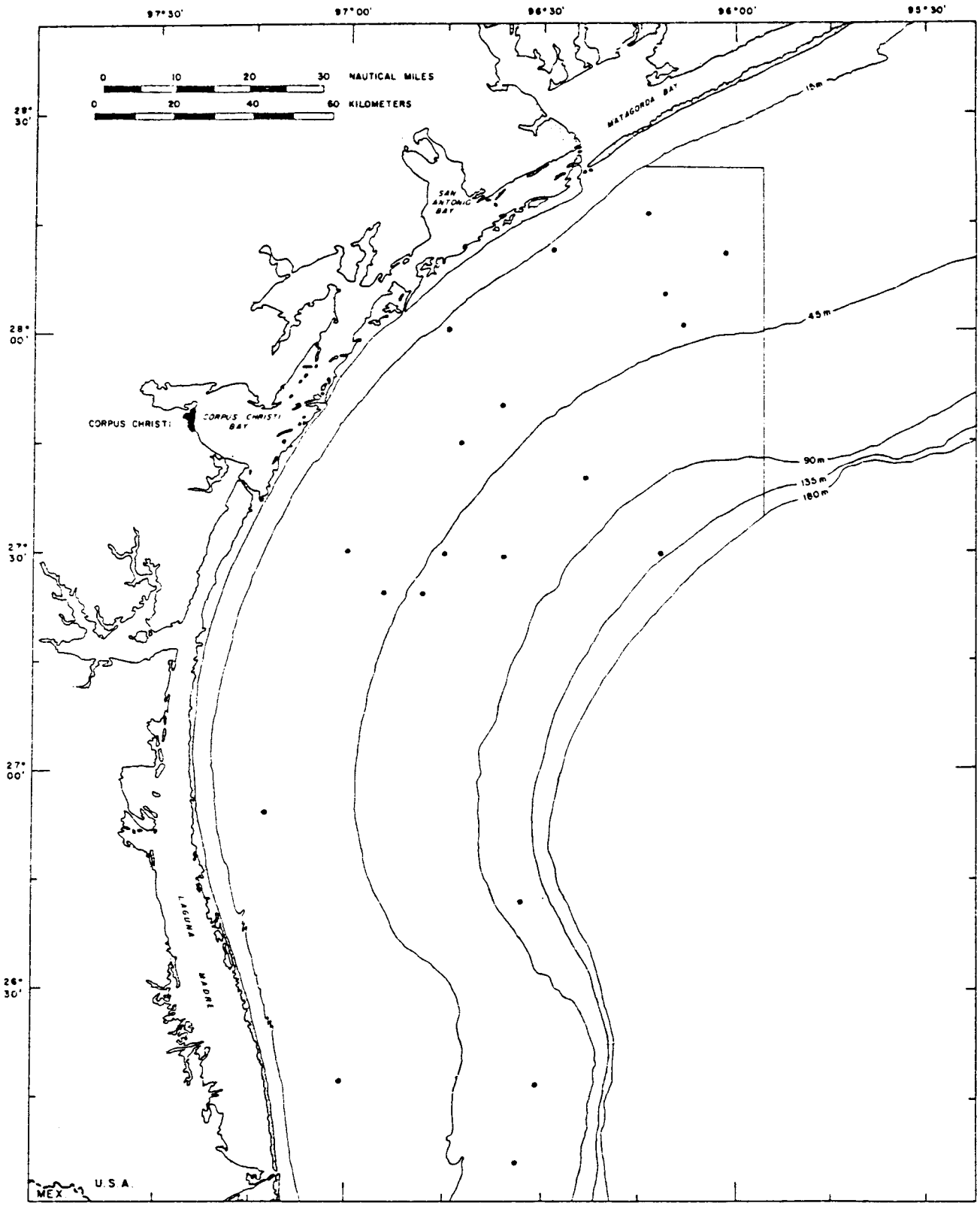


Figure 161. Distribution of Chasmocarcinus mississippiensis.

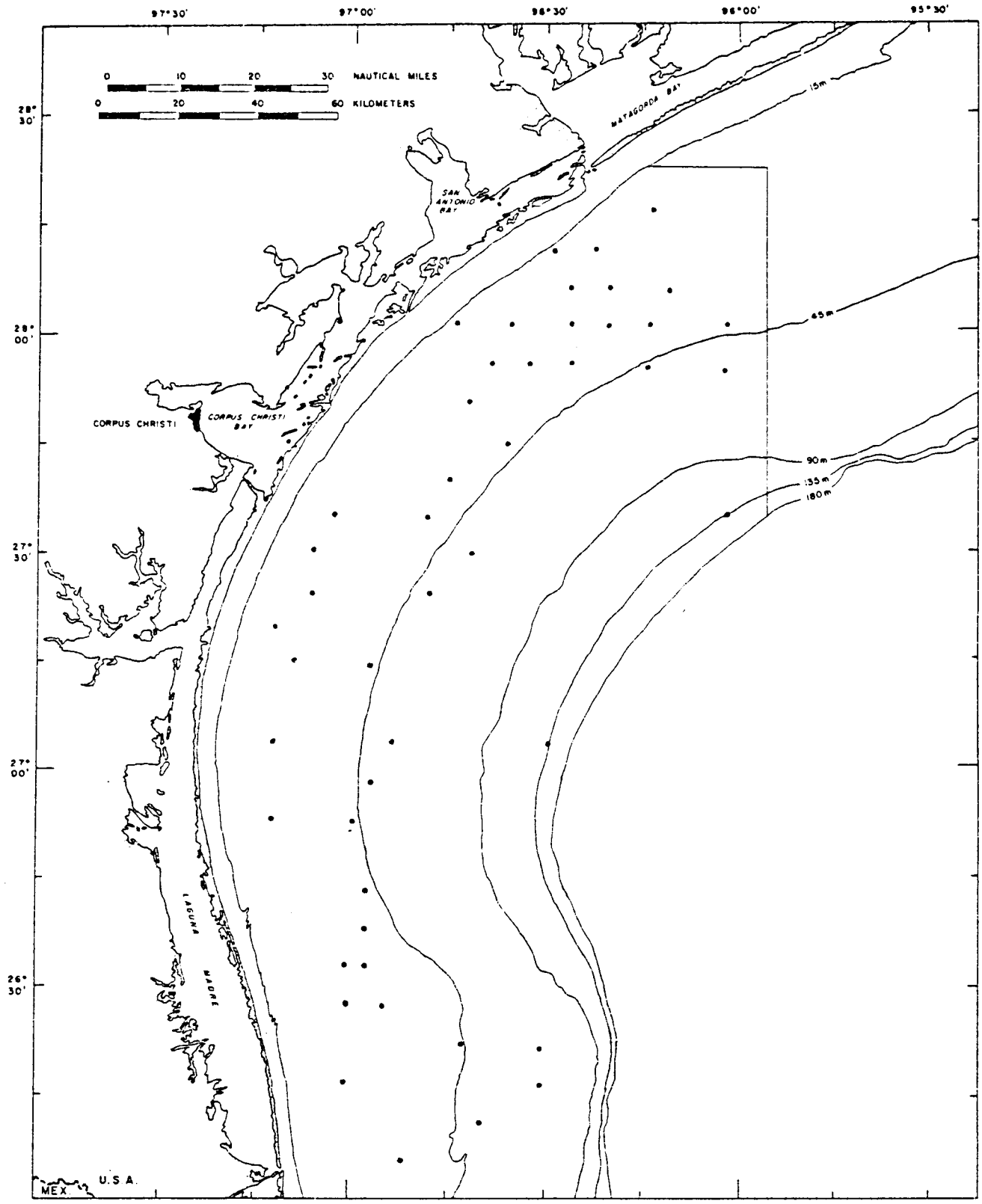


Figure 162. Distribution of Ninoe nigripes.

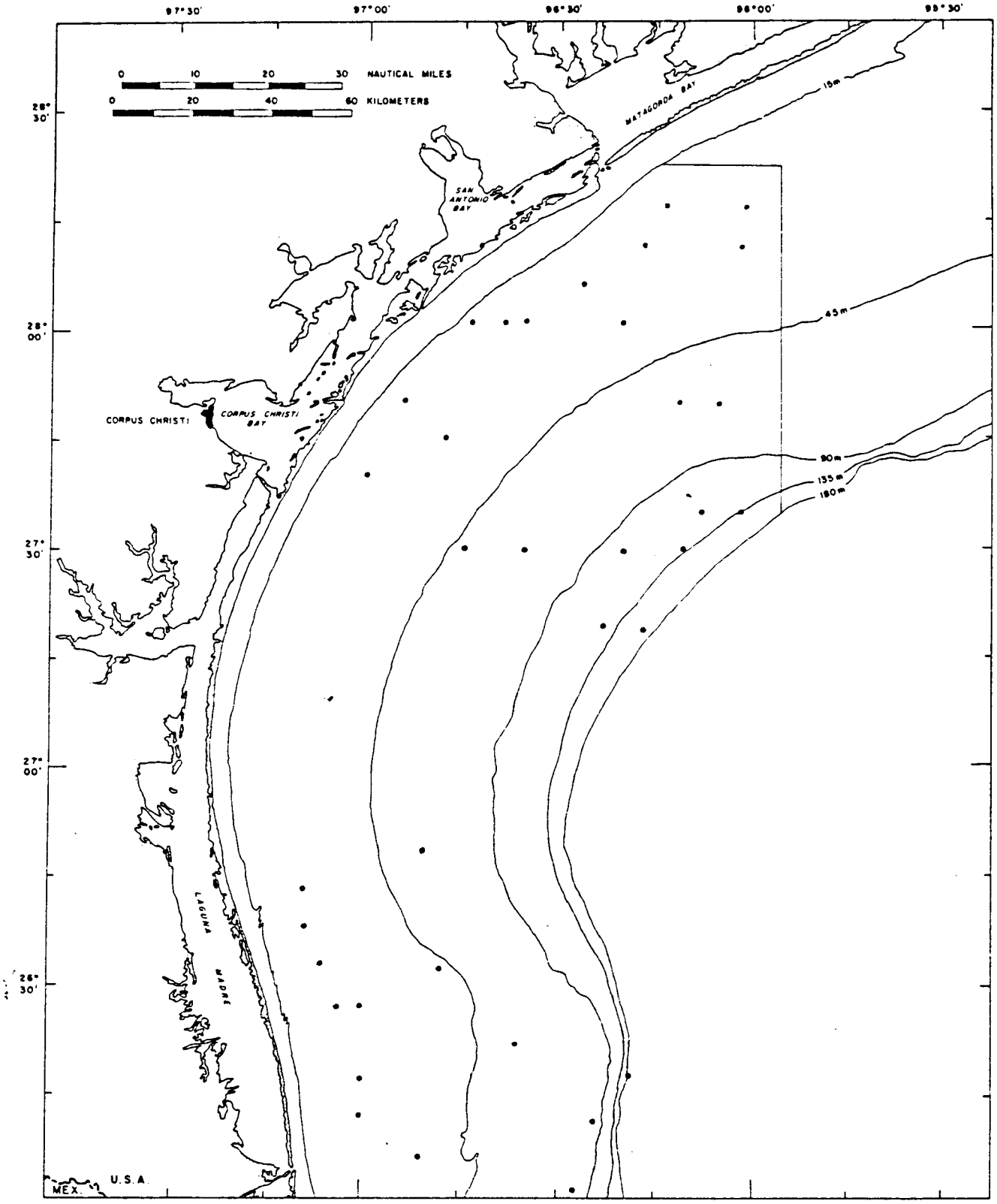


Figure 163. Distribution of Onuphis sp.

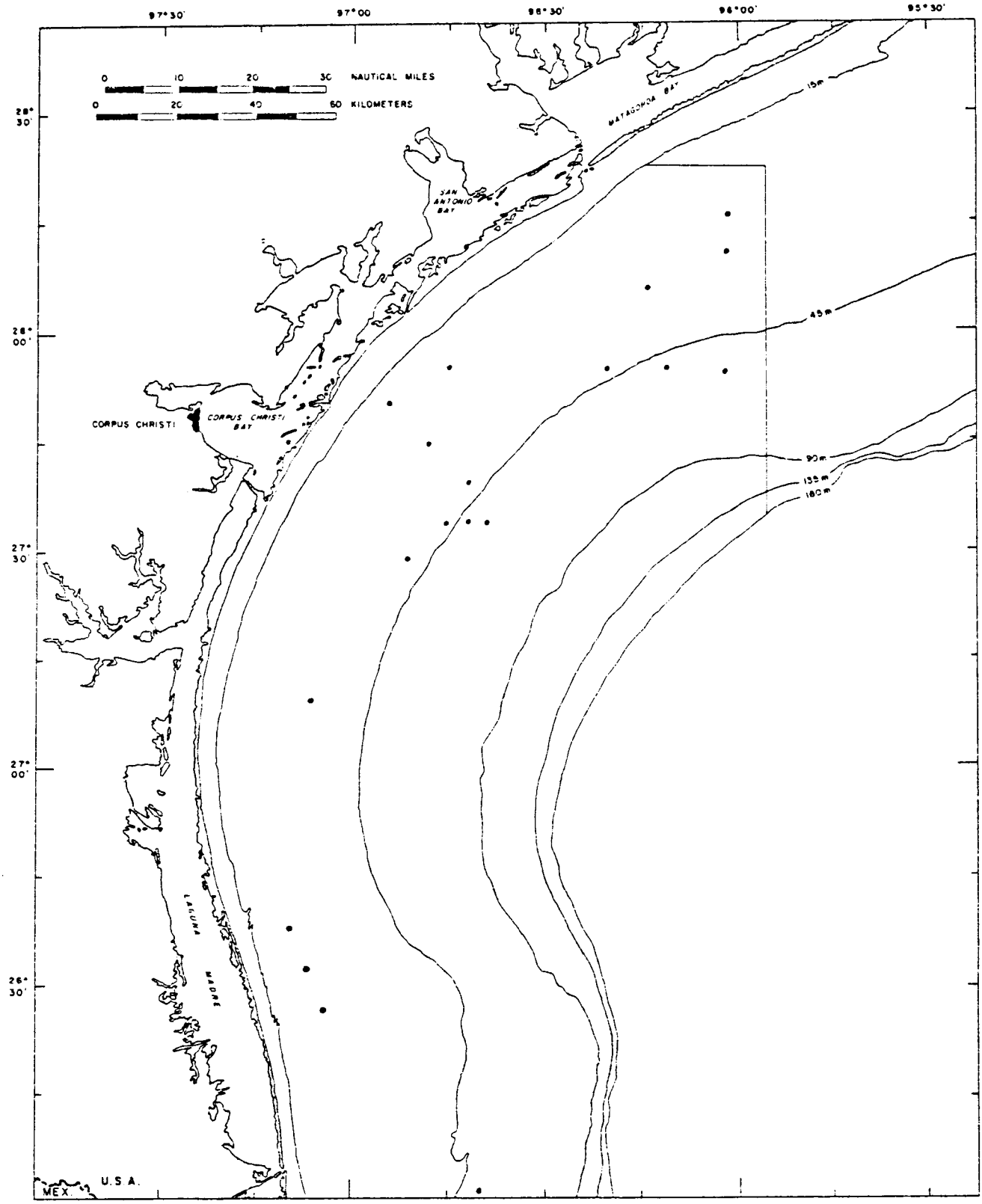


Figure 164. Distribution of Speocarcinus sp.

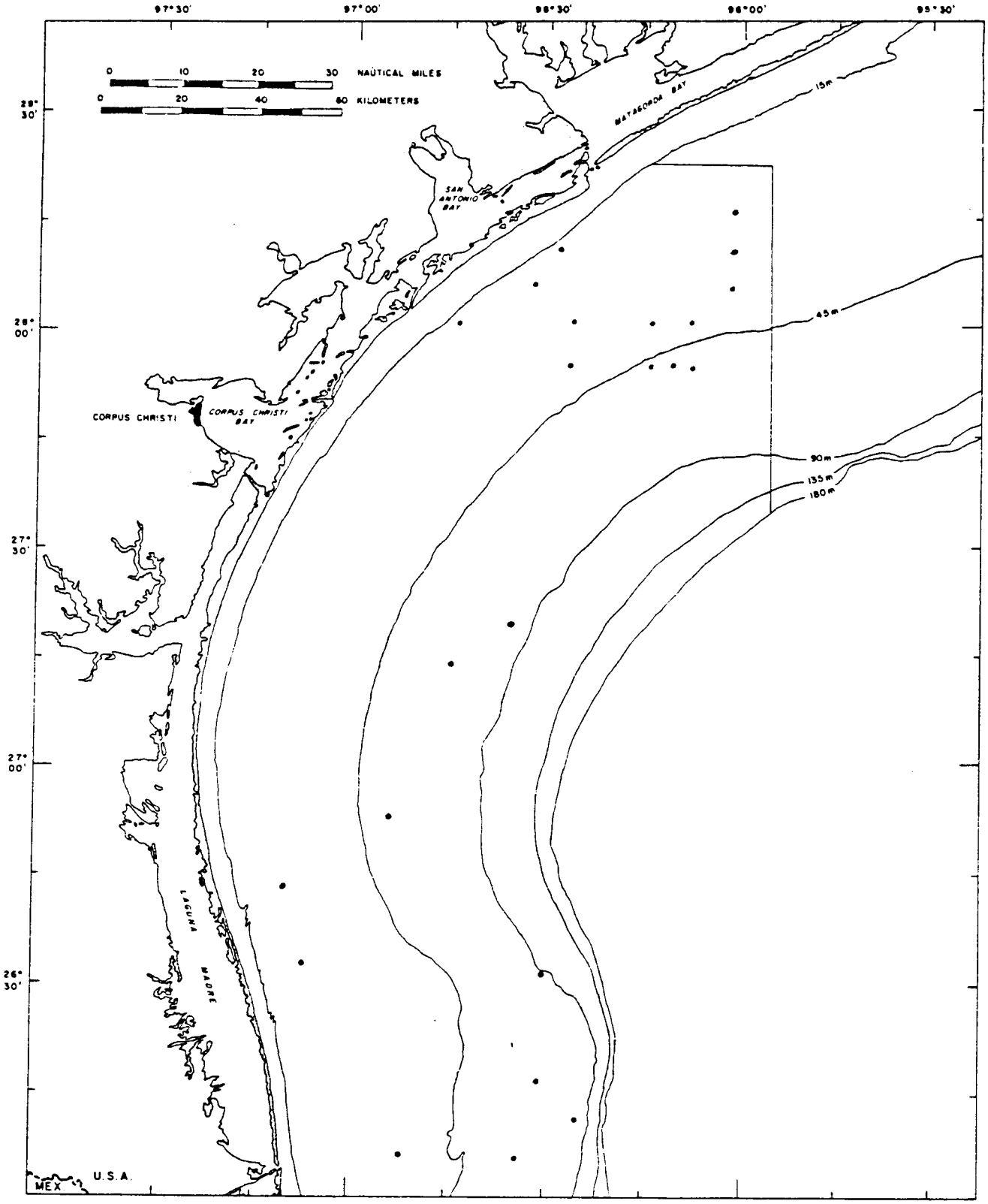


Figure 165. Distribution of an unidentified maldanid.

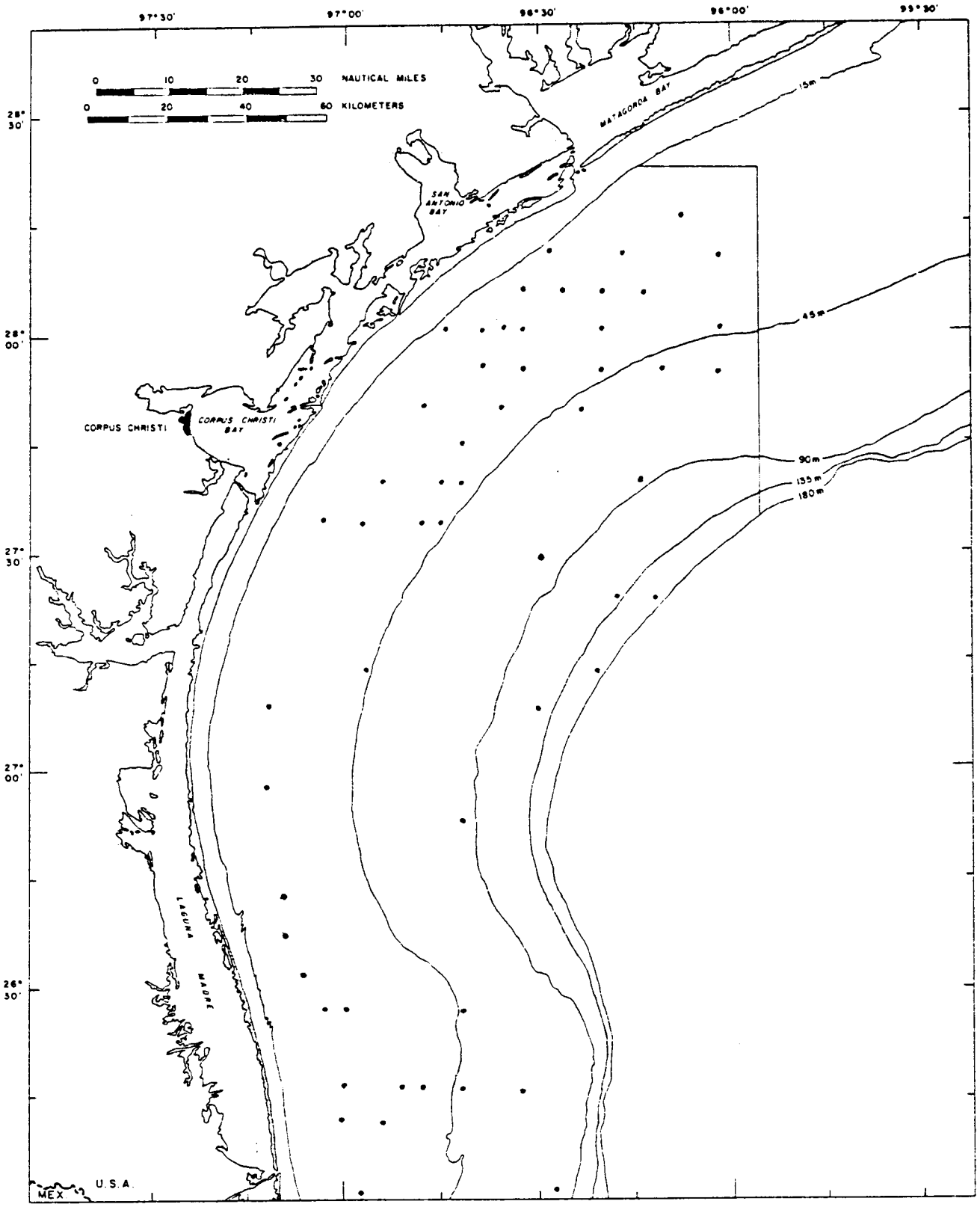


Figure 166. Distribution of Ampelisca cristoides.

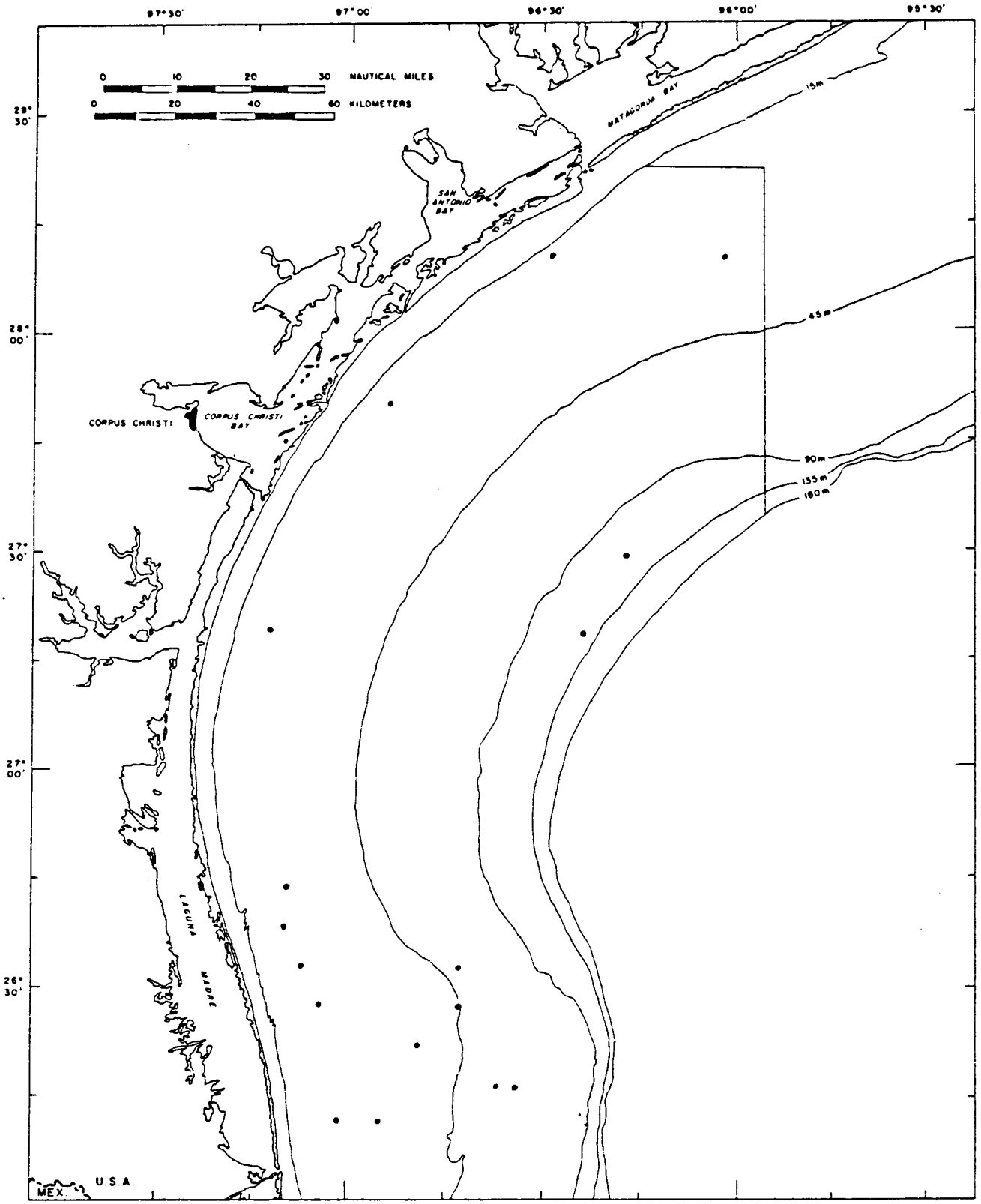


Figure 167. Distribution of Nuculana concentrica.

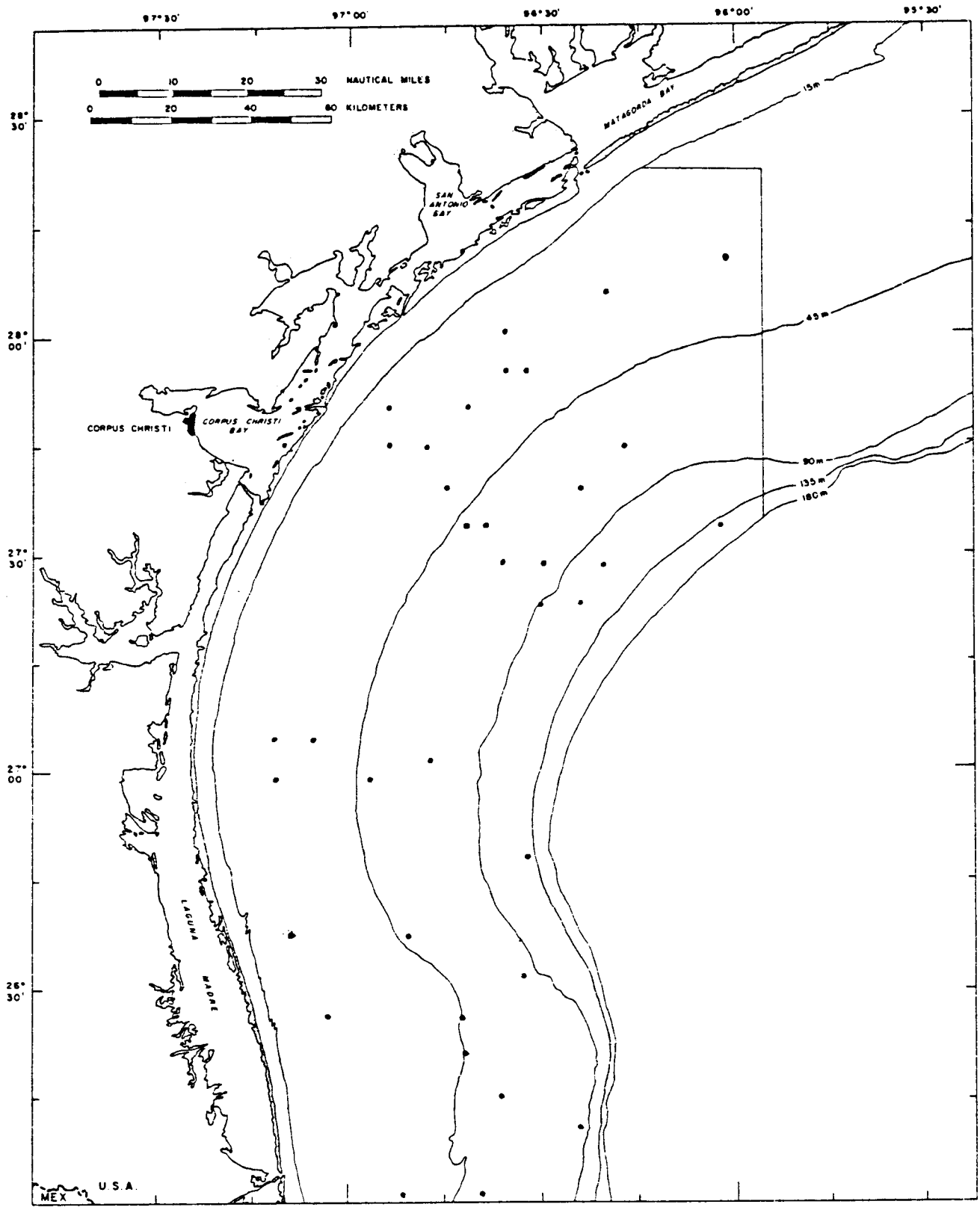


Figure 168. Distribution of Sigambra tentaculata.

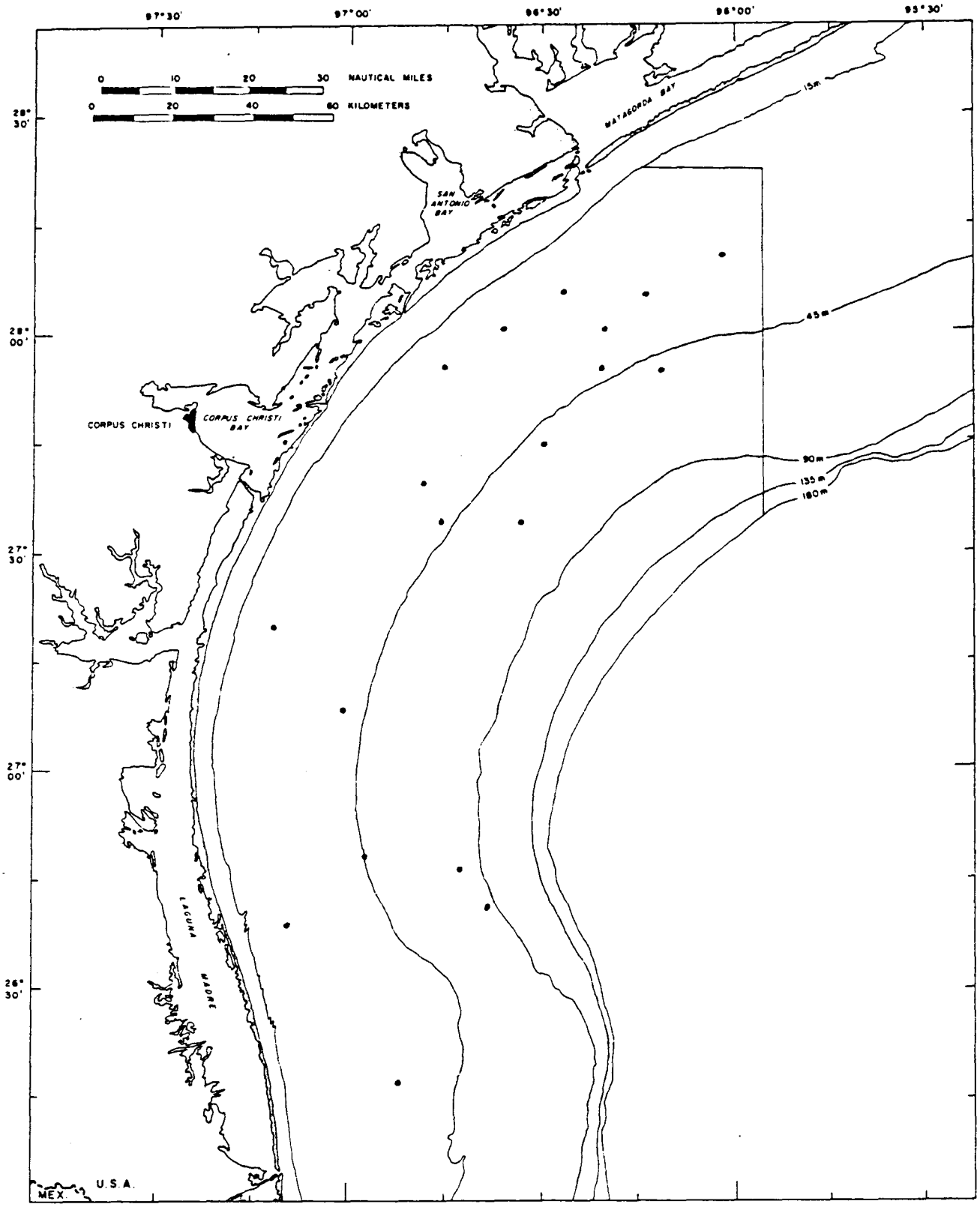


Figure 169. Distribution of Armandia agilis.

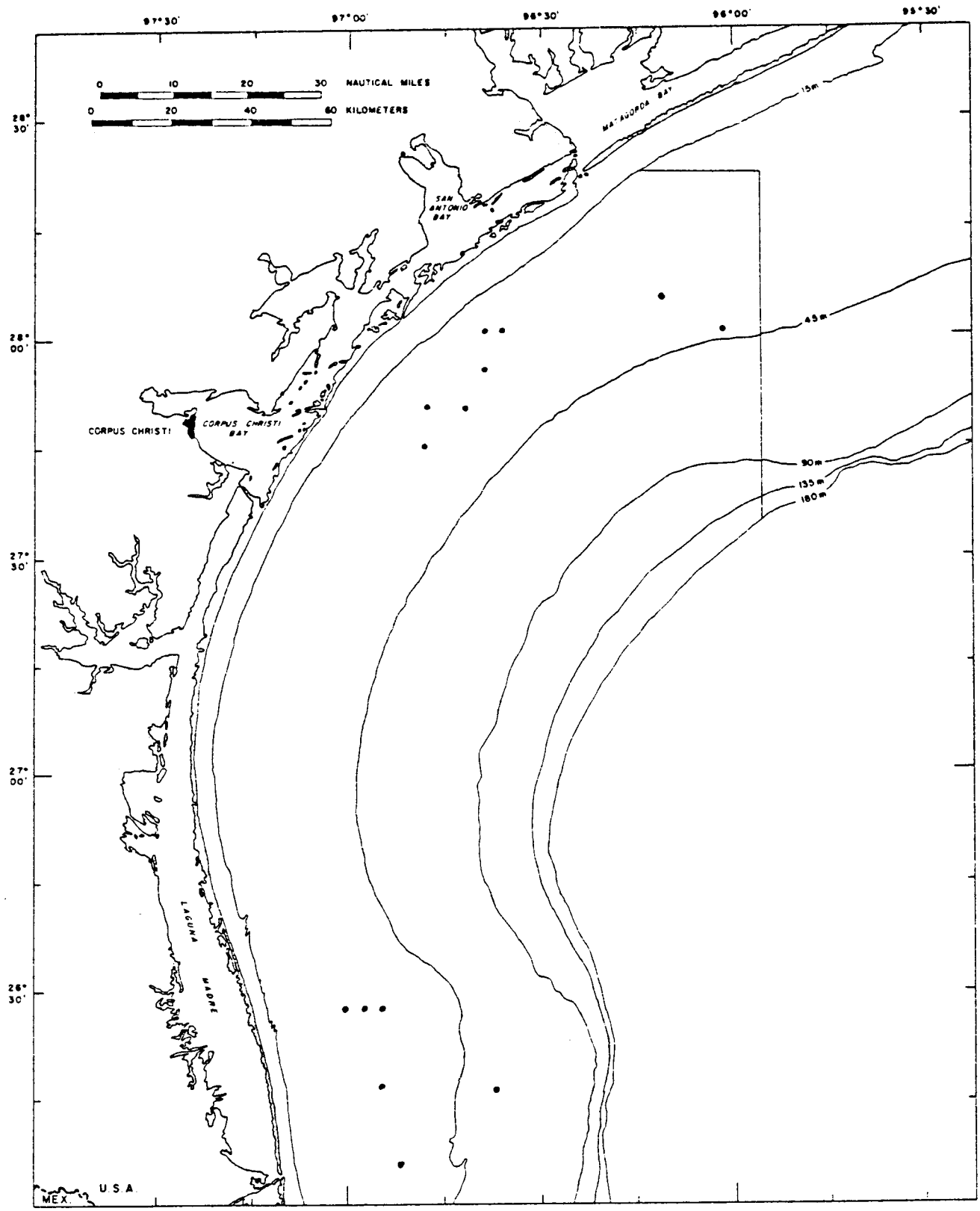


Figure 170. Distribution of Ampelisca cf. cristata.

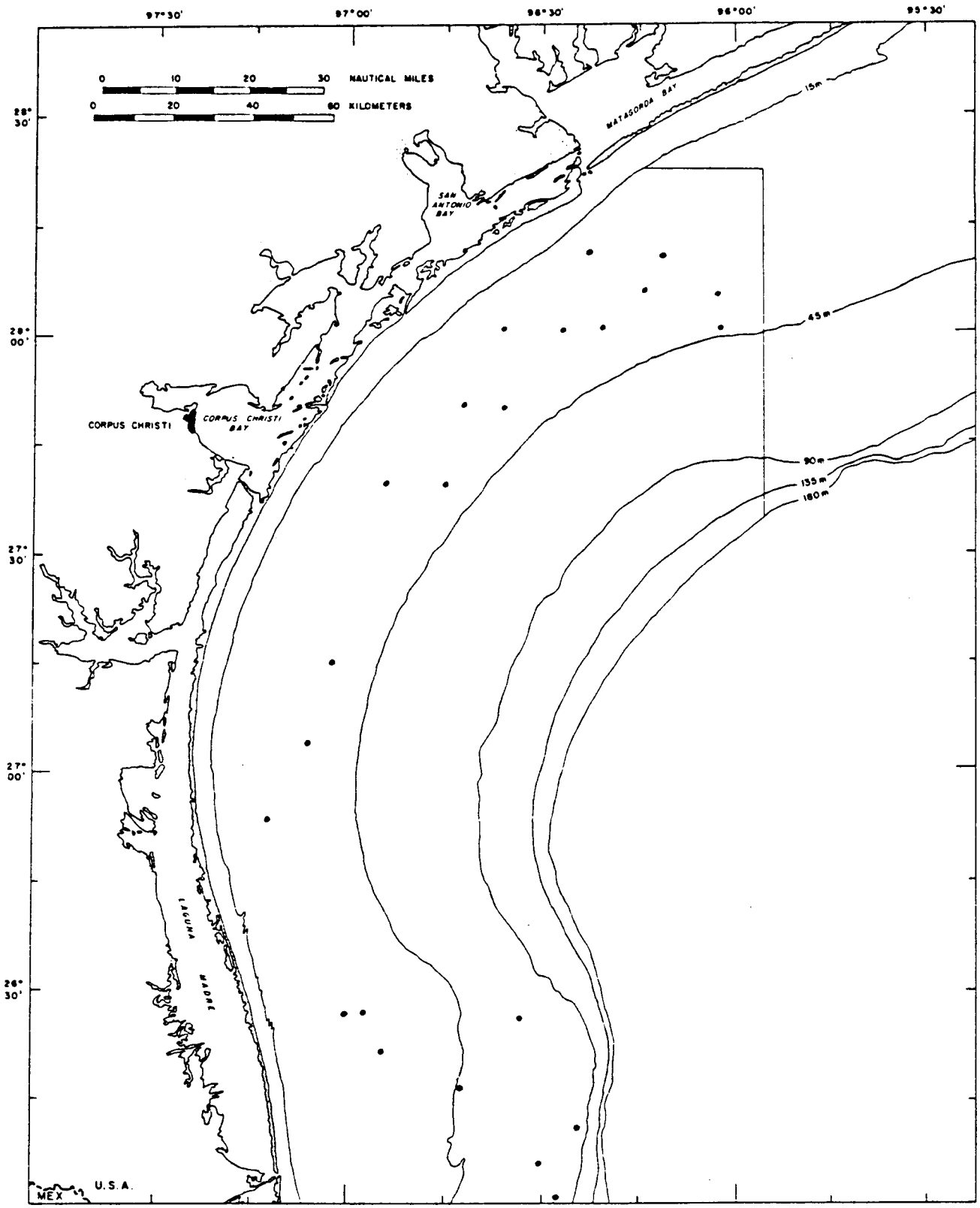


Figure 171. Distribution of Notomastus latericeus.

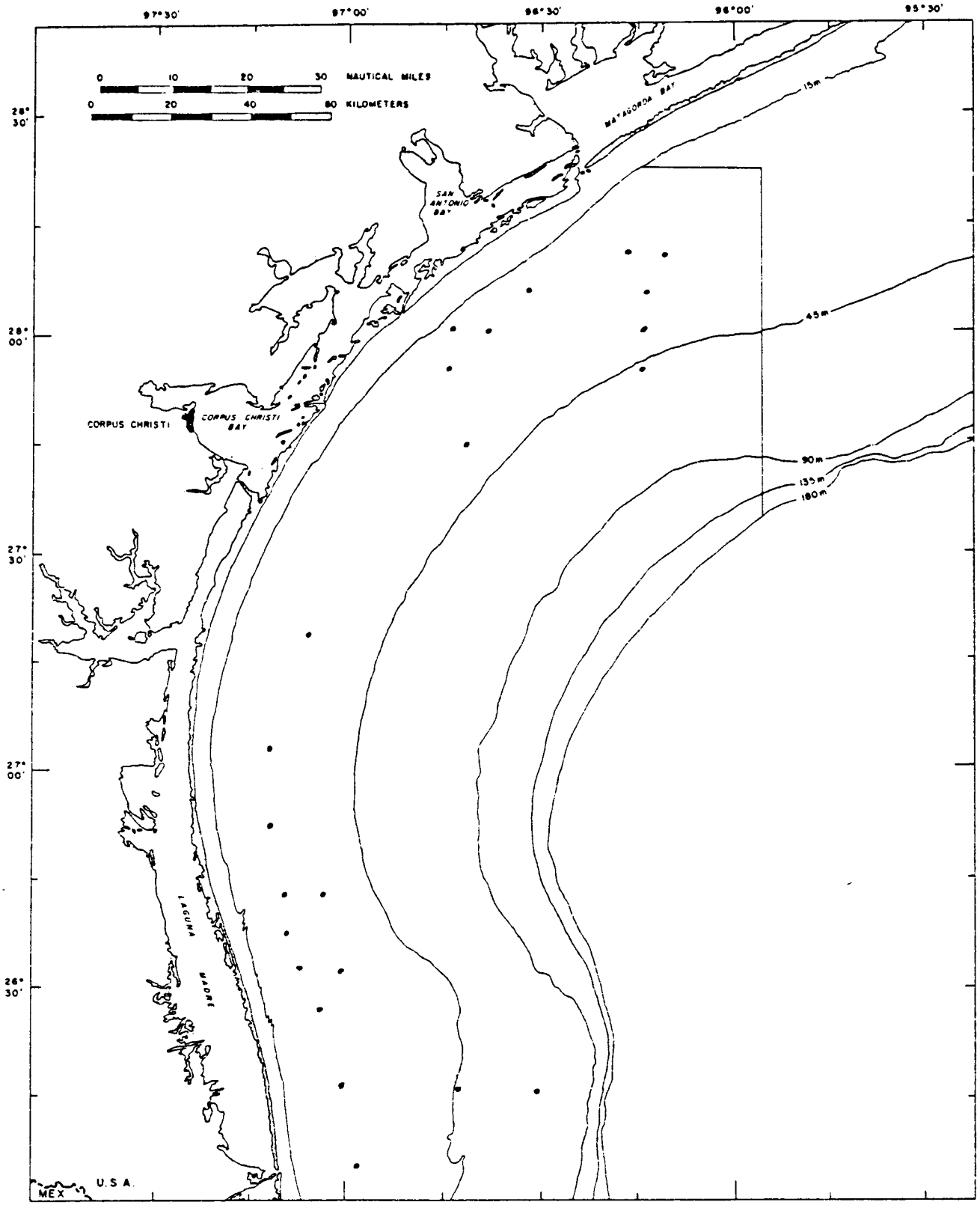


Figure 172. Distribution of Diopatra cuprea.

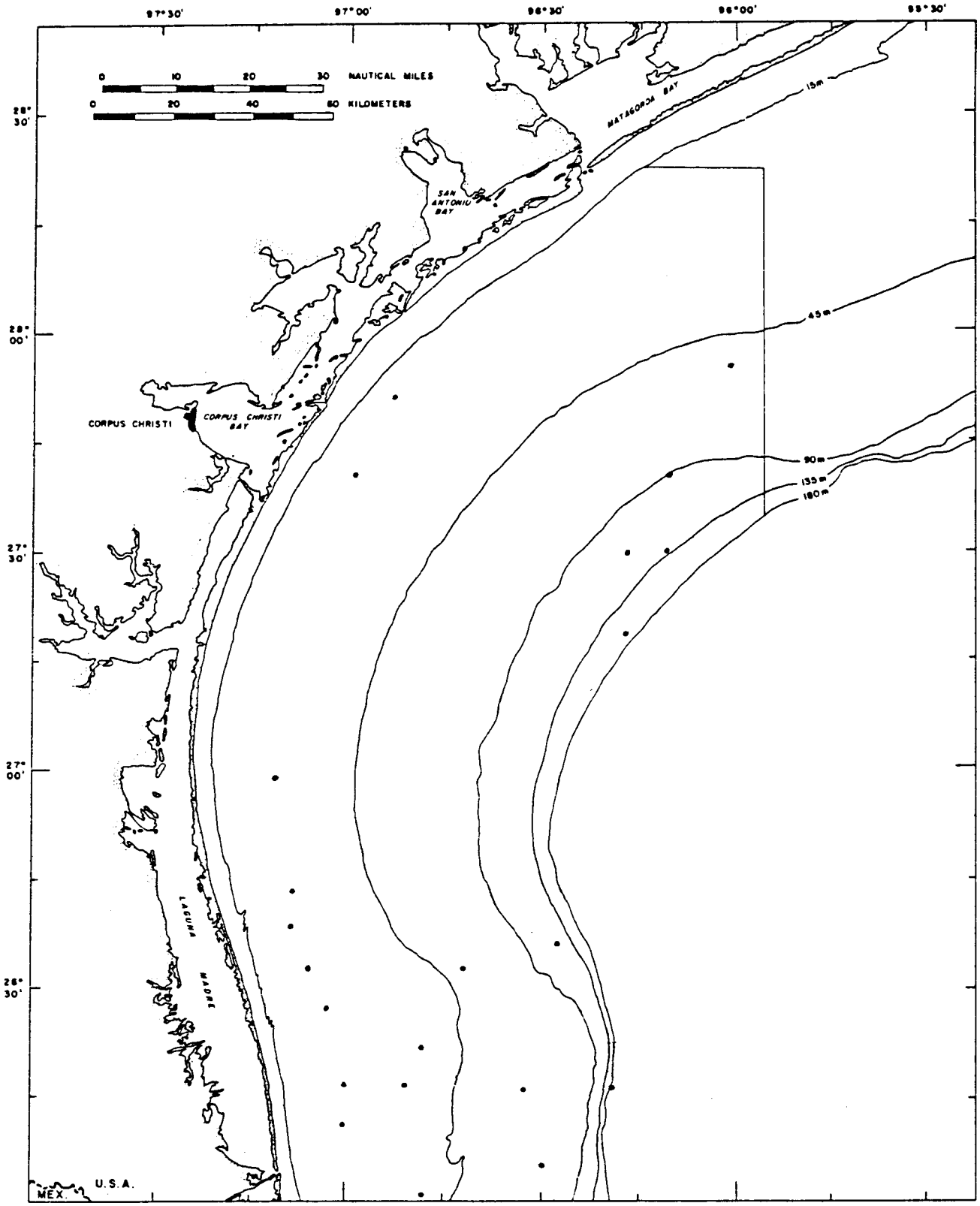


Figure 173. Distribution of Nuculana acuta.

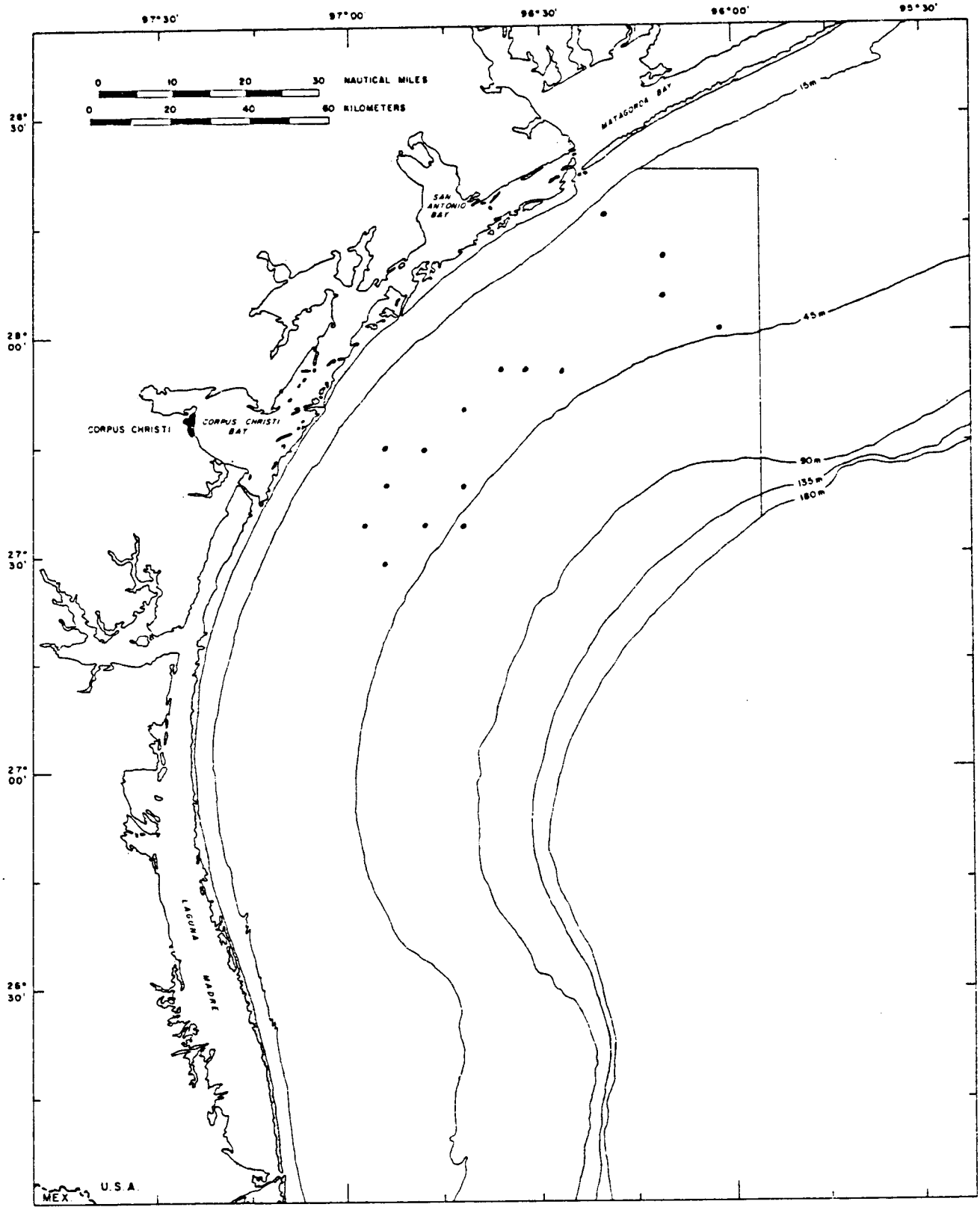


Figure 174. Distribution of Armandia maculata.

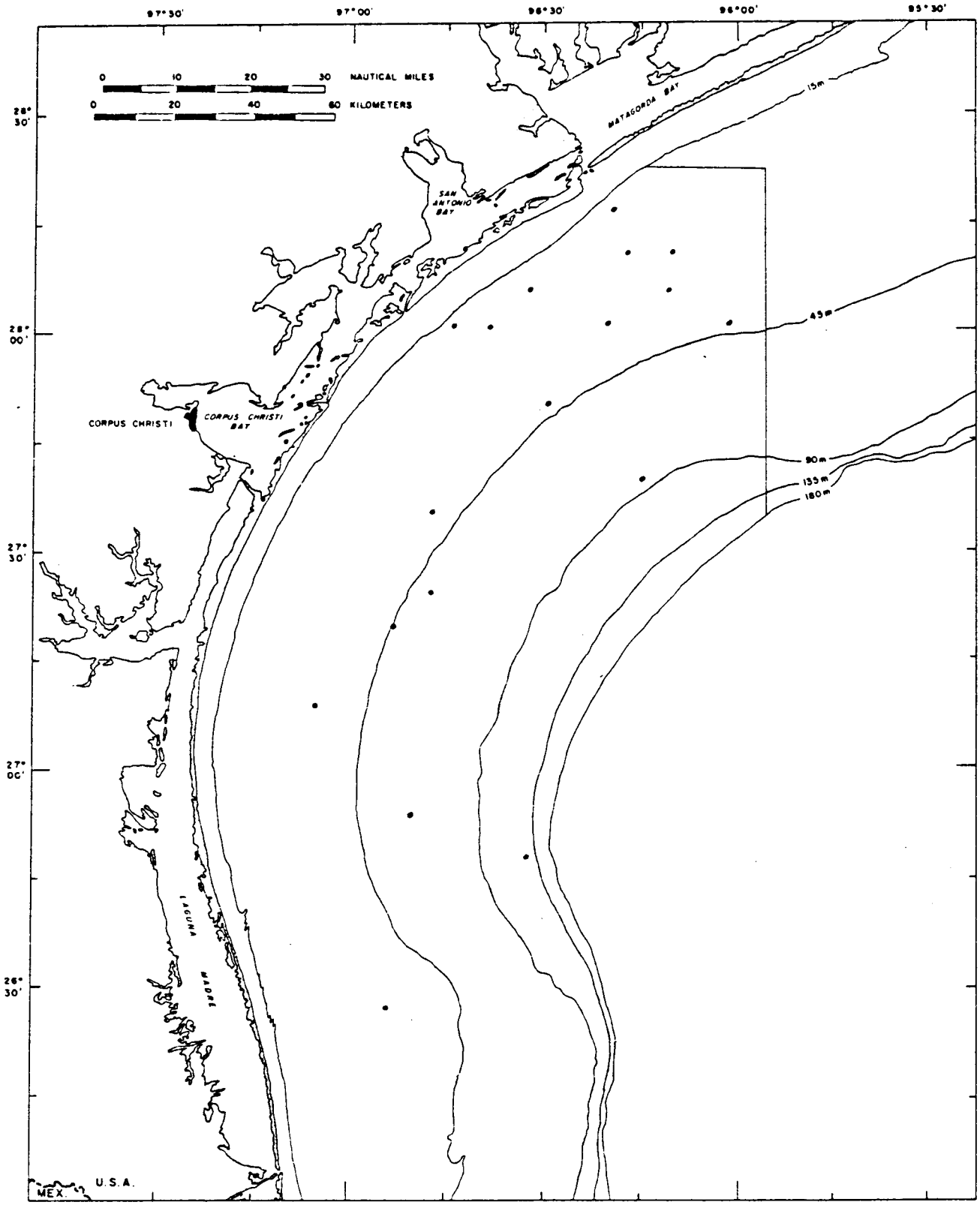


Figure 175. Distribution of an unidentified spionid.

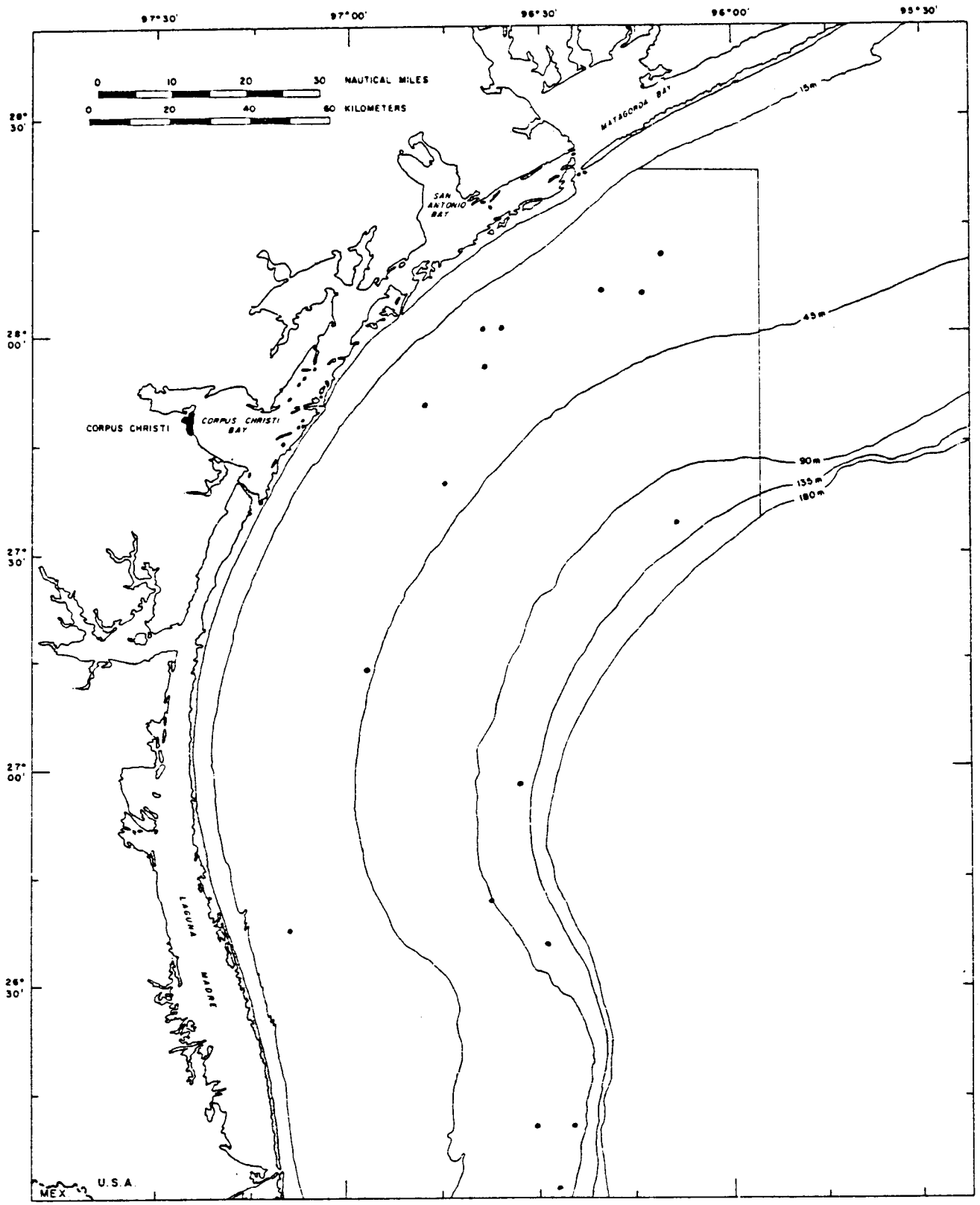


Figure 176. Distribution of Sthenelais sp.

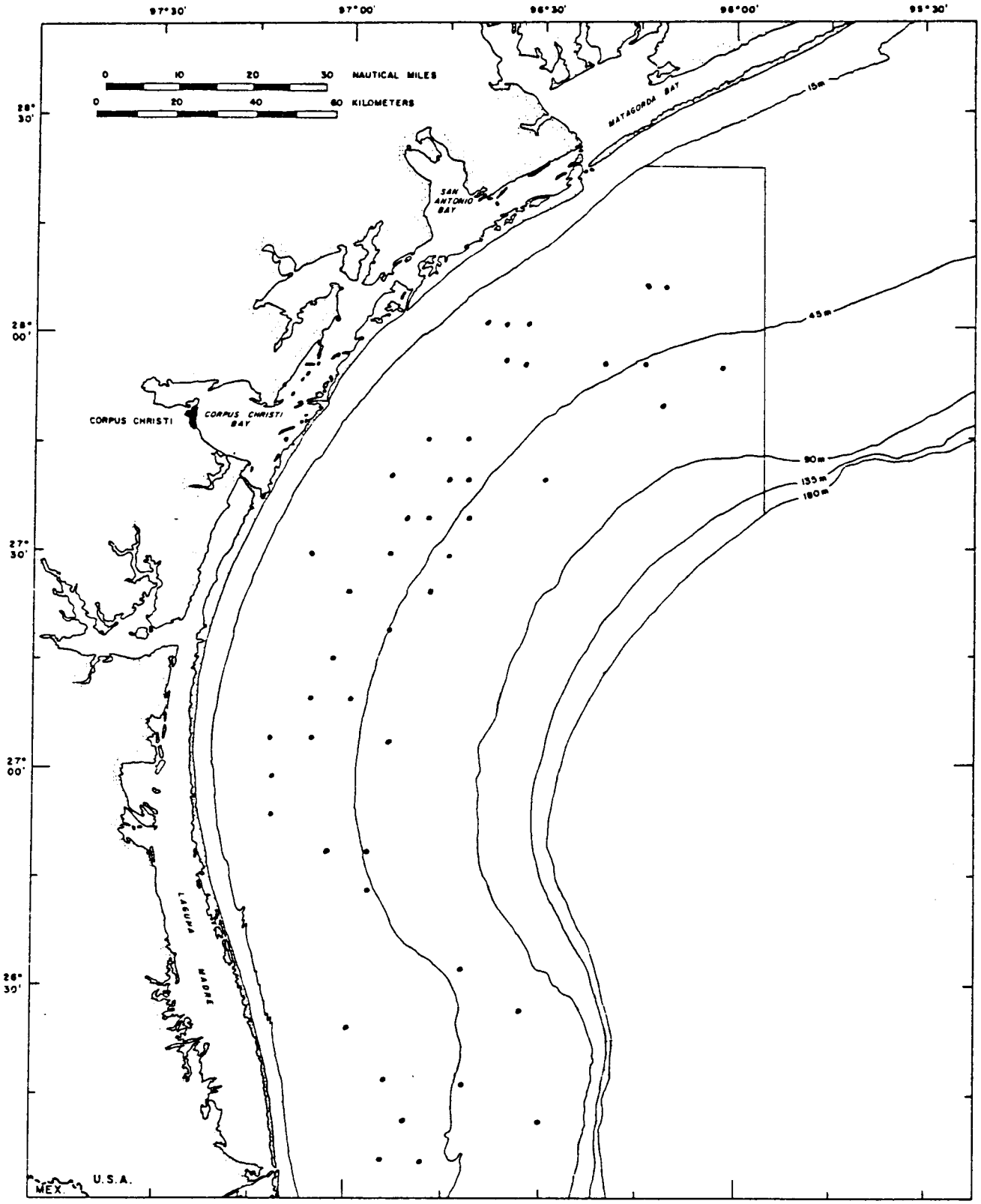


Figure 177. Distribution of Eudorella monodon.

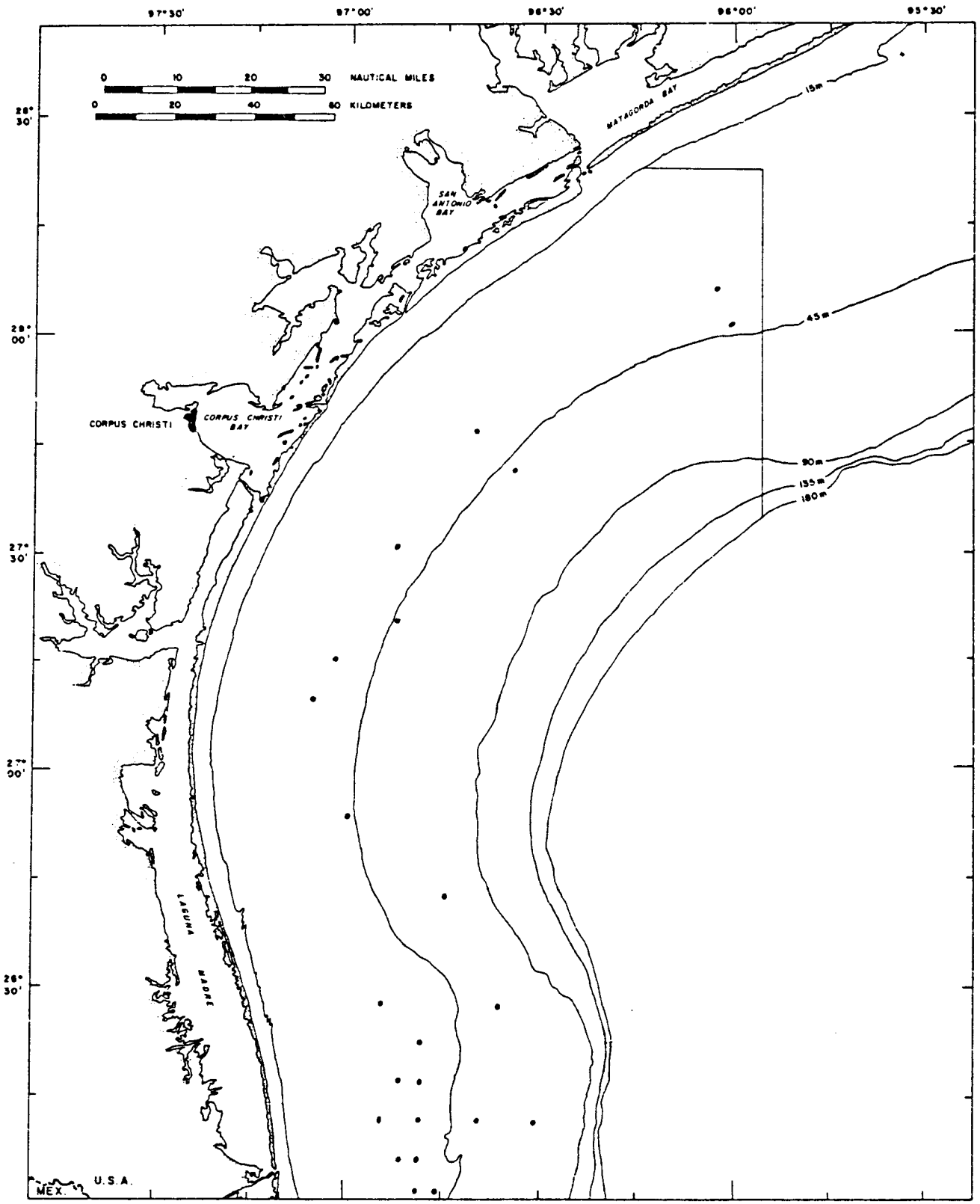


Figure 178. Distribution of Pinnixa retinens.

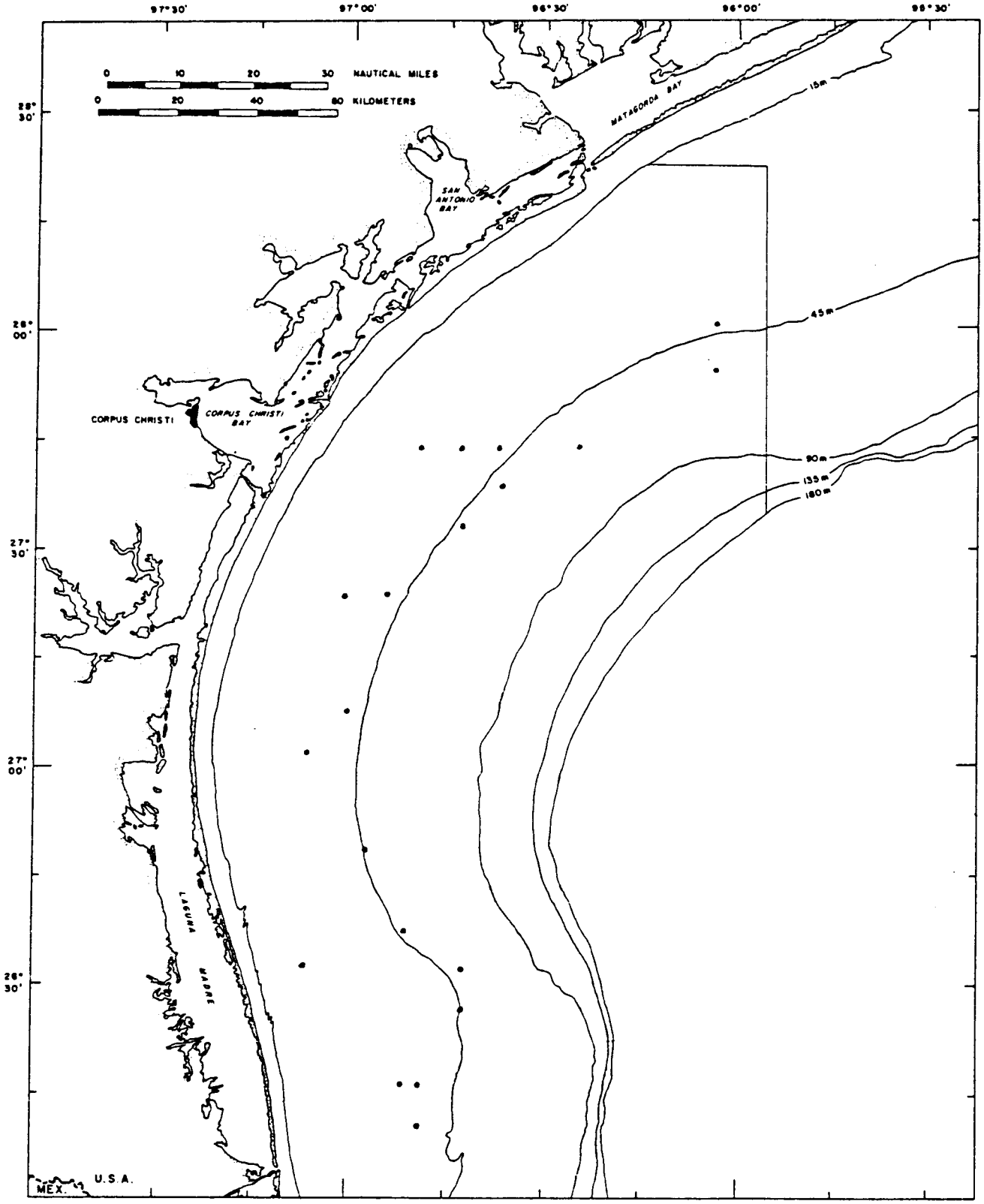


Figure 179. Distribution of Leptognatha gracilis.

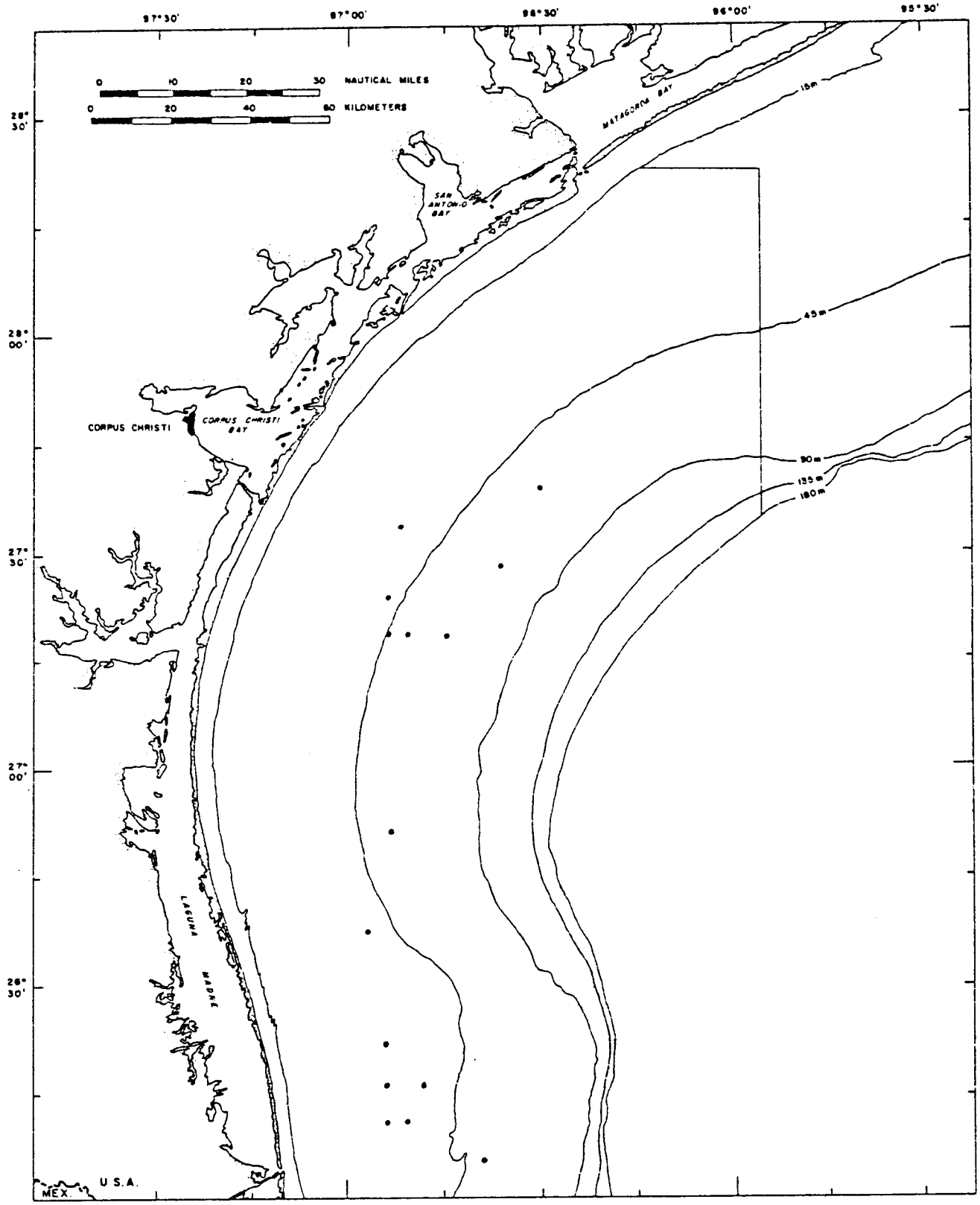


Figure 180. Distribution of an unidentified gastropod.

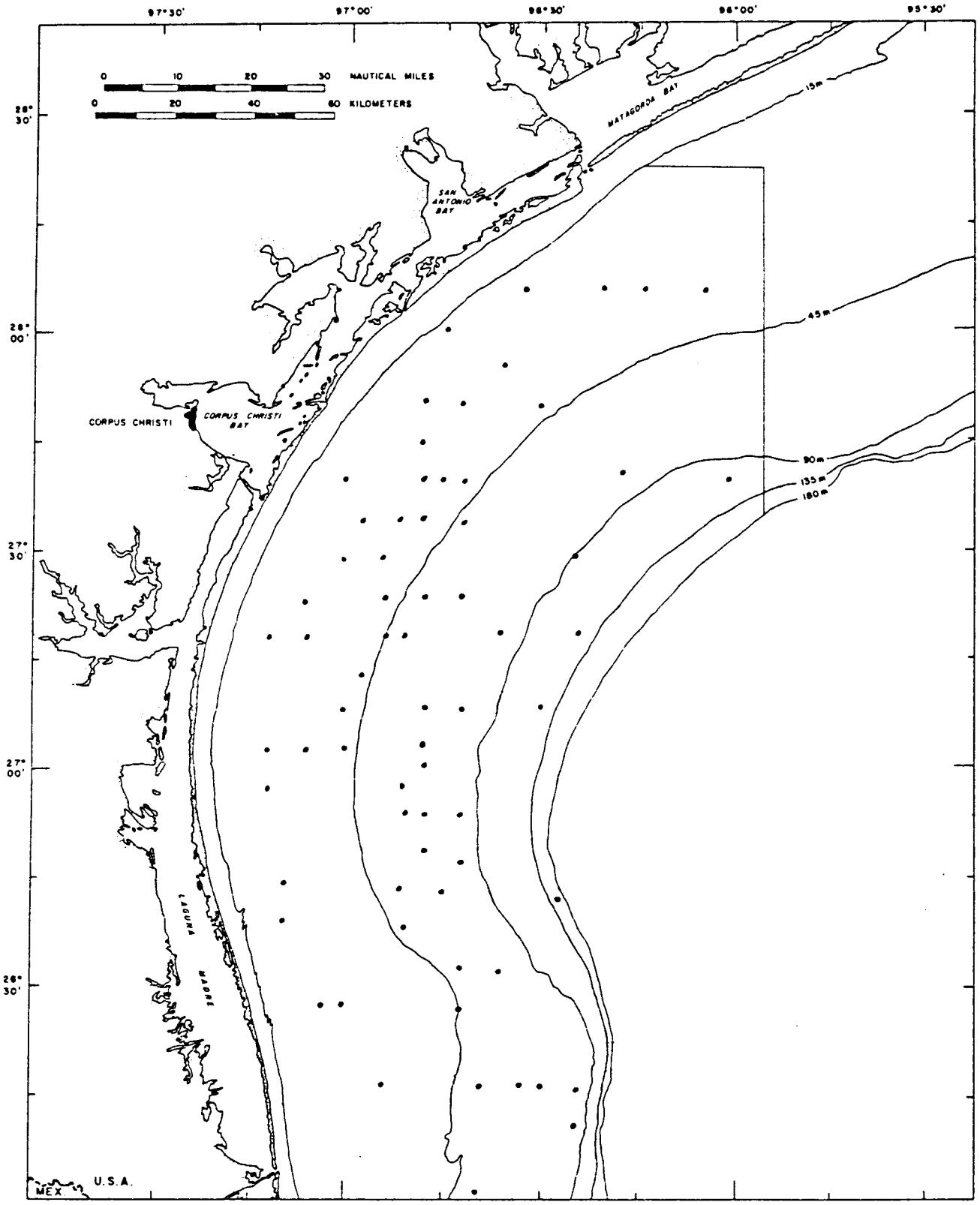


Figure 181. Distribution of Cossura delta.

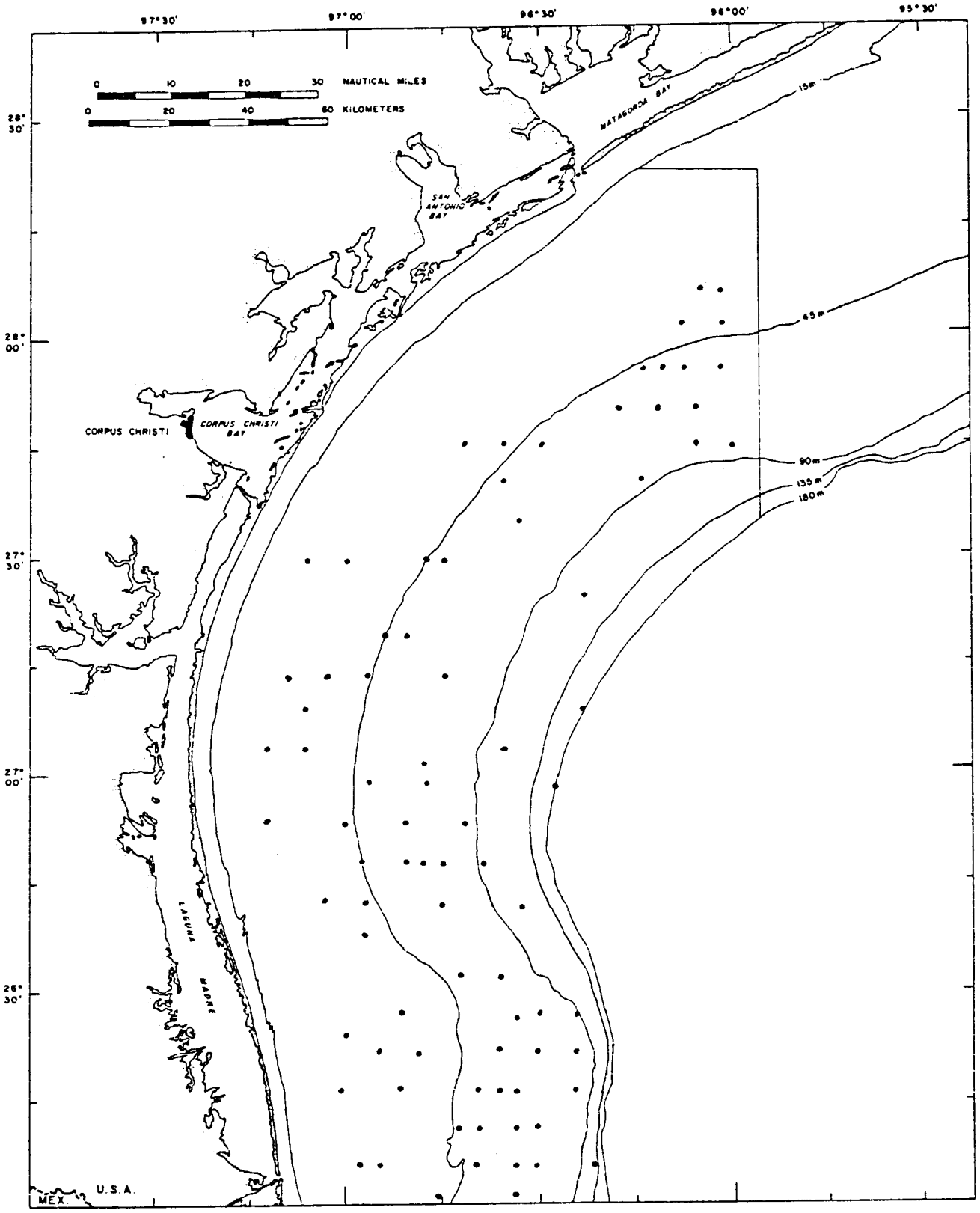


Figure 182. Distribution of an unidentified ophiurid.

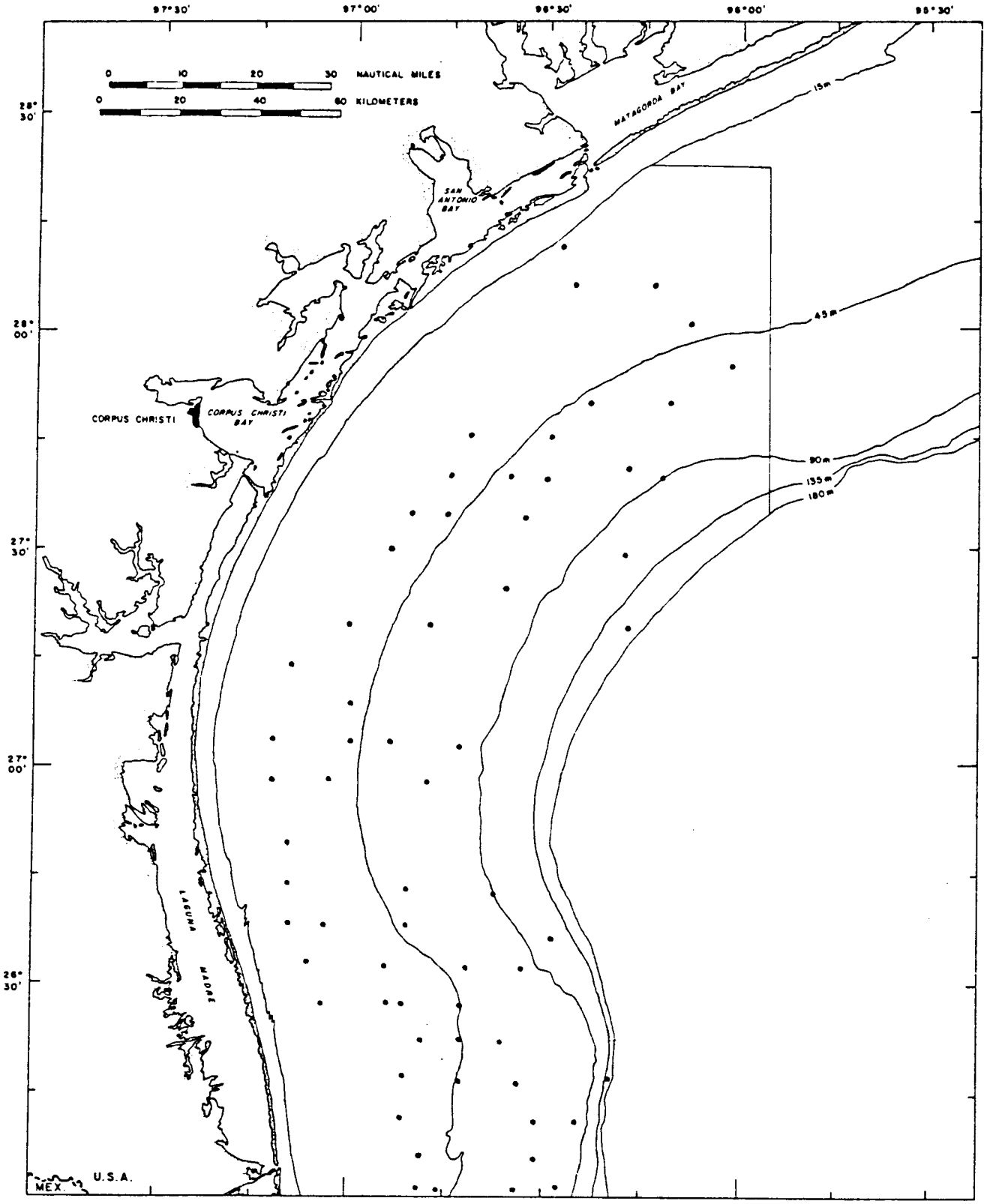


Figure 183. Distribution of Corbula sp.

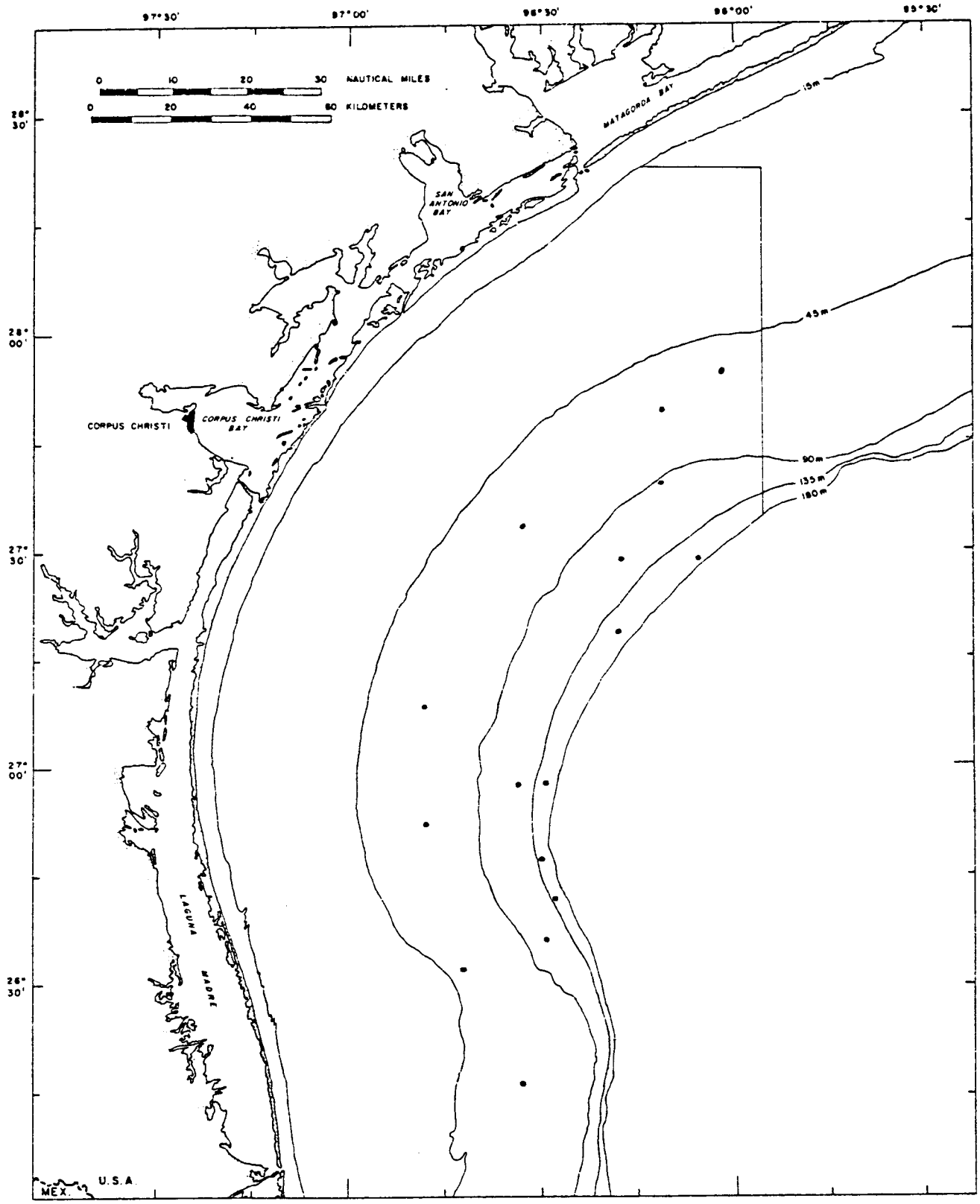


Figure 184. Distribution of Diplodonta sp.

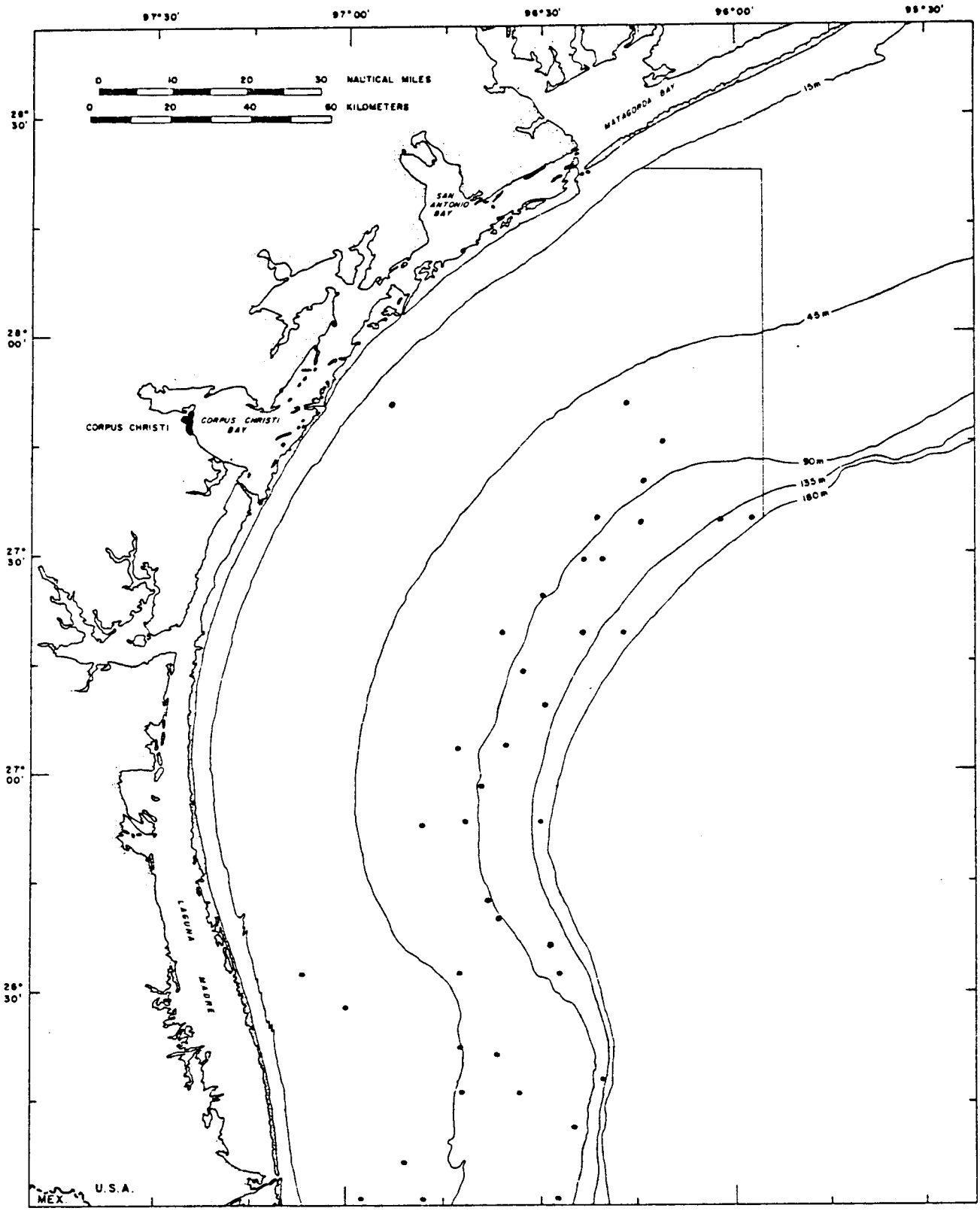


Figure 185. Distribution of Glycera sp.

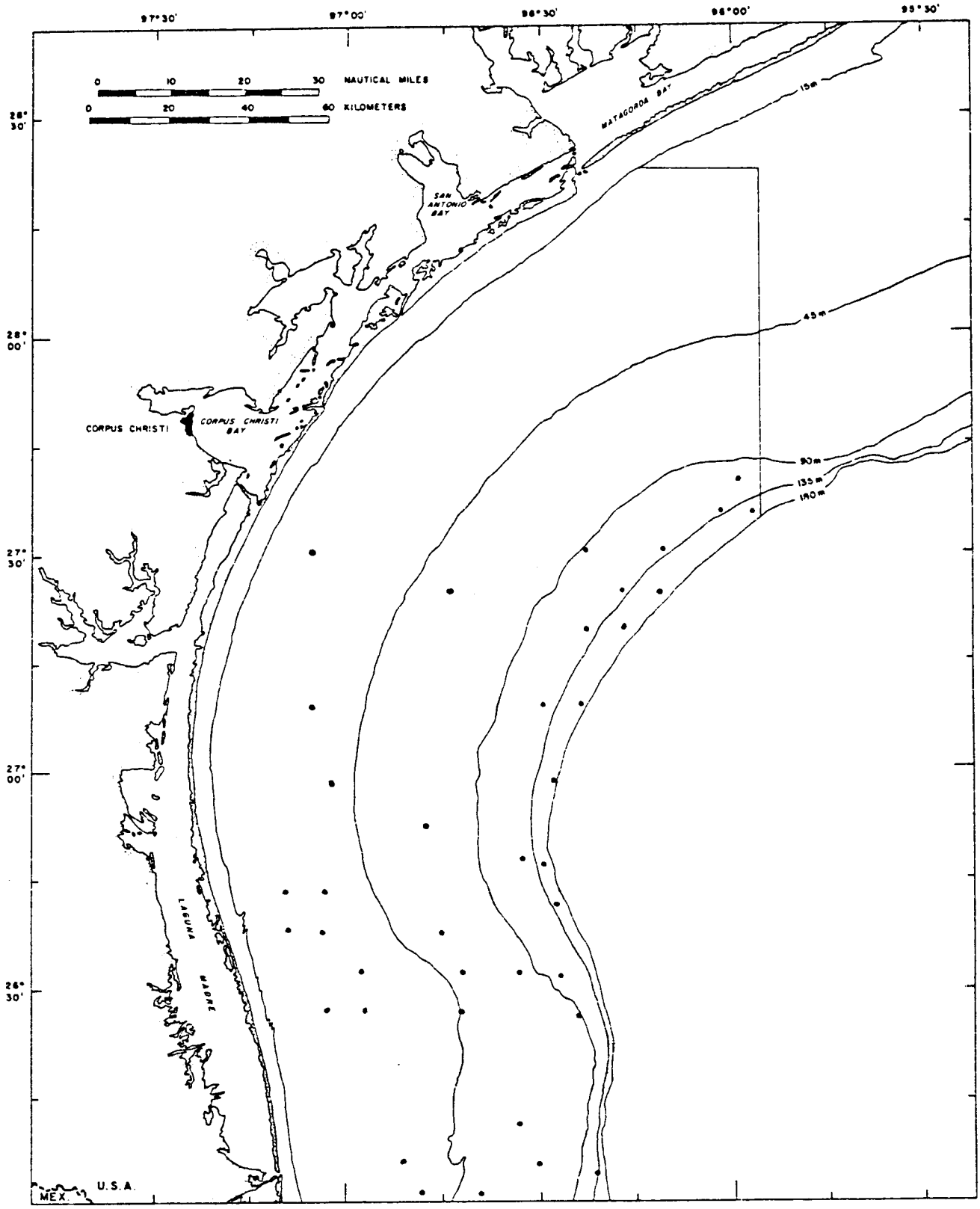


Figure 186. Distribution of an unidentified sipunculid.

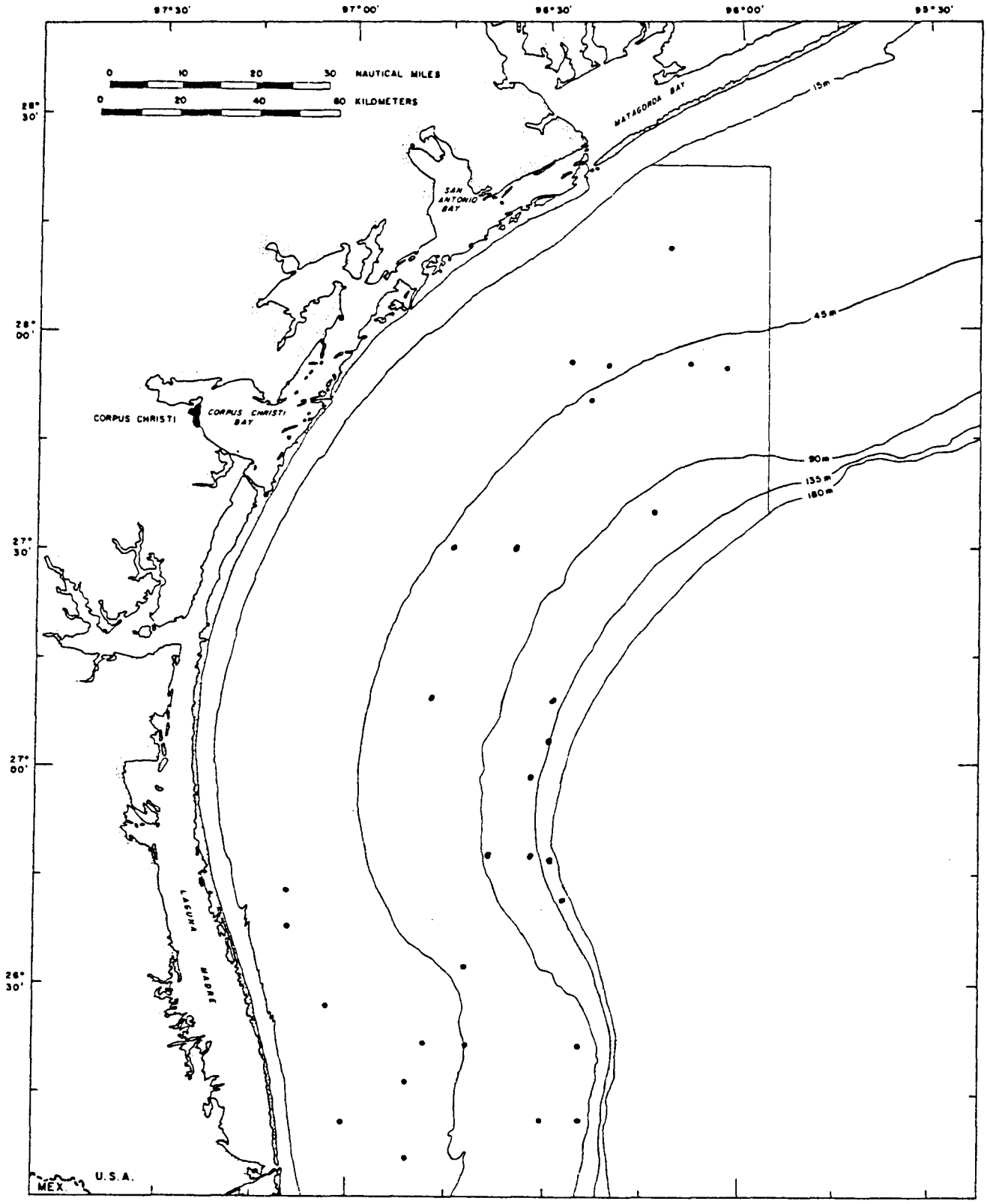


Figure 187. Distribution of an unidentified cirratulid.

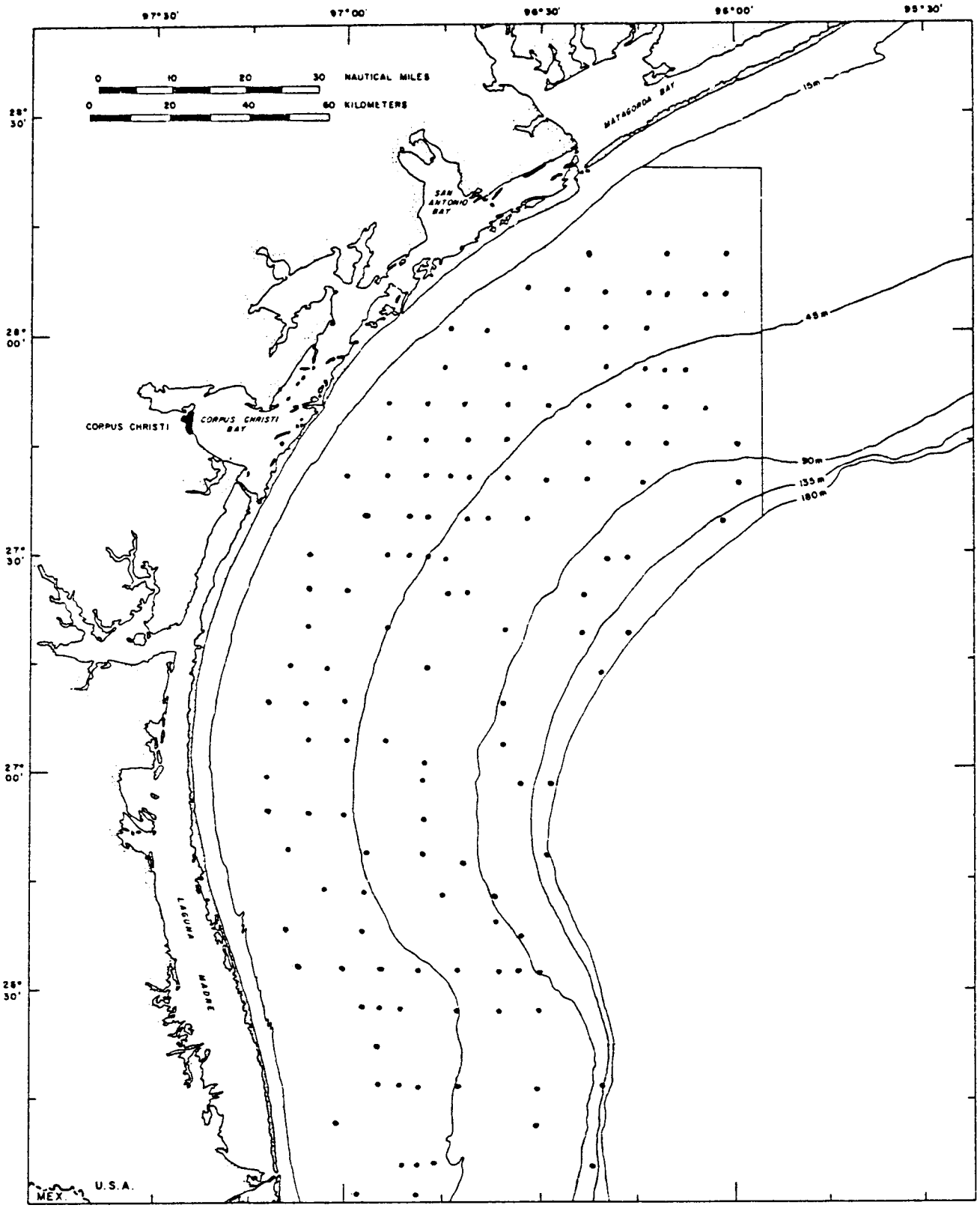


Figure 188. Distribution of Nephtys picta.

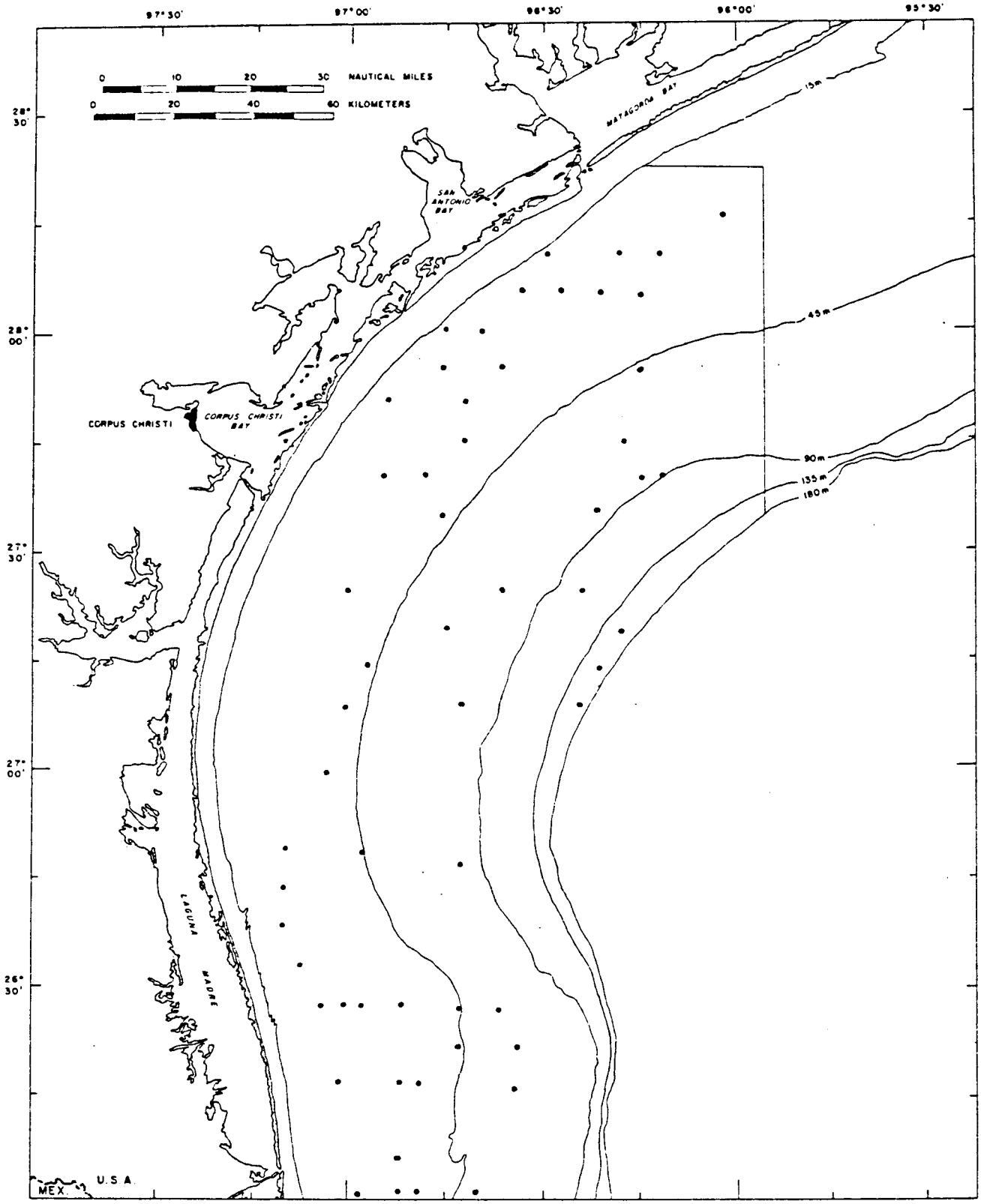


Figure 189. Distribution of Lumbrineris sp.

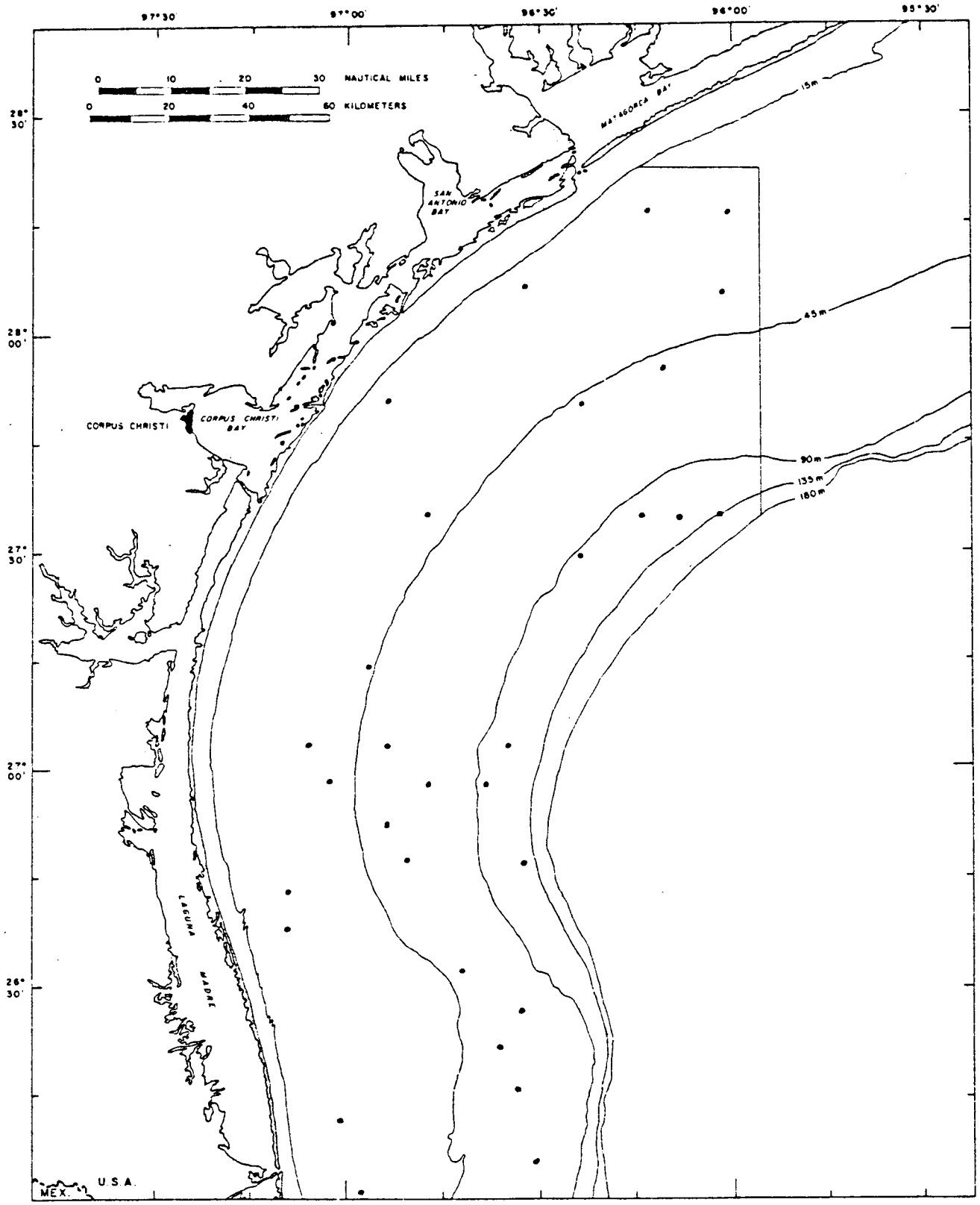


Figure 190. Distribution of an unidentified paraonid.

equitability and probably was true for diversity as well. Second, the smallest numbers of species, numbers of individuals, and amount of biomass were located generally in the central sector of the OCS, with numbers or amount in each category increasing to the north and south. The ancestral deltas of the Brazos-Colorado and Rio Grande generally had higher values than areas of comparable water depth in the central sector. Again, equitability and diversity seemed to reflect an inverse relationship to water depth and geomorphic features relative to the biological parameters.

Spatial distribution of common to uncommon species did not appear to be random. Most species were most common in the area of the ancestral deltas of the Brazos-Colorado and Rio Grande and landward of midshelf in the central sector.

Overall, general trends for the biological characteristics of the infauna seemed to be most sensitive to water depth and benthic sediment texture.

Macrobenthic Infaunal Assemblages

The regional patterns of distribution (figs. 147, 148, 153, 154, and 155) and large standard deviations from the means (table 12) of the biological parameters measured indicated that the biological makeup of the South Texas OCS is not homogeneous and implied that the macrobenthic infauna may occur in specific assemblages. As a means of identifying and differentiating macrobenthic infaunal assemblages from the data, a classification type of numerical analysis was used. Such analysis has been applied in other studies with good results (Day and others, 1971; Field, 1970, 1971; Field and McFarlane, 1968; Hughes and others, 1972; Hughes and Thomas, 1971a, 1971b; Stephenson and others, 1970; Santos and Simon, 1974). The computer program for the analysis was supplied by Dr. Joseph L. Simon, Department of Biology, University of South

Florida, with the permission of Dr. John G. Field of C.S.I.R.O. unit, Capetown, South Africa, who developed the program. A description of the program is given by Santos and Simon (1974) and is briefly reviewed here. The classification normally consists of four main steps:

1. similarity matrix computation;
2. application of sorting strategy:
3. application of a test of significance to determine homogeneity; and
4. expressing results by a suitable means.

Czekanowski's coefficient (Bray and Curtis, 1957; Field and McFarlane, 1968) was used to measure the faunal similarity between stations (i.e., interindividual measure). The Czekanowski coefficient is defined as:

$$C = \frac{2w}{(a+b)}$$

where a = sum of the species scores from sample a, b = sum of the species scores from sample b, and w = sum of the lesser scores of each common species in the two samples being compared. Several characteristics of Czekanowski's coefficient made it suitable for use. For example, large numbers of zeros in the data do not affect the coefficient, and it considers the relative abundance of each organism, rather than simply presence or absence. The sorting strategy used was group average sorting for Q or normal analysis, an agglomerative polythetic-type system used successfully by Field (1970, 1971). This sorting strategy was selected because the average level of similarity between stations was investigated, not the relations between individuals (Hughes and Thomas, 1971b; Orloci, 1967).

To determine if subsets generated by the similarity analysis differed significantly, the information statistic $2\Delta I$, (Williams and others, 1966; Field, 1969) was used. The results of the analysis are expressed in a hierarchical dendogram. The number of species was log transformed ($\log_e x+1$) to

save computer time, and species not in at least 5 percent of the samples were eliminated from the analysis.

The results of the numerical analysis based on the data from the South Texas OCS are shown in figure 191. Several major groups (Groups I through IV), which may be macrobenthic infaunal assemblages, are evident.

By mapping the major groups (I-IV) shown in figure 191, the approximate regional pattern of distribution for each macrobenthic infaunal assemblage, as defined by the clustering technique, was determined (fig. 192). If the macrobenthic infaunal assemblages are significantly different, the differences should be reflected in a comparison between the biological characteristics of each assemblage.

Macrobenthic infaunal assemblages are described and compared through a series of characteristics, including number of species and individuals, biomass, and faunal composition. For each of these characteristics, except faunal composition, the mean values were calculated by assemblage (table 13). The faunal composition for each assemblage relative to the percent of the total species and individuals represented by each of the major taxa (Polychaeta, Crustacea, Mollusca) is shown in table 14. The mean values of diversity (H") and equitability were calculated and also are expressed in table 13. Because of the interpretive problems associated with the derived data as previously discussed, they were not used in characterizing the macrobenthic infaunal assemblages.

Assemblage I

Assemblage I extends along the entire longitudinal axis of the OCS and is confined generally to that part of the shelf shoreward of the 40 m isobath, but the seaward boundary in the southern part of the shelf is very irregular.

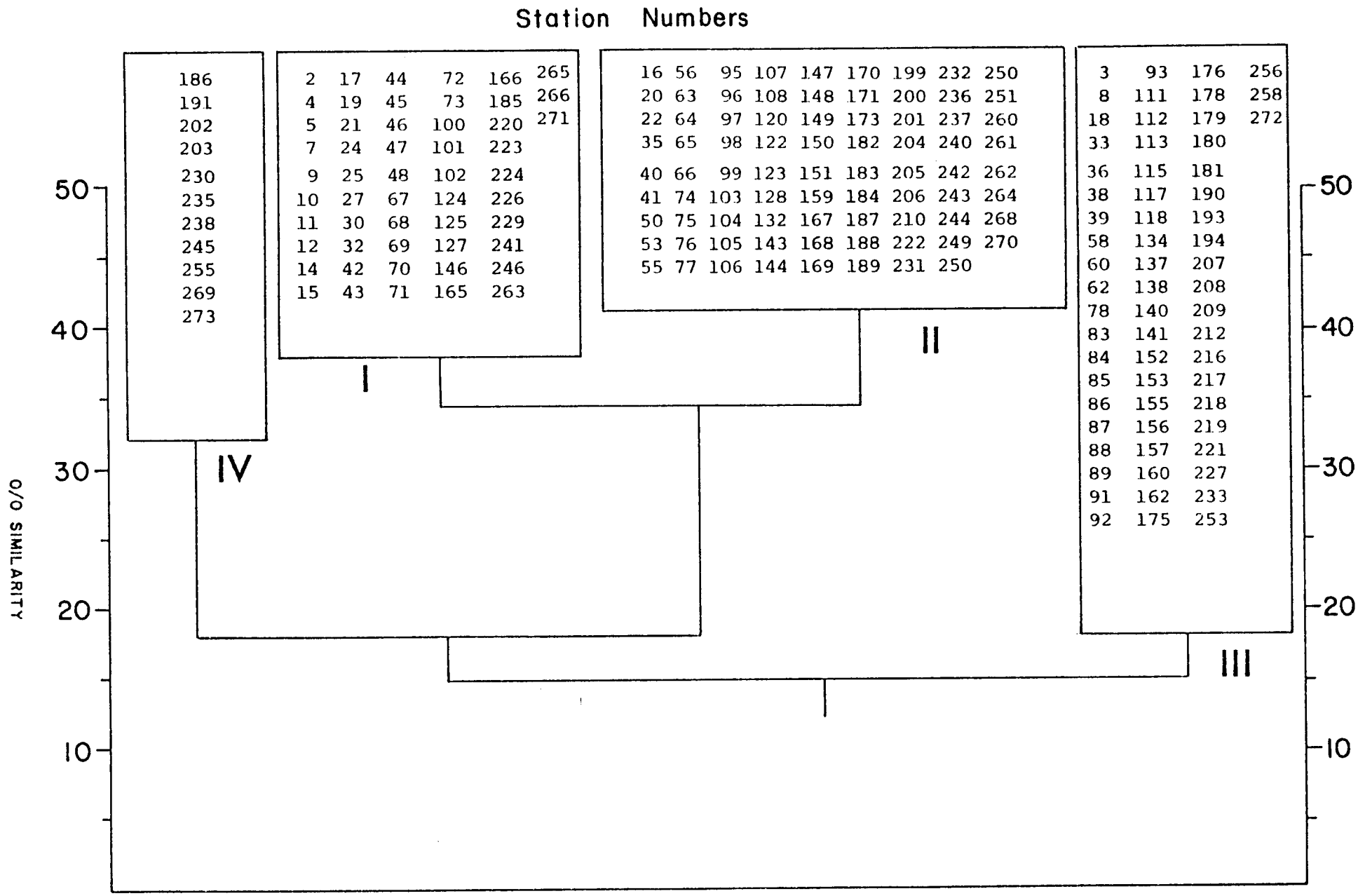


Figure 191. Dendogram showing similarity of stations in terms of Czekanowski coefficient and group average sorting for Q-mode analysis.

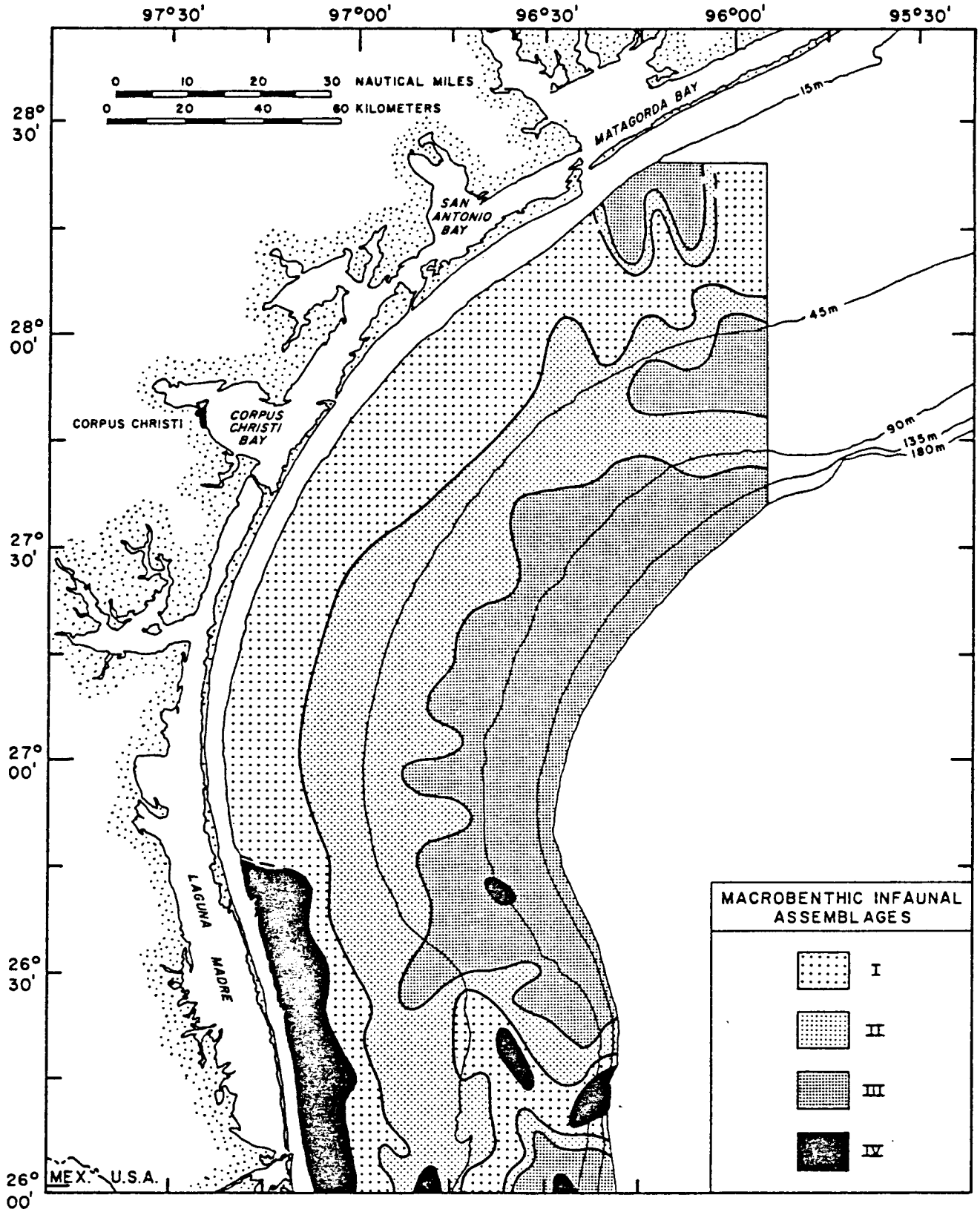
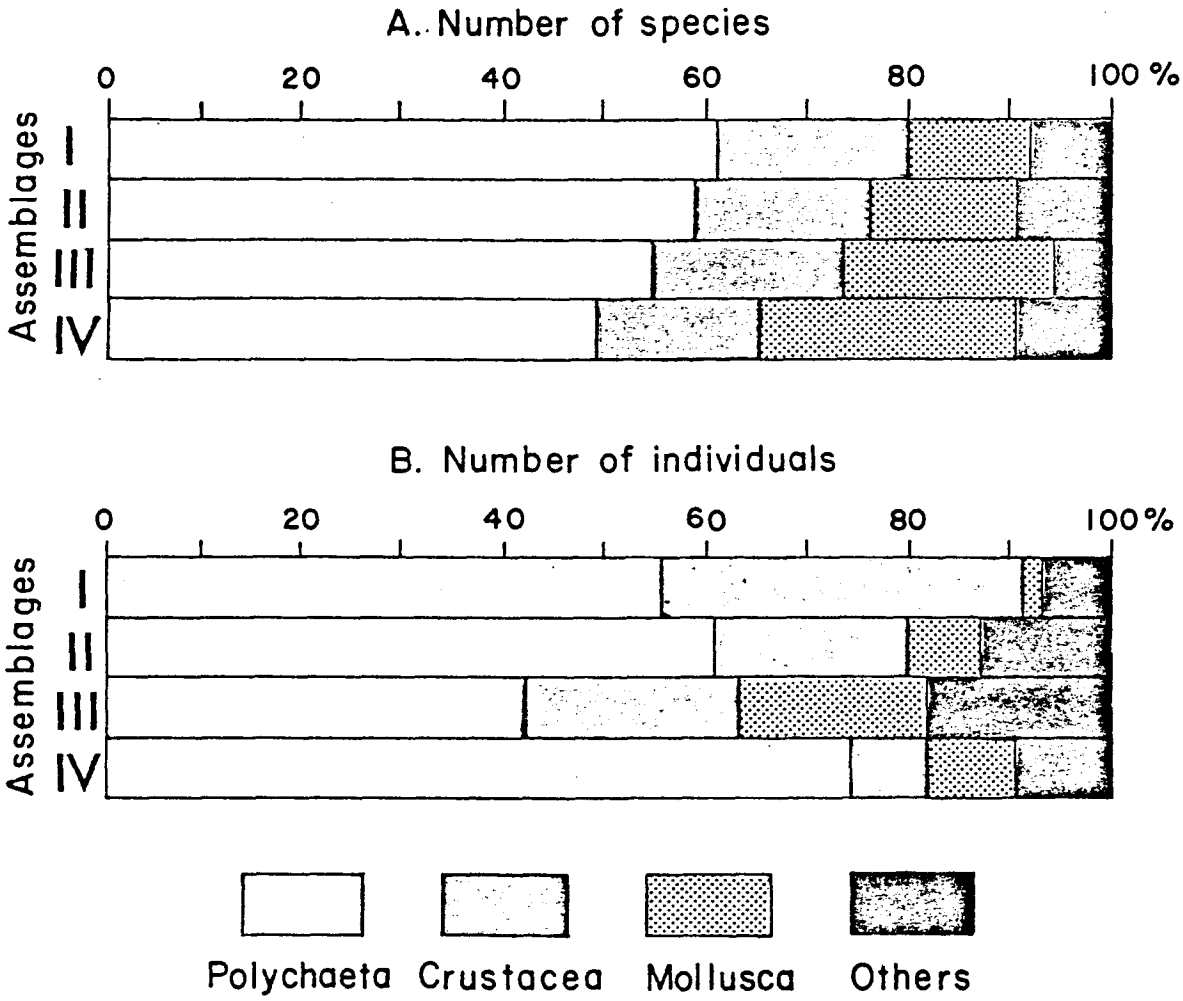


Figure 192. Distribution of macrobenthic infaunal assemblages. Individual assemblages are numbered I-IV.

Table 13. Characteristics of macrobenthic infaunal assemblages in the South Texas OCS

Parameters	Assemblage IV	I	II	III
Av. no. species/0.0125 m^3	18.0909	11.5472	6.8077	6.4576
Av. no. individuals/0.0125 m^3	347.5454	51.1887	11.2692	10.4576
Av. biomass g/0.0125 m^3	10.3882	0.7266	0.3213	0.2457
Av. diversity/0.0125 m^3	2.4400	1.8879	1.6791	1.5717
Av. equitability/0.0125 m^3	0.4727	0.4566	0.6769	0.7237
Av. water depth (m)	58.1812	29.3585	50.3205	96.1525

Table 14. Distribution of species and individuals among the major taxa relative to specific macrobenthic infaunal assemblages.



Assemblage I covers significantly large portions of the ancestral deltas of the Brazos-Colorado and Rio Grande and in the extreme southern sector extends well beyond the 40 m isobath to depths as much as 90 m.

Assemblage I (table 13) has the second largest (average per sample) number of species (11.5), number of individuals (51.2) and biomass (0.7g) of the four assemblages. Only assemblage IV had greater values for each parameter. Of the total number of stations (264), twenty percent (53 stations) were clustered in assemblage I (fig. 191).

The faunal composition of assemblage I (table 14) is characterized by high percentages of polychaetes in terms of both species (61 percent) and individuals (54 percent). Following polychaetes in order of abundance for number of species are crustaceans (19 percent) and molluscs (13 percent). The ranking of other organisms by decreasing number of individuals following polychaetes shows the same trend as species: crustaceans (38 percent) and molluscs (2 percent). Miscellaneous taxa accounted for seven percent or less of the total number of species and individuals.

The five most common species relative to numbers of individuals in descending order are Ampelisca cf. cucullata (Crustacea, Amphipoda), Paraprionospio pinnata (Polychaeta), Nephtys picta (Polychaeta), nereid polychaete, Ampelisca cristoides (Crustacea, Amphipoda). These five species represent 67 percent of the individuals in assemblage I. A total of 88 species were collected from samples comprising the assemblage.

Assemblage II

Similar to assemblage I, assemblage II extends along the entire longitudinal axis of the area, occupying a midshelf position that is generally bounded shoreward by the 40 m isobath. The seaward boundary is both irregular

and eurybathic: in the central sector of the OCS, it approximates the 75 m isobath, but to the north and south on the ancestral deltas the assemblage extends in places to the shelf edge.

The mean values for the biological aspects of assemblage II (table 13) are the second lowest of the four assemblages. The characteristics are (1) number of species, 6.8/0.0125 m^3; (2) number of individuals, 11.3/0.0125 m^3; and (3) biomass, 0.32 g/0.0125 m^3. Approximately 30 percent (79 samples) of the total number of samples are clustered in assemblage II (fig. 191).

The relative percentage of both polychaete species (59 percent) and individuals (63 percent) dominate the faunal composition of assemblage II (table 14). With respect to number of species, crustaceans ranked second (18 percent), molluscs third (14 percent) and other miscellaneous taxa rank fourth (9 percent). Crustaceans make up the second largest group of individuals (16 percent) followed by miscellaneous taxa (14 percent) and molluscs (7 percent).

Relative to numbers of individuals, the five most common species in descending order are Paraprionospio pinnata (Polychaeta), Nephtys picta (Polychaeta), Magelona sp. (Polychaeta), nemerteans (Nemertinea), and Eudorella monodon (Crustacea, Cumacea). In assemblage II, 52 percent of the individuals belong to the five species. A total of 91 species are in assemblage II.

Assemblage III

Assemblage III lies primarily along the outer part of the central sector of the South Texas OCS between the two ancestral deltas. The seaward boundary is the edge of the shelf (limit of area studied); the shoreward boundary is very irregular but approximates the 75 m isobath except in the

southern and northern parts of the OCS. The assemblage also was found at shallower depths in two "patches" in the northern sector of this study area, probably in response to local changes in sediment texture.

Assemblage III has the fewest average number of species (6.5/0.0125 m^3) and individuals (10.5/0.0125 m^3) and the smallest biomass (0.25 g/0.0125 m^3) when compared to the other assemblages (table 13). Of the total 264 samples, 24 percent (63 samples) are clustered in assemblage III (fig. 191).

Polychaetes make up the largest part (55 percent) of the total number of species. They were followed by molluscs (21 percent), crustaceans (18 percent), and other miscellaneous taxa (6 percent). Polychaetes also represent the largest part (42 percent) of the total individuals, followed by crustaceans (21 percent), molluscs (19 percent), and miscellaneous taxa (18 percent).

The five most common species based on numbers of individuals include Diplodonta sp. (Molluscs, Bivalvia), sipunculids (Sipunculida), Ampelisca cf. vera (Crustacea, Amphipoda), Nephtys picta (Polychaeta), and ophiurids (Echinodermata, Ophiuroidea). Only 30 percent of the total individuals from this assemblage belong to these five species. One hundred five (105) species were collected from samples in assemblage III.

Assemblage IV

Assemblage IV has the most inconsistent and smallest areal distribution of the four assemblages (fig. 191). It is located in the southernmost part of the South Texas OCS in a wide range of water depths that extend from the inner to the outer shelf. The inshore boundary could not be determined because of the limitation of the study area. The assemblage is associated with "gravelly substrates" that form low profile shell ridges from place to place across the ancestral Rio Grande delta. Most of the shell ridges are on the inner part of the ancestral delta.

Assemblage IV is the most densely populated and the most diverse (in number of species) of all the assemblages. Mean values for the parameters used to characterize the assemblage (table 13) were relatively very high, including number of species (18.1/0.0125 m^3), individuals (347.5/0.0125 m^3) and biomass (10.4 g/0.0125 m^3). Of the 264 stations studied, four percent (11 stations) were clustered in assemblage IV (fig. 191).

In terms of both species and individuals, polychaetes are most numerous (49 and 74 percent respectively) followed by molluscs (26 and 9 percent respectively). Crustaceans represent 16 and 7 percent, respectively and other miscellaneous taxa represent 9 and 10 percent, respectively, of species and individuals (table 14).

The five most common species in assemblage IV in order of decreasing abundance are Lumbrineris sp. (Polychaeta), a spionid (Polychaeta), Nereis sp. (Polychaeta), Melinna maculata (Polychaeta), and a cirratulid (Polychaeta). The five species make up 38 percent of all the individuals in assemblage IV.

Summary

From the results of a classification by numerical analysis of the data collected, four macrobenthic infaunal assemblages are recognized on the South Texas OCS. In spite of some overlap, a comparison between assemblages indicates that each has a relatively distinct geographic location and a set of biological parameters that include numbers of species and individuals, biomass, and faunal composition.

Assemblage IV in the southern part of the South Texas OCS is the most prolific of the assemblages. In the northern two-thirds of the OCS, the average biological parameters per 0.0125 m^3 decrease systematically seaward across the shelf relative to specific assemblages (Assemblages I-III).

Regional trends are evident in the distribution of macrobenthic infaunal species and individuals among the major taxa relative to assemblages (table 14). Polychaetes are the dominant taxa with regard to both numbers of species and individuals. Seaward, however, polychaete diversity and density generally decrease. In contrast, the diversity and density of molluscs increase significantly as depth of water increases. Crustacean diversity is fairly constant across the shelf, but density decreases as depth of water increases and also decreases in the southern sector of the OCS. In shallow water, the individuals tend to be concentrated in a few species (table 15), particularly in assemblage I, where large numbers of amphipods are common. The individuals generally are spread out among the species assemblages in deeper water and in assemblage IV. The percentage of species common to any two assemblages decreases with increasing spatial separation (table 16).

The only other study that attempted to recognize benthic assemblages on the South Texas OCS was that of Parker (1960). Of the several assemblages he described for the northwestern Gulf of Mexico, three are of particular significance to this study: the intermediate shelf assemblage, 22 to 73 m; the outer shelf assemblage, 73 to 119 m; and the upper continental slope assemblage, 119 to 1,098 m. Parker concluded that the distribution of species followed certain ranges of bottom temperatures and then separated according to major sediment types. His conclusions were based on the distribution of the molluscan fauna. Similar conclusions have been drawn for other parts of the U.S. continental shelf (Cerame-Vivas and Gray, 1966).

The results of this study generally agree with Parker's intermediate and outer shelf assemblages. Differences in sampling technique, density of samples, analysis and the difficulty inherent in determining exact assemblage boundaries in gradational environments, preclude a detailed comparison of the two studies.

Table 15. Percent of individuals found in the most common 5, 10, 15 and 20 species for each macrobenthic infaunal assemblage (e.g., 67 percent of all individuals in assemblage I belong to the five most common species in that assemblage).

	Assemblages			
Most common:	I	II	III	IV
5 species	67	52	30	38
10 species	81	67	49	55
15 species	86	78	51	68
20 species	90	82	60	79

Table 16. Similarity of macrobenthic infaunal assemblages relative to percent of common species

	I	II	III
II	67		
III	47	53	
IV	47	40	47

The differences in the mean values of the biological parameters (table 13) used to characterize benthic assemblages are consistent but small between assemblages II and III. The results may be explained in the biological concept of the ecotone or "boundary effect" where two hibitats overlap: the boundary between the two will be more favorable as a habitat than either type considered alone (Odum, 1959). In the case of assemblage III, the texture of the bottom sediment is similar to that for adjacent assemblages, but the physical oceanographic regime is different. Several studies (Parker, 1960; Berryhill and others, 1976) have provided biological, chemical, sedimentological, and hydrological data that indicate circulation of water from the deep gulf over the outer part of the shelf in the central sector of the study area, causing a change in the environmental conditions. As a result, the mixing of outer shelf and upper slope infauna would increase both the number of species and the density of the fauna.

Factors Controlling Macrobenthic Infaunal Zonation

Spatiotemporal variations in biotic regional distribution patterns can be better understood by determining the factors that control macrobenthic infaunal zonation. Although the study was not designed specifically to identify the factors that control faunal zonation, the variety of environmental aspects measured in the overall investigation (sedimentological, biological, geochemical, hydrological) can be assessed as to their impact on observed biotic zonation. Two general relations are described with regard to their contribution in controlling zonation: interspecific relations; and biologic-geologic-hydrologic relations.

Interspecific relations

The measure of interspecific relations as a controlling factor in macrobenthic infaunal zonation is indicated by the ecological complexity of each community. Highly diverse populations, relatively unique and constant in their composition, are said to exhibit a high measure of interspecific relations. High interspecific relations control to a great extent the biological parameters characteristic of a community.

The infaunal assemblages described are relatively low in taxonomic diversity, have many species in common, and, according to Holland (1976), fluctuate seasonally in composition. This would seem to indicate that interspecific relations are an insignificant factor in the control of macrobenthic infaunal zonation.

Biologic-geologic-hydrologic relations

A series of regression analyses were performed to determine if relations existed between biologic, geologic, and hydrologic parameters. Stepwise regression was used to determine multiple correlation coefficients between individual biological parameters (dependent variables) and various combinations of physical parameters (independent variables) (table 17). The dependent variables included number of species, number of individuals, and biomass; independent variables used were sand/mud ratios, mean grain size, standard deviation of grain size, and depth of water.

All the biological parameters correlated best with the sand/mud ratios. However the correlations are significant but only fair because the maximum variation explained was 30 percent. As additional independent factors were introduced into the analysis, only depth of water made a significant increase in the percentage of variation explained (44 percent).

Table 17. Stepwise regression analysis for biological parameters versus physical parameters

Dependent Variable	Independent Variable(s)	Multiple Correlation Coefficient
1	4, 5, 6, 7	0.5217
1	4, 5, 7	0.5200
1	4, 7	0.5076
1	4	0.4200
2	4, 5, 6, 7	0.6710
2	4, 5, 7	0.6707
2	4, 7	0.6606
2	4	0.5378
3	4, 5, 6, 7	0.5871
3	4, 5, 7	0.5870
3	4, 7	0.5795
3	4	0.5260

Explanation of variables:

1 - No. of species
2 - No. of individuals
3 - Biomass
4 - Sand-mud ratio
5 - Mean grain size
6 - Standard deviation
7 - Water depth

The correlations might be poorer than expected if the regional distribution maps for the various parameters are compared. Part of the explanation lies in the absence of a strict linear relationship between the biological parameters and the physical parameters (particularly water depth), probably precipitated by the ecotone phenomenon. Poorer correlations may also have resulted from the variability inherent in the small samples taken from a large and diverse population.

The average values for three biological parameters were calculated for various classes of sand/mud ratios (table 18) and depths of water (table 19). These two physical parameters were selected because of their apparent influence in controlling macrobenthic infaunal zonation in the study area as indicated by statistical analysis (table 17) and visual comparison of the regional distribution maps for the various parameters (figs. 147, 148, 150, 153, 154, 155 and 191). The number of species, number of individuals, and biomass increased with increasing sand/mud ratios. The most significant increase occurred where the sand/mud ratios exceeded 1.00.

One of the most important aspects of water depth to biological communities is changes in bottom-water temperature with increasing depth. The importance of water temperature in controlling the distribution of benthic fauna is generally accepted. The impact of bottom-water temperature on zonation of infauna within the study area was emphasized by Parker (1960). For this study, water temperature data were collected from XBT (expendable bathythermograph) casts made at 128 of the 264 bottom grab stations (fig. 193). For the winter of 1974, bottom-water temperatures reflect seasonal temperatures to about midshelf with the bottom of the seasonal layer at about 70 m (fig. 194). These results agree with Parker (1960), who showed that at a depth of approximately 73 m the average winter and summer bottom-water temperatures are the same;

Table 18. Some biological parameters of the South Texas OCS relative to sand/mud ratios (macrobenthic infauna/0.0125 m^3)

Parameters	Sand/Mud Ratios		
	<0.12	0.12-1.00	>1.00
No. of samples	158	69	23
Av. no. species	6.10	9.93	13.04
Av. no. individuals	14.78	26.72	82.78
Av. biomass (g)	0.10	0.64	8.14

Table 19. Some biological parameters of the South Texas OCS relative to water depth (macrobenthic infauna/0.0125 m^3)

Parameters	Water Depth (m)				
	0-40	41-80	81-120	121-160	161-220
No. of samples	87	105	42	14	7
Av. no of species	9.97	6.80	5.29	5.53	6.86
Av. no. of individuals	37.29	10.96	7.07	7.00	12.57
Av. biomass (g)	2.48	1.24	0.31	0.11	0.23

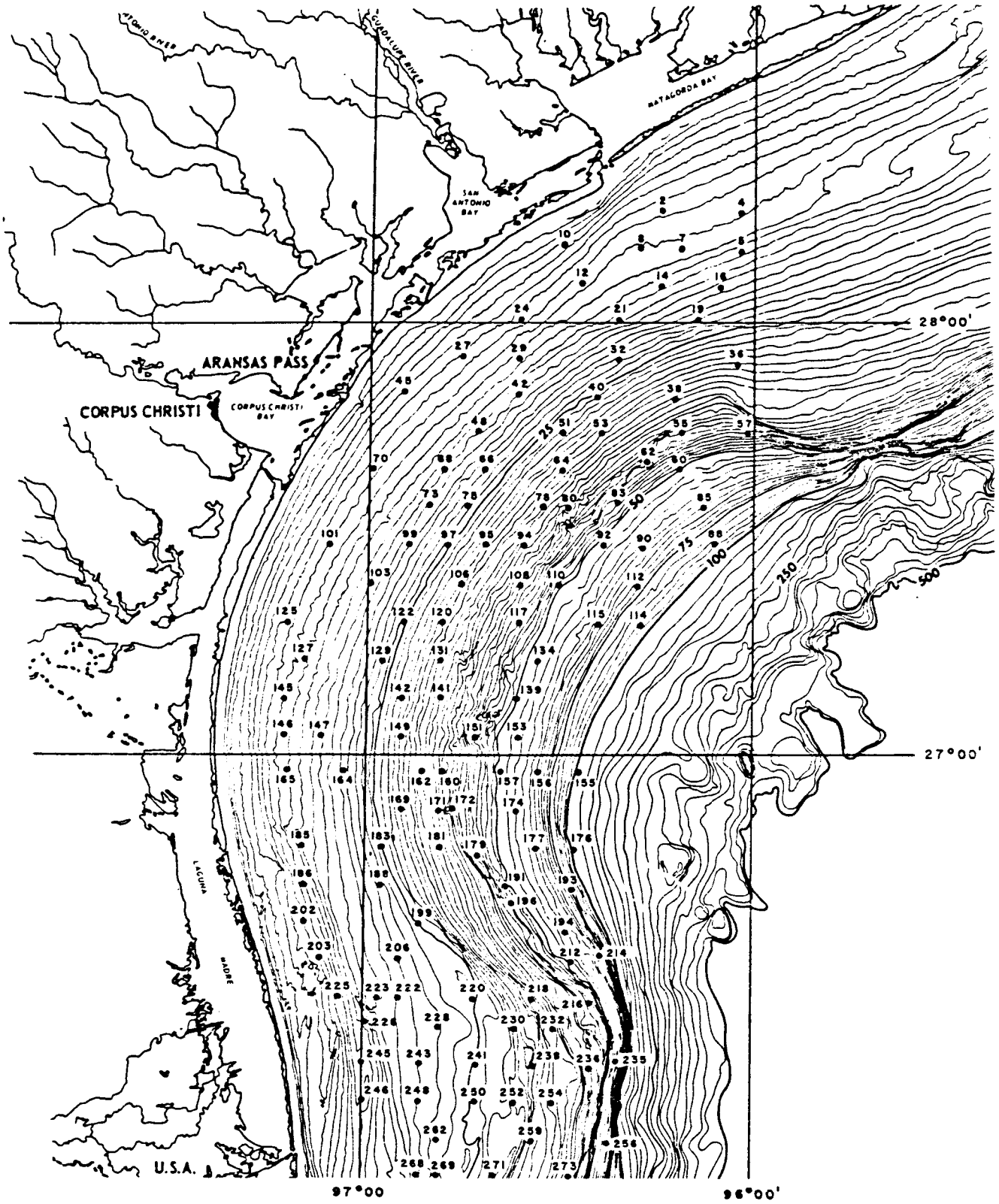


Figure 193. Location of XBT stations.

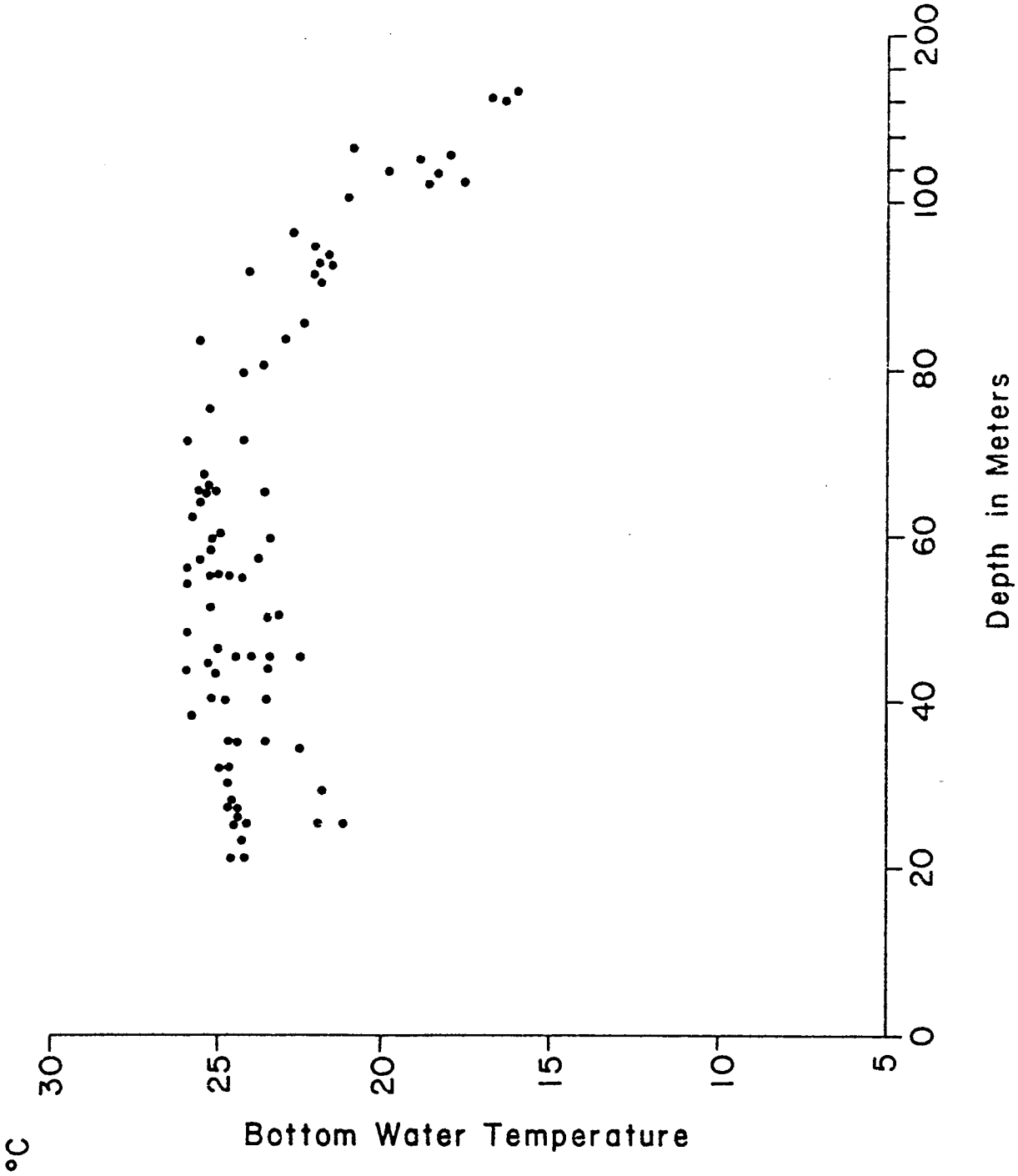


Figure 194. Winter bottom-water temperatures on the South Texas OCS.

inshore of that depth the winter and summer bottom-water temperatures differ, reflecting water mixing to the bottom (fig. 195). There is some indication in Parker's report that seasonal temperatures might be slightly reflected to depths as great as 110 m. In this study the magnitude of the biological parameters decreases to about 120 m. Seaward of that depth, a reversal in trend occurs, with the biological parameters increasing. The correlation of assemblage boundaries with the bottom of the seasonal water temperature layer and the increase in the magnitude of biological parameters in depths of relatively constant bottom-water temperatures stresses the importance of water depth and bottom-water temperatures in controlling macrobenthic infaunal zonation.

Discussion and summary

Some knowledge of the factors that control zonation is important in classifying the assemblages observed. Depending on the slope of environmental gradients and complexity of the communities involved, communities have been classified generally in other studies as discrete, discontinuous or continuous gradations of one species assemblage into another (Gleason, 1939; Mills, 1969). When environmental parameters are gradational, communities tend to be gradational as well (Beals, 1969). On the continental shelf, where parameters such as temperature, salinity, light, etc., tend to vary in a continuous fashion, benthic communities on clastic substrates tend to be continuous and intergrading (Sanders and Hessler, 1969).

Another factor in classifying assemblages is the ecological complexity of the community. Communities characterized by low species diversity and fluctuation in composition under the direct impact of the physical environment are classified as immature or low grade; those characterized by high diversity

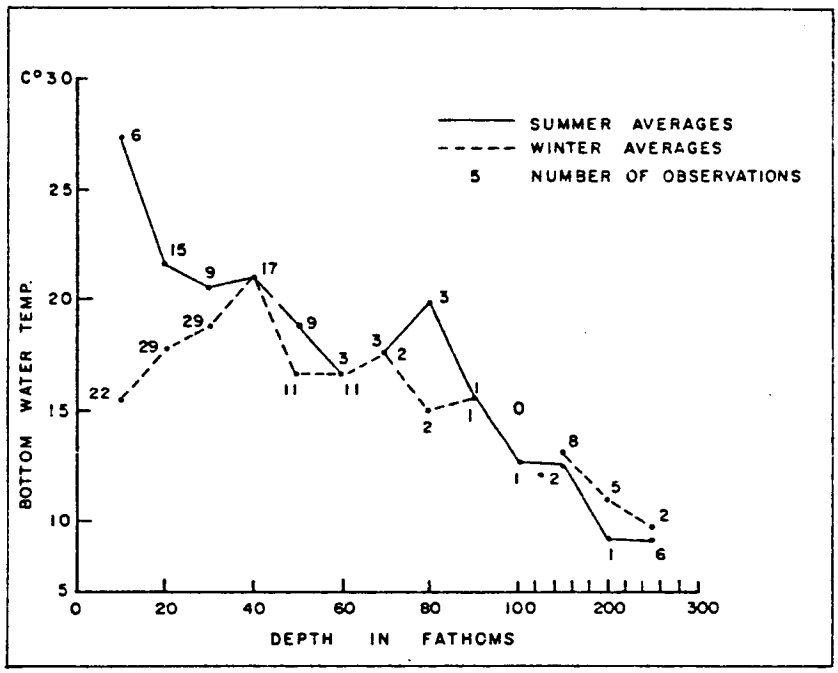


Figure 195. Comparison of summer and winter average bottom-water temperatures in the northern Gulf of Mexico (1951-1955) (from Parker, 1960, after Springer and Bullis, 1956)

and a relatively constant composition are mature or high grade communities (Margalef, 1957). Sanders (1968) classifies or grades communities in a similar manner. His concepts are physically controlled (low grade) and biologically accomodated (high grade) communities. Biologically accommodated communities evolve when physiological stresses are low for short periods of time. As physiological stress increases because of an increase in fluctuating or unfavorable physical conditions, a gradual change in the community takes place from a predominantly physically controlled community. In these classifications, assemblages with high interspecific relations are termed high grade or biologically accommodated while those with low interspecific relationships are termed low grade or physically controlled.

The results of this study indicate that: interspecific relations were low; biologic-geologic-hydrologic interrelations were high; environmental gradients were generally continuous; and the level of ecological complexity was relatively low. Consequently, assemblages on the South Texas OCS are classified as continuous, low grade and physically controlled. This classification agrees with Johnson (1971), who views the nature of shallow water marine benthic communities as "low-grade communities, largely controlled by the physical environment."

Biogenic Sedimentary Structures

Biogenic sedimentary structures on the South Texas OCS result from the interaction of geologic and biologic processes and are useful in sedimentologic and overall environmental interpretations of Holocene processes and events. As defined by Frey (1973), biogenic sedimentary structures are those "structures produced in the sediment by the activity of organisms upon or within an unconsolidated particulate substrate."

The general term used to discuss biotic activity in unconsolidated sediments is bioturbation. The majority of biogenic sedimentary structures are the result of bioturbation (burrows, trails, and other animal activities that modify the original deposit).

The bioturbation structures vary in type, size, and orientation and reflect variations in infaunal diversity, density, and behavior. Burrows are the most common bioturbation structure. Large burrows are commonly indicated by burrow walls or by infilling of sediment; smaller burrows are commonly seen only on X-ray radiographs. Intense burrowing destroys the original grain-size relationships in the sediment as well as the depositional layering.

Two aspects of bioturbation that are of importance to this study are (a) zonation of biogenic sedimentary structures and (b) spatiotemporal variations within this zonation. The distribution and variability of bioturbation were determined by studying the radiographs of the pipe cores and box cores taken as a part of the geologic studies (fig. 196) over a 2 year period. The extent and magnitude of bioturbation in the 74 cores collected during the first year are shown by Berryhill and others (1976, figs. 48-58). The results of similar analyses of the cores collected during the second year are shown along with the sedimentary descriptions by figures 93 through 100 in this report. In addition the density or degree of bioturbation by percent estimate in the cores was related to subsurface depth increments of 0 to 25 cm, 25 to 75 cm, 75 to 125 cm, and greater than 125 cm to see if changes in the amount of bioturbation with depth might indicate changes in the nature and distribution of infaunal assemblages with time.

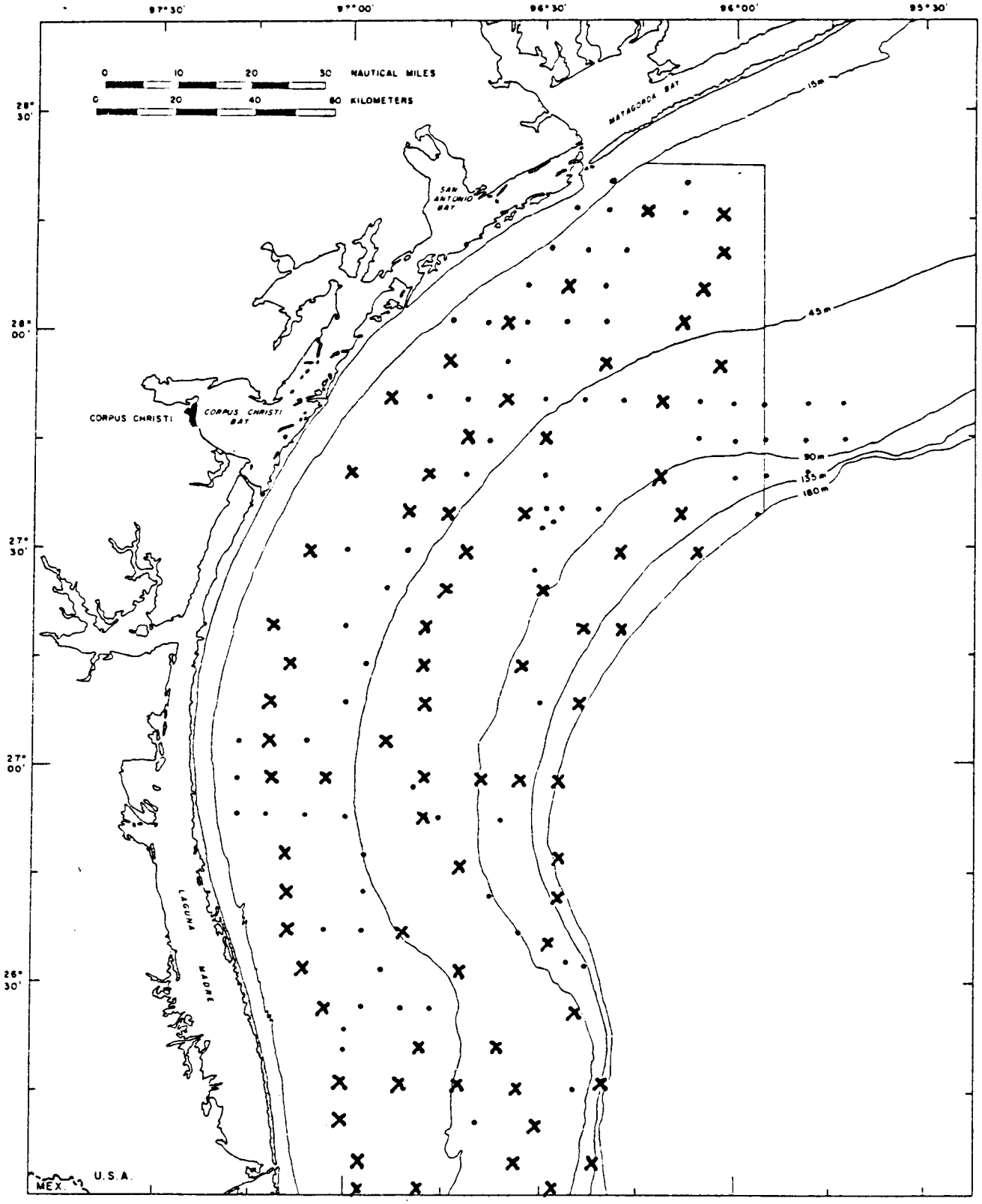


Figure 196. Locations of pipe core and box core stations. (•) pipe core only; (x) pipe core and box core.

Zonation of biogenic sedimentary structures

Zonation of biogenic sedimentary structures is related to macrobenthic infaunal assemblages and sediment facies. The zonation can be defined in terms of distribution, density, and diversity.

The regional distribution map of bioturbation in the upper 25 cm of all pipe cores (fig. 197) shows that the intensity of bioturbation generally decreases seaward and that surficial sediments of the ancestral deltas of the Brazos-Colorado and Rio Grande Rivers show a high degree of bioturbation.

Assemblages of biogenic sedimentary structures (ichnocoenoses) (fig. 198) were studied by dividing the study area latitudinally into thirds. Changes with water depth within each sector were also noted. The majority of biogenic sedimentary structures are the result of burrowing by polychaetes and crustaceans.

Zonation of biogenic sedimentary structures (fig. 197) generally parallels macrobenthic infaunal zonation (fig. 192). Substrates having relatively high diversity and density of biogenic sedimentary structures are associated with macrobenthic infaunal assemblages locally characterized by more species and individuals, and larger biomass. Infaunal assemblages with these characteristics are in shallow water and on both ancestral deltas.

Comparison of the regional distribution maps, indicates that a significant correlation seems to exist between the zonation of biogenic sedimentary structures (fig. 197) and the physical characteristics of the sediments (figs. 150, 151 and 152). Diversity and density of biogenic sedimentary structures decrease as mean grain size decreases; mean grain size generally decreases as water depth increases.

To define the apparent correlations just discussed, regression analysis for bioturbation (dependent variable) versus various biological and physical

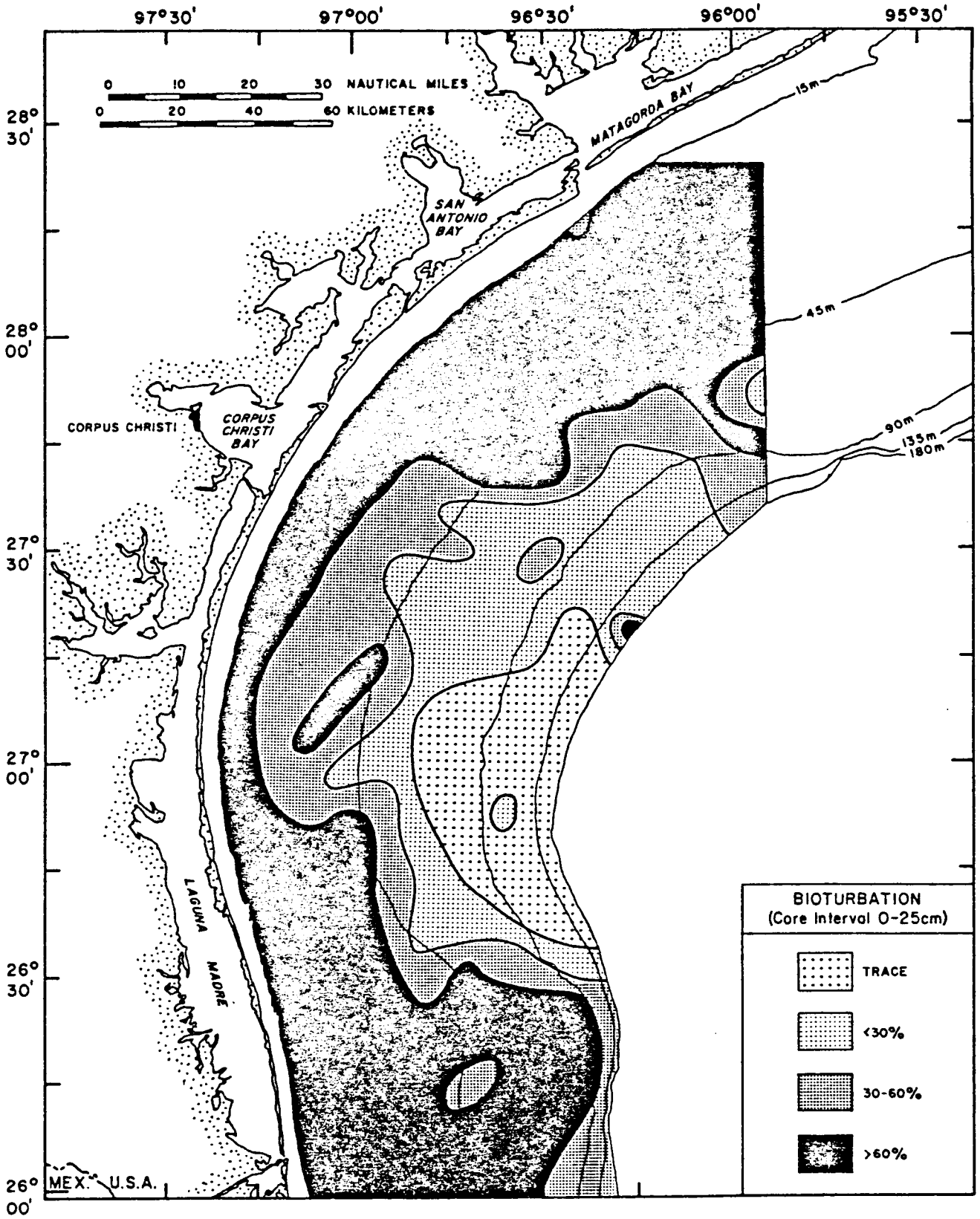
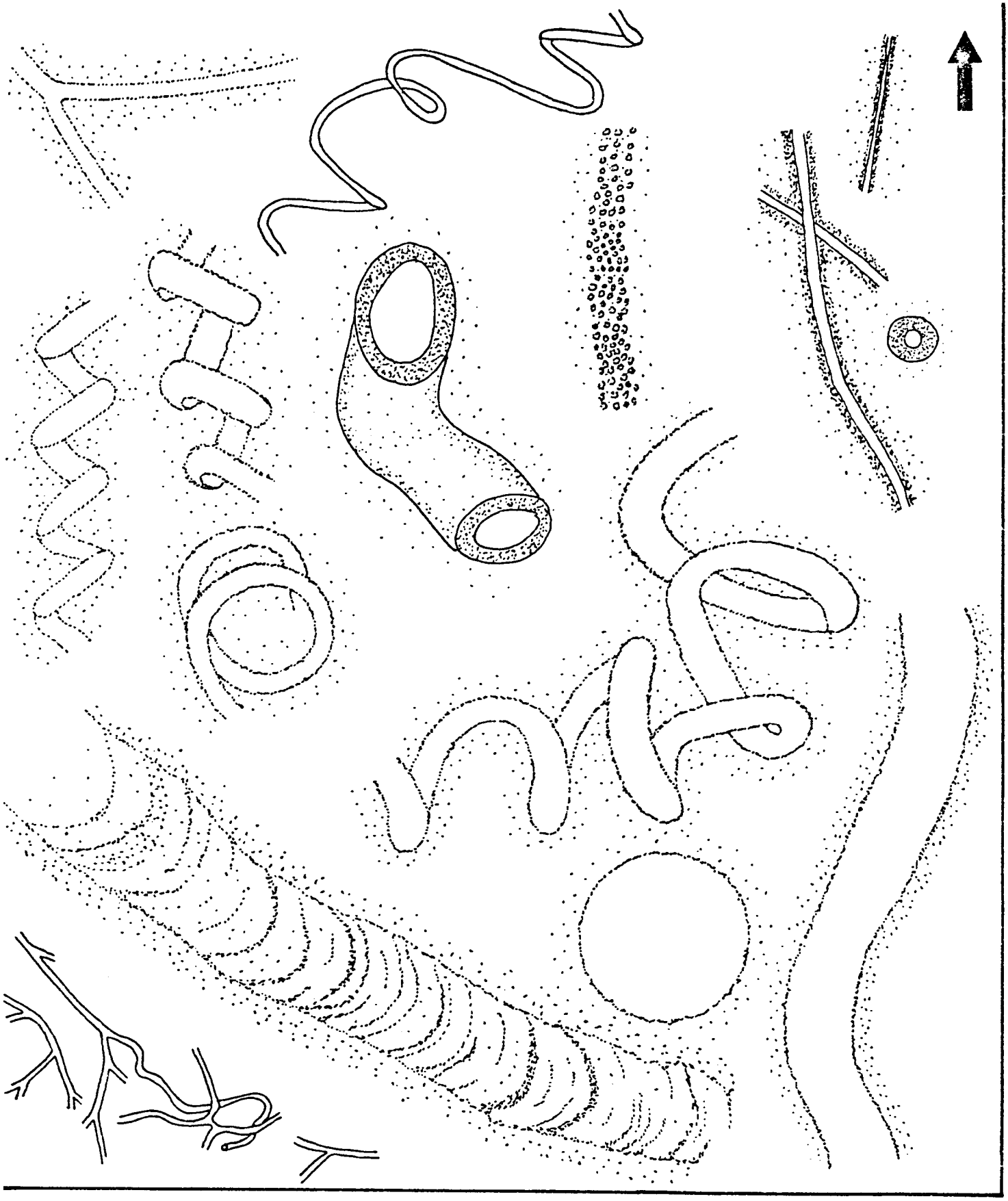


Figure 197. Bioturbation in the upper 25 cm of pipe cores.



gure 198. Examples of biogenic sedimentary structures observed in radiographs of box core slabs. Structures represent various types of animal burrows.

parameters (independent variables) was performed (table 20). In making these calculations, the several classes of bioturbation intensity (based on percentage estimate) were given an arbitrary value (trace = 1, less than 30 percent = 2, 30 to 60 percent = 3, greater than 60 percent = 4). In the broadest perspective, the degree of bioturbation correlates best with water depth; as water depth increases, bioturbation decreases. As other physical and biological aspects are introduced into the analysis, the correlation improves; mean grain size of the sediment is the most significant addition. This analysis, which explains almost 70 percent of the variation observed in bioturbation, helps to emphasize the magnitude of the interrelations that exist between biologic-geologic-hydrologic processes on the South Texas OCS.

In summary, the diversity and density of biogenic sedimentary structures generally decrease across the shelf as a result of macrobenthic infaunal assemblages becoming less dense and diverse locally and substrate becoming muddier or finer grained with increasing water depth. Biogenic structures may be thought of as the biological signature in the depositional record of a sedimentary province. As such, they are extremely useful in defining environments of deposition, in determining the extent to which original textural relations within a sediment have been altered by burrowing organisms, and in predicting the extent to which pollutants might become concentrated in sea floor sediments as a result of infaunal activity.

Spatiotemporal variations in zonation of biogenic sedimentary structures

The extent of bioturbation was mapped for deeper core intervals (25 to 75 cm; 75 to 125 cm; >125 cm) to determine if changes in the spatial distribution of bioturbation have occurred through time (figs. 199-201). The maps indicate that with passage of time, areas of greater than 60 percent

Table 20. Stepwise regression analysis for bioturbation versus biological and physical parameters

Dependent Variable	Independent Variable(s)	Multiple Correlation Coefficient
8	1, 2, 3, 4, 5, 6, 7	0.8179
8	1, 2, 4, 5, 6, 7	0.8176
8	1, 4, 5, 6, 7	0.8153
8	1, 4, 5, 7	0.8104
8	1, 5, 7	0.8054
8	5, 7	0.8004
8	7	0.7608

Explanation of variables:

1 - No. of species
2 - No. of individuals
3 - Biomass
4 - Sand-mud ratios
5 - Mean grain size
6 - Standard deviation
7 - Water depth
8 - Bioturbation

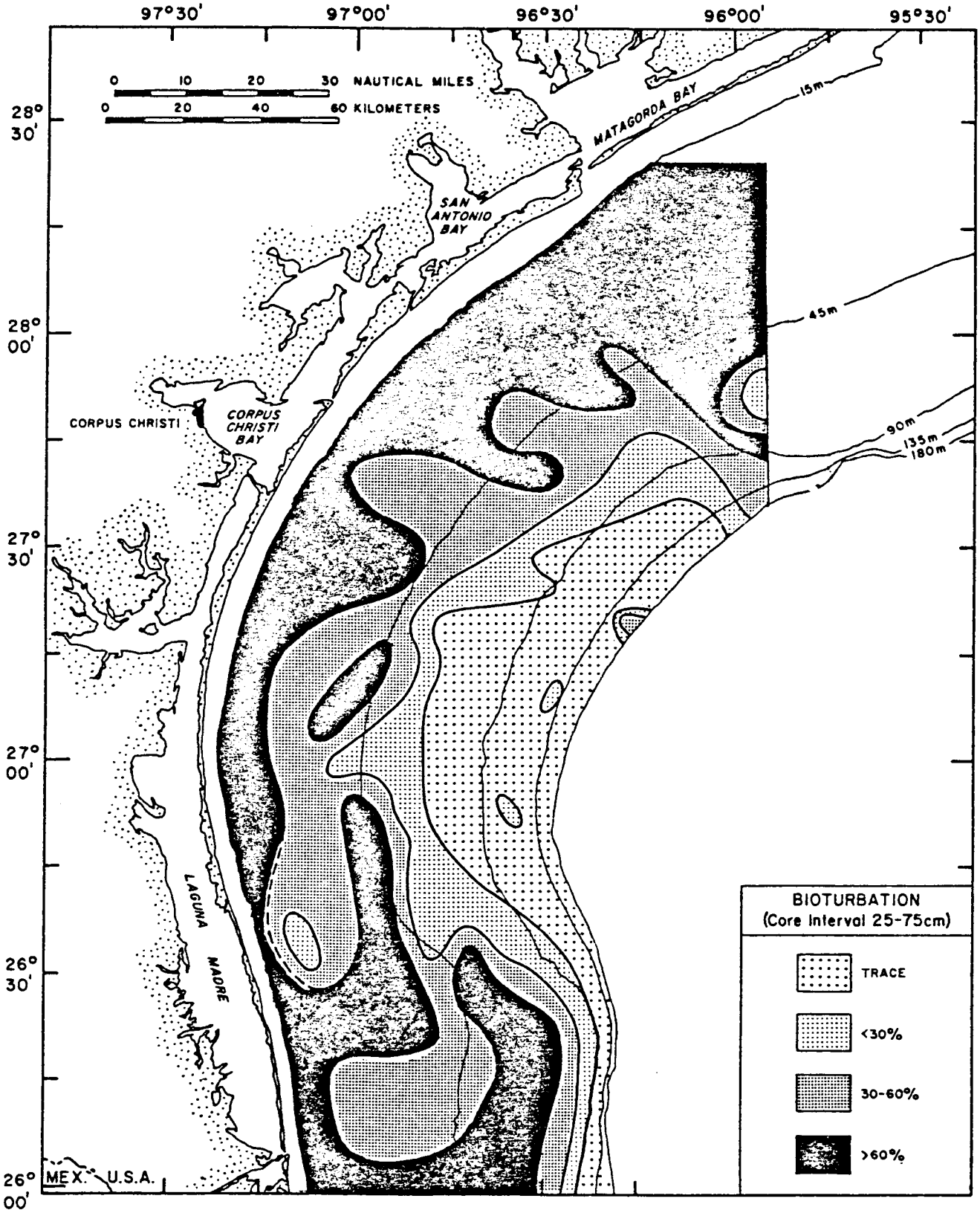


Figure 199. Bioturbation in the pipe core interval 25 to 75 cm.

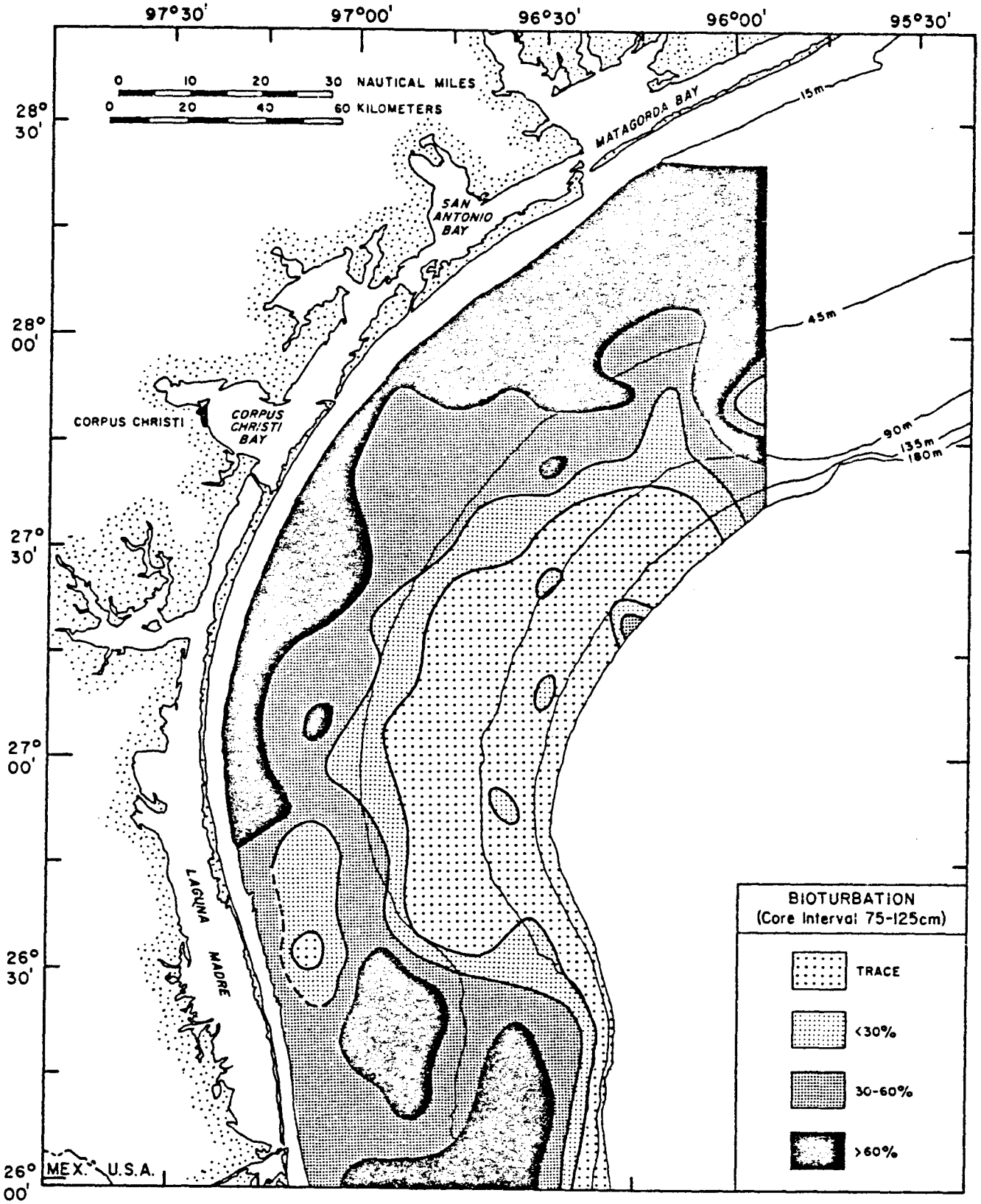


Figure 200. Bioturbation in the pipe core interval 75 to 125 cm.

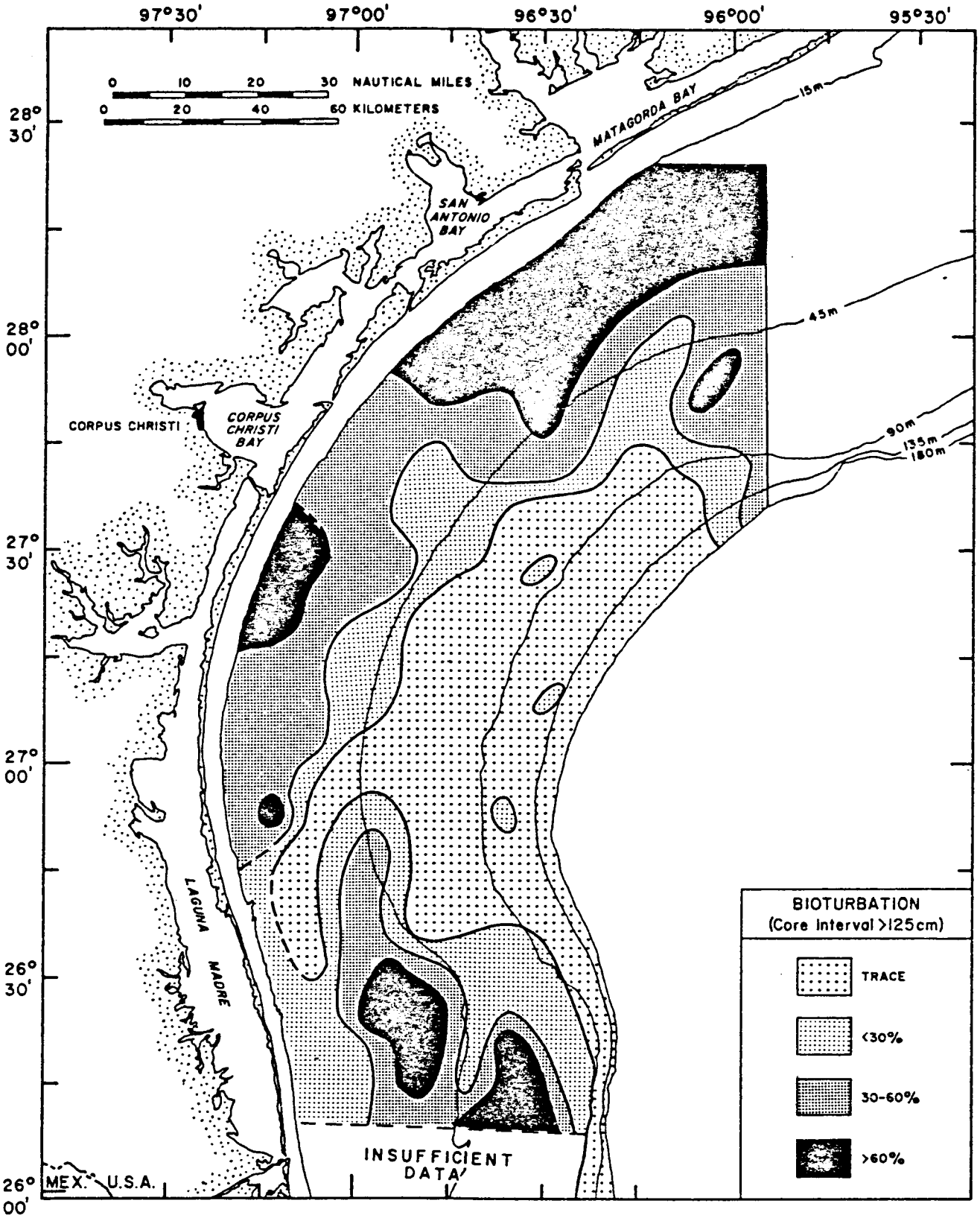


Figure 201. Bioturbation in the pipe core interval greater than 125 cm.

bioturbation have increased in size, whereas areas of little bioturbation have diminished. Although the variation in bioturbation is significant, the general regional pattern of distribution indicated by the upper 25 cm (fig. 197) has remained basically unchanged; the intensity of bioturbation generally decreases as water depth increases, and the central sector of the study area has little bioturbation relative to other parts of the OCS.

The spatiotemporal variations in bioturbation may be interpreted relative to changes in biological and physical processes during the time interval represented by the length of the pipe cores. According to Berryhill and others (1976), the "sediments obtained in the longer pipe cores would seem to represent an average of approximately 2000 to 2500 years." Both the time estimate and the interpretations of the spatiotemporal variations are tentative and subject to change after further study.

Determination of the original diversity and density of fossil assemblages is virtually impossible using biogenic sedimentary structures alone; however, the structures do permit at least an estimation of the assemblages involved (Frey, 1971). The observed variation in bioturbation through time could indicate changes in macrobenthic infaunal zonation. If this were true, a variation in diversity and composition of ichnocoenoses would accompany density changes, using the correlation between recent zonations of infaunal assemblages and bioturbation as a guide. The cores indicate that the most significant change has been in the density of bioturbation and not in the diversity, composition, or zonation of ichnocoenoses. This would imply little change in macrobenthic infaunal zonation but at least minor change in the physical processes.

Our study has shown that intensity of bioturbation correlates best with changes in water depth and sediment texture. Changes in these physical

parameters in the past could have produced the observed variation in bioturbation. For the study area in general, ample evidence (position of barrier islands and reefs for example) indicates little, if any, change in water depth during the last few thousand years.

Changes in sediment texture might explain the variation in bioturbation. In the upper 25 cm of sediment, bioturbation was most dense in areas of relatively high sand/mud ratios. If sand were more limited in areal distribution in the older Holocene sediment, a decrease in the density of bioturbation might be expected. The relative areal distribution of the sand and mud facies in the cores (fig. 202) indicates however, that sands are more widely distributed in the cored sediments than in the recent surficial sediments (Berryhill and others, 1976).

Review of the distributional and spatiotemporal variations of the biological and physical parameters indicates a correlation to the amount and extent of bioturbation, suggesting that the variations in density of bioturbation through time are caused by changes in the rate of sediment deposition. The overall increase in the density of bioturbation in the younger Holocene sediments probably is caused by a slight relative decrease in rates of deposition within the study area, particularly in the central part of the shelf. The conclusion is supported by results of the rates of sedimentation studies discussed elsewhere in this report, which indicate that the lowest rate of sedimentation during the past 150 years has been in the central part of the shelf. (See figures 234 and 235.) Furthermore, data on the overall thickness of the Holocene sequence reported by Berryhill and others (1976) indicate that the current area of low sedimentation previously had a much higher rate of sedimentation.

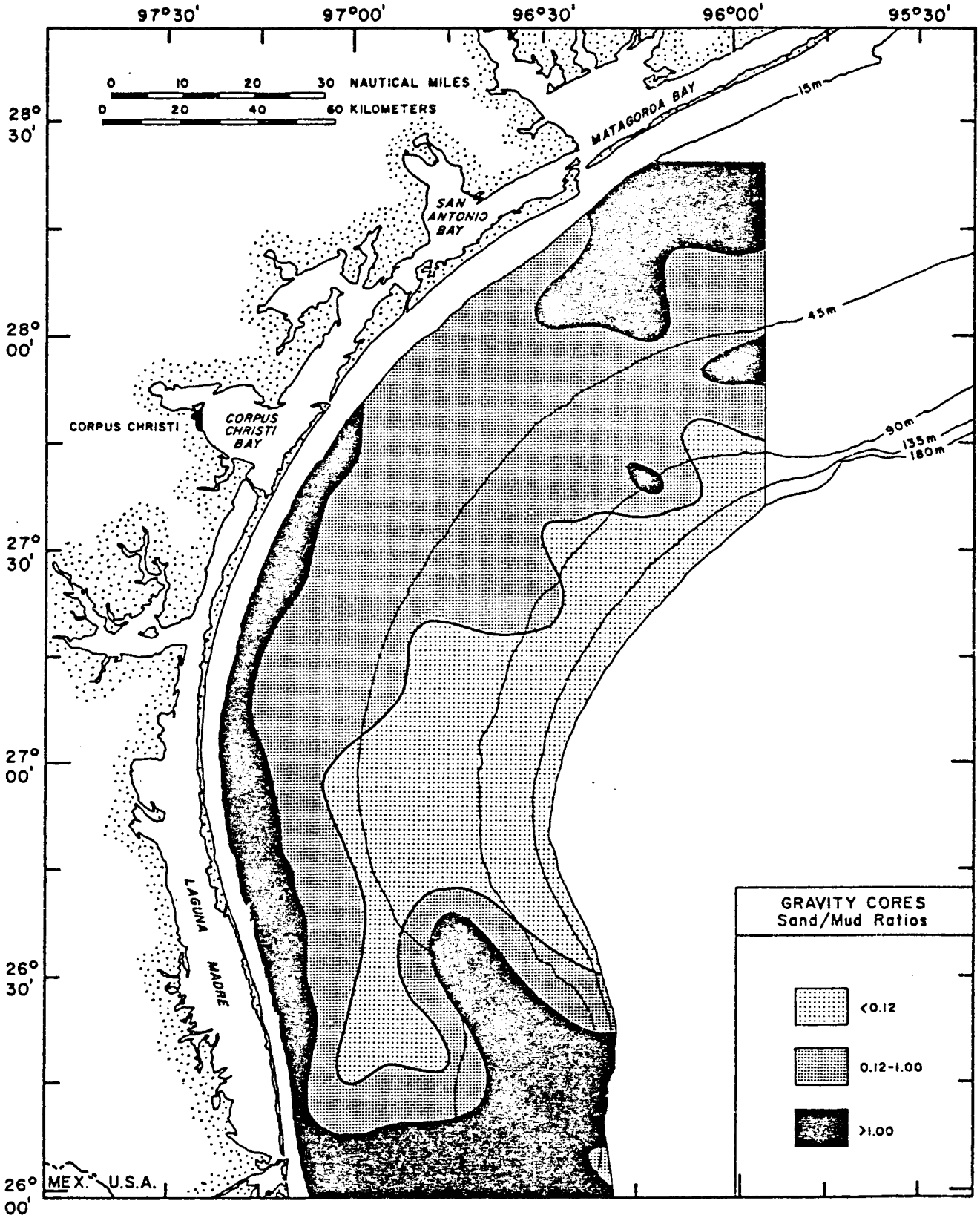


Figure 202. Sand/mud ratios in the pipe cores (modified from Berryhill and others, 1976).

Summary

1. The South Texas OCS is not homogeneous relative to distribution patterns of biological components. Generally, numbers of species and individuals and amount of biomass decrease with increasing water depth. Equitability increases across the shelf as water depth increases. The central sector has fewer dense and diverse populations locally than do the general areas of the ancestral Rio Grande and Brazos-Colorado deltas to the south and north.
2. Four macrobenthic infaunal assemblages in the study area can be defined relative to species distribution and density and relative to biogenic sedimentary structures. The most dense and diverse assemblage (IV) is located in the southern third of the study area, while assemblages near the shelf edge in the central sector are lowest in density.
3. Polychaeta, Crustacea, and Molluscs are the dominant infaunal taxa. As water depth increases, the relative percentage of polychaete species and individuals decreases. In contrast, the number of mollusc species and individuals increases seaward. The number of crustacean species shows minor fluctuations across the shelf; the number of crustacean individuals significantly decreases with increasing water depth, primarily because of a large reduction in number of amphipods.
4. Biologic-geologic-hydrologic relationships are more important in controlling macrobenthic infaunal zonation than are interspecific relationships.
5. Overall, macrobenthic infaunal zonation on the South Texas OCS is best described as continuous, low grade, and physically controlled. Water depth and sediment texture seem to be particularly important in controlling infaunal zonation.

6. Bioturbation ranges systematically from very great to very little. Diversity and density of biogenic structures decrease as mean grain size decreases and water depth increases.
7. Zonation of biogenic sedimentary structures generally parallels macrobenthic infaunal zonation and can be defined in terms of diversity, density, and distribution. Substrates with relatively high diversity and density of biogenic sedimentary structures are associated with macrobenthic infaunal assemblages characterized by larger numbers of species and individuals and a larger biomass. Distribution patterns of bioturbation are useful in identifying spatiotemporal variations in macrobenthic infaunal zonation.

Implications

Regarding offshore petroleum development on the South Texas OCS, the following environmental implications relative to the results of this study may be noted:

1. The impact by man on infaunal populations would be greatest in shallow water and in the general area of the ancestral deltas of the Brazos-Colorado and Rio Grande Rivers because these are areas with the greatest standing crop of infaunal invertebrates.
2. Vertical mixing of the sediment is most rapid in sectors of the OCS where infaunal activity is greatest. Any pollutants introduced into those areas will be worked downward into the sediments more readily. Consequently the potential for long-term retention and higher concentration of pollutants is increased.

If future studies indicate any significantly large seasonal changes in the infaunal composition and distribution, the statements above would have to be modified.

LATE QUATERNARY GEOLOGIC HISTORY OF THE SOUTH TEXAS CONTINENTAL SHELF

by

Carroll A. Pyle and Henry L. Berryhill, Jr.

INTRODUCTION

Study of more than 13,000 km of high-resolution seismic-reflection profiles offers some insight into the late Quaternary geologic history of the south Texas continental shelf and indicates the principal factors that have controlled the patterns of sedimentation and geologic development during Holocene time. Four seismic-stratigraphic units bounded by four prominent sound reflectors of regional scope have been mapped. The sequence of sediments involved extends downward to about 300 m beneath the sea floor. Correlation of the seismic stratigraphic units to published data from the Phillips Continental Offshore Stratigraphic Test COST) No. 1 well, drilled off Brownsville, Texas, permits identification of the major glacial events and the effects of sea level fluctuations on the extent and thickness of the late Quaternary deposits.

The shallow subsurface geology of the south Texas shelf has received little attention except for the work of Berryhill and others (1976). This study is an amplification of that work and offers both interpretations based on additional data in order to arrive at a late Quaternary geologic history for the region and delineation of the principal Holocene geologic features.

MATERIALS AND METHODS

Collection of Seismic Data

The data used in this study consist of over 13,000 km of high-resolution seismic-reflection profiles. Some 4,170 km of these profiles were obtained aboard the R/V H.J.W. FAY by the U.S. Geological Survey, Office of Marine Geology in Corpus Christi, Texas, at no cost to the BLM. The remaining profiles (8,860 km) were obtained from the Conservation Division of the U.S. Geological Survey in Metairie, Louisiana. Because of the density of profiles collected during the two surveys, the track coverage of each survey is shown on separate figures (figs. 203 and 204). Specific information concerning the two systems is given in table 21.

Table 21. Components of the high-resolution seismic profiling equipment

	ACOUSTIPULSE (Conservation Div., USGS)	U.S.G.S. Survey (Geologic Div.)
Acoustic source	Acoustipulse	Del Norte Model 561 sparker
Output	1000 or 1500 joules	700 joules
Source depth	3 m	3 m
Hydrostreamer	---	EG&G Model 262j
Hydrostreamer depth	3 m	3 m
Recorder	EPC Model 4100	EPC Model 4100
Amplifier	internal	Model 502A Del Norte analog signal processor
Filtering band	400 hz-20 kHz	60-1,000 Hz
Fix mark interval	305 m	305 m

The USGS profiles, recorded at a 1.0 second sweep speed, provided penetration to about 400 m subbottom with optimum resolution of sedimentary

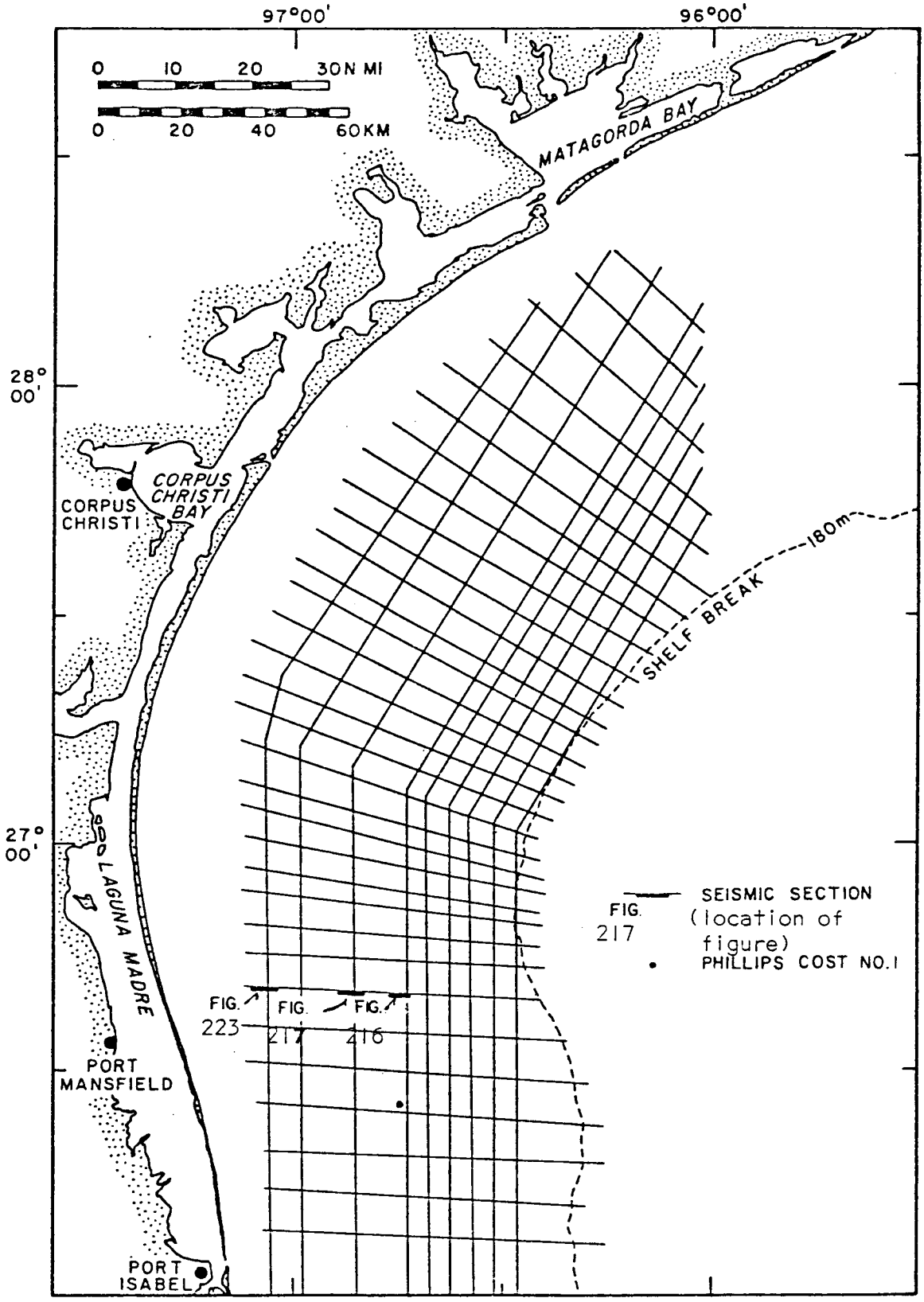


Figure 203. ACOUSTIPULSE survey line coverage.

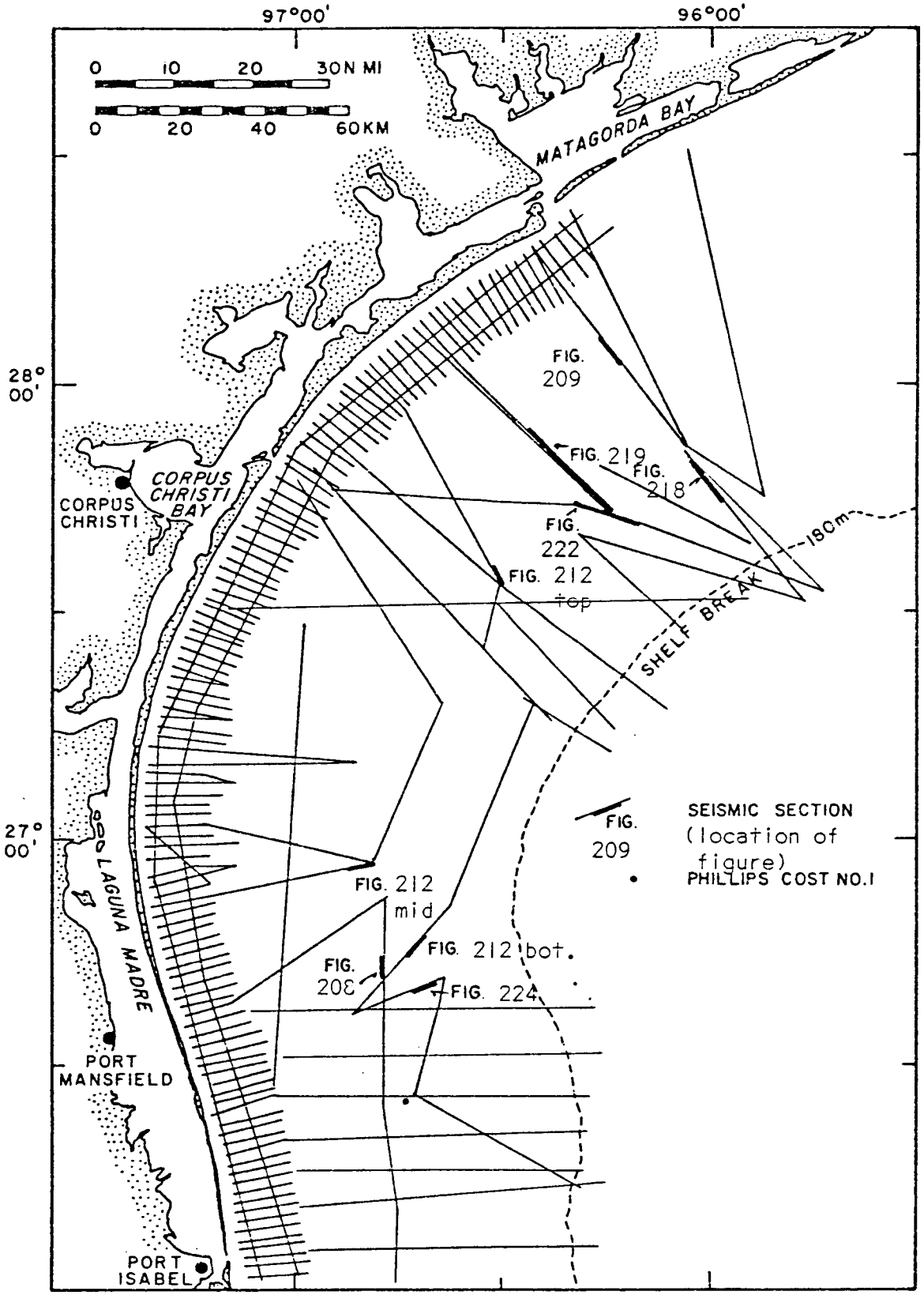


Figure 204. USGS survey line coverage.

units as thin as 4.5 m. The ACOUSTIPULSE data, recorded at a 0.25 second sweep speed, allowed penetration to only about 75 m subbottom but provided resolution of sedimentary units as thin as 1.5 m.

Navigation aboard the R/V H.J.W. FAY was accomplished using LORAC radiopositioning providing an accuracy of ±15 m. The ACOUSTIPULSE survey used RADIST radiopositioning accurate to ±15 m. Fix marks or shot points were recorded on the records at 305 m intervals for both surveys. The fix mark locations were post plotted on a scale of 1:96,000, and the geologic features were recorded on these maps.

Seismic Interpretation

The first step in the compilation and interpretation process was the delineation of the salient geologic structures, such as the folds and faults that have affected the upper 0.4 seconds of the sediment column. As the profile traverses were spaced several miles apart, the individual faults, though numerous, could not be correlated with confidence from one traverse to another.

The reflecting surfaces (reflection peaks) of regional persistence were assumed to be geologically significant and were mapped. The sediments bounded by the major reflectors, or sediments with persistent internal reflection patterns, were classed in a stratigraphic sense as reflection units (Meisburger and Field, 1976). The four reflection units mapped individually are illustrated by both isopach (thickness) and structural contour maps. The isopachous data are presented in milliseconds (msec) of two-way travel time, and the structural contour data are presented in two-way travel time below sea level.

The chronologic framework for the reflection units was established by correlating the regional reflectors with the stratigraphic units

identified and dated in the Phillips Continental Offshore Stratigraphic Test (COST) No. 1 well. Kahn and others (1975) reported a velocity profile below 340 m subbottom for the Phillips COST No. 1 well, which indicated a velocity of approximately 1700 m/sec at a depth of -340 m. As the study described herein is concerned with the section above -340 m, the velocity at -340 (1700 m/sec) was assumed to be a maximum for the overlying interval, and a profile above this level was constructed using the equation modified from Lehner (1969): $V + 1555 + .5z$, where V is the velocity of sound in meters per second and z is the depth below the sea floor in meters.

The nature of the sound analog patterns within a reflection unit can be used to infer the type of sediment and the depositional processes involved. Sangree and others (1976) employed this technique on the upper slope of the northern Gulf of Mexico and defined six types of seismic facies which corresponded to six types of sedimentary or depositional facies. Their conclusions were based on interpretations of high-resolution seismics and study of twenty-nine 1,000-ft bore holes placed along the profiles.

SEISMIC STRATIGRAPHY

The four major reflecting surfaces used to delineate the four seismic-stratigraphic units have been designated by letters A, B, C, D, and the stratigraphic units between them by numbers 1, 2, 3, 4. The interpreted stratigraphic relations of the four reflectors and the reflecting units across the shelf are shown by the profiles in figures 205 and 206. The location of the profiles is shown by figure 207.

The uppermost unit (4) includes all sediments above the stratigraphic position of Reflector A. As indicated on figures 205 and 206, Reflector A merges with Reflector B both on the inner and outer parts of the shelf, so

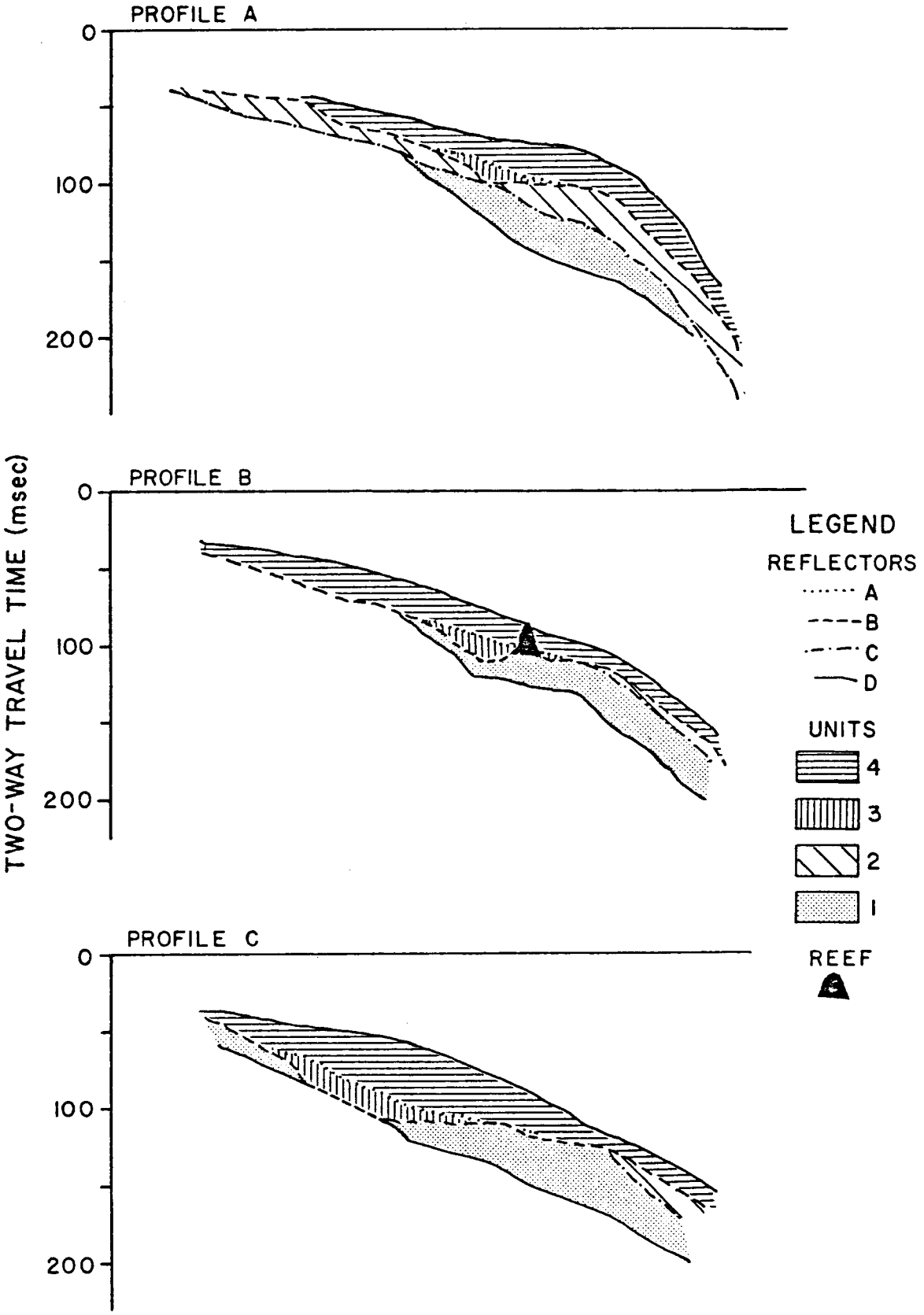


Figure 205. Seismic stratigraphy, northern half of the south Texas OCS. See figure 207 for location of profiles.

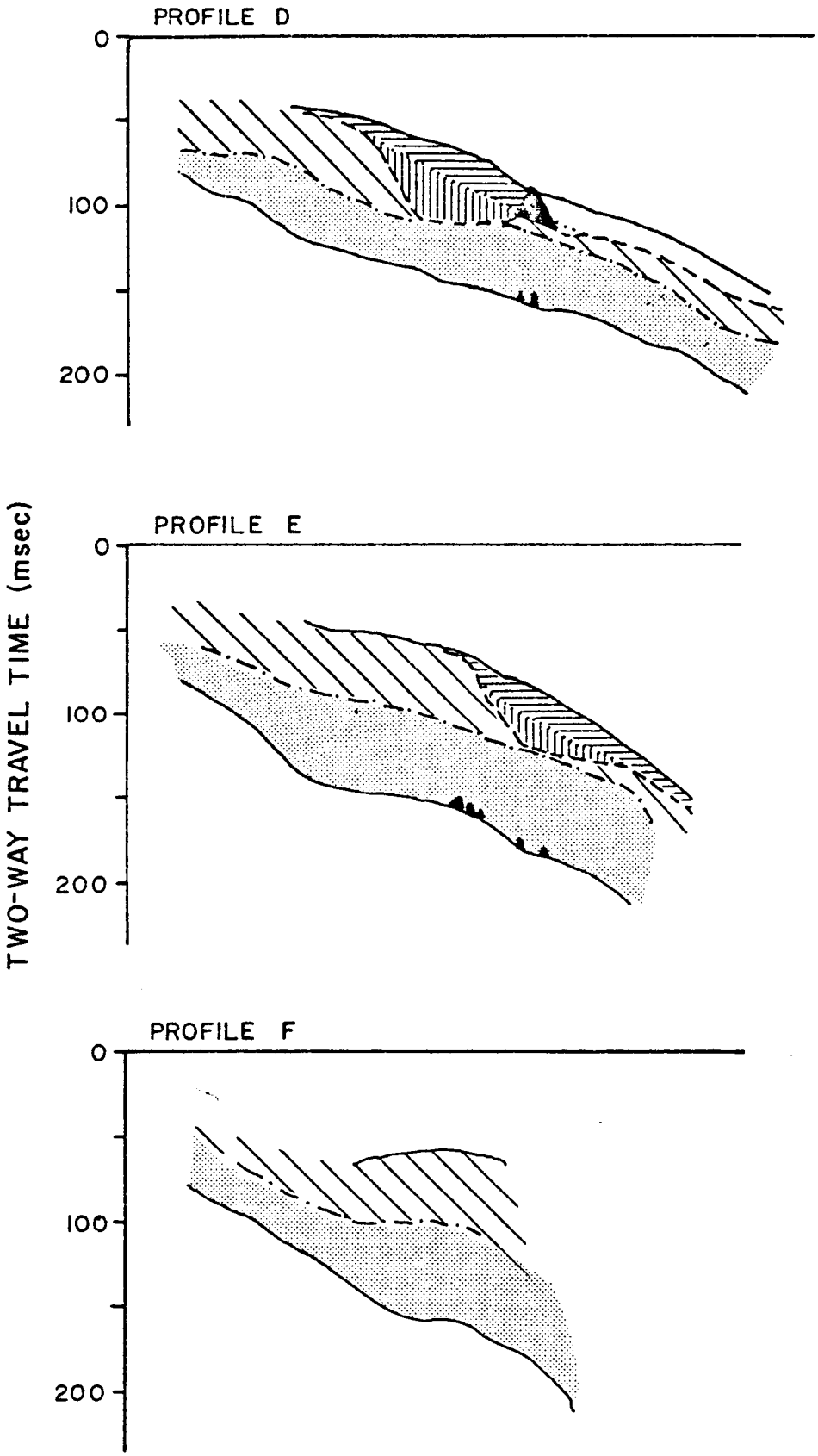


Figure 206. Seismic stratigraphy, southern half of the South Texas OCS. See figure 205 for legend and figure 207 for location of profiles.

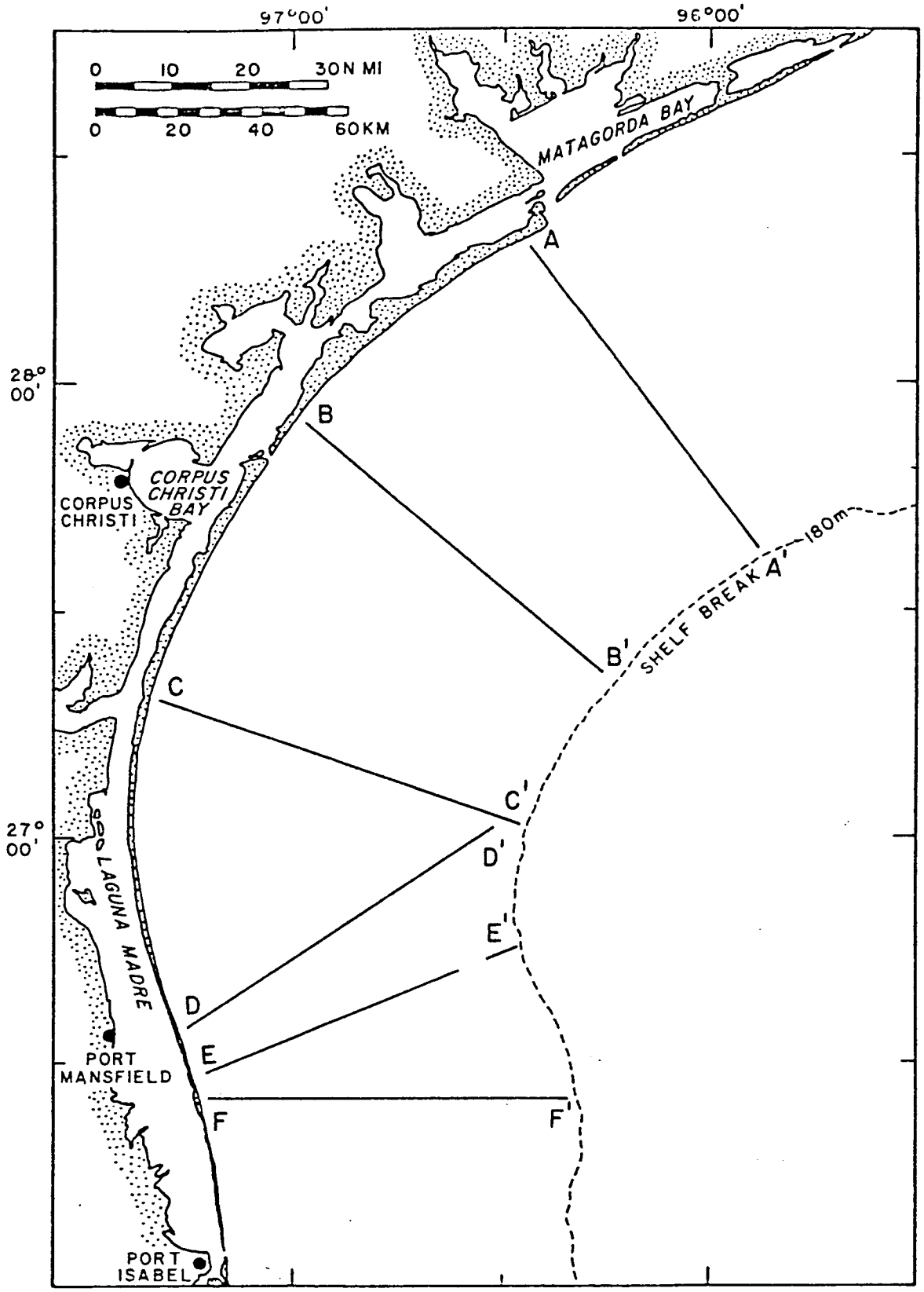


Figure 207. Location of seismic stratigraphic profiles shown by figures 205 and 206.

that the base of Unit 4 in those areas is defined by Reflector B. The sediments making up Unit 4 have a typically transparent reflection pattern in most areas, but locally the reflection pattern is low amplitude discontinuous reflection peaks on the sound analog. The stratigraphic position of Unit 4 and its analog sound pattern are shown by figure 208. The reflection peaks are generally parallel and onlapping on the central and inner shelf. On the inner shelf, where Unit 4 overlies Reflector B directly, the base of the unit is delineated in many areas by extensive channeling (fig. 209). The onlapping of sediments in Unit 4 over the underlying erosional surface indicates that Unit 4 was deposited during a transgressive rise of sea level.

Unit 4 is thickest in the central and northeastern parts of the South Texas OCS (fig. 210). It thins abruptly southward and is generally thicker at midshelf than along the outer part of the shelf except in the northeastern part of the South Texas OCS. Shoreward and to the south, the base of the unit lies within 8 msec of the sea floor and is masked by the bubble pulse.

The structural contour map on the base of Unit 4 (fig. 211) indicates a relatively gentle gradient from approximately the 40 to 120 msec contour lines; the gradient then increases rather sharply seaward. The area where the base of Unit 4 is defined by Reflector A also is shown by figure 211. Reflector A is very indiscrete and was picked over most of the study area on the basis of its position relative to subsurface benches or terraces on the buried flanks of most of the reefs that lie along the outer shelf (fig. 212). The merger of Reflector A and Reflector B coincides with the change in gradient along Reflector B that represents a buried erosional surface. (See Profiles A and B on fig. 205.) Obviously, Reflector A represents a stratigraphic position that connects erosional features, yet

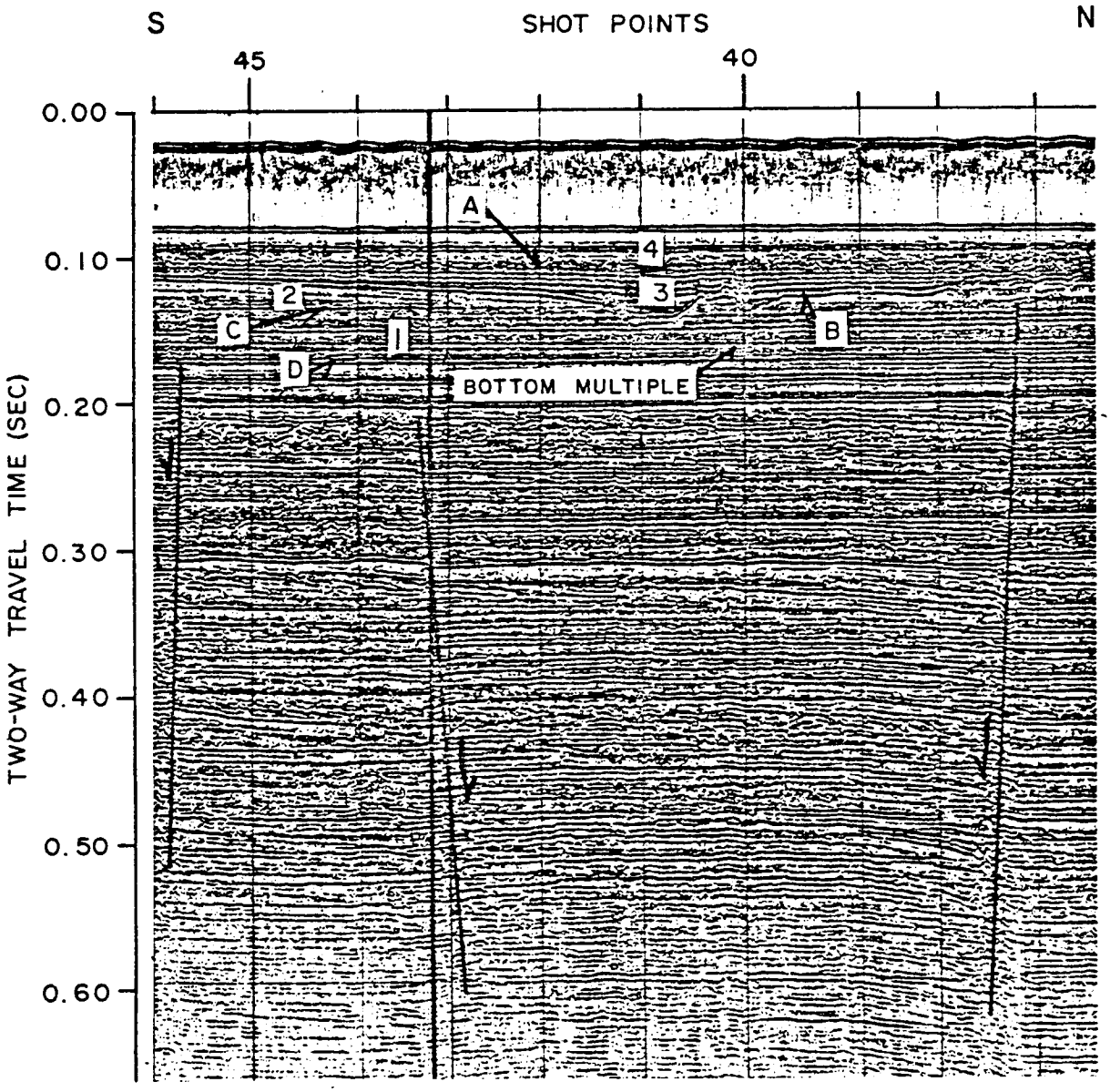


Figure 208. Sparker profile showing difference in reflection patterns between Units 3 and 4. Vertical exaggeration = 10x.

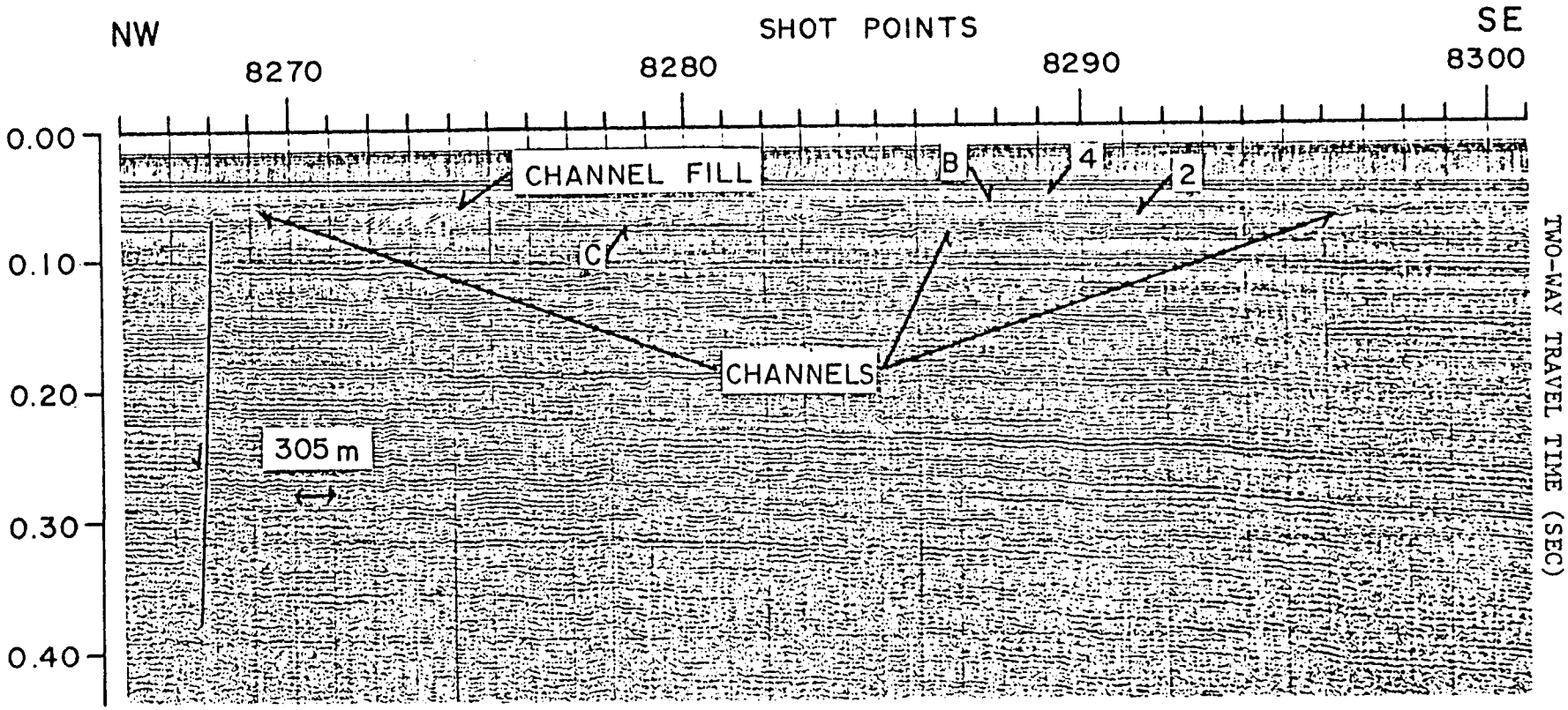


Figure 209. Sparker profile showing channeling associated with Unit 4. Vertical exaggeration = 12.5x.

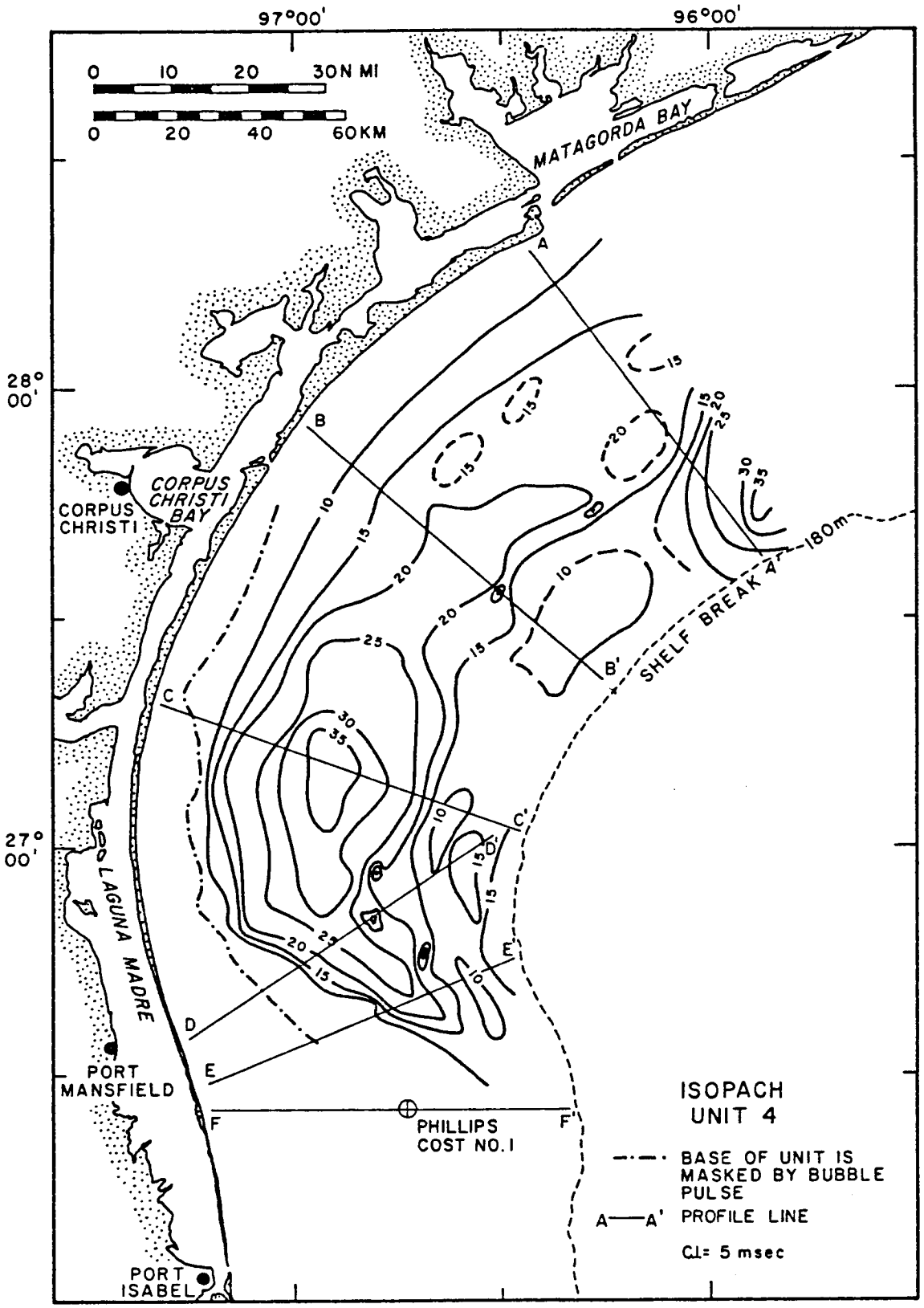


Figure 210. Isopach map of Unit 4.

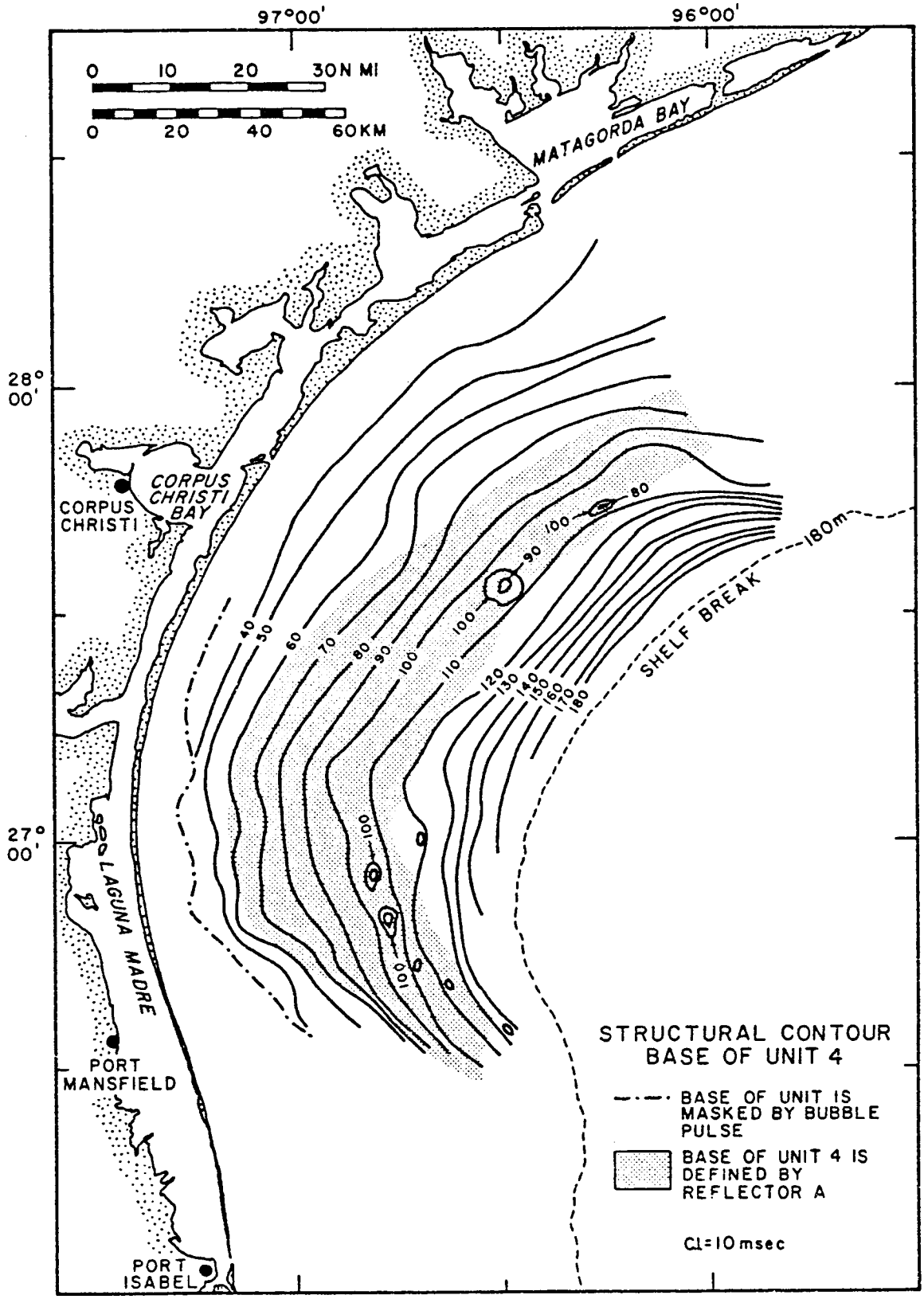


Figure 211. Structural contour map on base of Unit 4. Shaded area indicates where base of Unit 4 is coincident with Reflector A.

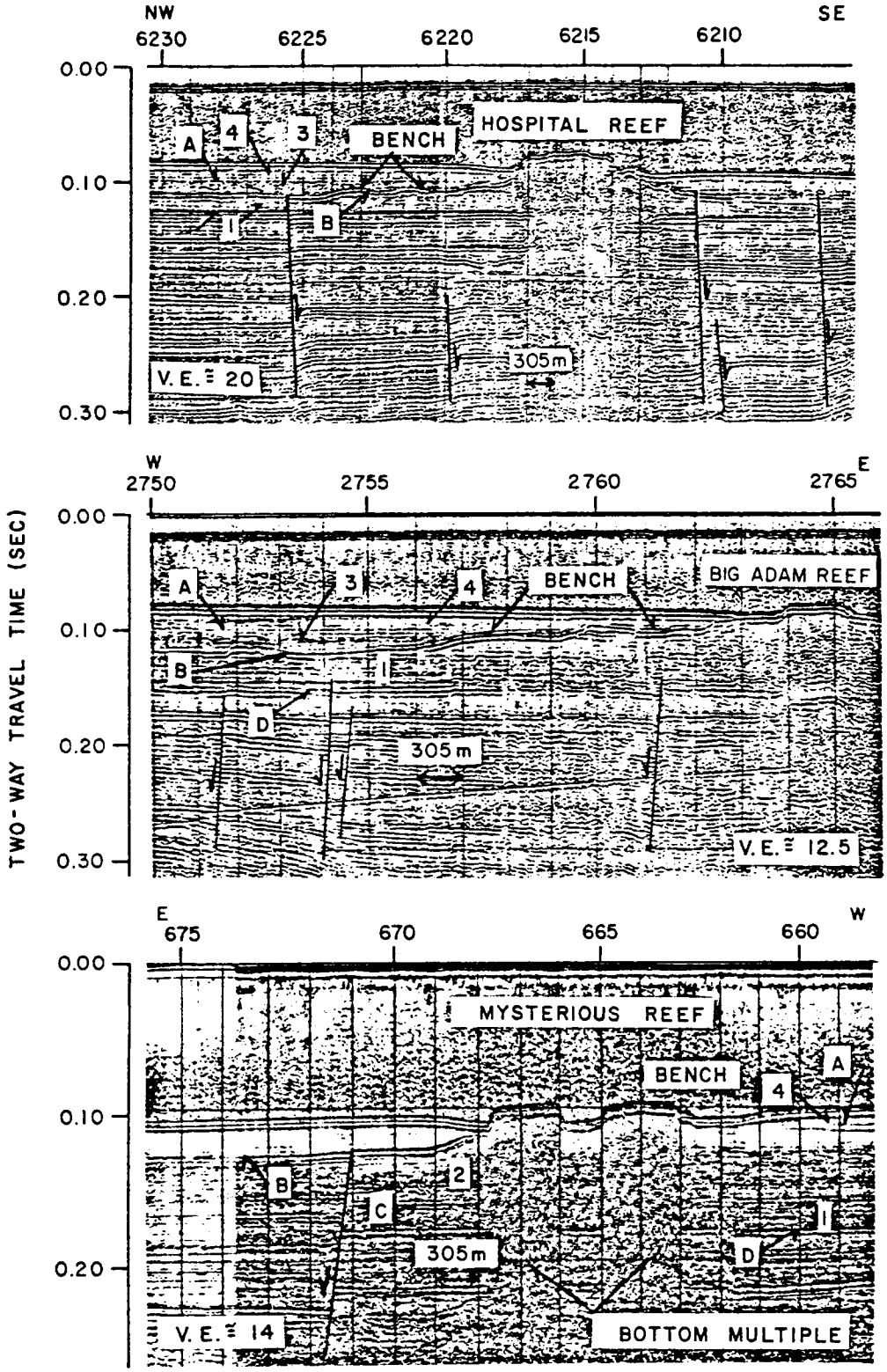


Figure 212. Sparker profile showing benches or terraces on the buried flanks of reefs.

the seismic reflection patterns above and below Reflector A are mutually parallel and appear conformable. Reflector A probably represents a static sea level that produced both surf-planed terraces on Reflector B along the shoreline and benches on the topographically high reefs offshore.

Unit 3, the next unit stratigraphically beneath Unit 4, is made up of the sediments between Reflectors A and B (figs. 205 and 206). Unit 3 is restricted mainly to the central part of the shelf (fig. 213). The thickest part of Unit 3 is in the south-central sector of the study area where the reflection pattern consists of widely-spaced, high-amplitude, parallel reflection peaks (fig. 208) that become more thinly-spaced and lower in amplitude northward. In the northern part of the South Texas OCS, the unit is difficult to distinguish from the overlying unit, and seaward of the reefs, it cannot be differentiated from Unit 4.

Figure 214 is a structural contour map on Reflector B, which marks the base of Unit 3. This reflecting horizon was first described by Berryhill and others (1976) and is his Reflector A. It is easily recognized in the sound analogs both by its characteristically high-amplitude reflection peak (fig. 208) and by the discordance of the sound signatures above and below it. The reflector is coincident with a major angular unconformity that represents the position and geographic extent of an ancient land surface. As shown by the structural contours, a broad terrace is defined by the 110 and 120 msec contours and, when compared to the thickness map for Unit 3 (fig. 213), it is apparent that the sediments of Unit 3 filled in this area in response to a transgressing sea. The reefs also lie on this terrace. The position and nature of the actual surface beneath the reefs cannot be determined because of the acoustic wipeout caused by the hard upper surface of the carbonate reefs. As Reflector B represents an erosional unconformity, a geologic

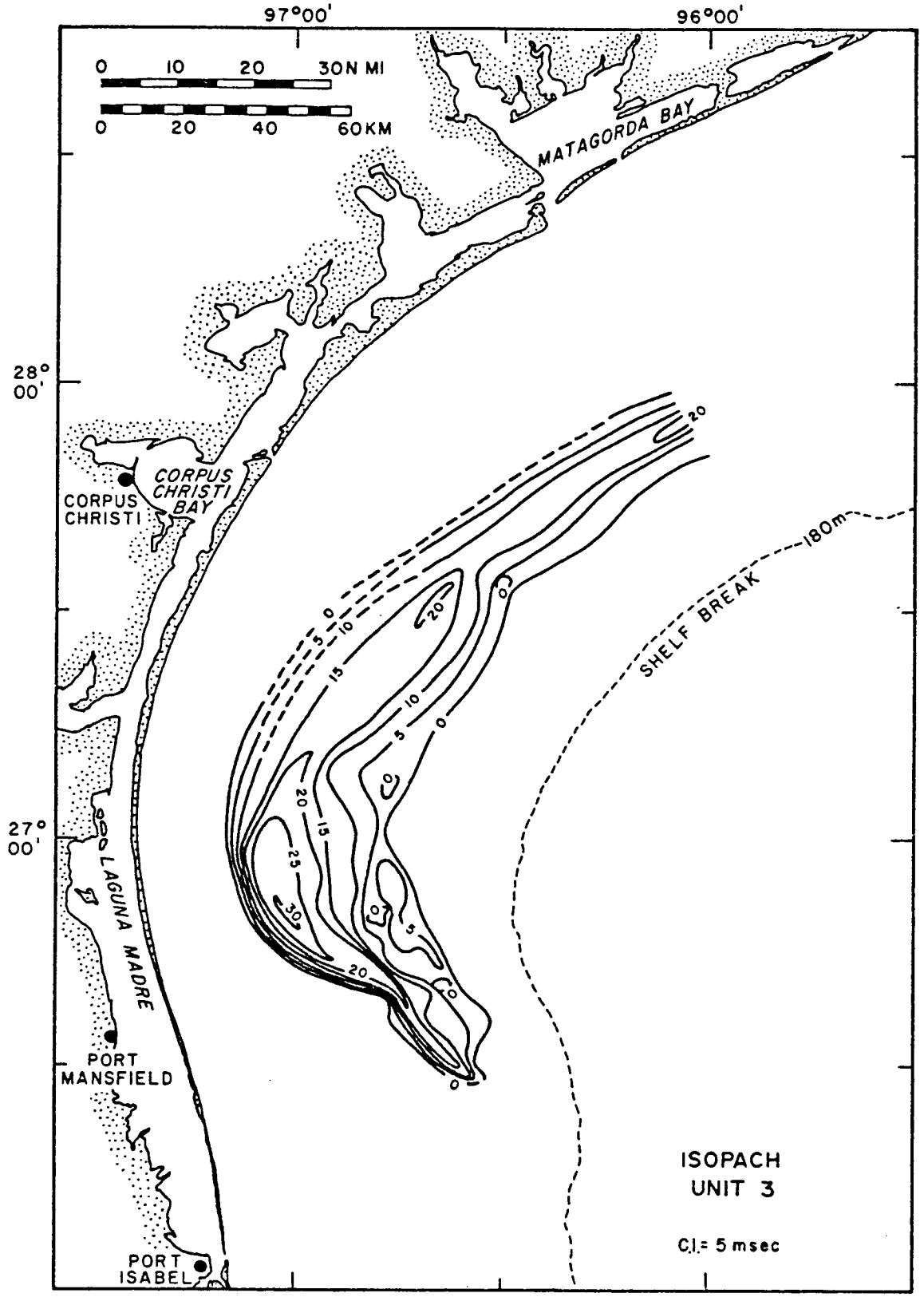


Figure 213. Isopach map of Unit 3.

subcrop map was constructed for this horizon (fig. 214). The map demonstrates that the southern reefs lie on younger strata (Unit 2) than the northern reefs (Unit 1), because of the selective erosion or nondeposition of Unit 2.

Unit 2 includes those sediments between Reflectors B and C (figs. 205 and 206). The areal extent and thickness of Unit 2 are shown by figure 215. The geometry and stratigraphic relations of the surfaces represented by Reflectors B and C indicate that the thickness of the sediments originally deposited above Reflector C was modified by subsequent erosion. The surface prescribed by Reflector B is the erosional surface carved into the upper part of Unit 2 and defines the terrace discussed previously. Unit 2 is thickest in the southern portion of the study area, but the thickness there varies considerably. Comparison of the cross sections on figures 205 and 206 shows that the two elongate pods of sediment are in fact separated by the erosional terrace outlined by Reflector B.

The seismic characteristics indicate two distinct facies within Unit 2 (fig. 215). Westward the reflection pattern consists of relatively high-angle reflection peaks that have the appearance of foreset bedding (fig. 216). This type of seismic facies was called oblique-progradational by Sangree and others (1976) and represents sedimentary layers formed by outbuilding into deep water from a common, upper shallow-to-subareal surface. Associated with the oblique-progradational facies of Unit 2 are numerous channels and truncating surfaces within the facies (fig. 217). The thick, oblique-progradational deposits are in both the northern and southern parts of the South Texas OCS, and they represent the outbuilding of the ancestral deltas of the Brazos-Colorado (fig. 218) and the Rio Grande Rivers (fig. 217) in response to a major lowering of sea level. Reflector C represents the surface onto which

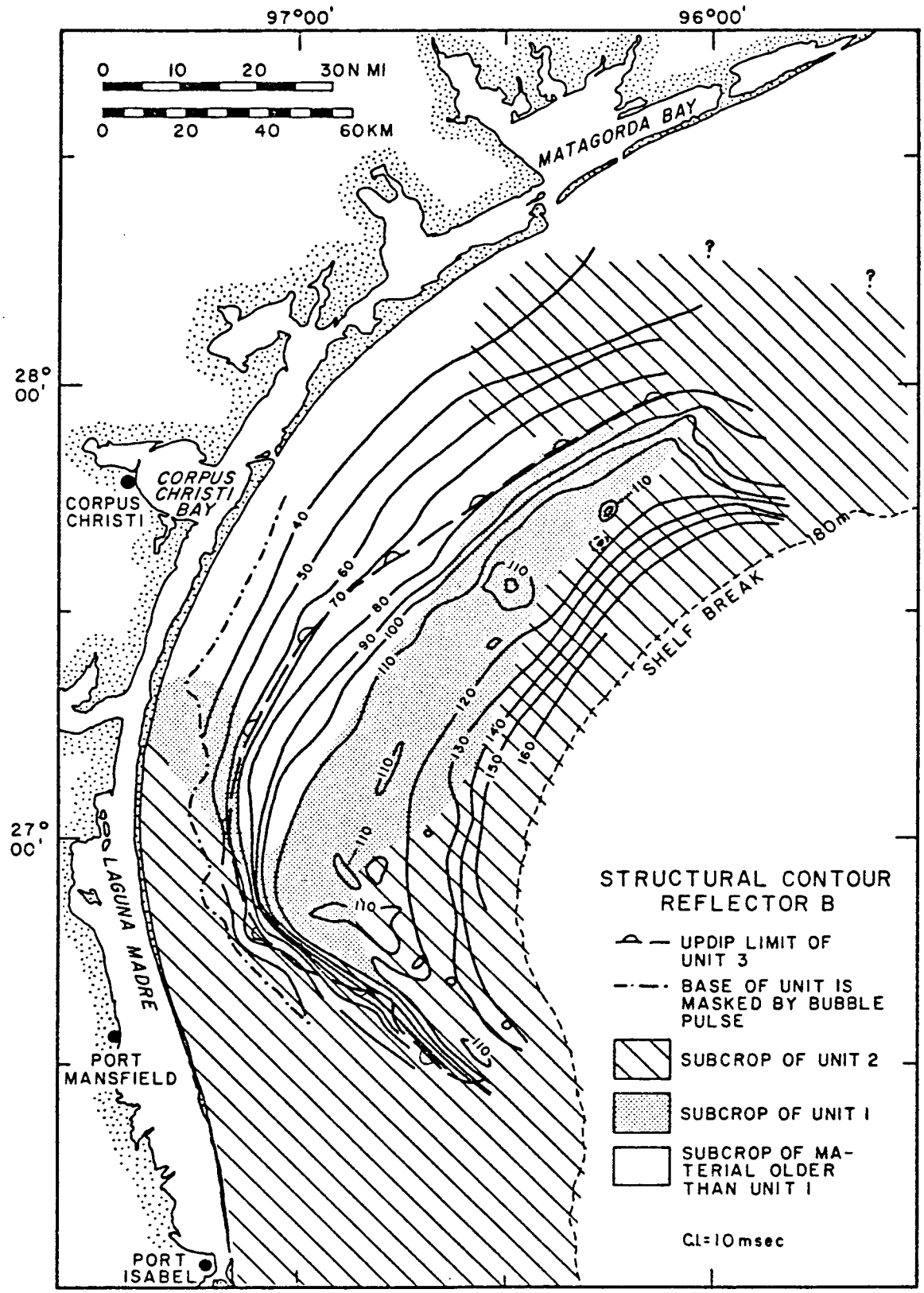


Figure 214. Structural contour map on Reflector B. Illustrations updip limit of Unit 3 and subcrop pattern of older units.

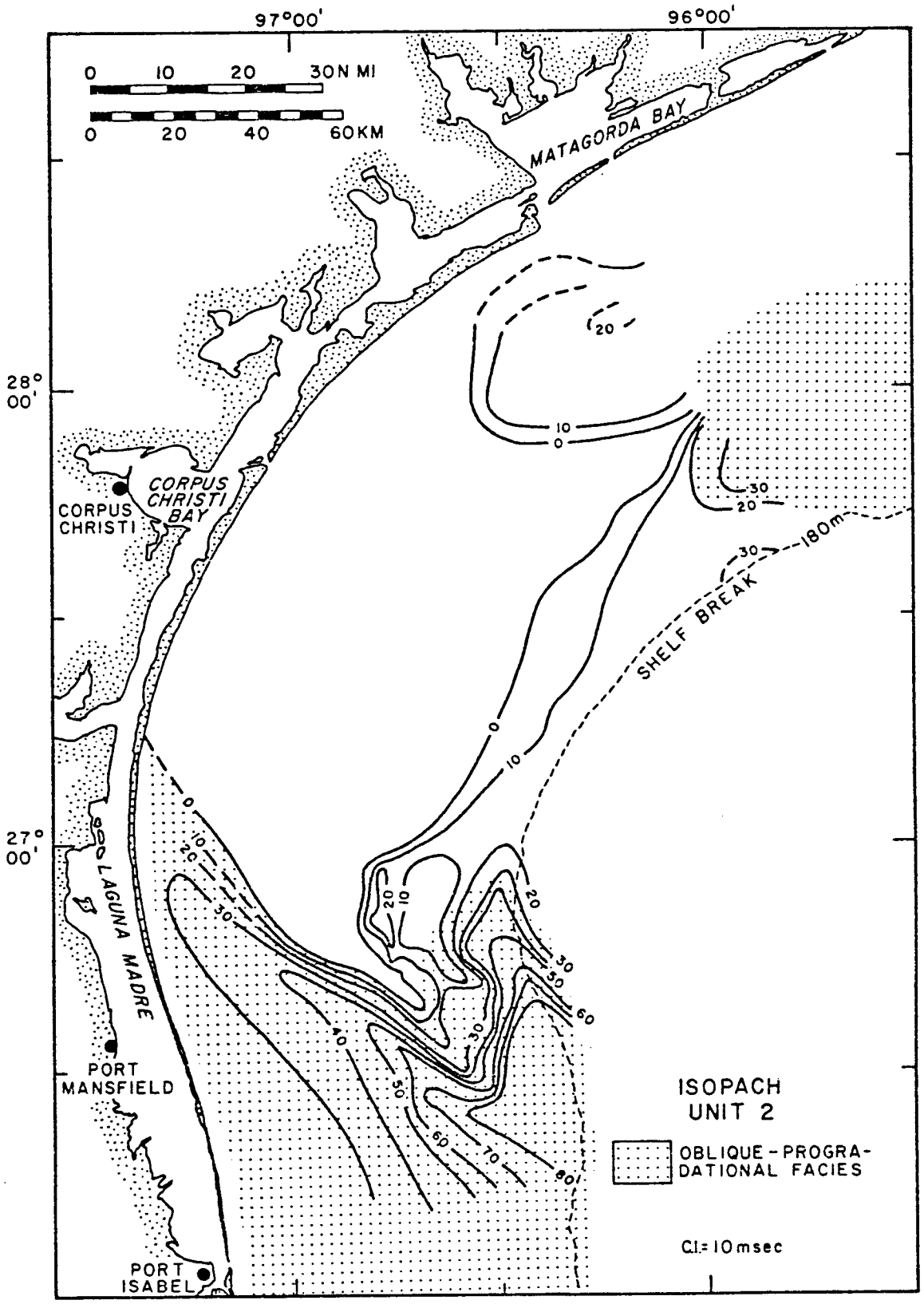


Figure 215. Isopach map showing areal extent and distribution of the oblique-progradational facies in Unit 2.

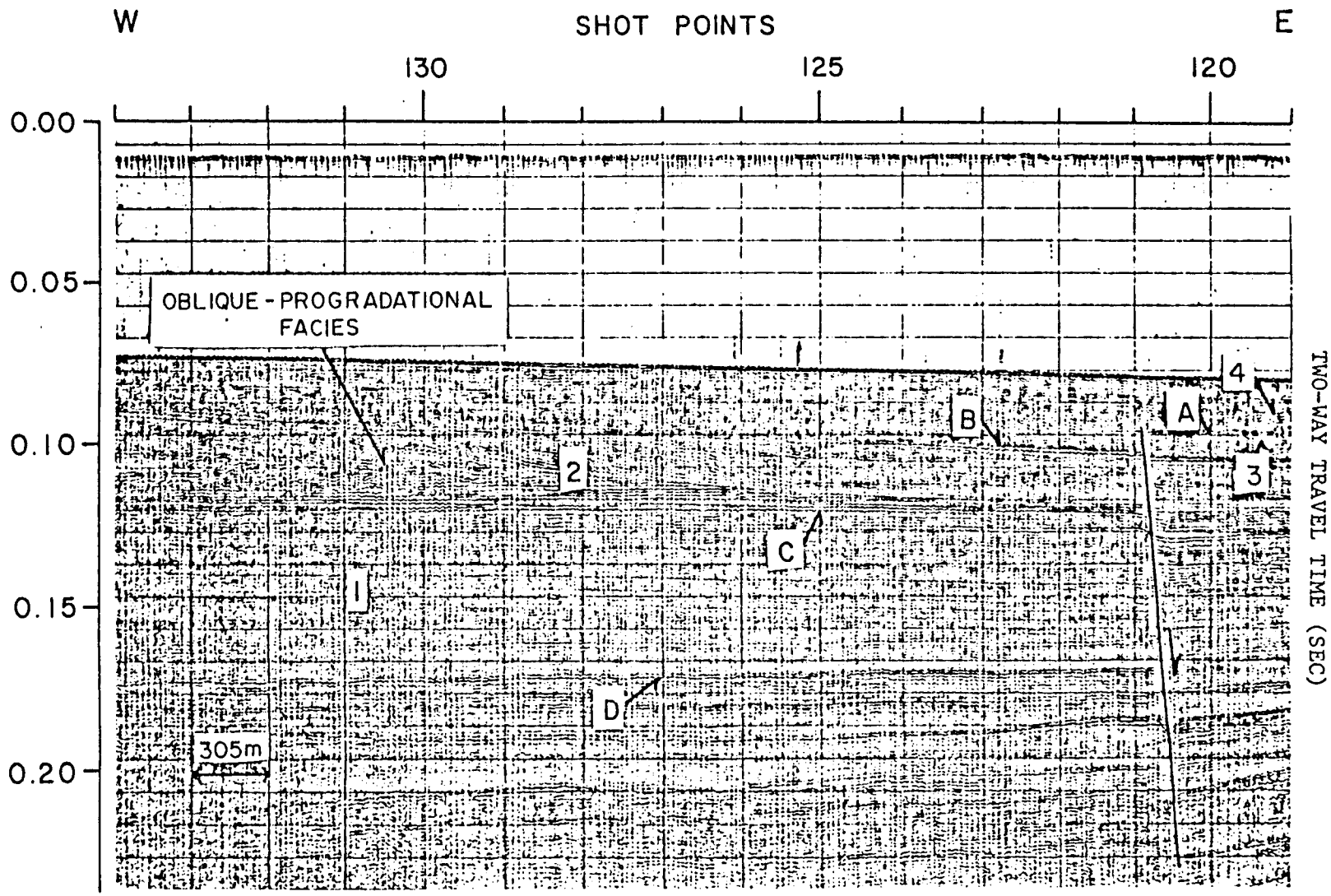


Figure 216. ACOUSTIPULSE profile showing oblique-progradational facies in Unit 2. Vertical exaggeration = 15x.

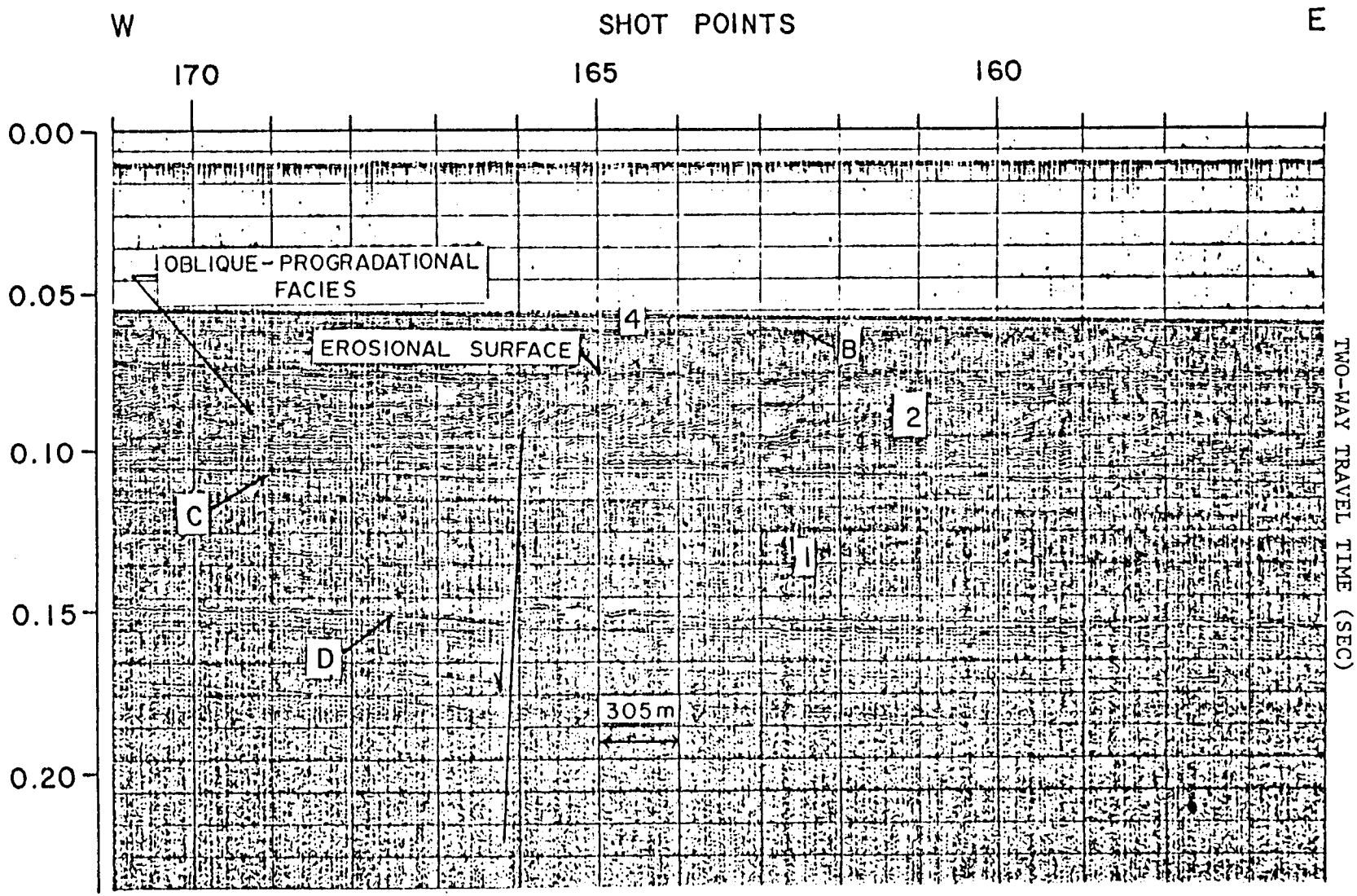


Figure 217. ACOUSTIPULSE profile showing erosional surface in oblique-progradational facies of Unit 2. Vertical exaggeration = 16x.

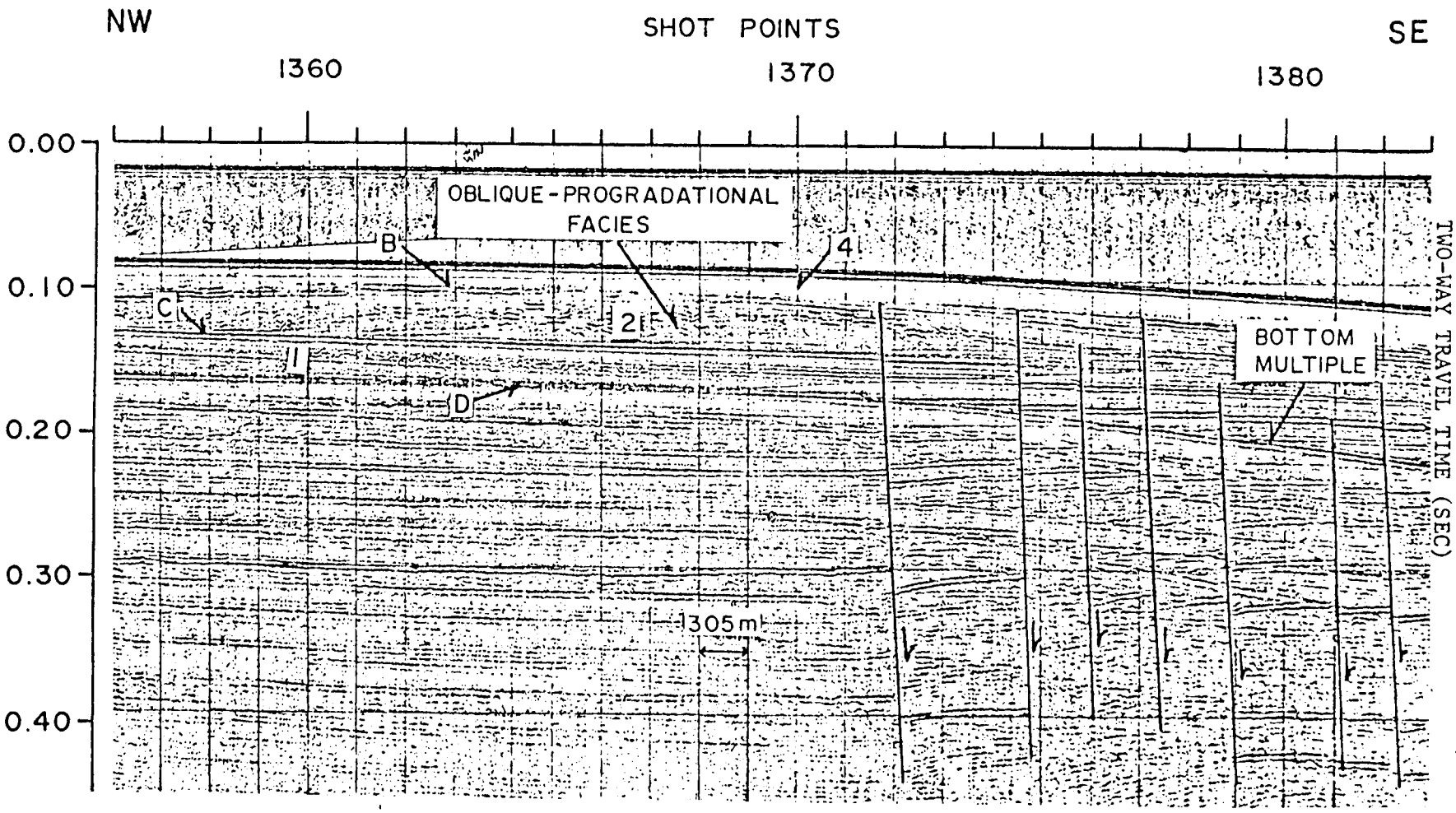


Figure 218. Sparker profile showing shelf-edge delta. Vertical exaggeration = 12x.

these deltas prograded, and it separates the oblique-progradational facies of Unit 2 from the distinctly different facies of Unit 1. The older seismic facies in Unit 2 consists of low-amplitude, thinly-spaced, offlapping reflection peaks.

The oldest stratigraphic unit with which this report is concerned (Unit 1) separates Reflectors C and D. The reflection pattern for Unit 1 consists of widely-spaced, low-amplitude reflection peaks on the middle shelf becoming transparent landward (fig. 219). An isopach map of the unit is shown by figure 220; the variations in thickness of the unit also are shown by the cross sections on figures 205 and 206. Unit 1 is thickest in the southern part of the study area, where the pattern of thickness is somewhat similar to that for Unit 2; however, the thickest part of Unit 1 lies slightly landward of the thickest part of Unit 2. The unit thins abruptly southward; northward the unit is thinner and wedge-shaped. Again, the original thickness of Unit 1 has been modified locally by subsequent erosion, and the zero isopach line represents an erosional pinchout (fig. 219).

The base of Unit 1 is marked by Reflector D, which has a very distinctive high-amplitude reflection peak, and was described originally by Berryhill and others (1976) (his Reflector B). In the northern half of the study area, this reflector merges with the younger reflectors, as shown by the cross sections in figures 205 and 206. Reflector D marks an angular unconformity over the middle part of the shelf that grades into a conformable surface near the outer edge of the shelf. The seaward extent of the disconformity represented by this reflector can be seen clearly only in the northern part of the study area (figs. 221 and 222). As the base of Unit 1 is marked by an erosional surface (Reflector D) and the top by a progradational surface

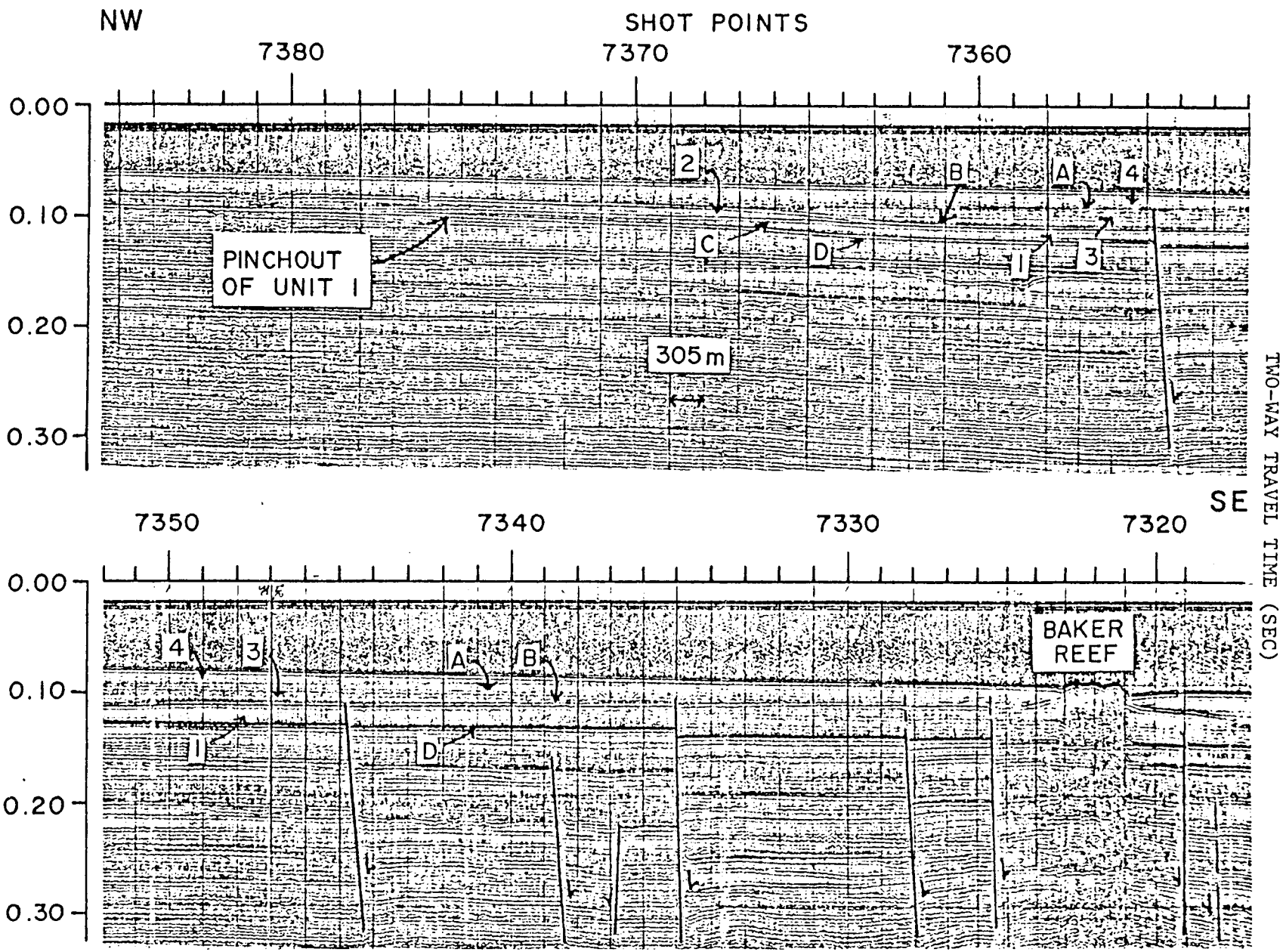


Figure 219. Sparker profile showing reflection pattern of Unit 1. Vertical exaggeration = 13x.

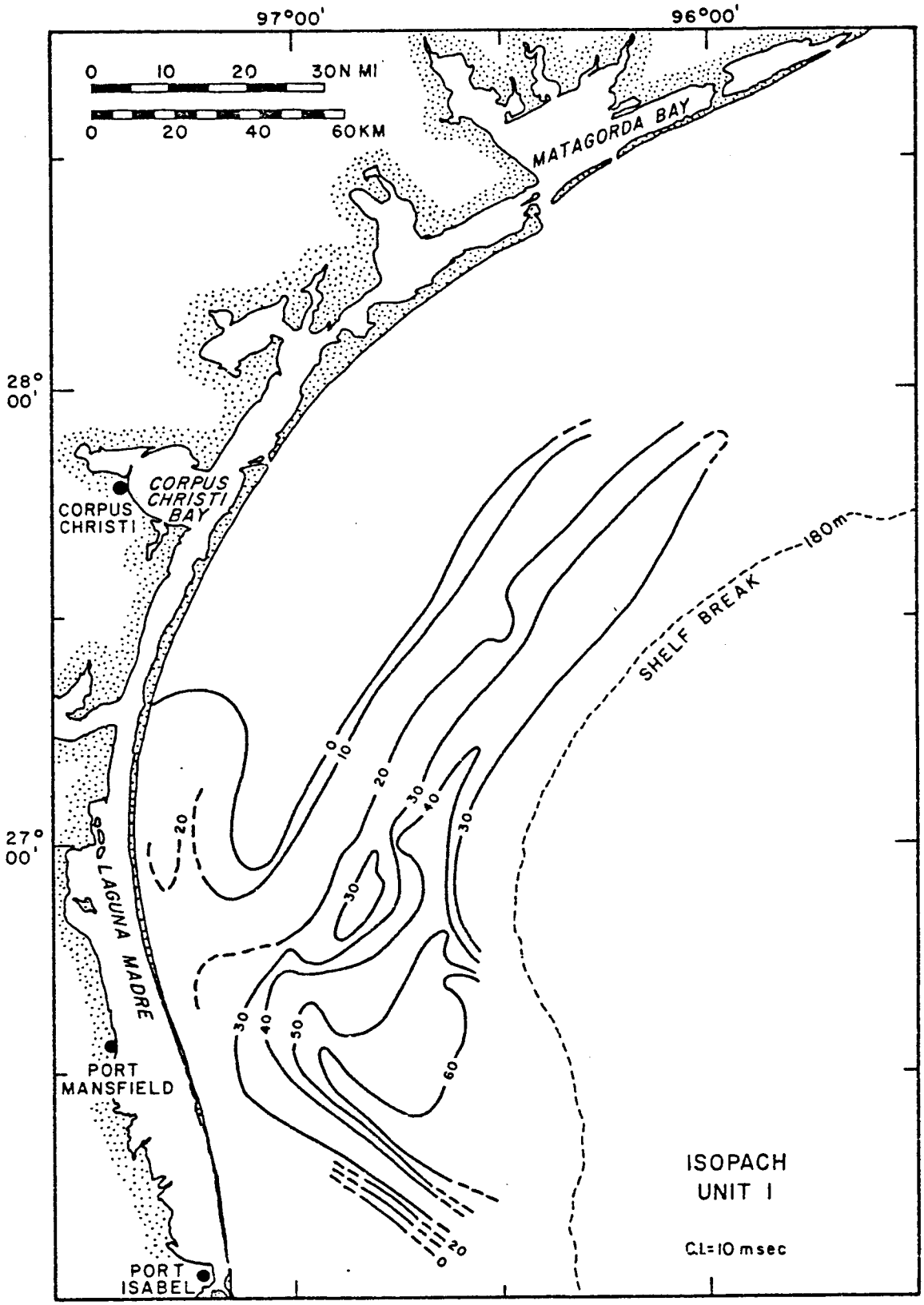


Figure 220. Isopach of Unit 1.

(Reflector C), Unit 1 is interpreted as the deposits of a transgressing sea that separated two periods of regression.

The structural contour map, based on the subseafloor position of Reflector D, defines a rather broad terrace at a depth of 120 to 140 msec (fig. 221). Toward the north, the terrace grades into a smooth slope (Profile A, fig. 205); southward the terrace intersects a steep slope, defined by the 120 to 150 msec contour lines, that represents the outer edge of the Rio Grande delta during an earlier stage of lowered sea level (fig. 223).

In some areas Reflector D reveals mound-shaped features interpreted by Berryhill and others (1976) as ancient reefs predating those associated with Reflector B (fig. 224). These mounds are clustered in the southern part of the study area (fig. 221) and occur where Reflector D appears to be conformable to strata above and below. The rather limited occurrence of these mounds is enigmatic. They lie in an area where the slope of the paleosurface is rather gentle (fig. 221) compared to the same depth to the north. The degree of slope may have been a factor that controlled their position of growth, or proximity to the Rio Grande River could indicate control by the availability of nutrient-enriched waters. No definitive reason to explain the location of the reefs is obvious in the seismic records.

STRUCTURAL CONTROL OF DEPOSITIONAL PATTERNS

Comparison of the isopach maps of each unit to the structure map of the south Texas shelf (fig. 225) demonstrates some structural control on the pattern of thickness for each unit (fig. 226). As a means of determining the relative ages of the progression of tectonic events, a fault chronology map was constructed (fig. 226e) by differentiating faulting that offset only Units 1 and 2 from those that offset Units 3 and 4 as well.

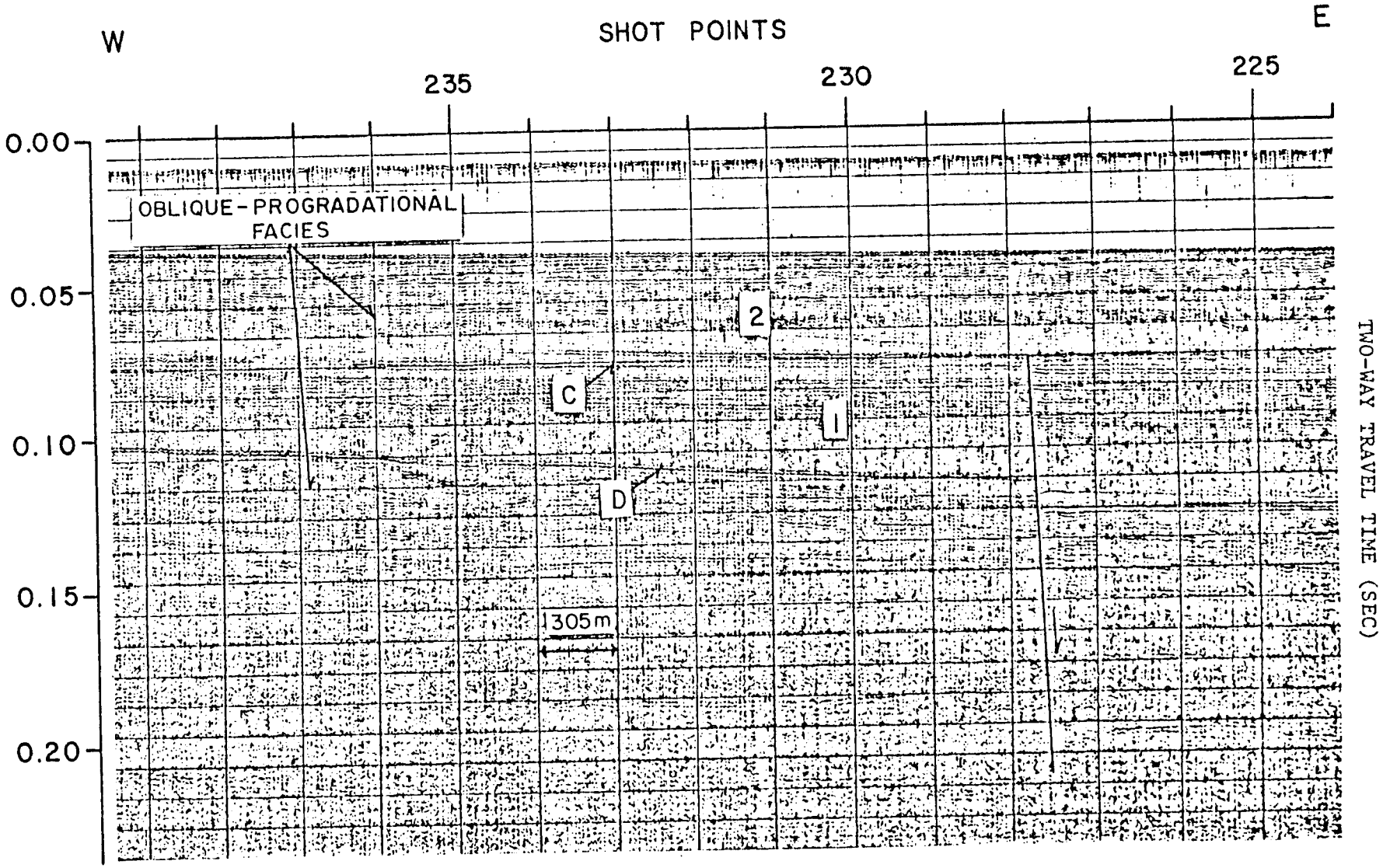


Figure 223. ACOUSTIPULSE profile showing onlap of ancient delta by Unit 1. Vertical exaggeration = 15x.

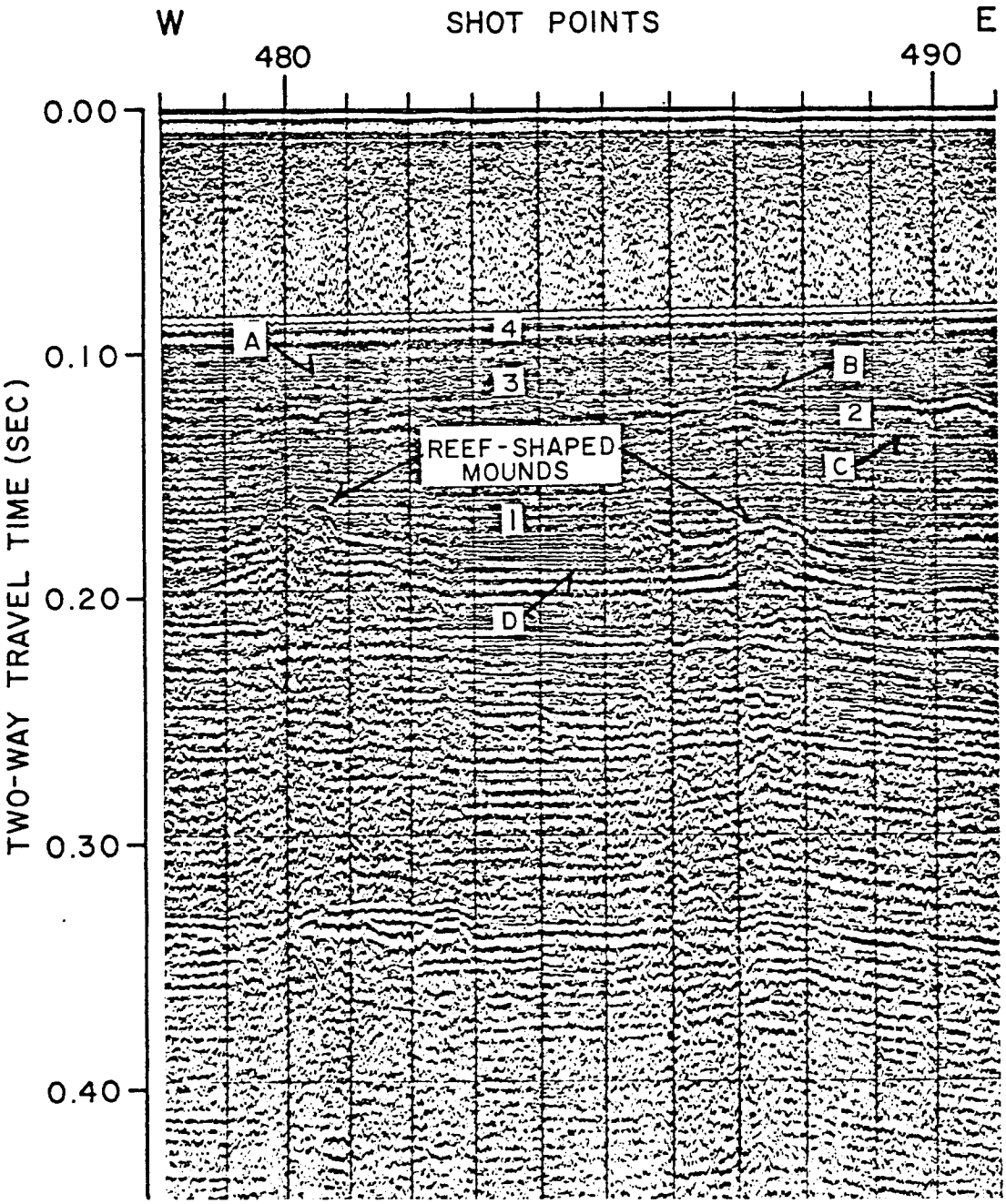


Figure 224. Sparker profile showing reef-shaped mounds associated with Reflector D. Vertical exaggeration = 9x.

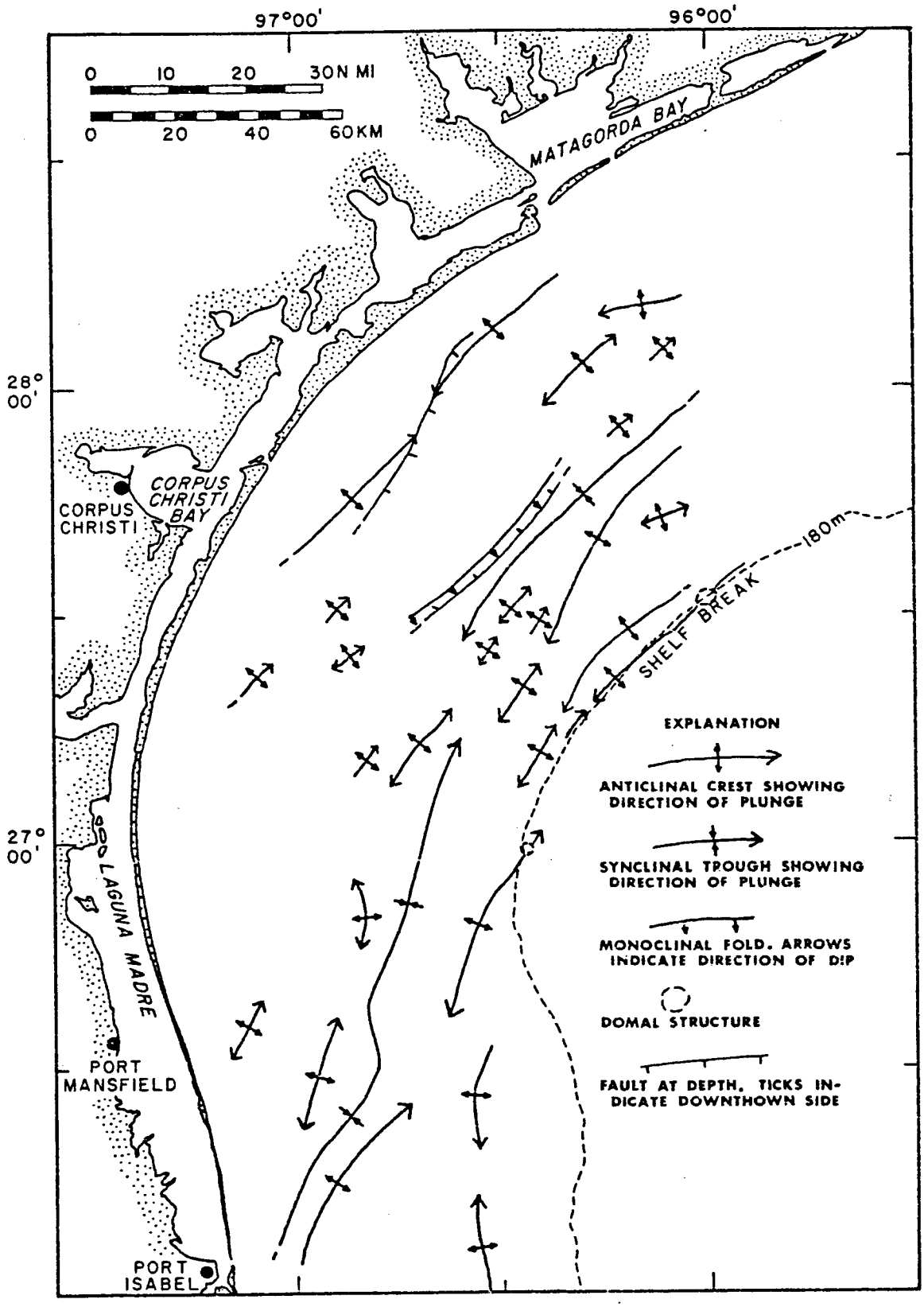


Figure 225. Structure map of the south Texas shelf (modified after Berryhill and others, 1976).

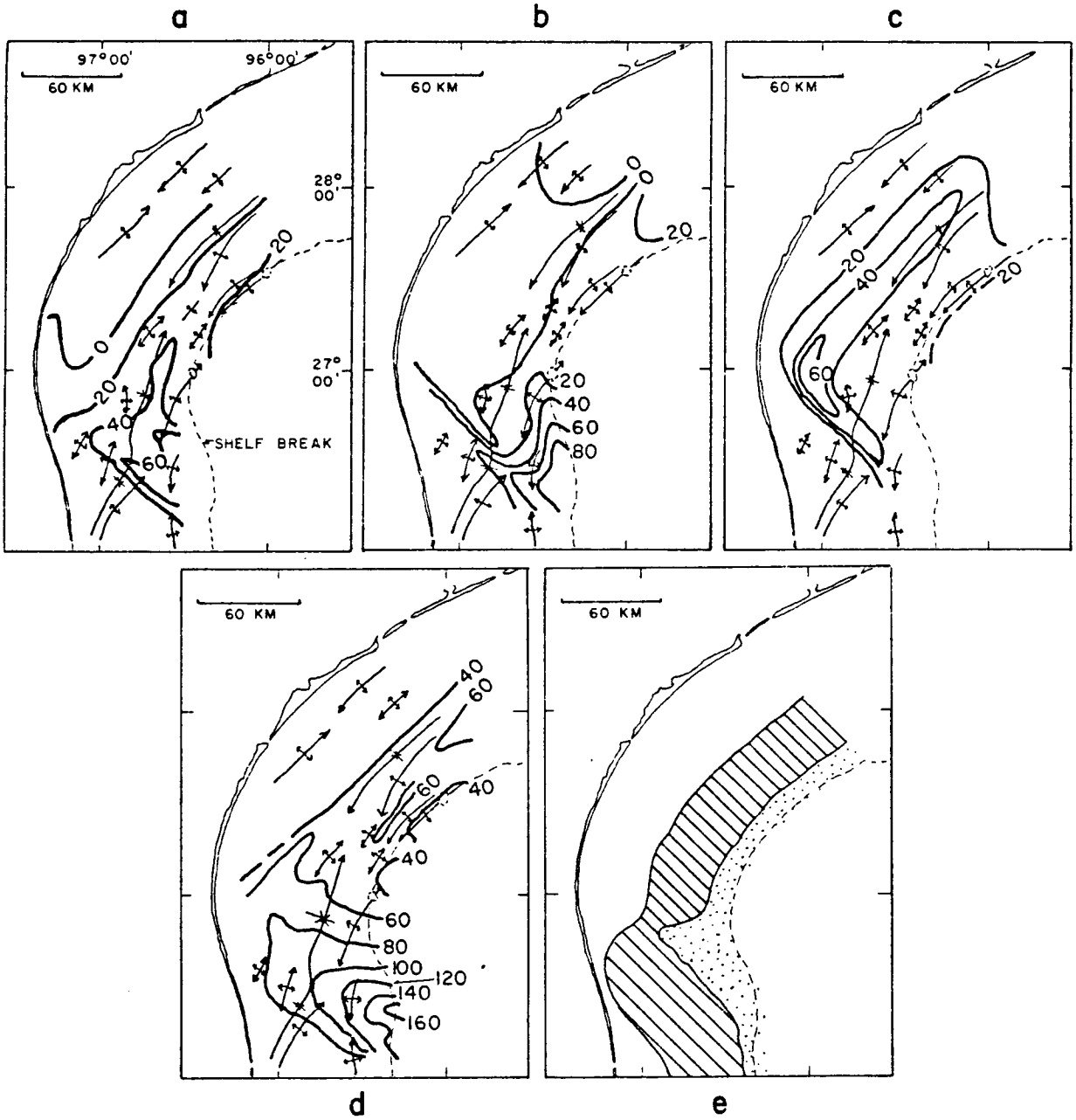


Figure 226. Relationship of depositional patterns to structure.

a. Isopach of Unit 1
b. Isopach of Unit 2
c. Isopach of Units 3 and 4
d. Combined thickness of sediments above Reflector D
e. Fault chronology
Slashed-Faults that cut Reflectors C or D
Shaded-Faults that cut Reflectors A or B

The depositional pattern of Unit 1, as indicated by its thickness characteristics, strongly reflects the tectonic control of an anticline at the outer edge of the shelf (fig. 226a). Thinning of Unit 1 over the anticline indicates that movement of the structure was contemporaneous with deposition of the unit. Active tectonism during the deposition of Unit 1 is documented by the concentration of contemporaneous faults associated with the anticline. The adjacent syncline landward of the anticline was a repository for sediments in Unit 1, as indicated by the tongue of sediment outlined by the 40 msec contour. The thickest part of Unit 1 filled a depression adjacent to an ancient Rio Grande delta front (fig. 221). The trend of the isopach contours in this area is oblique to the strike of the major structural features, yet the trend coincides with areas defined by oppositely plunging anticlines. To the north, Unit 1 is thin over the middle shelf above several prominent anticlines. Upward movement of these anticlines appears to have ceased shortly after the formation of Reflector D (fig. 221), as the erosional surface represented by Reflector D planes the uplifted area, and few faults offset the entire thickness of Unit 1 just above it.

The thickness of Unit 2, although extensively modified by subsequent erosion, also indicates a response to the structural framework of the continental terrace (fig. 226b). The thinning of Unit 2 along the edge of the shelf indicates that the underlying anticline was still active. The great thickness of sediments making up Unit 2 at the outer edge of the shelf in the south indicates that the deposition of the unit contributed considerably to shelf edge outbuilding. As this unit is represented largely by a progradational or deltaic facies, the thinning mentioned on the central part of the outer shelf could be due strictly to its distal location to the principal sources of sediment which were to the north and to the south.

Structural activity during the deposition of Units 3 and 4 was restricted to the outer edge of the shelf (fig. 226c). The shelf-edge anticline appears to have acted as a sediment dam, as undifferentiated deposits of Units 3 and 4 thin over the anticline. The units interpreted as representing transgressive deposits are thickest on the shelf, whereas those representing regressional deposits are thickest along the outer edge of the shelf (fig. 227).

As the interval studied contains major unconformities, rates of deposition could not be determined. The combined thickness of sediments above Reflector D (fig. 226d) does show that the greatest rate of deposition and/or subsidence occurred in the southern part of the study area. Figure 226 also shows that the anticline beneath the shelf edge has been actively rising throughout the interval of geologic time represented in the study. The variations in the patterns of thickness for the sedimentary units studied also indicate that the principal depocenter for the South Texas OCS seaward of the Rio Grande began shifting northward during late Pleistocene time, and, as indicated by the studies of most recent rates of sedimentation, now lies in the north central part.

SUMMARY AND CONCLUSIONS

Reflector D is the oldest reflecting horizon mapped in the study area and represents the base of a major transgressive sequence that makes up the lower part of Unit 1. When correlated stratigraphically to the COST No. 1 well, the level of Reflector D lies within the Gl. flexuosa Zone encompassing the period from 130,000 to 90,000 yrs BP. Whether Reflector D actually marks the base of this transgressive sequence or whether it marks a sea level fluctuation within the interval, the depositional interpretation is not affected and only the absolute age of the reflector is unknown.

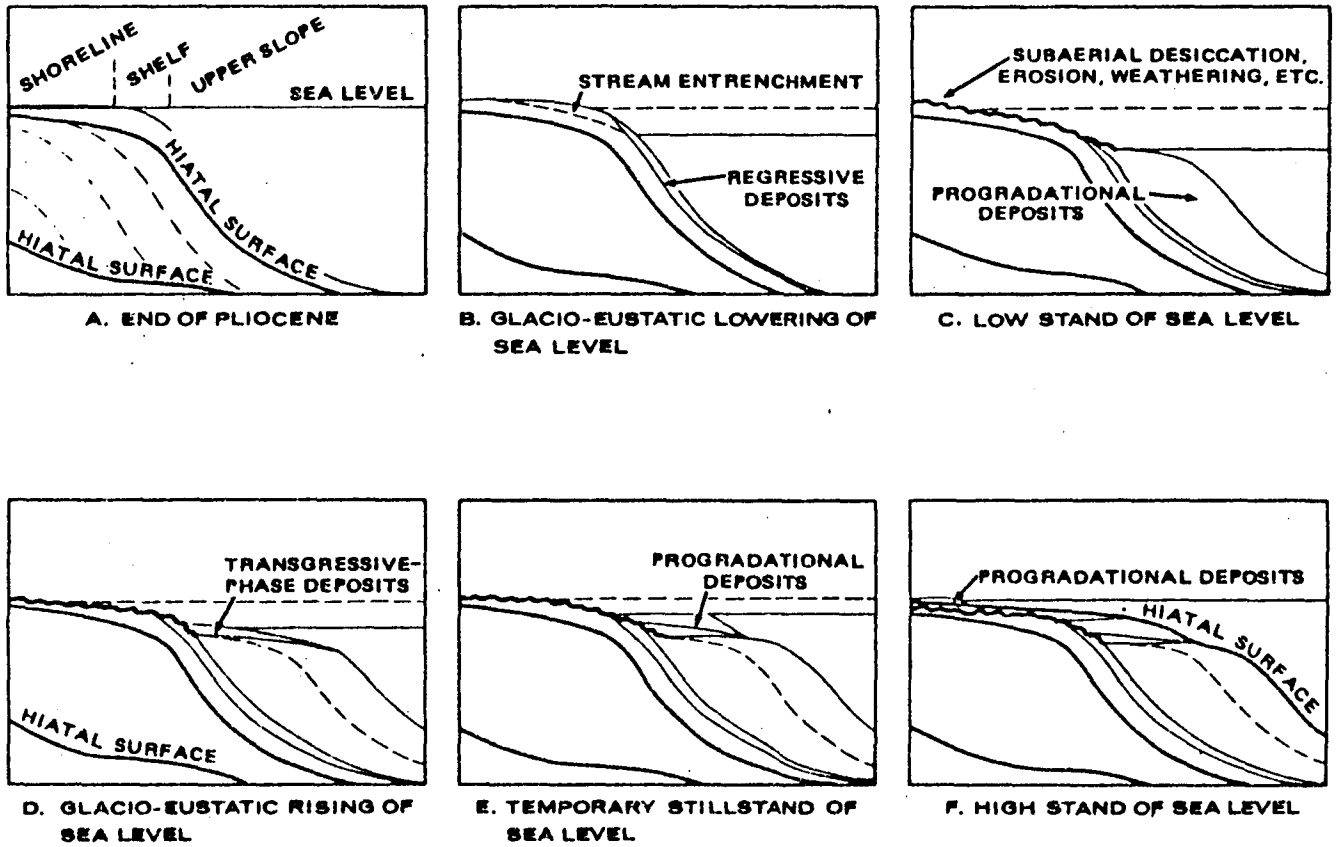


Figure 227. Deposition during glacial cycle (after Frazier, 1974).

The position of the shoreline prior to the deposition of Unit 1 is approximated by the seaward extent of the truncation of the underlying strata by Reflector D. As indicated by the data on figure 221, the shoreline would have been approximately the position of the 170 msec contour line in the northern part of the study area, corresponding to an isostatically uncorrected depth of approximately 130 m below present sea level. This position lies within the range of -122 to -137 m, which has been interpreted as an older terrace level by several investigators (fig. 228a).

As sea level rose in response to climatic warming, deposition of Unit 1 above Reflector D began. The high amplitude nature of Reflector D is attributed to either a soil horizon formed on the subareally exposed shelf and/or to a coarse, basal transgressive sand. The close association of Reflector D to Poag and Valentine's (1976) Amphistigina gibbosa II Zone, which is characteristic of basal transgressive sands, suggests the latter (fig. 229). As Am. gibbosa is a reef-dwelling organism, the previous low stand of sea level was apparently conducive to reef development (fig. 224). The position of the shoreline during the maximum transgression cannot be determined because of subsequent erosion of Unit 1, but would have been at least as far landward as the position of the zero isopach line for Unit 1 on figure 220. The depositional pattern for Unit 1 was partially controlled by structural features within the continental terrace, but the strong reentrant in the south, represented by the thickest part of the unit, is a response to paleotopography. The structural contour map on Reflector D (fig. 221) indicates a structural high in the southern part of the study area that represents the previous position of the Rio Grande delta. The thick accumulation of Unit 1 just north of this structural high indicates that the position of the Rio Grande shifted north during Unit 1 time, probably in response to climatic and sea level fluctuations.

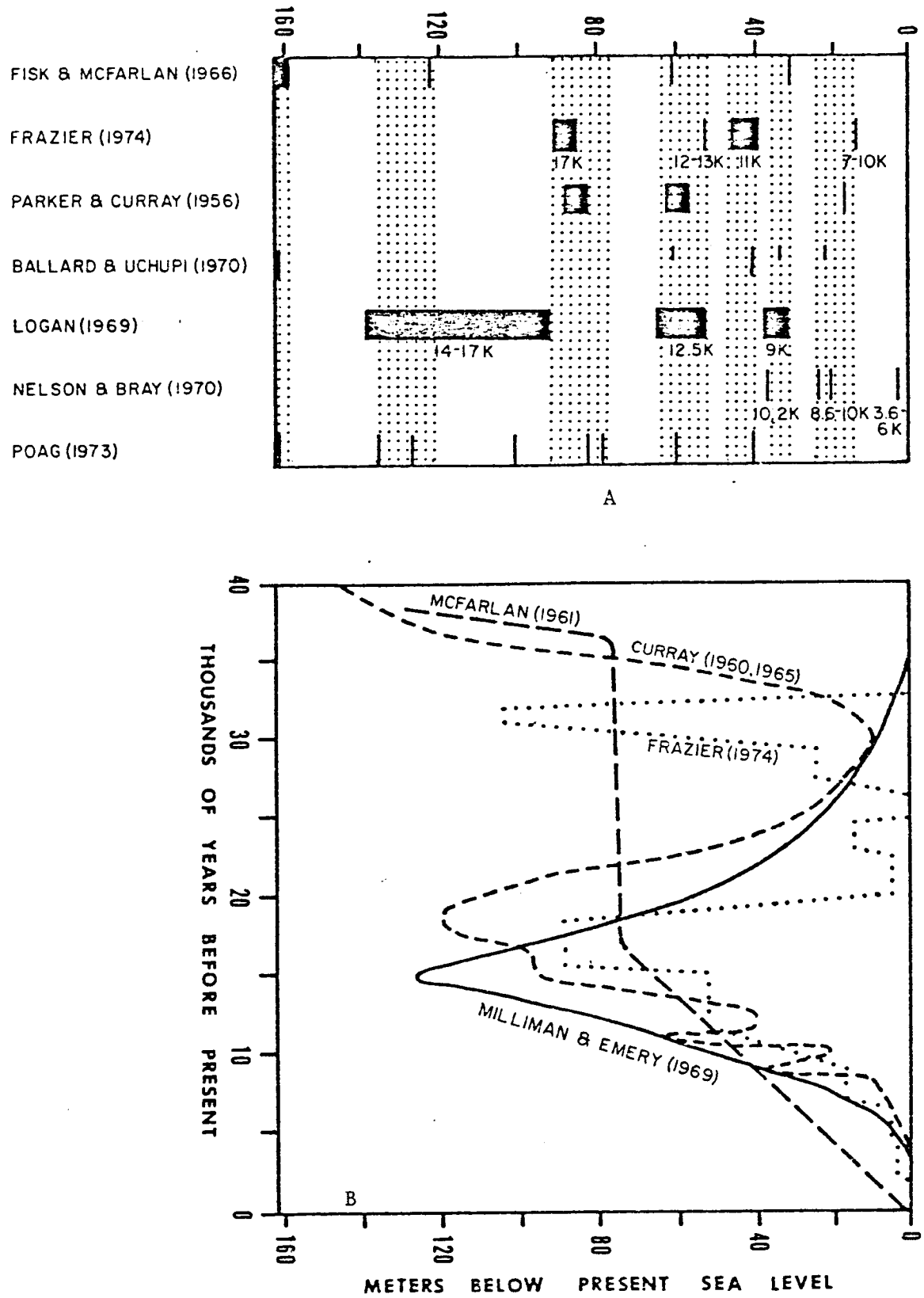


Figure 228. Summary of sea level investigations
a. Ancient terrace levels from geomorphic data,
b. Sea level curves constructed from dated paleoenvironments.

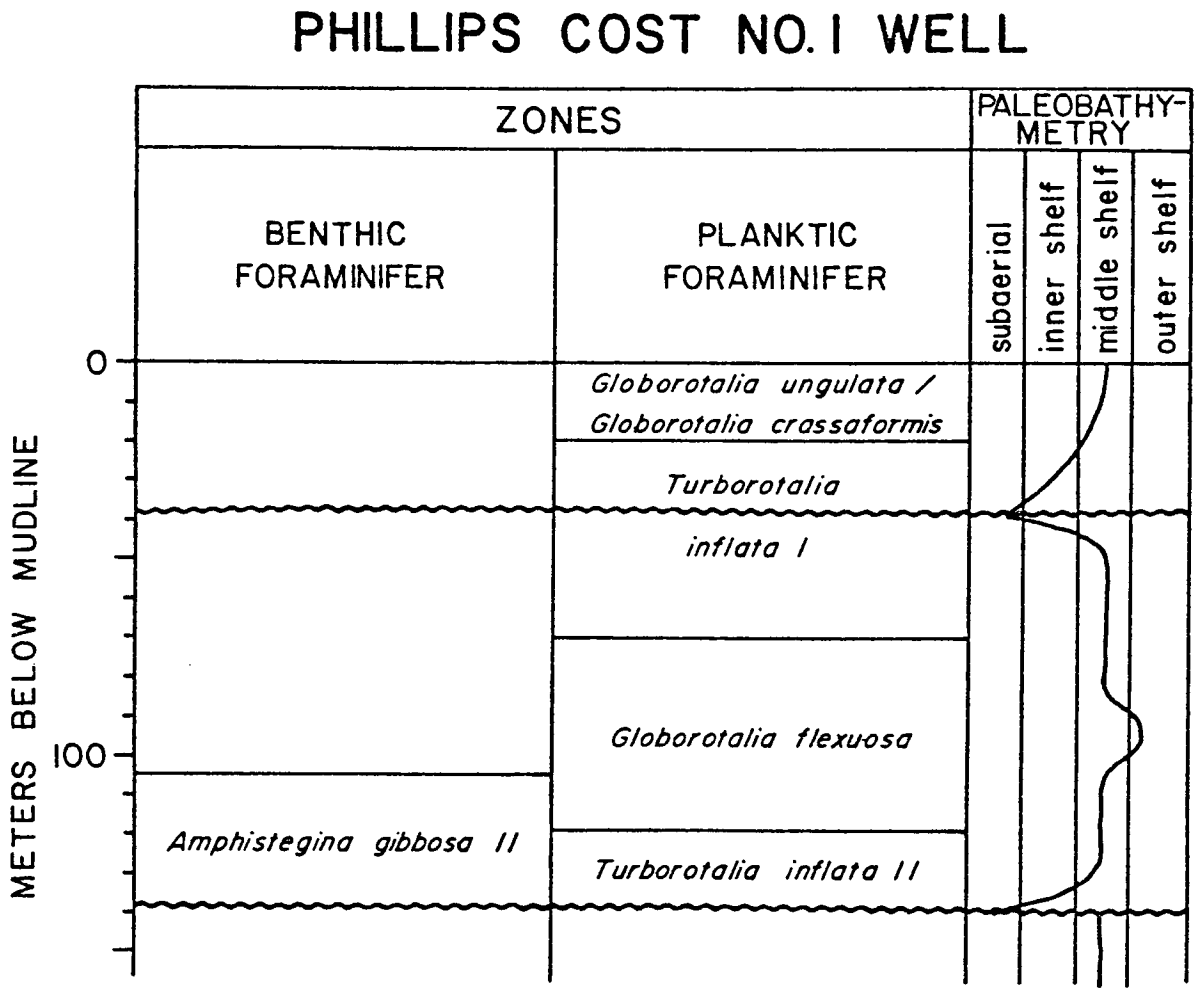


Figure 229. Biostratigraphic zonation in Phillips COST No. 1 well (from Poag and Valentine, 1976).

During deposition of Unit 1, sea level apparently remained static until the climate began to cool, as represented by T. inflata in the upper part of Unit 1. As sea level began to fall, the major drainage systems developed prograding deltas represented by the oblique-progradational facies in Unit 2.

The sediments making up Unit 2 are regressional, colder water deposits, as indicated by the T. inflata I Zone of Poag and Valentine (1976). The regressive stage lasted from about 90,000 to 28,000 yrs BP. Reflector C marks the surface onto which the progradational facies was deposited and is correlative to an unconformity in the T. inflata I Zone dated at approximately 50,000 yrs BP. Sea level reached a maximum low between 100 and 117 m below present sea level, as indicated by the seaward position of the shelf-edge deltaic deposits (fig. 218) (expressed bathymetrically by the 100 m isobath). The ^{18}O curves indicate a minor warm period about 60,000 yrs BP (^{18}O Stage-3), but no evidence of a transgression at that time is indicated.

Climatic warming began about 28,000 yrs BP, resulting in a major transgression that is marked by Reflector B. The seismic data indicate at least two distinct stillstands in sea level within this period of transgression. The first stillstand is indicated by a broad, surf-planed terrace represented by the 100 and 120 msec contours on figure 214. The offshore reefs began to grow on the outer edge of the terrace at this time and continued to grow until the second stillstand. The position of the shoreline formed by the second stillstand is approximated by the updip limit of Unit 3 (fig. 214). During stillstand, benches were formed on the flanks of the existing reefs because of either wave planation or predominantly lateral spreading of the reefs.

The broad terrace carved by the first stillstand lies at -76 to -80 m (100-120 msec), which corresponds reasonably well with the upper level of the -78 to -91 m terrace zone reported by several investigators (fig. 228a). Frazier (1974) dated a submerged terrace on the Texas shelf at 17,000 yrs BP at this depth, and his sea level curve shows a stillstand dated from 16,000 to 19,000 yrs BP at -88 m. McFarlan's (1961) curve also shows a major stillstand dating from 36,000 to 18,000 yrs BP at -76 m. The terrace probably was formed by a stillstand approximately 17,000 to 18,000 yrs BP. A sample of coralline material from Southern Reef, which rests on the terrace, has been dated at 18,000 yrs BP (Berryhill and others, 1976).

The second stillstand, thought to have produced the benches on the reefs during the period of time in which Unit 3 was deposited, lies at a depth of -50 to -60 m (70 to 80 msec). This shoreline closely matches the -52 to -64 m zone of terracing reported by several investigators (fig. 228a). Available dates for this zone range from 12,000 to 13,000 yrs BP, which is the age for the base of the Holocene generally accepted by the Gulf Coast stratigraphers. This stillstand, marked by Reflector A, very closely approximates the base of the last major transgression. It should be pointed out that an alternative explanation to a stillstand of sea level during deposition of Unit 3 is possible. Unit 3 is limited to the geographic extent of the terrace upon which it rests. It is true that the seismic reflectors characteristic of Unit 3 are different from Unit 4 above, which is seismically transparent, yet no evidence of fluvial outbuilding or progradation, as would be expected, is indicated in the deposits of Unit 3. Consequently, the seismic signature for Unit 3 may represent deposits that are sandier than those above, laid down as the rising sea spread slowly across the almost flat terrace. After the sediments filled across the

terrace and reached grade with the slope gradient of the coastal plain shoreward of the terrace, a more rapid rate of sea level rise ensued. At question is the date for the beginning of the Holocene. Was it 12,000 to 13,000 yrs BP as currently assumed, or did it begin earlier? Argument for a somewhat earlier date based on strict geologic rather than paleontologic evidence is possible on the basis of data available from the South Texas OCS.

During the resumed rise of sea level to its present position, the sediments of Unit 4 were deposited. The rise in sea level also renewed upward growth of the reefs, which formed pinnacles above the benched level (fig. 212). The reefs were unable to keep up with the rising sea level and no longer contain live reef-building organisms (Bouma and others, 1976).

The deposits of Unit 4 completed the filling of the bathymetric low related to the terrace and inundated the deltas landward of the terraced area. The isopach map of Unit 4 (fig. 210) indicates very little Holocene sedimentation over the ancestral Rio Grande delta, which seems to have remained slightly above sea level well into Holocene time. Consequently, the bathymetry across the southern part of the south Texas shelf today represents essentially the inundated topography of the old delta surface, modified by some reworking during the late Holocene transgression of the sea.

CONCLUSIONS AND INTERRELATIONSHIPS

by

Henry L. Berryhill, Jr.

GENERAL STATEMENT

The more significant results of the geologic environmental studies made in 1976 and their interrelations are summarized in the series of illustrations, figures 230 through 235. The figures are arranged in sequence on the basis of the nature and time span of the process involved, beginning with the ephemeral patterns for the suspended sediments (figs. 230, 231, 232, and 233), followed by the accumulative effects of processes spanning periods of time that range in length from a season to several years (fig. 234) and ending with those processes that are operative and cumulative over periods of time that range from tens of years to millennia (figs. 235). Those conditions that represent changes over relatively short periods of time are of the greatest direct concern in establishing baselines and in long-term monitoring; those that represent long-term cumulative processes affect the stability of the sea floor and are of concern in the selection of sites for offshore man-made structures. An exception to the sequencing is the pattern of suspended sediments plotted from ERTS imagery (fig. 235c; Hunter, written commun.), which has been placed with the maps showing rates of benthic sedimentation to demonstrate the probable oceanographic mechanism responsible for the localization of the latest Holocene depocenter on the shelf.

The individual maps on each figure have been selected and arranged so that they present visual summaries and relations that are readily apparent and do not require repetition of the details already given. The patterns

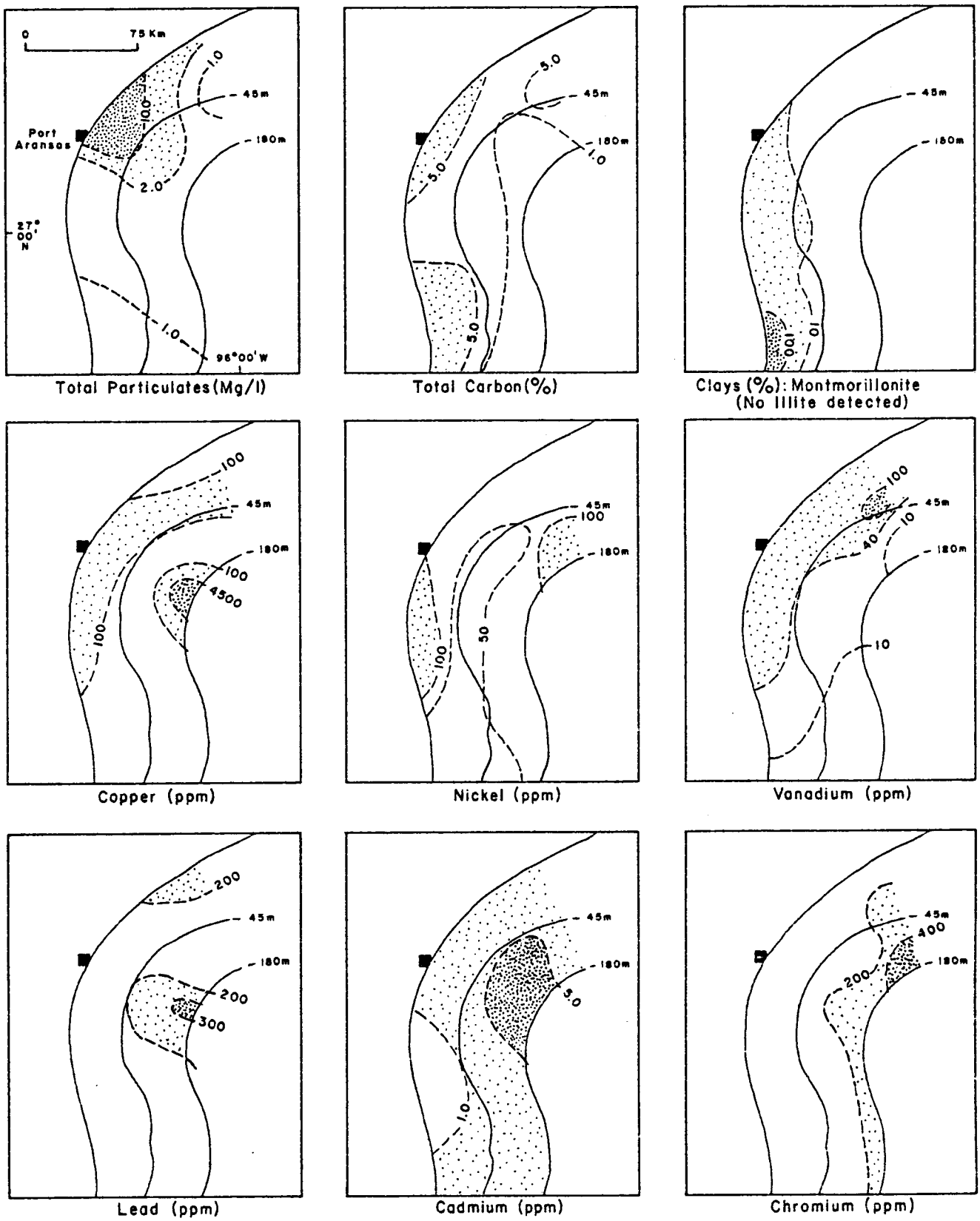


Figure 230. Patterns of distribution for various aspects of the suspended sediments, surface water, November 21 to 26, 1975.

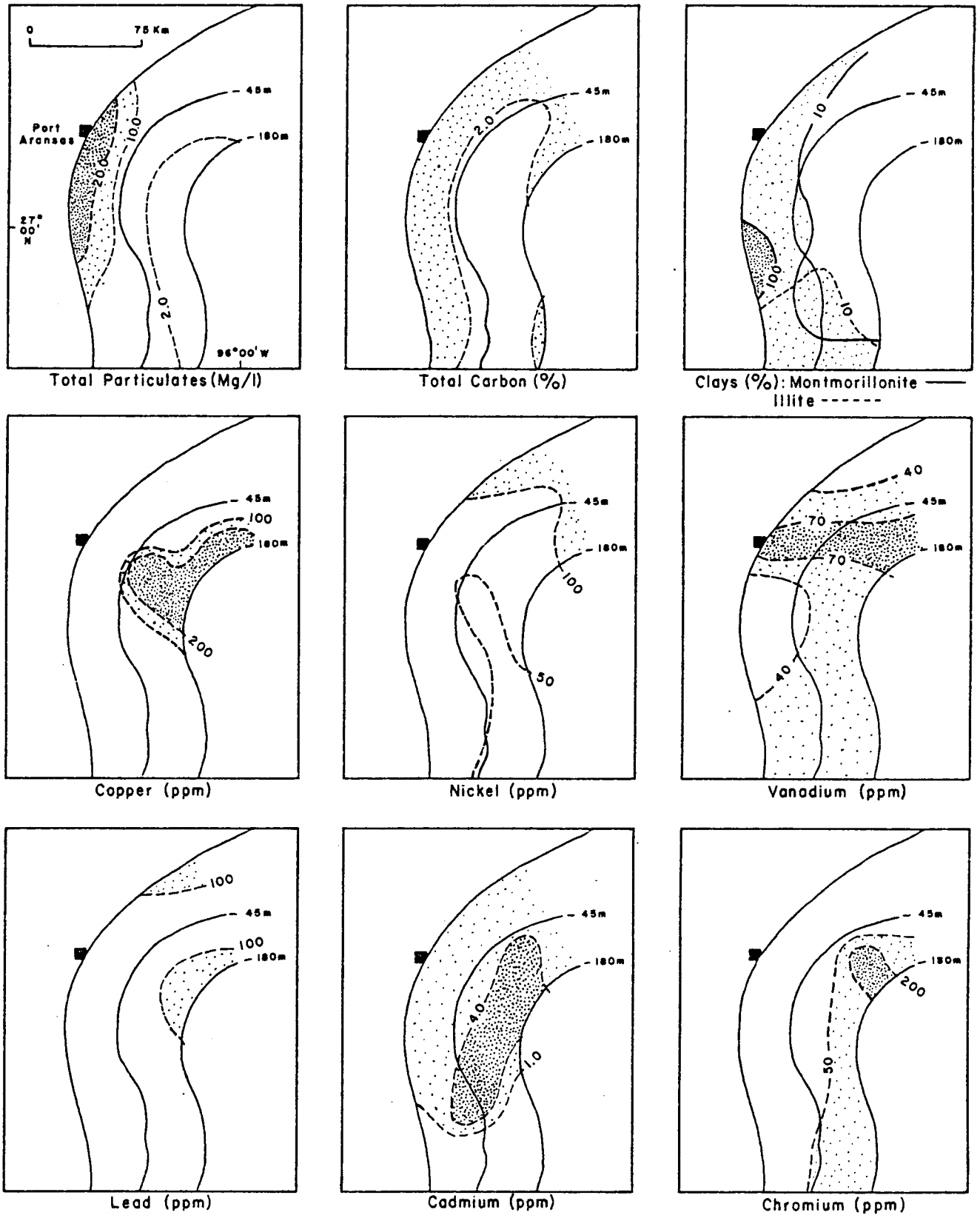


Figure 231. Patterns of distribution for various aspects of the suspended sediments, bottom water, November 21 to 26, 1975.

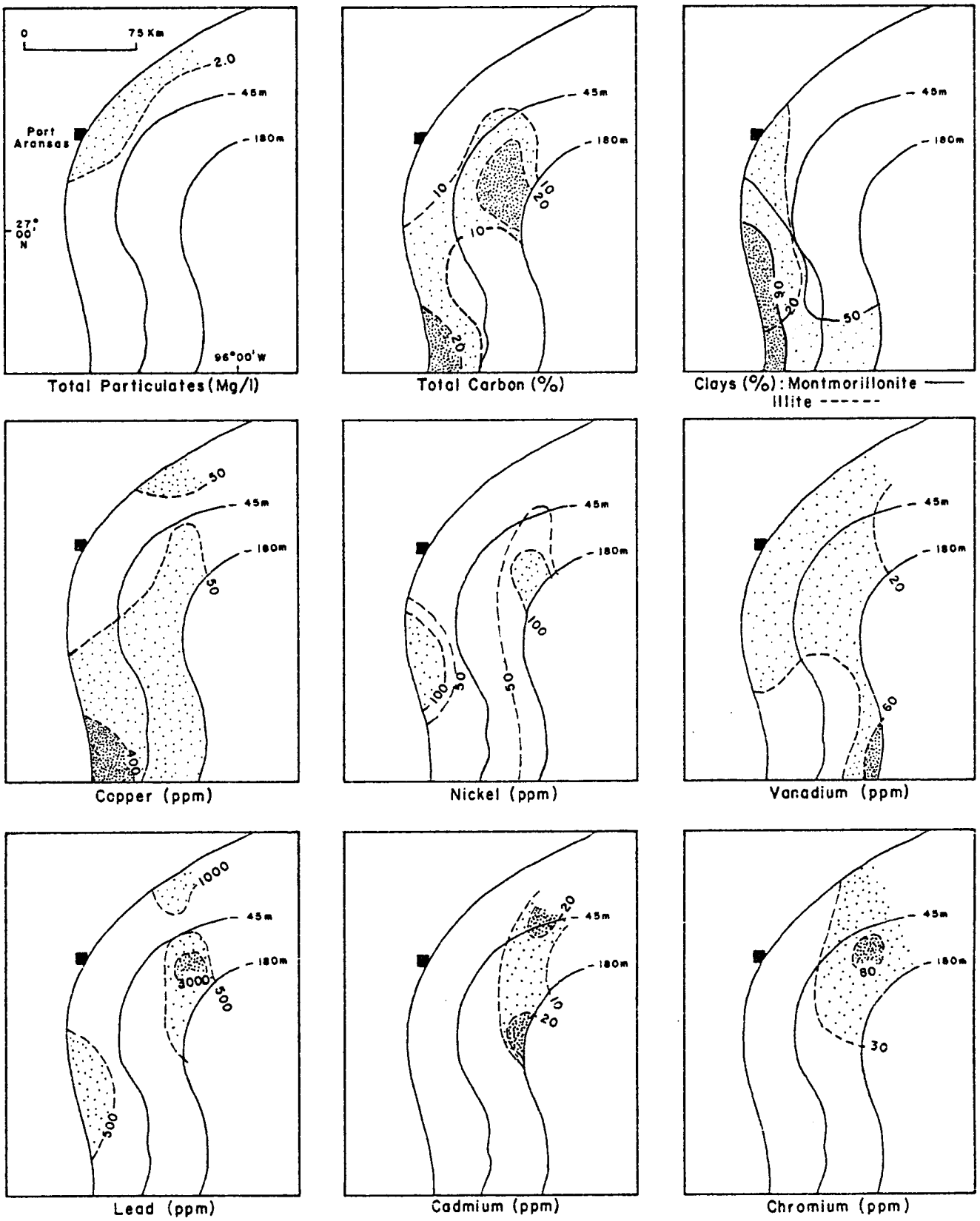


Figure 232. Patterns of distribution for various aspects of the suspended sediments, surface water, May 21 to 26, 1976.

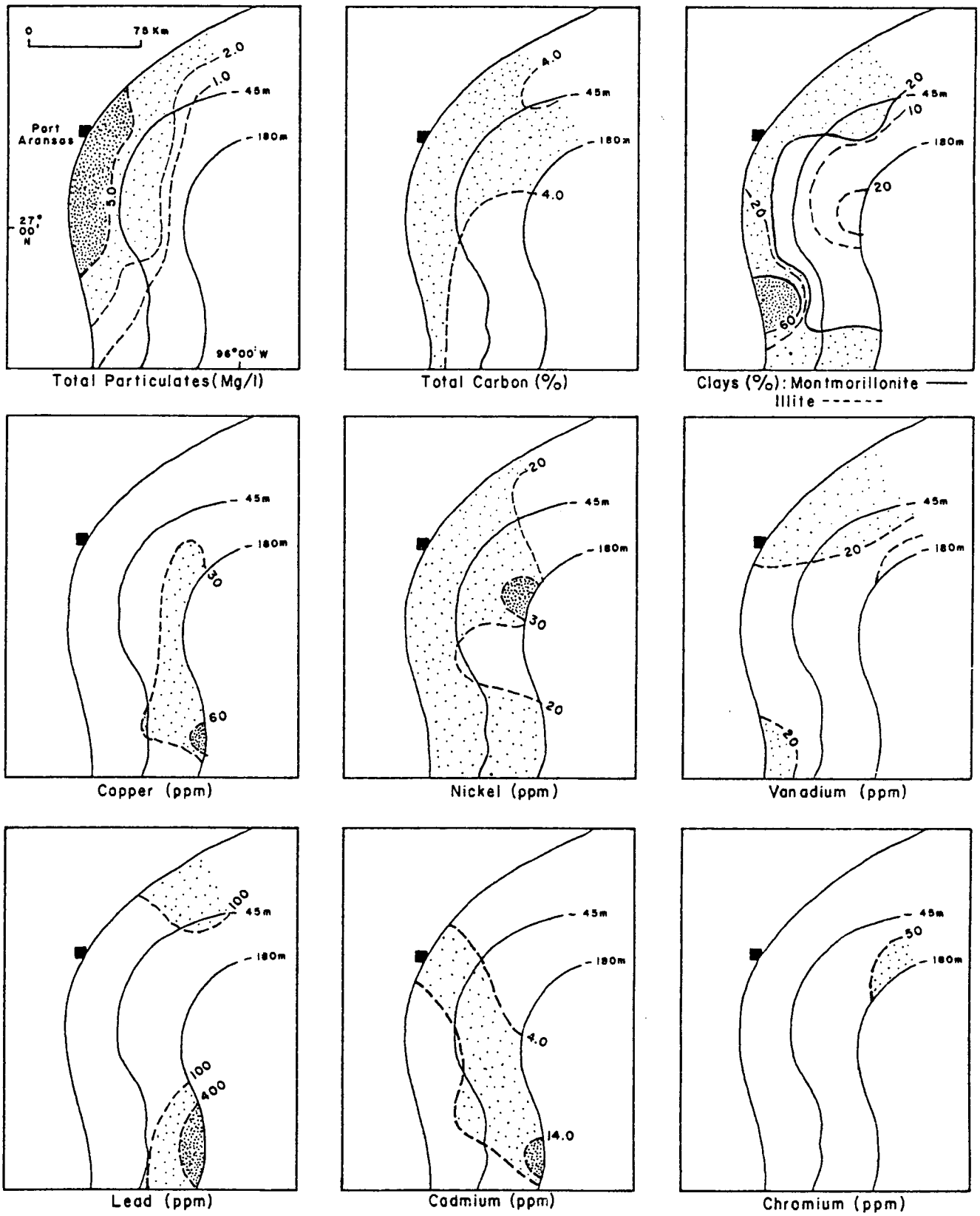


Figure 233. Patterns of distribution for various aspects of the suspended sediments, bottom water, May 21 to 26, 1976.

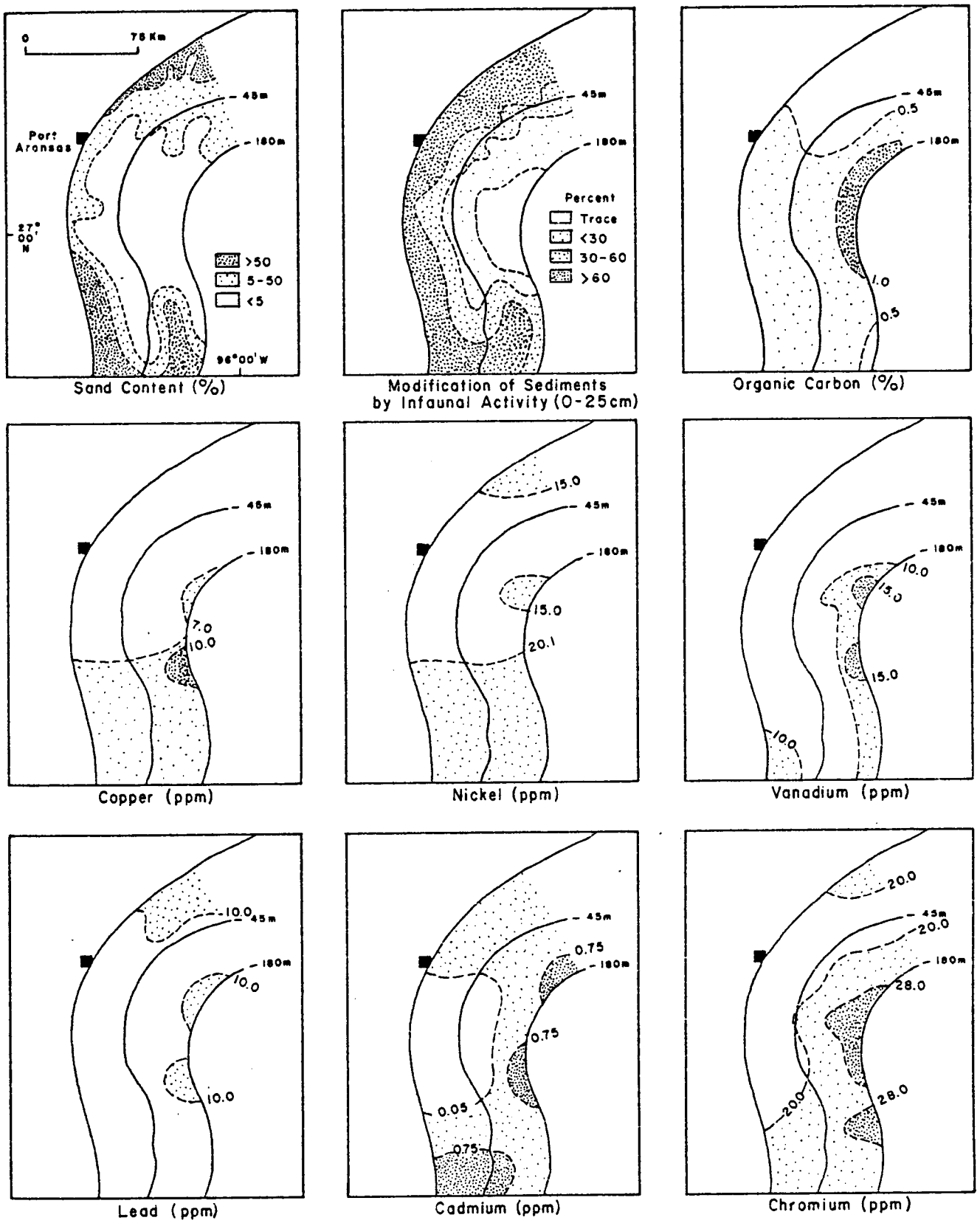


Figure 234. Patterns of distribution for various aspects of the benthic sediments as determined during the first year of study in 1975. Compare with figures 230 to 233.

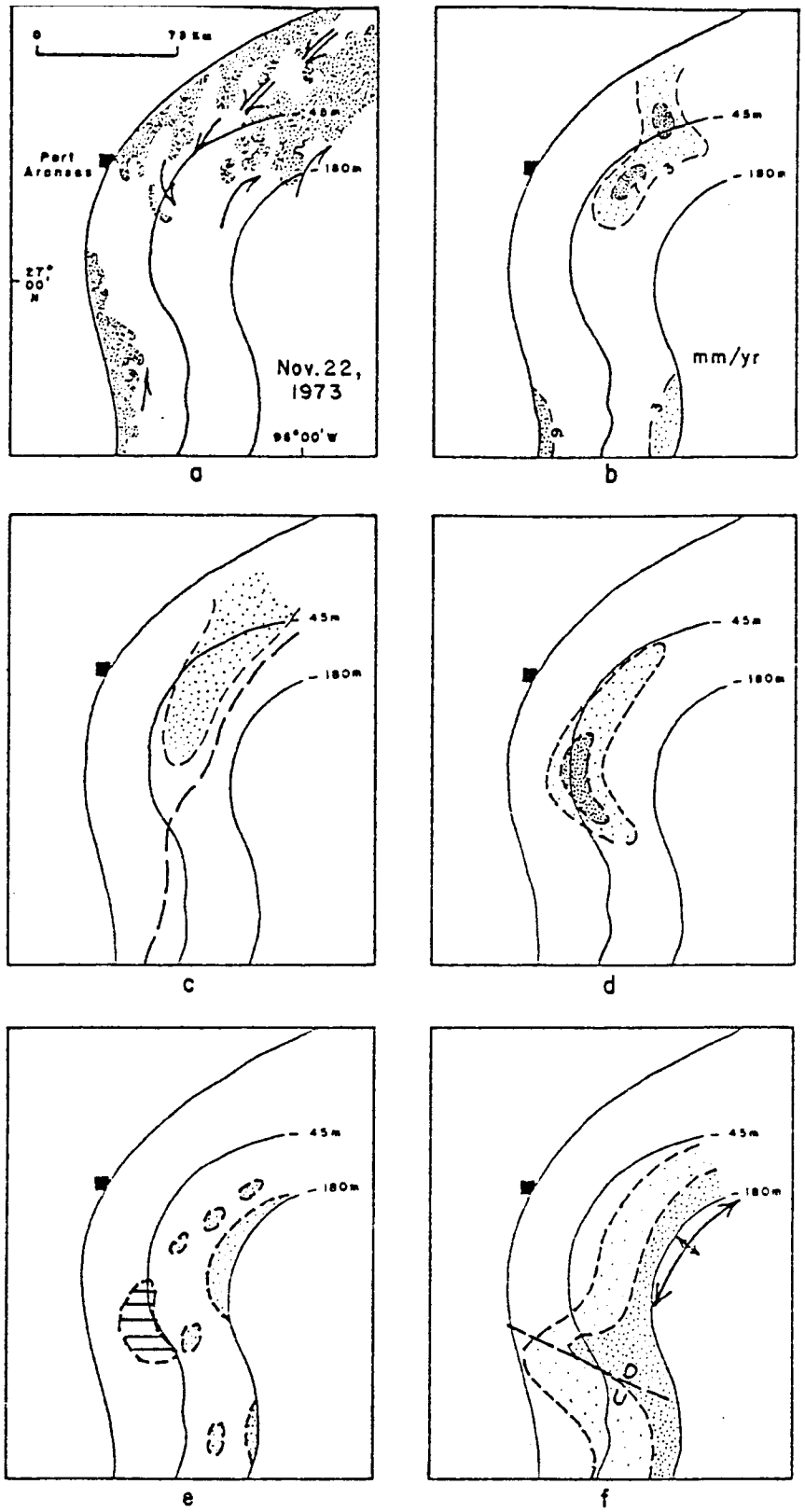


Figure 235. Interrelations of principal processes, past and present:

a) Patterns of transport for suspended sediments. Data on sediment plumes and water movement taken from ERTS imagery. Adapted from Hunter, written commun.
b) Current rates of sedimentation as indicated by ^{210}Pb.
c) Area of current depocenter as indicated by core data; the heavy dashed line indicates the apparent seaward extent of discrete sands carried over the shelf in the aftermath of hurricanes.
d) Principal depocenter during the late Pleistocene and early Holocene.
e) Areas of suspected natural gas seepage; lined pattern indicates area of probable high gas content at shallow depth.
f) Chronology of faulting: Innermost line indicates extent of late Pleistocene faulting; heavy stippling indicates extent of Holocene faulting.

of distribution shown by the figures demonstrate rather well the close interrelationship of the processes that have molded the environmental character of the South Texas OCS. The work during the second year confirms the general patterns outlined by the work done in 1975 and adds quantification for the suspended sediments on a seasonal basis. The striking similarity in the distributive patterns for the several aspects of the suspended sediments and the benthic sediments shown by the figures indicates on one hand the control of sediment movement and deposition by water movement and on the other a confirmation of the seasonal and longer term patterns of water movement. The two regimes of water movement over the South Texas OCS indicated by studies during the first year are confirmed in a general sense: fluvial water inflow to the inner and northern parts; and encroachment of water from the deeper gulf onto the outer part. An additional factor controlling distribution of the trace metals in sediments of the outer shelf, both suspended and benthic, may be biological. The increased amounts of trace metals in suspended sediments along the outer edge of the shelf where the amount of suspended inorganic particulates is low, may be associated with specific elements of the plankton, such as the foraminifera. Skeletal remains of forams are a prominent constituent of the benthic sediments along the outer shelf in the same general area where amounts of some of the trace metals in the suspended sediments are greater than in the suspended sediments of the inner shelf. Another possibility is that the increase in trace metals reflects the seepage of natural gas, even though the benthic sediments, according to Holmes, do not seem to have abnormally large concentrations of trace metals as a result of the gas seepage.

RESULTS RELATIVE TO STUDY OBJECTIVES

The salient results and conclusions relative to the objectives stated in the introduction are as follows:

1. <u>The amounts, composition, sources, and dispersal patterns for inorganic particulate matter suspended in the water column</u>

   a) Amounts of suspended particulate matter are largest along the inner shelf as would be expected. Geographically, amounts were largest in 1976 over the northern and inner central parts of the shelf; seasonally, amounts in November 1975 were larger than in May 1976. The principal sources for the suspended sediments in 1976 were the inlets along the northern part of the South Texas OCS as well as those farther north; a subordinate source was the Rio Grande. (See figs. 231 to 233.)

   b) The inorganic constituents, as determined by X-ray diffractometer, were, in order of abundance, quartz and clay minerals. Of the clay minerals, montmorillonite (17 Å) was predominant over the northern part of the shelf. Illite was predominant over the southern part and in the waters just above the sea floor in all parts of the shelf. (See figs. 230 to 233.)

   c) Regionally, the trace metals content of the suspended material had distinct patterns of distribution relative to the dispersal patterns for the total suspended particulates. Two geographic patterns of increased abundance were indicated for all trace metals except chromium: one on the inner shelf that relates closely to the larger amounts of total suspended particulates normal to that part of the shelf; and a second over the outer part of the shelf where relative amounts of total suspended particulates are lower and the inorganic particulates are very low. The increased amounts of trace metals on the inner shelf reflect in part the larger amounts of terrestrially derived particulates and in part the larger amounts of suspended biological constituents. As stated previously, the increased amounts

over the outer shelf probably reflect specific biological components, but may reflect natural gas seepage as well. Chromium, with the exception of the surface samples for May, 1976, was substantially more abundant over the outer part of the shelf.

2. Textural stratigraphy and sedimentary structures, shallow subbottom sediments

a) The grain size analyses of selected complete cores indicate that collective textural differences can be used to classify genetically the three types of benthic sediments represented on the South Texas OCS: relict deposits of the two ancestral deltas; the palimpsest or retransported and redeposited relict sediments; and the modern deposits carried onto the shelf during the Holocene. No single textural criterion can be used for genetic differentiation.

b) The discrete sand layers are the most useful stratigraphic component for determining the most prevalent patterns of sediment transport and deposition over the shelf. Analysis of the cores in depth increments indicates that sand in quantities sufficient to form discrete layers has been carried repeatedly seaward beyond midshelf, probably in the aftermath of hurricane passage when ebbing floodtides along the shoreline carried large quantities of sediments from the bays and barrier islands well out onto the shelf as turbidity flows. The crudely developed current-ripple and cross-laminal structures in the sand layers, indicative of faster moving water, plus the graded grain size in many of the layers support the stratigraphic evidence. The incremental analyses, carried to a subseafloor depth of 150 cm, demonstrate that the patterns of sediment dispersal have undergone little significant change for the period of time represented.

3. Animal-sediment relationships

a) The distribution of the infauna relative to the types of benthic sediments and the depth of water indicated by analysis of 74 benthic samples during the first year of study were confirmed by completion of the additional 190 samples. Localized refinements to the patterns of distribution were made but no changes of regional significance were indicated.

b) The results for 1976 also confirmed the relatively high degree of bioturbation or textural modification of the benthic sediments by the activity of infaunal organisms. The bioturbation has been most intensive in those parts of the OCS floored by sediments that have larger amounts of silt and sand and has been very low in the clayey sediments of the outer shelf.

4. Rates of sedimentation

a) Measurement of sedimentation rates for approximately the past 150 years, using ^{210}Pb as the dating agent, indicates considerable variation over the shelf: from 0 to as much as 9 mm per year. The rate has been highest over the northern part of the shelf.

b) The location of the present depocenter, as indicated by the ^{210}Pb data, is supported by both the core data and the more empirical oceanographic data. The patterns by which the sediments are transported and deposited under normal climatic conditions seem to reflect, as a general long-term process, the pattern of water movement indicated by the map, figure 235c.

5. Relation of trace metals concentrations in bottom sediments to natural gas seepage

a) Relative to the expectations expressed in the choice of the topic for study, the results were negative.

b) As indicated previously, the increased amounts of trace metals in the suspended sediments over the outer shelf could reflect gas seepage into the water, where it is picked up by microorganisms, even though the metals apparently are not being concentrated in the benthic sediments themselves.

6. Late Quaternary history and Holocene geology

a) The continental terrace off south Texas, though historically aseismic, has been molded by tectonism. Trends reflected by the thickness of late Pleistocene and Holocene stratigraphic sequences indicate control by structural movements, including diapirism and sediment loading, and significant fluctuations in sea level caused by cyclic glaciation. Faulting has been a continuous process; since late Pleistocene time the intensity of faulting has moved progressively seaward across the shelf. The most recent faulting has been along the outermost part of the shelf; continued faulting can be expected along a diapiric ridge or anticline that lies seaward of the shelf edge.

b) The main depocenter of sedimentation on the shelf has shifted northward since early Holocene time from just north of the ancestral Rio Grande delta to its present position on the northern part of the OCS. The earlier position of the depocenter was structurally controlled. The structural depression that acted as the depocenter became filled in early Holocene time. The present depocenter reflects the location of the sediment source and the prevailing oceanographic processes.

c) The series of maps that show the stratigraphy, thickness and distribution of late Pleistocene and Holocene deposits relative to earlier

positions of sea level provide a general guide to the competency of the buried sequence of beds for supporting man-made structures: probable nature and coherence of the deposits as indicated by the depositional history; depth to the harder surfaces represented by the paleo land surfaces; and susceptibility to faulting and slumping.

In summary, the results of analyses of benthic sediments transmitted to USGS by the University of Texas for determination of seasonal variations in grain size and trace metals content at biological stations were as follows:

1. Seasonal variation in the grain size of sediments at individual stations was indicated. The variation from one season to another in terms of sand/mud ratios was greatest along the inner shelf where water depths were shallowest, as would be expected. Causes for the seasonal variability probably are two-fold: sand is most abundant and transitory along the inner shelf; and the inner shelf is subject to a wider range in the energy of moving water. Transect 4, which crosses the highly variable relict sediments of the ancestral Rio Grande delta, had the most pronounced variations.
2. Seasonal variations in the trace metals content of the sediments at the biological stations also were indicated. The reason for the variations, significant in some cases, were not clearly established. The probable cause is variations in the magnitude of infaunal activity from one season to another. Considering the high degree of bioturbation documented for the South Texas OCS, significant modification of the sediment in the near-surface zone by infaunal activity logically would be expected.
3. Comparison of the analytical results for samples collected in November 1975 with those collected in November 1974 demonstrated a strong correlation. Even though the density of sample stations differed

(264 in 1975; 26 in 1974), the amounts of the trace metals in the sediments, both locally and regionally, were similar. Thus, the patterns of distribution indicated by the results in November 1974 were confirmed as characteristic of the South Texas OCS for that time of year. As samples for trace metals were collected only once during 1974, comparisons for the other seasons could not be made.

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APPENDIXES

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EXPLANATION FOR APPENDIX 1:

Properties of Suspended Sediments in Water-Column Samples

Column 1 - Sample station number: OCSS = STOCS 1976 program, second character = station locality, third character = water column sampling level (T = Top, M = mid depth, B = Bottom)

Column 2 - Sampling date

Column 3 - Station latitude

Column 4 - Station longitude

Column 5 - Water sample depth (meters)

Column 6 - Water sample in situ temperature (C°)

Column 7 - Water sample light transmissivity (% transmission/meter)

Column 8 - Data sheet designation number (#1 = first data sheet)

Column 9 - Sample station number (reiteration)

Column 10 - Total sediment particle counts (0.63-81 μm size range) x 10^4/cc of water sample

Column 11 - Suspended-sediment silt/clay ratio

Column 12 - Suspended-sediment mean diameter in phi units (first moment)

Column 13 - Suspended-sediment standard deviation in phi units (second moment)

Column 14 - Suspended-sediment skewness (third moment)

Column 15 - Data sheet designation number (#2 = second data sheet)

Note: The designation "ND" indicates no data for that specific item

Appendix 1 - Properties of Suspended Sediments in Water-Column Samples
November, 1975

1	2	3	4	5	6	7	8
OCSS-1-T	11-15-75	28.41774	96.27237	0.0	21.25	2.4	1
OCSS-1-M	11-15-75	28.41774	96.27237	4.5	21.50	2.4	1
OCSS-1-B	11-15-75	28.41774	96.27237	8.0	21.50	1.5	1
OCSS-1A-T	11-16-75	28.38739	96.32788	0.0	21.25	0.0	1
OCSS-1A-M	11-16-75	28.38739	96.32788	3.7	21.25	0.0	1
OCSS-1A-B	11-16-75	28.38739	96.32788	6.5	21.25	0.0	1
OCSS-2-T	11-16-75	28.34666	96.37500	0.0	22.00	24.0	1
OCSS-2-M	11-16-75	28.34666	96.37500	1.8	22.00	25.8	1
OCSS-2-B	11-16-75	28.34666	96.37500	2.7	22.19	26.1	1
OCSS-3-T	11-16-75	28.17822	96.38748	0.0	22.25	7.6	1
OCSS-3-M	11-16-75	28.17822	96.38748	12.0	22.25	22.0	1
OCSS-3-B	11-16-75	28.17822	96.38748	20.7	22.25	ND	1
OCSS-4-T	11-16-75	27.99858	96.14554	0.0	23.75	60.0	1
OCSS-4-M	11-16-75	27.99858	96.14554	19.6	23.75	50.3	1
OCSS-4-B	11-16-75	27.99858	96.14554	38.3	23.75	38.5	1
OCSS-5-T	11-16-75	27.73987	96.00642	0.0	24.50	79.7	1
OCSS-5-M	11-16-75	27.73987	96.00642	61.0	24.63	78.9	1
OCSS-5-B	11-16-75	27.73987	96.00642	78.0	22.25	76.4	1
OCSS-6-T	11-17-75	27.56316	95.95996	0.0	24.00	86.7	1
OCSS-6-M	11-17-75	27.56316	95.95996	47.0	24.94	78.1	1
OCSS-6-B	11-17-75	27.56316	95.95996	174.5	ND	ND	1
OCSS-7-T	11-17-75	27.68718	96.29082	0.0	24.75	96.1	1
OCSS-7-M	11-17-75	27.68718	96.29082	32.0	24.75	90.4	1
OCSS-7-B	11-17-75	27.68718	96.29082	63.5	24.75	84.9	1
OCSS-8-T	11-17-75	27.78411	96.59290	0.0	23.00	70.1	1
OCSS-8-M	11-17-75	27.78411	96.59290	30.0	24.25	74.8	1
OCSS-8-B	11-17-75	27.78411	96.59290	38.0	24.75	35.1	1
OCSS-9-T	11-21-75	27.84696	96.98851	0.0	20.00	0.0	1
OCSS-9-M	11-21-75	27.84696	96.98851	4.8	20.00	0.0	1
OCSS-9-B	11-21-75	27.84696	96.98851	10.5	20.00	0.0	1

Appendix 1

November, 1975

9	10	11	12	13	14	15	16
OCSS-1-T	91.4	1.48	7.78	1.26	-0.04	0.23	?
OCSS-1-M	111.5	0.99	7.99	1.23	-0.15	0.40	?
OCSS-1-B	159.2	2.03	7.59	1.13	-0.01	0.58	?
OCSS-1A-T	185.9	1.93	7.43	1.35	-0.10	-0.12	?
OCSS-1A-M	199.8	2.40	7.25	1.35	-0.05	-0.30	?
OCSS-1A-B	224.3	2.45	7.22	1.39	-0.06	-0.32	?
OCSS-2-T	132.9	1.28	7.73	1.20	-0.17	0.14	?
OCSS-2-M	174.5	1.27	7.76	1.18	-0.14	0.07	?
OCSS-2-B	183.2	1.24	7.80	1.18	-0.12	0.19	?
OCSS-3-T	29.3	1.22	7.82	1.51	-0.06	-0.48	?
OCSS-3-M	20.6	1.34	7.58	1.79	-0.02	-0.87	?
OCSS-3-B	ND	ND	ND	ND	ND	ND	?
OCSS-4-T	15.1	1.09	7.55	2.16	-0.06	-1.26	?
OCSS-4-M	41.8	1.28	7.35	2.23	0.00	-1.38	?
OCSS-4-B	16.4	2.45	7.16	1.56	0.23	-0.42	?
OCSS-5-T	12.1	1.34	7.59	1.79	-0.02	-0.87	?
OCSS-5-M	12.0	2.66	6.94	1.74	0.22	-0.64	?
OCSS-5-B	11.5	1.42	7.61	1.67	-0.06	-0.53	?
OCSS-6-T	26.1	1.01	7.69	2.07	-0.10	-1.14	?
OCSS-6-M	19.5	1.46	7.65	1.65	-0.30	-0.54	?
OCSS-6-B	14.0	2.04	7.36	1.66	0.12	-0.54	?
OCSS-7-T	22.9	1.41	7.40	2.07	0.04	-1.25	?
OCSS-7-M	17.9	1.08	7.77	2.00	-0.06	-1.12	?
OCSS-7-B	14.2	2.39	7.24	1.60	0.20	-0.55	?
OCSS-8-T	40.6	1.41	7.58	1.89	0.05	-1.17	?
OCSS-8-M	34.9	3.09	6.68	1.79	0.36	-0.54	?
OCSS-8-B	19.1	1.96	7.48	1.45	0.08	-0.31	?
OCSS-9-T	224.3	1.44	7.67	1.23	-0.11	0.07	?
OCSS-9-M	237.7	1.40	7.71	1.17	-0.06	0.04	?
OCSS-9-B	248.4	1.88	7.45	1.30	-0.11	0.05	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-9A-T	11-21-75	27.79668	97.02267	0.0	20.50	0.0	1
OCSS-9A-M	11-21-75	27.79668	97.02267	5.5	20.50	0.0	1
OCSS-9A-B	11-21-75	27.79668	97.02267	9.9	20.50	0.0	1
OCSS-10-T	11-18-75	27.57692	96.74031	0.0	23.00	86.7	1
OCSS-10-M	11-18-75	27.57692	96.74031	22.0	23.25	76.4	1
OCSS-10-B	11-18-75	27.57692	96.74031	38.7	24.50	19.0	1
OCSS-11-T	11-18-75	27.43317	96.53265	0.0	24.25	78.1	1
OCSS-11-M	11-18-75	27.43317	96.53265	51.0	24.44	67.1	1
OCSS-11-B	11-18-75	27.43317	96.53265	78.5	ND	ND	1
OCSS-12-T	11-18-75	27.13619	96.40814	0.0	23.00	99.6	1
OCSS-12-M	11-18-75	27.13619	96.40814	81.4	22.50	99.6	1
OCSS-12-B	11-18-75	27.13619	96.40814	161.8	ND	ND	1
OCSS-13-T	11-19-75	27.05201	96.71562	0.0	22.25	71.6	1
OCSS-13-M	11-19-75	27.05201	96.71562	31.0	24.44	45.2	1
OCSS-13-B	11-19-75	27.05201	96.71562	75.5	ND	ND	1
OCSS-14-T	11-19-75	26.96700	97.04292	0.0	21.75	61.3	1
OCSS-14-M	11-19-75	26.96700	97.04292	11.0	22.50	68.6	1
OCSS-14-B	11-19-75	26.96700	97.04292	33.5	24.00	0.2	1
OCSS-16-T	11-20-75	26.53405	97.09422	0.0	22.50	39.9	1
OCSS-16-M	11-20-75	26.53405	97.09422	10.0	22.50	43.0	1
OCSS-16-B	11-20-75	26.53405	97.09422	21.0	23.25	0.0	1
OCSS-17-T	11-19-75	26.53075	96.90106	0.0	22.25	44.1	1
OCSS-17-M	11-19-75	26.53075	96.90106	12.0	23.00	36.1	1
OCSS-17-B	11-19-75	26.53075	96.90106	36.5	24.75	2.8	1
OCSS-18-T	11-19-75	26.44037	96.51613	0.0	22.00	57.3	1
OCSS-18-M	11-19-75	26.44037	96.51613	33.0	25.19	51.6	1
OCSS-18-B	11-19-75	26.44037	96.51613	67.0	ND	ND	1
OCSS-19-T	11-19-75	26.41209	96.34731	0.0	22.75	71.6	1
OCSS-19-M	11-19-75	26.41209	96.34731	71.0	24.56	89.4	1
OCSS-19-B	11-19-75	26.41209	96.34731	107.7	ND	ND	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-9A-T	187.7	1.51	7.68	1.16	-0.06	-0.02	?
OCSS-9A-M	245.7	1.60	7.56	1.28	-0.17	0.21	?
OCSS-9A-B	205.7	1.98	7.53	1.16	0.01	-0.14	?
OCSS-10-T	32.1	1.10	7.58	2.16	-0.07	-1.29	?
OCSS-10-M	28.7	1.03	7.77	2.04	-0.08	-1.20	?
OCSS-10-B	42.5	1.67	7.71	1.24	0.00	0.36	?
OCSS-11-T	26.7	1.64	7.38	1.84	0.02	-0.89	?
OCSS-11-M	18.1	2.14	7.23	1.71	0.14	-0.71	?
OCSS-11-B	23.1	1.63	7.72	1.22	-0.02	0.43	?
OCSS-12-T	26.7	1.74	7.14	2.09	0.10	-1.17	?
OCSS-12-M	9.1	1.68	7.00	2.11	0.09	-1.17	?
OCSS-12-B	7.0	1.66	7.61	1.51	0.01	-0.30	?
OCSS-13-T	23.2	1.88	7.17	1.91	0.15	-0.98	?
OCSS-13-M	9.9	1.54	7.21	1.97	0.02	-1.02	?
OCSS-13-B	51.3	1.45	7.72	1.11	-0.11	0.39	?
OCSS-14-T	37.7	1.92	7.11	1.93	0.20	-1.07	?
OCSS-14-M	32.8	1.36	7.49	1.94	0.01	-1.13	?
OCSS-14-B	93.4	2.20	7.36	1.22	-0.05	-0.12	?
OCSS-16-T	42.8	2.28	6.89	1.93	0.24	-0.90	?
OCSS-16-M	35.3	1.83	7.10	2.00	0.15	-1.10	?
OCSS-16-B	152.1	3.10	7.03	1.35	-0.04	-0.37	?
OCSS-17-T	52.1	0.87	7.96	1.92	-0.15	-0.97	?
OCSS-17-M	37.5	1.16	7.52	2.05	-0.04	-1.14	?
OCSS-17-B	51.9	1.37	7.72	1.53	-0.17	0.51	?
OCSS-18-T	66.9	0.98	7.75	2.08	-0.09	-1.25	?
OCSS-18-M	21.7	1.18	7.72	1.53	-0.20	-0.21	?
OCSS-18-B	22.2	0.94	8.02	1.37	-0.27	0.44	?
OCSS-19-T	29.4	0.85	8.01	1.94	-0.14	-1.06	?
OCSS-19-M	25.4	0.78	7.97	1.83	-0.21	-0.84	?
OCSS-19-B	28.5	1.34	7.75	1.15	-0.15	0.41	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-20-T	11-19-75	26.26283	96.56506	0.0	22.50	76.4	1
OCSS-20-M	11-19-75	26.26283	96.56506	23.5	24.25	92.2	1
OCSS-20-B	11-19-75	26.26283	96.56506	46.0	25.00	22.7	1
OCSS-21-T	11-19-75	26.18097	96.81056	0.0	22.25	68.6	1
OCSS-21-M	11-19-75	26.18097	96.81056	18.0	23.75	73.2	1
OCSS-21-B	11-19-75	26.18097	96.81056	37.0	25.25	52.2	1
OCSS-22-T	11-20-75	26.17506	96.99780	0.0	22.25	53.4	1
OCSS-22-M	11-20-75	26.17506	96.99780	17.0	23.25	64.2	1
OCSS-22-B	11-20-75	26.17506	96.99780	24.0	24.75	0.0	1
OCSS-23-T	11-20-75	26.08895	97.11304	0.0	23.25	0.0	1
OCSS-23-M	11-20-75	26.08895	97.11304	8.0	23.75	71.6	1
OCSS-23-B	11-20-75	26.08895	97.11304	11.0	23.50	83.2	1
OCSS-23A-T	11-20-75	26.03070	97.10454	0.0	23.25	6.0	1
OCSS-23A-M	11-20-75	26.03070	97.10454	7.0	24.00	78.1	1
OCSS-23A-B	11-20-75	26.03070	97.10454	13.0	24.00	76.4	1
OCSS-24-T	11-20-75	25.99561	97.10997	0.0	23.50	2.7	1
OCSS-24-M	11-20-75	25.99561	97.10997	4.6	23.50	2.9	1
OCSS-24-B	11-20-75	25.99561	97.10997	12.0	24.25	0.0	1

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OCSS-1-T	3-2-76	28.41774	96.27237	0.0	14.50	0.0	1
OCSS-1-M	3-2-76	28.41774	96.27237	2.7	14.50	0.0	1
OCSS-1-B	3-2-76	28.41774	96.27237	4.5	14.50	0.0	1
OCSS-1A-T	3-2-76	28.38739	96.32788	0.0	15.75	1.5	1
OCSS-1A-M	3-2-76	28.38739	96.32788	5.2	15.50	0.6	1
OCSS-1A-B	3-2-76	28.38739	96.32788	8.0	15.25	0.0	1
OCSS-2-T	3-2-76	28.34792	96.38156	0.0	15.50	0.0	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-20-T	40.8	0.87	7.84	2.18	-0.13	-1.29	?
OCSS-20-M	18.9	0.95	7.95	1.64	-0.14	-0.57	?
OCSS-20-B	28.9	1.67	7.65	1.24	-0.07	0.39	?
OCSS-21-T	34.1	1.01	7.78	1.98	-0.07	-1.17	?
OCSS-21-M	16.6	1.26	7.47	1.95	-0.07	-1.02	?
OCSS-21-B	19.4	1.10	7.87	1.33	-0.26	0.66	?
OCSS-22-T	35.6	0.99	7.87	1.87	-0.08	-1.00	?
OCSS-22-M	29.1	1.25	7.43	2.09	-0.01	-1.18	?
OCSS-22-B	98.1	0.69	8.17	0.88	-0.08	1.14	?
OCSS-23-T	181.6	0.48	8.25	1.09	-0.54	2.57	?
OCSS-23-M	66.5	0.90	8.05	1.02	-0.28	2.55	?
OCSS-23-B	42.9	0.84	7.99	1.96	-0.18	-0.93	?
OCSS-23A-T	68.9	0.46	8.33	1.09	-0.44	2.63	?
OCSS-23A-M	24.9	1.11	7.45	1.98	-0.11	-0.93	?
OCSS-23A-B	20.4	1.70	6.84	2.12	0.06	-1.21	?
OCSS-24-T	55.4	0.60	8.19	1.14	-0.51	3.03	?
OCSS-24-M	84.4	0.78	8.09	1.06	-0.35	2.49	?
OCSS-24-B	31.6	2.66	7.22	1.36	0.00	-0.04	?

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OCSS-1-T	109.6	0.87	8.01	1.15	-0.16	0.31	?
OCSS-1-M	149.7	0.88	8.06	1.10	-0.21	1.00	?
OCSS-1-B	161.9	0.89	8.01	1.11	-0.29	1.25	?
OCSS-1A-T	84.9	1.06	7.88	1.35	-0.15	-0.04	?
OCSS-1A-M	210.8	1.00	7.88	1.16	-0.27	0.58	?
OCSS-1A-B	106.7	0.98	7.92	1.27	-0.17	0.01	?
OCSS-2-T	203.0	1.25	7.74	1.22	-0.22	0.31	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-2-M	3-2-76	28.34792	96.38156	4.5	15.50	0.0	1
OCSS-2-B	3-2-76	28.34792	96.38156	7.0	15.25	0.0	1
OCSS-3-T	3-3-76	28.17822	96.38748	0.0	14.25	54.7	1
OCSS-3-M	3-3-76	28.17822	96.38748	10.0	13.75	58.6	1
OCSS-3-B	3-3-76	28.17822	96.38748	16.0	12.75	51.0	1
OCSS-4-T	3-3-76	27.99858	96.14554	0.0	14.75	54.7	1
OCSS-4-M	3-3-76	27.99858	96.14554	15.0	14.25	48.6	1
OCSS-4-B	3-3-76	27.99858	96.14554	32.0	15.75	35.1	1
OCSS-5-T	3-3-76	27.73987	96.00642	0.0	20.50	79.7	1
OCSS-5-M	3-3-76	27.73987	96.00642	43.0	20.00	78.1	1
OCSS-5-B	3-3-76	27.73987	96.00642	84.0	ND	ND	1
OCSS-6-T	3-3-76	27.56316	95.95996	0.0	20.50	78.1	1
OCSS-6-M	3-3-76	27.56316	95.95996	95.0	19.50	84.9	1
OCSS-6-B	3-3-76	27.56316	95.95996	191.0	ND	ND	1
OCSS-7-T	3-6-76	27.68718	96.29082	0.0	20.50	90.3	1
OCSS-7-M	3-6-76	27.68718	96.29082	40.0	20.00	90.3	1
OCSS-7-B	3-6-76	27.68718	96.29082	79.0	ND	ND	1
OCSS-8-T	3-3-76	27.74811	96.59290	0.0	19.00	76.4	1
OCSS-8-M	3-3-76	27.74811	96.59290	20.5	19.00	76.4	1
OCSS-8-B	3-3-76	27.74811	96.59290	39.0	19.75	48.6	1
OCSS-9-T	3-3-76	27.84696	96.98851	0.0	15.50	19.6	1
OCSS-9-M	3-3-76	27.84696	96.98851	5.0	15.50	20.2	1
OCSS-9-B	3-3-76	27.84696	96.98851	10.0	ND	ND	1
OCSS-9A-T	3-3-76	27.79668	97.02267	0.0	15.25	0.1	1
OCSS-9A-M	3-3-76	27.79668	97.02267	6.0	15.25	0.1	1
OCSS-9A-B	3-3-76	27.79668	97.02267	10.5	15.25	0.0	1
OCSS-10-T	3-4-76	27.57692	96.74031	0.0	15.00	56.0	1
OCSS-10-M	3-4-76	27.57692	96.74031	20.0	14.75	62.7	1
OCSS-10-B	3-4-76	27.57692	96.74031	41.0	15.75	41.0	1
OCSS-11-T	3-4-76	27.43317	96.53265	0.0	16.50	86.7	1

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9	10	11	12	13	14	15	16
OCSS-2-M	221.8	1.04	7.74	1.36	-0.40	0.68	?
OCSS-2-B	329.3	1.30	7.33	1.64	-0.27	-0.59	?
OCSS-3-T	38.5	1.75	7.36	1.72	0.11	-0.97	?
OCSS-3-M	20.7	1.33	7.53	1.75	0.00	-1.00	?
OCSS-3-B	94.6	0.89	8.03	1.17	-0.19	0.51	?
OCSS-4-T	25.5	1.99	6.94	1.99	0.18	-1.05	?
OCSS-4-M	16.5	1.23	7.54	2.04	-0.01	-1.17	?
OCSS-4-B	21.8	1.83	7.49	1.52	0.03	-0.41	?
OCSS-5-T	10.4	1.53	6.94	2.16	0.07	-1.25	?
OCSS-5-M	7.5	0.88	7.76	1.98	-0.17	-0.94	?
OCSS-5-B	10.6	1.02	7.71	1.81	-0.17	-0.68	?
OCSS-6-T	8.5	1.00	7.56	2.11	-0.12	-1.11	?
OCSS-6-M	4.2	1.38	7.38	1.91	-0.01	-1.16	?
OCSS-6-B	8.9	1.29	7.72	1.51	-0.15	-0.14	?
OCSS-7-T	12.1	1.05	7.70	1.92	-0.08	-1.04	?
OCSS-7-M	10.5	1.44	7.26	2.03	0.02	-1.15	?
OCSS-7-B	28.7	0.85	8.05	1.41	-0.24	0.43	?
OCSS-8-T	15.9	1.11	7.54	2.05	-0.05	-1.22	?
OCSS-8-M	24.2	1.34	7.40	2.16	0.05	-1.37	?
OCSS-8-B	16.9	1.75	7.31	1.86	0.09	-1.05	?
OCSS-9-T	32.3	1.89	7.49	1.54	0.13	-0.58	?
OCSS-9-M	37.5	1.63	7.61	1.55	0.06	-0.60	?
OCSS-9-B	49.5	3.02	7.30	1.30	0.32	0.04	?
OCSS-9A-T	83.9	2.15	7.54	1.12	0.02	0.49	?
OCSS-9A-M	91.4	2.18	7.54	1.10	0.01	0.50	?
OCSS-9A-B	184.1	1.64	7.61	1.17	-0.21	0.75	?
OCSS-10-T	20.5	1.14	7.54	2.00	-0.06	-1.10	?
OCSS-10-M	14.4	1.29	7.45	1.95	-0.02	-1.07	?
OCSS-10-B	27.5	1.86	7.20	1.91	0.10	-1.02	?
OCSS-11-T	13.7	1.02	7.57	2.13	-0.09	-1.19	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-11-M	3-4-76	27.43317	96.53265	36.0	16.00	74.8	1
OCSS-11-B	3-4-76	27.43317	96.53265	76.0	15.00	28.4	1
OCSS-12-T	3-4-76	27.13619	96.40814	0.0	16.50	65.6	1
OCSS-12-M	3-4-76	27.13619	96.40814	87.0	14.50	67.1	1
OCSS-12-B	3-4-76	27.13619	96.40814	173.0	ND	ND	1
OCSS-13-T	3-4-76	27.05201	96.71562	0.0	15.50	71.6	1
OCSS-13-M	3-4-76	27.05201	96.71562	56.0	15.50	78.1	1
OCSS-13-B	3-4-76	27.05201	96.71562	81.0			1
OCSS-14-T	3-4-76	26.96700	97.04292	0.0	15.50	54.7	1
OCSS-14-M	3-4-76	26.96700	97.04292	29.0	15.25	70.1	1
					ND	ND	
OCSS-14-B	3-4-76	26.96700	97.04292	36.0	15.50	22.7	1
OCSS-16-T	3-4-76	26.53405	97.09422	0.0	16.25	28.4	1
OCSS-16-M	3-4-76	26.53405	97.09422	15.0	15.75	44.1	1
OCSS-16-B	3-4-76	26.53405	97.09422	21.0	16.00	8.5	1
OCSS-17-T	3-4-76	26.53075	96.90106	0.0	16.00	51.0	1
OCSS-17-M	3-4-76	26.53075	96.90106	19.0	15.75	68.6	1
OCSS-17-B	3-4-76	26.53075	96.90106	37.0	ND	ND	1
OCSS-18-T	3-5-76	26.44037	96.51613	0.0	20.50	76.4	1
OCSS-18-M	3-5-76	26.44037	96.51613	35.0	20.25	86.7	1
OCSS-18-B	3-5-76	26.44037	96.51613	67.0	ND	ND	1
OCSS-19-T	3-5-76	26.41209	96.34731	0.0	17.00	79.7	1
OCSS-19-M	3-5-76	26.41209	96.34731	48.0	16.25	84.9	1
OCSS-19-B	3-5-76	26.41209	96.34731	96.0	15.00	86.7	1
OCSS-20-T	3-5-76	26.26283	96.56506	0.0	16.25	73.2	1
OCSS-20-M	3-5-76	26.26283	96.56506	25.0	16.00	79.7	1
OCSS-20-B	3-5-76	26.26283	96.56506	47.0	15.50	46.3	1
OCSS-21-T	3-5-76	26.18097	96.81056	0.0	16.00	60.0	1
OCSS-21-M	3-5-76	26.18097	96.81056	25.0	16.00	65.6	1
OCSS-21-B	3-5-76	26.18097	96.81056	35.5	ND	ND	1
OCSS-22-T	3-5-76	26.17506	96.99780	0.0	16.25	61.3	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-11-M	3.5	0.78	7.84	2.09	-0.19	-1.04	?
OCSS-11-B	14.6	1.04	8.05	1.18	-0.10	1.05	?
OCSS-12-T	3.5	0.93	7.89	1.91	-0.12	-0.98	?
OCSS-12-M	8.5	1.01	7.36	1.63	-0.08	-0.31	?
OCSS-12-B	6.9	1.29	7.57	1.68	-0.20	-0.30	?
OCSS-13-T	17.0	0.97	7.88	1.78	-0.10	-0.96	?
OCSS-13-M	11.0	1.02	7.60	1.98	-0.13	-0.95	?
OCSS-13-B	30.2	0.59	8.26	0.89	-0.05	1.86	?
OCSS-14-T	19.6	1.13	7.50	2.02	-0.09	-1.06	?
OCSS-14-M	17.0	1.53	7.35	1.91	0.07	-1.18	?
OCSS-14-B	28.7	1.46	7.58	1.61	-0.04	-0.62	?
OCSS-16-T	51.1	0.55	8.28	1.62	-0.40	0.26	?
OCSS-16-M	37.2	1.09	7.77	1.75	-0.13	-0.70	?
OCSS-16-B	47.2	2.04	7.39	1.42	0.02	-0.30	?
OCSS-17-T	19.5	0.93	7.84	1.82	-0.17	-0.78	?
OCSS-17-M	17.9	1.22	7.62	1.83	-0.05	-0.99	?
OCSS-17-B	22.5	1.06	7.87	1.53	-0.11	-0.50	?
OCSS-18-T	22.5	0.93	7.92	1.86	-0.12	-0.99	?
OCSS-18-M	15.8	1.16	7.66	1.90	-0.03	-1.08	?
OCSS-18-B	23.8	1.19	7.90	1.27	-0.07	0.41	?
OCSS-19-T	10.0	1.20	7.40	2.09	-0.03	-1.27	?
OCSS-19-M	7.3	1.34	7.44	2.00	0.00	-1.17	?
OCSS-19-B	4.5	1.05	7.63	1.99	-0.09	-1.17	?
OCSS-20-T	22.8	0.88	7.57	2.22	-0.15	-1.23	?
OCSS-20-M	12.3	1.37	7.39	2.05	0.01	-1.20	?
OCSS-20-B	11.1	1.36	7.70	1.56	-0.06	-0.49	?
OCSS-21-T	13.9	1.13	7.64	1.95	-0.06	-1.08	?
OCSS-21-M	13.7	1.32	7.36	2.05	-0.00	-1.17	?
OCSS-21-B	20.2	0.90	7.99	1.53	-0.21	-0.01	?
OCSS-22-T	16.6	1.24	7.27	2.10	-0.02	-1.22	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-22-M	3-5-76	26.17506	96.99780	14.0	16.00	76.4	1
OCSS-22-B	3-5-76	26.17506	96.99780	20.5	15.50	73.2	1
OCSS-23-T	3-5-76	26.08895	97.11304	0.0	16.25	1.7	1
OCSS-23-M	3-5-76	26.08895	97.11304	7.0	16.25	1.3	1
OCSS-23-B	3-5-76	26.08895	97.11304	14.0	15.75	0.0	1
OCSS-23A-T	3-5-76	26.03070	97.10454	0.0	16.00	1.3	1
OCSS-23A-M	3-5-76	26.03070	97.10454	8.0	16.00	1.9	1
OCSS-23A-B	3-5-76	26.03070	97.10454	14.0	ND	ND	1
OCSS-24-T	3-5-76	25.99561	97.10997	0.0	16.00	2.1	1
OCSS-24-M	3-5-76	25.99561	97.10997	8.0	15.75	3.4	1
OCSS-24-B	3-5-76	25.99561	97.10997	12.5	ND	ND	1

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OCSS-1-T	5-21-76	28.41774	96.27237	0.0	21.00	32.5	1
OCSS-1-M	5-21-76	28.41774	96.27237	2.0	21.25	5.1	1
OCSS-1-B	5-21-76	28.41774	96.27237	9.0	23.25	0.1	1
OCSS-1A-T	5-21-76	28.38739	96.32788	0.0	21.50	51.0	1
OCSS-1A-M	5-21-76	28.38739	96.32788	3.0	21.50	1.7	1
OCSS-1A-B	5-21-76	28.38739	96.32788	8.0	23.50	0.3	1
OCSS-2-T	5-21-76	28.34792	96.38156	0.0	21.75	35.2	1
OCSS-2-M	5-21-76	28.34792	96.38156	4.0	23.75	0.5	1
OCSS-2-B	5-21-76	28.34792	96.38156	6.0	23.75	1.0	1
OCSS-3-T	5-21-76	28.17822	96.38748	0.0	22.25	52.2	1
OCSS-3-M	5-21-76	28.17822	96.38748	10.0	23.25	21.4	1
OCSS-3-B	5-21-76	28.17822	96.38748	21.0	22.75	2.2	1
OCSS-4-T	5-21-76	27.99858	96.14554	0.0	22.00	67.1	1
OCSS-4-M	5-21-76	27.99858	96.14554	17.0	21.75	56.0	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-22-M	16.0	1.04	7.62	2.05	-0.08	-1.18	?
OCSS-22-B	17.8	0.64	8.16	1.93	-0.26	-0.87	?
OCSS-23-T	117.6	0.45	8.35	1.16	-0.53	2.49	?
OCSS-23-M	88.6	0.44	8.35	1.10	-0.52	2.83	?
OCSS-23-B	116.7	0.68	8.14	1.05	-0.31	1.69	?
OCSS-23A-T	71.0	0.68	8.17	1.13	-0.37	1.88	?
OCSS-23A-M	79.6	0.54	8.26	1.11	-0.45	2.38	?
OCSS-23A-B	84.2	0.53	8.28	1.05	-0.39	2.44	?
OCSS-24-T	98.3	0.61	8.16	1.28	-0.50	1.73	?
OCSS-24-M	92.6	0.50	8.27	1.19	-0.53	2.30	?
OCSS-24-B	249.5	0.54	8.21	1.09	-0.51	2.37	?

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OCSS-1-T	184.6	0.89	8.09	1.39	-0.13	0.20	?
OCSS-1-M	157.9	0.83	8.07	1.23	-0.23	0.66	?
OCSS-1-B	129.0	1.71	7.60	1.17	-0.10	0.30	?
OCSS-1A-T	191.5	1.31	7.59	1.36	-0.12	-0.08	?
OCSS-1A-M	148.8	1.57	7.54	1.37	-0.06	-0.14	?
OCSS-1A-B	233.6	2.56	7.20	1.36	-0.16	0.00	?
OCSS-2-T	132.3	1.98	7.36	1.40	0.02	-0.41	?
OCSS-2-M	131.3	1.75	7.47	1.41	-0.02	-0.36	?
OCSS-2-B	138.5	2.24	7.25	1.42	-0.01	-0.26	?
OCSS-3-T	54.4	1.80	7.35	1.61	-0.09	-0.46	?
OCSS-3-M	50.4	2.77	7.31	1.40	0.11	0.15	?
OCSS-3-B	55.0	2.39	7.50	1.15	0.10	0.50	?
OCSS-4-T	23.9	1.53	7.00	2.09	0.07	-1.18	?
OCSS-4-M	19.1	3.22	6.78	1.62	0.25	-0.23	?

Appendix 1

1	2	3	4	5	6	7	9
OCSS-4-D	5-21-76	27.99958	96.14554	38.0	20.25	17.9	1
OCSS-5-T	5-22-76	27.73987	96.00642	0.0	23.75	88.5	1
OCSS-5-M	5-22-76	27.73987	96.00642	40.0	21.75	90.4	1
OCSS-5-B	5-22-76	27.73987	96.00642	73.0	20.25	32.5	1
OCSS-6-T	5-22-76	27.56316	95.95996	0.0	24.00	83.2	1
OCSS-6-M	5-22-76	27.56316	95.95996	56.0	21.50	86.7	1
OCSS-6-B	5-22-76	27.56316	95.95996	182.0	ND	ND	1
OCSS-7-T	5-22-76	27.68718	96.29082	0.0	23.00	81.5	1
OCSS-7-M	5-22-76	27.68718	96.29082	28.0	22.00	86.7	1
OCSS-7-B	5-22-76	27.68718	96.29082	74.0	19.50	0.0	1
OCSS-8-T	5-22-76	27.74811	96.59290	0.0	23.75	83.2	1
OCSS-8-M	5-22-76	27.74811	96.59290	26.0	21.00	84.9	1
OCSS-8-B	5-22-76	27.74811	96.59290	38.0	20.00	7.6	1
OCSS-9-T	5-22-76	27.84696	96.98851	0.0	25.00	16.8	1
OCSS-9-M	5-22-76	27.84696	96.98851	3.0	24.25	13.8	1
OCSS-9-B	5-22-76	27.84696	96.98851	10.0	23.00	1.3	1
OCSS-9A-T	5-22-76	27.79668	97.02267	0.0	22.50	3.3	1
OCSS-9A-M	5-22-76	27.79668	97.02267	6.0	23.25	3.6	1
OCSS-9A-B	5-22-76	27.79668	97.02267	11.0	23.25	0.5	1
OCSS-10-T	5-22-76	27.57692	96.74031	0.0	23.50	68.6	1
OCSS-10-M	5-22-76	27.57692	96.74031	18.0	20.75	64.2	1
OCSS-10-B	5-22-76	27.57692	96.74031	41.0	20.00	7.3	1
OCSS-11-T	5-23-76	27.43317	96.53265	0.0	23.00	90.4	1
OCSS-11-M	5-23-76	27.43317	96.53265	24.0	21.75	94.1	1
OCSS-11-B	5-23-76	27.43317	96.53265	69.0	ND	ND	1
OCSS-12-T	5-23-76	27.13619	96.40814	0.0	23.25	86.7	1
OCSS-12-M	5-23-76	27.13619	96.40814	60.0	20.25	94.1	1
OCSS-12-B	5-23-76	27.13619	96.40814	180.0	ND	ND	1
OCSS-13-T	5-23-76	27.05201	96.71562	0.0	23.00	79.7	1
OCSS-13-M	5-23-76	27.05201	96.71562	28.0	21.75	84.9	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-4-B	23.9	1.80	7.56	1.37	-0.08	0.19	?
OCSS-5-T	11.4	2.12	6.96	2.06	0.25	-1.08	?
OCSS-5-M	13.9	2.06	7.03	1.93	0.20	-1.00	?
OCSS-5-B	16.0	3.09	6.96	1.63	0.20	-0.32	?
OCSS-6-T	15.4	1.68	7.33	1.99	0.17	-1.20	?
OCSS-6-M	7.8	1.20	7.54	1.99	-0.05	-1.19	?
OCSS-6-B	6.2	2.34	6.98	1.75	0.04	-0.59	?
OCSS-7-T	19.8	0.75	8.00	2.03	-0.19	-1.05	?
OCSS-7-M	12.8	1.98	7.14	1.90	0.18	-1.04	?
OCSS-7-B	25.0	1.44	7.76	1.06	-0.10	0.97	?
OCSS-8-T	23.7	1.80	7.13	1.97	0.12	-1.01	?
OCSS-8-M	18.7	1.53	7.28	1.99	0.07	-1.23	?
OCSS-8-B	35.6	1.05	7.99	1.11	-0.14	1.01	?
OCSS-9-T	69.2	1.08	7.74	1.66	-0.15	-0.55	?
OCSS-9-M	77.5	1.25	7.66	1.69	-0.11	-0.52	?
OCSS-9-B	71.7	1.34	7.61	1.65	-0.08	-0.52	?
OCSS-9A-T	100.0	1.52	7.71	1.39	-0.06	0.07	?
OCSS-9A-M	97.5	1.29	7.83	1.30	-0.03	-0.02	?
OCSS-9A-B	128.5	2.45	7.50	1.11	0.11	0.48	?
OCSS-10-T	33.1	1.59	7.17	2.09	0.07	-1.18	?
OCSS-10-M	24.2	1.62	7.35	1.94	0.06	-1.06	?
OCSS-10-B	38.7	1.28	7.81	1.11	-0.19	1.11	?
OCSS-11-T	20.9	1.32	7.30	2.16	0.01	-1.24	?
OCSS-11-M	13.8	1.42	7.39	2.04	0.04	-1.23	?
OCSS-11-B	15.6	1.59	7.76	1.08	-0.10	1.35	?
OCSS-12-T	16.9	1.92	6.98	2.01	0.20	-1.06	?
OCSS-12-M	9.0	1.58	6.41	2.30	0.20	-1.19	?
OCSS-12-B	14.0	1.85	7.44	1.37	-0.20	0.24	?
OCSS-13-T	29.4	0.78	8.10	1.96	-0.17	-1.02	?
OCSS-13-M	14.6	1.35	7.23	1.92	-0.03	-0.90	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-13-B	5-23-76	27.05201	96.71562	75.0	ND	ND	1
OCSS-14-T	5-23-76	26.96700	97.04292	0.0	23.00	79.7	1
OCSS-14-M	5-23-76	26.96700	97.04292	14.0	22.50	30.0	1
OCSS-14-B	5-23-76	26.96700	97.04292	36.0	ND	ND	1
OCSS-16-T	5-23-76	26.53405	97.09422	0.0	23.25	74.8	1
OCSS-16-M	5-23-76	26.53405	97.09422	7.0	23.25	76.4	1
OCSS-16-B	5-23-76	26.53405	97.09422	21.0	23.00	61.3	1
OCSS-17-T	5-23-76	26.53075	96.90106	0.0	23.25	74.8	1
OCSS-17-M	5-23-76	26.53075	96.90106	24.0	22.00	54.7	1
OCSS-17-B	5-23-76	26.53075	96.90106	37.0	20.25	7.9	1
OCSS-18-T	5-23-76	26.44037	96.51613	0.0	23.75	76.4	1
OCSS-18-M	5-23-76	26.44037	96.51613	16.0	21.25	86.7	1
OCSS-18-B	5-23-76	26.44037	96.51613	67.0	ND	ND	1
OCSS-19-T	5-23-76	26.41209	96.34731	0.0	23.00	81.5	1
OCSS-19-M	5-23-76	26.41209	96.34731	56.0	19.75	90.4	1
OCSS-19-B	5-23-76	26.41209	96.34731	108.0	ND	ND	1
OCSS-20-T	5-23-76	26.26283	96.56506	0.0	23.25	76.4	1
OCSS-20-M	5-23-76	26.26283	96.56506	16.0	22.00	83.2	1
OCSS-20-B	5-23-76	26.26283	96.56506	49.0	ND	ND	1
OCSS-21-T	5-24-76	26.18097	96.81056	0.0	23.50	70.1	1
OCSS-21-M	5-24-76	26.18097	96.81056	18.0	22.00	74.8	1
OCSS-21-B	5-24-76	26.18097	96.81056	38.0	20.25	16.8	1
OCSS-22-T	5-24-76	26.17506	96.99780	0.0	23.25	76.4	1
OCSS-22-M	5-24-76	26.17506	96.99780	8.0	23.00	79.7	1
OCSS-22-B	5-24-76	26.17506	96.99780	21.0	22.00	53.4	1
OCSS-23-T	5-24-76	26.08895	97.11304	0.0	24.00	39.0	1
OCSS-23-M	5-24-76	26.08895	97.11304	8.0	24.00	41.0	1
OCSS-23-B	5-24-76	26.08895	97.11304	14.0	23.25	0.7	1
OCSS-23A-T	5-24-76	26.03070	97.10454	0.0	23.75	6.8	1
OCSS-23A-M	5-24-76	26.03070	97.10454	8.0	23.75	3.4	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-13-B	40.5	1.29	7.82	1.00	-0.10	0.72	?
OCSS-14-T	35.7	1.10	7.87	1.85	-0.06	-1.00	?
OCSS-14-M	25.2	1.15	7.45	1.78	0.03	-0.82	?
OCSS-14-B	80.0	1.86	7.47	1.24	-0.29	0.82	?
OCSS-16-T	32.6	1.64	7.20	2.04	0.09	-1.10	?
OCSS-16-M	25.9	2.29	6.93	1.98	0.22	-0.89	?
OCSS-16-B	28.8	1.94	7.39	1.67	0.08	-0.57	?
OCSS-17-T	34.7	1.57	7.23	2.18	0.10	-1.25	?
OCSS-17-M	22.7	1.92	7.33	1.71	-0.00	-0.48	?
OCSS-17-B	43.0	2.07	7.61	1.01	-0.07	1.38	?
OCSS-18-T	25.7	0.87	7.94	2.02	-0.11	-1.17	?
OCSS-18-M	16.3	1.79	7.11	2.03	0.12	-1.09	?
OCSS-18-B	12.3	2.20	6.85	1.98	0.14	-0.96	?
OCSS-19-T	22.1	1.35	7.35	2.06	0.01	-1.11	?
OCSS-19-M	12.1	2.69	6.61	1.98	0.29	-0.79	?
OCSS-19-B	9.7	1.77	7.41	1.50	-0.02	-0.42	?
OCSS-20-T	20.8	1.46	7.28	2.09	0.07	-1.20	?
OCSS-20-M	11.5	1.53	7.46	1.81	0.05	-0.97	?
OCSS-20-B	15.8	2.44	7.09	1.69	0.12	-0.49	?
OCSS-21-T	23.1	1.30	7.47	2.10	0.03	-1.28	?
OCSS-21-M	15.2	1.82	7.14	2.00	0.13	-1.11	?
OCSS-21-B	27.7	1.83	7.61	1.17	-0.04	0.59	?
OCSS-22-T	20.5	1.40	7.35	1.99	0.00	-1.08	?
OCSS-22-M	15.0	1.55	7.21	2.05	0.08	-1.19	?
OCSS-22-B	28.4	1.55	7.70	1.43	0.05	-0.16	?
OCSS-23-T	75.0	1.54	7.54	1.69	-0.02	-0.63	?
OCSS-23-M	74.1	2.18	7.41	1.47	0.09	-0.13	?
OCSS-23-B	52.1	2.94	7.17	1.23	-0.07	0.02	?
OCSS-23A-T	40.4	7.52	6.71	1.18	0.09	0.75	?
OCSS-23A-M	37.9	7.36	6.73	1.15	0.18	0.71	?

Appendix 1

1	2	3	4	5	6	7	8
OCSS-23A-B	5-24-76	26.03070	97.10454	14.0	23.75	4.3	1
OCSS-24-T	5-24-76	25.99561	97.10997	0.0	23.50	12.5	1
OCSS-24-M	5-24-76	25.99561	97.10997	7.0	23.50	14.8	1
OCSS-24-B	5-24-76	25.99561	97.10997	12.0	ND	ND	1

Appendix 1

9	10	11	12	13	14	15	16
OCSS-23A-B	45.3	8.85	6.80	1.02	0.08	0.88	2
OCSS-24-T	39.4	5.52	6.80	1.28	0.09	0.42	2
OCSS-24-M	39.8	5.59	6.76	1.29	0.06	0.28	2
OCSS-24-B	39.6	4.55	6.94	1.25	0.10	0.20	2

EXPLANATION FOR APPENDIX 2:

Clay Mineralogy

November 1975

Column 1 - Station number

Column 2 - Mass

Column 3 - 17 Å

Column 4 - 10 Å

Column 5 - 7.0 Å

Column 6 - 3.3 Å

Column 7 - Mass

Column 8 - 17 Å

Column 9 - 10 Å

Column 10 - 7.0 Å

Column 11 - 3.3 Å

1	2	3	4	5	6	7	8	9	10	11
3T	2.45	ND	ND	ND	100.0	2.39	6.1	ND	7.4	86.0
3B	1.71	7.6	ND	82.0	82.0	5.37	29.0	9.5	14.5	47.0
4T	1.16	ND	ND	50.0	50.0	.51	ND	ND	9.0	91.0
4B	3.63	17.1	9.2	ND	73.0	1.12	16.2	9.3	13.0	60.0
6T	2.22	ND	ND	ND	100.0	.33	100.0	ND	ND	ND
6B	1.44	ND	ND	ND	100.0	.16	ND	ND	ND	100.0
7T	3.13	ND	ND	ND	ND	.35	ND	ND	ND	ND
7B	2.68	ND	ND	ND	ND	1.68	20.1	6.7	4.2	68.0
9AT	10.54	5.7	ND	5.0	89.3	3.87	2.0	8.0	14.0	75.0
9AB	22.24	34.5	4.6	9.5	50.0	8.84	22.0	9.4	11.0	58.0
10T	2.17	ND	ND	ND	ND	.34	ND	ND	19.0	81.0
10B	3.77	ND	ND	ND	ND	2.76	6.0	6.0	17.0	69.0
12T	1.50	ND	ND	5.0	94.0	.22	100.0	ND	ND	ND
12B	0.80	ND	ND	ND	ND	.87	ND	16.0	16.0	66.0
14T	1.33	28.2	ND	7.6	64.0	.30	74.0	ND	22.0	4.0
14B	19.12	100.0	ND	ND	ND	5.50	ND	3.3	1.0	84.0
17T	1.17	2.7	ND	6.0	91.0	.33	53.0	7.6	ND	38.0
17B	4.44	4.2	12.8	7.0	75.0	2.70	44.0	13.6	10.0	32.0
19T	1.44	ND	ND	ND	ND	.22	66.0	ND	16.0	16.0
19B	3.30	6.8	8.9	6.8	77.0	.34	27.0	ND	ND	72.0
22T	.72	100.0	ND	ND	ND	.20	75.0	ND	12.0	12.0
22B	7.65	11.0	22.0	29.0	38.0	1.68	16.2	ND	16.2	67.0

1	2	3	4	5	6	7	8	9	10	11
3T	2.45	ND	ND	ND	100.0	2.39	6.1	ND	7.4	86.0
3B	1.71	7.6	ND	82.0	82.0	5.37	29.0	9.5	14.5	47.0
4T	1.16	ND	ND	50.0	50.0	.51	ND	ND	9.0	91.0
4B	3.63	17.1	9.2	ND	73.0	1.12	16.2	9.3	13.0	60.0
6T	2.22	ND	ND	ND	100.0	.33	100.0	ND	ND	ND
6B	1.44	ND	ND	ND	100.0	.16	ND	ND	ND	100.0
7T	3.13	ND	ND	ND	ND	.35	ND	ND	ND	ND
7B	2.68	ND	ND	ND	ND	1.68	20.1	6.7	4.2	68.0
9AT	10.54	5.7	ND	5.0	89.3	3.87	2.0	8.0	14.0	75.0
9AB	22.24	34.5	4.6	9.5	50.0	8.84	22.0	9.4	11.0	58.0
10T	2.17	ND	ND	ND	ND	.34	ND	ND	19.0	81.0
10B	3.77	ND	ND	ND	ND	2.76	6.0	6.0	17.0	69.0
12T	1.50	ND	ND	5.0	94.0	.22	100.0	ND	ND	ND
12B	0.80	ND	ND	ND	ND	.87	ND	16.0	16.0	66.0
14T	1.33	28.2	ND	7.6	64.0	.30	74.0	ND	22.0	4.0
14B	19.12	100.0	ND	ND	ND	5.50	ND	3.3	1.0	84.0
17T	1.17	2.7	ND	6.0	91.0	.33	53.0	7.6	ND	38.0
17B	4.44	4.2	12.8	7.0	75.0	2.70	44.0	13.6	10.0	32.0
19T	1.44	ND	ND	ND	ND	.22	66.0	ND	16.0	16.0
19B	3.30	6.8	5.9	6.8	77.0	.34	27.0	ND	ND	72.0
22T	.72	100.0	ND	ND	ND	.20	75.0	ND	12.0	12.0
22B	7.65	11.0	22.0	29.0	38.0	1.68	16.2	ND	16.2	67.0

EXPLANATION FOR APPENDIX 3:

Trace Metal Content, Suspended Sediments

November 1975

Column 1 - Station number

Column 2 - Mass

Column 3 - Cadmium

Column 4 - Chromium

Column 5 - Copper

Column 6 - Manganese

Column 7 - Nickel

Column 8 - Lead

Column 9 - Vanadium

Column 10 - Zinc

Column 11 - Iron

Column 12 - Carbon

1	2	3	4	5	6	7	8	9	10	11	12
3T	2.45	1.7	30	49	157	63	190	46	152	1.8	3.3
3B	1.71	1.8	22	31	294	128	127	28	171	1.6	2.9
4T	1.16	3.2	289	227	169	69	115	115	171	1.5	5.2
4B	3.36	2.8	29	19	218	50	42	46	15	1.8	2.2
6T	2.22	3.9	468	59	199	269	129	ND	ND	4.9	0.9
6B	1.44	1.9	181	250	849	104	126	79	93	5.9	3.5
7T	3.13	40.0	84	166	123	36	146	49	ND	0.8	0.3
7B	2.68	4.2	241	74	199	80	85	82	74	4.2	0.4
9AT	10.54	1.1	21	212	948	98	20	54	157	2.1	5.3
9AB	22.24	1.6	40	50	751	74	13	76	84	2.1	3.3
10T	2.17	4.7	127	60	159	33	259	35	246	1.1	1.8
10B	3.77	3.0	15	353	1420	36	93	36	182	1.8	1.1
12T	1.50	7.7	209	ND	196	74	296	38	ND	3.9	0.7
12B	0.80	4.0	50	209	1200	67	273	44	295	2.2	1.3
14T	1.33	0.6	76	106	67	131	136	49	64	0.8	5.3
14B	19.12	3.2	23	22	1330	65	22	35	68	1.9	4.6
17T	1.17	0.5	49	38	87	43	62	32	47	1.8	6.0
17B	4.44	4.2	18	13	1190	73	36	45	66	1.1	1.8
19T	1.44	1.0	172	38	59	91	75	ND	34	1.3	0.0
19B	3.30	0.1	77	11	103	40	27	47	ND	2.0	1.2
22T	0.72	1.5	40	79	139	31	138	12	236	1.1	8.3
22B	7.65	0.3	36	48	788	59	18	54	66	2.0	2.6

1	2	3	4	5	6	7	8	9	10	11	12
3T	2.39	4.4	52	82	359	36	963	26	590	1.2	7.5
3B	5.37	1.0	8	15	455	24	115	17	92	0.9	4.1
4T	0.52	45.0	28	26	56	68	167	12	103	0.2	4.8
4B	1.12	0.2	6	23	64	ND	62	24	99	0.7	2.3
6T	0.33	1.0	35	ND	79	ND	39	12	32	0.1	2.1
6B	0.16	0.8	64	ND	38	34	76	ND	ND	0.1	4.9
7T	0.35	14.0	82	80	107	105	ND	3	752	1.0	18.6
7B	1.68	2.2	13	25	691	48	84	36	161	1.1	4.1
9AT	3.87	9.9	12	15	440	17	48	21	94	0.7	5.2
9AB	8.84	6.2	5	9	349	30	47	17	470	0.7	6.9
10T	0.34	3.1	28	31	29	9	73	15	1300	0.3	15.9
10B	2.76	4.8	3	3	548	9	62	14	52	0.7	4.3
12T	0.22	23.0	19	157	51	94	526	19	1340	0.5	13.1
12B	0.86	4.2	6	33	338	27	63	16	105	0.6	5.6
14T	0.30	9.4	18	59	381	139	884	23	134	0.4	11.2
14B	5.50	0.9	4	6	451	11	20	14	82	0.6	6.2
17T	0.33	1.1	13	41	34	28	243	ND	229	0.4	3.9
17B	2.70	5.5	5	17	862	22	58	12	141	1.0	3.4
19T	0.22	1.1	20	62	155	69	99	65	487	0.5	0.0
19B	0.34	15.0	24	62	359	53	455	12	312	1.4	1.8
22T	0.20	2.7	26	480	283	27	452	5	577	0.3	23.7
22B	1.68	2.8	11	20	637	24	77	17	210	0.6	4.8

EXPLANATION FOR APPENDIX 4:

Textural Properties of Seasonal Benthic Sediment Samples

Column 1 - Sample station number (Univ. Texas Marine Science Institute designation)

Column 2 - Sample station number (USGS designation): TS = Texas seasonal samples, second character = station number, third character = transect number, fourth character = subsample designation, fifth character = seasonal suite (1 = winter, 2 = spring, 3 = summer/fall)

Column 3 - Station latitude: first two digits = degrees, last two digits = minutes

Column 4 - Station longitude: first two digits = degrees, last two digits = minutes

Column 5 - Station water depth (meters)

Column 6 - Sand percentage (%)

Column 7 - Silt percentage (%)

Column 8 - Clay percentage (%)

Column 9 - Sand/Mud ratio

Column 10 - Data sheet designation numbers (#1 = first data sheet)

Column 11 - Sample station number reiteration (Univ. Texas Marine Science Institute designation)

Column 12 - Sample station number reiteration (USGS designation)

Column 13 - Silt/Clay ratio

Column 14 - Mean diameter in phi units (first moment)

Column 15 - Standard deviation in phi units (second moment)

Column 16 - Skewness (third moment)

Column 17 - Kurtosis (fourth moment)

Column 18 - Data sheet designation number (#2 = second data sheet)

Note: The designation "ND" indicates no data for that specific item.

Appendix 4 - Textural Properties of Seasonal Benthic Sediment Samples

1	2	3	4	5	6	7	8	9	10
HSE-SED	TS-1-1-A-1	28 12	96 27	18	54.66	18.38	26.96	1.20	1
HSF-SED	TS-1-1-B-1	28 12	96 27	18	60.37	15.50	24.13	1.52	1
HSG-SED	TS-2-1-A-1	27 55	96 20	42	17.57	41.06	41.37	0.21	1
HSH-SED	TS-2-1-B-1	27 55	96 20	42	11.98	38.45	49.58	0.14	1
HSI-SED	TS-3-1-A-1	27 34	96 07	134	3.87	35.02	61.11	0.04	1
HSJ-SED	TS-3-1-B-1	27 34	96 07	134	4.54	27.56	67.89	0.05	1
HSR-SED	TS-4-1-A-1	28 14	96 29	10	65.93	11.61	22.46	1.93	1
HSS-SED	TS-4-1-B-1	28 14	96 29	10	59.47	14.54	25.98	1.47	1
HTA-SED	TS-5-1-A-1	27 44	96 14	82	14.27	25.75	59.98	0.17	1
HTB-SED	TS-5-1-B-1	27 44	96 14	82	0.93	32.27	66.80	0.01	1
HTJ-SED	TS-6-1-A-1	27 39	96 12	100	8.94	46.24	44.83	0.10	1
HTK-SED	TS-6-1-B-1	27 39	96 12	100	5.56	41.05	53.39	0.06	1
HRM-SED	TS-1-2-A-1	27 40	96 59	22	11.60	36.26	52.14	0.13	1
HRN-SED	TS-1-2-B-1	27 40	96 59	22	13.20	25.69	61.11	0.15	1
HRP-SED	TS-2-2-A-1	27 30	96 45	49	9.73	39.30	50.97	0.11	1
HRO-SED	TS-2-2-B-1	27 30	96 45	49	18.15	40.26	41.59	0.22	1
HRQ-SED	TS-3-2-A-1	27 18	96 23	131	2.40	35.59	62.02	0.02	1
HRS-SED	TS-3-2-B-1	27 18	96 23	131	1.60	26.18	72.22	0.02	1
HSA-SED	TS-4-2-A-1	27 34	96 50	34	5.99	40.68	53.33	0.06	1
HSB-SED	TS-4-2-B-1	27 34	96 50	34	10.10	40.02	49.88	0.11	1
HOI-SED	TS-5-2-A-1	27 24	96 36	78	2.93	41.54	55.53	0.03	1
HOJ-SED	TS-5-2-B-1	27 24	96 36	78	3.58	35.84	60.58	0.04	1
HPP-SED	TS-6-2-A-1	27 24	96 29	98	0.85	39.53	59.62	0.01	1
HPX-SED	TS-6-2-B-1	27 24	96 29	98	0.79	43.98	55.23	0.01	1
HUH-SED	TS-1-3-A-1	26 58	97 11	25	2.39	37.97	59.65	0.02	1
HUJ-SED	TS-1-3-B-1	26 58	97 11	25	1.28	47.73	50.99	0.01	1
IAD-SED	TS-2-3-A-1	26 58	96 48	65	0.33	56.15	43.52	0.00	1
IAK-SED	TS-2-3-B-1	26 58	96 48	65	1.06	40.81	58.13	0.01	1
IBZ-SED	TS-3-3-A-1	26 58	96 33	106	0.52	33.84	65.64	0.00	1
ICH-SED	TS-3-3-B-1	26 58	96 33	106	0.84	40.52	58.65	0.01	1

Appendix 4

11	12	13	14	15	16	17	18
HSE-SED	TS-1-1-A-1	0.68	5.43	2.84	0.28	-1.29	2
HSF-SED	TS-1-1-B-1	0.64	4.91	3.02	0.31	-1.16	2
HSG-SED	TS-2-1-A-1	0.99	7.18	2.30	-0.11	-1.10	2
HSH-SED	TS-2-1-B-1	0.77	7.49	2.50	-0.41	-0.03	2
HSI-SED	TS-3-1-A-1	0.57	8.26	1.85	-0.41	0.26	2
HSJ-SED	TS-3-1-B-1	0.41	8.49	1.85	-0.57	1.03	2
HSR-SED	TS-4-1-A-1	0.52	4.64	3.02	0.40	-0.94	2
HSS-SED	TS-4-1-B-1	0.56	4.91	3.18	0.27	-1.29	2
HTA-SED	TS-5-1-A-1	0.43	7.76	2.74	-0.65	0.85	2
HTB-SED	TS-5-1-B-1	0.48	8.61	1.48	-0.30	-0.11	2
HTJ-SED	TS-6-1-A-1	1.03	7.48	2.19	-0.24	-0.45	2
HTK-SED	TS-6-1-B-1	0.77	7.94	1.98	-0.27	-0.47	2
HRM-SED	TS-1-2-A-1	0.69	7.61	2.39	-0.38	-0.26	2
HRN-SED	TS-1-2-B-1	0.42	8.01	2.25	-0.44	-0.30	2
HRP-SED	TS-2-2-A-1	0.77	7.53	2.51	-0.48	0.47	2
HRO-SED	TS-2-2-B-1	0.97	7.00	2.59	-0.24	-0.78	2
HRQ-SED	TS-3-2-A-1	0.57	8.38	1.69	-0.34	0.01	2
HRS-SED	TS-3-2-B-1	0.36	8.72	1.57	-0.50	0.87	2
HSA-SED	TS-4-2-A-1	0.76	7.89	2.00	-0.28	-0.43	2
HSB-SED	TS-4-2-B-1	0.80	7.62	2.17	-0.21	-0.97	2
HOI-SED	TS-5-2-A-1	0.75	8.13	1.78	-0.24	-0.46	2
HOJ-SED	TS-5-2-B-1	0.59	8.27	1.79	-0.35	-0.11	2
HPP-SED	TS-6-2-A-1	0.66	8.36	1.61	-0.20	-0.66	2
HPX-SED	TS-6-2-B-1	0.80	8.15	1.71	-0.16	-0.84	2
HUH-SED	TS-1-3-A-1	0.64	8.25	1.74	-0.29	-0.37	2
HUJ-SED	TS-1-3-B-1	0.94	7.93	1.79	-0.12	-0.92	2
IAD-SED	TS-2-3-A-1	1.29	7.68	1.77	0.05	-1.21	2
IAK-SED	TS-2-3-B-1	0.70	8.24	1.74	-0.21	-0.80	2
IBZ-SED	TS-3-3-A-1	0.51	8.59	1.55	-0.27	-0.50	2
ICH-SED	TS-3-3-B-1	0.69	8.29	1.61	-0.19	-0.69	2

Appendix 4

1	2	3	4	5	6	7	8	9	10
IDV-SED	TS-4-3-A-1	26 58	97 20	15	88.84	3.27	7.89	7.96	1
IDX-SED	TS-4-3-B-1	26 58	97 20	15	81.19	4.65	14.16	4.32	1
IFS-SED	TS-5-3-A-1	26 58	97 02	40	1.67	29.49	68.85	0.02	1
IFW-SED	TS-5-3-B-1	26 58	97 02	40	1.30	29.20	69.50	0.01	1
IHK-SED	TS-6-3-A-1	26 58	96 30	125	0.73	28.51	70.76	0.01	1
IHO-SED	TS-6-3-B-1	26 58	96 30	125	1.21	32.12	66.67	0.01	1
IJE-SED	TS-1-4-A-1	26 10	97 01	27	69.15	9.89	20.96	2.24	1
IJK-SED	TS-1-4-B-1	26 10	97 01	27	67.92	13.77	18.31	2.12	1
JCF-SED	TS-2-4-A-1	26 10	96 39	47	31.90	27.00	41.10	0.47	1
JCG-SED	TS-2-4-B-1	26 10	96 39	47	4.97	25.70	69.33	0.05	1
IMY-SED	TS-3-4-A-1	26 10	96 24	91	46.98	21.28	31.74	0.89	1
INC-SED	TS-3-4-B-1	26 10	96 24	91	51.70	12.78	35.52	1.07	1
IOW-SED	TS-4-4-A-1	26 10	97 08	15	77.23	6.44	16.34	3.39	1
IPA-SED	TS-4-4-B-1	26 10	97 08	15	78.86	6.22	14.93	3.73	1
IQO-SED	TS-5-4-A-1	26 10	96 54	37	26.42	26.41	47.18	0.36	1
IQS-SED	TS-5-4-B-1	26 10	96 54	37	12.60	37.00	50.40	0.14	1
ISF-SED	TS-6-4-A-1	26 10	96 31	65	50.28	16.02	33.70	1.01	1
ISJ-SED	TS-6-4-B-1	26 10	96 31	65	47.37	16.34	36.29	0.90	1
IUG-SED	TS-7-4-A-1	26 10	96 20	130	0.13	33.19	66.69	0.00	1
IUK-SED	TS-7-4-B-1	26 10	96 20	130	0.28	26.77	72.95	0.00	1
LYK	TS-1-1-A-2	28 12	96 27	18	37.72	28.22	34.07	0.61	1
LYR	TS-1-1-B-2	28 12	96 27	18	45.34	30.21	24.45	0.83	1
MAK	TS-2-1-A-2	27 55	96 20	42	8.93	53.45	37.63	0.10	1
MAR	TS-2-1-B-2	27 55	96 20	42	18.67	41.67	39.66	0.23	1
MCH-SED	TS-3-1-A-2	27 34	96 07	134	8.20	41.04	50.75	0.09	1

Appendix 4

11	12	13	14	15	16	17	18
IDV-SED	TS-4-3-A-1	0.41	4.08	1.73	1.34	5.87	2
IDX-SED	TS-4-3-B-1	0.33	4.23	2.39	0.77	1.24	2
IFS-SED	TS-5-3-A-1	0.43	8.61	1.61	-0.43	0.37	2
IFW-SED	TS-5-3-B-1	0.42	8.66	1.54	-0.40	0.33	2
IHK-SED	TS-6-3-A-1	0.40	8.71	1.46	-0.36	0.03	2
IHO-SED	TS-6-3-B-1	0.48	8.60	1.55	-0.35	0.00	2
IJE-SED	TS-1-4-A-1	0.47	3.97	3.29	0.45	-0.80	2
IJK-SED	TS-1-4-B-1	0.75	3.97	3.05	0.48	-0.53	2
JCF-SED	TS-2-4-A-1	0.66	6.47	3.06	-0.12	-1.47	2
JCG-SED	TS-2-4-B-1	0.37	8.50	1.96	-0.67	1.63	2
IMY-SED	TS-3-4-A-1	0.67	5.60	3.14	0.12	-1.54	2
INC-SED	TS-3-4-B-1	0.36	5.53	3.33	0.11	-1.62	2
IOW-SED	TS-4-4-A-1	0.39	4.09	2.63	0.69	0.38	2
IPA-SED	TS-4-4-B-1	0.42	3.94	2.63	0.73	0.65	2
IQO-SED	TS-5-4-A-1	0.56	6.70	3.25	-0.29	-1.09	2
IQS-SED	TS-5-4-B-1	0.73	7.44	2.58	-0.46	0.10	2
ISF-SED	TS-6-4-A-1	0.47	5.29	3.53	0.09	-1.62	2
ISJ-SED	TS-6-4-B-1	0.45	5.70	3.35	0.02	-1.53	2
IUG-SED	TS-7-4-A-1	0.50	8.60	1.46	-0.23	-0.65	2
IUK-SED	TS-7-4-B-1	0.37	8.78	1.35	-0.32	-0.10	2
LYK	TS-1-1-A-2	0.83	6.15	2.85	0.04	-1.48	2
LYR	TS-1-1-B-2	1.24	5.55	2.65	0.26	-1.17	2
MAK	TS-2-1-A-2	1.42	7.09	2.16	0.01	-1.13	2
MAR	TS-2-1-B-2	1.05	6.95	2.34	-0.05	-1.25	2
MCH-SED	TS-3-1-A-2	0.81	7.71	2.20	-0.27	-0.60	2

Appendix 4

1	2	3	4	5	6	7	8	9	10
MCO-SED	TS-3-1-B-2	27 34	96 07	134	12.18	42.12	45.70	0.14	1
MEB	TS-4-1-A-2	28 14	96 29	10	66.12	18.94	14.94	1.95	1
MEI	TS-4-1-B-2	28 14	96 29	10	60.18	18.08	21.74	1.51	1
MFV	TS-5-1-A-2	27 44	96 14	82	11.40	45.92	42.68	0.13	1
MGC	TS-5-1-B-2	27 44	96 14	82	0.81	27.81	71.38	0.01	1
MHP	TS-6-1-A-2	27 39	96 12	100	15.67	44.90	39.43	0.19	1
MEJ	TS-6-1-B-2	27 39	96 12	100	7.71	54.34	37.94	0.08	1
MJJ	TS-1-2-A-2	27 40	96 59	22	0.0	57.18	42.82	0.00	1
MJQ	TS-1-2-B-2	27 40	96 59	22	20.86	49.08	30.06	0.26	1
MLL	TS-2-2-A-2	27 30	96 45	49	9.61	52.65	37.74	0.11	1
MLS	TS-2-2-B-2	27 30	96 45	49	9.34	50.39	40.27	0.10	1
MNM-SED	TS-3-2-A-2	27 18	96 23	131	2.58	35.08	62.34	0.03	1
MNT-SED	TS-3-2-B-2	27 18	96 23	131	2.53	38.05	59.42	0.03	1
MPN	TS-4-2-A-2	27 34	96 50	34	46.24	31.40	22.36	0.86	1
MPG	TS-4-2-B-2	27 34	96 50	34	31.25	35.34	33.41	0.45	1
MQY	TS-5-2-A-2	27 24	96 36	78	4.76	55.20	40.04	0.05	1
MRF	TS-5-2-B-2	27 24	96 36	78	5.18	39.13	55.69	0.05	1
MSQ	TS-6-2-A-2	27 24	96 29	98	2.51	46.15	51.34	0.03	1
MSX	TS-6-2-B-2	27 24	96 29	98	2.57	47.60	49.84	0.03	1
MXM-SED	TS-1-3-A-2	26 58	97 11	25	2.25	46.64	51.12	0.02	1
MXT-SED	TS-1-3-B-2	26 58	97 11	25	1.89	54.99	43.12	0.02	1
MZM-SED	TS-2-3-A-2	26 58	96 48	65	1.19	52.59	46.22	0.01	1
MZT-SED	TS-2-3-B-2	26 58	96 48	65	0.31	43.93	55.76	0.00	1
NBJ-SED	TS-3-3-A-2	26 58	96 33	106	0.0	45.02	54.98	0.00	1
NBQ-SED	TS-3-3-B-2	26 58	96 33	106	0.0	43.24	56.76	0.00	1
NDD-SED	TS-4-3-A-2	26 58	97 20	15	90.60	4.91	4.50	9.64	1
NDK-SED	TS-4-3-B-2	26 58	97 20	15	94.81	3.28	1.91	18.26	1
NEX-SED	TS-5-3-A-2	26 58	97 02	40	1.22	45.73	53.05	0.01	1
NFE-SED	TS-5-3-B-2	26 58	97 02	40	0.74	46.05	53.21	0.01	1
NGP-SED	TS-6-3-A-2	26 58	96 30	125	0.52	43.85	56.30	0.00	1

Appendix 4

11	12	13	14	15	16	17	18
MCO-SED	TS-3-1-B-2	0.92	7.29	2.40	-0.71	-1.03	2
MEB	TS-4-1-A-2	1.27	4.54	2.49	0.57	-0.09	2
MEI	TS-4-1-B-2	0.83	4.96	2.80	0.36	-0.93	2
MFV	TS-5-1-A-2	1.08	7.16	2.33	-0.08	-1.22	2
MGC	TS-5-1-B-2	0.39	8.67	1.47	-0.47	0.31	2
MHP	TS-6-1-A-2	1.14	7.01	2.36	-0.06	-1.19	2
MEJ	TS-6-1-B-2	1.43	6.99	2.26	0.03	-1.30	2
MJJ	TS-1-2-A-2	1.33	7.40	2.03	-0.00	-1.31	2
MJQ	TS-1-2-B-2	1.63	6.26	2.46	0.18	-1.26	2
MLL	TS-2-2-A-2	1.39	7.09	2.21	0.01	-1.21	2
MLS	TS-2-2-B-2	1.25	7.17	2.18	-0.02	-1.17	2
MNM-SED	TS-3-2-A-2	0.56	8.33	1.87	-0.36	-0.22	2
MNT-SED	TS-3-2-B-2	0.64	8.21	1.84	-0.32	-0.29	2
MPN	TS-4-2-A-2	1.40	5.52	2.51	0.35	-0.88	2
MPQ	TS-4-2-B-2	1.06	6.44	2.52	0.09	-1.40	2
MQY	TS-5-2-A-2	1.38	7.23	2.11	-0.00	-1.19	2
MRF	TS-5-2-B-2	0.70	7.91	2.06	-0.27	-0.77	2
MSQ	TS-6-2-A-2	0.90	7.92	1.92	-0.17	-0.84	2
MSX	TS-6-2-B-2	0.95	7.85	1.96	-0.13	-0.99	2
MXM-SED	TS-1-3-A-2	0.91	7.85	1.95	-0.15	-0.97	2
MXT-SED	TS-1-3-B-2	1.27	7.48	2.01	-0.02	-1.20	2
MZM-SED	TS-2-3-A-2	1.14	7.53	2.07	-0.07	-1.24	2
MZT-SED	TS-2-3-B-2	0.79	8.17	1.72	-0.13	-1.02	2
NBJ-SED	TS-3-3-A-2	0.82	8.04	1.88	-0.19	-0.94	2
NBQ-SED	TS-3-3-B-2	0.76	8.20	1.74	-0.17	-0.93	2
NDD-SED	TS-4-3-A-2	1.13	3.85	1.38	1.74	11.93	2
NDK-SED	TS-4-3-B-2	1.76	3.66	0.94	2.69	20.84	2
NEX-SED	TS-5-3-A-2	0.87	7.86	1.96	-0.16	-0.79	2
NFE-SED	TS-5-3-B-2	0.86	7.98	1.87	-0.16	-0.99	2
NGP-SED	TS-6-3-A-2	0.78	8.17	1.73	-0.17	-0.89	2

Appendix 4

1	2	3	4	5	6	7	8	9	10
NGW-SED	TS-6-3-B-2	26 58	96 30	125	1.01	43.46	55.53	0.01	1
NIJ-SED	TS-1-4-A-2	26 10	97 01	27	81.39	9.81	8.80	4.37	1
NIQ-SED	TS-1-4-B-2	26 10	97 01	27	70.72	13.39	15.89	2.42	1
NKJ-SED	TS-2-4-A-2	26 10	96 39	47	44.65	24.55	30.81	0.81	1
NKQ-SED	TS-2-4-B-2	26 10	96 39	47	46.94	21.44	31.61	0.88	1
NMG-SED	TS-3-4-A-2	26 10	96 24	91	11.73	41.29	46.99	0.13	1
NMN-SED	TS-3-4-B-2	26 10	96 24	91	10.15	39.73	50.12	0.11	1
NOA-SED	TS-4-4-A-2	26 10	97 08	15	90.38	5.38	4.24	9.40	1
NOH-SED	TS-4-4-B-2	26 10	97 08	15	80.86	8.83	10.31	4.22	1
NPS-SED	TS-5-4-A-2	26 10	96 54	37	60.51	18.48	21.02	1.53	1
NPZ-SED	TS-5-4-B-2	26 10	96 54	37	57.77	24.85	17.37	1.37	1
NRK-SED	TS-6-4-A-2	26 10	96 31	65	28.03	32.78	39.19	0.39	1
NRP-SED	TS-6-4-B-2	26 10	96 31	65	44.25	24.13	31.62	0.79	1
NTL-SED	TS-7-4-A-2	26 10	96 20	130	0.70	42.95	56.35	0.01	1
NTJ-SED	TS-7-4-B-2	26 10	96 20	130	0.79	40.24	58.97	0.01	1
QYR-SED	TS-1-1-A-3	28 12	96 27	18	47.26	30.18	22.46	0.90	1
QYT-SED	TS-1-1-B-3	28 12	96 27	18	40.21	26.97	32.81	0.67	1
RAI-SED	TS-2-1-A-3	27 55	96 20	42	38.35	35.50	26.16	0.62	1
RAK-SED	TS-2-1-B-3	27 55	96 20	42	23.90	38.05	38.06	0.31	1
RCL-SED	TS-3-1-A-3	27 34	96 07	134	4.70	36.90	58.41	0.05	1
RCN-SED	TS-3-1-B-3	27 34	96 07	134	3.26	38.78	57.96	0.03	1
REC-SED	TS-4-1-A-3	28 14	96 29	10	65.03	15.21	19.76	1.86	1
REE-SED	TS-4-1-B-3	28 14	96 29	10	54.01	22.19	23.80	1.18	1
RFT-SED	TS-5-1-A-3	27 44	96 14	82	0.94	34.41	64.64	0.01	1
RFV-SED	TS-5-1-B-3	27 44	96 14	82	4.81	43.98	51.21	0.05	1

Appendix 4

11	12	13	14	15	16	17	18
NGW-SED	TS-6-3-B-2	0.78	8.11	1.82	-0.19	-0.79	2
NIJ-SED	TS-1-4-A-2	1.11	3.51	2.19	0.98	2.72	2
NIQ-SED	TS-1-4-B-2	0.84	3.99	2.80	0.61	0.01	2
NKJ-SED	TS-2-4-A-2	0.80	5.59	3.15	0.11	-1.54	2
NKQ-SED	TS-2-4-B-2	0.68	5.54	3.19	0.11	-1.51	2
NMG-SED	TS-3-4-A-2	0.88	7.49	2.28	-0.25	-0.68	2
NMN-SED	TS-3-4-B-2	0.79	7.59	2.32	-0.33	-0.44	2
NOA-SED	TS-4-4-A-2	1.27	3.21	1.55	1.58	9.85	2
NOH-SED	TS-4-4-B-2	0.86	3.61	2.32	0.89	1.91	2
NPS-SED	TS-5-4-A-2	0.88	4.57	2.98	0.42	-0.90	2
NPZ-SED	TS-5-4-B-2	1.43	4.42	2.76	0.50	-0.45	2
NRK-SED	TS-6-4-A-2	0.84	6.49	2.97	-0.11	-1.32	2
NRR-SED	TS-6-4-B-2	0.76	5.62	3.16	0.11	-1.54	2
NTL-SED	TS-7-4-A-2	0.76	8.23	1.70	-0.15	-0.93	2
NTJ-SED	TS-7-4-B-2	0.68	8.29	1.67	-0.20	-0.75	2
QYR-SED	TS-1-1-A-3	1.34	6.09	2.53	0.34	-0.96	2
QYT-SED	TS-1-1-B-3	0.82	6.15	2.76	0.06	-1.49	2
RAI-SED	TS-2-1-A-3	1.36	6.00	2.47	0.22	-1.20	2
RAK-SED	TS-2-1-B-3	1.00	6.75	2.53	-0.00	-1.37	2
RCL-SED	TS-3-1-A-3	0.63	8.04	2.08	-0.40	0.02	2
RCN-SED	TS-3-1-B-3	0.67	8.13	1.96	-0.31	-0.49	2
REC-SED	TS-4-1-A-3	0.77	4.80	2.70	0.48	-0.64	2
REE-SED	TS-4-1-B-3	0.93	5.30	2.80	0.28	-1.20	2
RFT-SED	TS-5-1-A-3	0.53	8.53	1.61	-0.31	-0.24	2
RFV-SED	TS-5-1-B-3	0.86	7.87	2.01	-0.26	-0.50	2

Appendix 4

1	2	3	4	5	6	7	8	9	10
RHK-SED	TS-6-1-A-3	27 39	96 12	100	13.21	38.11	48.68	0.15	1
RHM-SED	TS-6-1-B-3	27 39	96 12	100	15.13	49.90	34.96	0.18	1
RJL-SED	TS-1-2-A-3	27 40	96 59	22	10.04	38.81	51.15	0.11	1
RJN-SED	TS-1-2-B-3	27 40	96 59	22	5.27	40.36	54.36	0.06	1
RLL-SED	TS-2-2-A-3	27 30	96 45	49	7.73	49.20	43.07	0.08	1
RLN-SED	TS-2-2-B-3	27 30	96 45	49	8.66	45.46	45.88	0.10	1
RNK-SED	TS-3-2-A-3	27 18	96 23	131	1.77	33.84	64.39	0.02	1
RNM-SED	TS-3-2-B-3	27 18	96 23	131	2.35	33.66	64.00	0.02	1
RPA-SED	TS-4-2-A-3	27 34	96 50	34	10.81	42.27	46.92	0.12	1
RPC-SED	TS-4-2-B-3	27 34	96 50	34	8.16	47.30	44.55	0.09	1
RQJ-SED	TS-5-2-A-3	27 24	96 36	78	3.63	53.18	43.18	0.04	1
RQL-SED	TS-5-2-B-3	27 24	96 36	78	7.21	41.02	51.78	0.08	1
RRT-SED	TS-6-2-A-3	27 24	96 29	98	1.18	40.05	58.77	0.01	1
RRV-SED	TS-6-2-B-3	27 24	96 29	98	0.00	37.34	62.66	0.00	1
RTE-SED	TS-1-3-A-3	26 58	97 11	25	6.17	47.36	46.46	0.07	1
RTG-SED	TS-1-3-B-3	26 58	97 11	25	2.02	45.69	52.30	0.02	1
RVC-SED	TS-2-3-A-3	26 58	96 48	65	0.00	45.93	54.07	0.00	1
RVE-SED	TS-2-3-B-3	26 58	96 48	65	1.29	42.50	56.21	0.01	1
RXE-SED	TS-3-3-A-3	26 58	96 33	106	0.79	36.53	62.68	0.01	1
RXG-SED	TS-3-3-B-3	26 58	96 33	106	0.56	40.22	59.22	0.01	1
RYU-SED	TS-4-3-A-3	26 58	97 20	15	74.30	11.06	14.64	2.89	1
RYW-SED	TS-4-3-B-3	26 58	97 20	15	77.96	8.91	13.13	3.54	1
SAD-SED	TS-5-3-A-3	26 58	97 02	40	0.56	43.55	55.89	0.01	1
SAF-SED	TS-5-3-B-3	26 58	97 02	40	1.44	41.86	56.69	0.02	1
SBM-SED	TS-6-3-A-3	26 58	96 30	125	0.78	36.92	62.30	0.01	1
SBO-SED	TS-6-3-B-3	26 58	96 30	125	0.82	38.56	60.62	0.01	1
SCX-SED	TS-1-4-A-3	26 10	97 01	27	65.01	12.22	22.76	1.86	1
SCZ-SED	TS-1-4-B-3	26 10	97 01	27	64.67	18.20	17.13	1.83	1
SEU-SED	TS-2-4-A-3	26 10	96 39	47	3.49	34.46	62.05	0.04	1
SEW-SED	TS-2-4-B-3	26 10	96 39	47	7.10	42.56	50.33	0.08	1

Appendix 4

11	12	13	14	15	16	17	18
RHK-SED	TS-6-1-A-3	0.78	7.48	2.35	-0.19	-1.06	2
RHM-SED	TS-6-1-B-3	1.43	6.81	2.35	0.04	-1.23	2
RJL-SED	TS-1-2-A-3	0.76	7.58	2.30	-0.21	-1.06	2
RJN-SED	TS-1-2-B-3	0.74	7.96	1.98	-0.29	-0.40	2
RLL-SED	TS-2-2-A-3	1.14	7.36	2.17	-0.06	-1.17	2
RLN-SED	TS-2-2-B-3	0.99	7.56	2.12	-0.16	-0.96	2
RNK-SED	TS-3-2-A-3	0.52	8.42	1.76	-0.38	-0.02	2
RNM-SED	TS-3-2-B-3	0.53	8.35	1.80	-0.40	0.10	2
RPA-SED	TS-4-2-A-3	0.90	7.45	2.26	-0.13	-1.16	2
RPC-SED	TS-4-2-B-3	1.06	7.34	2.26	-0.07	-1.29	2
RQJ-SED	TS-5-2-A-3	1.23	7.44	2.09	-0.04	-1.21	2
RQL-SED	TS-5-2-B-3	0.79	7.79	2.12	-0.22	-0.87	2
RRT-SED	TS-6-2-A-3	0.68	8.26	1.75	-0.23	-0.69	2
RRV-SED	TS-6-2-B-3	0.60	8.43	1.64	-0.23	-0.79	2
RTE-SED	TS-1-3-A-3	1.02	7.55	2.10	-0.13	-1.00	2
RTG-SED	TS-1-3-B-3	0.87	7.81	2.03	-0.18	-1.06	2
RVC-SED	TS-2-3-A-3	0.85	7.99	1.85	-0.15	-1.07	2
RVE-SED	TS-2-3-B-3	0.76	8.02	1.83	-0.22	-0.81	2
RXE-SED	TS-3-3-A-3	0.58	8.44	1.75	-0.28	-0.58	2
RXG-SED	TS-3-3-B-3	0.68	8.24	1.72	-0.22	-0.75	2
RYU-SED	TS-4-3-A-3	0.75	4.78	2.19	0.78	0.94	2
RYW-SED	TS-4-3-B-3	0.68	4.49	2.18	0.82	1.50	2
SAD-SED	TS-5-3-A-3	0.78	8.06	1.81	-0.19	-0.92	2
SAF-SED	TS-5-3-B-3	0.74	8.05	1.84	-0.24	-0.74	2
SBM-SED	TS-6-3-A-3	0.59	8.41	1.65	-0.27	-0.53	2
SBO-SED	TS-6-3-B-3	0.64	8.28	1.77	-0.26	-0.71	2
SCX-SED	TS-1-4-A-3	0.54	4.63	2.99	0.43	-0.91	2
SCZ-SED	TS-1-4-B-3	1.06	4.44	2.74	0.49	-0.52	2
SEU-SED	TS-2-4-A-3	0.56	8.27	1.93	-0.54	1.25	2
SEW-SED	TS-2-4-B-3	0.85	7.63	2.24	-0.28	-0.55	2

Appendix 4

1	2	3	4	5	6	7	8	9	10
SGT-SED	TS-3-4-A-3	26 10	96 24	91	38.67	22.35	38.98	0.63	1
SGV-SED	TS-3-4-B-3	26 10	96 24	91	40.00	29.13	30.86	0.67	1
SIK-SED	TS-4-4-A-3	26 10	97 08	15	74.81	12.27	12.92	2.97	1
SIM-SED	TS-4-4-B-3	26 10	97 08	15	70.78	11.41	17.80	2.42	1
SJU-SED	TS-5-4-A-3	26 10	96 54	37	16.71	35.63	47.66	0.20	1
SJW-SED	TS-5-4-B-3	26 10	96 54	37	11.46	31.00	57.54	0.13	1
SLE-SED	TS-6-4-A-3	26 10	96 31	65	41.02	25.01	33.97	0.69	1
SLG-SED	TS-6-4-B-3	26 10	96 31	65	57.72	15.88	26.40	1.36	1
SMO-SED	TS-7-4-A-3	26 10	96 20	130	0.00	40.51	59.49	0.00	1
SMQ-SED	TS-7-4-B-3	26 10	96 20	130	0.00	36.45	63.55	0.00	1

Appendix 4

11	12	13	14	15	16	17	18
SGT-SED	TS-3-4-A-3	0.57	6.18	3.12	-0.03	-1.60	2
SGV-SED	TS-3-4-D-3	0.94	5.77	3.04	0.05	-1.48	2
SIK-SED	TS-4-4-A-3	0.95	4.11	2.44	0.69	0.70	2
SIM-SED	TS-4-4-D-3	0.64	4.35	2.73	0.56	-0.34	2
SJU-SED	TS-5-4-A-3	0.75	7.24	2.65	-0.31	-0.76	2
SJW-SED	TS-5-4-D-3	0.54	7.79	2.47	-0.49	0.08	2
SLE-SED	TS-6-4-A-3	0.74	5.80	3.15	0.05	-1.57	2
SLG-SED	TS-6-4-B-3	0.60	4.93	3.17	0.29	-1.35	2
SMO-SED	TS-7-4-A-3	0.68	8.31	1.63	-0.17	-0.93	2
SMQ-SED	TS-7-4-D-3	0.57	8.45	1.60	-0.24	-0.71	2

APPENDIX 5:

Rates of Sedimentation

RATES OF SEDIMENTATION

CORE	LAT	LONG	TYPE	BIO	RATE	REMARKS
5	28 10	96 02	BOX		.48	
9	28 10	96 23	HDC	10	1.92	
10	28 10	96 29	BOX	NA	0.00	
19	27 59	96 08	G	NA	1.98	
21	29 00	96 20	HDC	NA	4.41	
23A	26 03	97 08	G	NA	9.88	TOP 30CM APPEARS TO HAVE CONSTANT PB-210
27	27 55	96 44	BOX	NA	.97	TOP 5CM SAND LAYER
32	27 54	96 20	BOX	10	1.42	
42	27 50	96 35	BOX	7	1.93	
45	27 50	96 53	BOX	NA	0.00	
57	27 44	96 00	G	NA	1.90	
60	27 39	96 12	BOX	2	.99	
62	27 41	96 17	G	NA	3.32	
64	27 39	96 29	HDC	NA	7.39	
70	27 39	96 59	BOX	NA	2.01	
75	27 34	96 47	G	NA	3.73	
87	27 33	95 57	G	NA	0.19	
106	27 24	96 44	BOX	NA	3.45	SAW TOOTH PATTERN DUE TO SAND LAYERS
115	27 18	96 24	BOX	NA	0.02	
120	27 18	96 47	BOX	NA	1.89	TOP SAND LAYER
127	27 13	97 08	BOX	NA	0.00	
137	27 08	96 24	HDC	NA	.64	

RATES OF SEDIMENTATION

CORE	LAT	LONG	TYPE	BIO	RATE	REMARKS
137A	27 08	96 24	G	NA	.50	
151	27 03	96 43	G	13	1.42	
155	26 57	96 27	BOX	NA	.03	
156	26 57	96 33	BOX	NA	0.00	
157	26 57	96 39	BOX	NA	0.00	
160	26 58	96 47	BOX	NA	0.00	
164	26 58	97 02	G	NA	2.40	
171	26 52	96 43	BOX	NA	0.00	
174	26 52	96 36	BOX	NA	0.54	
176	26 47	96 27	BOX	NA	.03	
179	26 46	96 41	BOX	NA	.03	
185	26 47	97 08	BOX	NA	0.00	
191	26 42	96 33	BOX	NA	0.03	
193	26 41	96 27	BOX	NA	0.00	
199	26 37	96 51	G	NA	1.12	
203	26 32	97 05	G	NA	0.00	
206	26 31	96 54	G	4	1.37	
217	26 26	96 31	G	9	2.04	
235	26 16	96 21	G	5	3.61	
238	26 15	96 34	G	3	2.66	
243	26 16	96 51	BOX	NA	0.00	
249	26 10	96 48	G	NA	2.71	

EXPLANATION FOR APPENDIX 6:

Trace Metals Content, Seasonal Sediment Samples

Column 1 - Sample number

Column 2 - Barium

Column 3 - Cadmium

Column 4 - Chromium

Column 5 - Copper

Column 6 - Iron

Column 7 - Manganese

Column 8 - Nickel

Column 9 - Lead

Column 10 - Vanadium

Column 11 - Zinc

University of Texas - Season I

1		2	3	4	5	6	7	8	9	10	11
1/I	HAT	91.9	0.16	15.9	4.6	17500	312	16.4	4.8	13.1	52.1
2/I	HCO	66.3	0.11	23.6	6.4	21500	287	16.2	6.7	15.5	70.0
3/I	HDX	145.9	0.14	37.7	6.6	19700	321	20.0	5.6	16.1	75.4
4/I	HFE	104.0	0.15	18.9	5.6	23300	379	12.9	7.0	11.0	56.0
5/I	HGE	43.0	0.07	24.9	6.3	19300	285	17.4	10.0	14.0	81.3
6/I	HHE	40.6	0.10	34.3	5.8	19000	306	17.2	9.8	11.5	66.7
1/II	HIP	114.3	0.12	29.6	6.4	19300	291	12.6	5.5	13.2	57.0
2/II	HKG	54.1	0.07	19.9	5.4	19000	262	11.7	5.3	15.4	64.8
3/II	HLR	85.9	0.20	29.6	6.4	20500	311	16.3	6.8	15.9	75.0
4/II	HMX	65.1	0.09	13.4	4.5	10500	252	12.6	5.7	11.0	51.0
5/II	HOE	42.8	0.09	32.1	5.6	19700	301	13.7	7.0	13.4	65.6
6/II	HPO	46.9	0.11	25.4	6.5	19900	341	19.6	14.9	13.7	81.4
1/III	HUC	100.5	0.13	21.3	6.6	19700	325	15.6	9.0	14.8	63.9
2/III	IAE	72.9	0.10	33.1	6.6	19900	320	17.4	6.2	16.3	71.2
3/III	ICE	61.1	0.17	21.8	6.6	20900	325	18.0	7.6	18.1	74.4
4/III	IEA	32.8	0.04	14.5	1.4	21100	222	5.5	2.4	6.7	28.1
5/III	IFN	70.0	0.11	37.8	7.2	16400	343	15.8	9.4	15.1	72.2
6/III	IHF	48.7	0.13	28.9	6.8	19600	530	17.4	13.6	16.8	82.0
1/IV	IIY	123.2	0.15	20.0	5.3	16400	282	14.0	6.0	13.6	55.3
2/IV	ILE	58.2	0.12	23.8	6.3	19600	299	22.8	7.0	17.3	67.6
3/IV	INB	79.7	0.13	18.7	5.9	19300	370	14.8	7.3	16.5	65.5
4/IV	IOY	113.8	0.19	18.8	4.5	17500	305	9.3	4.2	17.6	43.4
5/IV	IQJ	67.7	0.10	21.5	6.3	21500	334	13.2	9.0	13.7	66.7
6/IV	ISA	44.4	0.11	30.4	5.8	19700	339	14.3	11.7	16.0	67.2
7/IV	IUR	47.3	0.12	40.9	7.2	20500	560	17.9	12.0	15.1	82.6
SB1	JEG	113.6	0.07	31.7	5.5	19300	364	14.4	11.4	15.7	66.5
SB2	JFN	99.9	0.10	31.3	7.2	23300	373	18.9	16.5	19.0	81.5
HR1	JHA	69.1	0.17	18.4	3.9	10500	369	9.6	6.8	16.8	46.4
HR2	JIO	74.1	0.09	27.6	6.6	21100	303	24.4	11.4	21.1	74.6

University of Texas - Season II

1		2	3	4	5	6	7	8	9	10	11
1/I	LYF	85.9	0.19	22.0	5.5	18500	288	12.7	9.7	14.8	55.5
	LYG	43.7	0.15	15.9	4.0	13300	221	9.8	2.9	11.1	39.6
	LYH	107.6	0.17	19.1	5.3	15600	275	11.4	5.3	12.3	47.1
	LYI	103.0	0.16	17.6	4.7	16200	259	10.7	5.3	12.5	46.9
	AVG.	85.1	0.17	18.7	4.9	15900	261	11.1	5.8	12.7	47.3
	LYJ	84.0	0.17	19.3	4.8	16300	265	11.1	5.1	12.2	45.9
2/I	MAF	62.1	0.18	21.2	5.5	20500	264	13.6	6.7	13.8	55.3
	MAG	61.0	0.20	24.1	4.9	21000	296	15.0	7.3	14.4	57.3
	MAH	58.0	0.19	26.1	5.7	21900	310	14.6	9.3	20.0	62.8
	MAI	69.0	0.19	24.1	5.2	20200	314	14.0	8.1	17.5	57.6
	AVE.	62.5	0.19	23.9	5.3	20900	296	14.3	7.8	16.4	58.3
	MAJ	68.4	0.20	24.0	5.1	20400	287	13.9	8.1	17.8	57.5
3/I	MCC	57.7	0.28	31.9	7.0	22900	348	17.0	6.3	28.4	69.5
	MCD	41.1	0.28	23.6	7.0	20800	333	17.3	6.0	21.0	61.0
	MCE	45.6	0.28	28.3	6.8	23500	338	16.8	5.8	23.5	67.6
	MCF	48.6	0.29	29.0	7.2	24200	328	18.9	7.7	26.4	70.9
	AVE.	48.3	0.28	28.2	7.0	22900	337	17.5	6.4	24.8	67.3
	MCG	47.5	0.28	25.7	6.4	21200	322	16.4	6.4	22.7	62.6
4/I	MDW	29.1	0.16	8.0	2.3	7600	170	5.4	2.1	10.4	26.7
	MDX	34.8	0.14	8.2	2.3	7800	195	5.1	2.4	9.9	26.4
	MDY	36.4	0.18	9.8	2.8	9700	218	6.1	3.3	10.9	31.1
	MDZ	51.0	0.17	11.8	3.5	12900	263	7.2	4.0	10.1	35.6
	AVG.	37.8	0.16	9.5	2.7	9500	212	6.0	2.9	10.3	30.0
	MEA	43.6	0.17	9.4	2.9	9500	191	6.1	3.1	12.2	30.3
5/I	MFQ	51.2	0.26	27.2	6.1	23100	294	12.9	8.4	20.4	68.3
	MFR	47.7	0.26	29.3	6.1	25500	312	14.4	10.3	20.6	76.7
	MFS	58.4	0.27	30.6	7.0	28200	334	14.9	11.9	23.1	82.4
	MFT	44.6	0.26	29.0	6.7	25000	308	15.0	9.6	20.3	77.5
	AVG.	50.5	0.26	29.0	6.5	25400	312	14.3	10.1	21.1	76.2
	MFU	48.3	0.27	27.7	6.7	23300	319	14.2	9.5	21.9	72.6

University of Texas - Season II

1		2	3	4	5	6	7	8	9	10	11
6/I	MHK	36.4	0.20	23.5	4.9	18300	293	12.7	6.1	23.4	58.9
	MHL	39.9	0.20	25.0	7.6	20600	303	14.0	6.8	23.2	59.2
	MHM	41.7	0.21	19.5	4.5	16900	244	11.8	8.3	18.2	49.4
	MHN	42.8	0.21	23.6	5.1	19000	280	12.9	7.3	26.3	61.3
	AVG.	40.2	0.21	22.9	5.5	18700	280	12.9	7.1	22.8	57.2
	MHO	35.9	0.21	23.0	4.9	19100	289	13.7	6.5	27.4	59.8
1/II	MJE	93.1	0.17	16.5	5.4	18800	316	12.1	7.3	17.6	53.3
	MJF	70.5	0.17	13.5	4.3	16000	298	10.9	6.1	15.4	50.2
	MJG	94.8	0.18	15.4	5.2	17800	314	12.0	7.4	16.6	57.2
	MJH	53.3	0.11	8.3	2.8	11700	188	7.3	4.9	11.3	37.6
	AVG.	77.9	0.16	13.4	4.4	16100	279	10.6	6.4	15.2	49.6
	MJI	89.6	0.16	14.2	4.5	16300	283	10.9	6.9	15.4	48.7
2/II	MLG	66.8	0.18	20.4	4.8	19100	288	12.5	7.0	19.5	63.4
	MLH	59.5	0.17	17.1	5.0	18600	300	12.5	6.9	14.7	56.1
	MLI	75.3	0.18	17.6	5.4	18800	307	12.7	7.6	15.0	56.2
	MLJ	63.6	0.18	17.3	5.0	18700	282	12.3	7.4	14.0	53.2
	AVG.	66.3	0.18	18.2	5.1	18800	294	12.5	7.2	15.8	57.2
	MLR	75.3	0.19	18.7	5.3	18700	296	10.7	7.7	14.0	54.6
3/II	MNH	51.5	0.27	34.6	6.7	22800	390	17.0	6.7	16.9	72.8
	MNI	50.4	0.23	32.4	6.7	23600	356	16.7	6.9	17.5	73.1
	MNJ	66.9	0.24	36.1	7.0	25800	372	16.3	9.4	18.2	75.2
	MNK	46.4	0.24	34.0	7.2	26300	500	18.2	6.3	19.4	80.8
	AVG.	53.8	0.25	34.3	6.9	24600	405	17.1	7.3	18.0	75.5
	MNL	51.7	0.23	36.0	6.8	24400	411	16.1	5.5	19.1	80.7
4/II	MPB	91.1	0.20	23.1	5.7	21700	323	14.2	5.2	14.7	63.3
	MPC	90.4	0.19	22.0	5.4	20000	324	13.2	4.7	13.7	59.1
	MPD	104.8	0.19	27.6	6.1	21600	337	13.5	5.5	15.7	67.5
	MPE	88.2	0.19	26.8	5.5	20000	329	13.9	5.3	15.2	62.0
	AVG.	93.6	0.19	24.9	5.6	20800	328	13.7	5.2	14.8	63.0
	MPF	82.8	0.19	23.5	5.4	21300	328	14.1	4.7	13.3	60.1

University of Texas - Season II

1		2	3	4	5	6	7	8	9	10	11
5/II	MQT	75.4	0.23	25.0	5.0	20500	318	13.3	5.6	15.6	63.6
	MQU	55.3	0.21	21.2	4.5	18100	291	12.8	5.7	14.9	54.7
	MQV	94.9	0.21	26.5	5.8	20600	314	15.9	6.2	18.2	67.7
	MQW	70.6	0.22	26.7	5.6	21600	296	14.8	5.0	17.5	64.0
	AVG.	74.1	0.22	24.9	5.3	20200	305	14.2	5.6	16.6	62.5
	MQX	67.8	0.22	25.7	5.5	21400	302	15.7	6.1	15.0	67.2
6/II	MSL	76.2	0.24	29.3	6.1	22900	333	17.6	5.2	20.1	68.3
	MSM	71.3	0.23	31.3	6.2	23900	346	16.7	5.4	17.6	78.0
	MSN	66.0	0.22	31.2	6.0	22500	328	15.4	5.3	17.2	68.9
	MSO	60.5	0.23	30.9	5.5	21800	339	14.6	5.2	19.0	67.7
	AVG.	68.5	0.23	30.7	6.0	22800	339	16.1	5.3	18.5	70.7
	MSP	58.8	0.23	30.9	6.0	21700	327	15.6	5.6	19.0	66.1
1/III	MXH	134.3	0.21	23.3	6.7	23100	353	16.3	6.4	14.1	60.9
	MXI	97.7	0.22	21.1	6.8	22300	328	14.9	5.5	13.7	63.7
	MXJ	144.3	0.23	23.0	6.4	18500	342	13.1	5.4	16.2	61.1
	MXK	151.1	0.23	24.0	6.9	21600	355	15.8	6.1	14.6	61.3
	AVG.	131.9	0.22	22.9	6.7	21400	345	15.0	5.8	14.7	61.8
	MXL	110.9	0.22	22.5	6.3	20200	340	14.2	5.8	15.5	61.4
2/III	MZH	138.0	0.21	29.6	6.4	21900	363	16.7	8.4	22.4	76.7
	MZI	169.5	0.24	32.2	8.1	27800	448	19.4	9.0	20.4	86.4
	MZJ	182.1	0.26	23.8	6.2	19600	434	14.7	5.8	16.9	67.0
	MZK	60.2	0.24	27.3	7.4	21600	479	16.8	9.1	17.3	74.5
	AVG.	137.5	0.24	28.2	7.0	22700	431	16.9	8.1	19.2	76.2
	MZL	139.6	0.24	26.9	7.3	22000	425	18.1	8.9	18.4	70.9
3/III	NBE	40.6	0.24	25.1	8.0	24500	411	18.8	9.0	19.0	78.8
	NBF	37.2	0.23	26.8	7.0	22800	379	18.7	11.8	22.5	75.6
	NBG	41.1	0.17	28.1	7.5	24400	392	18.0	8.2	20.2	75.7
	NBH	37.1	0.18	29.5	6.7	21800	376	16.4	7.3	19.7	73.6
	AVG.	39.0	0.20	27.4	7.3	23400	390	18.0	9.1	20.6	75.9
	NBI	34.9	0.18	28.5	7.4	22300	382	17.1	7.6	20.8	75.3

University of Texas - Season II

1		2	3	4	5	6	7	8	9	10	11
4/III	NCY	15.1	0.06	4.6	0.8	4900	299	3.8	1.7	6.4	21.6
	NCZ	16.8	0.09	6.4	1.2	5800	170	4.4	2.3	7.1	22.3
	NDA	14.2	0.06	4.5	0.6	4600	247	3.6	1.8	5.5	20.9
	NDB	20.4	0.10	5.3	1.5	6700	241	5.2	2.5	7.3	27.6
AVG.		16.6	0.08	5.2	1.0	5500	239	4.3	2.1	6.6	23.1
	NDC	21.0	0.08	5.0	1.0	5500	251	3.7	2.0	7.1	26.2
5/III	NES	44.0	0.19	23.2	5.9	19500	350	15.1	6.0	16.6	67.6
	NET	46.6	0.19	29.9	6.7	21100	363	22.4	7.2	17.9	73.4
	NEU	54.0		28.1		25400	413			14.9	82.4
	NEV	46.3	0.20	28.0	6.2	20000	340	15.6	7.1	18.2	68.9
AVG.		47.7	0.20	27.3	6.3	21500	366	17.7	6.8	16.9	73.1
	NEW	47.2	0.20	27.1	6.5	20400	348	18.9	6.9	18.5	71.3
6/III	NGK	37.1	0.18	29.4	6.8	22600	368	18.3	7.8	19.7	78.8
	NGL	35.7	0.20	31.3	6.4	23200	403	18.5	6.6	30.6	80.8
	NGM	33.9	0.20	31.4	6.2	22400	341	18.9	6.6	26.4	81.2
	NGN	40.5	0.20	31.5	6.3	23800	357	17.5	6.8	22.4	78.1
AVG.		36.8	0.20	30.9	6.4	23000	367	18.3	7.0	24.8	80.0
	NGO	34.5	0.20	32.0	6.2	23200	369	18.3	6.9	24.2	81.5
1/IV	NIE	22.3	0.15	6.7	1.4	5200	118	3.0	1.9	10.4	23.8
	NIF	29.3	0.15	9.0	1.6	5800	110	4.0	2.2	10.7	16.8
	NIG	25.7	0.15	9.5	2.0	6800	131	5.3	2.4	11.1	22.9
	NIH	23.5	0.17	10.8	1.9	6300	136	5.2	2.7	12.2	22.6
AVG.		25.2	0.16	9.0	1.7	6000	123	4.4	2.3	11.1	21.5
	NII	24.5	0.15	9.8	1.9	6000	133	5.0	2.4	11.7	25.4
2/IV	NKE	19.5	0.15	17.8	3.8	14100	190	8.7	4.1	16.9	47.0
	NKF	19.8	0.16	16.0	3.4	12500	195	8.2	4.0	13.6	37.8
	NKG	21.5	0.16	14.6	2.7	10600	183	6.8	4.1	14.6	33.5
	NKH	23.1	0.16	17.6	4.1	14300	211	9.7	4.6	16.1	41.2
AVG.		21.0	0.16	16.5	3.5	12900	195	8.4	4.2	15.3	39.9
	NKI	25.4	0.16	15.6	3.5	12600	189	9.4	5.5	15.2	39.0

University of Texas - Season II

	1	2	3	4	5	6	7	8	9	10	11
3/IV	NMB	39.1	0.19	28.1	6.0	20800	353	16.9	6.4	22.7	70.6
	NMC	37.0	0.18	28.3	6.1	23000	377	17.1	6.5	19.4	75.0
	NMD	34.4	0.18	27.8	6.0	22700	385	16.7	6.7	17.0	74.9
	NME	39.3	0.17	28.2	6.5	22400	409	17.6	7.9	17.4	73.7
	AVG.	37.5	0.18	28.1	6.2	22200	381	17.1	6.9	19.1	73.6
	NMF	38.3	0.18	28.8	6.5	22900	381	17.6	6.7	21.9	74.9
4/IV	NNV	28.3	0.08	5.3	1.4	5400	112	4.3	2.2	8.5	16.1
	NNW	24.9	0.08	4.8	0.9	4700	121	3.4	2.0	8.2	13.8
	NNX	26.3	0.08	5.0	0.9	4500	124	3.7	2.4	7.7	15.7
	NNY	24.2	0.10	7.3	1.4	5700	127	3.9	2.2	9.7	15.4
	AVG.	25.6	0.09	5.6	1.2	5100	121	3.8	2.2	8.5	14.7
	NNZ	26.9	0.08	5.2	1.1	4800	111	3.4	2.5	8.5	14.0
5/IV	NPN	37.3	0.13	12.7	3.2	9900	191	7.4	3.6	12.1	32.2
	NPO	35.4	0.13	12.8	3.1	9200	181	6.5	2.9	13.6	27.7
	NPP	45.4	0.12	12.5	3.2	8900	172	6.7	2.9	11.3	32.5
	NPQ	46.2	0.14	14.2	3.4	9500	195	7.0	3.0	13.4	35.5
	AVG.	41.1	0.13	13.1	3.2	9400	185	6.9	3.1	12.6	32.0
	NPR	49.6	0.13	13.8	3.3	9400	190	7.8	2.9	12.1	30.4
6/IV	NRF	38.5	0.16	23.2	4.9	17300	252	13.9	3.9	14.9	52.5
	NRG	32.8	0.17	26.8	4.5	19000	289	15.2	4.7	15.2	62.4
	NRH	28.6	0.12	13.9	3.0	10400	246	7.8	3.5	11.3	30.8
	NRI	35.7	0.15	19.7	4.4	15100	302	11.4	3.6	12.3	44.4
	AVG.	33.9	0.15	20.9	4.2	15500	272	12.1	3.9	13.4	47.5
	NRJ	27.6	0.16	20.2	4.7	17300	267	12.0	4.0	14.4	48.7
7/IV	NSX	38.0	0.19	32.9	7.1	24100	531	18.7	10.3	18.2	79.9
	NSY	37.9	0.20	32.4	6.9	25700	497	19.1	5.6	19.0	78.3
	NSZ	43.9	0.23	36.1	7.6	26600	624	20.8	5.6	23.2	84.4
	NTA	46.5	0.21	30.3	6.9	23100	568	18.3	6.5	18.9	76.9
	AVG.	41.6	0.21	32.9	7.1	24900	486	19.2	7.0	19.8	79.9
	NTB	39.4	0.19	32.3	7.1	26600	564	19.0	5.5	19.7	79.4

University of Texas - Season III

1		2	3	4	5	6	7	8	9	10	11
1/I	QYY	103.0	0.08	12.1	4.5	15800	257	10.8	4.3	9.6	50.6
2/I	RAP	74.4	0.06	17.5	4.7	18900	239	14.8	6.9	13.8	58.8
3/I	RCS	54.9	0.09	26.3	6.9	21300	328	16.7	7.1	19.2	75.7
4/I	REJ	40.3	0.05	8.4	2.4	8800	194	6.2	2.3	9.2	30.1
5/I	RGA	77.2	0.09	31.0	6.4	24900	273	17.3	7.7	18.4	81.9
6/I	RHR	54.6	0.06	20.0	4.6	16800	251	11.8	4.9	13.9	58.7
1/II	RJS	102.7	0.08	17.9	5.1	19400	272	12.3	6.5	15.0	59.8
2/II	RLS	63.9	0.07	19.8	4.7	20000	264	13.9	6.1	14.3	61.6
3/II	RNR	67.2	0.37	26.7	6.4	22500	345	16.1	7.5	21.7	78.8
4/II	RPH	131.5	0.08	23.7	5.3	19600	299	14.8	7.0	15.8	66.1
5/II	RQQ	71.7	0.08	23.6	5.5	21100	294	16.9	7.3	19.5	70.7
6/II	RSA	65.7	0.08	26.7	6.2	23900	305	20.9	7.6	17.6	79.9
1/III	RTL	77.3	0.10	24.3	5.4	23300	280	15.3	8.0	19.4	72.5
2/III	RVJ	55.2	0.09	22.8	5.4	21700	287	14.2	6.7	17.1	72.8
3/III	RXL	84.0	0.13	34.0	6.8	24600	388	17.2	9.0	20.9	83.2
4/III	RZB	47.6	0.04	7.9	1.7	8300	247	6.0	2.2	11.8	30.2
5/III	SAK	103.4	0.09	28.1	6.5	23300	399	16.4	8.7	14.2	72.7
6/III	SBT	72.5	0.12	29.1	6.8	25000	321	16.6	7.7	21.4	81.7
1/IV	SDE	64.3	0.05	8.1	2.4	8500	132	6.0	2.3	9.6	27.1
2/IV	SFB	60.0	0.07	24.6	5.8	21700	298	14.3	7.7	17.4	69.0
3/IV	SHA	51.2	0.06	21.4	4.5	16100	248	11.0	5.4	19.3	53.7
4/IV	SIR	49.7	0.05	7.7	1.9	7400	168	4.8	2.0	13.0	24.1
5/IV	SKB	83.8	0.09	22.9	5.8	21200	276	13.7	8.2	17.3	66.7
6/IV	SLL	44.7	0.05	13.9	3.1	11000	200	8.2	3.7	9.7	37.8
7/IV	SMV	76.1	0.11	38.2	7.1	25500	444	16.5	9.1	18.3	84.3

EXPLANATION FOR APPENDIX 7:

Gas Seep Study - Squeezed Cores

Column 1 - Sample number

Column 2 - Cadmium

Column 3 - Iron

Column 4 - Manganese

Column 5 - Nickel

Column 6 - Lead

Column 7 - Vanadium

Column 8 - Zinc

Column 9 - Zinc (water sample)

Column 10 - Manganese (water sample)

Column 11 - Montmorillonite

Column 12 - Illite

Column 13 - Kaolinite and Chlorite

Column 14 - Quartz

Column 15 - Carbonate

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-1- 30	0.32	23800	412	22.0	8.2	16.2	72.0	0.08	0.52	63.5	16.0	9.5	8.5	1.0
1-1- 60	0.31	21500	336	20.7	7.7	19.7	72.2	0.08	0.46	64.0	12.0	9.0	11.5	2.7
1-1- 90	0.30	22200	386	20.5	7.5	17.8	72.0	0.09	0.46	33.8	23.2	13.0	15.0	14.0
1-1-120	0.34	23700	396	22.9	7.5	17.9	78.4	0.09	0.49	69.6	9.5	9.0	9.0	1.2
1-1-150	0.34	24500	363	22.1	8.5	22.1	74.5	0.08	0.37	79.1	5.8	6.8	6.0	2.0
1-1-180	0.34	24100	350	24.9	7.2	19.9	76.0	0.23	0.59	36.3	17.7	14.2	24.5	7.2
1-2- 15	0.37	23700	388	20.9	8.4	18.5	76.9	0.31	0.90	58.5	13.0	12.5	11.0	3.1
1-2- 45	0.41	23900	379	21.4	7.8	20.2	79.4	0.17	0.40	72.0	9.0	7.0	7.2	8.2
1-2- 75	0.35	20900	346	19.0	7.1	10.9	75.6	0.14	0.46	60.0	17.0	9.6	10.5	2.8
1-2-105	0.36	22400	366	20.0	7.6	22.4	142.9	0.38	0.51	57.0	15.0	13.5	9.0	2.5
1-2-135	0.36	24200	378	21.8	7.9	19.3	82.4	0.26	0.58	57.5	19.4	12.5	7.0	2.5
1-2-165	0.33	22800	339	22.5	7.2	16.2	78.1	0.12	0.58	23.5	19.0	11.0	36.5	3.1
1-3- 15	0.41	25100	352	22.2	9.2	22.5	77.0	0.05	0.32	57.8	17.0	10.5	11.0	.9
1-3- 45	0.39	24300	356	21.9	8.2	24.7	81.5	0.16	0.37	74.0	12.5	7.0	5.8	.5
1-3- 75	0.38	22600	331	20.0	8.1	24.0	75.8	0.06	0.23	49.3	18.1	9.0	17.2	5.4
1-3-105	0.46	23600	364	21.6	8.0	27.4	77.8	0.16	0.39	34.2	18.2	11.2	20.0	15.6
1-3-135	0.44	23900	372	20.6	7.5	17.9	71.0	0.08	0.31	24.0	21.0	14.2	31.5	9.2
1-3-165	0.38	22700	349	21.1	6.6	16.0	74.6	0.12	0.49	58.4	16.7	9.9	10.4	4.2
1-3-195	0.44	26400	350	21.6	7.2	14.4	80.7	0.14	0.34	51.5	18.2	15.2	12.1	3.0
1-3-225	0.43	27100	358	22.4	7.5	20.2	75.3	0.09	0.49	43.2	16.5	14.6	18.5	6.6

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2-1- 30	0.42	24900	383	19.6	8.7	17.6	83.2	0.19	0.56	51.5	21.2	12.1	15.0	0.0
2-1- 60	0.45	24400	395	19.5	8.6	22.5	82.9	0.95	0.59	44.5	18.0	13.2	15.0	8.1
2-1- 90	0.45	23600	359	20.1	8.3	21.9	83.0	0.10	0.43	40.0	21.0	15.5	15.5	4.5
2-1-120	0.39	21900	328	18.6	7.2	24.1	71.2	0.05	0.46	48.5	20.5	10.5	9.9	4.5
2-1-150	0.37	21800	346	18.5	7.4	20.1	93.4	0.07	0.40	43.9	16.9	16.5	9.5	11.5
2-1-180	0.43	23100	368	20.2	7.3	19.2	75.7	0.31	0.67	8.6	14.2	13.6	47.5	10.5
2-1-210	0.43	24900	364	22.4	7.1	19.4	79.1	0.46	0.73	47.7	22.9	15.0	14.4	0.0
2-2- 30	0.37	23000	353	20.1	7.4	22.9	91.3	0.13	0.34	9.3	16.8	13.2	53.5	6.2
2-2- 60	0.45	25700	376	20.2	8.5	17.6	86.6	0.27	0.52					
2-2- 90	0.38	23700	352	17.7	8.1	15.8	76.5	0.25	0.67					
2-2-120	0.43	24400	357	20.0	6.8	18.3	81.2	0.11	0.36	69.0	13.0	5.0	7.9	0.1
2-2-150	0.42	24000	364	19.3	8.2	20.5	83.5	0.08	0.63	58.5	17.2	12.3	9.1	2.2
2-2-180	0.43	22900	343	19.5	8.2	15.9	79.1	0.16	0.80	75.0	10.2	5.2	8.5	.3
2-3- 30	0.43	23400	391	19.4	7.7	17.2	73.3	0.14	0.49	38.8	18.2	16.2	15.2	9.0
2-3- 60	0.40	21200	367	18.1	7.0	16.0	73.0	0.20	0.43	47.3	20.3	15.4	12.2	3.2
2-3- 90	0.38	22200	342	19.2	7.4	16.7	68.4	0.06	0.30	22.8	21.7	12.4	34.2	8.6
2-3-120	0.36	19500	348	17.5	5.8	12.9	64.2	0.07	0.32	70.0	12.3	9.5	7.1	0.5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3-1- 30	0.43	22100	323	19.8	6.1	16.1	80.4	0.07	0.34	48.0	16.5	10.2	12.2	7.2
3-1- 60	0.43	21800	309	19.2	5.9	15.9	73.9	0.08	0.27	41.8	18.0	11.5	21.3	6.8
3-1- 90	0.45	21900	310	19.5	5.8	18.4	78.9	0.06	0.23	40.9	19.2	17.2	14.5	7.5
3-1-120	0.44	21600	325	20.6	5.7	17.6	74.3	0.07	0.37	15.0	20.3	15.1	31.5	17.5
3-1-150	0.42	19000	298	20.3	5.4	15.1	66.6	0.18	0.56	58.0	16.9	15.6	8.7	1.0
3-2- 30	0.43	22700	311	21.8	5.2	18.2	81.3	0.17	0.34	47.5	16.0	15.6	17.5	3.0
3-2- 60	0.52	23900	324	23.4	6.6	23.2	82.7	0.53	0.49	12.8	16.0	14.6	36.6	19.7
3-2- 90	0.49	23700	319	22.2	6.3	17.6	81.6	0.25	0.64	25.9	20.5	16.0	27.6	9.8
3-2-120	0.46	22300	349	22.0	6.1	19.2	76.1	0.36	0.84	40.2	18.6	13.2	21.4	6.4
3-2-150	0.45	23400	325	22.1	5.6	16.5	73.6	0.22	0.52	33.5	16.8	15.7	21.9	11.9
3-2-180	0.44	22100	309	22.2	5.5	13.9	77.0	0.13	0.43	63.0	13.4	8.3	12.1	3.0
3-3- 15	0.44	24600	329	21.1	5.5	20.8	88.4	0.08	0.63	31.0	16.0	12.5	31.2	9.1
3-3- 45	0.47	23300	326	21.4	6.0	17.6	76.6	0.16	0.43	50.5	17.0	14.2	12.7	4.2
3-3- 75	0.52	24400	329	21.8	6.3	22.1	86.3	0.13	0.43	44.0	18.9	12.8	10.9	13.2
3-3-105	0.51	23600	346	22.1	5.3	18.9	83.6	0.11	0.49	32.7	16.5	15.4	24.3	11.0
3-3-135	0.50	23500	337	22.9	6.0	17.9	82.6	0.07	0.49	52.4	22.0	10.7	12.3	2.3
3-3-165	0.44	22500	320	22.6	6.5	15.5	79.2	0.20	0.40	46.2	20.0	11.6	15.4	6.7
3-3-195	0.50	24700	336	24.5	7.0	15.0	84.3	0.20	0.52	69.9	14.7	6.6	6.8	2.2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
114- 30	0.50	21600	265	15.1	5.7	15.3	76.1	0.61	0.73	31.4	26.0	27.9	10.7	3.8
114- 60	0.56	21000	262	13.8	5.4	13.2	81.6	0.11	0.37	71.3	13.4	10.8	4.3	.1
114- 90	0.54	21700	280	14.2	5.2	13.5	80.1	0.06	0.20	39.7	19.9	19.8	13.8	6.6
114-120	0.60	19300	234	12.4	5.5	12.8	76.7	0.47	0.38	37.7	19.7	19.4	17.2	5.8
114-150	0.57	19900	242	12.8	7.6	15.1	77.0	0.60	0.51	29.6	18.0	13.3	24.2	14.7
114-180	0.58	19000	331	13.7	12.5	19.5	79.2	0.23	0.20	11.6	17.2	14.7	35.9	20.4

EXPLANATION FOR APPENDIX 8:

Gas Seep Study

Column 1 - Core number

Column 2 - Methane

Column 3 - Ethane

Column 4 - Ethene

Column 5 - Propane

Column 6 - Propene

Column 7 - pH

Column 8 - Sul fate

Column 9 - Silicate

Column 10 - Sodium

Column 11 - Potassium

Column 12 - Calcium

Column 13 - Magnesium

Column 14 - Chlorine

Column 15 - Bromine

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-1- 15	1.26	.0172	.0080	.0068	.0083									
1-1- 30						4.8	2800	6.5	13200	490	330	1080	20000	140
1-1- 45	1.59	.0307	.0137	.0173	.0154									
1-1- 60						5.5	2800	6.2	13600	500	280	1080	20200	180
1-1- 75	1.95	.0549	.0253	.0181	.0180									
1-1- 90						4.0	2500	5.3	13300	490	290	1180	19500	125
1-1-105	1.90	.0241	.0074	.0116	.0090									
1-1-120						6.3	2500	6.5	12600	500	255	1000	20000	125
1-1-135	2.06	.0165	.0053	.0073	.0046									
1-1-150						5.9	2850	5.5	13600	500	270	1080	20200	165
1-1-165	2.25	.0214	.0059	.0094	.0048									
1-1-180						3.5	3800	6.3	14200	500	460	1040	19800	205
1-1-195	1.72	.0290	.0084	.0145	.0116									
1-2- 15						2.1	2500	6.1	13400	485	385	1080	20000	100
1-2- 30	1.29	.0219	.0097	.0076	.0068									
1-2- 45						5.6	2500	4.4	13500	460	442	944	20100	250
1-2- 60	1.53	.0158	.0066	.0066	.0024									
1-2- 75						3.0	2500	4.7	12800	490	340	1040	20000	65
1-2- 90	1.57	.0184	.0070	.0081	.0049									
1-2-105						3.3	3050	5.0	13400	490	335	1110	19900	85
1-2-120	2.13	.0094	.0059	.0049	.0039									
1-2-135						3.3	2750	5.2	13500	474	433	927	20100	195
1-2-150	1.62	.0053	.0030	.0024	.0017									
1-2-165						3.1	3100	5.3	13000	474	400	962	19900	110
1-2-180	2.19	.0131	.0061	.0011	.0006									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-3- 15						6.0	3150	5.7	12800	540	245	940	20200	195
1-3- 30	1.74	.0112	.0056	.0054	.0075									
1-3- 45						2.5	2800	4.1	13400	510	352	1080	20100	205
1-3- 60	2.23	.0112	.0044	.0062	.0101									
1-3- 75						4.0	3100	3.7	13800	500	280	1020	20100	80
1-3- 90														
1-3-105						2.6	2850	5.0	12300	485	442	978	20100	125
1-3-120	2.46	.0101	.0037	.0044	.0057									
1-3-135						3.1	2800	4.2	12800	525	290	955	20200	125
1-3-150	2.53	.0076	.0034	.0034	.0051									
1-3-165						5.9	2450	5.3	13900	490	280	1080	20000	150
1-3-180	2.98	.0058	.0059	.0028	.0021									
1-3-195						6.0	2800	5.2	12800	520	223	1000	20200	150
1-3-210	2.93	.0098	.0047	.0034	.0072									
1-3-225						3.0	2800	5.8	12900	510	318	1070	19000	125
1-3-240	2.90	.0127	.0060	.0046	.0055									
2-1- 15	0.94	.0130	.0060	.0083	.0122									
2-1- 30						3.0	3100	4.8	13800	460	322	895	20100	255
2-1- 45	1.07	.0232	.0059	.0110	.0097									
2-1- 60						2.5	3650	4.5	14800	500	585	1060	20100	100
2-1- 75	1.14	.0168	.0059	.0096	.0095									
2-1- 90						5.4	2800	4.4	15200	462	298	1120	20100	165
2-1-105	1.43	.0144	.0051	.0058	.0053									
2-1-120						6.1	2500	5.5	13600	490	245	1070	20200	180
2-1-135	1.75	.0136	.0068	.0078	.0100									
2-1-150						6.3	2500	5.2	14000	500	305	1070	20300	180
2-1-165	1.68	.0139	.0051	.0065	.0066									
2-1-180						3.9	3100	5.3	12200	474	433	962	19900	260
2-1-195	1.74	.0179	.0070	.0081	.0088									
2-1-210						2.6	3200	6.1	14200	500	585	1080	20100	125
2-1-225	1.79	.0142	.0058	.0048	.0067									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2-2- 15														
2-2- 30						3.2	3100	4.2	12600	490	340	1050	20300	85
2-2- 45	2.06	.0089	.0044	.0036	.0067									
2-2- 60						3.4	3050	5.7	12000	460	423	978	19800	170
2-2- 75	3.15	.0076	.0056	.0028	.0054									
2-2- 90						3.1	4000	6.5	14800	484	450	1110	19900	100
2-2-105	3.03	.0111	.0056	.0033	.0045									
2-2-120						3.3	2750	5.0	14200	485	413	962	20000	215
2-2-135	2.81	.0079	.0064	.0041	.0051									
2-2-150						5.7	2950	7.5	12800	485	380	978	20300	105
2-2-165	2.57	.0114	.0084	.0037	.0066									
2-2-180						2.7	2950	8.7	12000	474	519	997	20000	110
2-2-195	2.41	.0400	.0372	.0162	.0217									
2-3- 15	1.53	.0122	.0069	.0049	.0132									
2-3- 30						2.9	2800	4.0	17100	476	378	920	20200	205
2-3- 45	1.51	.0085	.0088	.0064	.0150									
2-3- 60						3.0	2850	4.7	16900	465	305	1000	20200	215
2-3- 75	1.89	.0114	.0081	.0059	.0171									
2-3- 90						6.6	2450	5.3	14100	490	280	1070	20300	165
2-3-105	2.14	.0131	.0092	.0067	.0169									
2-3-120						6.4	2800	5.7	13600	495	280	1050	20300	195
2-3-135	1.89	.0191	.0113	.0083	.0135									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3-1- 15	0.81	.0268	.0162	.0118	.0144									
3-1- 30						4.3	2550	5.0	13500	494	423	962	20000	125
3-1- 45	0.99	.0184	.0055	.0051	.0074									
3-1- 60						3.2	2500	6.3	16200	480	349	1060	20000	195
3-1- 75	1.26	.0182	.0074	.0055	.0105									
3-1- 90						6.2	3050	6.1	13700	505	270	1050	20000	125
3-1-105	1.84	.0143	.0057	.0039	.0086									
3-1-120						5.6	2550	6.5	14000	480	306	1010	20000	140
3-1-135	1.53	.0137	.0116	.0064	.0129									
3-1-150						2.5	3150	9.1	14800	500	530	1080	19900	125
3-1-165	1.45	.0163	.0076	.0059	.0084									
3-2- 15	0.75	.0163	.0054	.0071	.0071									
3-2- 30						2.9	2800	4.7	15500	482	339	922	20000	250
3-2- 45	0.93	.0084	.0042	.0016	.0005									
3-2- 60						3.5	2400	6.6	13500	474	442	978	20100	50
3-2- 75	1.15	.0240	.0090	.0083	.0079									
3-2- 90						2.6	2800	7.8	11500	485	472	962	19400	170
3-2-105	1.58	.0237	.0214	.0093	.0096									
3-2-120						2.5	3450	11.3	14800	500	550	1090	19900	100
3-2-135	2.15	.0140	.0079	.0055	.0046									
3-2-150						2.7	2650	9.9	13500	485	433	962	19500	195
3-2-165	2.94	.0097	.0056	.0027	.0028									
3-2-180						5.9	2500	8.7	14500	494	413	927	19900	140
3-2-195	1.96	.0233	.0074	.0079	.0059									

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3-3- 15						2.5	2950	7.1	13500	494	500	1020	18500	150
3-3- 30	1.66	.0181	.0058	.0069	.0083									
3-3- 45						3.4	2450	6.3	16000	490	297	1130	19900	165
3-3- 60	1.95	.0252	.0082	.0090	.0076									
3-3- 75						4.1	2800	6.4	13600	520	285	1040	19900	180
3-3- 90	2.93	.0148	.0061	.0060	.0080									
3-3-105						6.0	2350	7.8	13200	460	460	944	19700	125
3-3-120	3.68	.0234	.0117	.0110	.0112									
3-3-135						5.6	2450	8.8	13100	500	270	1030	19800	150
3-3-150	3.82	.0249	.0099	.0088	.0121									
3-3-165						4.9	2500	5.8	14600	465	246	861	19600	255
3-3-180	4.53	.0093	.0034	.0035	.0045									
3-3-195						5.4	2450	11.3	15400	484	368	1030	19900	85
3-3-210	4.56	.0151	.0043	.0048	.0048									
114- 15	0.47	.0155	.0125	.0092	.0116									
114- 30						2.7	3900	6.7	14200	545	738	1080	19600	125
114- 45	2.63	.0463	.0525	.0165	.0369									
114- 60						5.6	2650	8.0	12000	515	292	1020	20000	180
114- 75	4.67	.0134	.0586	.0075	.0297									
114- 90						6.7	2500	6.5	13700	490	255	1070	20100	140
114-105	5.78	.0184	.0813	.0069	.0366									
114-120						6.0	3300	8.3	13500	484	550	1060	19500	110
114-135	9.16	.0170	.0139	.0082	.0303									
114-150						1.8	3500	10.1	14800	470	754	1140	18800	73
114-165	8.96	.0219	.1721	.0110	.0563									
114-180						5.3	2500	6.3	14400	476	290	980	20200	250
114-195	18.05	.0222	.0977	.0060	.0442									

EXPLANATION FOR APPENDIX 9:

Mean and Standard Deviation for Each Measurement for Each Core

C1 - methane

C2S - ethane

C2U - ethene

C3S - propane

C3U - propene

PH - pH

SO4 - sulfate

SI02 - silicon dioxide

NA - sodium

K - potassium

CA - calcium

MG - magnesium

CL - chlorine

BR - bromine

CD - cadmium

FE - iron

MN - manganese

NI - nickel

PB - lead

V - vanadium

ZN - zinc

ZW - zinc in water

MW - manganese in water

MONT - montmorillonite

ILLIT - illite

K+C - kaolinite plus chloride

Appendix 9. Mean and standard deviation for each measurement for each core

VARI-ABLE	SITE 1 CORE 1		SITE 1 CORE 2	
	MEAN	STD DEV	MEAN	STD DEV
CL	1.87833333	0.24846864	1.72000000	0.22561028
C2S	0.02845667	0.01014015	0.01330000	0.00494419
C2U	0.01100000	0.00576507	0.00612000	0.00157067
C3S	0.01243333	0.00343492	0.00530000	0.00244438
C3U	0.01039000	0.00451176	0.00334000	0.00138852
BR	5.00000000	1.69909053	3.66000000	1.09224539
SO4	2875.00000000	475.32243845	2780.00000000	288.53076093
SIO2	6.05000000	0.52057560	4.92000000	0.37013511
NA	13416.66665667	530.72277760	13240.00000000	320.93613072
K	496.66665667	5.16397779	477.60000000	12.68069399
CA	314.16665667	75.79026082	490.00000000	50.44303718
MG	1076.66665667	54.88878582	996.60000000	76.73200115
CL	19950.00000000	266.45325145	20000.00000000	100.00000000
BB	156.66666667	32.35222816	141.00000000	78.53343237
CD	0.32500000	0.01760632	0.36200000	0.02949576
FE	23300.00000000	1178.13411906	22840.00000000	1316.43457870
MN	373.33333333	29.02566893	361.60000000	18.33648412
NI	22.13333333	1.61048647	20.94000000	1.41703917
SR	7.76666667	0.48453523	7.52000000	0.35637059
V	18.53333333	2.06752070	17.80000000	4.45365019
ZN	74.13333333	2.63242600	91.63000000	28.73755383
ZR	0.10533333	0.05980524	0.21400000	0.10714476
SW	0.49166667	0.07305249	0.50600000	0.07797435
MONT	57.71666667	15.45930262	54.00000000	18.10731896
ILLIT	14.63333333	6.22596713	15.88000000	4.22752883
K+C	10.25000000	2.78406178	12.72000000	2.81371640

VARI- SITE 1 SAMPLE 114
ABLE CORE 3

	MEAN	STD DEV	MEAN	STD DEV
C1	2.62600000	0.39894934	6.74500000	4.25469975
C2S	0.00919000	0.00204377	0.02266667	0.00633898
C2H	0.00480000	0.00072457	0.10393333	0.07352762
C3S	0.00398000	0.00110318	0.00963333	0.00235004
C3H	0.00578000	0.00197282	0.03631667	0.00911535
PH	4.10000000	1.70440605	4.65333333	1.96307582
SO4	2730.00000000	156.52475842	3058.33333333	591.96002117
SIO2	4.92000000	0.73959448	7.65000000	1.45567854
NA	13160.00000000	482.70073545	13766.66666667	985.22417077
K	511.00000000	13.41640786	496.66666667	28.33843091
CA	292.60000000	47.91450720	479.83333333	231.77956482
MG	1037.00000000	55.74504384	1058.33333333	54.55883674
CL	19900.00000000	509.90195136	19700.00000000	521.53619242
SR	151.00000000	32.67261851	146.33333333	61.76298784
CO	0.33960000	0.16735536	0.55333333	0.03488075
FE	24630.00000000	1922.63545450	20416.66666667	1175.44317683
MN	357.00000000	9.21954446	269.00000000	34.59479730
NT	21.52000000	0.69785385	13.66666667	0.97091023
PB	7.40000000	0.57479185	6.98333333	2.84071587
V	18.64000000	4.02032337	14.90000000	2.47467170
ZN	76.62000000	4.41214234	78.45000000	2.18609240
ZR	0.11500000	0.03346640	0.34666667	0.24516661
AW	0.40000000	0.09485281	0.39833333	0.20113843
MOMT	50.22000000	18.51221219	36.88333333	19.57277872
TILTT	16.99000000	3.05334234	19.03333333	4.14471551
K+C	12.18000000	3.57379350	17.65000000	6.12037581

VARI-ABLE	SITE 2 CORE 1		SITE 2 CORE 2	
	MEAN	STD DEV	MEAN	STD DEV
C1	1.45714286	0.31542111	2.70000000	0.21517435
C2S	0.01421429	0.00220260	0.01496667	0.00929568
C2H	0.00624571	0.00026725	0.01206667	0.00932166
C3S	0.00792857	0.00147503	0.00566667	0.00358097
C3H	0.00000000	0.00132162	0.00830000	0.00513907
DH	4.28714286	1.65414343	3.90000000	1.55745079
SO4	2376.57142857	412.15617094	2883.33333333	115.47005384
SIO2	5.11428571	0.59841059	7.96666667	1.88767935
NA	13571.42857143	962.14047088	13000.00000000	1113.55287257
K	443.71428571	18.08972347	481.33333333	6.35085296
CA	366.14285714	140.81480577	437.33333333	72.62460556
MG	1136.71428571	78.77544943	979.00000000	17.52141547
CL	23114.28571429	121.49857926	26100.00000000	173.20508076
BR	140.71428571	60.09912447	143.33333333	62.11548385
CO	0.42000000	0.03000000	0.42666667	0.00577350
FE	23514.28571429	1313.30190922	23766.66666667	776.74534652
MN	336.28571429	22.28338271	354.66666667	10.69267662
NT	19.85714714	1.30748759	19.66666667	0.47258156
PB	7.80000000	0.70237692	7.73333333	0.80829038
V	20.85714429	2.24159807	18.23333333	2.30072452
ZN	-1.21428571	6.90557663	81.26666667	2.20075745
ZR	0.31428571	0.32030491	0.11666667	0.04041452
MN	0.65714143	0.12482369	0.59666667	0.22188586
SOMT	41.57142857	14.61765078	67.50000000	3.35164654
TLLIT	19.28714714	3.00935051	13.46666667	3.52325607
K+C	13.77142857	2.07341448	7.50000000	4.15812458

VARI-ABLE	SITE 2 CORE 3		SITE 3 CORE 1	
	MEAN	STD DEV	MEAN	STD DEV
C1	1.51500000	0.24785749	1.35200000	0.32637402
C2S	0.01220000	0.00278687	0.01724000	0.00340044
C2U	0.00895000	0.00102470	0.00846000	0.00191128
C3S	0.00642500	0.00076322	0.00598000	0.00150897
C3U	0.01560000	0.00124097	0.01020000	0.00085147
PH	4.72500000	2.05152537	4.36000000	1.55980768
SO4	2725.00000000	184.84227511	2760.00000000	313.04951685
SIO2	4.92500000	0.74105780	6.60000000	1.51327460
NA	15425.00000000	1831.49337390	14440.00000000	1101.36279218
K	491.50000000	13.62595562	491.80000000	11.45425685
CA	310.75000000	46.35640912	375.60000000	103.42775256
MG	1010.00000000	66.23312552	1032.40000000	46.89136381
CL	20250.00000000	57.73502692	19980.00000000	44.72135955
BR	195.00000000	21.60246899	142.00000000	30.33150178
CD	0.39250000	0.02986079	0.43400000	0.01140175
FE	21575.00000000	1650.00000000	21280.00000000	1287.24512040
MN	362.00000000	22.07562759	313.00000000	11.11305539
NI	18.55000000	0.90369611	19.88000000	0.57183914
PB	6.97500000	0.83416625	5.78000000	0.25884358
V	15.70000000	1.93045763	16.62000000	1.34424700
ZN	69.72500000	4.31228864	74.82000000	5.39601705
ZR	0.11750000	0.06551081	0.09200000	0.04969909
MW	0.39500000	0.09036961	0.35400000	0.12778889
MONT	44.72500000	19.67458174	40.74000000	15.92413263
ILLIT	18.12500000	4.14115523	18.18000000	1.58335088
K+C	13.37500000	3.05764070	13.92000000	2.94397690

VARI-ABLE	SITE 3 CORE 2		SITE 3 CORE 3	
	MEAN	STD DEV	MEAN	STD DEV
C1	1.68666667	0.72068486	3.34000000	1.04781678
C2S	0.01663333	0.00443787	0.01905000	0.00412735
C2U	0.00910000	0.00459042	0.00741667	0.00231293
C3S	0.00593333	0.00185975	0.00736333	0.00197526
C3U	0.00533333	0.00211250	0.00335000	0.00230369
PH	3.35000000	1.29324564	4.90000000	0.94386991
SO4	2766.66666667	371.03458958	2504.00000000	154.91933385
SIO2	8.16666667	2.35428687	7.73333333	2.07042669
NA	13883.33333333	1400.59511161	14316.66666667	1210.64720983
K	486.66666667	9.15737457	455.50000000	22.30470862
CA	441.50000000	69.41685674	321.00000000	79.53364068
MG	979.50000000	61.16891915	1005.33333333	92.25273257
CL	19800.00000000	282.84271247	19300.00000000	126.49110641
BR	150.83333333	70.74013477	165.00000000	57.27128425
CD	0.46333333	0.03265985	0.43000000	0.02966479
FE	23016.66666667	754.76265585	23666.66666667	791.62280580
MN	322.83333333	14.40023148	332.33333333	9.22315926
NI	22.28333333	0.56715665	22.55000000	1.09681357
PB	5.84333333	0.53447794	6.18333333	0.57067212
V	18.10000000	3.08804145	17.33333333	2.56411128
ZN	78.71666667	3.65590846	82.10000000	3.56763227
ZR	0.27666667	0.14692402	0.14500000	0.05167204
MN	0.54333333	0.17603030	0.46000000	0.04647580
MONT	37.15000000	17.42099308	49.28333333	12.23657087
ILLIT	16.34333333	2.43837378	18.16333333	2.63622204
K+C	13.96000000	2.92848083	11.93333333	3.09736447

EXPLANATION FOR APPENDIX 10:

Raw Data Relative to Biological Sampling
and Data Inventory

Card Type #01
(Administrative and Station Data)

Column(s)	Data Type	Explanation
1 - 4	Consecutive sample number	
6 - 10	Project identification code	
12 - 16	Originators station number	
18 - 19	Originator sample number	
21 - 27	Date sample collected	e.g. 271074 = 27 Oct. 1974
29 - 33	Time of day	e.g. 1350 = 1:50 PM
35 - 41	Latitude	degrees, minutes, tenths of minutes
43 - 50	Longitude	degrees, minutes, tenths of minutes
54 - 55	Sampling device	05 = Smith-McIntyre grab sampler
69	Bottom photographs	3 = black and white only
75 - 80	Card type, card number, deck	0 = none taken e.g. 07001A = card type 07, card number 001, deck A

Card Type #03
(Environmental Data)

Column(s)	Data Type	Explanation
1 - 20	(Identical to card type #01)	
21 - 22	Environment	4 = continental shelf
24 - 25	Depth range	(0) 0-50m, (1) 51-100m, (2) 101-200m
27 - 31	Water depth	in meters
75 - 80	(Identical to Card Type #01)	

Card Type #05
(Sample Data)

Column(s)	Data Type	Explanation
1 - 29	(Identical to card type #01)	
21 - 23	Total sample volume	(m^3)
25 - 27	Volume of sample retained	(m^3)
29 - 31	Volume of aliquot	(cm^3)
33 - 34	Number of aliquots	
46 - 49	Wet weight of "live" material	(g)
58	Collection method	s = sieving
60	Retention of small organisms	3 = lost
62	Retention of large organisms	1 = retained
64 - 66	Minimum size retained	size of organisms in mm
68 - 69	Maximum size retained	NL = No limit
71	Taxonderic status	4 = Sample enumerated to the generic level or below
73	Type of search	1 = general
75 - 80	(Identical to card type #01)	

Card Type #10

Column	Data Type	Explanation
1 - 20	(Identical to card type #01)	
21 - 30	Taxonomy	*ten digit species identification code
32 - 35	Number of individuals	
75 - 80	(Identical to card type #01)	

*See List of Taxonomic Codes

LIST OF TAXONOMIC CODES

	TEN DIGIT IDENTIFICATION CODE
COELENTERATA	
Anthozoa	
Pennatulacea	
Renillidae	
Renilla mulleri	3303910101
Actiniaria	
unidentified anenome	3301880101
PLATYHELMINTHES	
Turbellaria	
Polycladida	
unidentified flatworm	0000000001
NEMERTINEA	
unidentified nemerteans	4001010101
ANNELIDA	
Polychaeta	
Phyllodocida	
Phyllodocidae	
phyllodocid	4802050190
Polynoidae	
Phyllohartmania taylori	4802020301
Polyodontidae	
Polyodontes lupina	4802180101
Sigalionidae	
Leanira sp.	4802030401
Sthenelais sp.	4802030103
Chrysopetalidae	
Paleonotus heteroseta	4802040101
Glyceridae	
Glycera tesselata	4802140105
Glycera sp.	4802140106
Goniadidae	
Glycinde sp.	4802150102
Goniada sp.	4802150202
Nephtyidae	
Aglaophamus verrilli	4802130101
Nephtys picta	4802130204
Nephtys sp. A	4802130206
Nephtys sp. B	4802130207
Syllidae	
Exogone dispar	4802110301
Exogone sp.	4802110304
syllid A	4802111190
syllid B	4802111290
syllid C	4802111390
Hesionidae	
Nereimyra punctata	4802090601
hesionid	4802090790

Pilargidae
- Ancistrosyllis papillosa 4802100103
- Ancistrosyllis cf. rigida 4802100104
- Sigambra tentaculata 4802100301
- pilargid A 4802100490
- pilargid B 4802100590
- pilargid C 4802100690

Nereidae
- Nereis sp. A 4802120403
- Nereis sp. B 4802120401
- nereid A 4802120407
- nereid B 4802120405

Capitellida

Capitellidae
- Leiocapitella glabra 4803030501
- Notomastus cf. hemipodus 4803030303
- Notomastus latericeus 4803030301

Maldanidae
- Branchioasychis americana 4803051001
- Clymenella torquata 4803050101
- maldanid A 4803051190
- maldanid B 4803051290
- maldanid C 4803051390

Opheliidae
- Armandia agilis 4803020401
- Armandia maculata 4803020402
- Armandia sp. 4803020403
- Polyophthalmus pictus 4803020501

Sternaspida

Sternaspidae
- Sternaspis scutata 4804010101

Spionida

Spionidae
- Laonice cirrata 4805021301
- Malacoceros indicus 4805021401
- Malacoceros sp. 4805021402
- Paraprionospio pinnata 4805021501
- Prionospio cirrifera 4805020302
- Prionospio sp. 4805020307
- Scolelepis sp. 4805020603
- Spiophanes cf. bombyx 4805020801
- Spiophanes sp. 4805020802
- spionid A 4805021390
- spionid B 4805020703

Heterospionidae
- heterospionid 4805030190

Trochochaetidae
- trochochaetid 4805040190

Paraonidae
- Aricidea sp. A 4805070101
- Aricidea sp. B 4805070102
- Cirrophorus branchiatus 4805070201
- Paraonides sp. 4805070301
- Faraonis sp. 4805070302
- paraonid A 4805070490
- paraonid B 4805070491
- paraonid C 4805070492

Chaetopteridae
chaetopterid
Eunicida
Onuphidae
Diopatra cuprea 4806010101
Onuphis sp. A 4806010203
Onuphis sp. B 4806010204
Eunicidae
Marphysa aransensis 4806020103
Lumbrineridae
Lumbrineris sp. A 4806030105
Lumbrineris sp. B 4806030106
Lumbrineris sp. C 4806030107
Ninoe nigripes 4806030201
Arabellidae
Arabella sp. 4806040102
Drilonereis magna 4806040203
Lysaretidae
Lysarete brasiliensis 4806050101
lysaretid 4806050290
Amphinomida
Amphinomidae
Amphinome rostrata 4807010301
Chloeia viridis 4807010401
Pseudeurythoe sp. 4807010202
Magelonida
Magelonidae
Magelona pettiboneae 4808010102
Magelona sp. 4808010103
Ariciida
Orbiniidae
orbiniid 4809010590
Cirratulida
Cirratulidae
cirratulid A 4810010790
cirratulid B 4810010890
Cossuridae
Cossura delta 4810010203
Oweniida
Oweniidae
Owenia fusiformis 4811010101
Terebellida
Pectinariidae
Pectinaria gouldii 4812010101
Ampharetidae
Melinna maculata 4812020301
Terebellidae
Terebellides stroemi 4812030901
Flabelligerida
Flabelligeridae
Diplocirrus cf. *capensis* 4813010401
flabelligerid A 4813010590
flabelligerid B 4813010591

unidentified polychaete A 4800000004
unidentified polychaete B 4800000005
unidentified polychaete C 4800000006
unidentified polychaete D 4800000007

MOLLUSCA
Gastropoda
Rissoinidae
Zebina browniana 4904990101
Vitrinellidae
Episcynia inornata 4904990201
Melanellidae
Strombiformis sp. 4904980101
Naticidae
Polinices duplicatus 4904660101
Natica pusilla 4904660501
Ringiculidae
Ringicula semistriata 4905020101
Retusidae
Volvulella texasiana 4905130101
Pyrunculus caelatus 4904001011

gastropod 4904001010
Scaphopoda
Dentaliidae
Dentalium eboreum 4903020101
Dentalium sp. A 4903900101
Dentalium sp. B 4903900102
Bivalvia
Nuculidae
Nucula proxima 4908110101
Nuculanidae
Nuculana acuta 4908129090
Nuculana concentrica 4908129091
Yoldia solenoides 4908120190
Yoldia sp. 4908120191
nuculanid A 4908129191
nuculanid B 4908129192
Arcidae
Anadara transversa 4908001003
Lucinidae
Linga amiantus 4908509090
Linga multilineata 4908509091
Thyasiridae
Thyasira sp. 4908999001
Diplodontidae
Diplodonta sp. 4908000003
Carditidae
Cycolcardia sp. 4908459090
Veneridae
Cyclinella tenuis 4908000009
Anomalocardia auberiana 4908000010
Chione clenchi 4908550602
Chione intapurpurea 4908550605
Crassatellidae
Crassinella lunulata 4908440190

Tellinidae
- *Tellina squamifera* 4908570199
- *Tellina versicolor* 4908570194
- *Macoma pulleyi* 4908570290
- *Macoma* sp. 4908570291

Semelidae
- *Abra aequalis* 4908580102

Corbulidae
- *Corbula* sp. 4908760202

Periplomatidae
- *Periploma* sp. 4908830102

Verticordiidae
- *Verticordia ornata* 4905940101
- *Verticordia* sp. 4905940102

Cuspidariidae
- *Cardiomya perrostrata* 4908930102
- *Cardiomya* sp. 4908930103

Leptonidae
- *Mysella* sp. 4908000012

Lasaeidae
- *Aligena* sp. 4908000017

- bivalve A 4908000001
- bivalve B 4908000002

ARTHROPODA

Crustacea

Nebaliacea
- *Nebalia* sp. 5308000001

Cumacea

Leuconidae
- *Eudorella monodon* 5314020203
- *Eudorella* sp. 5314020204
- leuconid 5314020001

- unidentified cumacea 5314000001

Tanaidacea

Apseudidae
- *Leptognatha gracilis* 5315020102
- apseudid 5315020001

Tanaidae
- *Pseudotanais oculatus* 5315010001
- unidentified tanaid A 5315000001
- unidentified tanaid B 5315000002

Isopoda

Gnathiidae
- *Gnathia* cf. *prouctatrideus* 5316500001

Anthuridae
- *Hyssura* sp. 5316100001
- anthurid 5316100002

Stomatopoda

Squillidae
- *Squilla empusa* 5316000011
- *Squilla* sp. 5316000012

Amphipoda

Ampeliscidae

Ampelisca cristoides 5317020106
Ampelisca cf. *cucullata* 5317020107
Ampelisca cf. *cristata* 5317020108
Ampelisca cf. *vera* 5317020109

Ampithoidae

Ampithoe sp. 5317040104

Gammaridae

Gammarus sp. A 5317210208
Gammarus sp. B 5317210209
Gammarus sp. C 5317210210

Lysianassidae

Tmetonyx sp. 5317340001
Orchomonella pinguis 5317340402
lysianassid 5317340001

Phoxocephalidae

Heterophoxus sp. 5317420201
Proharpina antipoda 5317420101
Proharpina tropicana 5317420102
Pseudharpina cf. *dentata* 5317420001

unidentified amphipod A 5317000001
unidentified amphipod B 5317000002
unidentified amphipod C 5317000003

Decapoda

Penaeidae

Penaeus aztecus 5319000015
Penaeus setiferus 5319000016

Alpheidae

Alpheus sp. 5319000021

Callianassidae

Callianassa sp. 5319000031

Leucosiidae

Myropsis quinquespincsa 5319560201

Xanthidae

Micropanope sp. 5319600101
xanthid 5319600001

Pinnotheridae

Pinnixa retinens 5319620204
Pinnixa sayana 5319620205
Pinnixa sp. 5319620001

Goneplacidae

Speocarcinus sp. 5319610201
Goneplax hirsuta 5319610301
Chasmocarcinus mississippiensis 5319610401
Euryplax nitida 5319610501

Raninidae

Raninoides louisianensis 5319510201

unidentified crab A 5319000001
unidentified crab B 5319000002

SIPUNCULIDA

sipunculid A 5902010101
sipunculid B 5902010102

ECHIURIDA

echiurid A 4001010102
echiurid B 4001010103

BRYOZOA

unidentified bryozoan 6602010101

ECHINODERMATA
- Echinoidea
  - Spatangoida
    - Schizasteridae
      - *Moira atropos* 6802800101
- Asteroidea
  - Paxillosida
    - Astropectinidae
      - *Astropecten* sp. 6801510101
- Ophiuroidea
  - Ophiurida
    - unidentified brittle star 6803200102

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0001 STOCS 0002G 01 0271074 00315 281538N 0961416W C 05          00 3 002 01001A
0001 STOCS 0002G 01 04 00 00020              0 0 1 14 1 0 0                 03001A
0001 STOCS 0002G 01 002                       .157       3 2 3 1 0.5 NL 4 1 05001A
0001 STOCS 0002G 01 5319610401 0001 00.0516            2   0 0              10001A
0001 STOCS 0002G 01 5317020107 0008 00.0047            2   0 0              10002A
0001 STOCS 0002G 01 4806030201 0002                        0 0              10003A
0001 STOCS 0002G 01 4802120407 0002                        0 0              10004A
0001 STOCS 0002G 01 4805070490 0001                        0 0              10005A
0001 STOCS 0002G 01 4805021501 0003                        0 0              10006A
0001 STOCS 0002G 01 4806010204 0001                        0 0              10007A
0001 STOCS 0002G 01 4803050101 0001                        0 0              10008A
0001 STOCS 0002G 01 4001010101 0002                        0 0              10009A
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0002 STOCS 0004G 01 04 00 00020              0 0 1 18 1 0 0                 03001A
0002 STOCS 0004G 01 .02                       .667       3 2 3 1 0.5 NL 4 1 05001A
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0002 STOCS 0004G 01 4805070490 0001                        0 0              10002A
0002 STOCS 0004G 01 4802120407 0010                        0 0              10003A
0002 STOCS 0004G 01 4806010204 0004                        0 0              10004A
0002 STOCS 0004G 01 4805021501 0014                        0 0              10005A
0002 STOCS 0004G 01 4802180101 0001                        0 0              10006A
0002 STOCS 0004G 01 4806030105 0003                        0 0              10007A
0002 STOCS 0004G 01 4808010103 0003                        0 0              10008A
0002 STOCS 0004G 01 4803051190 0005                        0 0              10009A
0002 STOCS 0004G 01 4803050101 0001                        0 0              10010A
0002 STOCS 0004G 01 4803051390 0002                        0 0              10011A
0002 STOCS 0004G 01 4001010101 0001                        0 0              10012A
0003 STOCS 0005G 01 0271074 01130 281019N 0960237W C 05          00 3 .02 01001A
0003 STOCS 0005G 01 04 00 00031              0 0 1 13 1 0 0                 03001A
0003 STOCS 0005G 01 .02                       .291       3 2 3 1 0.5 NL 4 1 05001A
0003 STOCS 0005G 01 5319610401 0001 00.0516            2   0 0              10001A
0003 STOCS 0005G 01 5317020406 0001 00.0016            2   0 0              10002A
0003 STOCS 0005G 01 5319610201 0001 00.0975            2   0 0              10003A
0003 STOCS 0005G 01 4908129091 0001                    1   0 0              10004A
0003 STOCS 0005G 01 4805021501 0003                        0 0              10005A
0003 STOCS 0005G 01 4806010204 0002                        0 0              10001A
0003 STOCS 0005G 01 4802120407 0002                        0 0              10007A
0003 STOCS 0005G 01 4802130204 0007                        0 0              10008A
0003 STOCS 0005G 01 4802100301 0001                        0 0              10009A
0003 STOCS 0005G 01 4808010103 0001                        0 0              10010A
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0003 STOCS 0005G 01 4803051190 0001                          0 0                10011A
0003 STOCS 0005G 01 4802100490 0001                          0 0                10012A
0003 STOCS 0005G 01 4803020401 0001                          0 0                10013A
0003 STOCS 0005G 01 4001010101 0001                          0 0                10014A
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0004 STOCS 0010G 01 4803051190 0001                         0 0                10009A
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0004 STOCS 0010G 01 4908129091 0001                         0 0                10012A
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0004 STOCS 0010G 01 4904660101 0002                         0 0                10014A
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0005 STOCS 0012G 01 .02 P29                      .399       3 2 3 1 0.5 NL 4 1 05001A
0005 STOCS 0012G 01 5317020106 0012 00.0016            2    0 0                10001A
0005 STOCS 0012G 01 4803020401 0002                         0 0                10002A
0005 STOCS 0012G 01 4808010103 0001                         0 0                10003A
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0005 STOCS 0012G 01 4908570291 0001                         0 0                10013A
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0006 STOCS 0016G 01 04 00 00033                0 0 1 21 1 0 0                 03001A
0006 STOCS 0016G 01 .02 P27                     .272       3 2 3 1 0.5 NL 4 1 05001A
0006 STOCS 0016G 01 5319620204 0001 000.032              2   0 0             10001A
0006 STOCS 0016G 01 6803200102 0001 000.038                  0 0             10002A
0006 STOCS 0016G 01 3303910101 0001 000.101              1 1 0 0             10003A
0006 STOCS 0016G 01 4810010203 0001                          0 0             10004A
0006 STOCS 0016G 01 4802130204 0001                          0 0             10005A
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0006 STOCS 0016G 01 4806020103 0001                          0 0             10009A
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0007 STOCS 0019G 01 04 00 00033                0 0 1 14 1 0 0                 03001A
0007 STOCS 0019G 01 .02 2.9                     .594       3 2 3 1 0.5 NL 4 1 05001A
0007 STOCS 0019G 01 5319610401 0001 00.0516              2   0 0             10001A
0007 STOCS 0019G 01 5317020107 0003 00.0047              2   0 0             10002A
0007 STOCS 0019G 01 6803200102 0001 00.0378              2 1 0 0             10003A
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0007 STOCS 0019G 01 4908760202 0002                      1   0 0             10005A
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0007 STOCS 0019G 01 4802120407 0006                          0 0             10007A
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0008 STOCS 0024G 01 0301074 01340 280023N 0963512W C 05          00 3 .02 01001A
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0008 STOCS 0024G 01 .02 1K6                     .190       3 2 3 1 0.5 NL 4 1 05001A
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0008 STOCS 0024G 01 5317020106 0006 00.0016              2   0 0             10002A
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0008 STOCS 0024G 01 5317000001 0001                      2   0 0             10005A
0008 STOCS 0024G 01 4904660501 0001                      1   0 0             10006A
0008 STOCS 0024G 01 4803020401 0001                          0 0             10007A
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0008 STOCS 0024G 01 4806010103 0001                          0 0                10015A
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0009 STOCS 0027G 01 04 00 00021                0 0 1 21 1 0 0                   03001A
0009 STOCS 0027G 01 .02 1M2                     .720       3 2 3 1 0.5 NL 4 1 05001A
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0009 STOCS 0027G 01 5319610201 0002 00.0975            2    0 0                10002A
0009 STOCS 0027G 01 4803020401 0004                          0 0                10003A
0009 STOCS 0027G 01 4805021501 0009                          0 0                10004A
0009 STOCS 0027G 01 4802120407 0003                          0 0                10005A
0009 STOCS 0027G 01 4806030105 0018                          0 0                10006A
0009 STOCS 0027G 01 4802130204 0001                          0 0                10007A
0009 STOCS 0027G 01 4806010101 0002                          0 0                10008A
0010 STOCS 0032G 01 0311074 02155 275503N 0962042W C 05            00 3 .02 01001A
0010 STOCS 0032G 01 04 00 00048                0 0 1 14 1 0 0                   03001A
0010 STOCS 0032G 01 .02 1.4                     .084       3 2 3 1 0.5 NL 4 1 05001A
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0010 STOCS 0032G 01 5317020106 0001 00.0016            2    0 0                10003A
0010 STOCS 0032G 01 5314020203 0002 0.00015            2    0 0                10004A
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0010 STOCS 0032G 01 4802120407 0003                          0 0                10006A
0010 STOCS 0032G 01 4802130204 0001                          0 0                10007A
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0011 STOCS 0036G 01 .02 103                     .214       3 2 3 1 0.5 NL 4 1 05001A
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0011 STOCS 0036G 01 5317020106 0002 00.0016            2    0 0                10002A
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0011 STOCS 0036G 01 4908000003 0001                          0 0                10017A
0011 STOCS 0036G 01 4908129191 0001                          0 0                10018A
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0012 STOCS 0038G 01 04 01 00064                0 0 1 14 1 0 0                   03001A
0012 STOCS 0038G 01 .02 R72                     .123        3 2 3 1 0.5 NL 4 1 05001A
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0012 STOCS 0038G 01 5314020203 0001 0.00015            2    0 0                10002A
0012 STOCS 0038G 01 6803200102 0001 00.0378            2 1  0 0                10003A
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0013 STOCS 0042G 01 04 00 00033                0 0 1 21 1 0 0                   03001A
0013 STOCS 0042G 01 .02 5M3                     .169        3 2 3 1 0.5 NL 4 1 05001A
0013 STOCS 0042G 01 5319610401 0001 00.0516            2    0 0                10001A
0013 STOCS 0042G 01 5317020106 0001 00.0016            2    0 0                10002A
0013 STOCS 0042G 01 4805021501 0014                         0 0                10003A
0013 STOCS 0042G 01 4802120407 0003                         0 0                10004A
0013 STOCS 0042G 01 4802130204 0005                         0 0                10005A
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0014 STOCS 0045G 01 04 00 00019                0 0 1 21 1 0 0                   03001A
0014 STOCS 0045G 01 .02 1L7                     .644        3 2 3 1 0.5 NL 4 1 05001A
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0014 STOCS 0045G 01 5317020109 0001 000.005            2    0 0                10002A
0014 STOCS 0045G 01 5319610201 0002 00.0975            2    0 0                10003A
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0014 STOCS 0045G 01 4806030105 0008                          0 0              10007A
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0014 STOCS 0045G 01 4806010204 0001                          0 0              10014A
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0014 STOCS 0045G 01 4908129191 0001                          0 0              10016A
0015 STOCS 0048G 01 0011174 02245 274458N 0964125W C 05          00 3 .02 01001A
0015 STOCS 0048G 01 04 00 00031              0 0 1 14 1 0 0                   03001A
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0015 STOCS 0048G 01 5319620204 0001 000.032            2   0 0              10002A
0015 STOCS 0048G 01 5319610401 0001 00.0516            2   0 0              10003A
0015 STOCS 0048G 01 5317020107 0001 00.0047            2   0 0              10004A
0015 STOCS 0048G 01 5317020106 0005 00.0016            2   0 0              10005A
0015 STOCS 0048G 01 5315020102 0001 0.00152            2   0 0              10006A
0015 STOCS 0048G 01 6803200102 0001 00.0378            2 1 0 0              10007A
0015 STOCS 0048G 01 4805021501 0016                        0 0              10008A
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0017 STOCS 0060G 01 04 01 00100              0 0 1 21 1 0 0                   03001A
0017 STOCS 0060G 01 .02 1.2                   .040       3 2 3 1 0.5 NL 4 1 05001A
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0017 STOCS 0060G 01 4908000003 0001                          0 0                10009A
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0018 STOCS 0068G 01 04 00 00032              0 0 1 14 1 0 0                     03001A
0018 STOCS 0068G 01 .02 010                   .213       3 2 3 1 0.5 NL 4 1 05001A
0018 STOCS 0068G 01 5317020107 0002 00.0047            2   0 0                10001A
0018 STOCS 0068G 01 4908570290 0001                    1   0 0                10002A
0018 STOCS 0068G 01 4001010101 0001                        0 0                10003A
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0019 STOCS 0070G 01 04 00 00021              0 0 1 21 1 0 0                     03001A
0019 STOCS 0070G 01 .02 006                   .331       3 2 3 1 0.5 NL 4 1 05001A
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0019 STOCS 0070G 01 4001010101 0001                        0 0                10006A
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0020 STOCS 0073G 01 4908760202 0002                        0 0                10008A
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0021 STOCS 0075G 01 5319610201 0001 0000975            2   0 0             10002A
0021 STOCS 0075G 01 4908760202 0001                    1   0 0             10003A
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0021 STOCS 0075G 01 4803020401 0002                        0 0             10006A
0021 STOCS 0075G 01 4806010103 0001                        0 0             10007A
0021 STOCS 0075G 01 4806030105 0001                        0 0             10008A
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0022 STOCS 0078G 01 04 01 00064 TBNWN        0 0 1 14 1 0 0                 03001A
0022 STOCS 0078G 01 .02 M16                   .066     3 2 3 1 0.5 NL 4 1 05001A
0022 STOCS 0078G 01 6803200102 0004 00.1027            1 1 0 0             10001A
0022 STOCS 0078G 01 4802130204 0003                        0 0             10002A
0022 STOCS 0078G 01 4803020401 0001                        0 0             10003A
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0022 STOCS 0078G 01 4908760202 0002                        0 0             10005A
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0023 STOCS 080AG 01 0024174 00934 273421N 0962855W C 05          00 3 .02 01001A
0023 STOCS 080AG 01 04 01 00072              0 0 1 14 1 0 0                 03001A
0023 STOCS 080AG 01 .02 247                   78.9     3 2 3 1 0.5 NL 4 1 05001A
0023 STOCS 080AG 01 4806050101 0109                        0 0             10001A
0023 STOCS 080AG 01 5319610301 0054 00.0259            2   0 0             10002A
0023 STOCS 080AG 01 4908000009 0054                        0 0             10003A
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0024 STOCS 0083G 01 04 02 00102              0 0 1 14 1 0 0                 03001A
0024 STOCS 0083G 01 .02 M19                   .093     3 2 3 1 0.5 NL 4 1 05001A
0024 STOCS 0083G 01 4806030105 0001                        0 0             10001A
0024 STOCS 0083G 01 4805021501 0001                        0 0             10002A
0024 STOCS 0083G 01 4802140106 0002                        0 0             10003A
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0025 STOCS 0085G 01 .02 3J7                   .240     3 2 3 1 0.5 NL 4 1 05001A
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0025 STOCS 0085G 01 5315010001 0003 0000015            2   0 0             10002A
0025 STOCS 0085G 01 5317420101 0003 0000017            2   0 0             10003A
0025 STOCS 0085G 01 4810010203 0003                        0 0             10004A
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0025 STOCS 00856 01 4001010101 0003                          0 0                10005A
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0025 STOCS 00856 01 4802030103 0003                          0 0                10008A
0025 STOCS 00856 01 4001010102 0003                          0 0                10009A
0025 STOCS 00856 01 4908459090 0003                          0 0                10010A
0026 STOCS 00886 01 0031174 01300 272842N 0960635W C 05            00 3 .02 01001A
0026 STOCS 00886 01 04 02 00186                0 0 1 15 1 0 0                   03001A
0026 STOCS 00886 01 .02 5M5                     .153       3 2 3 1 0.5 NL 4 1 05001A
0026 STOCS 00886 01 4802180101 0001                          0 0                10001A
0026 STOCS 00886 01 4908000003 0010                          0 0                10002A
0140 STOCS 00896 01 4908129191 0001                          0 0                10006A
0027 STOCS 00906 01 0031174 01500 272904N 0961815W C 05            00 3 .02 01001A
0027 STOCS 00906 01 04 02 00122                0 0 1 14 1 0 0                   03001A
0027 STOCS 00906 01 .02 3K2                     .538       3 2 3 1 0.5 NL 4 1 05001A
0027 STOCS 00906 01 5317420101 0005 0000017            2   0 0                10001A
0027 STOCS 00906 01 5316100001 0002 0000015            2   0 0                10002A
0027 STOCS 00906 01 4908000001 0002                    1   0 0                01003A
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0027 STOCS 00906 01 4802130204 0002                        0 0                10006A
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0027 STOCS 00906 01 4908129191 0002                        0 0                10008A
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0027 STOCS 00906 01 4908000010 0002                        0 0                10011A
0027 STOCS 00906 01 4908129091 0007                        0 0                10012A
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0028 STOCS 00956 01 04 01 00055                0 0 1 14 1 0 0                   03001A
0028 STOCS 00956 01 002 0K6                     .049       3 2 3 1 0.5 NL 4 1 05001A
0028 STOCS 00956 01 4001010101 0001                        0 0                10001A
0028 STOCS 00956 01 4808010103 0001                        0 0                10002A
0028 STOCS 00956 01 4805021501 0003                        0 0                10003A
0028 STOCS 00956 01 4806030201 0001                        0 0                10004A
0029 STOCS 01036 01 0041174 00145 272412N 0965919W C 05            00 0 .02 01001A
0029 STOCS 01036 01 04 00 00032                0 0 1 14 1 0 0                   03001A
0029 STOCS 01036 01 .02 008                     .085       3 2 3 1 0.5 NL 4 1 05001A
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0029 STOCS 0103G 01 5315020102 0001 0000152            2   0 0              10001A
0029 STOCS 0103G 01 5314020203 0002 0000015            2   0 0              10002A
0029 STOCS 0103G 01 4001010101 0003                        0 0              10003A
0029 STOCS 0103G 01 4806030105 0001                        0 0              10004A
0029 STOCS 0103G 01 4802130204 0005                        0 0              10005A
0029 STOCS 0103G 01 4805021501 0003                        0 0              10006A
0029 STOCS 0103G 01 4808010103 0001                        0 0              10007A
0030 STOCS 0106G 01 0041174 00350 272405N 0964443W C 05          00 3 .02 01001A
0030 STOCS 0106G 01 04 01 00058              0 0 1 14 1 0 0                 03001A
0030 STOCS 0106G 01 .02 0J4                   .015       3 2 3 1 0.5 NL 4 1 05001A
0030 STOCS 0106G 01 4805021501 0001                        0 0              10001A
0030 STOCS 0106G 01 4802130204 0002                        0 0              10002A
0030 STOCS 0106G 01 4808010103 0001                        0 0              10003A
0030 STOCS 0106G 01 4001010103 0001                        0 0              10004A
0031 STOCS 0110G 01 0041174 00727 272358N 0962958W C 05          00 3 .02 01001A
0031 STOCS 0110G 01 04 01 00095              0 0 1 14 1 0 0                 03001A
0031 STOCS 0110G 01 .02 J93                   .040       3 2 3 1 0.5 NL 4 1 05001A
0031 STOCS 0110G 01 4802140106 0001                        0 0              10001A
0031 STOCS 0110G 01 4802120407 0001                        0 0              10002A
0031 STOCS 0110G 01 4802100301 0001                        0 0              10003A
0032 STOCS 0114G 01 0051174 00925 271630N 0961625W C 05          00 3 .02 01001A
0032 STOCS 0114G 01 04 02 00180              0 0 1 15 1 0 0                 03001A
0032 STOCS 0114G 01 .02 2N5                   .255       3 2 3 1 0.5 NL 4 1 05001A
0032 STOCS 0114G 01 4908459090 0003                    1   0 0              10001A
0032 STOCS 0114G 01 4802140106 0003                        0 0              10002A
0032 STOCS 0114G 01 4805021501 0005                        0 0              10003A
0032 STOCS 0114G 01 4806030105 0003                        0 0              10004A
0032 STOCS 0114G 01 4806010204 0003                        0 0              10005A
0032 STOCS 0114G 01 4802130204 0003                        0 0              10006A
0032 STOCS 0114G 01 4813010590 0003                        0 0              10007A
0032 STOCS 0114G 01 4001010102 0003                        0 0              10008A
0032 STOCS 0114G 01 4001010103 0028                        0 0              10009A
0032 STOCS 0114G 01 4908129191 0003                        0 0              10010A
0032 STOCS 0114G 01 4908129090 0001                        0 0              10011A
0032 STOCS 0114G 01 4908760202 0008                        0 0              10012A
0032 STOCS 0114G 01 4908000003 0003                        0 0              10013A
0033 STOCS 0115G 01 0041174 00817 271835N 0962418W C 05          00 3 .02 01001A
0033 STOCS 0115G 01 04 02 00133              0 0 1 14 1 0 0                 03001A
0033 STOCS 0115G 01 .02 001                   .103       3 2 3 1 0.5 NL 4 1 05001A
0033 STOCS 0115G 01 5315000001 0001 00.0015            2   0 0              10001A
0033 STOCS 0115G 01 5317020107 0002 00.0047            2   0 0              10002A
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0033 STOCS 0115G 01 4908129090 0001                          1   0 0                10003A
0033 STOCS 0115G 01 4806010204 0001                              0 0                10004A
0033 STOCS 0115G 01 4810010203 0001                              0 0                10005A
0033 STOCS 0115G 01 4802140106 0001                              0 0                10006A
0033 STOCS 0115G 01 4802130204 0001                              0 0                10007A
0033 STOCS 0115G 01 4001010102 0001                              0 0                10008A
0033 STOCS 0115G 01 4001010103 0001                              0 0                10009A
0033 STOCS 0115G 01 4908129091 0001                              0 0                10010A
0034 STOCS 0120G 01 0051174 00145 271853N 0964740W C 05            00 3 002 01001A
0034 STOCS 0120G 01 04 01 00060                 0 0 1 14 1 0 0                     03001A
0034 STOCS 0120G 01 .02 010                      .200       3 2 3 1 0.5 NL 4 1 05001A
0034 STOCS 0120G 01 4001010101 0001                              0 0                10001A
0034 STOCS 0120G 01 4806010103 0001                              0 0                10002A
0034 STOCS 0120G 01 4908760202 0005                              0 0                10003A
0035 STOCS 0125G 01 0051174 02150 271906N 0971108W C 05            00 3 .02 01001A
0035 STOCS 0125G 01 04 00 00022                 0 0 1 14 1 0 0                     03001A
0035 STOCS 0125G 01 .02 1N3                      .347       3 2 3 1 0.5 NL 4 1 05001A
0035 STOCS 0125G 01 5317020107 0043 00.0016                 2   0 0                10001A
0035 STOCS 0125G 01 5317020106 0001 00.0047                 2   0 0                10002A
0035 STOCS 0125G 01 4908129091 0001                          1   0 0                10003A
0035 STOCS 0125G 01 4001010101 0001                              0 0                10004A
0035 STOCS 0125G 01 4806030201 0002                              0 0                10005A
0035 STOCS 0125G 01 4802120407 0008                              0 0                10006A
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0035 STOCS 0125G 01 4803020401 0002                              0 0                10008A
0035 STOCS 0125G 01 4810010203 0001                              0 0                10009A
0036 STOCS 0127G 01 0051174 00230 271352N 0970312W C 05            00 3 .02 01001A
0036 STOCS 0127G 01 04 00 00028                 0 0 1 14 1 0 0                     03001A
0036 STOCS 0127G 01 .02 1K3                      .735       3 2 3 1 0.5 NL 4 1 05001A
0036 STOCS 0127G 01 5317020107 0110 20.0047                 2   0 0                10001A
0036 STOCS 0127G 01 6803200102 0001 0000378                 2 1 0 0                10002A
0036 STOCS 0127G 01 4908760202 0002                          1   0 0                10003A
0036 STOCS 0127G 01 4001010101 0006                              0 0                10004A
0036 STOCS 0127G 01 4806030201 0001                              0 0                10005A
0036 STOCS 0127G 01 4805021501 0002                              0 0                10006A
0036 STOCS 0127G 01 4802130204 0002                              0 0                10007A
0036 STOCS 0127G 01 4808010103 0002                              0 0                10008A
0037 STOCS 0131G 01 0051174 01621 271334N 0964747W C 05            00 3 .02 01001A
0037 STOCS 0131G 01 04 01 00072                 0 0 1 14 1 0 0                     03001A
0037 STOCS 0131G 01 .02 7P4                      .084       3 2 3 1 0.5 NL 4 1 05001A
0037 STOCS 0131G 01 5317020107 0015 00.0047                 2   0 0                10001A
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0037 STOCS 0131G 01 4908760202 0002                    1   0 0                10002A
0037 STOCS 0131G 01 4805030190 0001                        0 0                10003A
0037 STOCS 0131G 01 4805021501 0001                        0 0                10004A
0037 STOCS 0131G 01 4302130204 0001                        0 0                10005A
0037 STOCS 0131G 01 4808010103 0002                        0 0                10006A
0038 STOCS 0134G 01 0051174 01418 271326N 0963305W C 05          00 3 002 01001A
0038 STOCS 0134G 01 04 02 00103              0 0 1 14 1 0 0                   03001A
0038 STOCS 0134G 01 002 701                   .078       3 2 3 1 0.5 NL 4 1 05001A
0038 STOCS 0134G 01 5317020107 0001 00.0047            2   0 0                10001A
0038 STOCS 0134G 01 6802800101 0001                    2 1 0 0                10002A
0038 STOCS 0134G 01 4802100103 0001                        0 0                10003A
0038 STOCS 0134G 01 4805021501 0001                        0 0                10004A
0038 STOCS 0134G 01 4802140106 0002                        0 0                10005A
0039 STOCS 0137G 01 0211174 01139 270811N 0962430W C 05          00 3 .02 01001A
0039 STOCS 0137G 01 04 02 00185              0 0 1 14 1 0 0                   03001A
0039 STOCS 0137G 01 .02 105                   .052       3 2 3 1 0.5 NL 4 1 05001A
0039 STOCS 0137G 01 5317340001 0001 0000155            2   0 0                10001A
0039 STOCS 0137G 01 6803200102 0001 00.0378            2 1 0 0                10002A
0039 STOCS 0137G 01 4806030105 0001                        0 0                10003A
0039 STOCS 0137G 01 4001010103 0001                        0 0                10004A
0040 STOCS 0141G 01 0141174 01533 270822N 0964758W C 05          00 0 .02 01001A
0040 STOCS 0141G 01 04 01 00068              0 0 1 14 1 0 0                   03001A
0040 STOCS 0141G 01 .02 J80                   .104       3 2 3 1 0.5 NL 4 1 05001A
0040 STOCS 0141G 01 4810010203 0002                        0 0                10001A
0040 STOCS 0141G 01 4808010103 0003                        0 0                10002A
0040 STOCS 0141G 01 4810010790 0003                        0 0                10003A
0040 STOCS 0141G 01 4908000003 0003                        0 0                10004A
0040 STOCS 0141G 01 4908000009 0001                        0 0                10005A
0041 STOCS 0143G 01 0061174 00830 270835N 0965930W C 05          00 0 .02 01001A
0041 STOCS 0143G 01 04 00 00043              0 0 1 14 1 0 0                   03001A
0041 STOCS 0143G 01 .02 1M1                   .173       3 2 3 1 0.5 NL 4 1 05001A
0041 STOCS 0143G 01 5315020102 0001 0.00152            2   0 0                10001A
0041 STOCS 0143G 01 5314020203 0001 0.00015            2   0 0                10002A
0041 STOCS 0143G 01 4908760202 0003                    1   0 0                10003A
0041 STOCS 0143G 01 4001010101 0001                        0 0                10004A
0041 STOCS 0143G 01 4803020401 0001                        0 0                10005A
0041 STOCS 0143G 01 4808010103 0002                        0 0                10006A
0041 STOCS 0143G 01 4805021501 0003                        0 0                10007A
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0042 STOCS 0145G 01 04 00 00025              0 0 1 14 1 0 0                   03001A
0042 STOCS 0145G 01 .02 P42                    .280       3 2 3 1 0.5 NL 4 1 05001A
0042 STOCS 0145G 01 5317020106 0042 00.0047            2   0 0                10001A
0042 STOCS 0145G 01 5317020107 0001 00.0016            2   0 0                10002A
0042 STOCS 0145G 01 4908580102 0001                    1   0 0                10003A
0042 STOCS 0145G 01 4001010101 0003                        0 0                10004A
0042 STOCS 0145G 01 4802130204 0002                        0 0                10005A
0043 STOCS 0146G 01 0211174 01624 270330N 0971118W C 05          00 0 .02 01001A
0043 STOCS 0146G 01 04 00 00028              0 0 1 14 1 0 0                   03001A
0043 STOCS 0146G 01 .02 104                    .264       3 2 3 1 0.5 NL 4 1 05001A
0043 STOCS 0146G 01 5317020107 0021 00.0047            2   0 0                10001A
0043 STOCS 0146G 01 5314020203 0001 0.00015            2   0 0                10002A
0043 STOCS 0146G 01 6803200102 0001 00.0378            2 1 0 0                10003A
0043 STOCS 0146G 01 4810010203 0001                        0 0                10004A
0043 STOCS 0146G 01 4808010103 0001                        0 0                10005A
0043 STOCS 0146G 01 4806030201 0001                        0 0                10006A
0043 STOCS 0146G 01 4802100301 0001                        0 0                10007A
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0043 STOCS 0146G 01 4001010101 0001                        0 0                10010A
0043 STOCS 0146G 01 4908760202 0001                        0 0                10011A
0044 STOCS 0149G 07 0211174 00816 270320N 0965345N C 05          00 3 .02 01001A
0044 STOCS 0149G 07 04 01 00057              0 0 1 23 1 0 0                   03001A
0044 STOCS 0149G 07 .02 1.1                    .084       3 2 3 1 0.5 NL 4 1 05001A
0044 STOCS 0149G 07 5314020203 0001 0.00015            2   0 0                10001A
0044 STOCS 0149G 07 6802600101 0001                    2 1 0 0                10002A
0044 STOCS 0149G 07 4908760202 0001                    1   0 0                10003A
0044 STOCS 0149G 07 4001010101 0001                        0 0                10004A
0044 STOCS 0149G 07 4805070490 0003                        0 0                10005A
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0044 STOCS 0149G 07 4805021501 0002                        0 0                10007A
0044 STOCS 0149G 07 4802130204 0003                        0 0                10008A
0044 STOCS 0149G 07 4808010103 0002                        0 0                10009A
0045 STOCS 0155G 01 0191174 01305 265746N 0962742W C 05          00 3 .02 01001A
0045 STOCS 0155G 01 04 02 00195              0 0 1 14 1 0 0                   03001A
0045 STOCS 0155G 01 .02 P60                    .072       3 2 3 1 0.5 NL 4 1 05001A
0045 STOCS 0155G 01 5317340001 0002 0.00155            2   0 0                10001A
0045 STOCS 0155G 01 6803200102 0001 00.0378            2 1 0 0                10002A
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0045 STOCS 0155G 01 4908000001 0003                    1   0 0                10003A
0045 STOCS 0155G 01 4001010103 0003                        0 0                10004A
0045 STOCS 0155G 01 4802130204 0001                        0 0                10005A
0045 STOCS 0155G 01 4908459090 0004                        0 0                10006A
0045 STOCS 0155G 01 4908000003 0004                        0 0                10007A
0045 STOCS 0155G 01 4905940101 0002                        0 0                10009A
0045 STOCS 0155G 01 4908129090 0001                        0 0                10009A
0045 STOCS 0155G 01 4908000012 0001                        0 0                10010A
0046 STOCS 0156G 01 0191174 01459 265748N 0963327W C 05          00 3 .02 01001A
0046 STOCS 0156G 01 04 02 00125              0 0 1 14 1 0 0                  03001A
0046 STOCS 0156G 01 .02 L52                    .025       3 2 3 1 0.5 NL 4 1 05001A
0046 STOCS 0156G 01 5317420001 0001 0.00017            2   0 0                10001A
0046 STOCS 0156G 01 4903900102 0001                    1   0 0                10002A
0046 STOCS 0156G 01 4001010101 0001                        0 0                10003A
0046 STOCS 0156G 01 4802030103 0001                        0 0                10004A
0046 STOCS 0156G 01 4802130204 0001                        0 0                10005A
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0046 STOCS 0156G 01 4908000003 0001                        0 0                10008A
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0047 STOCS 0157G 01 0191174 01641 265751N 0963908W C 05          00 3 .32 01001A
0047 STOCS 0157G 01 04 01 00100              0 0 1 14 1 0 0                  03001A
0047 STOCS 0157G 01 .02 P56                    .637       3 2 3 1 0.5 NL 4 1 05001A
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0047 STOCS 0157G 01 4001010101 0001                        0 0                10002A
0047 STOCS 0157G 01 4805070490 0001                        0 0                10003A
0047 STOCS 0157G 01 4802140106 0001                        0 0                10004A
0048 STOCS 01606 01 0191174 02310 265804N 0964750N C 05          00 3 .02 01001A
0048 STOCS 01606 01 04 01 00073              0 0 1 14 1 0 0                  03001A
0048 STOCS 01606 01 .02 K85                    .083       3 2 3 1 0.5 NL 4 1 05001A
0048 STOCS 01606 01 6803200102 0001 00.0378            2 1 0 0                10001A
0048 STOCS 01606 01 4908760202 0001                    1   0 0                10002A
0048 STOCS 01606 01 4802130204 0001                        0 0                10003A
0048 STOCS 01606 01 4805070490 0002                        0 0                10004A
0049 STOCS 0164G 01 0211174 00601 265804N 0970234W C 05          00 3 .02 01001A
0049 STOCS 0164G 01 04 00 00040              0 0 1 14 1 0 0                  03001A
0049 STOCS 0164G 01 .02 0M5                    .099       3 2 3 1 0.5 NL 4 1 05001A
0049 STOCS 0164G 01 4908760202 0002                    1   0 0                10001A
0049 STOCS 0164G 01 4001010101 0001                        0 0                10002A
0049 STOCS 0164G 01 4806030105 0001                        0 0                10003A
0049 STOCS 0164G 01 4805070490 0001                        0 0                10004A
0049 STOCS 0164G 01 4001010103 0001                        0 0                10005A
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0050 STOCS 0165G 01 .02 4R0                   .486       3 2 3 1 0.5 NL 4 1 05001A
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0050 STOCS 0165G 01 5317020106 0005 00.0047            2   0 0              10002A
0050 STOCS 0165G 01 5314020203 0002 0.00015            2   0 0              10003A
0050 STOCS 0165G 01 4001010101 0002                        0 0              10004A
0050 STOCS 0165G 01 4805021501 0002                        0 0              10005A
0050 STOCS 0165G 01 4802130204 0005                        0 0              10006A
0050 STOCS 0165G 01 4302100301 0003                        0 0              10007A
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0050 STOCS 0165G 01 4808010103 0002                        0 0              10009A
0050 STOCS 0165G 01 4908760202 0002                        0 0              10010A
0050 STOCS 0165G 01 4908129191 0002                        0 0              10011A
0051 STOCS 0171G 01 0191174 02037 265254N 0964804W C 05          00 3 .02 01001A
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0051 STOCS 0171G 01 .02 1N1                   .063       3 2 3 1 0.5 NL 4 1 05001A
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0052 STOCS 0176G 01 .02 706                   .027       3 2 3 1 0.5 NL 4 1 05001A
0052 STOCS 0176G 01 5317020107 0001 00.0047            2   0 0              10001A
0052 STOCS 0176G 01 4001010101 0001                        0 0              10002A
0052 STOCS 0176G 01 4802130204 0001                        0 0              10003A
0052 STOCS 0176G 01 4810010790 0001                        0 0              10004A
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0052 STOCS 0176G 01 4908000003 0003                        0 0              10006A
0053 STOCS 0179G 01 0191174 00821 264609N 0964160W C 05          00 3 .02 01001A
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0053 STOCS 0179G 01 4803020401 0001                          0 0              10002A
0053 STOCS 0179G 01 4810010203 0001                          0 0              10003A
0053 STOCS 0179G 01 4810010790 0001                          0 0              10004A
0053 STOCS 0179G 01 4806030105 0001                          0 0              10005A
0053 STOCS 0179G 01 4802130204 0001                          0 0              10006A
0054 STOCS 0183G 01 0191174 00502 264733N 0965657W C 05          00 0 .02 01001A
0054 STOCS 0183G 01 04 00 00047                0 0 1 14 1 0 0                  03001A
0054 STOCS 0183G 01 .02 016                     .095       3 2 3 1 .05 NL 4 1 05001A
0054 STOCS 0183G 01 5317020107 0001 00.0016              2   0 0              10001A
0054 STOCS 0183G 01 5315020102 0002 0.00152              2   0 0              10002A
0054 STOCS 0183G 01 5314020203 0001 0.00015              2   0 0              10003A
0054 STOCS 0183G 01 6803200102 0001 00.0378              2 1 0 0              10004A
0054 STOCS 0183G 01 4803020401 0001                          0 0              10005A
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0054 STOCS 0183G 01 4802130204 0005                          0 0              10007A
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0055 STOCS 0185G 01 04 00 00032                0 0 1 14 1 0 0                  03001A
0055 STOCS 0185G 01 .02 091                     .616       3 2 3 1 0.5 NL 4 1 05001A
0055 STOCS 0185G 01 4001010101 0006                          0 0              10001A
0055 STOCS 0185G 01 4805021501 0012                          0 0              10002A
0055 STOCS 0185G 01 4802130204 0009                          0 0              10003A
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0055 STOCS 0185G 01 4806030105 0012                          0 0              10006A
0055 STOCS 0185G 01 4001010102 0009                          0 0              10007A
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0056 STOCS 0186G 01 .02 337                     13.9       3 2 3 1 0.5 NL 4 1 05001A
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0056 STOCS 0186G 01 4803051190 0034                          0 0              10004A
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0056 STOCS 0186G 01 4001010103 0101                          0 0                10019A
0056 STOCS 0186G 01 5902010101 0022                          0 0                10020A
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0056 STOCS 0186G 01 4908129191 0045                          0 0                10022A
0056 STOCS 0186G 01 4908000009 0011                          0 0                10023A
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0075 STOCS 0254G 01 .02 6P5                    1.77       3 2 3 1 0.5 NL 4 1 05001A
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0075 STOCS 0254G 01 5314020203 0005 0.00015            2   0 0                10002A
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0075 STOCS 0254G 01 6803200102 0005 00.0378            2 1 0 0                10004A
0075 STOCS 0254G 01 4908760202 0024                    1   0 0                10005A
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0078 STOCS 0265G 01 4808010103 0004                          0 0               10005A
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0079 STOCS 0266G 01 04 00 00012                0 0 1 18 1 0 0                  03001A
0079 STOCS 0266G 01 .02 091                     .416       3 2 3 1 0.5 NL 4 1 05001A
0079 STOCS 0266G 01 5317020106 0030 00.0016              2   0 0               10001A
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0079 STOCS 0266G 01 4802130204 0015                          0 0               10003A
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0080 STOCS 0269G 01 04 00 00045                0 0 1 01 1 0 0                  03001A
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0080 STOCS 0269G 01 4802130204 0022                         0 0              10005A
0080 STOCS 0269G 01 4805021501 0022                         0 0              10006A
0080 STOCS 0269G 01 4802120407 0022                         0 0              10007A
0080 STOCS 0269G 01 4808010103 0029                         0 0              10008A
0080 STOCS 0269G 01 4802140106 0007                         0 0              10009A
0080 STOCS 0269G 01 4805020703 0007                         0 0              10010A
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0081 STOCS 0273G 01 04 01 00073                0 0 1 18 1 0 0                03001A
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0082 STOCS 0008G 01 04 00 00023                0 0 1 18 1 0 0                03001A
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0082 STOCS 0008G 01 4806010101 0001                         0 0              10006A
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0083 STOCS 0014G 01 5317020107 0004 00.0047            2   0 0                10002A
0083 STOCS 0014G 01 5317210208 0001 0.00117            2   0 0                10003A
0083 STOCS 0014G 01 5314020203 0001 0.00015            2   0 0                10004A
0083 STOCS 0014G 01 5319610201 0002 00.0975            2   0 0                10005A
0083 STOCS 0014G 01 4001010101 0001                          0 0                10006A
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0084 STOCS 0021G 01 5317020106 0003 00.0016            2   0 0                10002A
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0084 STOCS 0021G 01 4805020703 0001                          0 0                10013A
0085 STOCS 0030G 01 0301074 01620 2755090N 0963225W C 05            00 0 .02 01001A
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0085 STOCS 0030G 01 .02 0M3                     .447       3 2 3 1 0.5 NL 4 1 05001A
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0085 STOCS 0030G 01 4802130204 0010                        0 0              10005A
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0086 STOCS 0034G 01 04 01 00052              0 0 1 18 1 0 0                 03001A
0086 STOCS 0034G 01 .02 048                   J210       3 2 3 1 0.5 NL 4 1 05001A
0086 STOCS 0034G 01 5317020107 0001 00.0047            2   0 0              10001A
0086 STOCS 0034G 01 5317020106 0001 00.0016            2   0 0              10002A
0086 STOCS 0034G 01 5319610201 0002 00.0016            2   0 0              10003A
0086 STOCS 0034G 01 6603200102 0001 00.0578            2 1 0 0              10004A
0086 STOCS 0034G 01 4802120407 0001                        0 0              10005A
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0086 STOCS 0034G 01 4802130204 0002                        0 0              10008A
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0089 STOCS 0057G 01 .02 185                    .093       3 2 3 1 0.5 NL 4 1 05001A
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0089 STOCS 0057G 01 6803200102 0001 00.0373              2 1 0 0                10002A
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0093 STOCS 0065G 01 5317020107 0001 00.0016            2   0 0                10001A
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0093 STOCS 0065G 01 5317210209 0001 000.001            2   0 0                10003A
0093 STOCS 0065G 01 5319620204 0001 000.032            1   0 0                10004A
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0095 STOCS 0093G 01 5317020106 0002 0000016            2   0 0                10002A
0095 STOCS 0093G 01 4802130207 0001                        0 0                10003A
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0096 STOCS 0252G 01 .02                       .103       3 2 3 1 0.5 NL 4 1 05001A
0097 STOCS 0101G 01 0041174 02400 272936N 0970512W C 05          00 3 .02 01001A
0097 STOCS 0101G 01 04 00 00022              0 0 1 14 1 0 0                 03001A
0097 STOCS 0101G 01 .02 1K4                   J532       3 2 3 1 0.5 NL 4 1 05001A
0097 STOCS 0101G 01 5317020107 0115 00.0047            2   0 0              10001A
0097 STOCS 0101G 01 5314020203 0001 0.00015            2   0 0              10002A
0097 STOCS 0101G 01 6803200102 0001 00.0378            2 1 0 0              10003A
0097 STOCS 0101G 01 4001010101 0005                        0 0              10004A
0097 STOCS 0101G 01 4802130204 0004                        0 0              10005A
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0097 STOCS 0101G 01 4802120407 0003                        0 0              10007A
0097 STOCS 0101G 01 4805020603 0001                        0 0              10008A
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0098 STOCS 0113G 01 4802130206 0002                        0 0              10004A
0098 STOCS 0113G 01 4001010102 0001                        0 0              10005A
0098 STOCS 0113G 01 4001010103 0006                        0 0              10006A
0099 STOCS 0117G 01 0051174 00445 271841N 0963606W C 05          00 0 .02 01001A
0099 STOCS 0117G 01 04 01 00090              0 0 1 14 1 0 0                 03001A
0099 STOCS 0117G 01 .02 004                   .174       3 2 3 1 0.5    4 1 05001A
0099 STOCS 0117G 01 4903900102 0003                    1   0 0              10001A
0099 STOCS 0117G 01 4802130204 0001                        0 0              10002A
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0099 STOCS 0117G 01 4802140106 0001                        0 0              10006A
0099 STOCS 0117G 01 4802100490 0001                        0 0              10007A
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0100 STOCS 0123G 01 04 00 00035              0 0 1 14 1 0 0                 03001A
0100 STOCS 0123G 01 .02 1M5                   .031       3 2 3 1 0.5 NL 4 1 05001A
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0101 STOCS 0129G 01 04 00 00044                0 0 1 14 1 0 0                    03001A
0101 STOCS 0129G 01 .02 008                     .362       3 2 3 1 0.5 NL 4 1 05001A
0101 STOCS 0129G 01 5317020107 0002 00.0047               2   0 0                10001A
0101 STOCS 0129G 01 5317020106 0001 0.00016               2   0 0                10002A
0101 STOCS 0129G 01 6803200102 0001 00.0378               2 1 0 0                10003A
0101 STOCS 0129G 01 4808010103 0005                           0 0                10004A
0101 STOCS 0129G 01 4810010203 0001                           0 0                10005A
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0101 STOCS 0129G 01 4806030201 0001                           0 0                10007A
0101 STOCS 0129G 01 4805021501 0005                           0 0                10008A
0101 STOCS 0129G 01 4802030103 0001                           0 0                10009A
0101 STOCS 0129G 01 4805070490 0002                           0 0                10010A
0101 STOCS 0129G 01 4001010101 0001                           0 0                10011A
0102 STOCS 0136G 01 0051174 01301 271315N 0962124W C 05            00 0 .02 01001A
0102 STOCS 0136G 01 04 02 00184                0 0 1 14 1 0 0                    03001A
0102 STOCS 0136G 01 .02 101                     .158       3 2 3 1 0.5 NL 4 1 05001A
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0102 STOCS 0136G 01 4905940102 0001                       1   0 0                10002A
0102 STOCS 0136G 01 4806030105 0002                           0 0                10003A
0102 STOCS 0136G 01 4802130204 0001                           0 0                10004A
0102 STOCS 0136G 01 4809010590 0001                           0 0                10005A
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0102 STOCS 0136G 01 4812030901 0001                           0 0                10008A
0102 STOCS 0136G 01 4001010102 0002                           0 0                10009A
0103 STOCS 0138G 01 0211174 01234 270807N 0963024W C 05            00 0 .02 01001A
0103 STOCS 0138G 01 04 02 00125                0 0 1 14 1 0 0                    03001A
0103 STOCS 0138G 01 .02 4M0                     .050       3 2 3 1 0.5 NL 4 1 05001A
0103 STOCS 0138G 01 5317020106 0002 00.0047               2   0 0                10001A
0103 STOCS 0138G 01 4810010203 0001                           0 0                10002A
0103 STOCS 0138G 01 4802140106 0002                           0 0                10003A
0103 STOCS 0138G 01 4802100490 0001                           0 0                10004A
0103 STOCS 0138G 01 4810010790 0001                           0 0                10005A
0103 STOCS 0138G 01 4001010103 0002                           0 0                10006A
0104 STOCS 0139G 01 0211174 01310 270818N 0963612W C 05            00 0 002 01001A
0104 STOCS 0139G 01 04 02 00102                0 0 1 14 1 0 0                    03001A
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0104 STOCS 0139G 01 4805020603 0001                        0 0              10002A
0104 STOCS 0139G 01 4001010101 0002                        0 0              10003A
0105 STOCS 0140G 01 0141174 01659 270844N 0964050W C 05          00 0 .02 01001A
0105 STOCS 0140G 01 04 01 00088              0 0 1 14 1 0 0                 03001A
0105 STOCS 0140G 01 .02 L20                    .239      3 2 3 1 0.5 NL 4 1 05001A
0105 STOCS 0140G 01 4810010203 0001                        0 0              10001A
0105 STOCS 0140G 01 4802100103 0002                        0 0              10002A
0105 STOCS 0140G 01 4806030105 0001                        0 0              10003A
0106 STOCS 0150G 01 0211174 00903 270311N 0964753W C 05          00 0 .02 01001A
0106 STOCS 0150G 01 04 01 00072              0 0 1 14 1 0 0                 03001A
0106 STOCS 0150G 01 .02 L10                    .562      3 2 3 1 0.5 NL 4 1 05001A
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0106 STOCS 0150G 01 4810010203 0001                        0 0              10002A
0106 STOCS 0150G 01 4802150102 0001                        0 0              10003A
0106 STOCS 0150G 01 4808010103 0001                        0 0              10004A
0107 STOCS 0151G 01 0211174 00933 270308N 0964301W C 05          00 0 002 01001A
0107 STOCS 0151G 01 04 01 00086              0 0 1 14 1 0 0                 03001A
0107 STOCS 0151G 01 0.2 L35                    .303      3 2 3 1 0.5 NL 4 1 05001A
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0107 STOCS 0151G 01 4802140106 0001                        0 0              10002A
0107 STOCS 0151G 01 4808010103 0001                        0 0              10003A
0108 STOCS 0159G 01 0191174 02227 270040N 0964756N C 05          00 0 .02 01001A
0108 STOCS 0159G 01 04 01 00074              0 0 1 14 1 0 0                 03001A
0108 STOCS 0159G 01 .02 1K2                    .439      3 2 3 1 0.5 NL 4 1 05001A
0108 STOCS 0159G 01 6803200102 0001 00.0378              2 1 0 0              10001A
0108 STOCS 0159G 01 4802130204 0002                        0 0              10002A
0108 STOCS 0159G 01 4810010203 0001                        0 0              10003A
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0108 STOCS 0159G 01 4802100301 0001                        0 0              10005A
0109 STOCS 0162G 01 /201174 00946 265805N 0965051W C 05          00 0 .02 01001A
0109 STOCS 0162G 01 04 01 00065              0 0 1 14 1 0 0                 03001A
0109 STOCS 0162G 01 .02 Q25                    .397      3 2 3 1 0.5 NL 4 1 05001A
0109 STOCS 0162G 01 4810010203 0001                        0 0              10001A
0109 STOCS 0162G 01 4805030190 0001                        0 0              10002A
0110 STOCS 0167G 01 0101274        265253N 0970539W C 05          00 0 .02 01001A
0110 STOCS 0167G 01 04                       0 0 1 14 1 0 0                 03001A
0110 STOCS 0167G 01 .02 1.4                    .087      3 2 3 1 0.5 NL 4 1 05001A
0110 STOCS 0167G 01 4802130204 0002                        0 0              10001A
0110 STOCS 0167G 01 4802100490 0001                        0 0              10002A
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0110 STOCS 0167G 01 4001010101 0002                          0 0                10004A
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0111 STOCS 0174G 01 04 02 00101                0 0 1 14 1 0 0                   03001A
0111 STOCS 0174G 01 .02 L90                     .409       3 2 3 1 0.5 NL 4 1 05001A
0111 STOCS 0174G 01 4809010590 0001                          0 0                10001A
0112 STOCS 0189G 01 0171174 01702 264219N 0965106W C 05            00 0 .02 01001A
0112 STOCS 0189G 01 04 01 00057                0 0 1 14 1 0 0                   03001A
0112 STOCS 0189G 01 .02 Q50                     .684       3 2 3 1 0.5 NL 4 1 05001A
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0112 STOCS 0189G 01 4810010203 0001                          0 0                10002A
0112 STOCS 0189G 01 4808010103 0001                          0 0                10003A
0112 STOCS 0189G 01 4908760202 0001                          0 0                10004A
0113 STOCS 0197G 01 0071174 01825 263703N 0963944W C 05            00 0 .02 01001A
0113 STOCS 0197G 01 04                         0 0 1 14 1 0 0                   03001A
0113 STOCS 0197G 01 .02 Q51                     .149       3 2 3 1 0.5 NL 4 1 05001A
0113 STOCS 0197G 01 4805040190 0001                          0 0                10001A
0113 STOCS 0197G 01 4806020103 0001                          0 0                10002A
0114 STOCS 0206G 01 0071174 00235 263154N 0965407W C 05            00 0 .02 01001A
0114 STOCS 0206G 01 04 00 00042                0 0 1 14 1 0 0                   03001A
0114 STOCS 0206G 01 .02 2J8                     .061       3 2 3 1 0.5 NL 4 1 05001A
0114 STOCS 0206G 01 5317020107 0001 00.0016                2 0 0                10001A
0114 STOCS 0206G 01 4908760202 0001                    1     0 0                10002A
0114 STOCS 0206G 01 4802130204 0004                          0 0                10003A
0114 STOCS 0206G 01 4805021501 0001                          0 0                10004A
0114 STOCS 0206G 01 4001010101 0001                          0 0                10005A
0115 STOCS 0210G 01 0071174 00545 263135N 0963343W C 05            00 0 .02 01001A
0115 STOCS 0210G 01 04 02 00088 TBNWV          0 0 1 15 1 0 0                   03001A
0115 STOCS 0210G 01 .02 J56                     .158       3 2 3 1 0.5 NL 4 1 05001A
0115 STOCS 0210G 01 4908760202 0002                    1     0 0                10001A
0115 STOCS 0210G 01 4802130204 0002                          0 0                10002A
0115 STOCS 0210G 01 4805021501 0002                          0 0                10003A
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0115 STOCS 0210G 01 4802100301 0001                          0 0                10005A
0115 STOCS 0210G 01 4001010101 0001                          0 0                10006A
0115 STOCS 0210G 01 4001010103 0001                          0 0                10007A
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0116 STOCS 0219G 01 04 01 00058                0 0 1 18 1 0 0                   03001A
0116 STOCS 0219G 01 .02 100                     .377       3 2 3 1 0.5 NL 4 1 05001A
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0116 STOCS 0219G 01 4807010301 0001                      0 0              10006A
0116 STOCS 0219G 01 4802100104 0001                      0 0              10007A
0116 STOCS 0219G 01 5902010101 0001                      0 0              10008A
0117 STOCS 0223G 01 0161174 02314 262645N 0965707W C 05          00 0 .02 01001A
0117 STOCS 0223G 01 04 00 00038              0 0 1 14 1 0 0               03001A
0117 STOCS 0223G 01 .02 015                   .709       3 2 3 1 0.5 NL 4 1 05001A
0117 STOCS 0223G 01 5317020108 0004 000.005          2   0 0              10001A
0117 STOCS 0223G 01 4808010103 0001                      0 0              10002A
0117 STOCS 0223G 01 4805021501 0001                      0 0              10003A
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0117 STOCS 0223G 01 4802130204 0003                      0 0              10005A
0117 STOCS 0223G 01 4806030105 0001                      0 0              10006A
0117 STOCS 0223G 01 4001010101 0003                      0 0              10007A
0117 STOCS 0223G 01 4001010103 0003                      0 0              10008A
0118 STOCS 0224G 01 0161174 02207 262644N 0970010W C 05          00 0 .02 01001A
0118 STOCS 0224G 01 04 00 00035              0 0 1 16 1 0 0               03001A
0118 STOCS 0224G 01 .02 200                   J890       3 2 3 1 0.5 NL 4 1 05001A
0118 STOCS 0224G 01 5317020108 0003 0000005          2   0 0              10001A
0118 STOCS 0224G 01 5317020107 0001 0000047          2   0 0              10002A
0118 STOCS 0224G 01 4905130101 0002                  2   0 0              10003A
0118 STOCS 0224G 01 4806030105 0001                      0 0              10004A
0118 STOCS 0224G 01 4806030201 0001                      0 0              10005A
0118 STOCS 0224G 01 4806010204 0003                      0 0              10006A
0118 STOCS 0224G 01 4803030301 0003                      0 0              10007A
0118 STOCS 0224G 01 4808010103 0008                      0 0              10008A
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0118 STOCS 0224G 01 4802140106 0001                      0 0              10010A
0118 STOCS 0224G 01 4810010203 0001                      0 0              10011A
0118 STOCS 0224G 01 4001010101 0005                      0 0              10012A
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0119 STOCS 0228G 01 04 00 00043              0 0 1 16 1 0 0               03001A
0119 STOCS 0228G 01 .02 146                   .175       3 2 3 1 0.5 NL 4 1 05001A
0119 STOCS 0228G 01 5319620204 0001 000.032          1   0 0              10001A
0119 STOCS 0228G 01 6803200102 0001 00.0378          2 1 0 0              10002A
0119 STOCS 0228G 01 4908760202 0001                  1   0 0              10003A
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0119 STOCS 0228G 01 4908129091 0001                    1   0 0                10004A
0119 STOCS 0228G 01 4808010103 0003                        0 0                10005A
0119 STOCS 0228G 01 4810010790 0001                        0 0                10006A
0119 STOCS 0228G 01 4804010101 0001                        0 0                10007A
0119 STOCS 0228G 01 4001010101 0002                        0 0                10008A
0119 STOCS 0228G 01 4908129191 0001                        0 0                10009A
0120 STOCS 0233G 01 0231474 01123 262108N 0962518W C 05          00 0 .02 01001A
0120 STOCS 0233G 01 04 01 00083              0 0 1 18 1 0 0                   03001A
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0120 STOCS 0233G 01 4908129090 0004                    1   0 0                10003A
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0121 STOCS 0234G 01 04 02 00142              0 0 1 14 1 0 0                   03001A
0121 STOCS 0234G 01 .02                       0000       3 2 3 1 0.5 NL 4 1 05001A
0122 STOCS 0249G 01 0041274 01032 261056N 0964840W C 05          00 0 .02 01001A
0122 STOCS 0249G 01 04 00 00043              0 0 1 14 1 0 0                   03001A
0122 STOCS 0249G 01 .02 0L2                   .078       3 2 3 1 0.5 NL 4 1 05001A
0122 STOCS 0249G 01 5315020102 0001 00.0152            2   0 0                10001A
0122 STOCS 0249G 01 5319620204 0001 000.032            1   0 0                10002A
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0123 STOCS 0251G 01 5319620204 0001 000.032            1   0 0                10001A
0123 STOCS 0251G 01 6803200102 0001 00.0378            2 1 0 0                10002A
0123 STOCS 0251G 01 4806030201 0001                        0 0                10003A
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0124 STOCS 0262G 01 04 00 00043              0 0 1 14 1 0 0                   03001A
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0124 STOCS 0262G 01 5317020107 0001 00.0047            2   0 0                10002A
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0125 STOCS 0263G 01 04 00 00040              0 0 1 16 1 0 0                 03001A
0125 STOCS 0263G 01 .02 116                   .726       3 2 3 1 0.5 NL 4 1 05001A
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0125 STOCS 0263G 01 5317020107 0002 0000047          2   0 0                10002A
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0125 STOCS 0263G 01 4802130204 0001                      0 0                10013A
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0125 STOCS 0263G 01 4806010204 0001                      0 0                10015A
0125 STOCS 0263G 01 4803051190 0001                      0 0                10016A
0125 STOCS 0263G 01 4001010101 0002                      0 0                10017A
0125 STOCS 0263G 01 4001010103 0006                      0 0                10018A
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0126 STOCS 0271G 01 .02 235                   J507       3 2 3 1 0.5 NL 4 1 05001A
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0126 STOCS 0271G 01 4806020103 0001                      0 0                10003A
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0126 STOCS 0271G 01 4001010103 0001                          0 0                10013A
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0127 STOCS 0064G 01 04 01 00062              0 0 1 14 1 0 0                   03001A
0127 STOCS 0064G 01 .02 002                   .038       3 2 3 1 0.5 NL 4 1 05001A
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0127 STOCS 0064G 01 4908760202 0001                    1   0 0                10002A
0127 STOCS 0064G 01 4904001010 0001                    1   0 0                10003A
0127 STOCS 0064G 01 4802130204 0003                        0 0                10004A
0127 STOCS 0064G 01 4001010101 0002                        0 0                10005A
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0128 STOCS 0066G 01 5319610201 0001 00.0975            2   0 0                10003A
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0129 STOCS 0067G 01 04 00 00037              0 0 1 14 1 0 0                   03001A
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0129 STOCS 0067G 01 5314020203 0002 0.00015            2   0 0                10001A
0129 STOCS 0067G 01 5317020106 0004 00.0016            2   0 0                10002A
0129 STOCS 0067G 01 4908760202 0005                    1   0 0                10003A
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0130 STOCS 0099G 01 04 00 00026                0 0 1 14 1 0 0                         03001A
0130 STOCS 0099G 01 .02 003                     J274       3 2 3 1 0.5 NL 4 1 05001A
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0130 STOCS 0099G 01 5317020107 0001 00.0047              2   0 0                    10002A
0130 STOCS 0099G 01 5319620204 0001 000.032              2   0 0                    10003A
0130 STOCS 0099G 01 4908760202 0001                      1   0 0                    10004A
0130 STOCS 0099G 01 4805021501 0003                          0 0                    10005A
0130 STOCS 0099G 01 4805021401 0001                          0 0                    10006A
0130 STOCS 0099G 01 4802130204 0002                          0 0                    10007A
0130 STOCS 0099G 01 4803020402 0001                          0 0                    10008A
0130 STOCS 0099G 01 4808010103 0001                          0 0                    10009A
0130 STOCS 0099G 01 4810010203 0001                          0 0                    10010A
0130 STOCS 0099G 01 4802100490 0001                          0 0                    10011A
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0131 STOCS 0274G 01 04 02 00134                0 0 1 14 1 0 0                         03001A
0131 STOCS 0274G 01 .02 003 N                   .058       3 2 3 1 0.5 NL 4 1 05001A
0131 STOCS 0274G 01 4905020101 0002                      2   0                      10001A
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0132 STOCS 0069G 01 04 00 00026                0 0 1 14 1 0 0                         03001A
0132 STOCS 0069G 01 .02                         .417       3 2 3 1 0.5 NL 4 1 05001A
0132 STOCS 0069G 01 5314020203 0003 0.00015              2   0 0                    10001A
0132 STOCS 0069G 01 5317210208 0001 0.00117              2   0 0                    10002A
0132 STOCS 0069G 01 5317020107 0031 00.0047              2   0 0                    10003A
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0132 STOCS 0069G 01 4905130101 0001                      2   0 0                    10005A
0132 STOCS 0069G 01 4803030301 0005                          0 0                    10006A
0132 STOCS 0069G 01 4805021501 0006                          0 0                    10007A
0132 STOCS 0069G 01 4808010103 0004                          0 0                    10008A
0132 STOCS 0069G 01 4803020402 0001                          0 0                    10009A
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0132 STOCS 0069G 01 4802120407 0002                          0 0                    10011A
0132 STOCS 0069G 01 4802130204 0005                          0 0                    10012A
0132 STOCS 0069G 01 4805020603 0002                          0 0                    10013A
0132 STOCS 0069G 01 4001010101 0006                          0 0                    10014A
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0133 STOCS 0071G 01 .02                         .198       3 2 3 1 0.5 NL 4 1 05001A
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0133 STOCS 0071G 01 5317210209 0001 000.001              2   0 0              10002A
0133 STOCS 0071G 01 5317020107 0055 00.0047              2   0 0              10003A
0133 STOCS 0071G 01 4001010101 0002                          0 0              10004A
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0133 STOCS 0071G 01 4808010103 0001                          0 0              10007A
0133 STOCS 0071G 01 4805021501 0005                          0 0              10008A
0133 STOCS 0071G 01 4805070101 0001                          0 0              10009A
0134 STOCS 0072G 01 0031174 00030 273443N 0965837W C 05          00 0 .02 01001A
0134 STOCS 0072G 01 04 00 00026                0 0 1 14 1 0 0                 03001A
0134 STOCS 0072G 01 .02                         .288       3 2 3 1 0.5 NL 4 1 05001A
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0134 STOCS 0072G 01 5317020106 0008 00.0016              2   0 0              10002A
0134 STOCS 0072G 01 4001010101 0003                          0 0              10003A
0134 STOCS 0072G 01 4001010102 0001                          0 0              10004A
0134 STOCS 0072G 01 4803020402 0002                          0 0              10005A
0134 STOCS 0072G 01 4808010103 0001                          0 0              10006A
0134 STOCS 0072G 01 4810010203 0001                          0 0              10007A
0134 STOCS 0072G 01 4802130204 0002                          0 0              10008A
0134 STOCS 0072G 01 4802120407 0001                          0 0              10009A
0134 STOCS 0072G 01 4805021501 0010                          0 0              10010A
0134 STOCS 0072G 01 4802100301 0001                          0 0              10011A
0135 STOCS 0074G 01 0031174 00240 273437N 0964722W C 05          00 0 .02 01001A
0135 STOCS 0074G 01 04 00 00036                0 0 1 16 1 0 0                 03001A
0135 STOCS 0074G 01 .02                         .355       3 2 3 1 0.5 NL 4 1 05001A
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0135 STOCS 0074G 01 5317020106 0001 00.0047              2   0 0              10002A
0135 STOCS 0074G 01 5314020203 0006 0.00015              2   0 0              10003A
0135 STOCS 0074G 01 4805070490 0001                          0 0              10004A
0135 STOCS 0074G 01 4805070491 0002                          0 0              10005A
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0135 STOCS 0074G 01 4808010103 0002                          0 0              10011A
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0136 STOCS 0076G 01 04 00 00048                0 0 1 14 1 0 0                   03001A
0136 STOCS 0076G 01 .02                         .196       3 2 3 1 0.5 NL 4 1 05001A
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0136 STOCS 0076G 01 5314020203 0002 0.00015              2   0 0                10002A
0136 STOCS 0076G 01 5319610201 0001 00.0975              2   0 0                10003A
0136 STOCS 0076G 01 4802120407 0002                          0 0                10004A
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0136 STOCS 0076G 01 4802130204 0004                          0 0                10007A
0136 STOCS 0076G 01 4803020402 0001                          0 0                10008A
0136 STOCS 0076G 01 4802150202 0001                          0 0                10009A
0136 STOCS 0076G 01 4802100301 0001                          0 0                10010A
0136 STOCS 0076G 01 4001010101 0001                          0 0                10011A
0137 STOCS 0077G 01 0031174 00500 273427N 0963908W C 05            00 0 .02 01001A
0137 STOCS 0077G 01 04 01 00053                0 0 1 14 1 0 0                   03001A
0137 STOCS 0077G 01 .02                         J003       3 2 3 1 0.5 NL 4 1 05001A
0137 STOCS 0077G 01 5319610201 0001 00.0975              2   0 0                10001A
0137 STOCS 0077G 01 4802130204 0003                          0 0                10002A
0137 STOCS 0077G 01 4805021501 0006                          0 0                10003A
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0137 STOCS 0077G 01 4001010101 0001                          0 0                10006A
0138 STOCS 0084G 01 0021174 01518 273411N 0961509W C 05            00 0 .02 01001A
0138 STOCS 0084G 01 04 02 00110                0 0 1 14 1 0 0                   03001A
0138 STOCS 0084G 01 .02                         .062       3 2 3 1 0.5 NL 4 1 05001A
0138 STOCS 0084G 01 5317020107 0001 00.0047              2   0 0                10001A
0138 STOCS 0084G 01 4904990101 0002                      1   0 0                10002A
0138 STOCS 0084G 01 4805021501 0001                          0 0                10003A
0138 STOCS 0084G 01 4802140106 0002                          0 0                10004A
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0138 STOCS 0084G 01 4805070491 0001                          0 0                10007A
0138 STOCS 0084G 01 4802120407 0001                          0 0                10008A
0138 STOCS 0084G 01 4001010101 0001                                             10009A
0139 STOCS 0086G 01 0021174 01315 273356N 0960338W C 05            00 0 .02 01001A
0139 STOCS 0086G 01 04 02 00154                0 0 1 14 1 0 0                   03001A
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0139 STOCS 0086G 01 .02                          .264       3 2 3 1 0.5 NL 4 1 05001A
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0139 STOCS 0086G 01 5316500001 0002                       2   0 0              10003A
0139 STOCS 0086G 01 5319560201 0001                       2   0 0              10004A
0139 STOCS 0086G 01 4908459090 0001                       1   0 0              10005A
0139 STOCS 0086G 01 4905940101 0000 1                     1   0 0              10006A
0139 STOCS 0086G 01 4805021501 0001 1                         0 0              10007A
0139 STOCS 0086G 01 4802130204 0001 1                         0 0              10008A
0139 STOCS 0086G 01 4806010204 0004 1                         0 0              10009A
0139 STOCS 0086G 01 4802140106 0001 1                         0 0              10010A
0139 STOCS 0086G 01 4806030201 0001 1                         0 0              10011A
0139 STOCS 0086G 01 4802100301 0003 1                         0 0              10012A
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0139 STOCS 0086G 01 4802111290 0001 1                         0 0              10016A
0139 STOCS 0086G 01 4001010101 0002 1                         0 0              10017A
0139 STOCS 0086G 01 4001010103 0002 1                         0 0              10018A
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0140 STOCS 0089G 01 04 02 00143                0 0 1 14 1 0 0                  03001A
0140 STOCS 0089G 01 .02                          .040       3 2 3 1 0.5 NL 4 1 05001A
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0140 STOCS 0089G 01 5319610401 0001 00.0516               2   0 0              10002A
0140 STOCS 0089G 01 4806010204 0001                           0 0              10003A
0140 STOCS 0089G 01 4001010101 0001                           0 0              10004A
0140 STOCS 0089G 01 4001010103 0004                           0 0              10005A
0141 STOCS 0092G 01 0031174 01644 272853N 0962400W C 05            00 0 .02 01001A
0141 STOCS 0092G 01 04 02 00103                0 0 1 14 1 0 0                  03001A
0141 STOCS 0092G 01 .02                          .102       3 2 3 1 0.5 NL 4 1 05001A
0141 STOCS 0092G 01 5319510201 0001 00.3214               2   0 0              10001A
0141 STOCS 0092G 01 4810010203 0001                           0 0              10002A
0141 STOCS 0092G 01 4802140106 0002                           0 0              10003A
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0142 STOCS 0094G 01 04 01 00080                0 0 1 14 1 0 0                  03001A
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0142 STOCS 0094G 01 4806010204 0001                          0 0             10004A
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0142 STOCS 0094G 01 4802100301 0001                          0 0             10007A
0142 STOCS 0094G 01 4810010790 0001                          0 0             10008A
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0143 STOCS 0091G 01 04 02 00110                0 0 1 14 1 0 0                03001A
0143 STOCS 0091G 01 .02                          .052      3 2 3 1 0.5 NL 4 1 05001A
0143 STOCS 0091G 01 5317020107 0001 00.0047              2   0 0             10001A
0143 STOCS 0091G 01 4802140106 0002                          0 0             10002A
0143 STOCS 0091G 01 4802100301 0001                          0 0             10003A
0143 STOCS 0091G 01 4806010204 0001                          0 0             10004A
0143 STOCS 0091G 01 4802130204 0001                          0 0             10005A
0143 STOCS 0091G 01 4001010101 0002                          0 0             10006A
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0144 STOCS 0097G 01 04 00 00044                0 0 1 14 1 0 0                03001A
0144 STOCS 0097G 01 .02                          .051      3 2 3 1 0.5 NL 4 1 05001A
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0144 STOCS 0097G 01 6803200102 0001 00.0378              2 1 0 0             10002A
0144 STOCS 0097G 01 4805021501 0004                          0 0             10003A
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0144 STOCS 0097G 01 4808010103 0002                          0 0             10005A
0144 STOCS 0097G 01 4802130204 0001                          0 0             10006A
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0145 STOCS 0098G 01 04 00 00041                0 0 1 14 1 0 0                03001A
0145 STOCS 0098G 01 .02                          .034      3 2 3 1 0.5 NL 4 1 05001A
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0145 STOCS 0098G 01 4805021501 0004                          0 0             10002A
0145 STOCS 0098G 01 4802130204 0003                          0 0             10003A
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0146 STOCS 0100G 01 04 00 00028                0 0 1 14 1 0 0                03001A
0146 STOCS 0100G 01 .02                          N936      3 2 3 1 0.5 NL 4 1 05001A
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0146 STOCS 0100G 01 6803200102 0002 00.0378              2 1 0 0             10003A
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0146 STOCS 0100G 01 4001010101 0004                          0 0                10008A
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0147 STOCS 0102G 01 04 00 00026              0 0 1 14 1 0 0                     03001A
0147 STOCS 0102G 01 .02                        .459       3 2 3 1 0.5 NL 4 1 05001A
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0148 STOCS 0096G 01 .02                        .285       3 2 3 1 0.5 NL 4 1 05001A
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0148 STOCS 0096G 01 5319610401 0001 00.0516            2   0 0                10002A
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0149 STOCS 0107G 01 04 01 00065              0 0 1 14 1 0 0                     03001A
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0150 STOCS 0104G 01 .02                        .073       3 2 3 1 0.5 NL 4 1 05001A
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0150 STOCS 0104G 01 4802100103 0001                        0 0                10007A
0150 STOCS 0104G 01 4001010101 0005                        0 0                10008A
0151 STOCS 0108G 01 0041174 00505 272406N 0963601W C 05          00 0 .02 01001A
0151 STOCS 0108G 01 04 01 00078              0 0 1 14 1 0 0                   03001A
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0152 STOCS 112AG 01 4802100490 0001                        0 0                10002A
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0153 STOCS 0105G 01 04 01 00052              0 0 1 23 1 0 0                   03001A
0153 STOCS 0105G 01 .02                       0374       3 2 3 1 0.5 NL 4 1 05001A
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0154 STOCS 0111G 01 04 02 00110              0 0 1 14 1 0 0                   03001A
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0156 STOCS 0118G 01 .02                       .051     3 2 3 1 0.5 NL 4 1 05001A
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0156 STOCS 0118G 01 4805021501 0001                        0 0             10002A
0157 STOCS 0119G 01 0051174 00230 271849N 0964446W C 05          00 0 .02 01001A
0157 STOCS 0119G 01 04 01 00067 TONWU       0 0 1 14 1 0 0                 03001A
0157 STOCS 0119G 01 .02                       .023     3 2 3 1 0.5 NL 4 1 05001A
0157 STOCS 0119G 01 5319620001 0001                      2   0 0             10001A
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0157 STOCS 0119G 01 4806030105 0001                        0 0             10003A
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0158 STOCS 0121G 01 04 01 00052             0 0 1 14 1 0 0                 03001A
0158 STOCS 0121G 01 .02                       .092     3 2 3 1 0.5 NL 4 1 05001A
0158 STOCS 0121G 01 6803200102 0001 00.0378              2 1 0 0             10001A
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0159 STOCS 0122G 01 5319620204 0002 000.032              1   0 0             10002A
0159 STOCS 0122G 01 5314020203 0001 0.00015              2   0 0             10003A
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0160 STOCS 0124G 01 4810010203 0001                          0 0                10006A
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0161 STOCS 0126G 01 04 00 00025              0 0 1 14 1 0 0                   03001A
0161 STOCS 0126G 01 .02                                    3 2 3 1 0.5 NL 4 1 05001A
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0162 STOCS 0128G 01 04 00 00038 TUNWN        0 0 1 14 1 0 0                   03001A
0162 STOCS 0128G 01 .02                       .095         3 2 3 1 0.5 NL 4 1 05001A
0162 STOCS 0128G 01 6803200102 0001 00.0378              2 1 0 0               10001A
0162 STOCS 0128G 01 5319620204 0002 000.032              2   0 0               10002A
0162 STOCS 0128G 01 5314020203 0001 0.00015              2   0 0               10003A
0162 STOCS 0128G 01 4808010103 0001                          0 0                10004A
0162 STOCS 0128G 01 4805021501 0002                          0 0                10005A
0162 STOCS 0128G 01 4802130204 0002                          0 0                10006A
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0162 STOCS 0128G 01 4001010101 0001                          0 0                10008A
0163 STOCS 0130G 01 0051174 01750 271340N 0965039W C 05            00 0 .02 01001A
0163 STOCS 0130G 01 04 01 00072              0 0 1 14 1 0 0                   03001A
0163 STOCS 0130G 01 .02                                    3 2 3 1 0.5 NL 4 1 05001A
0164 STOCS 0132G 01 0051176 01555 271334N 0964453W C 05            00 0 .02 01001A
0164 STOCS 0132G 01 04 01 00072              0 0 1 23 1 0 0                   03001A
0164 STOCS 0132G 01 .02                       .052         3 2 3 1 005 NL 4 1 05001A
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0164 STOCS 0132G 01 4808010103 0001                          0 0                10003A
0164 STOCS 0132G 01 4805070101 0002                          0 0                10004A
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0165 STOCS 0133G 01 04 01 00082              0 0 1 14 1 0 0                   03001A
0165 STOCS 0133G 01 .02                                    3 2 3 1 0.5 NL 4 1 05001A
0166 STOCS 0135G 01 0051174 01340 271323N 0962716W C 05            00 0 .02 01001A
0166 STOCS 0135G 01 04 02 00131              0 0 1 14 1 0 0                   03001A
0166 STOCS 0135G 01 .02                       .036         3 2 3 1 0.5 NL 4 1 05001A
0167 STOCS 0142G 01 0141174 01419 270819N 0965348W C 05            00 0 002 01001A
0167 STOCS 0142G 01 04 01 00055              0 0 1 14 1 0 0                   03001A
0167 STOCS 0142G 01 .02                       .023         3 2 3 1 0.5 NL 4 1 05001A
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0168 STOCS 0144G 01 04 00 00032              0 0 1 14 1 0 0                   03001A
0168 STOCS 0144G 01 .02                       .343         3 2 3 1 0.5 NL 4 1 05001A
0168 STOCS 0144G 01 6803200102 0001 00.0378              2 1 0 0               10001A
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0168 STOCS 0144G 01 4802100104 0001                        0 0                10011A
0168 STOCS 0144G 01 4001010101 0006                        0 0                10012A
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0169 STOCS 0148G 01 04 00 00044              0 0 1 14 1 0 0                   03001A
0169 STOCS 0148G 01 .02                       .088      3 2 3 1 0.5 NL 4 1 05001A
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0169 STOCS 0148G 01 4802130204 0002                        0 0                10002A
0169 STOCS 0148G 01 4810010203 0001                        0 0                10003A
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0169 STOCS 0148G 01 4804010101 0003                        0 0                10006A
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0170 STOCS 0152G 01 04 01 00090              0 0 1 14 1 0 0                   03001A
0170 STOCS 0152G 01 .02                       .022      3 2 3 1 0.5 NL 4 1 05001A
0170 STOCS 0152G 01 4805021501 0001                        0 0                10001A
0170 STOCS 0152G 01 4802150102 0001                        0 0                10002A
0170 STOCS 0152G 01 4800000004 0001                        0 0                10003A
0171 STOCS 0153G 01 0211174 01014 270304N 0963605W C 05          00 0 .02 01001A
0171 STOCS 0153G 01 04 01 00096              0 0 1 14 1 0 0                   03001A
0171 STOCS 0153G 01 .02                       .185      3 2 3 1 0.5 NL 4 1 05001A
0171 STOCS 0153G 01 6803200102 0001 0000378            2 1 0 0                10001A
0171 STOCS 0153G 01 4806030105 0002                        0 0                10002A
0171 STOCS 0153G 01 4802130204 0001                        0 0                10003A
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0171 STOCS 0153G 01 4001010101 0001                        0 0                10006A
0172 STOCS 0154G 01 0211174 01047 270246N 0963056W C 05          00 0 .02 01001A
0172 STOCS 0154G 01 04 02 00135              0 0 1 14 1 0 0                   03001A
0172 STOCS 0154G 01 .02                       .008      3 2 3 1 0.5 NL 4 1 05001A
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0173 STOCS 0158G 01 04 01 00082                0 0 1 14 1 0 0                  03001A
0173 STOCS 0158G 01 .02                         .011        3 2 3 1 0.5 NL 4 1 05001A
0174 STOCS 0163G 01 0211174 00726 265804N 0965637W C 05            00 0 .02 01001A
0174 STOCS 0163G 01 04 01 00052                0 0 1 14 1 0 0                  03001A
0174 STOCS 0163G 01 .02                         .810        3 2 3 1 0.5 NL 4 1 05001A
0174 STOCS 0163G 01 6803200102 0001 00.0378            2 1 0 0                 10001A
0174 STOCS 0163G 01 4802120407 0001                          0 0                10002A
0174 STOCS 0163G 01 4802100301 0001                          0 0                10003A
0174 STOCS 0163G 01 4805021501 0001                          0 0                10004A
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0175 STOCS 0147G 01 0211174 01552 270323N 0970532W C 05            00 0 .02 01001A
0175 STOCS 0147G 01 04 00 00034                0 0 1 21 1 0 0                  03001A
0175 STOCS 0147G 01 .02                         J096        3 2 3 1 0.5 NL 4 1 05001A
0175 STOCS 0147G 01 6803200102 0001 00.0378            2 1 0 0                 10001A
0175 STOCS 0147G 01 5315020102 0001 0.00152            2   0 0                 10002A
0175 STOCS 0147G 01 5314020203 0003 0.00015            2   0 0                 10003A
0175 STOCS 0147G 01 4802130204 0002                          0 0                10004A
0175 STOCS 0147G 01 4808010103 0004                          0 0                10005A
0175 STOCS 0147G 01 4810010203 0001                          0 0                10006A
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0175 STOCS 0147G 01 4001010101 0006                          0 0                10011A
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0176 STOCS 0169G 01 04 01 00057                0 0 1 14 1 0 0                  03001A
0176 STOCS 0169G 01 .02                         .041        3 2 3 1 0.5 NL 4 1 05001A
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0176 STOCS 0169G 01 4808010103 0001                          0 0                10002A
0176 STOCS 0169G 01 4802120407 0001                          0 0                10003A
0176 STOCS 0169G 01 4805070490 0001                          0 C                10004A
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0177 STOCS 0168G 01 0211174 00515 265251N 0965946W C 05            00 0 .02 01001A
0177 STOCS 0168G 01 04 00 00044                0 0 1 14 1 0 0                  03001A
0177 STOCS 0168G 01 .02                         J032        3 2 3 1 0.5 NL 4 1 05001A
0177 STOCS 0168G 01 6803200102 0001 00.0378            2 1 0 0                 10001A
0177 STOCS 0168G 01 5319620204 0001 000.032            1   0 0                 10002A
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0177 STOCS 0168G 01 4802120407 0001                          0 0                10006A
0178 STOCS 0175G 01 0191174 01158 265235N 0963352W C 05            00 0 002 01001A
0178 STOCS 0175G 01 04 02 00123              0 0 1 14 1 0 0                   03001A
0178 STOCS 0175G 01 0.2                       .015       3 2 3 1 0.5 NL 4 1 05001A
0178 STOCS 0175G 01 4802140105 0001                          0 0                10001A
0178 STOCS 0175G 01 4802140106 0001                          0 0                10002A
0178 STOCS 0175G 01 4813010401 0001                          0 0                10003A
0179 STOCS 0170G 01 0201174 00835 265242N 0965057W C 05            00 0 .02 01001A
0179 STOCS 0170G 01 04 01 00063              0 0 1 14 1 0 0                   03001A
0179 STOCS 0170G 01 .02                       .033       3 2 3 1 0.5 NL 4 1 05001A
0179 STOCS 0170G 01 6803200102 0001 00.0378            2 1 0 0                10001A
0179 STOCS 0170G 01 4810010203 0001                          0 0                10002A
0179 STOCS 0170G 01 4808010103 0005                          0 0                10003A
0179 STOCS 0170G 01 4805021390 0001                          0 0                10004A
0180 STOCS 0173G 01 0191174 01929 265242N 0964222W C 05            00 0 .02 01001A
0180 STOCS 0173G 01 04 01 00093              0 0 1 14 1 0 0                   03001A
0180 STOCS 0173G 01 .02                       .107       3 2 3 1 0.5 NL 4 1 05001A
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0180 STOCS 0173G 01 5317020106 0001 00.0016            2   0 0                10002A
0180 STOCS 0173G 01 5319600001 0001                    2   0 0                10003A
0180 STOCS 0173G 01 4808010103 0001                          0 0                10004A
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0180 STOCS 0173G 01 4802140106 0001                          0 0                10006A
0180 STOCS 0173G 01 4805070301 0001                          0 0                10007A
0180 STOCS 0173G 01 4802090601 0001                          0 0                10008A
0181 STOCS 0177G 01 0191174 00952 264718N 0963323W C 05            00 0 .02 01001A
0181 STOCS 0177G 01 04 02 00102              0 0 1 14 1 0 0                   03001A
0181 STOCS 0177G 01 .02                       .049       3 2 3 1 0.5 NL 4 1 05001A
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0182 STOCS 0166G 01 5317020107 0032 00.0047            2   0 0              10002A
0182 STOCS 0166G 01 5317020109 0003 000.005            2   0 0              10003A
0182 STOCS 0166G 01 5314020203 0001 0.00015            2   0 0              10004A
0182 STOCS 0166G 01 5319610401 0001 00.0516            2   0 0              10005A
0182 STOCS 0166G 01 4806010101 0001                        0 0              10006A
0182 STOCS 0166G 01 4802130204 0003                        0 0              10007A
0182 STOCS 0166G 01 4806030201 0002                        0 0              10008A
0182 STOCS 0166G 01 4805021501 0001                        0 0              10009A
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0182 STOCS 0166G 01 4806040102 0001                        0 0              10011A
0182 STOCS 0166G 01 4001010101 0006                        0 0              10012A
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0183 STOCS 0180G 01 04 01 00078              0 0 1 14 1 0 0                 03001A
0183 STOCS 0180G 01 .02                       .087       3 2 3 1 0.5 NL 4 1 05001A
0183 STOCS 0180G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0184 STOCS 0181G 01 0191174 00616 264729N 0964804W C 05          00 0 .02 01001A
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0184 STOCS 0181G 01 .02                       .070       3 2 3 1 0.5 NL 4 1 05001A
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0184 STOCS 0181G 01 4802130204 0001                        0 0              10003A
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0184 STOCS 0181G 01 4001010101 0001                        0 0              10005A
0185 STOCS 0182G 01 0191174 00538 264732N 0965104W C 05          00 0 .02 01001A
0185 STOCS 0182G 01 04 01 00056              0 0 1 14 1 0 0                 03001A
0185 STOCS 0182G 01 .02                       .267       3 2 3 1 0.5 NL 4 1 05001A
0185 STOCS 0182G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0185 STOCS 0182G 01 4808010103 0001                        0 0              10002A
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0186 STOCS 0178G 01 .02                       .017       3 2 3 1 0.5 NL 4 1 05001A
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0187 STOCS 0190G 01 5319620204 0001 000.032            1   0 0              10002A
0187 STOCS 0190G 01 4802130204 0001                        0 0              10003A
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0187 STOCS 0190G 01 4805020603 0001                        0 0              10005A
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0188 STOCS 0187G 01 04 00 00033              0 0 1 14 1 0 0                 03001A
0188 STOCS 0187G 01 .02                       .526      3 2 3 1 0.5 NL 4 1 05001A
0188 STOCS 0187G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0188 STOCS 0187G 01 4808010103 0001                        0 0              10002A
0188 STOCS 0187G 01 4806010101 0001                        0 0              10003A
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0189 STOCS 0188G 01 04 00 00045              0 0 1 14 1 0 0                 03001A

0189 STOCS 0188G 01 .02                       .140      3 2 3 1 0.5 NL 4 1 05001A
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0189 STOCS 0188G 01 5314020203 0001 0.00015            2   0 0              10002A
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0189 STOCS 0188G 01 4805021501 0006                        0 0              10004A
0189 STOCS 0188G 01 4802130204 0001                        0 0              10005A
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0190 STOCS 0192G 01 5319610401 0001 00.0516            2   0 0              10002A
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0190 STOCS 0192G 01 4001010101 0001                        0 0              10005A
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0193 STOCS 0196G 01 04 01 00085                0 0 1 16 1 0 0                  03001A
0193 STOCS 0196G 01 .02                         .254       3 2 3 1 0.5 NL 4 1 05001A
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0193 STOCS 0196G 01 5317420201 0001 00.0002            2   0 0                10002A
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0194 STOCS 0200G 01 04 00 00040                0 0 1 14 1 0 0                  03001A
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0194 STOCS 0200G 01 4806030201 0001                          0 0                10003A
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0194 STOCS 0200G 01 4802130204 0001                          0 0                10005A
0194 STOCS 0200G 01 4001010101 0003                          0 0                10006A
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0195 STOCS 0205G 01 04 00 00040                0 0 1 14 1 0 0                  03001A
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0195 STOCS 0205G 01 4803020403 0001                          0 0                10003A
0195 STOCS 0205G 01 4808010103 0001                          0 0                10004A
0195 STOCS 0205G 01 4001010101 0001                          0 0                10005A
0195 STOCS 0205G 01 4001010103 0003                          0 0                10006A
0196 STOCS 0198G 01 0071174 01737 263644N 0964514W C 05            00 0 .02 01001A
0196 STOCS 0198G 01 04 01 00067                0 0 1 14 1 0 0                  03001A
0196 STOCS 0198G 01 .02                         .008       3 2 3 1 0.5 NL 4 1 05001A
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0197 STOCS 0201G 01 0071174 01418 263705N 0970248W C 05          00 0 .02 01001A
0197 STOCS 0201G 01 04 00 00035              0 0 1 14 1 0 0                03001A
0197 STOCS 0201G 01 .02                       .108      3 2 3 1 0.5 NL 4 1 05001A
0197 STOCS 0201G 01 4908760202 0001                        0 0             10001A
0197 STOCS 0201G 01 4808010103 0002                        0 0             10002A
0197 STOCS 0201G 01 4805020307 0001                        0 0             10003A
0197 STOCS 0201G 01 4806040263 0001                        0 0             10004A
0197 STOCS 0201G 01 4811010101 0001                        0 0             10005A
0197 STOCS 0201G 01 4001010103 0002                        0 0             10006A
0198 STOCS 0204G 01 0071174 00100 263151N 0965957W C 05          00 0 .02 01001A
0198 STOCS 0204G 01 04 00 00035              0 0 1 14 1 0 0                03001A
0198 STOCS 0204G 01 .02                       .153      3 2 3 1 0.5 NL 4 1 05001A
0198 STOCS 0204G 01 4806010101 0002                        0 0             10001A
0198 STOCS 0204G 01 4806030201 0001                        0 0             10002A
0198 STOCS 0204G 01 4802130204 0002                        0 0             10003A
0198 STOCS 0204G 01 4001010101 0001                        0 0             10004A
0198 STOCS 0204G 01 5902010101 0001                        0 0             10005A
0199 STOCS 0211G 01 0071174 00615 263134N 0963050W C 05          00 0 .02 01001A
0199 STOCS 0211G 01 04 01 00095              0 0 1 15 1 0 0                03001A
0199 STOCS 0211G 01 .02                       .050      3 2 3 1 0.5 NL 4 1 05001A
0199 STOCS 0211G 01 4802130204 0001                        0 0             10001A
0199 STOCS 0211G 01 4803051190 0001                        0 0             10002A
0199 STOCS 0211G 01 4805021501 0002                        0 0             10003A
0199 STOCS 0211G 01 4804010101 0001                        0 0             10004A
0200 STOCS 0207G 01 0071174 00330 263150N 0964827W C 05          00 0 .02 01001A
0200 STOCS 0207G 01 04 00 00046              0 0 1 14 1 0 0                03001A
0200 STOCS 0207G 01 .02                       J742      3 2 3 1 0.5 NL 4 1 05001A
0200 STOCS 0207G 01 4806010204 0001                        0 0             10001A
0200 STOCS 0207G 01 4802130204 0001                        0 0             10002A
0200 STOCS 0207G 01 4802100103 0003                        0 0             10003A
0201 STOCS 0227G.01 0231174 00423 262127N 0965423W C 05          00 0 .02 01001A
0201 STOCS 0227G 01 04 00 00039              0 0 1 14 1 0 0                03001A
0201 STOCS 0227G 01 .02                       .170      3 2 3 1 0.5 NL 4 1 05001A
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0201 STOCS 0227G 01 4904001010 0001                        0 0             10002A
0201 STOCS 0227G 01 4905130101 0001                        0 0             10003A
0201 STOCS 0227G 01 4802130204 0002                        0 0             10004A
0201 STOCS 0227G 01 4806040203 0001                        0 0             10005A
0201 STOCS 0227G 01 4805070101 0001                        0 0             10006A
0201 STOCS 0227G 01 4803030301 0001                        0 0             10007A
0202 STOCS 0217G 01 0231174 00825 262629N 0963105W C 05          00 0 .02 01001A
0202 STOCS 0217G 01 04 01 00078              0 0 1 14 1 0 0                03001A
0202 STOCS 0217G 01 .02                       .006      3 2 3 1 0.5 NL 4 1 05001A
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0202 STOCS 0217G 01 4802130204 0001                        0 0                10002A
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0203 STOCS 0209G 01 04 01 00075              0 0 1 14 1 0 0                   03001A
0203 STOCS 0209G 01 .02                        .040       3 2 3 1 0.5 NL 4 1 05001A
0203 STOCS 0209G 01 6803200102 0001 00.0378            2 1 0 0                10001A
0203 STOCS 0209G 01 5317020107 0001 00.0047            2   0 0                10002A
0203 STOCS 0209G 01 4810010203 0001                        0 0                10003A
0203 STOCS 0209G 01 4802130204 0001                        0 0                10004A
0203 STOCS 0209G 01 4802050190 0001                        0 0                10005A
0204 STOCS 0232G 01 0231174 01041 262114N 0963106W C 05          00 0 .02 01001A
0204 STOCS 0232G 01 04 01 00068              0 0 1 16 1 0 0                   03001A
0204 STOCS 0232G 01 .02                        .709       3 2 3 1 0.5 NL 4 1 05001A
0204 STOCS 0232G 01 6803200102 0001 00.0378            2 1 0 0                10001A
0204 STOCS 0232G 01 5316100001 0001 00.0015            2   0 0                10002A
0204 STOCS 0232G 01 4806030201 0001                        0 0                10003A
0204 STOCS 0232G 01 4808010103 0001                        0 0                10004A
0205 STOCS 0222G 01 0171174 00936 262641N 0965414W C 05          00 0 .02 01001A
0205 STOCS 0222G 01 04 00 00038              0 0 1 14 1 0 0                   03001A
0205 STOCS 0222G 01 .02                        .116       3 2 3 1 0.5 NL 4 1 05001A
0205 STOCS 0222G 01 5317020108 0001 000.005            2   0 0                10001A
0205 STOCS 0222G 01 5319620204 0001 000.032            1   0 0                10002A
0205 STOCS 0222G 01 4908760202 0001                        0 0                10003A
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0205 STOCS 0222G 01 4808010103 0001                        0 0                10005A
0205 STOCS 0222G 01 4802130204 0001                        0 0                10006A
0205 STOCS 0222G 01 4805021390 0001                        0 0                10007A
0205 STOCS 0222G 01 4001010101 0003                        0 0                10008A
0206 STOCS 0212G 01 0081174 02217 263126N 0962801W C 05          00 0 .02 01001A
0206 STOCS 0212G 01 04 02 00100              0 0 1 14 1 0 0                   03001A
0206 STOCS 0212G 01 .02                        0026       3 2 3 1 0.5 NL 4 1 05001A
0206 STOCS 0212G 01 4908120191 0001                        0 0                10001A
0206 STOCS 0212G 01 4805021501 0001                        0 0                10002A
0206 STOCS 0212G 01 4802140106 0001                        0 0                10003A
0206 STOCS 0212G 01 4001010103 0001                        0 0                10004A
0207 STOCS 0240G 01 0221174 01850 261604N 0963951W C 05          00 0 .02 01001A
0207 STOCS 0240G 01 04 01 00051              0 0 1 14 1 0 0                   03001A
0207 STOCS 0240G 01 .02                        .224       3 2 3 1 0.5 NL 4 1 05001A
0207 STOCS 0240G 01 6803200102 0001 00.0378            2 1 0 0                10001A
0207 STOCS 0240G 01 4808010103 0001                        0 0                10002A
0207 STOCS 0240G 01 4805070101 0001                        0 0                10003A
0207 STOCS 0240G 01 4810010203 0001                        0 0                10004A
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0207 STOCS 0240G 01 4001010101 0001                          0 0                10005A
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0208 STOCS 0220G 01 04 01 00046                0 0 1 18 1 0 0                  03001A
0208 STOCS 0220G 01 .02                         J703       3 2 3 1 0.5 NL 4 1 05001A
0208 STOCS 0220G 01 5317020106 0001 00.0016            2   0 0                10001A
0208 STOCS 0220G 01 5315020102 0002 0.00152            2   0 0                10002A
0208 STOCS 0220G 01 5316100002 0003                    2   0 0                10003A
0208 STOCS 0220G 01 4908129091 0001                        0 0                10004A
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0208 STOCS 0220G 01 4908760202 0002                        0 0                10006A
0208 STOCS 0220G 01 4802120407 0004                        0 0                10007A
0208 STOCS 0220G 01 4810010203 0003                        0 0                10008A
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0208 STOCS 0220G 01 4001010103 0004                        0 0                10024A
0209 STOCS 0218G 01 0231174 00729 262624N 0963356W C 05            00 0 .02 01001A
0209 STOCS 0218G 01 04 01 00065                0 0 1 18 1 0 0                  03001A
0209 STOCS 0218G 01 .02                         J553       3 2 3 1 0.5 NL 4 1 05001A
0209 STOCS 0218G 01 6303200102 0001 00.0378            2 1 0 0                10001A
0209 STOCS 0218G 01 5314020203 0001 0.00015            2   0 0                10002A
0209 STOCS 0218G 01 4908110101 0001                        0 0                10003A
0209 STOCS 0218G 01 4803030301 0002                        0 0                10004A
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0209 STOCS 0218G 01 4805070490 0001                          0 0                10007A
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0210 STOCS 0229G 01 04 00 00046                0 0 1 18 1 0 0                   03001A
0210 STOCS 0229G 01 .02                         .111        3 2 3 1 0.5 NL 4 1 05001A
0210 STOCS 0229G 01 5317020107 0001 00.0047            2    0 0                10001A
0210 STOCS 0229G 01 5317420101 0001 0.00017            2    0 0                10002A
0210 STOCS 0229G 01 5316100001 0001 00.0015            2    0 0                10003A
0210 STOCS 0229G 01 4906760202 0001                         0 0                10004A
0210 STOCS 0229G 01 4808010103 0007                         0 0                10005A
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0210 STOCS 0229G 01 5902010101 0001                         0 0                10017A
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0211 STOCS 0231G 01 04 01 00060                0 0 1 18 1 0 0                   03001A
0211 STOCS 0231G 01 .02                         .071        3 2 3 1 0.5 NL 4 1 05001A
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0211 STOCS 0231G 01 4802120407 0001                         0 0                10003A
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0211 STOCS 0231G 01 4800000006 0001                         0 0                10006A
0212 STOCS 0239G 01 0031274 01224 261553N 0963650W C 05            00 0 .02 01001A
0212 STOCS 0239G 01 04 01 00053                0 0 1 16 1 0 0                   03001A
0212 STOCS 0239G 01 .02                         .133        3 2 3 1 0.5 NL 4 1 05001A
0212 STOCS 0239G 01 6803200102 0001 00.0378            2 1 0 0                10001A
0212 STOCS 0239G 01 5317020108 0001 000.005            2    0 0                10002A
0212 STOCS 0239G 01 4906129091 0001                         0 0                10003A
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0213 STOCS 0244G 01 04 00 00037                0 0 1 14 1 0 0                   03001A
0213 STOCS 0244G 01 .02                         .190        3 2 3 1 0.5 NL 4 1 05001A
0213 STOCS 0244G 01 5314020203 0003 0.00015            2    0 0                10001A
0213 STOCS 0244G 01 5317020107 0012 00.0047            2    0 0                10002A
0213 STOCS 0244G 01 5317020108 0001 000.005            2    0 0                10003A
0213 STOCS 0244G 01 4904001010 0001                          0 0                10004A
0213 STOCS 0244G 01 4802130204 0003                          0 0                10005A
0213 STOCS 0244G 01 4808010103 0001                          0 0                10006A
0213 STOCS 0244G 01 4810010203 0001                          0 0                10007A
0213 STOCS 0244G 01 4805021501 0001                          0 0                10008A
0213 STOCS 0244G 01 4001010101 0002                          0 0                10009A
0214 STOCS 0237G 01 0031274 01423 261557N 0963108W C 05            00 0 .02 01001A
0214 STOCS 0237G 01 04 01 00063                0 0 1 16 1 0 0                   03001A
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0214 STOCS 0237G 01 4808010103 0005                          0 0                10003A
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0214 STOCS 0237G 01 4802130204 0002                          0 0                10005A
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0215 STOCS 0247G 01 04 00 00037                0 0 1 14 1 0 0                   03001A
0215 STOCS 0247G 01 .02                         .179        3 2 3 1 0.5 NL 4 1 05001A
0215 STOCS 0247G 01 5319620204 0001 000.032            1    0 0                10001A
0215 STOCS 0247G 01 5317020107 0001 00.0047            2    0 0                10002A
0215 STOCS 0247G 01 5317020106 0001 00.0016            2    0 0                10003A
0215 STOCS 0247G 01 5314020204 0004 00.0002            2    0 0                10004A
0215 STOCS 0247G 01 4904001010 0002                    2    0 0                10005A
0215 STOCS 0247G 01 4908129091 0001                    1    0 0                10006A
0216 STOCS 0248G 01 0041274 01010 261053N 0965130W C 05            00 0 .02 01001A
0216 STOCS 0248G 01 04 00 00040                0 0 1 14 1 0 0                   03001A
0216 STOCS 0248G 01 .02                         .019        3 2 3 1 0.5 NL 4 1 05001A
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0216 STOCS 0248G 01 4908760202 0002                    1    0 0                10002A
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0217 STOCS 0250G 01 .02                       .093      3 2 3 1 0.5 NL 4 1 05001A
0217 STOCS 0250G 01 6803200102 0001 00.0378            2 1 0 0               10001A
0217 STOCS 0250G 01 4805021501 0001                        0 0               10002A
0217 STOCS 0250G 01 4808010103 0001                        0 0               10003A
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0218 STOCS 0255G 01 04 01 00088              0 0 1 18 1 0 0                  03001A
0218 STOCS 0255G 01 .02                       .515      3 2 3 1 0.5 NL 4 1 05001A
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0218 STOCS 0255G 01 4803051190 0002                        0 0               10003A
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0219 STOCS 0258G 01 6803200102 0001 00.0378            2 1 0 0               10001A
0219 STOCS 0258G 01 5317420201 0001 0.00017            2   0 0               10002A
0219 STOCS 0258G 01 5315020001 0001 00.0015            2   0 0               10003A
0219 STOCS 0258G 01 4908110101 0001                    1   0 0               10004A
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0219 STOCS 0258G 01 4908570199 0001                          0 0                10018A
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0220 STOCS 0260G 01 04 00 00048                0 0 1 14 1 0 C                   03001A
0220 STOCS 0260G 01 .02                         .174        3 2 3 1 0.5 NL 4 1 05001A
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0220 STOCS 0260G 01 6801510101 0001                       2 1 0 0               10002A
0220 STOCS 0260G 01 4904001010 0001                       2   0 0               10003A
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0221 STOCS 0268G 01 .02                         .543        3 2 3 1 0.5 NL 4 1 05001A
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0221 STOCS 0268G 01 4802120407 0001                           0 0               10002A
0221 STOCS 0268G 01 4805020703 0001                           0 0               10003A
0221 STOCS 0268G 01 4806030105 0001                           0 0               10004A
0222 STOCS 0261G 01 0071274 02010 260515N 0964545W C 05            00 0 .02 01001A
0222 STOCS 0261G 01 04 00 00045                0 0 1 16 1 0 0                   03001A
0222 STOCS 0261G 01 .02                         .062        3 2 3 1 0.5 NL 4 1 05001A
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0222 STOCS 0261G 01 4808010103 0001                           0 0               10002A
0222 STOCS 0261G 01 4802120407 0001                           0 0               10003A
0222 STOCS 0261G 01 4802130204 0001                           0 0               10004A
0223 STOCS 0242G 01 0031274 02255 261611N 0964839W C 05            00 0 .02 01001A
0223 STOCS 0242G 01 04 00 00043                0 0 1 14 1 0 0                   03001A
0223 STOCS 0242G 01 .02                         .109        3 2 3 1 0.5 NL 4 1 05001A
0223 STOCS 0242G 01 5319620204 0001 000.032               1   0 0               10001A
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0223 STOCS 0242G 01 5317020106 0001 00.0016            2   0 0              10002A
0223 STOCS 0242G 01 5315020102 0001 0.00152            2   0 0              10003A
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0223 STOCS 0242G 01 4808010103 0001                        0 0              10005A
0223 STOCS 0242G 01 4802130204 0002                        0 0              10006A
0223 STOCS 0242G 01 4806030105 0001                        0 0              10007A
0223 STOCS 0242G 01 4805021501 0004                        0 0              10008A
0223 STOCS 0242G 01 4001010101 0004                        0 0              10009A
0224 STOCS 0236G 01 0031274 01506 261544N 0962519W C 05          00 3 .02 01001A
0224 STOCS 0236G 01 04 01 00075              0 0 1 18 1 0 0                 03001A
0224 STOCS 0236G 01 .02                       J585       3 2 3 1 0.5 NL 4 1 05001A
0224 STOCS 0236G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0224 STOCS 0236G 01 5317020107 0001 00.0047            2   0 0              10002A
0224 STOCS 0236G 01 5317020109 0001 000.005            2   0 0              10003A
0224 STOCS 0236G 01 5317000003 0003                    2   0 0              10004A
0224 STOCS 0236G 01 5317420001 0002 0.00017            2   0 0              10005A
0224 STOCS 0236G 01 4908129090 0005                    1   0 0              10006A
0224 STOCS 0236G 01 4908830102 0001                    1   0 0              10007A
0224 STOCS 0236G 01 4808010103 0001                        0 0              10008A
0224 STOCS 0236G 01 4810010203 0001                        0 0              10009A
0225 STOCS 0253G 01 0041274 01405 261104N 0963424W C 05          00 0 .02 01001A
0225 STOCS 0253G 01 04 01 00054              0 0 1 18 1 0 0                 03001A
0225 STOCS 0253G 01 .02                       .446       3 2 3 1 0.5 WL 4 1 05001A
0225 STOCS 0253G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0225 STOCS 0253G 01 4001010103 0001                        0 0              10002A
0226 STOCS 0264G 01 0071274 01815 260544N 0965429W C 05          00 0 .02 01001A
0226 STOCS 0264G 01 04    00                 0 0 1 18 1 0 0                 03001A
0226 STOCS 0264G 01 .02                       .178       3 2 3 1 0.5 NL 4 1 05001A
0226 STOCS 0264G 01 5314020203 0001 0.00015            2   0 0              10001A
0226 STOCS 0264G 01 4808010103 0002                        0 0              10002A
0226 STOCS 0264G 01 4802120407 0001                        0 0              10003A
0226 STOCS 0264G 01 4806040203 0002                        0 0              10004A
0226 STOCS 0264G 01 6803200102 0001                        0 0              10005A
0227 STOCS 0270G 01 0071274 01036 260009N 0964550W C 05          00 0 .02 01001A
0227 STOCS 0270G 01 04 00 00047              0 0 1 16 1 0 0                 03001A
0227 STOCS 0270G 01 .02                       .298       3 2 3 1 0.5 NL 4 1 05001A
0227 STOCS 0270G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0227 STOCS 0270G 01 5319620204 0002 000.032            2   0 0              10002A
0227 STOCS 0270G 01 4908760202 0001                    1   0 0              10003A
0227 STOCS 0270G 01 4001010101 0001                        0 0              10004A
0228 STOCS 0272G 01 0071274 00330 260045N 0963435W C 05          00 0 .02 01001A
0228 STOCS 0272G 01 04 01 00057              0 0 1 16 1 0 0                 03001A
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0228 STOCS 0272G 01 .02                          J173       3 2 3 1 0.5 NL 4 1 05001A
0228 STOCS 0272G 01 6803200102 0001 00.0378               2 1 0 0              10001A
0228 STOCS 0272G 01 5319510201 0001 00.3214               2   0 0              10002A
0228 STOCS 0272G 01 4908760202 0001                       1   0 0              10003A
0229 STOCS 0001G 01 0271074 00750 281545N 0962010W C 05           00 0 .02 01001A
0229 STOCS 0001G 01 04 00 00020                0 0 1 14 1 0 0                  03001A
0229 STOCS 0001G 01 .02                                   3 2 3 1 0.5 NL 4 1 05001A
0230 STOCS 0003G 01 0271074 00300 281534N 0960821W C 05           00 0 .02 01001A
0230 STOCS 0003G 01 04 00 00024                0 0 1 16 1 0 0                  03001A
0230 STOCS 0003G 01 .02                          .005      3 2 3 1 0.5 NL 4 1 05001A
0230 STOCS 0003G 01 5317020106 0003 00.0016               2   0 0              10001A
0231 STOCS 0006G 01 0271074 00145 281025N 0960836W C 05           00 0 002 01001A
0231 STOCS 0006G 01 04 00 00027                0 0 1 16 1 0 0                  03001A
0231 STOCS 0006G 01 .02                                   3 2 3 1 0.5 NL     05001A
0232 STOCS 0007G 01 0271074 00220 281034N 0961126W C 05           00 0 002 01001A
0232 STOCS 0007G 01 04 00 00026                0 0 1 18 1 0 0                  03001A
0232 STOCS 0007G 01 .02                          .691      3 2 3 1 0.5 NL 4 1 05001A
0232 STOCS 0007G 01 4802130204 0016                          0 0               10001A
0232 STOCS 0007G 01 4305021501 0040                          0 0               10002A
0232 STOCS 0007G 01 4805020802 0001                          0 0               10003A
0232 STOCS 0007G 01 4805021390 0007                          0 0               10004A
0232 STOCS 0007G 01 4803020402 0004                          0 0               10005A
0232 STOCS 0007G 01 4802030103 0001                          0 0               10006A
0232 STOCS 0007G 01 4802120407 0003                          0 0               10007A
0232 STOCS 0007G 01 4806030105 0006                          0 0               10008A
0232 STOCS 0007G 01 4806010101 0001                          0 0               10009A
0232 STOCS 0007G 01 4810010790 0001                          0 0               10010A
0232 STOCS 0007G 01 4803030301 0001                          0 0               10011A
0233 STOCS 0009G 01 0291074 00630 281041N 0962314W C 05           00 0 002 01001A
0233 STOCS 0009G 01 04 00 00022                0 0 1 14 1 0 0                  03001A
0233 STOCS 0009G 01 .02                          .156      3 2 3 1 0.5 NL 4 1 05001A
0233 STOCS 0009G 01 5317020107 0033 00.0047               2   0 0              10001A
0233 STOCS 0009G 01 4802130204 0002                          0 0               10002A
0233 STOCS 0009G 01 4802120407 0001                          0 0               10003A
0233 STOCS 0009G 01 4806030201 0001                          0 0               10004A
0233 STOCS 0009G 01 4807010202 0002                          0 0               10005A
0233 STOCS 0009G 01 4805021501 0018                          0 0               10006A
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0233 STOCS 0009G 01 4808010103 0002                          0 0                10007A
0233 STOCS 0009G 01 4803030301 0002                          0 0                10008A
0233 STOCS 0009G 01 4001010101 0002                          0 0                10009A
0234 STOCS 0011G 01 0271074 01150 280532N 0963211W C 05            00 0 002 01001A
0234 STOCS 0011G 01 04 00 00020                0 0 1 18 1 0 0                   03001A
0234 STOCS 0011G 01 .02                         .751       3 2 3 1 0.5 NL 4 1 05001A
0234 STOCS 0011G 01 5317020106 0012 00.0016            2   0 0                10001A
0234 STOCS 0011G 01 4806010101 0001                          0 0                10002A
0234 STOCS 0011G 01 4803051190 0001                          0 0                10003A
0234 STOCS 0011G 01 4802130204 0004                          0 0                10004A
4803020402 0001G 01                                          0 0                10005A
0234 STOCS 0011G 01 4808010103 0003                          0 0                10006A
0234 STOCS 0011G 01 4810010203 0003                          0 0                10007A
0234 STOCS 0011G 01 4806030105 0002                          0 0                10008A
0234 STOCS 0011G 01 4805070490 0001                          0 0                10009A
4802100407 0017G 01 4805070490 0001                          0 0                10010A
0234 STOCS 0011G 01 4805021501 0021                          0 0                10011A
0234 STOCS 0011G 01 4805021390 0002                          0 0                10012A
0234 STOCS 0011G 01 4001010101 0001                          0 0                10013A
0235 STOCS 0013G 01 0281074 02300 280527N 0962021W C 05            00 0 002 01001A
0235 STOCS 0013G 01 04 00 00027                0 0 1 16 1 0 0                   03001A
0235 STOCS 0013G 01 .02                         .721       3 2 3 1 0.5 NL 4 1 05001A
0235 STOCS 0013G 01 5317020106 0007 00.0016            2   0 0                10001A
0235 STOCS 0013G 01 4808010103 0004                          0 0                10002A
0235 STOCS 0013G 01 4806030105 0002                          0 0                10003A
0235 STOCS 0013G 01 4806030201 0001                          0 0                10004A
0235 STOCS 0013G 01 4802130204 0014                          0 0                10005A
0235 STOCS 0013G 01 4802120407 0001                          0 0                10006A
0235 STOCS 0013G 01 4802030103 0001                          0 0                10007A
0235 STOCS 0013G 01 4802100301 0002                          0 0                10008A
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0235 STOCS 0013G 01 4810010203 0001                          0 0                10010A
0235 STOCS 0013G 01 4001010101 0001                          0 0                10011A
0236 STOCS 0015G 01 0301074 01500 280512N 0961131W C 05            00 0 002 01001A
0236 STOCS 0015G 01 04 00 00032                0 0 1 16 1 0 0                   03001A
0236 STOCS 0015G 01 .02                         1.63       3 2 3 1 0.5 NL 4 1 05001A
0236 STOCS 0015G 01 5319610401 0002 00.0516            2   0 0                10001A
0236 STOCS 0015G 01 5317020108 0006 000.005            2   0 0                10002A
0236 STOCS 0015G 01 5314020203 0003 0.00015            2   0 0                10003A
0236 STOCS 0015G 01 4802130204 0004                          0 0                10004A
0236 STOCS 0015G 01 4808010103 0003                          0 0                10005A
0236 STOCS 0015G 01 4806030201 0001                          0 0                10006A
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0236 STOCS 0015G 01 4802120407 0002                          0 0                10007A
0236 STOCS 0015G 01 4803020402 0001                          0 0                10008A
0236 STOCS 0015G 01 4802150202 0001                          0 0                10009A
0236 STOCS 0015G 01 4805021501 0029                          0 0                10010A
0236 STOCS 0015G 01 4805021390 0002                          0 0                10011A
0236 STOCS 0015G 01 4802100103 0003                          0 0                10012A
0236 STOCS 0015G 01 4001010101 0002                          0 0                10013A
0237 STOCS 0017G 01 0301074 01715 280501N 0960242W C 05          00 0 002 01001A
0237 STOCS 0017G 01 04 00 00035                0 0 1 16 1 0 0                   03001A
0237 STOCS 0017G 01 .02                         .706       3 2 3 1 0.5 NL 4 1 05001A
0237 STOCS 0017G 01 5317020107 0001 00.0047            2    0 0                10001A
0237 STOCS 0017G 01 5317210208 0002 0.00117            2    0 0                10002A
0237 STOCS 0017G 01 4802120407 0005                          0 0                10003A
0237 STOCS 0017G 01 4808010103 0006                          0 0                10004A
0237 STOCS 0017G 01 4806020103 0001                          0 0                10005A
0237 STOCS 0017G 01 4806030105 0001                          0 0                10006A
0237 STOCS 0017G 01 4805021401 0001                          0 0                10007A
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0237 STOCS 0017G 01 4802130204 0001                          0 0                10009A
0237 STOCS 0017G 01 4803051190 0003                          0 0                10010A
0237 STOCS 0017G 01 6803200102 0001                          0 0                10011A
0237 STOCS 0017G 01 4001010101 0001                          0 0                10012A
0237 STOCS 0017G 01 4803030301 0001                          0 0                10013A
0238 STOCS 0018G 01 0301074 01805 275946N 0960247W C 05          00 0 002 01001A
0238 STOCS 0018G 01 04 01 00054                0 0 1 18 1 0 0                   03001A
0238 STOCS 0018G 01 .02                         1.74       3 2 3 1 0.5 NL 4 1 05001A
0238 STOCS 0018G 01 5317020106 0001 00.0047            2    0 0                10001A
0238 STOCS 0018G 01 5317020108 0001 000.005            2    0 0                10002A
0238 STOCS 0018G 01 5315020102 0001 0.00152            2    0 0                10003A
0238 STOCS 0018G 01 5317020109 0001 000.005            2    0 0                10004A
0238 STOCS 0018G 01 5317020107 0002 00.0016            2    0 0                10005A
0238 STOCS 0018G 01 5319620204 0001 000.032            1    0 0                10006A
0238 STOCS 0018G 01 4803020402 0001                          0 0                10007A
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0238 STOCS 0018G 01 4808010103 0002                          0 0                10010A
0238 STOCS 0018G 01 4806030201 0001                          0 0                10011A
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0238 STOCS 0018G 01 4805021390 0001                          0 0                10014A
0238 STOCS 0018G 01 4001010101 0002                          0 0                10015A
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0239 STOCS 0020G 01 0301074 02210 280006N 0961437W C 05          00 0 002 01001A
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0239 STOCS 0020G 01 4802130204 0004                        0 0              10001A
0239 STOCS 0020G 01 4802120407 0001                        0 0              10002A
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0239 STOCS 0020G 01 4805021501 0003                        0 0              10004A
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0239 STOCS 0020G 01 4808010103 0002                        0 0              10006A
0239 STOCS 0020G 01 4803051190 0005                        0 0              10007A
0239 STOCS 0020G 01 4001010101 0001                        0 0              10008A
0240 STOCS 0022G 01 0301074 02212 280016N 0962622W C 05          00 0 002 01001A
0240 STOCS 0022G 01 04 00 00027              0 0 1 14 1 0 0                03001A
0240 STOCS 0022G 01 .02                       1.70       3 2 3 1 0.5 NL 4 1 05001A
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0241 STOCS 0023G 01 04 00 00024              0 0 1 16 1 0 0                03001A
0241 STOCS 0023G 01 .02                       .274       3 2 3 1 0.5 NL 4 1 05001A
0241 STOCS 0023G 01 5317020106 0008 00.0016            2   0 0              10001A
0241 STOCS 0023G 01 5314020203 0001 0.00015            2   0 0              10002A
0242 STOCS 0025G 01 0301074 00314 280029N 0963810W C 05          00 0 002 01001A
0242 STOCS 0025G 01 04 00 00021              0 0 1 16 1 0 0                03001A
0242 STOCS 0025G 01 .02                       1.37       3 2 3 1 0.5 NL 4 1 05001A
0242 STOCS 0025G 01 5314020203 0001 0.00015            2   0 0              10001A
0242 STOCS 0025G 01 5317020106 0005 00.0016            2   0 0              10002A
0242 STOCS 0025G 01 5317020108 0001 000.005            2   0 0              10003A
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0242 STOCS 0025G 01 4806030105 0005                        0 0              10006A
0242 STOCS 0025G 01 4802120407 0008                        0 0              10007A
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0243 STOCS 0026G 01 04 00 00015              0 0 1 16 1 0 0                    03001A
0243 STOCS 0026G 01 .02                        2.36       3 2 3 1 0.5 NL 4 1 05001A
0243 STOCS 0026G 01 5317020106 0012 00.0016            2   0 0                10001A
0243 STOCS 0026G 01 5317020107 0006 00.0047            2   0 0                10002A
0243 STOCS 0026G 01 5317020109 0005 000.005            2   0 0                10003A
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0243 STOCS 0028G 01 04 00 00025              0 0 1 14 1 0 0                    03001A
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0243 STOCS 0028G 01 5317020108 0001 00 .005            2   0 0                10002A
0243 STOCS 0028G 01 5317020107 0006 00.0047            2   0 0                10003A
0244 STOCS 0029G 01 0311074 00643 275515N 0963521W C 05          00 0 002 01001A
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0244 STOCS 0029G 01 .02                                  3 2 3 1 0.5 NL 4 1 05001A
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0244 STOCS 0029G 01 4001010101 0001                        0 0              10010A
0244 STOCS 0029G 01 4806030105 0003                        0 0              10011A
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0245 STOCS 0031G 01 04 00 00036              0 0 1 14 1 0 0                 03001A
0245 STOCS 0031G 01 .02                       0.54      3 2 3 1 0.5 NL 4 1 05001A
0245 STOCS 0031G 01 4805021501 0001                        0 0              10001A
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0245 STOCS 0031G 01 4810010790 0001                        0 0              10006A
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0246 STOCS 0033G 01 04 01 00052              0 0 1 14 1 0 0                 03001A
0246 STOCS 0033G 01 .02                       .426      3 2 3 1 0.5 NL 4 1 05001A
0246 STOCS 0033G 01 5317020109 0033 000.005            2   0 0              10001A
0246 STOCS 0033G 01 5314020203 0005 0.00015            2   0 0              10002A
0246 STOCS 0033G 01 6803200102 0001                        0 0              10003A
0246 STOCS 0033G 01 4805030190 0001                        0 0              10004A
0246 STOCS 0033G 01 4802120407 0002                        0 0              10005A
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0247 STOCS 0035G 01 0311074 01345 275448N 0960857W C 05          00 0 002 01001A
0247 STOCS 0035G 01 04 01 00054              0 0 1 16 1 0 0                 03001A
0247 STOCS 0035G 01 .02                       .805      3 2 3 1 0.5 NL 4 1 05001A
0247 STOCS 0035G 01 6803200102 0001 00.0378            2 1 0 0              10001A
0247 STOCS 0035G 01 5317020109 0002 000.005            2   0 0              10002A
0247 STOCS 0035G 01 4802130204 0002                        0 0              10003A
0247 STOCS 0035G 01 4806010101 0002                        0 0              10004A
0247 STOCS 0035G 01 4805021501 0003                        0 0              10005A
0247 STOCS 0035G 01 4805021301 0001                        0 0              10006A
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0247 STOCS 0035G 01 4810010790 0002                          0 0                10010A
0248 STOCS 0037G 01 0311074 01815 274924N 0960604W C 05            00 0 002 01001A
0248 STOCS 0037G 01 04 01 00060              0 0 1 16 1 0 0                   03001A
0248 STOCS 0037G 01 .02                       9517       3 2 3 1 0.5 NL 4 1 05001A
0248 STOCS 0037G 01                                                           09001A
0248 STOCS 0037G 01 6803200102 0001                          0 0                10001A
0248 STOCS 0037G 01 4806010204 0001                          0 0                10002A
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0249 STOCS 0039G 01 04 01 00066              0 0 1 14 1 0 0                   03001A
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0249 STOCS 0039G 01 5317020109 0001 000.005            2   0 0                10001A
0249 STOCS 0039G 01 6803200102 0001                          0 0                10002A
0249 STOCS 0039G 01 4805021501 0001                          0 0                10003A
0249 STOCS 0039G 01 4802140106 0001                          0 0                10004A
0249 STOCS 0039G 01 4802130204 0001                          0 0                10005A
0250 STOCS 0041G 01 0311074 02334 274956N 0962936W C 05            00 0 002 01001A
0250 STOCS 0041G 01 04 00 00040              0 0 1 23 1 0 0                   03001A
0250 STOCS 0041G 01 .02                        .375       3 2 3 1 0.5 NL 4 1 05001A
0250 STOCS 0041G 01 4802130204 0001                          0 0                10001A
0250 STOCS 0041G 01 4805021501 0001                          0 0                10002A
0250 STOCS 0041G 01 4805021390 0001                          0 0                10003A
0250 STOCS 0041G 01 4810010203 0001                          0 0                10004A
0250 STOCS 0041G 01 4808010103 0003                          0 0                10005A
0250 STOCS 0041G 01 4802120407 0002                          0 0                10006A
0250 STOCS 0041G 01 4001010101 0003                          0 0                10007A
```

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0251 STOCS 0043G 01 0311074 00132 275023N 0964107W C 05          00 0 002 01001A
0251 STOCS 0043G 01 04 00 00027              0 0 1 16 1 0 0                 03001A
0251 STOCS 0043G 01 .02                       .677      3 2 3 1 0.5 NL 4 1 05001A
0251 STOCS 0043G 01 5317020107 0003 00.0047            2   0 0             10001A
0251 STOCS 0043G 01 4812010101 0001                        0 0             10003A
0251 STOCS 0043G 01 4806030105 0001                        0 0             10005A
0251 STOCS 0043G 01 4803030301 0001                        0 0             10007A
0251 STOCS 0043G 01 4802100690 0001                        0 0             10010A
0251 STOCS 0043G 01 4808010103 0001                        0 0             10011A
0251 STOCS 0043G 01 4805021501 0028                        0 0             10012A
0251 STOCS 0043G 01 4805021401 0001                        0 0             10013A
0251 STOCS 0043G 01 4001010101 0003                        0 0             10014A
0251 STOCS 0043G 01 4810010203 0001                        0 0             10015A
0252 STOCS 0044G 01 0311074 00219 275003N 0964717W C 05          00 0 002 01001A
0252 STOCS 0044G 01 04 00 00022              0 0 1 16 1 0 0                 03001A
0252 STOCS 0044G 01 .02                       .248      3 2 3 1 0.5 NL 4 1 05001A
0252 STOCS 0044G 01 5317020106 0001 00.0016            2   0 0             10001A
0252 STOCS 0044G 01 5317020107 0005 00.0047            2   0 0             10002A
0252 STOCS 0044G 01 5317020108 0001 000.005            2   0 0             10003A
0252 STOCS 0044G 01 5317020109 0004 000.005            2   0 0             10004A
0252 STOCS 0044G 01 4802120407 0009                        0 0             10005A
0252 STOCS 0044G 01 4808010103 0003                        0 0             10006A
0251 STOCS 0043G 01 4800000004 0002                        0 0             10016A
0252 STOCS 0044G 01 4805021501 0006                        0 0             10007A
0252 STOCS 0044G 01 4802130204 0002                        0 0             10008A
0252 STOCS 0044G 01 4802030103 0001                        0 0             10009A
0252 STOCS 0044G 01 4810010203 0001                        0 0             10010A
0252 STOCS 0044G 01 4001010101 0005                        0 0             10011A
0253 STOCS 0046G 01 0011174 00932 274506N 0965310W C 05          00 0 002 01001A
0253 STOCS 0046G 01 04 00 00023              0 0 1 16 1 0 0                 03001A
0253 STOCS 0046G 01 .02                       .339      3 2 3 1 0.5 NL 4 1 05001A
0253 STOCS 0046G 01 5317020107 0016 00.0047            2   0 0             10001A
0253 STOCS 0046G 01 5317020109 0006 000.005            2   0 0             10002A
0253 STOCS 0046G 01 4803020402 0001                        0 0             10003A
0253 STOCS 0046G 01 4802120407 0002                        0 0             10004A
0253 STOCS 0046G 01 4805021501 0005                        0 0             10006A
0253 STOCS 0046G 01 4805021401 0001                        0 0             10007A
0253 STOCS 0046G 01 4802100301 0002                        0 0             10008A
0253 STOCS 0046G 01 4804010101 0002                        0 0             10009A
0254 STOCS 0047G 01 0011174 01000 274504N 0964718W C 05          00 0 002 01001A
0254 STOCS 0047G 01 04 00 00023              0 0 1 14 1 0 0                 03001A
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0254 STOCS 0047G 01 .02                          .667       3 2 3 1 0.5 NL 4 1 05001A
0254 STOCS 0047G 01                                                           06001A
0254 STOCS 0047G 01                                                           09001A
0254 STOCS 0047G 01 5317020108 0004 000.005            2   0 0               10001A
0254 STOCS 0047G 01 5317020107 0008 00.0047            2   0 0               10002A
0254 STOCS 0047G 01 5315020102 0001 00.0152            2   0 0               10003A
0254 STOCS 0047G 01 5314020203 0006 0.00015            2   0 0               10004A
0254 STOCS 0047G 01 5319610201 0001 00.0975            2   0 0               10005A
0254 STOCS 0047G 01 5317340001 0001                    2   0 0               10006A
0254 STOCS 0047G 01 4810010203 0001                        0 0               10007A
0254 STOCS 0047G 01 4802120407 0003                        0 0               10008A
0254 STOCS 0047G 01 4802130204 0014                        0 0               10009A
0254 STOCS 0047G 01 4805021501 0049                        0 0               10010A
0254 STOCS 0047G 01 4805021401 0002                        0 0               10011A
0254 STOCS 0047G 01 4803020402 0009                        0 0               10012A
0254 STOCS 0047G 01 4806010204 0001                        0 0               10013A
0254 STOCS 0047G 01 4802100301 0001                        0 0               10014A
0254 STOCS 0047G 01 4001010101 0002                        0 0               10015A
0255 STOCS 0050G 01 0011174 02130 274452N 0963531W C 05          00 0 002 01001A
0255 STOCS 0050G 01 04 00 00042                0 0 1 14 1 0 0                 03001A
0255 STOCS 0050G 01 .02                          .224       3 2 3 1 0.5 NL 4 1 05001A
0255 STOCS 0050G 01 5315020102 0016 0.00152            2   0 0               10001A
0255 STOCS 0050G 01 6803200102 0001                        0 0               10002A
0255 STOCS 0050G 01 4802130204 0001                        0 0               10003A
0255 STOCS 0050G 01 4802120407 0001                        0 0               10004A
0255 STOCS 0050G 01 4805021501 0009                        0 0               10005A
0255 STOCS 0050G 01 4806030201 0002                        0 0               10006A
0255 STOCS 0050G 01 4001010101 0001                        0 0               10007A
0256 STOCS 0057G 01 0011174 00250 096002N          W C 05          00 0 002 01001A
0256 STOCS 0057G 01 04 01 00092                0 0 1 16 1 0 0                 03001A
0256 STOCS 0057G 01 002                                  3 2 3 1 005 NL 4 1 05001A
0256 STOCS 0057G 01 5319610501 0001                    2   0 0               10001A
0257 STOCS 0053G 01 0011174 02350 274445N 0962351W C 05          00 0 002 01001A
0257 STOCS 0053G 01 04 01 00061                0 0 1 14 1 0 0                 03001A
0257 STOCS 0053G 01 .02                          .024       3 2 3 1 0.5 NL 4 1 05001A
0257 STOCS 0053G 01 5317420001 0001 0.00017            2   0 0               10001A
0257 STOCS 0053G 01 5315020102 0001 0.00152            2   0 0               10002A
0257 STOCS 0053G 01 4802130204 0001                        0 0               10003A
0257 STOCS 0053G 01 4805021501 0001                        0 0               10004A
0257 STOCS 0053G 01 4808010103 0003                        0 0               10005A
0258 STOCS 0055G 01 0011174 00129 274435N 0961203W C 05          00 0 002 01001A
0258 STOCS 0055G 01 04 01 00082                0 0 1 16 1 0 0                 03001A
0258 STOCS 0055G 01 .02                          .044       3 2 3 1 0.5 NL 4 1 05001A
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0258 STOCS 0055G 01 4805021501 0002                          0 0                10001A
0258 STOCS 0055G 01 4802130204 0001                          0 0                10002A
0258 STOCS 0055G 01 4808010103 0003                          0 0                10003A
0258 STOCS 0055G 01 4802140106 0001                          0 0                10004A
0258 STOCS 0055G 01 4803050101 0001                          0 0                10005A
0258 STOCS 0055G 01 4811010101 0001                          0 0                10006A
0259 STOCS 0056G 01 0011174 00208 274430N 0960603W C 05            00 0 002 01001A
0259 STOCS 0056G 01 04 01 00091              0 0 1 16 1 0 0                    03001A
0259 STOCS 0056G 01 4808010103 0003                          0 0                10001A
0259 STOCS 0056G 01 4806020103 0001                          0 0                10002A
0259 STOCS 0056G 01 6803200102 0001                          0 0                10003A
0260 STOCS 0058G 01 0011174 00430 273904N 0960028W C 05            00 1 002 01001A
0260 STOCS 0058G 01 05 02 00125              0 0 1 14 1 0 0                    03001A
0260 STOCS 0058G 01 .02                       .064       3 2 3 1 0.5 NL 4 1 05001A
0260 STOCS 0058G 01 5317420001 0001 0.00017            2   0 0                10001A
0260 STOCS 0058G 01 4810010203 0001                          0 0                10002A
0260 STOCS 0058G 01 4802130204 0001                          0 0                10003A
0260 STOCS 0058G 01 4802180101 0001                          0 0                10004A
0260 STOCS 0058G 01 4001010103 0001                          0 0                10005A
0261 STOCS 0059G 01 0021174 02205 273912N 0960261W C 05            00 0 002 01001A
0261 STOCS 0059G 01 04 02 00115              0 0 1 14 1 0 0                    03001A
0261 STOCS 0059G 01 .02                                    3 2 3 1 0.5 NL 4 1 05001A
0262 STOCS 0257G 01 0071274 01028 260512N 0962860W C 05            00 0 002 01001A
0262 STOCS 0257G 01 04 01 00065              0 0 1 14 1 0 0                    03001A
0262 STOCS 0257G 01 .02                                    3 2 3 1 0.5 NL 4 1 05001A
0262 STOCS 0257G 01                                                            06001A
0262 STOCS 0257G 01 5319610501 0001                    2   0 0                10001A
```

EXPLANATION FOR APPENDIX 11:

Listing of Number of Individuals by Species at Each Infaunal Station

D1 - *Ampelisca* cf. *cucullata*

D2 - *Nereis* sp.

D3 - *Paraprionospio pinnata*

D4 - unidentified nemertean

D5 - *Magelona* sp.

D6 - *Nephtys picta*

D7 - *Cossura delta*

D8 - unidentified ophiurid

D9 - *Chasmocarcinus mississippiensis*

D10 - *Ninoe nigripes*

D11 - unidentified paraonid

D12 - *Onuphis* sp.

D13 - *Speocarcinus* sp.

D14 - *Lumbrineris* sp.

D15 - unidentified maldanid

D16 - *Ampelisca cristoides*

D17 - *Nuculana concentrica*

D18 - *Sigambra tentaculata*

D19 - *Armandia agilis*

D20 - *Corbula* sp.

D21 - *Pinnixa retinens*

D22 - *Eudorella monodon*

D23 - *Ampelisca* cf. *cristata*

D24 - *Notomastus latericeus*

D25 - *Sthenelais* sp.

D26 - *Diopatra cuprea*

D27 - unidentified cirratulid

D28 - *Leptognatha gracilis*

D29 - *Diplodonta* sp.

D30 - *Nuculana acuta*

D31 - *Glycera* sp.

D32 - unidentified gastropod

D33 - unidentified sipunculid

D34 - unidentified spionid

D35 - *Armandia maculata*

Columns represent sampling station numbers.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
D 1	-	8	-	-	-	-	-	-	33	-	-	-	-	4
D 2	-	2	-	10	2	-	3	4	1	8	-	-	1	2
D 3	-	3	-	14	3	-	40	-	18	10	21	18	19	31
D 4	-	2	-	1	1	-	-	3	2	1	1	1	1	1
D 5	-	-	-	3	1	-	-	-	2	6	3	1	4	1
D 6	-	-	-	-	7	-	16	-	2	-	4	14	14	5
D 7	-	-	-	-	-	-	-	-	-	-	3	1	1	1
D 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D 9	-	1	-	-	1	-	-	-	-	1	-	-	-	-
D10	-	2	-	-	-	-	-	-	1	8	-	1	1	-
D11	-	1	-	1	-	-	-	-	-	-	1	-	-	-
D12	-	1	-	1	2	-	-	1	-	-	-	1	-	-
D13	-	-	-	2	1	-	-	-	-	-	-	-	-	2
D14	-	-	-	3	-	-	6	3	-	1	2	3	2	1
D15	-	-	-	5	1	-	-	-	-	1	1	-	-	-
D16	-	-	3	-	1	-	-	6	-	7	12	12	7	6
D17	-	-	-	-	1	-	-	-	-	1	-	-	-	-
D18	-	-	-	-	1	-	-	-	-	-	-	-	2	-
D19	-	-	-	-	1	-	-	-	-	-	-	2	-	6
D20	-	-	-	-	-	-	-	-	-	2	-	2	-	1
D21	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D22	-	-	-	-	-	-	-	-	-	-	-	-	-	1
D23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D24	-	-	-	-	-	-	1	-	2	-	-	-	-	1
D25	-	-	-	-	-	-	1	-	-	-	-	-	1	1
D26	-	-	-	-	-	-	1	1	-	-	1	-	-	1
D27	-	-	-	-	-	-	1	-	-	-	-	-	-	-
D28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D31	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D34	-	-	-	-	-	-	7	2	-	-	2	-	-	-
D35	-	-	-	-	-	-	4	-	-	-	-	-	-	-

	15	16	17	18	19	20	21	22	23	24	25	26
D 1	-	-	1	2	3	-	2	-	-	8	-	6
D 2	2	3	5	-	6	1	1	-	-	-	8	6
D 3	29	16	-	10	5	3	17	7	-	10	10	2
D 4	2	1	1	2	2	1	2	1	-	1	1	6
D 5	3	3	6	2	3	2	4	2	-	1	4	9
D 6	4	1	1	-	-	4	7	3	-	-	2	2
D 7	-	1	-	-	-	-	-	-	-	-	-	1
D 8	-	1	1	1	1	-	-	-	-	-	-	-
D 9	2	-	-	-	1	-	-	-	-	-	-	1
D10	1	-	-	1	-	1	2	2	-	1	-	2
D11	-	-	1	-	-	-	-	-	-	-	-	-
D12	-	-	-	-	-	-	1	-	-	1	2	2
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	-	-	1	-	-	-	-	-	-	-	5	5
D15	-	-	3	-	8	5	-	13	-	-	-	3
D16	-	-	-	1	-	-	3	-	8	6	5	12
D17	-	-	-	-	-	-	-	-	-	-	-	-
D18	-	-	-	-	-	-	-	-	-	4	-	-
D19	-	-	-	-	-	-	1	-	-	1	-	-
D20	-	-	-	-	2	-	-	-	-	-	-	-
D21	-	1	-	1	-	-	-	-	-	-	-	-
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D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	-	-	-	-	-	-	-	-	-	-	-
D34	2	-	-	1	-	-	1	-	-	-	1	1
D35	1	-	-	1	-	-	-	-	-	-	-	-

	27	28	29	30	31	32	33	34	35	36	37	38
D 1	37	6	2	13	-	3	-	1	-	1	-	-
D 2	3	-	2	-	3	3	2	1	-	-	1	-
D 3	9	1	27	7	1	1	-	2	3	3	2	-
D 4	-	-	1	-	-	2	-	2	-	1	1	-
D 5	-	-	1	-	2	1	-	1	3	1	3	1
D 6	1	-	8	10	-	1	3	2	2	-	1	1
D 7	-	-	2	-	-	-	-	-	-	-	-	-
D 8	-	-	-	-	-	-	1	1	1	1	1	1
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	1	1	-	1	-	-	1	-	-
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D16	-	17	-	8	-	1	-	1	-	2	-	-
D17	-	-	-	-	-	-	-	-	-	-	-	-
D18	-	-	1	1	-	-	-	-	-	-	-	-
D19	4	-	-	-	-	2	-	1	-	-	-	-
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D21	-	-	-	-	-	-	-	-	-	-	-	-
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D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	1	3	1	-	-	-	-	-	-	-

	39	40	41	42	43	44	45	46	47	48	49	50
D 1	-	-	-	-	3	5	45	16	8	1	-	-
D 2	-	-	2	3	-	9	12	2	3	-	-	1
D 3	1	-	1	14	28	6	8	5	49	16	-	9
D 4	-	-	3	1	3	5	-	-	2	1	-	1
D 5	-	2	3	2	1	3	13	-	-	-	-	-
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D 8	1	-	-	-	-	-	-	-	-	1	-	1
D 9	-	-	-	1	-	-	-	-	-	1	-	-
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D33	-	-	-	-	-	-	-	-	-	-	-	-
D34	-	-	1	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	1	-	-	1	9	-	-	-

	51	52	53	54	55	56	57	58	59	60	61	62
D 1	1	-	-	2	-	-	-	-	-	2	1	-
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D 3	-	-	1	-	2	-	-	-	-	2	-	-
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D 7	-	-	-	-	-	-	-	1	-	-	-	1
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D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-	-	-	-	-
D11	-	-	-	-	-	-	-	-	-	-	-	-
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D19	1	-	-	-	-	-	-	-	-	-	-	-
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D21	-	-	-	-	-	-	-	-	-	-	-	-
D22	-	-	-	-	-	-	-	-	-	-	-	-
D23	-	-	-	-	-	-	-	-	-	-	-	-
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D25	-	-	-	-	-	-	-	-	-	-	-	-
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D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	-	-	-	-	-	-	1	-	-	-	-
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	63	64	65	66	67	68	69	70	71	72	73	74
D 1	-	-	1	-	-	2	31	-	55	53	-	2
D 2	-	-	-	1	2	5	2	4	3	1	-	1
D 3	1	-	3	2	13	16	6	1	5	10	28	1
D 4	-	2	3	1	3	1	6	1	2	3	7	2
D 5	1	-	1	4	1	4	4	-	1	1	-	2
D 6	2	3	4	4	7	11	5	1	-	2	8	5
D 7	-	-	-	1	1	1	-	1	-	1	1	1
D 8	-	-	1	-	-	-	-	-	-	-	-	-
D 9	1	-	-	-	-	-	-	-	-	-	-	-
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	75	76	77	78	79	80	81	82	83	84	85	86
D 1	-	-	-	-	-	-	-	-	-	1	3	3
D 2	-	2	-	-	-	-	-	-	-	1	-	-
D 3	-	5	6	-	-	-	-	-	1	1	-	-
D 4	1	1	1	1	-	-	-	-	1	1	3	-
D 5	1	-	5	-	-	-	-	-	-	-	-	-
D 6	-	4	3	3	-	-	-	-	-	-	-	1
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D 8	-	-	-	4	-	-	-	-	-	-	-	-
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	87	88	89	90	91	92	93	94	95	96	97	98
D 1	2	-	-	-	1	-	-	-	-	-	1	-
D 2	-	-	-	-	-	-	-	-	-	-	1	-
D 3	-	-	-	-	-	-	-	-	3	2	4	4
D 4	-	-	1	5	2	1	-	-	1	-	-	1
D 5	-	-	-	5	-	-	-	1	1	3	2	-
D 6	-	-	-	2	1	-	-	-	-	2	1	3
D 7	-	-	-	-	-	1	-	-	-	-	-	-
D 8	-	-	-	-	-	-	-	-	-	1	1	-
D 9	-	-	1	-	-	-	-	1	-	1	-	-
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D35	-	-	-	-	-	-	-	-	-	-	-	-

	99	100	101	102	103	104	105	106	107	108	109	110
D 1	1	7	115	63	-	-	-	-	-	-	-	-
D 2	-	-	3	-	-	-	-	-	-	-	-	1
D 3	3	7	4	3	3	2	1	1	-	-	-	-
D 4	-	4	5	6	3	5	2	-	-	-	-	-
D 5	1	-	-	-	1	3	2	1	1	-	-	-
D 6	2	-	4	1	5	-	-	2	2	-	-	-
D 7	1	2	-	1	-	1	1	-	1	-	-	-
D 8	-	2	1	-	-	-	-	-	-	-	-	-
D 9	-	2	-	-	-	1	1	-	-	-	-	-
D10	-	-	2	1	-	-	2	-	-	-	-	-
D11	-	-	-	-	-	-	-	-	-	-	-	-
D12	-	-	-	-	-	-	-	-	-	-	-	-
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D32	-	-	-	-	-	2	-	-	-	-	-	-
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	111	112	113	114	115	116	117	118	119	120	121	122
D 1	-	-	-	-	2	-	-	-	-	-	-	-
D 2	-	-	-	-	-	-	-	-	-	-	-	-
D 3	-	-	-	5	-	-	1	1	-	-	-	2
D 4	-	-	-	-	-	-	-	-	-	1	-	2
D 5	-	-	-	-	-	-	-	-	-	1	-	1
D 6	1	-	-	3	1	-	1	-	-	-	-	2
D 7	-	-	-	-	1	-	1	-	-	-	1	1
D 8	2	-	-	-	-	-	-	-	-	-	1	1
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-	-	-	-	-
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D12	-	-	-	3	1	-	-	-	-	-	-	-
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	1	-	-	3	-	-	-	-	1	-	-	-
D15	-	-	-	-	-	-	2	-	-	-	-	-
D16	-	1	1	-	-	-	-	-	-	-	-	-
D17	-	-	-	-	1	-	-	-	-	-	-	-
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D19	-	-	-	-	-	-	-	-	-	-	-	-
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D22	-	-	-	-	-	-	-	-	-	-	-	1
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	123	124	125	126	127	128	129	130	131	132	133	134
D 1	-	15	43	-	110	-	2	-	15	-	-	1
D 2	-	-	8	-	-	-	-	-	-	-	-	-
D 3	-	-	16	-	2	2	5	-	1	-	-	1
D 4	-	1	1	-	6	1	1	-	-	-	-	-
D 5	-	1	-	-	2	1	5	-	2	1	-	-
D 6	-	1	-	-	2	2	-	-	1	-	-	-
D 7	-	1	1	-	-	-	1	-	-	-	-	-
D 8	-	-	-	-	1	1	1	-	-	1	-	-
D 9	-	-	-	-	-	-	-	-	-	-	-	-
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D35	-	-	-	-	-	-	-	-	-	-	-	-

	135	136	137	138	139	140	141	142	143	144	145	146
D 1	-	-	-	-	-	-	-	-	-	-	1	21
D 2	-	-	-	-	-	-	-	-	-	1	-	1
D 3	-	-	-	-	-	-	-	-	3	5	-	-
D 4	-	-	-	-	2	-	-	-	1	6	3	1
D 5	-	-	-	-	-	-	3		2	1	-	1
D 6	-	1	-	-	1	-	-	-	4	2	2	-
D 7	-	-	-	1	-	1	2	-	1	-	-	1
D 8	-	-	1	-	-	-	-	-	-	1	-	1
D 9	-	-	-	-	-	-	-	-	-	-	-	-
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D17	-	-	-	-	-	-	-	-	-	-	-	-
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D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	-	1	2	-	-	-	-	-	1	-	-
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D35	-	-	-	-	-	-	-	-	-	-	-	-

	147	148	149	150	151	152	153	154	155	156	157	158
D 1	-	-	-	-	-	-	-	-	-	-	-	-
D 2	-	-	-	-	-	-	-	-	-	-	-	-
D 3	-	1	2	-	-	1	-	-	-	-	-	-
D 4	6	-	1	-	-	-	1	1	-	1	1	-
D 5	4	2	2	1	1	-	-	-	-	-	-	-
D 6	2	2	3	-	-	-	1	-	1	1	-	-
D 7	1	1	-	1	-	-	-	-	-	-	-	-
D 8	1	-	-	-	-	-	1	-	1	-	-	-
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	1	-	-	-	-	1	-	-	-	-
D11	1	-	3	-	-	-	1	-	-	-	1	-
D12	-	-	-	-	-	-	-	-	-	-	-	-
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	-	-	-	-	-	-	2	-	-	-	-	-
D15	-	-	-	-	-	-	-	-	-	-	-	-
D16	-	-	-	-	-	-	-	-	-	-	-	-
D17	-	-	-	-	-	-	-	-	-	-	-	-
D18	1	-	-	-	-	-	-	-	-	-	-	-
D19	-	-	-	-	-	-	-	-	-	-	-	-
D20	-	1	1	-	1	-	-	-	-	-	-	-
D21	-	-	-	-	-	-	-	-	-	-	-	-
D22	3	-	1	-	-	-	-	-	-	-	-	-
D23	-	-	-	-	-	-	-	-	-	-	-	-
D24	4	-	-	-	-	-	-	-	-	-	-	-
D25	-	-	-	-	-	-	-	-	-	1	-	-
D26	-	-	-	-	-	-	-	-	-	-	-	-
D27	-	-	-	-	-	-	-	1	-	1	-	-
D28	1	-	-	-	-	-	-	-	-	-	-	-
D29	-	-	-	-	-	-	-	-	4	1	-	-
D30	-	-	-	-	-	-	-	-	-	-	-	-
D31	-	-	-	-	1	-	1	-	-	-	1	-
D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	-	-	-	-	-	-	-	3	-	-	-
D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	159	160	161	162	163	164	165	166	167	168	169	170
D 1	-	-	-	-	-	-	70	32	-	-	-	-
D 2	-	-	-	-	1	-	-	-	-	1	1	-
D 3	3	-	-	-	1	-	2	1	-	-	-	-
D 4	-	-	-	-	1	1	2	6	2	-	-	-
D 5	-	-	-	-	-	-	2	-	-	4	1	5
D 6	2	1	-	-	-	-	5	3	2	1	-	-
D 7	1	-	-	1	-	-	1	-	-	-	-	1
D 8	1	1	-	-	1	-	-	1	-	1	-	1
D 9	-	-	-	-	-	-	-	1	-	-	-	-
D10	-	-	-	-	1	-	-	2	-	1	-	-
D11	-	2	-	-	-	1	-	-	-	-	1	-
D12	-	-	-	-	-	-	-	-	-	-	-	-
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D21	-	-	-	-	-	-	-	-	-	1	-	-
D22	-	-	-	-	-	-	2	1	-	-	-	-
D23	-	-	-	-	-	-	-	-	-	-	-	-
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D31	-	-	-	-	-	-	-	-	-	-	-	-
D32	-	-	-	-	-	-	-	-	-	-	1	-
D33	-	-	-	-	-	1	-	-	-	-	-	-
D34	-	-	-	-	-	-	-	-	-	-	-	1
D35	-	-	-	-	-	-	-	-	-	-	-	-

	171	172	173	174	175	176	177	178	179	180	181	182
D 1	-	-	-	-	-	1	-	-	-	-	-	-
D 2	-	-	-	-	-	-	-	-	-	-	-	-
D 3	1	-	-	-	-	-	-	-	-	-	-	-
D 4	-	-	-	-	-	1	-	-	-	-	1	3
D 5	1	-	1	-	-	-	-	-	-	-	-	1
D 6	2	-	-	-	-	1	-	-	1	-	1	-
D 7	1	-	1	-	-	-	-	-	1	-	1	-
D 8	-	-	1	-	-	-	-	1	-	1	1	1
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-	-	-	-	-
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D12	-	-	-	-	-	-	-	-	-	-	-	1
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D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	2	-	-	-	-	2	1	-	-	-	-	-
D34	-	-	-	-	-	-	1	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	183	184	185	186	187	188	189	190	191	192	193	194
D 1	1	-	-	-	-	-	-	-	-	-	-	-
D 2	1	-	-	112	-	-	1	-	11	-	-	-
D 3	3	-	12	146	-	6	-	-	-	-	1	1
D 4	-	1	6	11	2	2	-	-	11	1	1	-
D 5	-	-	9	90	1	-	1	-	-	-	-	-
D 6	5	-	9	-	1	1	-	1	56	-	-	-
D 7	-	-	-	11	-	-	1	1	-	-	2	-
D 8	1	-	-	-	1	1	-	2	-	2	-	-
D 9	-	-	-	-	-	-	-	-	-	1	-	-
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D11	-	-	-	45	-	-	-	-	-	-	-	-
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D32	-	-	-	-	-	-	-	-	-	-	-	-
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	195	196	197	198	199	200	201	202	203	204	205	206
D 1	-	-	-	-	-	-	-	-	-	-	-	1
D 2	-	-	-	-	3	-	-	317	84	-	-	-
D 3	-	2	-	-	1	-	-	63	-	-	1	1
D 4	-	-	-	-	2	3	-	84	12	1	1	1
D 5	-	-	-	-	-	-	2	-	12	-	1	-
D 6	-	2	-	-	3	1	-	21	12	2	-	4
D 7	-	-	-	-	1	-	-	148	-	-	-	-
D 8	-	-	-	-	-	1	-	-	-	-	-	-
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	1	-	-	-	1	1	-
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D16	-	-	-	-	-	-	-	21	48	-	-	-
D17	-	-	-	-	-	-	-	2	2	-	-	-
D18	-	-	-	-	1	-	-	42	-	-	-	-
D19	-	-	-	-	-	-	-	21	-	-	-	-
D20	-	-	-	-	2	-	1	-	5	-	-	1
D21	-	-	-	-	-	-	-	-	-	-	-	-
D22	-	-	-	-	-	-	-	-	-	-	-	-
D23	-	-	-	-	-	-	-	-	-	-	-	-
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D25	-	-	-	-	-	-	-	21	-	-	-	-
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D29	-	-	-	-	-	-	-	-	-	-	-	-
D30	-	-	-	-	-	-	-	3	3	-	-	-
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D32	-	-	-	-	-	1	-	-	-	-	-	-
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D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	207	208	209	210	211	212	213	214	215	216	217	218
D 1	-	1	1	-	-	-	-	-	-	1	-	-
D 2	-	1	-	-	-	-	-	-	-	-	-	-
D 3	-	3	-	2	2	1	-	-	-	-	-	-
D 4	-	1	-	1	-	-	-	-	-	-	-	-
D 5	-	-	-	-	-	-	-	-	-	-	-	-
D 6	1	1	1	2	1	-	-	-	-	-	1	-
D 7	-	1	1	-	-	-	-	-	-	-	-	-
D 8	-	1	1	-	-	-	-	-	-	1	1	1
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-	-	-	-	-
D11	-	1	-	-	-	-	-	-	-	-	-	1
D12	1	-	-	-	-	-	-	-	-	-	-	-
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	-	-	-	-	-	-	-	-	-	-	-	-
D15	-	-	-	-	1	-	-	-	-	-	-	-
D16	-	-	-	-	-	-	-	-	-	-	-	-
D17	-	1	-	-	-	-	-	-	-	-	-	-
D18	-	-	-	1	-	-	-	-	-	-	-	-
D19	-	-	-	-	-	-	-	-	-	-	-	-
D20	-	2	-	2	-	-	-	-	-	-	-	-
D21	-	-	-	-	-	-	-	-	-	-	-	-
D22	-	1	-	-	-	-	-	-	-	-	-	1
D23	-	-	-	-	-	-	-	-	-	-	-	-
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D25	-	-	-	-	-	-	-	-	-	-	-	-
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D27	-	1	-	-	-	-	-	-	-	-	-	-
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D30	-	11	-	-	-	-	-	-	-	-	-	-
D31	-	2	-	-	-	1	-	-	-	-	-	-
D32	-	-	-	-	-	-	-	-	-	-	-	-
D33	-	3	-	1	-	1	-	-	-	1	-	-
D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	219	220	221	222	223	224	225	226	227	228	229	230
D 1	-	-	-	-	-	1	263	4	-	-	1	-
D 2	-	4	-	-	-	-	342	-	-	-	1	14
D 3	-	1	-	-	1	1	79	-	-	-	2	-
D 4	-	-	1	3	3	5	105	1	-	2	-	14
D 5	-	7	-	1	1	8	237	1	-	3	7	14
D 6	1	1	1	1	3	-	-	-	2	-	-	-
D 7	-	3	-	-	-	1	26	-	-	-	-	-
D 8	-	-	1	-	-	-	-	1	1	1	-	14
D 9	-	-	-	-	-	-	-	-	-	-	-	-
D10	-	-	-	2	-	1	-	-	-	-	1	-
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D12	-	-	-	-	-	3	53	-	-	-	-	14
D13	-	-	-	-	-	-	26	-	-	-	-	-
D14	2	4	2	-	1	1	10	-	-	-	3	-
D15	-	-	-	-	-	-	-	-	-	-	-	-
D16	-	1	-	-	-	-	53	1	-	-	-	-
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D32	-	-	-	-	-	-	-	-	1	-	-	-
D33	-	4	-	-	3	-	53	-	-	-	-	-
D34	-	-	-	1	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	231	232	233	234	235	236	237	238	239	240	241	242
D 1	-	-	-	-	-	1	-	-	-	-	-	-
D 2	1	-	-	-	9	-	-	9	-	-	3	-
D 3	-	-	-	-	-	-	-	9	-	-	3	4
D 4	-	-	-	-	-	-	2	-	-	1	3	4
D 5	1	1	-	-	-	1	5	9	-	1	3	1
D 6	-	-	-	-	9	-	2	-	-	-	8	2
D 7	-	-	-	-	-	1	2	18	-	1	-	-
D 8	-	1	1	-	-	1	-	9	1	1	-	-
D 9	-	-	-	-	-	-	1	-	-	-	-	-
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D18	-	-	-	-	-	-	-	-	1	-	-	-
D19	-	-	-	-	-	-	-	-	-	-	-	-
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D21	-	-	-	-	-	-	-	-	-	-	-	1
D22	-	-	-	-	-	-	-	-	-	-	5	-
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D32	-	-	-	-	-	-	-	-	-	-	-	3
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	243	244	245	246	247	248	249	250	251	252	253	254
D 1	-	12	-	1	1	-	-	-	-	-	-	5
D 2	-	-	7	4	-	-	1	-	-	-	-	-
D 3	1	1	-	2	-	-	-	1	-	-	-	-
D 4	2	2	14	2	-	-	1	1	1	-	-	-
D 5	4	1	7	-	-	-	-	1	-	-	-	-
D 6	1	3	-	3	-	-	-	-	-	-	-	5
D 7	-	1	-	-	-	-	-	-	-	-	-	-
D 8	1	-	7	-	-	-	-	1	1	-	1	5
D 9	-	-	7	-	-	-	-	-	-	-	-	-
D10	-	-	7	-	-	-	-	-	1	-	-	-
D11	-	-	-	1	-	-	-	-	-	-	-	-
D12	-	-	7	1	-	-	-	-	-	-	-	-
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	1	-	7	-	-	-	-	-	-	-	-	-
D15	-	-	-	-	-	-	-	-	-	-	-	-
D16	1	-	7	2	1	-	-	-	-	-	-	-
D17	-	-	-	2	1	-	-	-	-	-	-	-
D18	-	-	-	-	-	-	-	-	-	-	-	-
D19	1	-	-	-	-	-	-	-	-	-	-	24
D20	1	-	-	-	-	2	-	-	-	-	-	5
D21	1	-	-	-	1	-	1	-	1	-	-	5
D22	-	3	-	-	-	1	-	-	-	-	-	5
D23	-	1	-	-	-	-	-	-	-	-	-	-
D24	-	-	-	-	-	-	-	-	-	-	-	-
D25	-	-	-	-	-	-	-	-	-	-	-	5
D26	-	-	7	-	-	-	-	-	-	-	-	5
D27	1	-	-	1	-	-	-	-	-	-	-	-
D28	1	-	-	-	-	-	1	-	-	-	-	-
D29	-	-	-	-	-	-	-	-	-	-	-	-
D30	1	-	7	4	-	-	-	-	-	-	-	-
D31	-	-	-	-	-	-	-	-	-	-	-	-
D32	-	1	-	-	2	5	-	-	-	-	1	-
D33	-	-	-	-	-	-	-	-	-	-	-	-
D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	255	256	257	258	259	260	261	262	263	264	265	266
D 1	-	-	-	-	-	-	-	1	2	-	-	-
D 2	1	1	-	-	10	-	1	-	3	1	18	4
D 3	-	-	-	-	-	1	-	-	2	-	33	22
D 4	18	-	-	1	-	1	-	1	2	-	7	4
D 5	3	-	-	-	-	2	1	2	1	2	4	4
D 6	-	1	-	-	-	-	1	1	1	-	-	15
D 7	1	-	-	-	-	-	-	-	-	-	-	-
D 8	-	1	-	1	20	1	-	-	-	1	4	-
D 9	-	-	-	-	10	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-	1	-	-	-
D11	-	-	-	2	-	-	-	-	-	-	-	4
D12	3	-	-	-	-	-	-	-	1	-	-	-
D13	-	-	-	-	-	-	-	-	-	-	-	-
D14	-	-	-	-	-	-	-	-	2	-	-	4
D15	2	-	-	-	10	-	-	-	1	-	-	-
D16	-	-	-	-	-	-	-	-	-	-	-	30
D17	-	-	-	-	-	-	-	-	-	-	-	-
D18	2	-	-	-	-	-	-	-	-	-	-	-
D19	-	-	-	-	-	-	-	-	-	-	-	-
D20	1	-	-	-	-	-	-	1	-	-	-	-
D21	-	-	-	-	-	-	-	1	1	-	-	-
D22	-	-	-	-	-	-	-	1	-	1	-	-
D23	-	-	-	-	-	-	-	-	2	-	-	-
D24	1	-	-	1	-	-	-	-	-	-	-	-
D25	1	-	-	-	-	-	-	-	-	-	-	-
D26	-	-	-	-	-	-	-	-	-	-	4	-
D27	3	-	-	-	-	-	-	-	1	-	-	-
D28	-	-	-	-	-	-	-	-	-	-	-	-
D29	-	-	-	-	-	-	-	-	-	-	-	-
D30	-	-	-	1	-	-	-	-	-	-	-	-
D31	3	-	-	-	-	-	-	-	4	-	-	4
D32	-	-	-	-	-	1	-	-	-	-	-	-
D33	-	1	-	2	-	-	-	-	6	-	-	-
D34	-	-	-	-	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-	-	-	-	-

	267	268	269	270	271	272	273	274
D 1	-	-	-	-	-	-	-	-
D 2	-	1	22	-	-	-	-	-
D 3	-	-	22	-	-	-	-	-
D 4	-	-	7	1	2	-	-	-
D 5	-	3	29	-	3	-	26	-
D 6	-	-	22	-	-	-	-	-
D 7	-	-	-	-	2	-	-	-
D 8	-	-	-	1	-	1	-	-
D 9	-	-	-	-	-	-	-	-
D10	-	-	-	-	-	-	-	-
D11	-	-	-	-	-	-	-	-
D12	-	-	-	-	-	-	26	-
D13	-	-	-	-	1	-	-	-
D14	-	1	15	-	3	-	-	-
D15	-	-	-	-	-	-	-	-
D16	-	-	-	-	-	-	53	-
D17	-	-	-	-	-	-	-	-
D18	-	-	7	-	1	-	-	-
D19	-	-	-	-	-	-	-	-
D20	-	-	7	1	-	1	1	-
D21	-	-	7	2	-	-	-	-
D22	-	-	-	-	-	-	-	-
D23	-	-	-	-	-	-	-	-
D24	-	-	-	-	-	-	26	-
D25	-	-	-	-	-	-	53	-
D26	-	-	-	-	-	-	-	-
D27	-	-	-	-	-	-	-	-
D28	-	-	-	-	-	-	-	-
D29	-	-	-	-	-	-	-	-
D30	-	-	16	-	-	-	-	-
D31	-	-	7	-	-	-	53	-
D32	-	-	-	-	-	-	-	-
D33	-	-	7	-	1	-	-	-
D34	-	-	-	-	-	-	-	-
D35	-	-	-	-	-	-	-	-

The Department of the Interior Mission

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

The Minerals Management Service Mission

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

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

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