# MAFLA BASELINE STUDY

# STANDARD SEDIMENT PARAMETERS

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# INTRODUCTION

## Setting

The Mississippi River Delta System forms a continental margin province which dominates the north central portion of the Gulf of Mexico. East of the Delta, off the coast of Mississippi, Alabama, and Florida lies a second province known by the acronym MAFLA (Figure 1). The eastern part of the MAFLA margin is dominated by the Florida platform, an accumulation of over 4572 m feet of carbonate sediment ranging in age from Jurassic to Recent. West of Cape San Bias, carbonates become intercalated with more and more elastics. Across the northern extension of the Florida Escarpment (Figure 1) the sedimentary basement rocks change from dominantly carbonates on the east to Cenozoic elastics on the west. The Florida Escarpment trend therefore represents a major sedimentary boundary between the Gulf Coast Geosyncline and the Florida carbonate platform.

Most of the sediment of the Mississippi River is delivered directly to the shelf edge or is transported west by the coriolis effect, the long-shore current system, and the prevailing surface currents. As a result, the MAFLA continental margin is covered by a sand sheet which Uchupi and Emery (1968) have called relict, which is dominantly quartz west of Cape San Blas and carbonate east of Cape San Bias.

Excepting mineralogy, the MAFLA sand sheet is much like that of the continental shelf of the southeastern Atlantic margin. Rivers which empty into [illegible] waters [illegible] is sand sized. Furthermore, most of the fine sediments delivered to the coast are trapped in estuaries, bays, and lagoons.

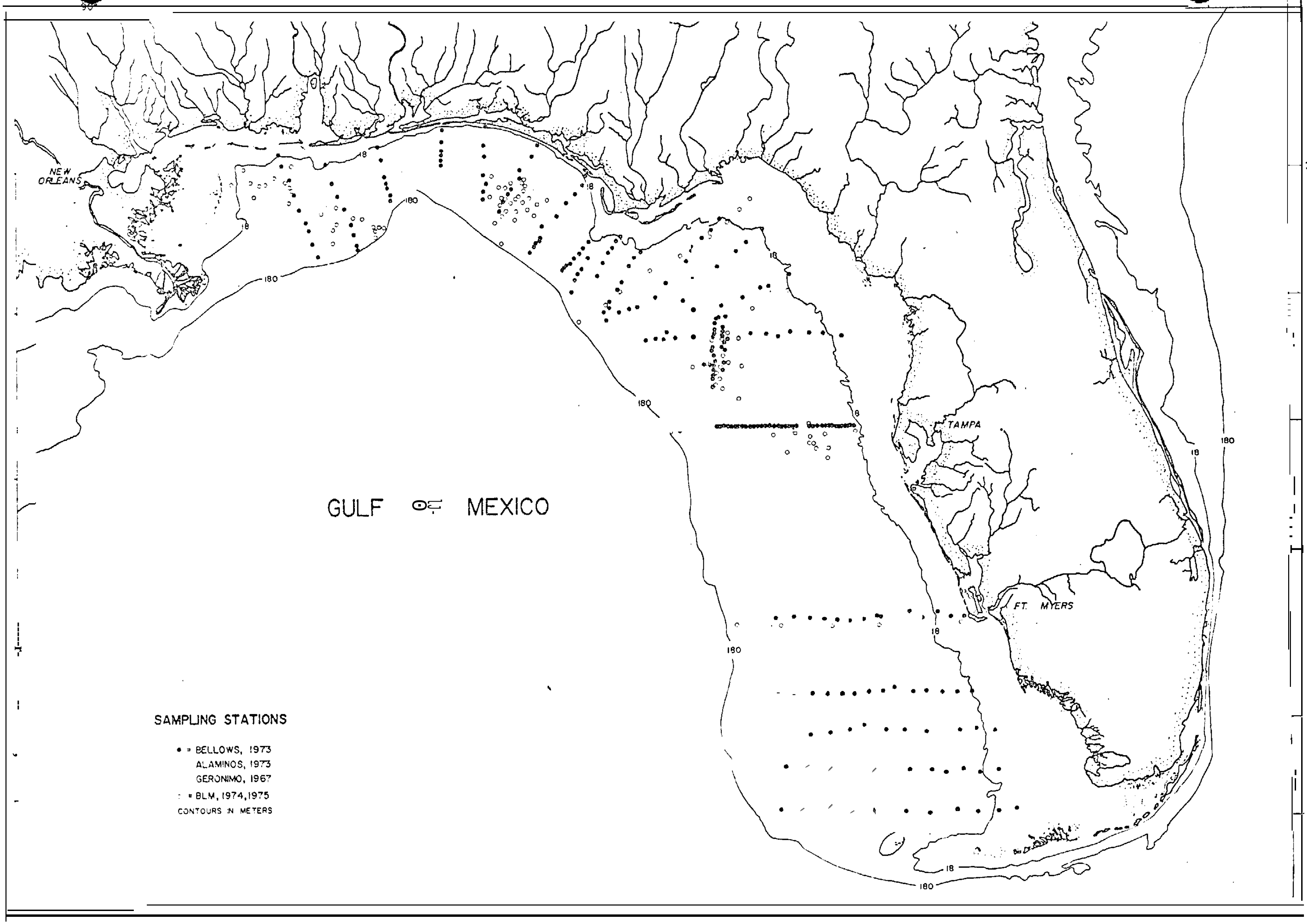



Figure MAFLA study area

## Previous Investigations

Estuaries, bays, and the coastal zone of the MAFLA area have been thoroughly investigated by Tanner (1960}, Goodell and Gorsline (1961), Kofoed and Gorsline (1963), Tanner and others (1963), Kofoed and Jordan , (1964), Gorsline (1966), and many more. However, surprisingly few studies of the continental shelf of the MAFLA area have been undertaken and with the exception of the broad overview of Uchupi and Emery (1968) data covering limited sectors of the area have never been integrated. Many of the individual investigations which have been conducted are listed in Brooks (1973). Gould and Stewart (1955), Ludwick (1964), and Grady (1972) have contributed most to the description of the MAFLA continental shelf. Holmes and others (1963) have investigated the innershelf sediments between Cape Romano and Cape Sable and Shepard (1956) the eastern flank of the Mississippi Delta. Gould and Stewart (1955) have depicted the central portion of the West Florida Shelf as covered with predominantly carbonate sediments zoned into quartz sand, quartz-shell sand, shell sand, algal sand, oolite sand, and foram sand and silt bands. Banded character of the sediments was also evident in Stewart and Gould's (1955) description of sediment textures. Ludwick (1964) described the sediments between the Mississippi Delta and Cape San Bias as a number of sand, mud, and transitional facies. Grady (1972) mapped sediment textures based upon a triangular diagram presentation of percent sand, silt, and clay in the northern Gulf of Mexico and his data was used to construct the latest existing sediment texture chart of the area published by BLM (1.974). Finally, Van Andel and Poole (1960) and Fairbank (1962) have described the heavy mineral suites of the Eastern Gulf.

Although never before integrated, these studies are of good quality and provide a framework upon which a discussion of the sediments and sedimentary processes of the MAFLA shelf can be built and compared and contrasted with those of the southeastern United States. Data analyzed for this study is small in comparison to those of the aforementioned work, but ties those investigations together and provides a basis for modifying interpretations put forth in them.

## METHODS

### At sea

At each station when box cores were obtained, two were subsampled with a five centimeter diameter sub-core for analysis for standard sediment parameters. One box core was subsampled with a five centimeter diameter sub-core for archiving. Each core collected was described and the top and one side were photographed in color. Each photograph included an identification tag, *a* color code system, a linear scale, and a designation of the top of the core. All sample containers were clearly labeled and boxed for delivery to shoreside facilities. The core to be archived was sent to the Florida State facility. Scoop samples were taken during the first sampling period at each dive station. These were also forwarded to a shoreside laboratory for analysis.

### Analysis for Standard Sediment Parameters

The top ten centimeters of each sub-core and splits of each scoop sample were analyzed for grain size and percent calcium carbonate. In the former, core samples were split and wet sieved through 62 μm mesh. If the percentage of finer than sand sized sediments exceeded ten, pipette analysis was conducted to determine the percentage of silt and clay in the sample. Coarser than 62 μm sediments were sieved for 15 min through one phi interval. nested 7.62 cm. A second split of sediment from each sample coarser than 62 µm was run through the rapid sediment analyzer.

Percent calcium carbonate was determined for each sample by leaching a known weight of sample with dilute hydrochloric acid until no more gas was given off, washing, drying, and reweighing. All data is stored in the DMSAG data bank and is available upon request.

## Geology Data Synthesis

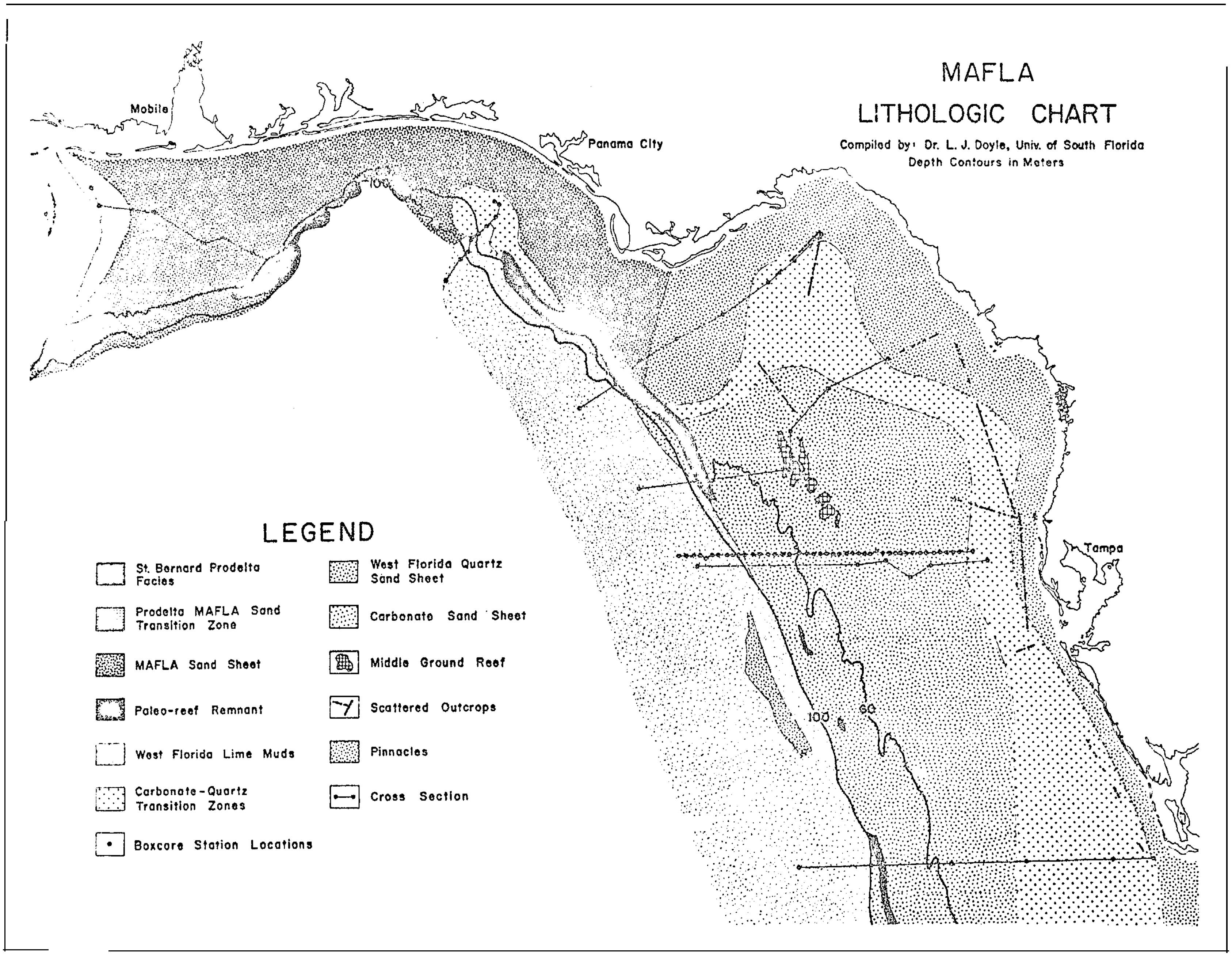
Available published and unpublished data have been perused and pertinent points collated and incorporated into the biolithologic map. Figure 1 shows the locations of all samples which were used to provide direct input into the map. Splits of samples from the National. Marine Fisheries Service gathered and reported upon by Grady (1972) were obtained and visually scanned for mineralogy; but at Grady's request, standard sediment parameter analyses which he had done, were not duplicated. Existing samples from the West Florida continental shelf available from the University of South Florida, Department of Marine Science sediment collection were analyzed for the standard sediment parameters as outlined above.

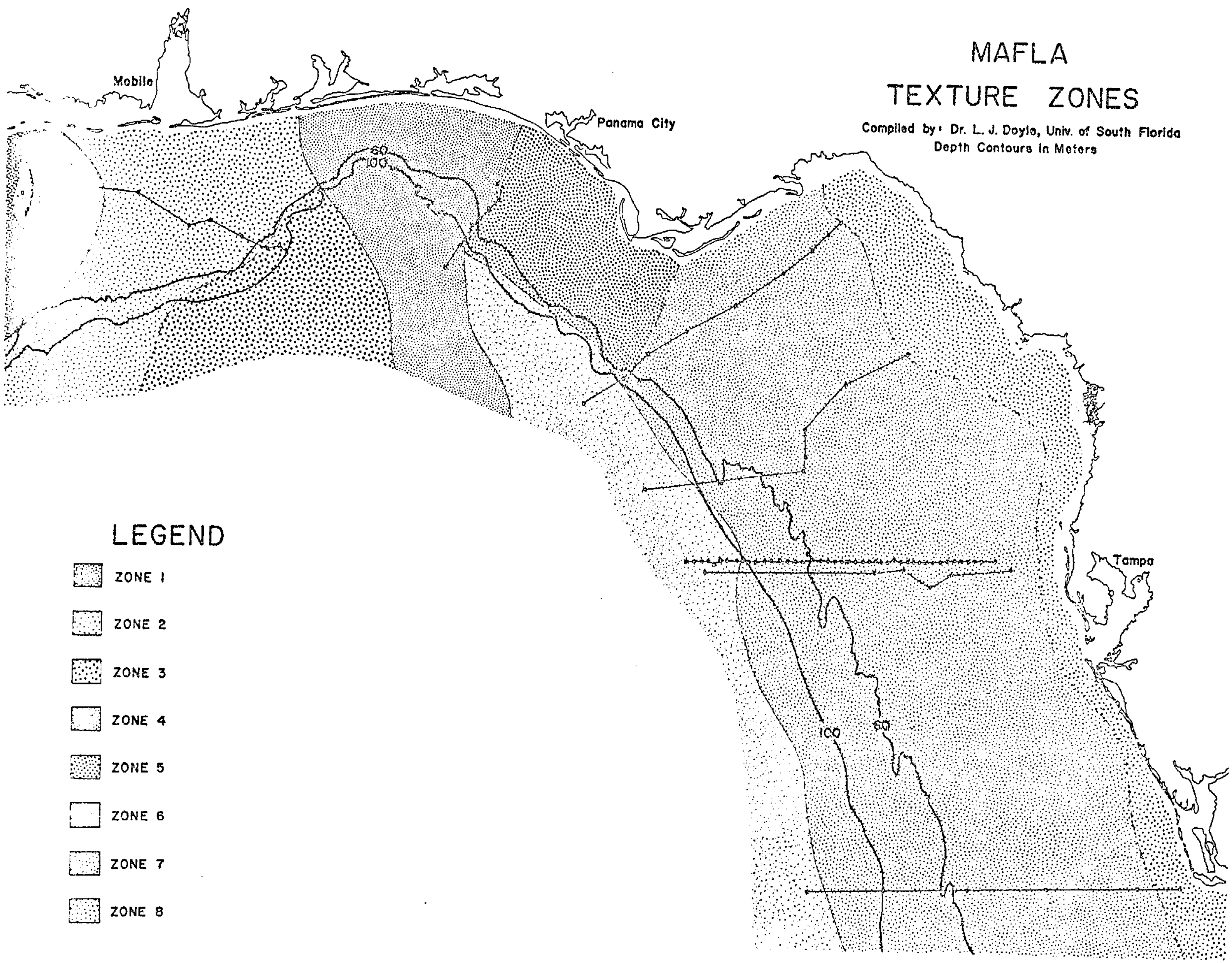
The digitized sediment data file at Scripps Institution of Oceanography, La Jolla, California was queried. Data within it refer to the deeper parts of the Gulf of Mexico and are not appropriate to this study.

# RESULTS AND DISCUSSION

## Sediment *Sheet*

Characteristics of the MAFLA sediment sheet are summarized in Figures 2 through 3 and cross sections 4 through 6 of the biolithologic map


MAFLA
LITHOLOGIC CHART
Compiled by: Dr. L. J. Doyle, Univ. of South Florida
Depth Contours in Meters
Mobile
Panama City
Tampa
100
60
LEGEND
St. Bernard Prodelta Facies
Prodelta MAFLA Sand Transition Zone
MAFLA Sand Sheet
Paleo-reef Remnant
West Florida Lime Muds
Carbonate-Quartz Transition Zones
Boxcore Station Locations
West Florida Quartz Sand Sheet
Carbonate Sand Sheet
Middle Ground Reef
Scattered Outcrops
Pinnacles
Cross Section


MAFLA
TEXTURE ZONES
Compiled by: Dr. L. J. Doyle, Univ. of South Florida
Depth Contours in Meters
Mobile
Panama City
Tampa
60
100
LEGEND
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 5
ZONE 6
ZONE 7
ZONE 8

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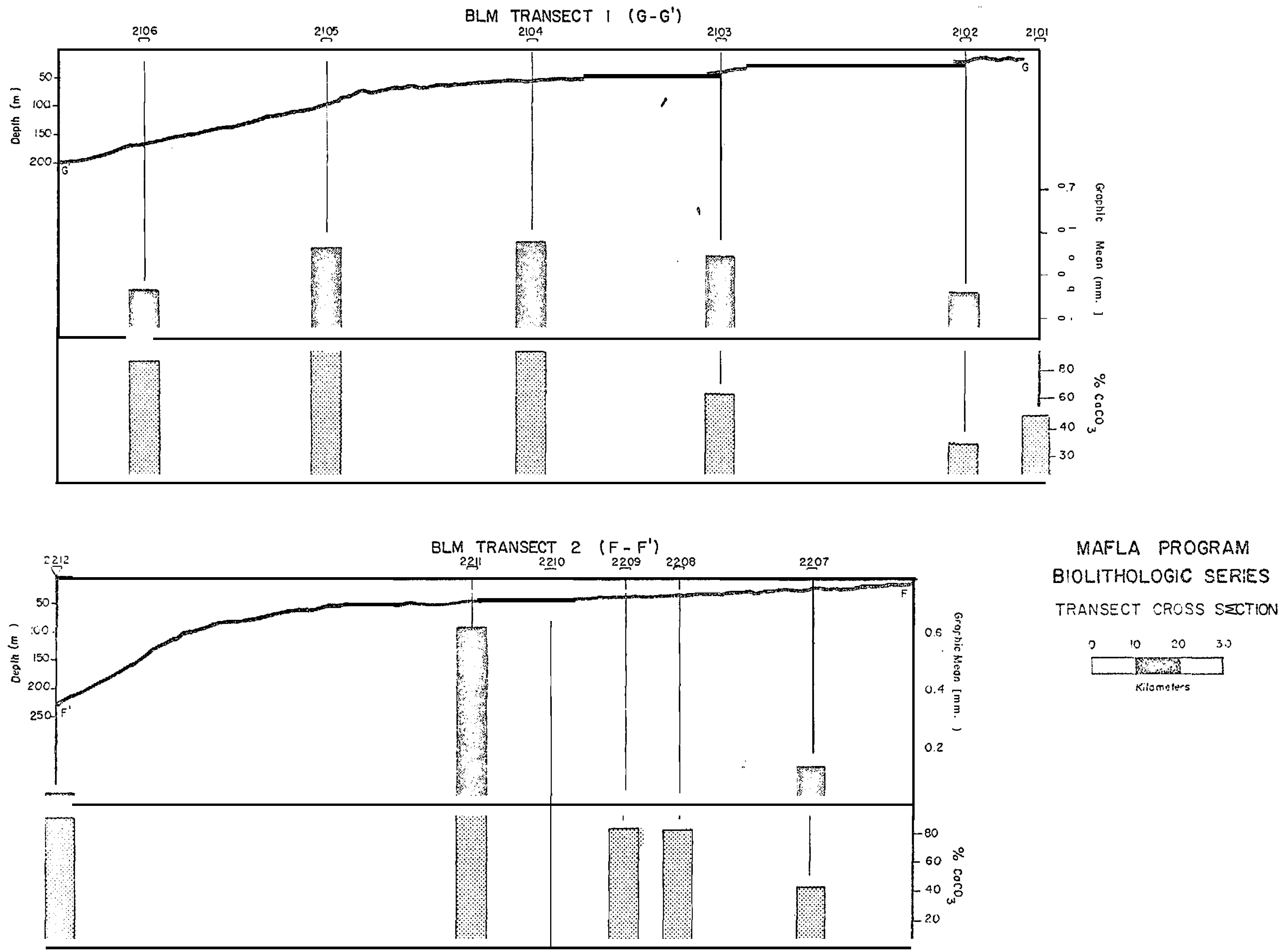


Figure 4. MAFLA Boxcore transect cross section (1 and 2).

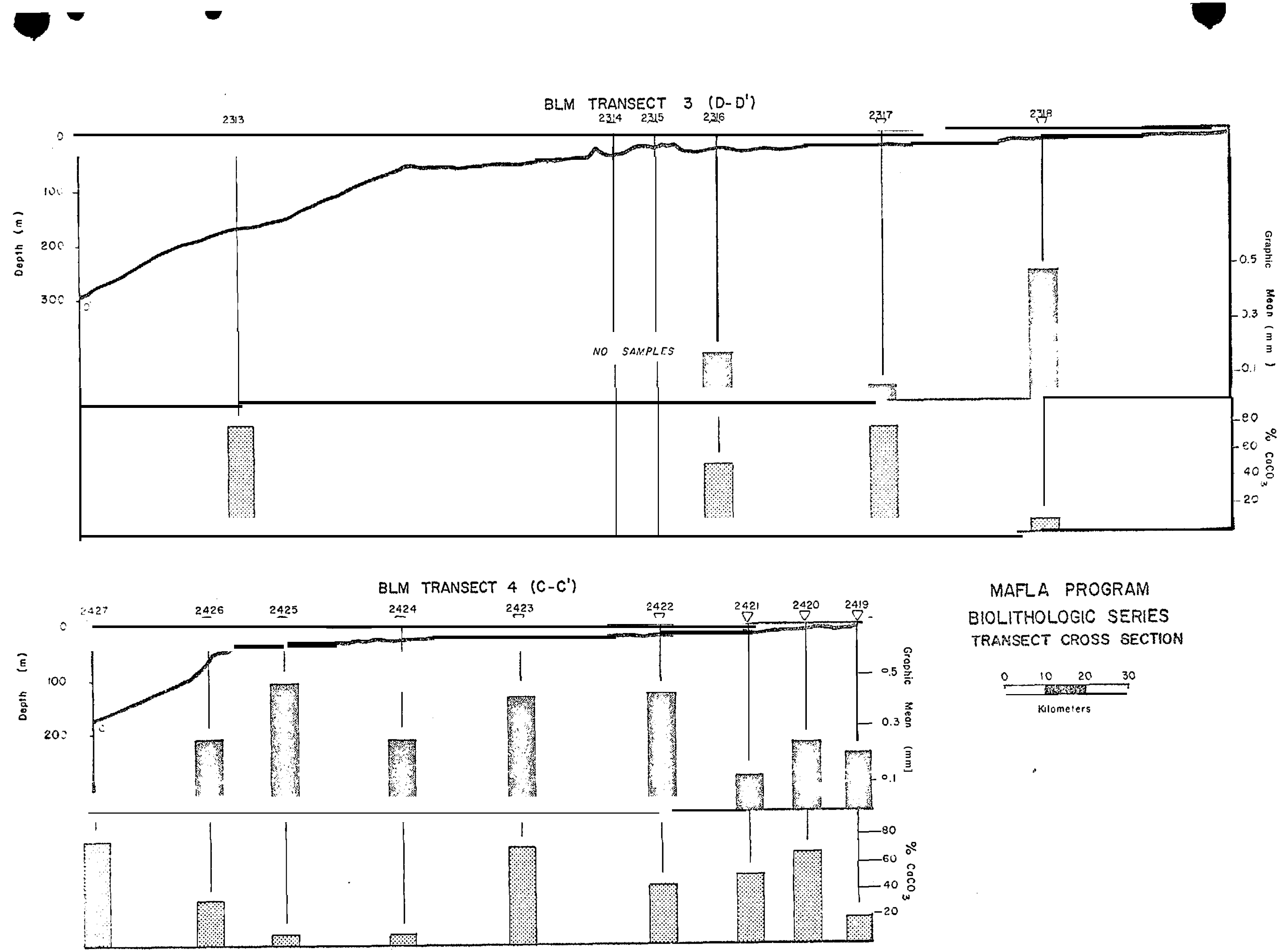


Figure 5. MAFLA Boxcore transect cross section (3 and 4).

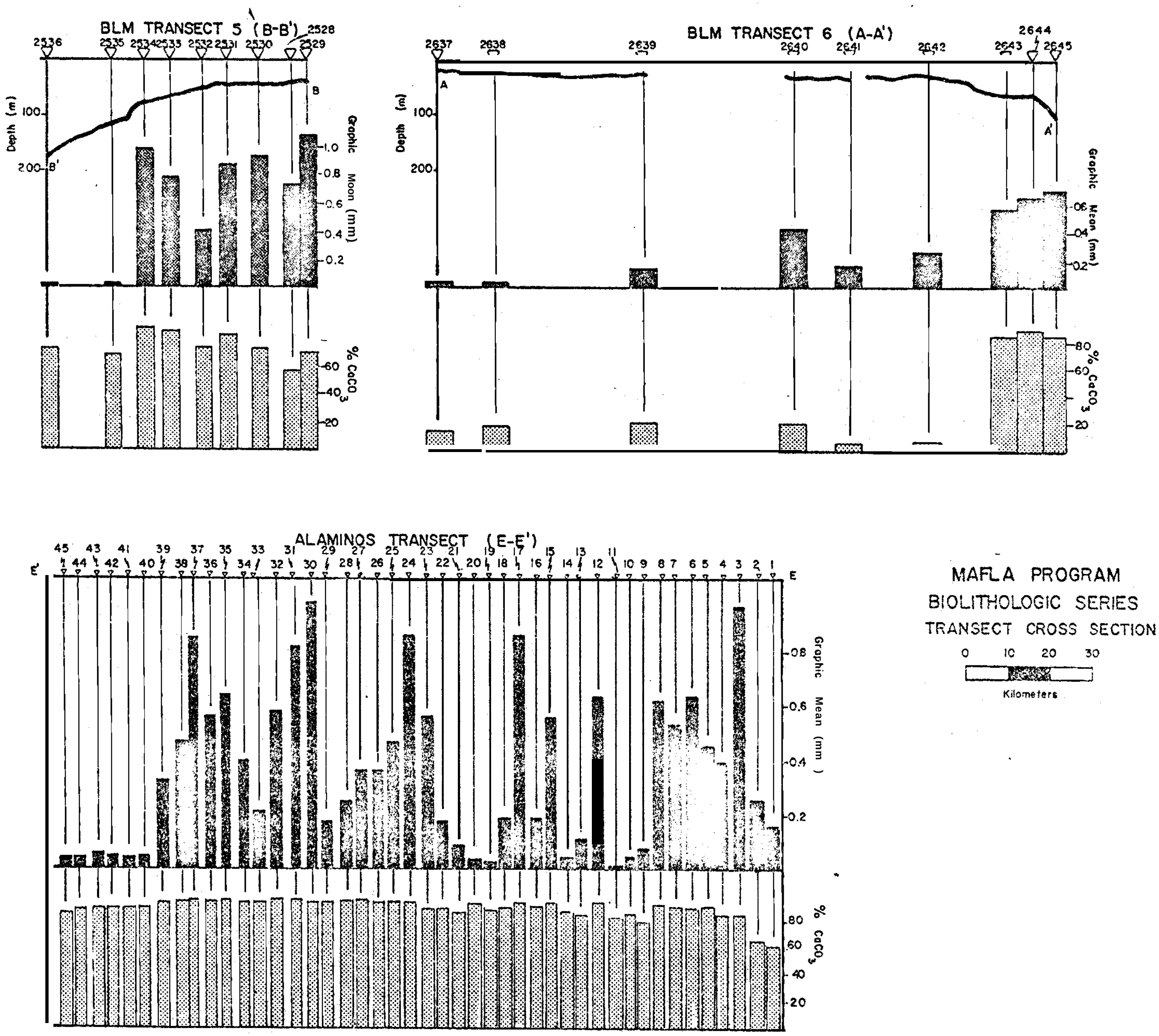


Figure 6. MAFLA Boxcore transect cross section (5,6, and 7).

which depict among other parameters, the graphic mean grain size, the sand/fine ratio (sand/silt -i- clay = sand/fine ratio), and the percent $CaCO_3$ in the sediments. The sand/fine figure (2) shows the MAFLA continental shelf and upper slope divided into a number of zones and serves as a convenient base upon which to build a discussion of the MAFLA sediment sheet. One must keep in mind that zone boundaries are rather arbitrary and that transitions between zones are gradational.

Zone I reflects the influence of deposition of Mississippi River sediments. It is characterized by a sand/fine ratio of less than 1.0 and a low (less than 25%) calcium carbonate content. Silt predominates over clay sizes. Sand and silt sized particles are dominantly quartz while the clay minerals are dominated by smectite (Huang and others, 1975). The heavy mineral suite is relatively depaupered in the most resistant minerals such as zircon and is dominated by hematite, micas, amphiboles, and pyroxenes.

Zone II has a sand/fine ratio of between about 1.0 and about 58.5. The ratio increases toward the east showing the diminishing though still detectable, influence of Mississippi deposition and the exposure of the relict quartz sand sheet. Calcium carbonate in the sediments remains low at less than 25%. Kaolinite becomes a major constituent of the clay mineral assemblage although smectite remains dominant. Heavy minerals reflects southern Appalachian provenance and are characterized as a kyanite/staurolite suite (Van Andel and Poole, 1960, and Fairbank, 1962) with ilmenite, zircon, and tourmaline common, but hematite, pyroxenes, and amphiboles diminished.

Zone III reflects the abrupt bathymetric change at the western margin of DeSoto Canyon. Sediments are still sands, but have a lower sand/fine ratio than do those of the eastern portion of Zone II. Calcium carbonate content jumps to greater than 75X at the shelf edge. Sediments shoreward are still dominated by quartz. Heavy minerals are similar to those of Zone II.

Zone IV, containing the more gently sloping eastern margin of DeSoto Canyon, Is characterized by lowered sand/fine ratios and high carbonate content typical of the western Florida lime-mud facies of Ludwick (1964) on the upper continental slope.

Zone V is a transition between the slope muds and the quartz sand sheet south and west of Cape San Bias. West of Cape San Bias the clay mineral suite becomes dominated by kaolinite showing the continued waning influence of the Mississippi River. Heavy minerals are similar to those of Zones II and 111. The eastern portion of Zone V is transitional to the west Florida carbonate sand sheet.

Zone VI represents the upper continental slope of the west Florida margin. It is characterized by limey muds with a sand/fine ratio less than 1.0 and a high (>75%) carbonate content. It is similar to Zone IV.

Zone VII is the carbonate sand sheet of the west Florida shelf. While sand/fine ratios are generally greater than 1.0, they vary from 1.0 to 90.0 reflecting the effect of local bathymetry. This variation may be seen in Figure 6 which shows the *graphic* mean grain size of a series of stations at 1.85 km intervals across the west Florida shelf. (See Figure 3 for locations.) The variation is impressive. Stations 40-45 of Figure 2 are in the upper continental slope Zone IV. Carbonate constituents of cross sections A through D show that the banding reported by Stewart and Gould (1955) is not present with one notable exception, the inner shelf quartz band. The carbonate sand sheet is thin with many outcrops of tertiary rocks exposed through it.

Zone VIII is the inner portion of the West Florida shelf. It is a relatively pure quartz sand that also makes up the beaches of west Florida. It will be discussed in more detail in a latter section. The heavy mineral suite of the MAFLA Zone VIII east of Cape San Bias is dominated by zircon, staurolite, tourmaline, and garnet (Fairbank, 1962). As expected, heavy minerals decrease *as* carbonate increases and are essentially absent in Zone VII. Clay minerals are dominated in both Zones VII and VIII by kaolinite with chlorite next in abundance (Huang and others, 1975).

## Quartz Sand Band

One of the most significant aspects of the MAFLA sediment sheet is the quartz band that is shown as Zone VIII in Figure 2 and the transition between it and the carbonate sand sheet of the west Florida continental shelf. Since virtually no sand sized sediment has been brought into the system during the present high stand of sea level, and since it is bordered on the south and west by carbonate sands, the quartz sand belt provides a natural laboratory in which to test some of the current theories on shelf sediment transport. Since it is cut off from *a* quartz source, longshore current systems that affect it must balance out essentially to zero net transport or else the band should have disappeared or evinced dilution with carbonates.

Pilkey and others (1972) have suggested that the beaches of the southeastern Atlantic continental margin are fed by sediments from the adjacent continental shelf. If this is indeed the case, the ramifications for the onshore transport of oil related pollutants which have become incorporated in shelf sediments are ominous.

A study should therefore be initiated to investigate the quartz band carbonate boundary in three dimensions. The mineralogical difference will provide a definitive solution to the problem of efficacy of shelf to coastal zone sediment transport which will in turn have ramifications far beyond the MAFLA margin.

## Small Scale Variability

Sediment texture in any sand sheet is subject to considerable variation over short distances. A major factor in controlling textural variation is local bathymetry. Thus while the attributes of a sand sheet as a whole may be accurately described, specific grain size is difficult or impossible to predict at any projected station. Small scale variability is illustrated by Figure 6 which shows a series of stations taken at 1..6 km intervals across the central portion of the west Florida carbonate sand sheet (see Figure 1 for station locations). Table 1 shows variation within the sand sheet on an even smaller scale, i.e. variation among the box cores at each station among the several sampling periods. Distances among the individual box cores are limited by the swing of the vessel and by accuracy and reproducibility of the various navigation systems used. Average maximum variation within a station among the sampling periods is 7.9% in sand sized sediment. Maximum variation in percent sand at one station is about 28.6. These variations are significant and suggest that grain size analysis should be run on each box core sample in order to have complete confidence in biological and chemical data interpretations.

## Hydraulic Equivalency vs. Sieve Analysis

Analysis by settling tube should theoretically result in a hydraulic equivalent grain size since the particles are sized by the Lime it takes them to settle through a water column of known length. Sieve analysis is

TABLE 1

| Station | Greatest Deviation Among Box Cores Over Three Cruises Expressed as Weight Percent |
|---|---|
| 2101 | 8.0 |
| 2102 | 9.9 |
| 2103 | 20.6 |
| 2104 | 14.8 |
| 2105 | 12.0 |
| 2106 | 16.3 |
| 2207 | 2.3 |
| 2208 | 9.7 |
| 2209 | 8.0 |
| 2210 | 9.0 |
| 2211 | 4.8 |
| 2212 | 6.2 |
| 2313 | 9.0 |
| 2314 | 4.0 |
| 2315 | 28.2 |
| 2316 | 7.7 |
| 2317 | 15.5 |
| 2318 | 2.6 |
| 2419 | 7.6 |
| 2420 | 3.1 |
| 2421 | 6.3 |
| 2422 | 7.9 |
| 2423 | 5.1 |
| 2424 | 8.0 |
| 2425 | 5.0 |
| 2426 | 2.7 |
| 2427 | 7.6 |
| 2528 | 8.7 |
| 2529 | 3.6 |
| 2530 | 8.4 |
| 2531 | 9.3 |
| 2532 | 8.1 |
| 2533 | 6.7 |
| 2534 | 9.2 |
| 2535 | 9.9 |
| 2636 | 7.0 |
| 2637 | 7.6 |
| 2638 | 1.0 |
| 2639 | 9.3 |
| 2640 | 1.8 |
| 2641 | 7.4 |
| 2642 | 0.8 |
| 2643 | 5.9 |
| 2644 | 4.6 |
| 2645 | 3.7 |

a direct measure of particle diameter. Comparison of settling tube and sieve analyses (see DMSAG for data) shows no interpretable pattern of variation. It is therefore recommended that settling tube analysis of grain size be discontinued. Since organisms respond to the physical size of the particles and not to the hydraulic character of the grains, sieving should be the preferred method for MAFLA type studies.

## CONCLUSIONS

1. There are two major divisions of sediments within the MAFLA area. West of Cape San Bias sediments are dominantly elastic; *east* of Cape San Blas carbonates dominate. Within these major subdivisions, at least eight separate sediment zones can be defined on the basis of sand/fine ratios, percent carbonate, and mineralogy. Mississippi River influence diminishes from west to east and is undetectable in shelf sediments east of Cape San Bias.
2. Zone I is composed of fine grained pro-delta sediments characterized by a smectite dominated clay mineral suite.
3. Zone II is composed primarily of quartz sand with the clay fraction still dominated by smectite.
4. Zones III and IV are the steep western and gentler eastern flanks of the DeSoto Canyon. The former is made up of carbonate sands; the latter of lime muds typical of the upper west Florida continental slope.
5. Zone V is the transition from the DeSoto Canyon to the elastic shelf of the northwest Florida margin. West of Cape San Bias, transition to the Florida carbonate platform begins. Kaolinite becomes the predominant clay mineral and carbonates increase at the eastern outer edge of the shelf.
6. Zone VI represents the upper continental slope of the Florida platform.
7. Zone VII is the thin carbonate sand sheet covering most of the west Florida shelf and Zone VIII is the quartz band of the inner shelf and coastal zone.
8. The quartz band represents a closed nearshore transport system; and as such, its boundary with carbonate shelf sediments offers a unique

opportunity to test the theory that shelf sediments along with entrained pollutants are transported into the beach system.

9. Small scale textural variation due to local bathymetry within the sand sheets is significant.

10. Sieving should be. the method of choice of sand fraction analysis of sediments in MAFLA type programs.

11. Bands of carbonate constituents shown by Gould and Stewart (1955) are not present, rather the carbonate sediments are patchy in distribution,

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