STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Elton J. Gissendanner, *Executive Director*

DIVISION OF RESOURCE MANAGEMENT
Art Wilde, *Director*

BUREAU OF GEOLOGY
Walter Schmidt, *Chief*

Report of Investigation No. 95

HEAVY MINERAL RECONNAISSANCE OFF THE COAST OF THE APALACHICOLA RIVER DELTA, NORTHWEST FLORIDA

by

Jonathan D. Arthur
Joseph Applegate
Shekhar Melkote
Thomas M. Scott

Published for the
FLORIDA GEOLOGICAL SURVEY

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U. S. MINERALS MANAGEMENT SERVICE

TALLAHASSEE
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LETTER OF TRANSMITTAL

BUREAU OF GEOLOGY
TALLAHASSEE
June 1986

Governor Bob Graham, Chairman
Florida Department of Natural Resources
Tallahassee, Florida 32301

Dear Governor Graham,

The Bureau of Geology, Division of Resource Management, Department of Natural Resources, is publishing as Report of Investigation 95, "Heavy Mineral Reconnaissance Off The Coast Of The Apalachicola River Delta, Northwest Florida".

An increasing demand for heavy minerals, due to their unique physical and chemical properties, requires that Florida's heavy mineral deposits be delineated. This report presents basic data on the types, occurrence, and distribution of heavy minerals offshore of northwest Florida. These data are necessary for resource planning and development purposes.

Respectfully yours,

Walter Schmidt, Chief
Bureau of Geology

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Tallahassee
1986

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INTRODUCTION

OBJECTIVES AND SCOPE

The objectives of this investigation are to systematically examine heavy mineral concentrations along the inner continental shelf of the northeastern Gulf of Mexico and to summarize the textural characteristics of the region. The study area extends along Florida's northwest coastline from approximately 15 miles (24 km) offshore of Apalachee Bay to the same distance offshore of Pensacola Bay. Grain size analyses and possible sediment sources are discussed in the "Granulometric Analyses" section of the report. The "Heavy Mineral Reconnaissance" section presents data pertaining to heavy mineral suites, provenance, concentration and distribution. Also included in the report is background information regarding heavy mineral classifications, uses, resources, sampling and analytical methods.

ACKNOWLEDGEMENTS

This investigation was made possible by a cooperative agreement between the Florida Bureau of Geology and the Minerals Management Service of the U. S. Department of the Interior (Contract number 14-12-0001-30115).

The authors gratefully acknowledge the Florida State University (F.S.U.) for use of its various facilities. More specifically, we are indebted to Dr. William Herrnkind, Director of the F.S.U. Marine Laboratory and his secretary, Mary Westberg, for the arrangements and permission to use the research vessel R/V *Wolf* for sediment sampling offshore of northwest Florida. Further appreciation is extended to Dennis S. Cassidy, Director of the Antarctic Research Facility and to Drs. Joseph F. Donoghue and William C. Parker, Department of Geology, F.S.U. for use of their storage and laboratory facilities.

Special thanks are extended to Kenneth M. Campbell, Tony Murray and Thomas S. Wilson (boat captain) for assistance in obtaining samples. The authors deeply appreciate the critical reading of the manuscript and helpful comments throughout the investigation made by Drs. William F. Tanner and Joseph F. Donoghue, Department of Geology, F.S.U. We also are appreciative of the review by the staff of the Florida Bureau of Geology.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either express or implied, of the U. S. Government.

DEFINITIONS AND USES OF HEAVY MINERALS

Heavy minerals are defined as discrete, liberated, sand-sized particles having a density greater than 2.85 (Garner, 1978; Gary, et al., 1972). Heavy minerals are generally categorized as "beach sands" or as "beach environment" deposits due to their depositional association with coastal processes (see "Heavy Minerals Occurrence"). The heavy mineral suite characterizing the area of investigation consists of ilmenite, kyanite, staurolite, tourmaline, zircon, rutile and minor amounts of epidote, sphene, amphibole, magnetite, sillimanite, leucoxene and garnet. These minerals are significant in both industrial and scientific aspects.

The worldwide industrial importance of heavy minerals has become more apparent in the past few decades. An increasing demand for these minerals, due to their unique physical and chemical properties, requires that new deposits be discovered and developed. Table 1 lists a few important properties and industrial uses of the heavy minerals occurring within the study area. Titanium minerals (rutile, ilmenite and leucoxene) are currently mined for titanium metal and titanium oxide. The metallic phase of titanium is useful in high temperature alloy production (e.g., for use in aircraft and aerospace industries). Titanium oxide is primarily used in pigment manufacturing. Magnetite, usually the hard rock (igneous and metamorphic) variety, is mined as a source of iron. The minerals staurolite, garnet and zircon are useful as abrasives. Staurolite can also serve as a source of aluminum for the manufacture of portland cement and zircon is a source of zirconium and hafnium. Kyanite, sillimanite (hard rock varieties) and zircon are refractory materials.

Table 1. Physical properties and industrial uses of heavy minerals occurring in the northeast Gulf of Mexico. Compiled from *Elements of Mineralogy,* 1968, and *1983 Minerals Yearbook.*

	Mineral	Composition	Density	Hardness	Common Uses
Opaque	Magnetite	Fe_3O_4	5.2	6.0	Ore of iron
	Ilmenite	$FeTiO_3$	4.7	6.0	Ore of titanium, TiO_2 pigment
Ultrastable	Zircon	$ZrSiO_4$	3.9-4.7	7.5	Ore of Zr, Hf, foundry sand, refractory
	Tourmaline	$Na(Fe,Mg)_3 Al_6(BO_3)_3 (Si_6O_8) (OH)_4$	3.0-3.2	7.5	None
	Rutile	TiO_2	4.2-4.5	6.5	Ore of titanium, pigment
Metastable	Kyanite	Al_2SiO_5	3.63	4.0-7.0	Refractory
	Staurolite	$FeAl_4Si_2O_{10}$	3.76	7.0	Abrasives, portland cement
	Sillimanite	Al_2SiO_5	3.24	7.0	Refractory
	Epidote	$Ca_2(Al, Fe,Mn)_3 (OH) Si_3O_{12}$	3.3-3.6	7.0	None
	Garnet	$(Fe,Mg,Ca)_3 (Al,Fe,Cr)_2 (SiO_4)_3$	3.5-4.3	7.0-7.5	Abrasives, filtering medium
	Sphene	$CaTiSiO_5$	3.5	6.0	None
	Hornblende	$NaCa_2 (Mg,Fe,Al)_6 (Si,Al)_8O_{22} (OH)_2$	3.0-3.4	6.0	None

Analysis of the heavy fraction of sands is useful in solving stratigraphic, paleostratigraphic and sedimentologic problems. Heavy mineral suites aid in the correlation of strata and in ascertaining sediment source areas. Furthermore, information regarding the direction and strength of sedimentation pulses and provenance mixing can be provided by heavy mineral investigations.

HEAVY MINERAL CLASSIFICATION

For the purpose of general study, Folk (1974) classified four groups of heavy minerals: opaques, micas, ultrastables, and metastables. These groups are discussed relative to minerals occurring in the study area. Minerals belonging to the opaque group (magnetite, ilmenite and leucoxene) average a higher specific gravity due to their iron and titanium content and dense crystallographic structure (Table 1). The mica-group minerals are omitted from this study because they are easily weathered and therefore are present only in trace amounts. The minerals zircon, tourmaline and rutile form the ultrastable group due to their high degree of hardness and resistance to chemical and physical weathering. Consequently, a high percentage of ultrastable minerals within a sample may indicate that the sands are mature and have been reworked from older sediments. Metastable minerals are slightly less resistant to weathering than the ultrastables, however, both groups are considerably more durable than the micas. The metastable mineral group includes garnet, hornblende, epidote, sphene, kyanite, sillimanite and staurolite.

HEAVY MINERAL OCCURRENCE

In order to illustrate the various modes of occurrence of heavy mineral deposits, Garner's (1978) depositional sequence for titanium minerals can be applied (Figure 1). In this sequence, "in situ alteration" deposits are the only deposits unique to titanium minerals. The remaining portion of the diagram is discussed in terms of all heavy minerals. These minerals crystallize as a result of igneous and metamorphic processes. For titanium minerals, the resulting "hard rock deposits" may undergo in situ alteration, thereby reacting to form new titanium-bearing phases (e.g., perovskite altering to anatase and ilmenite). Hard rocks may also be physically weathered and transported to form a variety of sedimentary deposits: continental alluvial, deltaic and marine deposits (Figure 1). Garner (1978) has subdivided marine deposits into aeolian (dunal), strandline beach and offshore sand deposits.

DOMESTIC SEDIMENTARY HEAVY MINERAL RESOURCES

Heavy mineral sand resources in the United States are widespread and numerous. However, few of these deposits are considered recoverable under current economic conditions. Heavy minerals in the northeastern Gulf of Mexico common to those valued as economic resources are rutile, ilmenite, staurolite, kyanite, sillimanite, garnet and zircon. Only four detrital heavy mineral mining operations of these minerals (except for kyanite and sillimanite) are currently active in the United States (1983 Minerals Yearbook).

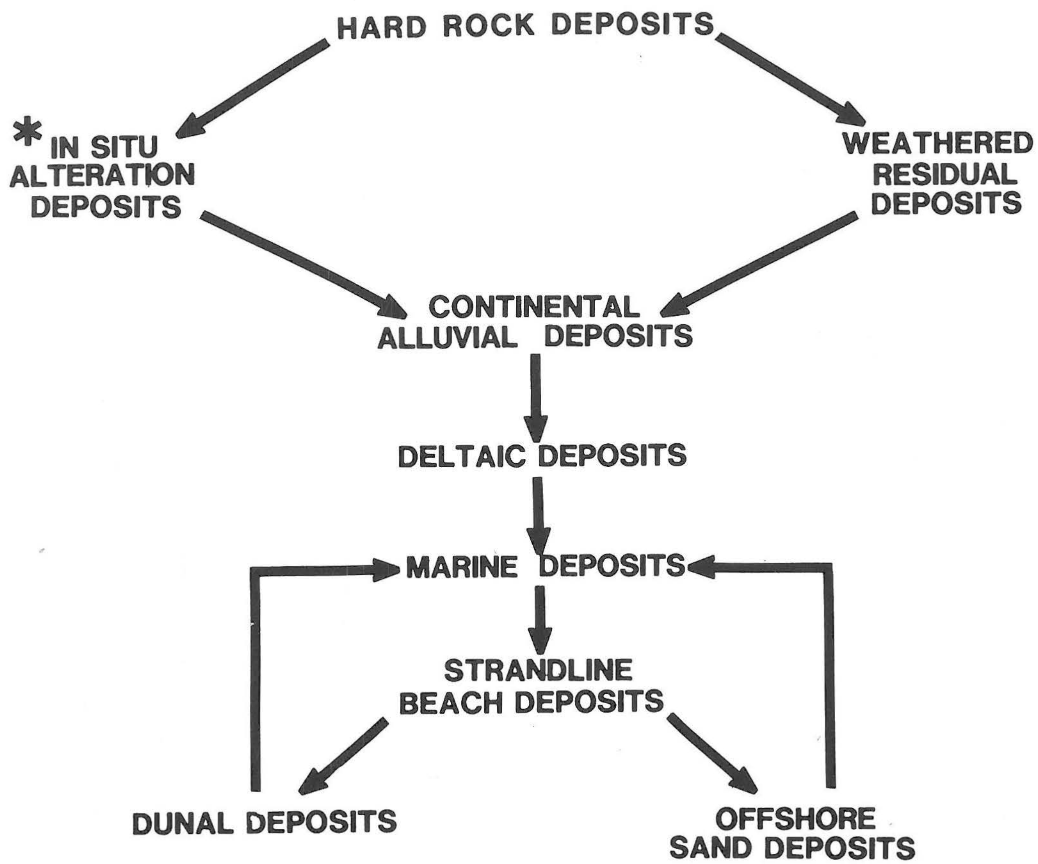

Figure 1. Depositional sequence for heavy mineral deposits (Garner, 1978). Asterisk indicates deposits unique to titanium materials.

Reserve estimates of titanium from domestic rutile and ilmenite are 1 million and 10 million tons, respectively. Rutile resources occur primarily in Georgia, Tennessee and Florida. These states, in addition to New Jersey, also host major sedimentary ilmenite resources. Mining operations in Starke and Highland, Florida (Trail Ridge area) and Green Cove Springs, Florida are currently the nation's only producers of ilmenite and rutile from sand deposits.

Economic co-products of titanium mineral production include kyanite, sillimanite, staurolite and zircon. Minor amounts of kyanite and sillimanite have been recovered from ilmenite sands of New Jersey, Georgia and Florida (Espenshade, 1973). An additional sedimentary resource of these two minerals is found within the pebble phosphate deposits of Florida (Stow, 1968). Staurolite resources in the Trail Ridge area are being mined at a rate of about 0.1 million tons per year (1982 and 1983 Minerals Yearbook). No other commercial production or resources of staurolite is reported. Zircon placers of Florida and Georgia are estimated to contain 4 million tons of zirconium (Lynd, 1980). Hafnium, an additional economic constituent of zircon, is concentrated within these reserves at an estimated 0.8 million tons. The Trail Ridge area is also the only producer of domestic zircon, which is mined at a rate slightly lower than staurolite (Adams, 1983).

Seventy-five percent of the world's garnet production is accounted for by the United States (Smoak, 1983). Although there are four active mining operations recovering domestic garnet, only one of the deposits is sedimentary. This resource is a continental alluvial garnet deposit in Benewah County, Idaho.

PREVIOUS INVESTIGATIONS

Phelps (1940), in analysing modern beach sands of Florida, observed highest heavy mineral concentrations at Jacksonville Beach (25 weight percent) on the Atlantic coast and in Venice and Indian Rocks beaches (13 and 10 weight percent, respectively) on the Gulf Coast. More recent heavy mineral surveys of Florida's Atlantic continental shelf were conducted by Pilkey (1963) and Grosz and Escowitz (1983). Similar studies of the Gulf Coast include Goldstein (1942), Tanner, et al. (1961) and Hood, et al. (1971), the first two of which are within or proximal to the present area of investigation. Goldstein's (1942) "Eastern Gulf Province" (northwest Florida and south Alabama) is characterized by a suite containing ilmenite, leucoxene, staurolite, kyanite, zircon, tourmaline and epidote, averaging 0.44 weight percent heavy minerals. An almost identical heavy mineral concentration and suite is reported for the vicinity of St. George Island (Tanner, et al., 1961). Heavy mineral concentrations within the shoal near St. George Island are hypothesized to increase with depth (Tanner, et al., 1961).

The most studied heavy mineral deposits within Florida's mainland occur within Pleistocene beach ridge deposits of northeast peninsular Florida. The Green Cove Springs, Boulougne and Trail Ridge (Highland) deposits average 2 to 3 weight percent heavy minerals and are characterized by a suite comprised of ilmenite, rutile, sillimanite, staurolite, zircon and tourmaline (Pirkle, et al., 1977). The nearby Yulee deposits contain different proportions of the same suite, which constitutes 3 to 4 weight percent of the sediment (Pirkle, el al., 1984).

SAMPLING TECHNIQUE

In May, 1984, 250 surface samples were taken with a Shipek grab sampler aboard the Florida State University Marine Laboratory's R/V *Wolf* in the northeastern Gulf of Mexico. Thirty-two north-south transects were constructed using Loran overprinted nautical charts. Sample collection sites along these transects were located using Loran coordinates, which were later converted to latitude and longitude. Appendix I lists the sample numbers, sample depths and corresponding latitude and longitude. The transects along the study area begin approximately 3.4 miles (5.5 km) offshore and average about 11.5 miles (18.5 km) in length. The transects are separated from each other by an average distance of 6 miles (9.5 km). In general, surface samples were collected at about 1.1 mile (1.8 km) intervals along the transects east of Cape San Blas, and at approximately 1.7 mile (2.7 km) intervals along transects west of Cape San Blas. Transect and sample numbers (labels) increase toward the west and south, respectively. For example, transect 1 (T-1) is the eastern-most transect, and T-28 is the western-most transect of the study area. Sample 1-1 is the first sample (northernmost and nearest to the shore) on transect 1 and sample 1-11 is the last sample (farthest from the shore) on transect 1. Figure 2 shows sample locations within the study area in addition to several morphological features which will be introduced in the next chapter of this report.

LABORATORY PROCEDURES

The samples were initially split to yield 75-100 grams (gm) and dried for 12 hours at 70°C. Organic material in the samples, present only in minor amounts, was handpicked and/or removed through decantation. The samples were then wet sieved, dried, and dry sieved at quarter-phi intervals (-1.0 phi to +4.0 phi) on a ro-tap machine. Weight percent, cumulative weight percent, and the four moment measures (mean, standard deviation, skewness and kurtosis) were computed using a granulometric program (Kirkpatrick, 1982).

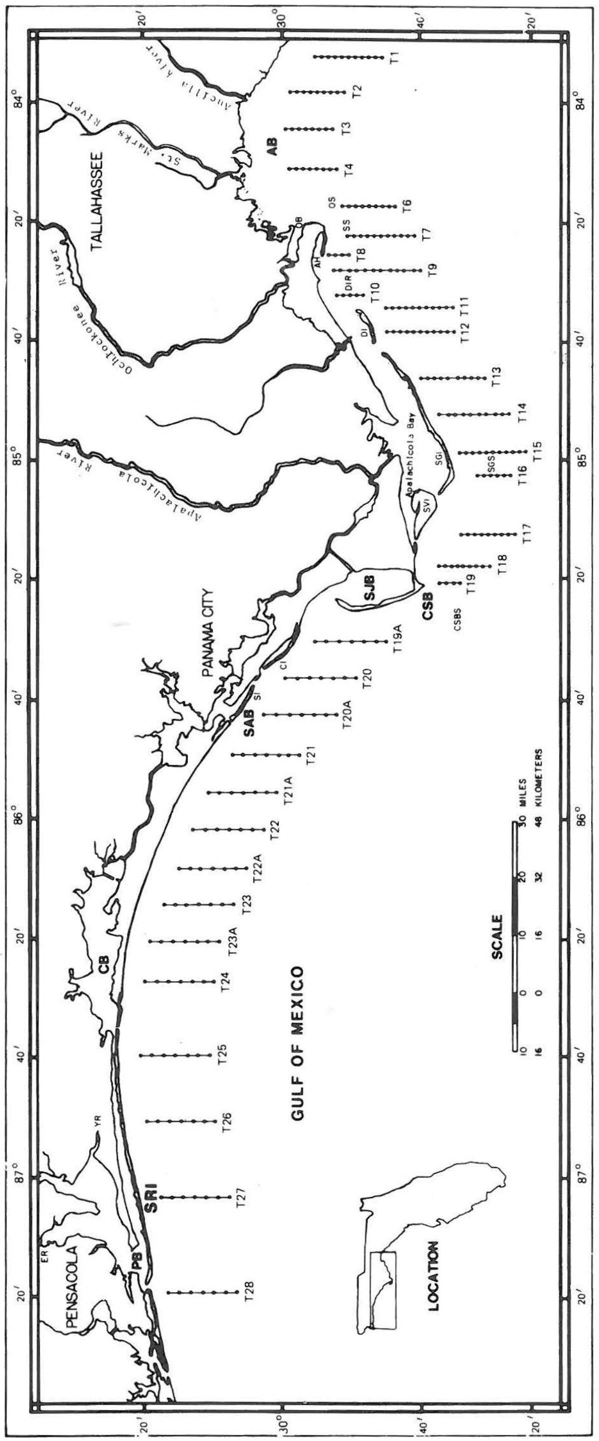

Figure 2. Study area and sample location map showing morphological features discussed in text: PB is Pensacola Bay; ER is Escambia River; YR is Yellow River; SRI is Santa Rosa Island; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; SI is Shell Island; CI is Crooked Island; SJB is St. Josephs Bay; CSB is Cape San Blas; CSBS is Cape San Blas Shoal; SVI is St. Vincent Island; SGI is St. George Island; CSGS is Cape St. George Shoal; DI is Dog Island; DIR is Dog Island Reef; AH is Alligator Harbor; OB is Ochlockonee Bay; OS is Ochlockonee Shoal; SS is South Shoal; AB is Apalachee Bay; solid lines with closed circles indicate transect and sample locations.

Sediments in the size fractions 2.25, 2.50, 2.75, and 3.00 phi and in 3.25, 3.50, 3.75, and 4.00 phi were combined to form two groups. The two groups were further split to yield a smaller fraction. These fractions (5-10 gm) were centrifuged using tetrabromoethane to separate the heavy minerals. Heavy mineral analyses for the 2-3 phi interval were completed for all samples. In the 3-4 phi fraction, one sample per transect (the middle sample where possible) was analyzed. The heavy mineral analyses included determination of the weight percent of heavy minerals and modal analysis (200 counts per slide). Figure 3 is a flowchart of the laboratory procedure used in this investigation.

Figure 3. Flowchart of laboratory procedure.

STEP		
1.	Start	
2.	Split ....>	Save 10% of sample
3.	Oven dry @ 70°C/12 hours and weigh...........>	Total sample weight
4.	Wet sieve ....>	Percent fines (>4.5 phi)
5.	Oven Dry @ 70°C/12 hours and weigh...........>	Percent coarse (≤ 4.5 phi)
6.	Dry seive 100gm @ 25 minutes @ 0.25 phi interval	
7.	Weigh sieve fractions...........>	Granulometric analysis
8.	Form 2-3 phi and 3-4 phi fractions	
9.	Centrifuge separation/tetrabromoethane @ 1000 rpm, 20 minutes...........>	Weight percent heavy minerals
10.	Modal analysis/200 counts per slide ....>	Volume percent heavy minerals

NORTHEASTERN GULF OF MEXICO: GENERAL SETTING

INTRODUCTION

The Gulf Coastal province has an area of approximately 150,000 square miles (388,500 square km) and contains about 50,000 feet (15,240 m) of predominantly arenaceous-argillaceous, marine to shallow marine strata (Murray, 1960). The area of this investigation, (Figure 2) is the inner-continental shelf of the province extending 15 miles (23 km) offshore from Apalachee Bay, Florida (83°40' longitude) to about 15 miles (23 km) offshore of Pensacola, Florida (87°00' longitude). Many modern coastal environments such as deltas, estuaries, shoals and bays exist along this stretch of coast (Figure 2). The climate is humid-semitropical with a mean annual temperature of 68.9°C (20.5°C) and a mean annual rainfall of 56.2 inches (142.8 cm), (Schnable and Goodell, 1968). Marine, coastal and alluvial sediments make up much of the Cretaceous and Tertiary strata of Florida. A veneer of sediments covering seaward portions of the coastal plain represents the Pleistocene.

In the northeastern Gulf of Mexico, the tidal range is approximately 3.3 feet. The surf zone wave energy levels range from "zero" [average annual breaker height much less than 4 inches (10 cm)] in Apalachee Bay to "moderate" [average annual breaker height approximately 9.8 inches (25 cm)] west of Cape San Blas (Tanner, et al., 1961).

RIVERS AND BAYS

The northeastern Gulf of Mexico is essentially a depositional basin with numerous rivers flowing into the bays that border the present coastline. In the study area, the Apalachicola River is the largest river and is a part of the three-state drainage system encompassing 19,614 square miles (50,800 square km), (Leitman,et al., 1983). The system is composed of four major rivers - the Flint, Chattahoochee, Chipola and Apalachicola rivers (Figure 4). The Flint and Chattahoochee rivers originate in northern Georgia, and ultimately join at the Jim Woodruff Dam on Lake Seminole. The Apalachicola River flows south from the dam approximately 66 miles (106 km) to Apalachicola Bay. The drainage basins of the Apalachicola River cover approximately 2,400 square miles (6,200 square km). Sediments from these extensive drainage basins are currently forming a modern delta, which is prograding into the Apalachicola Bay (Donoghue and Bedosky, 1985). However, upstream sediment transport is obstructed by the Jim Woodruff Dam. Apalachicola Bay is part of a lagoon-estuary complex behind St. George and St. Vincent islands.

Located east of the Apalachicola Bay are the Ochlockonee and Apalachee bays. Water and sediment are supplied to them by the Ochlockonee River. The Aucilla and St. Marks rivers, which drain the north Florida-south Georgia Coastal Plain, flow into the Apalachee Bay (Figure 4).

Four major bays are located within the western portion of the study area. From east to west, they are the St. Joseph, St. Andrews, Choctawhatchee and Pensacola bays. The morphology of these bays is similar to that of Apalachicola Bay in that they are bounded by barrier islands. St. Joseph Bay is an exception due to its confinement by a large spit (St. Joseph Spit). With respect to other bays in the study area, St. Joseph and St. Andrews bays are not recipient to any major rivers or drainage systems. Choctawhatchee Bay is primarily fed by the Choctawhatchee River while the largest rivers draining into the Pensacola Bay system are the Yellow and Escambia rivers. These three rivers transport sediment from the coastal plain of southern Alabama and the Florida panhandle (Figure 4).

BARRIER ISLANDS

The barrier island systems flanking Apalachicola Bay and St. George Sound consist of Dog Island, St. George Island, and St. Vincent Island. The eastern-most and smallest of the three islands, Dog Island, owes its present shape to two opposing littoral drift cells (Stapor, 1971). St. George Island, which is the largest of the three is approximately 28 miles (45 km) in length, 1 mile (1.5 km) in width. The island has the shape of a triple arc with two convex seaward arcs and a concave seaward arc in between (Schade, 1985). St. Vincent Island, a wedge-shaped barrier island, lies west of St. George Island. St. Vincent Island is approximately 9 miles (14.5 km) long, and 7 miles (11 km) wide at its east end but tapers to a point at its west end. Significant shoreline morphologies proximal to these islands are Alligator Peninsula to the east and the larger St. Joseph Spit to the west. Beach and dune ridges are common features of barrier islands, spits, and the mainland coast in this area.

In the Panama City region, Crooked Island and Shell Island separate St. Andrews Sound into an eastern and western portion. In the Pensacola region, Santa Rosa Island extends about 50 miles (80.5 km) from the mouth of Pensacola Bay to the mouth of Choctawhatchee Bay.

SHOALS

Several offshore sand bars or shoals exist in the vicinity of Dog Island, St. George Island, and Cape San Blas (Figure 2). These shoals are reported to contain high concentrations of heavy minerals (Tanner, et. al., 1961). West of Cape San Blas, the inner continental shelf is practically devoid of any major sand bars. The absence of sand bars in this region might be attributed to higher energy levels and a steeper shelf slope.

Three prominent shoals in the vicinity of Dog Island are Dog Island Reef, South Shoal and Ochlockonee Shoal. Dog Island Reef lies parallel to the coast between Dog Island and Alligator Harbor. The South Shoal extends into the Gulf approximately 5 miles (8 km) south of Alligator Harbor. Ochlockonee Shoal lies approximately 8 miles (13 km) southeast of Ochlockonee Bay.

Two well developed shoals seaward of Cape San Blas and St. George Island are important morphological features in this area. These shoals extend about 10 miles (16 km) into the Gulf and are characterized by broad irregular ridges and troughs.

Dog Island Reef, South Shoal, and Ochlockonee Shoal are believed to be drowned barrier islands (Schnable and Goodell, 1968). The origin of Cape San Blas Shoal and Cape St. George Shoal is unresolved.

Figure 4. Apalachicola River drainage system.

GRANULOMETRIC ANALYSES

INTRODUCTION

Granulometric moment measures include the mean grain size, standard deviation, skewness, and kurtosis. These textural parameters, along with the percent fines (finer than (>) 4.5 phi), reflect the physical processes operating at the site of deposition. Ostensibly, a set of physical processes is unique to a particular environment. The size frequency of particles in a sedimentary environment is thought to be a function of (1) the availability of source material, (2) the processes of erosion, transportation, and deposition, and (3) the energy level in the environment (Greenwood, 1969).

Sample mean grain size is the average grain size of a sediment sample. This parameter is thought to be an indicator of the availability of various sediment sizes for a given deposit.

Sample standard deviation is a measure of grain size dispersion about the sample mean. Values of standard deviation are used to indicate the relative degree of sorting in sediments. Well-sorted sediments have low standard deviation values. The scale of Friedman (1962) for sorting values is used in this study.

Sample skewness defines the symmetry of a grain size distribution. Negative skewness values indicate a dominance of fine-grained particles in the sample, whereas a positive value indicates that the sample contains a relative abundance of coarse grained particles. A gaussian or normal distribution has a skewness value of zero.

Sample kurtosis is a measure of the relative peakedness of a distribution. The gaussian distribution is mesokurtic and has a kurtosis value of three. Leptokurtic curves are more peaked and have kurtosis values exceeding three. This type of curve indicates that the population is concentrated in the central portion of the curve, hence better internal sorting of sediments. Platykurtic distributions, on the other hand have flatter curves with values less than three. Platykurtic curves generally indicate poorer sorting and tend to be coincident with high standard deviation values.

The percent fines within a sample is commonly used to differentiate fluvial from marine environments. The fine fraction is grouped in the >4.5 phi size class for the following reasons: (1) most samples have a very low percentage of fines; and (2) in that this study pertains to heavy mineral reconnaissance, granulometry of the sand size fraction is more relevant in understanding factors controlling heavy mineral distribution.

RESULTS

Results of textural analysis of samples from the northeast Gulf of Mexico (Appendix II) indicate that few overall longitudinal (east-west) trends exist within the data. However, several semi-regional trends are observed. Four point running averages (average of four transect averages) of two of the moment measures and of percent fines (Appendix III) were calculated and plotted versus longitude in order to enhance these distributions. Note that abbreviations for coastal features are included in Figures 5 through 7, 16 and 17. For purposes of discussion, these coastal geographic features are referred to as representative of actual sample locations, although we recognize that the features are actually north of the sediments.

Mean grain size is variable, but is consistently within the medium sand size grade: grand mean grain size equals 1.62 phi. Values of this parameter range from 1.25 phi to 2.87 phi. Figure 5 is a plot of four point running averages of mean grain size versus longitude. From Apalachee Bay westward to St. George Island, mean grain size generally decreases. A well-defined peak occurs symmetrically about the St. Andrews Bay area, coarsening to a maximum average value of 1.81 phi. A smaller, more poorly-defined peak is centered around Choctawhatchee Bay. The minimum mean grain size of these two peaks averages 1.35 phi.

Standard deviation four point running averages range from 0.66 phi (moderately well sorted) to 0.93 phi (moderately sorted). The mean of standard deviation values is 0.79 phi. Variation between four point running averages of standard deviation versus longitude (Figure 6) is inverse to that of the mean grain size distribution (Figure 5) in the central portion of the study area. Moderately sorted sediments occur near Dog Island Shoal, Cape San Blas and Pensacola Bay. Two peaks of standard deviation values represent moderately sorted sediments near St. George Island and midway between St. Andrews and Choctawhatchee bays. These two areas correspond to minimum mean grain size values.

The distribution of percent fines (weight percent) as four point running averages versus longitude (Figure 7) shows a correlation between high values and the areas near Apalachee Bay, Dog Island, Cape St. George, and immediately east of St. Andrews and Choctawhatchee bays. The areas between these localities and west of Choctawhatchee Bay contain a relatively lower percentage of fines. Also, the peak in percent fine values east of Choctawhatchee Bay roughly corresponds to a peak in mean grain size and standard deviation values for the same area. Values of percent fines (and to a lesser degree, mean grain size and standard deviation) show a general westward decrease throughout the study area (Figures 5, 6 and 7). Percent fines range from 0.00 to 22.66 and average 2.02.

Skewness and kurtosis are not plotted against longitude since they explain information similar to that of mean grain size and standard deviation, respectively. Skewness values average -0.38, indicating that samples generally have a coarse tail distribution. The mean kurtosis value equals 4.70, indicating that the average grain size distribution is slightly more peaked than a gaussian distribution.

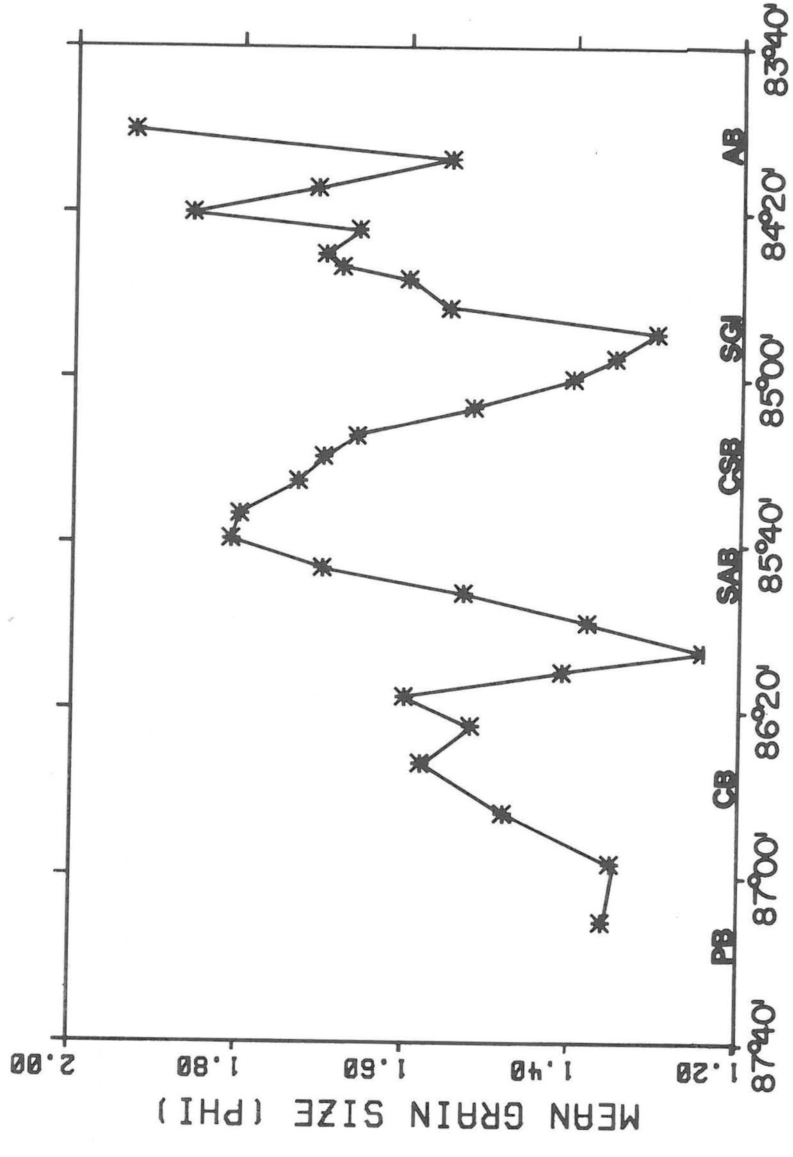

Figure 5. Four point (transect averages) running averages of sample mean grain size (phi units) versus longitude. PB is Pensacola Bay; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; CSB is Cape San Blas; SGI is St. George Island. AB is Apalachee Bay.

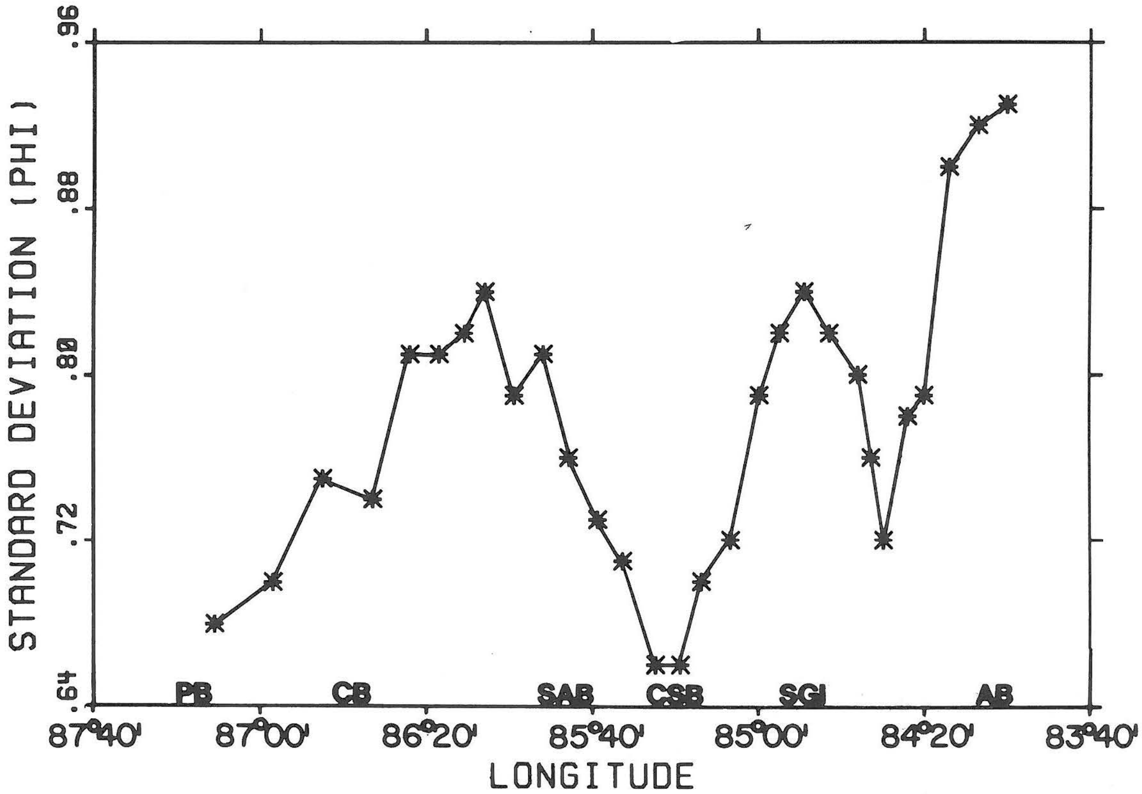

Figure 6. Four point (transect averages) running averages of sample standard deviation (phi units) versus longitude. PB is Pensacola Bay; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; CSB is Cape San Blas; SGI is St. George Island; AB is Apalachee Bay.

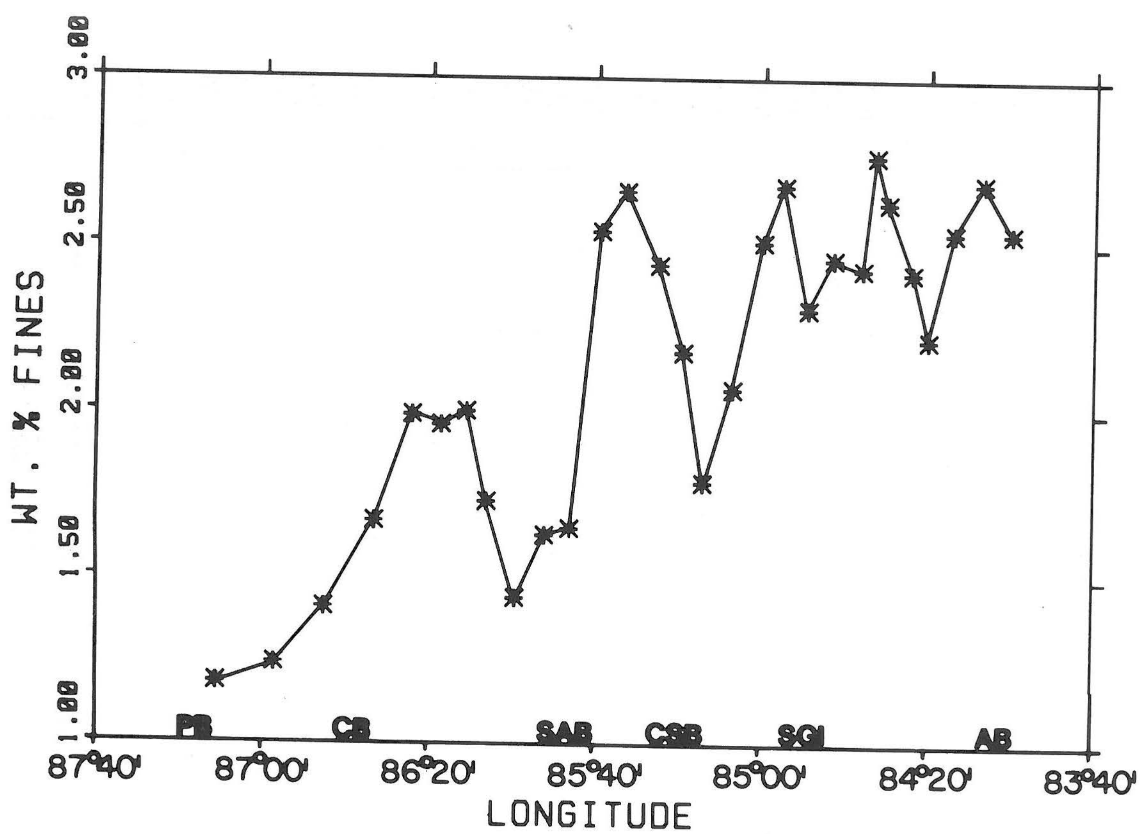

Figure 7. Four point (transect averages) running averages of sample percent fines > 4.5 phi versus longitude. PB is Pensacola Bay; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; CSB is Cape San Blas; SGI is St. George Island; AB is Apalachee Bay.

DISCUSSION

Interpretation of individual textural parameters, their interrelationships and grain size distributions indicates that sediments from the northeastern Gulf of Mexico are predominately fluvial in origin despite their present location within a low to moderate energy coastal area. Reworking of these sediments during Pleistocene sea level fluctuations was not efficient or rapid enough to remove the fluvial characteristics from the sediments. In the following discussion, bivariate plots confirm the fluvial origin; however, the influence of coastal or marine processes cannot be totally eliminated.

By plotting granulometric moment measures for more than 250 samples of known environments, Friedman (1961) has delineated bivariate fields representing beach, river and dune environments. Figure 8 is a plot of sample skewness versus sample standard deviation. When compared to Friedman's (1961) delineation, approximately 80 percent of the samples plot as river sediments. Similarly, the plot of sample kurtosis versus sample skewness (Figure 9) also indicates that the samples contain fluvial textural characteristics. The samples that plot as beach sediments on Figures 8 and 9 are located either proximal to a shoal or within the northern third of a transect (nearest the coastline).

Variation in percent fine data also separates beach from river samples (Tanner, 1985, unpublished research). This is shown in the bivariate log-log plot of the standard deviation of percent fines versus the mean of percent fines of Figure 10. The percent fines in this diagram is the weight percent greater than or equal to 4.0 phi. Note that all but two of the beach samples are from the northeastern Gulf of Mexico. The field of points representing transect averages plots within the "river" field, again suggesting a fluvial origin. A notable variation within the data on Figure 10 is that the standard deviation of percent fines for transects 23 through 29 decreases from 1.5 to 0.2. Increased sorting within the fine fraction westward from Choctawhatchee Bay is in accordance with decreasing values of mean grain size, standard deviation and percent fines (Figures 5, 6 and 7), all of which may be due to higher energy levels and a steeper shelf slope within the area.

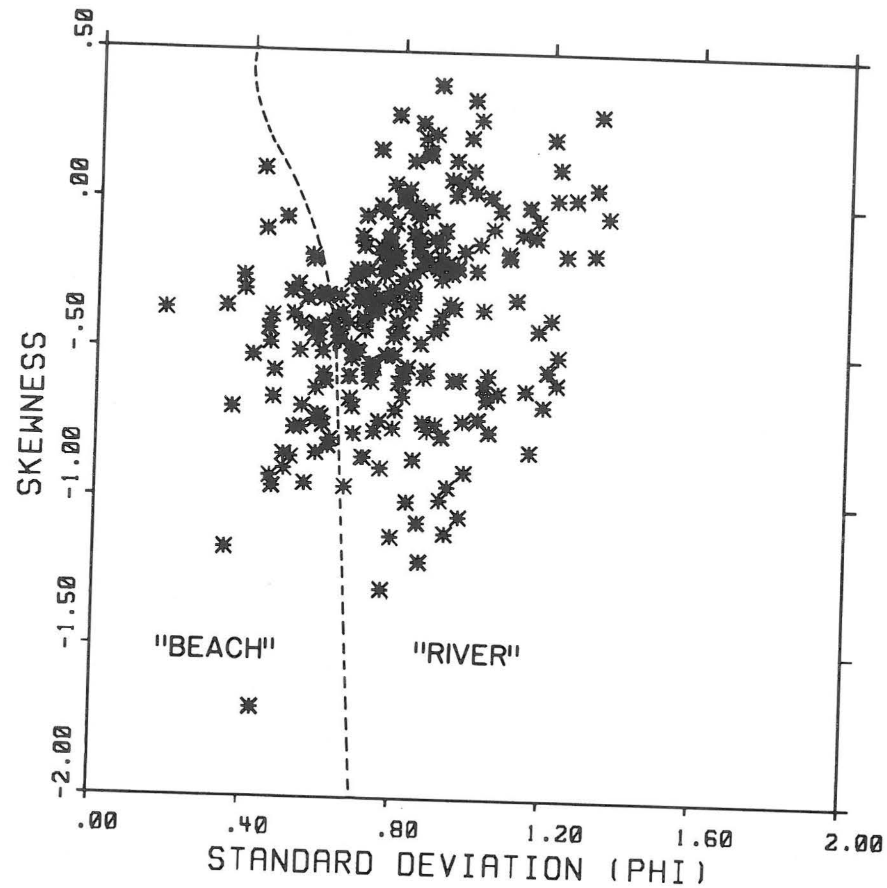

Figure 8. Sample skewness versus sample standard deviation. Beach and river reference fields are transposed from Friedman (1961).

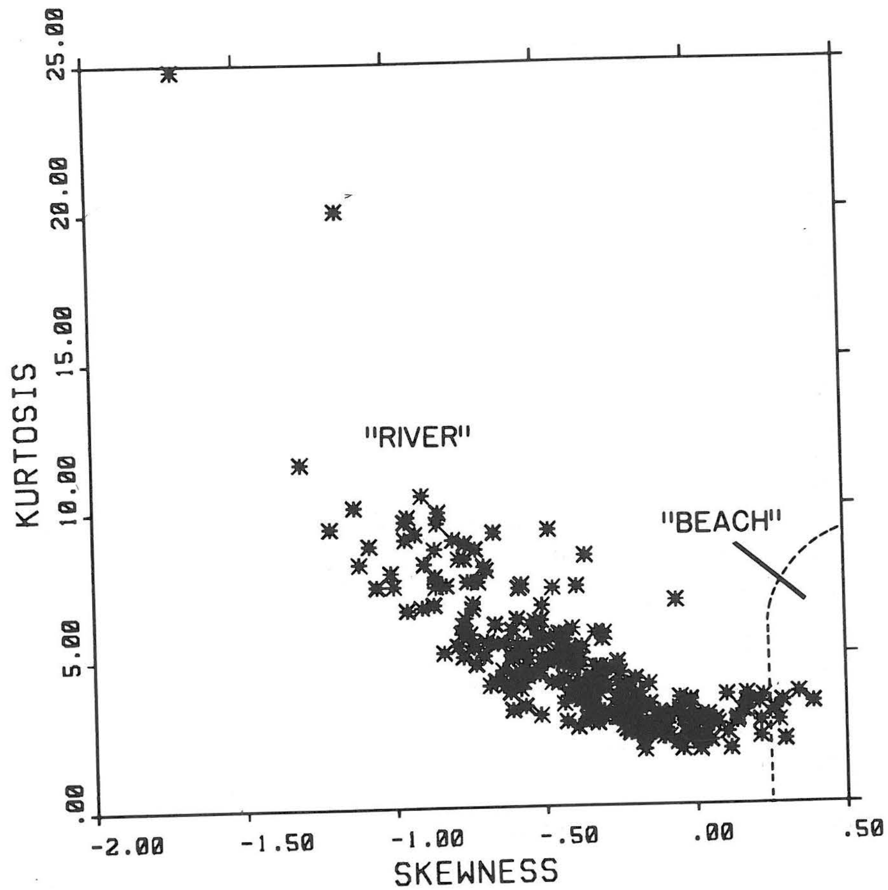

Figure 9. Sample kurtosis versus sample skewness. Beach and river reference fields are transposed from Friedman (1961).

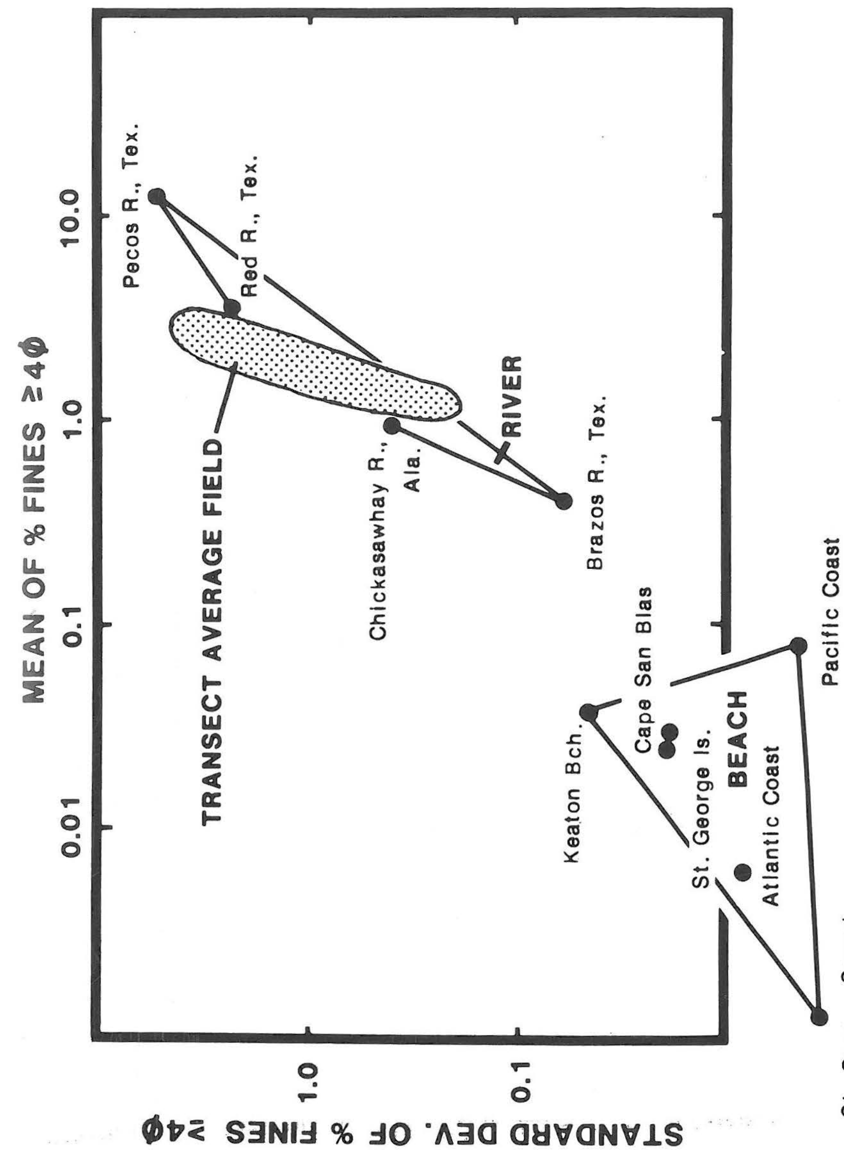

Figure 10. Log-log plot of sample suite standard deviation of percent fines versus sample suite mean of percent fines (Tanner, 1985, unpublished research).

Figure 11 contrasts variability (standard deviation) among sample suite means and sample suite standard deviations (Tanner, 1979). This plot emphasizes that no environments are mutually exclusive and that narrowly defined depositional processes operate in more than one depositional environment. Environments represented on the diagram are swash, dune, lagoon, offshore, coastal plain stream and mountain stream. The point representing the grand average of all samples for these two parameters falls within the coastal plain stream field. With respect to overlapping fields and transect averages, swash and offshore wave environments cannot be eliminated as possible depositional environments, although a fluvial origin accounts for most of the samples.

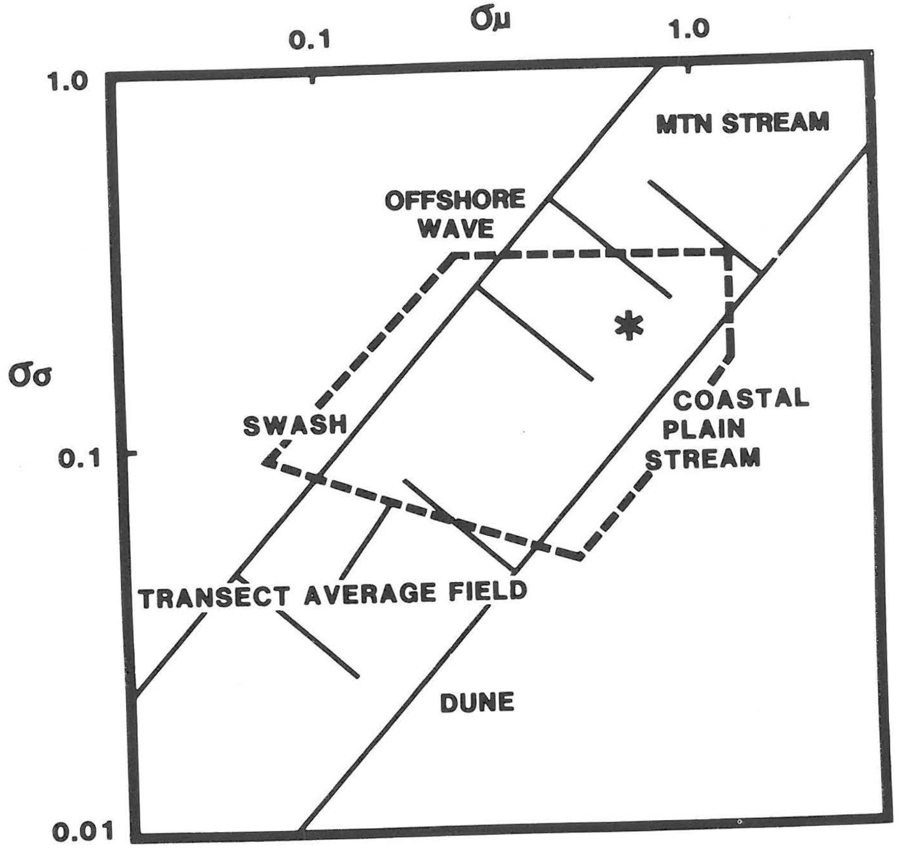

Figure 11. Log-log plot of sample suite standard deviation of means versus sample suite standard deviation of standard deviations (Tanner, 1979). Asterisk indicates the grand average value of samples from the study area.

Prior to discussion of the probability plots, a brief description of their application and data distribution is warranted. Probability plots are constructed by plotting the log of grain size class (phi) versus cumulative weight percent on arithmetic probability paper. These plots characterize sediment sorting, population mixing and other subtle textural characteristics within a sample. A gaussian distribution is observed as a linear segment on a probability plot. A combination of these linear segments may represent two or more components that make up the grain size distribution of a sample (Tanner, 1959). In some cases, the inflections between these segments represent "surf breaks" (Tanner, 1966). A "surf break" is a concave inflection in the coarse or middle part of a probability plot representing a winnowing process due to wave or surf action (Tanner, 1966). The slope of each linear segment represents the internal standard deviation of its distribution. Consequently, the plot of a normally distributed, well sorted sediment will have a gentle slope. Truncations of linear segments within the first and last tenths (10.0 weight percent) of the Y-axis may indicate the presence of a coarse or fine tail, respectively. Figure 12 illustrates textural characteristics of eolian, river beach and sediments on a probability plot. Included in the beach sample are gentle slopes, surf breaks, and the presence of coarse and fine tails. Configurations of eolian samples may contain convex inflections adjacent to a well sorted normal distribution of finer-grained particles and the absence of a coarse tail. Alluvial samples would typically plot as several linear segments with relatively steep slopes (both indicative of poor sorting) and a pronounced tail of fines or a high percentage of fines.

Figures 13 and 14 are probability plots representing the two most common, interpretable sample grain size distributions within our study area. The distribution of sample 26-5 (Figure 13) has characteristics most indicative of a beach or near-shore marine environment: coarse and fine tails, a possible surf break and relatively good sorting. The poor sorting and high percentage of fine particles reflected in the distribution of sample 19-2 (Figure 14) may best represent a fluvial environment, since it does not appear to contain eolian or beach characteristics. A large number of probability plots in our investigation show a single, apparently gaussian grain size distribution. Although many of these plots are problematic in their interpretation, a portion of the samples may reflect both fluvial and marine textural characteristics.

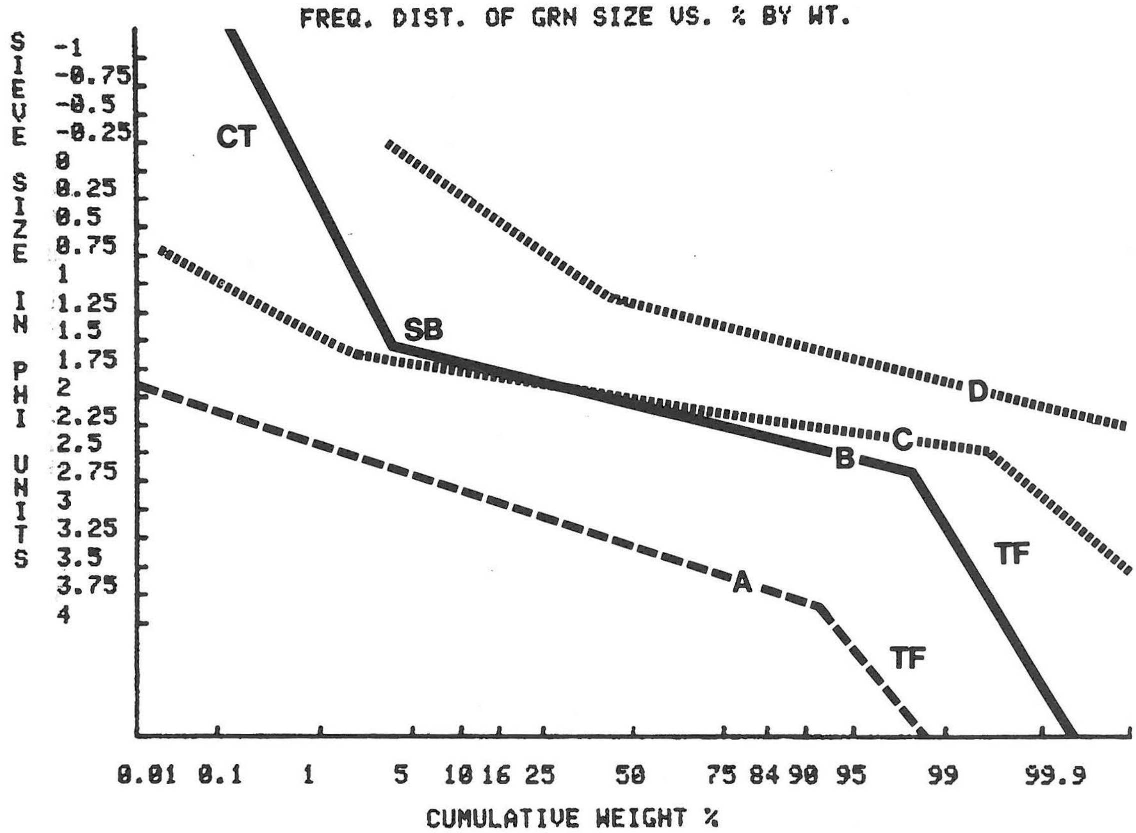

Figure 12. Representative grain size distributions on probability plots: A-Brazos River (Visher, 1969); B- sand placed in a beach environment (Tanner, 1966); C-Cape San Blas beach dune ridge (Visher, 1969); and D- Altamaha River (Visher, 1969). SB-surf break; CT-coarse tail; FT-fine tail.

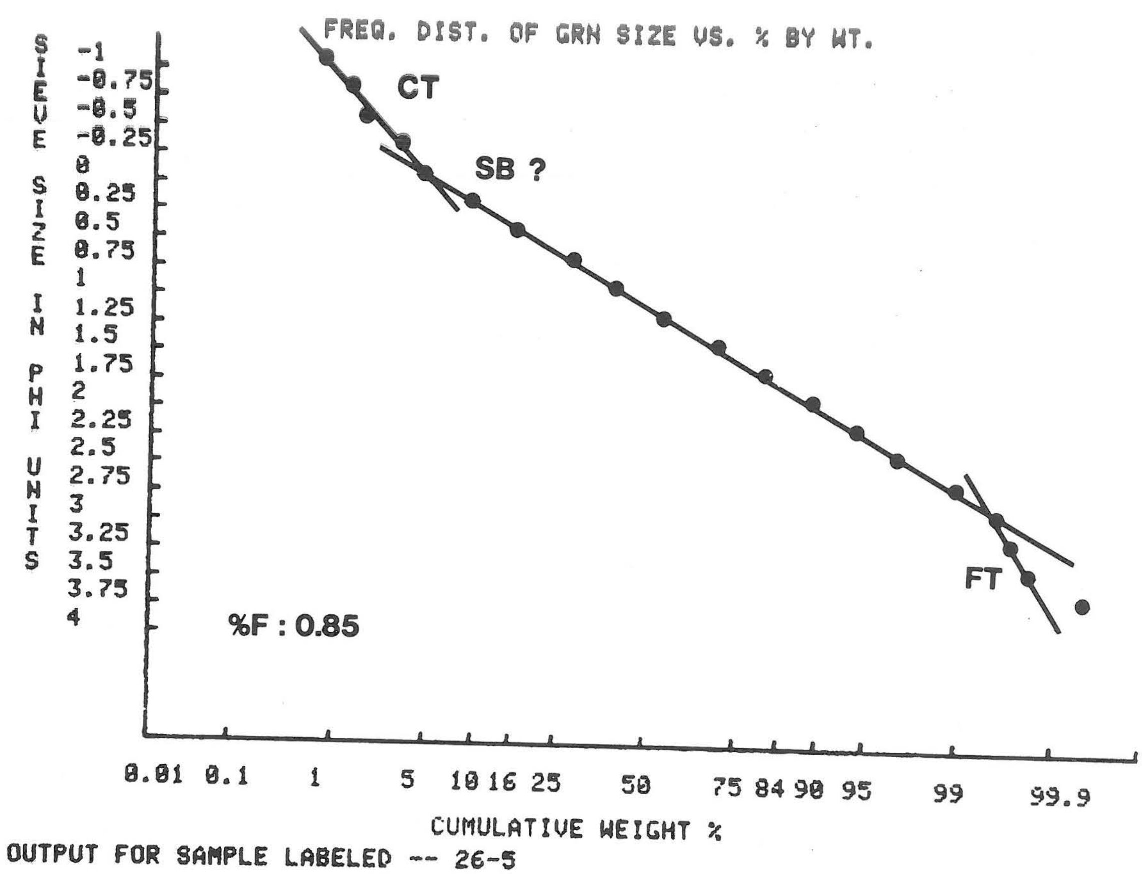

Figure 13. Probability plot of a representative sample within the study area. SB-surf break; CT-coarse tail; FT-fine tail.

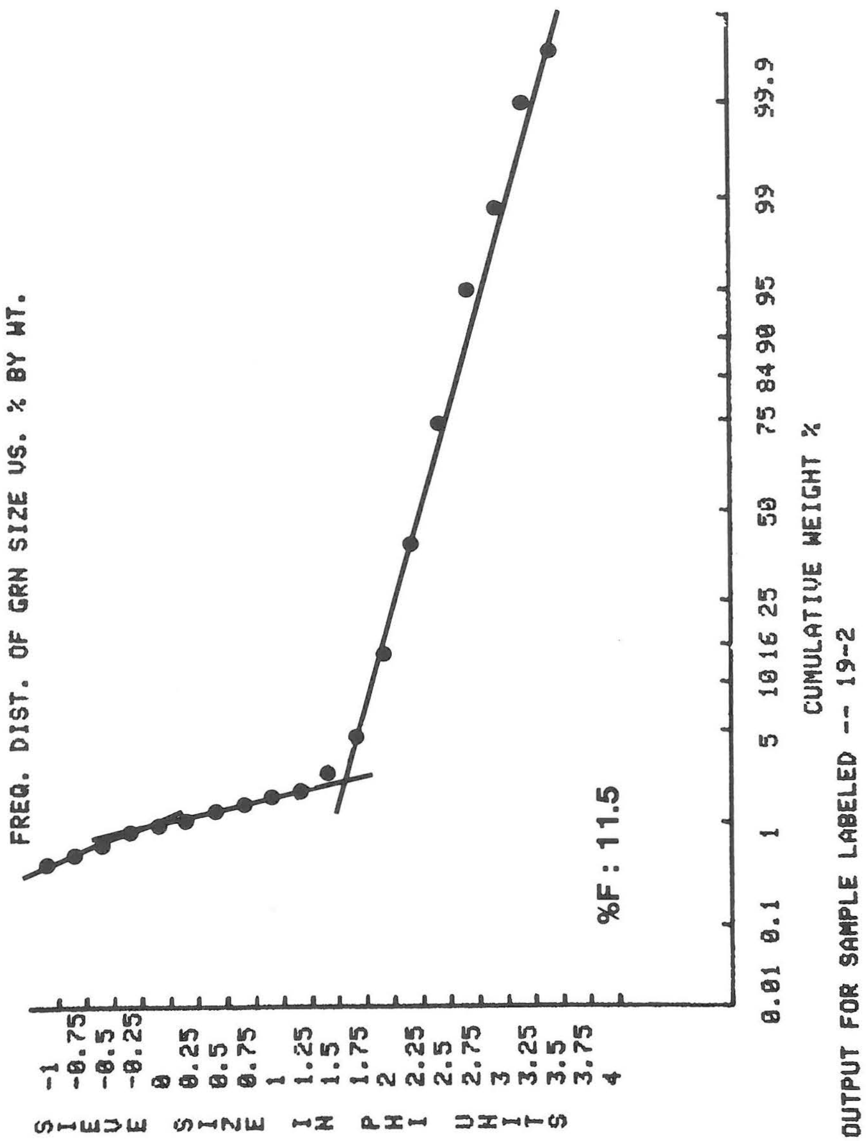

Figure 14. Probability plot of a representative sample within the study area.

HEAVY MINERAL RECONNAISSANCE

INTRODUCTION

The data base of this heavy mineral reconnaissance includes: (1) analysis of 250 samples for heavy mineral concentration in the 2 to 3 phi interval (2) analysis of 32 samples (one representative per transect) for heavy mineral concentration in the 3 to 4 phi interval and (3) modal analysis of the heavy minerals fraction. The 2 to 3 phi fraction was analyzed in much more detail because the 3 to 4 phi fraction typically contains a higher modal concentration of ultrastable minerals. This method provides a more diverse suite of heavy minerals due to the fact that the metastable mineral group would be more accurately represented for interpretation. Furthermore, the 2 to 3 phi fraction represents a much greater volume of the total sample as is documented by sample mean grain size in Appendix II.

HEAVY MINERAL CONCENTRATION

In the 2 to 3 phi fraction, heavy mineral concentrations range from 0.01 to 4.35 weight percent and average 0.51 weight percent (N=250) within the study area (Appendix IV). Sample concentrations times 100 are contoured on Figure 15. Local variations indicate high concentrations (2.0 weight percent) approximately 15 miles (24 km) south of Dog Island and west-central St. George Island and approximately 5 miles (8 km) south and 20 miles (32 km) southwest of Choctawhatchee Bay. Figure 16 illustrates the regional pattern of heavy mineral concentrations as a plot of four-point running averages versus longitude (Appendix III). Regional "highs" are located seaward of St. George and Santa Rosa islands (1.0 weight percent). The trend also indicates a westward increase in heavy mineral content (2 to 3 phi fraction) throughout the study area.

The regional distribution of heavy minerals in the 3 to 4 phi fraction mirrors that of the 2 to 3 phi fraction (Figure 17). The average concentration of heavy minerals in the 3 to 4 phi interval is 4.39 weight percent (N=32) and ranges from a low of 0.33 weight percent at transect 3 to a high of 18.78 weight percent at transect 16 (Appendix V).

In a comparison of semi-regional heavy mineral concentrations and textural characteristics of sediments within the study area, one possible correlation is observed. There appears to be an inverse relationship between four point running averages of transect mean grain size and weight percent heavy minerals (either fraction) with respect to longitude (Figures 5 and 16). For example, the relatively high concentrations within sediments near St. George Island correspond to relatively low mean grain size values for the region. Hydrodynamic processes responsible for the semi-regional fluctuations in mean grain size may also account for the relative heavy mineral enrichments. Further investigation of this apparent relationship is warranted.

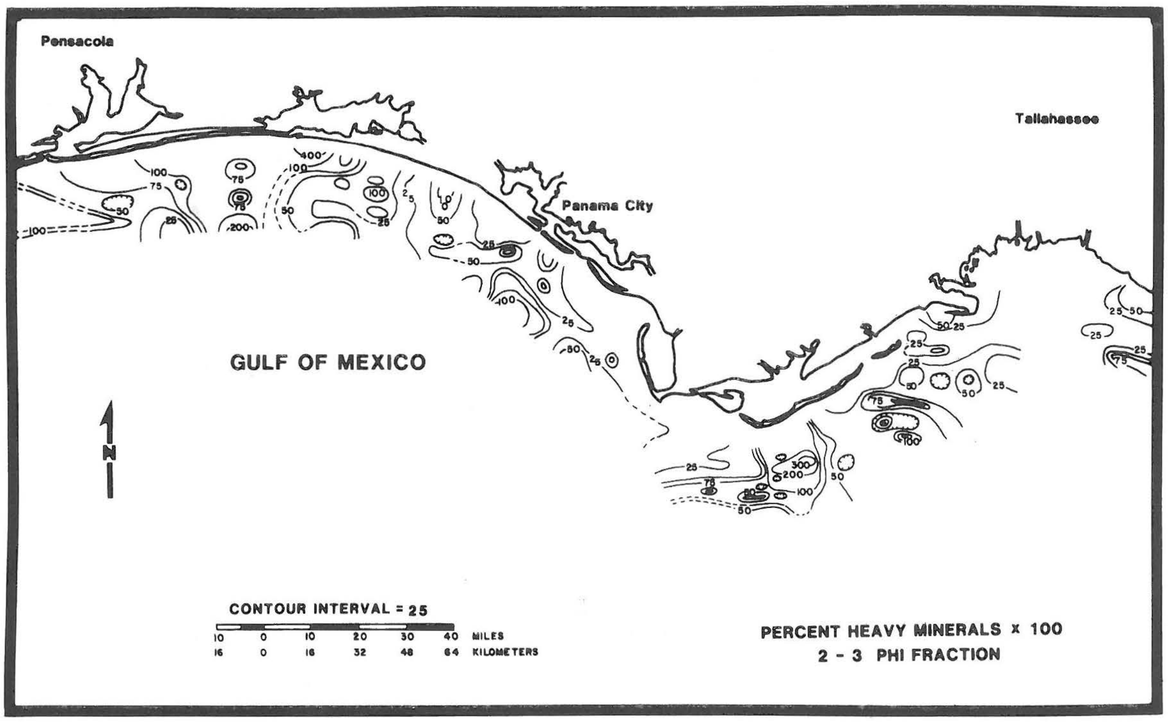

Figure 15. Distribution of weight percent heavy minerals within the 2-3 phi fraction. Note that the contour interval equals 100 for values greater than 100.

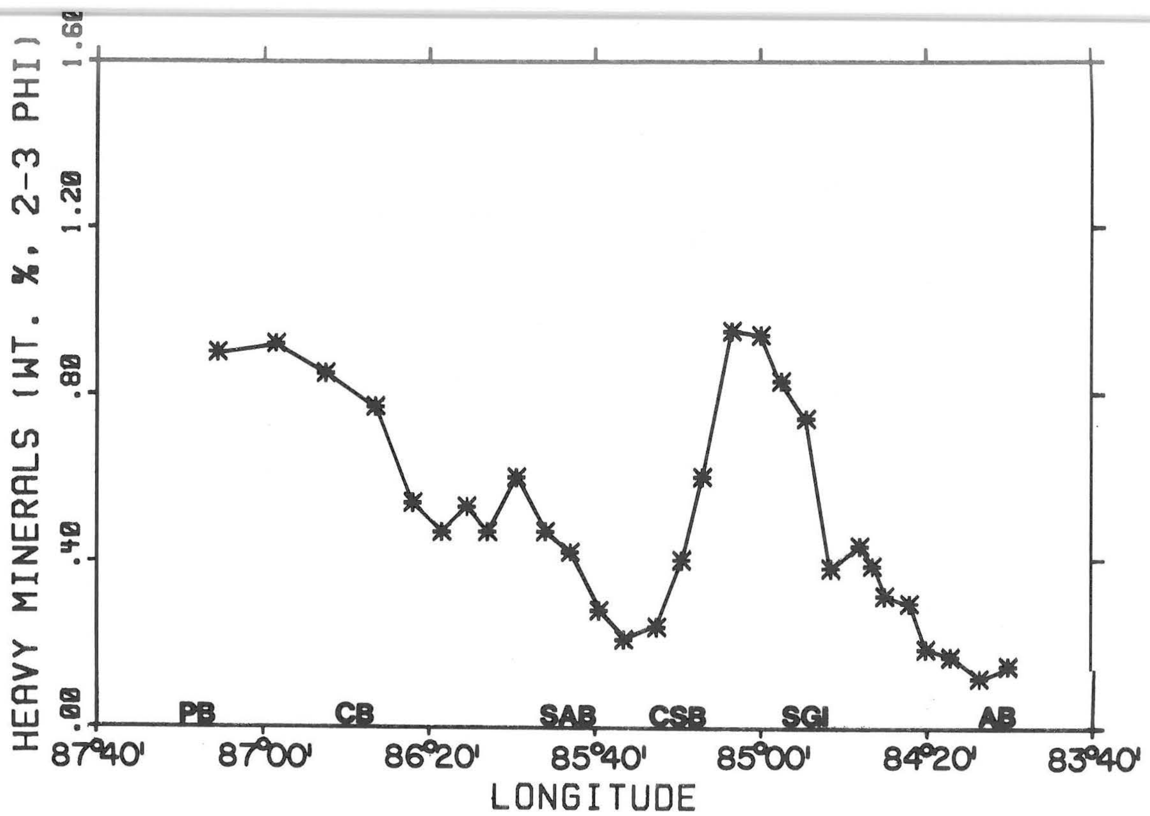

Figure 16. Four point (transect averages) running averages of weight percent heavy minerals within the 2-3 phi fraction versus longitude. PB is Pensacola Bay; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; CSB is Cape San Blas; SGI is St. George Island; AB is Apalachee Bay.

HEAVY MINERAL PROVENANCE

A provenance is defined as the "place of origin" or "the area from which the constituent minerals of sediment, sedimentary rocks or facies are derived" (Gary, et al., 1972). A heavy mineral provenance is the igneous and/or metamorphic source area contributing the heavy minerals to a receiving basin. Similar heavy mineral suites reported for proximal study areas may indicate similar provenance. Table 2 enables comparison of nearby heavy minerals suites reported by Goldstein (1942) and Drummond and Stow (1979) to the suite occurring in the present study area. Noting the proximity and similarity of mineral species and proportions among these suites, one may infer that the suites originated from the same provenance. These suites are characterized by the presence of kyanite, staurolite, tourmaline, zircon and opaque minerals. In agreement with

Table 2. Heavy minerals percentages of the heavy mineral fraction reported for northwest Florida, Alabama and Mississippi. NR = not reported.

	OFFSHORE NW FL. (PRESENT STUDY)		OFFSHORE ALA. AND MISSISSIPPI	OFFSHORE FL. AND ALA.
	2-3 phi (N=247)	3-4 phi (N=32)	Drummond and Stow, (1979)	Goldstein, (1942)
Opaques (Ilmenite)	32.1	42.6	28	27.0
Kyanite	24.7	16.5	22	10.8
Staurolite	13.9	9.4	18	9.4
Tourmaline	12.4	5.7	19	5.8
Zircon	3.3	8.7	7	7.0
Rutile	3.0	3.6	0.3	2.9
Epidote	2.8	1.7	NR	8.7
Sphene	3.0	1.6	NR	NR
Amphibole	2.3	0.7	NR	3.6
Sillimanite	1.8	4.2	2	1.5
Garnet	0.4	0.4	NR	0.8
Leucoxene	1.0	4.8	3	8.5

the findings of Goldstein (1942) and Drummond,et al., (1979), it is concluded that the heavy mineral provenance for the shelf sediments on the northeastern Gulf of Mexico is the crystalline belt of the southern Appalachian Piedmont. Although the ultimate source of heavy minerals is located north of the study area, Tanner (1985, personal communication) has proposed that sediments more recently were moved northward as sea level rose. These sediments were deposited as bars and shoals during low Pleistocene sea-level stands. Pertinent to this discussion is the fact that the Apalachicola River system presently does not contribute sediments to the Gulf. Instead, modern sediments are trapped in lagoons and estuaries (Doyle and Sparks, 1980; Donoghue and Bedosky, 1985). Drummond and Stow (1979) suggest that offshore shelf and shoals contribute

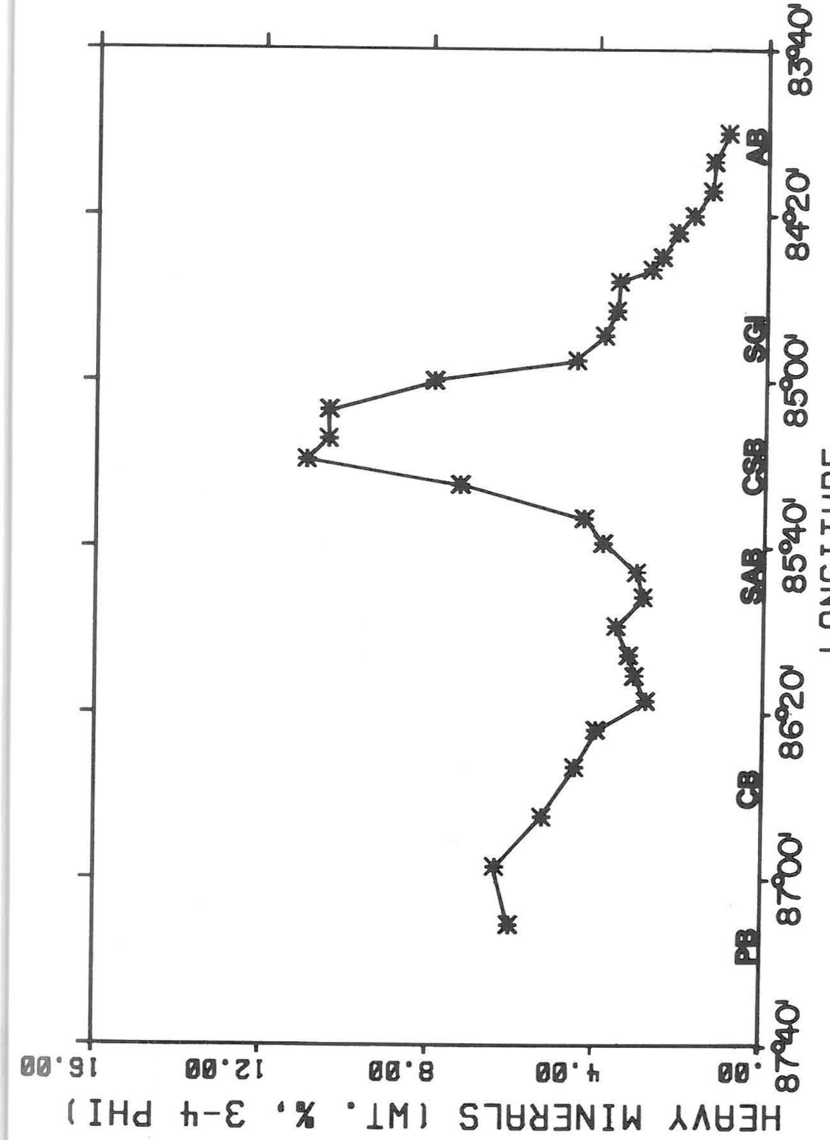

Figure 17. Four point (sample) running averages of weight percent heavy minerals within the 3-4 phi fraction versus longitude. PB is Pensacola Bay; CB is Choctawhatchee Bay; SAB is St. Andrews Bay; CSB is Cape San Blas; SGI is St. George Island; AB is Apalachee Bay.

sediments to the Alabama and Mississippi coastal areas as well.

DISTRIBUTION OF HEAVY MINERALS

Modal percentages of individual heavy minerals within the 2 to 3 phi heavy mineral fraction (Appendix IV) are contoured in figures 18 through 24. Average values of these minerals are listed in Table 2. Several local variations occur between Apalachee Bay and Cape San Blas as opposed to the more regional trends in the western half of the study area. In the discussion of concentrations in the finer grain size interval (3-4 phi, Appendix V), the reader is reminded that these data represent one sample per transect. Therefore, it is difficult to distinguish whether observed values from this size fraction represent local or regional trends.

OPAQUES

Figure 18 shows the distribution of the opaque group minerals, ilmenite, magnetite, and leucoxene. Highest concentrations (60 modal percent) within the 2-3 phi heavy mineral fraction occur near the shoals offshore of St. George and Dog Islands and in Apalachee Bay. Samples from the east-central portion of this bay contain the lowest concentrations within the study area (15 modal percent). Apalachee and St. Andrews bay sediments contain the lowest modal concentrations of opaques in the 3 to 4 phi heavy mineral fraction. Highest concentrations within this finer grain size interval occur offshore between St. Andrews and Choctawhatchee bays.

ULTRASTABLES

The ultrastable group minerals identified in this study include zircon, tourmaline and rutile. Local concentrations of zircon (15 modal percent, 2-3 phi) occur in the heavy mineral fraction of sediments seaward of Dog Island and Choctawhatchee Bay (Figure 19). In the 3 to 4 phi interval, the same area south of Dog Island and also sample number 1-5 contain zircon greater than 20 modal percent. The tourmaline distribution (Figure 20) best exemplifies the trend typical of all heavy minerals in the study area, having smooth regional trends in the west as opposed to irregular local variations in the east. Maximum concentrations of tourmaline occur in the eastern half of Apalachee Bay (30 modal percent, 2-3 phi) and seaward of Panama City (10 modal percent, 3-4 phi).

A westward decrease in rutile concentrations within the coarser sediment heavy mineral fraction is shown in Figure 21. High concentrations of rutile are observed in samples seaward of the eastern tip of St. George Island (12 modal percent). In the same location, heavy minerals in the 3 to 4 phi fraction contain the highest modal concentration of rutile.

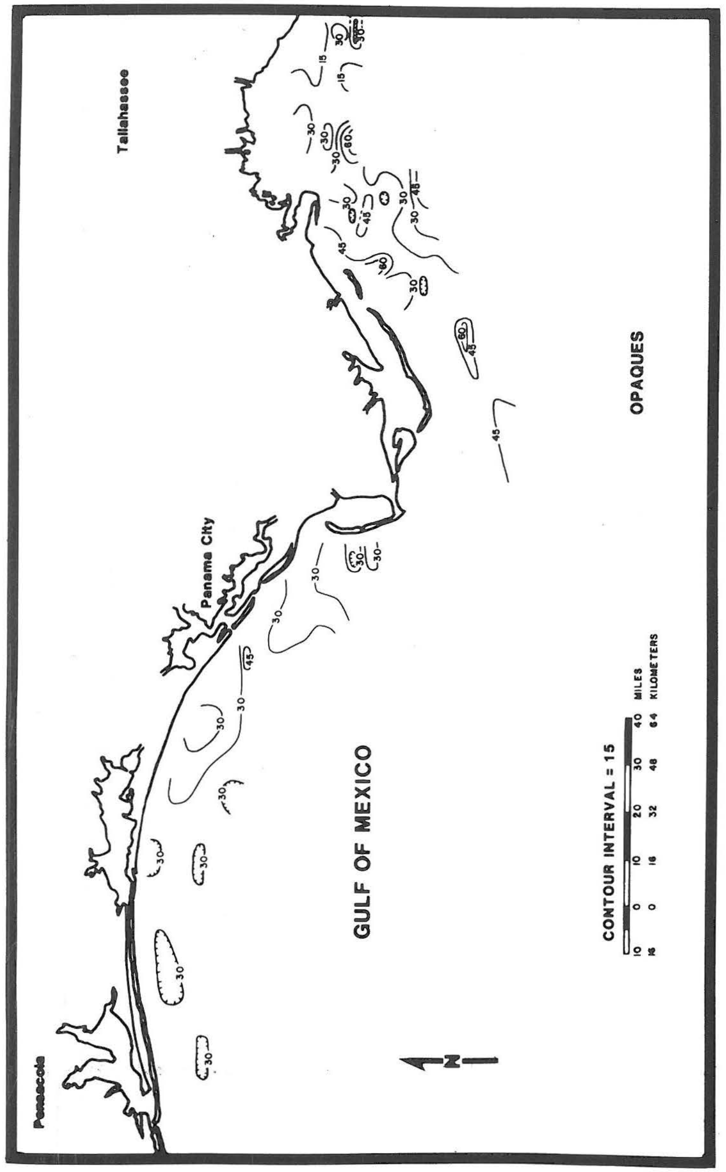

Figure 18. Distribution of opaque minerals (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

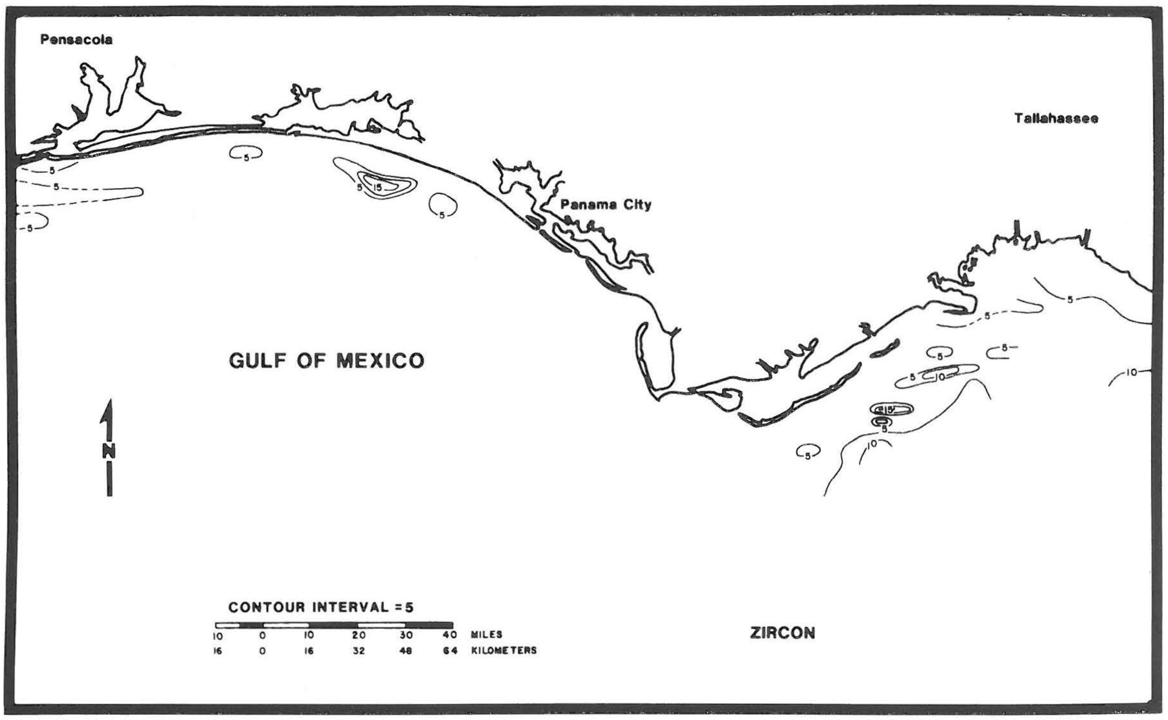

Figure 19. Distribution of zircon (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

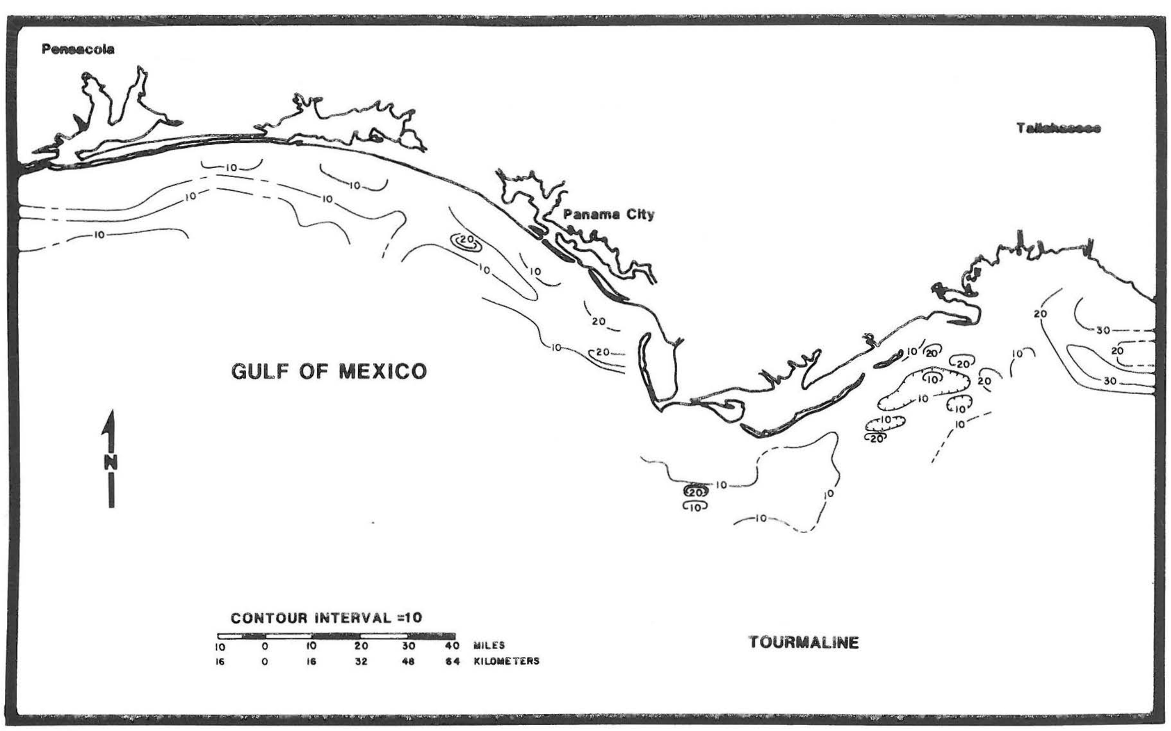

Figure 20. Distribution of tourmaline (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

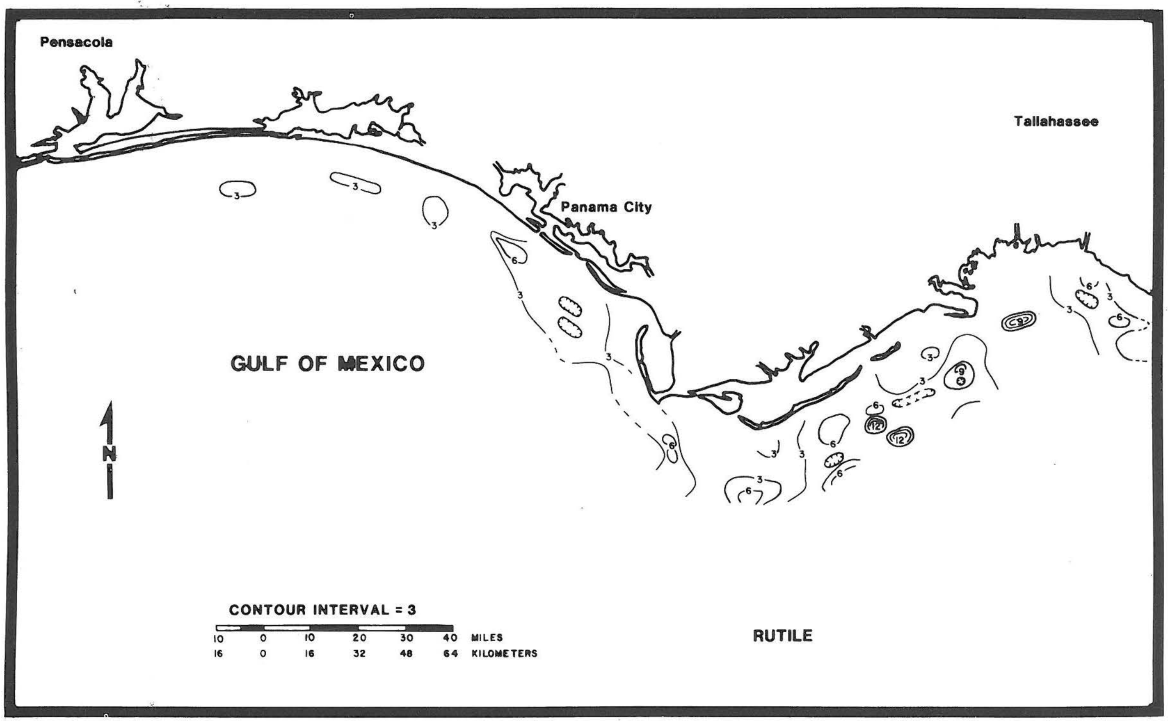

Figure 21. Distribution of rutile (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

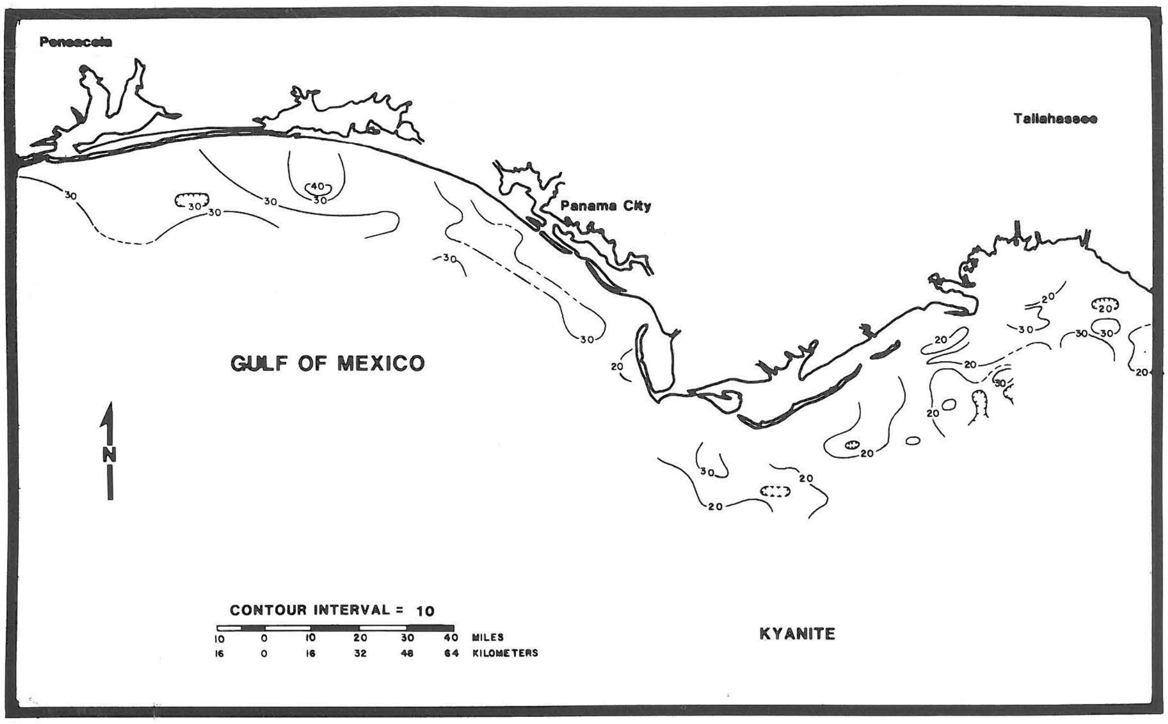

Figure 22. Distribution of kyanite (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

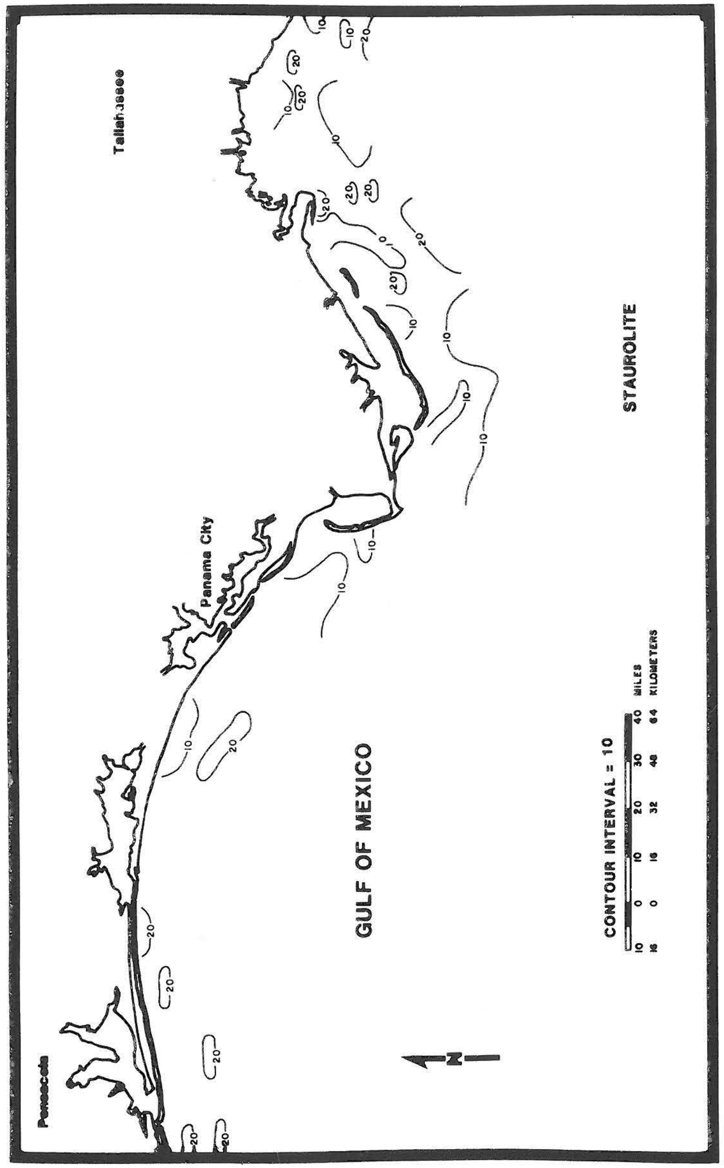

Figure 23. Distribution of staurolite (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

METASTABLES

Figures 22 and 23 show the distribution of kyanite and staurolite, respectively. The other metastable minerals, garnet, sphene, amphibole and sillimanite are not shown due to the fact that they are present only in trace amounts (values $\leq$ 3.0 modal percent) within the 2 to 3 phi heavy mineral fraction. Instead, these four minerals will be discussed with respect to the epidote distribution shown on Figure 24.

West of Cape San Blas, the kyanite mode averages 25 percent and shows a homogenous distribution (Figure 22). In the eastern half of the study area, kyanite is less abundant with the exception of sediments proximal to the shoals. Staurolite, however is relatively homogeneous in its distribution throughout the study area (Figure 23). Maximum observed concentrations of kyanite and staurolite in the 3 to 4 phi heavy mineral size grade occur in samples 20-5 (30.3 modal percent) and 16-5 (15.3 modal percent), respectively.

Figure 24 shows the distribution of epidote within the study area. The concentration of epidote in sediments between and offshore from Alligator Point and Dog Island corresponds to areas of maximum concentrations of garnet, amphibole and sphene (Appendix IV). Comparatively high concentrations of hornblende are also found near the epidote maximum (12 percent contour) within sediments near Cape St. George Shoal (Figure 24). Additional maximum garnet concentrations occur within samples from the southern half of transect 14. Within the 3 to 4 phi fraction, maximum concentrations of epidote, sillimanite and amphibole occur between transects 19 to 20.

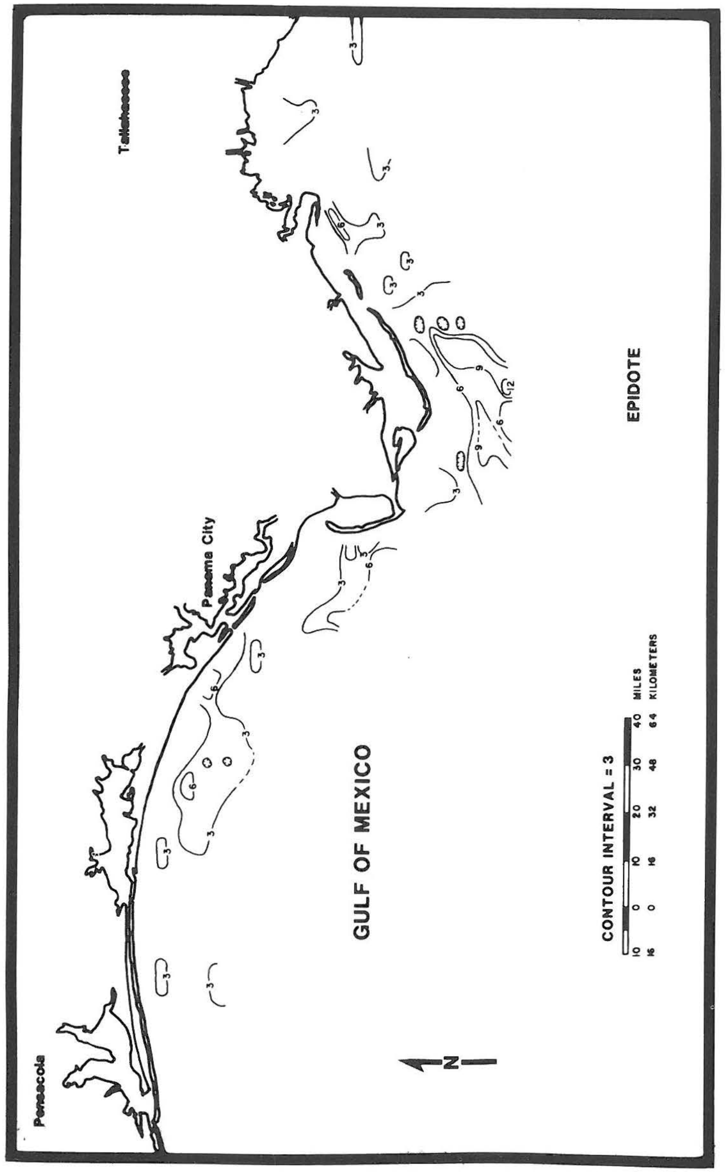

Figure 24. Distribution of epidote (estimate of volume percent) within the 2-3 phi heavy mineral fraction.

SUMMARY AND CONCLUSIONS

1. It is postulated from granulometric and heavy mineral analysis that the inner continental shelf sediments of the northeastern Gulf of Mexico are predominently fluvial in origin. These sediments have been transported to the shelf primarily by the Apalachicola River during the low sea level stands of the Pleistocene. Data also indicate evidence of reworking by coastal or marine offshore wave processes.

2. The primary source of sediments in the study area are the crystalline rocks of the southern Appalachians. However, results indicate that these sediments are presently being contributed from a reworked offshore sediment source.

3. There is a general westward decrease in values of sample mean grain size, standard deviation and percent fines throughout the study area.

4. Kyanite, staurolite, tourmaline, zircon and opaque minerals characterize the heavy mineral suite of sediments in the study area. Minor amounts of garnet, epidote, sillimanite, amphibole, rutile and sphene are also observed.

5. The grand average of heavy mineral concentrations in the 2 to 3 phi interval is 0.51 weight percent. Higher concentrations of heavy minerals are found in the 3 to 4 phi interval (4.39 weight percent). However, this very fine sand grade represents a very small weight fraction (approximately less than 3 percent) of the total sample.

6. There is a general westward increase in heavy mineral concentration throughout the study area. Maximum concentrations of heavy minerals (2-3 phi) superimposed on this trend occur within sediments offshore of St. George and Santa Rosa islands.

7. Local variations of individual heavy mineral species generally correspond to shoals located within the eastern half of the study area.

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APPENDIX I

Detailed Sample Location.
"Trans. #" is transect number

SAMPLE#	DATE	TRANS.#	LORAN-W	LORAN-Y	DEPTH(M)	LATITUDE	LONGITUDE
1-1	05/01/84	01	14490.5	46258.7	1.52	29 55.91	83 52.20
1-2	05/01/84	01	14487.8	46250.5	2.43	29 55.05	83 52.10
1-3	05/01/84	01	14484.3	46244.0	3.01	29 54.07	83 52.25
1-4	05/01/84	01	14480.8	46234.8	3.01	29 53.00	83 52.25
1-5	05/01/84	01	14477.4	46226.5	4.57	29 51.95	83 52.31
1-6	05/01/84	01	14473.0	46218.3	5.18	29 50.95	83 52.31
1-7	05/01/84	01	14470.5	46210.3	4.57	29 49.98	83 52.37
1-8	05/01/84	01	14467.0	46203.7	4.57	29 49.05	83 52.50
1-9	05/01/84	01	14463.8	46194.6	6.09	29 48.02	83 52.43
1-10	05/01/84	01	14460.6	46186.9	6.09	29 47.80	83 52.45
1-11	05/01/84	01	14456.5	46176.5	7.62	29 45.85	83 52.43
2-2	05/01/84	02	14492.0	46333.2	2.44	29 59.00	83 58.42
2-3	05/01/84	02	14488.5	46326.0	2.44	29 58.01	83 58.45
2-4	05/01/84	02	14484.6	46317.3	2.44	29 56.95	83 58.46
2-5	05/01/84	02	14481.3	46308.5	3.05	29 55.99	83 58.45
2-6	05/01/84	02	14472.9	46301.5	4.57	29 55.05	83 58.46
2-7	05/01/84	02	14474.5	46292.7	4.57	29 54.01	83 58.45
2-8	05/01/84	02	14470.6	46284.7	4.57	29 52.93	83 58.50
2-9	05/01/84	02	14467.7	46275.8	4.57	29 52.00	83 58.30
2-10	05/01/84	02	14464.0	46268.2	4.57	29 51.01	83 58.49
3-3	05/01/84	02	14484.5	46390.8	3.66	29 59.70	84 04.71
3-4	05/01/84	03	14481.0	46381.9	3.66	29 58.65	84 04.71
3-5	05/01/84	03	14476.6	46371.8	3.96	29 57.55	84 04.71
3-6	05/01/84	03	14473.8	46365.6	3.66	29 56.82	84 04.75
3-7	05/01/84	03	14470.1	46356.8	5.48	29 55.85	84 04.71
3-8	05/02/84	03	14466.9	46348.9	6.10	29 54.85	84 04.71
3-9	05/02/84	03	14462.5	46339.6	6.10	29 53.75	84 04.75
3-10	05/02/84	03	14459.1	46332.0	6.10	29 52.85	84 04.80
4-1	05/02/84	04	14471.3	46434.4	4.57	29 59.02	84 11.03
4-2	05/02/84	04	14467.2	46425.7	4.57	29 58.00	84 11.10
4-3	05/02/84	04	14463.5	46417.1	4.57	29 57.00	84 11.12
4-4	05/02/84	04	14459.5	46408.0	4.87	29 55.90	84 11.10
4-5	05/02/84	04	14455.5	46399.3	4.57	29 54.95	84 11.10
4-6	05/02/84	04	14451.6	46390.6	2.43	29 54.02	84 11.10
4-7	05/02/84	04	14448.0	46382.3	4.57	29 52.90	84 11.10
4-8	05/02/84	04	14444.1	46374.0	4.57	29 52.00	84 11.10
6-1	05/02/84	06	14427.0	46415.5	7.62	29 51.44	84 17.60
6-2	05/02/84	06	14422.8	46405.7	7.62	29 50.31	84 17.55
6-3	05/02/84	06	14418.7	46397.3	7.62	29 49.25	84 17.65
6-4	05/02/84	06	14414.7	46387.9	12.19	29 48.45	84 17.55
6-5	05/02/84	06	14410.5	46377.5	10.66	29 47.29	84 17.40
6-6	05/02/84	06	14407.8	46370.1	10.66	29 46.30	84 17.55
6-7	05/02/84	06	14402.8	46361.4	12.19	29 45.45	84 17.48
6-8	05/02/84	06	14398.5	46352.0	15.24	29 44.30	84 17.48
6-9	05/02/84	06	14394.6	46343.5	13.71	29 43.25	84 17.42
7-1	05/02/84	07	14410.6	46444.0	2.43	29 50.45	84 22.70
7-2	05/02/84	07	14407.2	46436.1	4.57	29 49.50	84 22.76

SAMPLE#	DATE	TRANS.#	LORAN-W	LORAN-Y	DEPTH(M)	LATITUDE	LONGITUDE
7-3	05/02/84	07	14402.8	46428.1	6.09	29 48.60	84 22.76
7-4	05/02/84	07	14399.1	46417.8	6.09	29 47.65	84 22.60
7-5	05/02/84	07	14395.2	46408.8	7.62	29 46.68	84 22.51
7-6	05/02/84	07	14390.7	46397.8	12.19	29 45.48	84 22.40
7-7	05/02/84	07	14386.7	46390.5	12.19	29 44.55	84 22.50
7-8	05/02/84	07	14382.7	46381.8	14.63	29 43.60	84 22.48
7-9	05/02/84	07	14378.0	46372.0	50.85	29 42.48	84 22.28
7-10	05/02/84	07	14374.0	46362.4	15.24	29 41.50	84 22.48
7-11	05/02/84	07	14370.8	46352.1	15.24	29 40.50	84 22.10
8-1	04/30/84	08	14414.5	46489.7	6.09	29 53.20	84 25.70
8-2	04/30/84	08	14410.6	46480.9	6.70	29 52.24	84 25.70
8-3	04/30/84	08	14405.9	46472.7	9.75	29 51.30	84 25.70
8-4	04/30/84	08	14401.8	46462.8	10.66	29 50.21	84 25.61
9-1	04/30/84	09	14405.4	46504.8	6.09	29 52.78	84 28.45
9-2	04/30/84	09	14401.4	46494.5	6.09	29 51.79	84 28.25
9-3	04/30/84	09	14397.5	46485.9	6.09	29 50.83	84 28.25
9-4	04/30/84	09	14393.9	46478.0	4.57	29 49.95	84 28.18
9-5	04/30/84	09	14389.1	46467.3	7.62	29 48.82	84 28.10
9-6	04/30/84	09	14384.5	46458.3	7.62	29 47.78	84 28.20
9-7	04/30/84	09	14380.0	46450.9	7.62	29 46.80	84 28.30
9-8	04/30/84	09	14375.8	46440.3	13.71	29 45.75	84 28.18
9-9	04/30/84	09	14371.5	46431.5	13.71	29 44.73	84 28.20
9-10	04/30/84	09	14367.8	46422.6	13.71	29 43.80	84 28.10
9-11	04/30/84	09	14363.4	46412.3	13.71	29 42.77	84 27.98
9-13	04/30/84	09	14350.5	46385.1	15.54	29 39.70	84 27.98
10-1	04/30/84	10	14392.7	46522.9	3.04	29 52.19	84 32.14
10-2	04/30/84	10	14387.8	46514.6	4.57	29 51.04	84 32.10
10-3	04/30/84	10	14384.8	46505.3	4.57	29 50.21	84 31.95
10-4	04/30/84	10	14378.8	46496.7	3.04	29 48.92	84 32.35
10-5	04/30/84	10	14374.5	46487.2	4.57	29 48.10	84 32.25
11-1	05/05/84	11	14353.9	46476.4	9.14	29 45.11	84 34.44
11-2	05/05/84	11	14349.6	46467.1	10.66	29 44.10	84 34.37
11-3	05/05/84	11	14345.0	46458.2	12.19	29 43.13	84 34.44
11-4	05/05/84	11	14340.1	46448.7	12.19	29 42.05	84 34.52
11-5	05/05/84	11	14336.3	46439.7	12.19	29 41.11	84 34.37
11-6	05/05/84	11	14331.7	46431.4	15.24	29 40.15	84 34.52
11-7	05/05/84	11	14327.6	46422.0	16.76	29 39.11	84 34.59
11-8	05/05/84	11	14323.0	46413.8	16.76	29 38.21	84 34.52
11-9	05/05/84	11	14318.4	46404.1	15.24	29 37.26	84 34.63
11-10	05/05/84	11	14313.9	46395.1	18.28	29 36.15	84 34.52
11-11	05/05/84	11	14309.4	46385.3	19.81	29 35.13	84 34.44
12-1	05/05/84	12	14331.7	46517.2	4.57	29 45.08	84 38.86
12-2	05/05/84	12	14328.0	46508.7	6.09	29 44.20	84 38.80
12-3	05/05/84	12	14324.5	46501.4	7.62	29 43.43	84 38.78
12-4	05/05/84	12	14321.7	46492.8	9.75	29 42.60	84 38.58
12-5	05/05/84	12	14314.1	46480.8	10.05	29 41.15	84 38.80
12-6	05/05/84	12	14310.4	46471.9	12.19	29 40.21	84 38.78
12-7	05/05/84	12	14306.9	46462.5	13.71	29 39.32	84 38.62
12-8	05/05/84	12	14301.2	46453.2	13.71	29 38.20	84 38.76
12-9	05/05/84	12	14295.6	46444.7	15.24	29 37.14	84 38.92
12-10	05/05/84	12	14292.0	46435.0	16.76	29 36.20	84 38.78
12-11	05/05/84	12	14286.1	46426.9	16.76	29 35.13	84 39.05
13-1	05/06/84	13	14287.3	46505.2	6.10	29 40.03	84 46.60
13-2	05/06/84	13	14283.0	46495.9	6.10	29 39.05	84 46.62
13-3	05/06/84	13	14277.6	46483.1	7.62	29 37.80	84 46.40
13-4	05/06/84	13	14272.5	46475.0	7.93	29 36.28	84 46.05

SAMPLE#	DATE	TRANS.#	LORAN-W	LORAN-Y	DEPTH(M)	LATITUDE	LONGITUDE
13-5	05/06/84	13	14268.4	46466.2	12.19	29 35.71	84 46.40
13-6	05/06/84	13	14263.4	46457.3	13.72	29 34.86	84 46.60
13-7	05/06/84	13	14259.2	46446.8	16.76	29 33.64	84 46.20
13-8	05/06/84	13	14253.7	46436.3	18.29	29 32.61	84 46.39
13-9	05/06/84	13	14249.0	46428.0	18.29	29 31.63	84 46.48
13-10	05/06/84	13	14245.2	46418.0	18.29	29 30.65	84 46.38
14-1	05/06/84	14	14250.3	46517.9	4.88	29 37.49	84 52.78
14-2	05/06/84	14	14245.8	46508.3	9.14	29 36.50	84 52.69
14-3	05/06/84	14	14241.1	46498.9	7.62	29 35.51	84 52.71
14-4	05/06/84	14	14235.9	46488.4	12.19	29 34.39	84 52.68
14-5	05/06/84	14	14231.8	46482.3	10.67	29 33.62	84 52.73
14-6	05/06/84	14	14227.0	46470.5	12.19	29 32.40	84 52.63
14-7	05/06/84	14	14222.6	46459.9	12.19	29 31.34	84 52.52
14-8	05/06/84	14	14213.1	46441.3	13.72	29 29.28	84 52.52
14-9	05/06/84	14	14208.5	46423.1	18.29	29 27.60	84 51.95
14-10	05/06/84	14	14205.6	46419.6	19.81	29 27.12	84 52.02
15-1	05/07/84	15	14207.8	46523.4	7.62	29 34.42	84 59.10
15-2	05/07/84	15	14203.3	46513.9	3.05	29 33.40	84 59.03
15-3	05/07/84	15	14199.3	46504.6	9.14	29 32.42	84 58.98
15-4	05/07/84	15	14193.0	46495.0	7.62	29 31.31	84 59.20
15-5	05/07/84	15	14189.0	46485.3	9.14	29 30.32	84 59.03
15-6	05/07/84	15	14184.6	46475.7	9.14	29 29.30	84 58.98
15-7	05/07/84	15	14180.7	46467.4	4.57	29 28.33	84 58.97
15-8	05/07/84	15	14176.0	46457.0	7.62	29 27.20	84 58.84
15-9	05/07/84	15	14171.0	46447.0	16.76	29 26.19	84 58.88
15-10	05/07/84	15	14165.7	46436.8	16.76	29 25.00	84 58.92
16-1	05/07/84	16	14178.1	46517.5	3.05	29 31.70	85 02.75
16-2	05/07/84	16	14175.5	46512.6	7.62	29 31.13	85 02.75
16-3	05/07/84	16	14170.5	46502.5	4.88	29 30.10	85 02.73
16-4	05/07/84	16	14167.4	46495.3	6.10	29 29.35	85 02.65
16-5	05/07/84	16	14161.6	46484.8	9.14	29 28.13	85 02.75
16-6	05/07/84	16	14157.2	46474.5	6.10	29 27.06	85 02.65
17-1	05/07/84	17	14150.5	46616.0	6.10	29 34.55	85 12.98
17-2	05/07/84	17	14146.0	46600.5	6.10	29 33.10	85 12.58
17-3	05/07/84	17	14141.5	46591.3	7.62	29 32.05	85 12.51
17-4	05/07/84	17	14135.5	46581.3	7.62	29 30.80	85 12.62
17-5	05/07/84	17	14133.1	46570.8	9.14	29 29.81	85 12.21
17-6	05/07/84	17	14127.2	46563.7	12.19	29 29.00	85 12.58
17-7	05/07/84	17	14122.0	46554.6	13.72	29 27.88	85 12.67
17-8	05/07/84	17	14118.2	46545.2	16.76	29 26.90	85 12.48
17-9	05/07/84	17	14114.1	46536.9	21.34	29 26.01	85 12.45
18-1	05/10/84	18	14108.7	46654.2	1.52	29 37.52	85 17.82
18-2	05/10/84	18	14105.4	46647.3	4.57	29 36.75	85 17.80
18-3	05/10/84	18	14100.1	46638.3	6.10	29 35.70	85 17.90
18-4	05/10/84	18	14095.6	46628.8	7.62	29 34.62	85 17.83
18-5	05/10/84	18	14091.1	46620.4	13.72	29 33.75	85 17.92
18-6	05/10/84	18	14086.7	46610.9	13.72	29 32.69	85 17.83
18-7	05/10/84	18	14080.8	46601.8	13.72	29 31.57	85 17.57
18-8	05/10/84	18	14076.7	46593.0	18.29	29 30.55	85 17.98
19-1	05/10/84	19	14092.1	46663.6	9.14	29 37.32	85 20.55
19-2	05/10/84	19	14087.3	46653.6	9.14	29 36.25	85 20.48
19-3	05/10/84	19	14082.3	46645.2	6.10	29 35.25	85 20.52
19-4	05/10/84	19	14077.5	46635.7	9.14	29 34.18	85 20.58
19A-1	05/14/84	19A	14139.9	46847.3	7.62	29 55.28	85 29.40
19A-2	05/14/84	19A	14121.5	46833.1	12.19	29 53.18	85 30.70
19A-3	05/14/84	19A	14113.9	46816.4	13.72	29 51.37	85 30.53

SAMPLE#	DATE	TRANS.#	LORAN-W	LORAN-Y	DEPTH(M)	LATITUDE	LONGITUDE
19A-4	05/14/84	19A	14105.7	46801.2	15.24	29 49.65	85 30.58
19A-5	05/14/84	19A	14098.8	46787.2	18.29	29 48.08	85 30.51
19A-6	05/14/84	19A	14091.2	46772.6	18.29	29 46.40	85 30.50
19A-7	05/14/84	19A	14084.0	46756.8	18.29	29 44.77	85 30.40
20-1	05/10/84	20	14108.5	46908.3	18.23	29 59.48	85 36.75
20-2	05/10/84	20	14100.4	46894.5	19.81	29 57.85	85 36.88
20-3	05/10/84	20	14092.1	46877.9	21.34	29 56.02	85 36.80
20-4	05/10/85	20	14084.1	46863.4	21.34	29 54.40	85 36.91
20-5	05/10/84	20	14076.9	46828.3	22.86	29 52.72	86 36.80
20-6	05/10/84	20	14069.1	46832.4	22.86	29 50.90	85 36.81
20-7	05/10/84	20	14060.2	46817.4	24.38	29 49.12	85 36.92
20A-1	05/13/84	20A	14077.7	46954.6	18.23	30 03.01	85 42.98
20A-2	05/13/84	20A	14070.2	46940.4	18.23	30 01.38	85 43.00
20A-3	05/13/84	20A	14062.2	46926.5	19.81	29 59.72	85 43.10
20A-4	05/13/84	20A	14055.1	46912.2	22.86	29 58.10	85 43.11
20A-5	05/13/84	20A	14047.5	46897.1	22.86	29 56.39	85 43.12
20A-6	05/13/84	20A	14040.3	46883.4	24.38	29 54.73	85 43.10
20A-7	05/13/84	20A	14032.8	46858.4	25.91	29 52.00	85 42.50
21-1	05/10/84	21	14046.4	47005.4	18.23	30 07.51	85 49.40
21-2	05/10/84	21	14039.2	46991.9	19.81	30 05.89	85 49.49
21-3	05/10/84	21	14032.3	46977.8	21.34	30 04.21	85 49.40
21-4	05/10/84	21	14025.4	46964.3	22.86	30 02.57	85 49.43
21-5	05/10/84	21	14018.2	46949.8	24.38	30 00.82	85 49.40
21-6	05/10/84	21	14011.7	46935.7	21.34	29 59.20	85 49.34
21-7	05/10/84	21	14003.1	46922.5	27.43	29 57.54	85 49.59
21A-1	05/13/84	21A	14008.3	47041.3	19.81	30 10.89	85 55.64
21A-2	05/13/84	21A	14001.6	47027.7	21.33	30 09.15	85 55.66
21A-3	05/13/84	21A	13994.0	47015.0	24.38	30 07.55	85 55.75
21A-4	05/13/84	21A	13987.1	47001.8	25.90	30 05.90	85 55.76
21A-5	05/13/84	21A	13979.5	46988.1	25.90	30 04.16	85 55.88
21A-6	05/13/84	21A	13972.2	46974.5	28.95	30 02.42	85 55.95
21A-7	05/13/84	21A	13965.6	46962.5	27.43	30 00.95	85 56.05
22-1	05/11/84	22	13963.2	47068.5	21.34	30 13.61	86 01.76
22-2	05/11/84	22	13956.5	47056.0	24.38	30 11.86	86 01.89
22-3	05/11/84	22	13949.2	47043.2	25.90	30 10.20	86 02.00
22-4	05/11/84	22	13945.3	47031.1	24.38	30 08.59	86 02.05
22-5	05/11/84	22	13936.5	47018.3	25.90	30 06.95	86 02.14
22-6	05/11/84	22	13929.7	47004.9	27.43	30 05.30	86 02.22
22-7	05/11/84	22	13922.6	46993.0	27.43	30 03.66	86 02.25
22A-1	05/13/84	22A	13914.8	47090.9	21.34	30 15.95	86 08.01
22A-2	05/13/84	22A	13908.1	47078.9	22.86	30 14.26	86 08.14
22A-3	05/13/84	22A	13901.8	47067.8	24.38	30 12.62	86 08.23
22A-4	05/13/84	22A	13895.7	47055.3	25.91	30 10.98	86 08.26
22A-5	05/13/84	22A	13889.2	47043.4	28.95	30 09.38	86 08.38
22A-6	05/13/84	22A	13882.8	47031.2	30.48	30 07.69	86 08.40
22A-7	05/13/84	22A	13876.8	47018.5	32.00	30 06.00	86 08.48
23-1	05/11/84	23	13860.3	47105.2	24.38	30 17.49	86 14.32
23-2	05/11/84	23	13854.7	47094.5	22.86	30 15.88	86 14.40
23-3	05/11/84	23	13849.2	47084.4	27.43	30 14.42	86 14.51
23-4	05/11/84	23	13842.8	47071.1	30.48	30 12.63	86 14.45
23-5	05/11/84	23	13836.1	47059.7	28.95	30 10.88	86 14.70
23-6	05/11/84	23	13830.3	47048.8	30.48	30 09.18	86 14.72
23-7	05/11/84	23	13823.7	47035.8	32.00	30 07.49	86 14.92
23A-1	05/13/84	23A	13804.3	47118.4	19.81	30 19.12	86 20.48
23A-2	05/13/84	23A	13798.4	47107.3	21.33	30 17.40	86 20.65
23A-3	05/13/84	23A	13793.4	47095.9	24.38	30 15.70	86 20.70

SAMPLE#	DATE	TRANS.#	LORAN-W	LORAN-Y	DEPTH(M)	LATITUDE	LONGITUDE
23A-4	05/13/84	23A	13787.1	47086.0	27.43	30 14.21	86 20.95
23A-5	05/13/84	23A	13789.1	47074.7	28.95	30 12.69	86 20.20
23A-6	05/13/84	23A	13776.4	47064.0	32.00	30 10.89	86 21.05
23A-7	05/13/84	23A	13770.8	47053.3	30.48	30 09.34	86 21.12
24-1	05/11/84	24	13744.5	47125.0	21.34	30 20.01	86 26.89
24-2	05/11/84	24	13739.7	47114.9	21.34	30 18.41	86 26.95
24-3	05/11/84	24	13734.3	47104.4	19.20	30 16.77	86 27.01
24-4	05/11/84	24	13730.0	47095.0	24.38	30 15.30	86 27.12
24-5	05/11/84	24	13723.7	47083.4	27.43	30 13.48	86.27.32
24-6	05/11/84	24	13718.6	47072.4	27.43	30 11.78	86 27.40
24-7	05/11/84	24	13711.6	47060.9	28.95	30 09.99	86 27.55
25-1	05/12/84	25	13618.6	47128.5	18.29	30 20.65	86 39.65
25-2	05/12/84	25	13614.4	47119.3	18.29	30 19.00	86 39.70
25-3	05/12/84	25	13609.4	47109.7	19.81	30 17.35	86 39.85
25-4	05/12/84	25	13605.0	47099.3	21.34	30 15.60	86 39.95
25-5	05/12/84	25	13599.8	47089.8	25.91	30 14.01	86 40.10
25-6	05/12/84	25	13595.6	47079.7	22.86	30 12.34	86 40.15
25-7	05/12/84	25	13591.4	47069.7	24.38	30 10.65	86 40.22
26-1	05/12/84	26	13506.1	47123.4	19.81	30 19.86	86 50.53
26-2	05/12/84	26	13499.1	47114.5	18.29	30 18.23	86 50.90
26-3	05/12/84	26	13496.4	47104.3	19.81	30 16.38	86 50.85
26-4	05/12/84	26	13492.5	47095.2	22.86	30 14.75	86 50.90
26-5	05/12/84	26	13490.2	47086.2	24.38	30 13.18	86 50.85
26-6	05/12/84	26	13487.3	47077.7	27.43	30 11.69	86 50.90
26-7	05/12/84	26	13481.3	47067.8	30.48	30 09.94	86 51.13
27-1	05/12/84	27	13367.5	47110.3	18.29	30 17.68	87 03.74
27-2	05/12/84	27	13366.0	47101.3	19.81	30 15.94	87 13.65
27-3	05/12/84	27	13363.6	47091.8	16.76	30 14.15	87 03.60
27-4	05/12/84	27	13361.4	47084.1	25.91	30 12.73	87 03.58
27-5	05/12/84	27	13358.5	47075.0	27.43	30 11.02	87 03.62
27-6	05/12/84	27	13355.6	47065.8	21.34	30 09.33	87 03.62
27-7	05/12/84	27	13353.2	47056.4	22.86	30 07.60	87 03.60
28-1	05/12/84	28	13236.0	47102.6	10.67	30 16.50	87 19.43
28-2	05/12/84	28	13234.1	47094.8	15.24	30 14.90	87 19.40
28-3	05/12/84	28	13232.2	47086.4	18.29	30 13.23	87 19.38
28-4	05/12/84	28	13230.2	47077.6	18.29	30 11.51	87 19.39
28-5	05/12/84	28	13227.3	47069.5	21.34	30 09.95	87 19.43
28-6	05/12/84	28	13226.1	47060.6	21.34	30 08.19	87 19.32
28-7	05/12/84	28	13223.2	47052.0	25.91	30 06.55	87 19.38

APPENDIX II

Sample Textural Characteristics. Abbreviations are as follows: Num is sample number; Tweight is total sample weight used for granulometric and heavy mineral analyses; %Fine is weight percent fines < 4.5 phi; Mean is mean grain size; Median is median grain size; S is standard deviation of mean grain size; Skew is skewness; Kurt is kurtosis.

NUM	TWEIGHT	%FINE	MEAN	MEDIAN	S	SKEW.	KURT.
1-1	100.084	2.790	2.744	2.793	0.526	-0.763	8.297
1-2	99.560	2.647	2.841	2.876	0.499	-0.853	9.480
1-3	93.620	2.223	2.501	2.733	0.830	-1.009	7.853
1-4	86.961	2.401	1.981	2.479	1.199	-0.566	3.344
1-5	85.611	1.613	2.370	2.686	0.937	-0.957	6.596
1-6	106.080	1.469	1.243	1.209	1.166	-0.062	2.066
1-7	99.467	2.872	0.523	0.194	1.330	0.294	2.113
1-8	112.575	1.504	2.437	2.675	0.867	-1.209	9.354
1-9	74.812	1.585	2.226	2.500	0.970	-1.056	7.384
1-10	85.037	1.897	1.309	1.403	1.088	-0.171	2.379
1-11	78.143	1.445	1.254	1.376	1.091	-0.186	2.423
2-2	74.697	1.791	2.517	2.776	0.918	-1.000	7.399
2-3	79.637	1.132	2.825	2.836	0.455	-0.434	5.538
2-4	79.956	0.945	2.874	2.847	0.389	-0.303	5.759
2-5	78.583	1.123	2.776	2.811	0.495	-0.061	6.825
2-6	75.230	1.333	2.045	2.456	1.189	-0.683	4.048
2-7	94.610	1.689	1.987	2.419	1.172	-0.429	2.809
2-8	74.435	2.936	2.079	2.410	1.040	-0.582	3.925
2-9	75.684	1.096	0.795	0.720	0.873	0.153	3.101
2-10	78.176	1.806	2.214	2.590	1.015	-0.728	4.766
3-3	81.364	1.212	1.066	1.186	0.926	-0.206	3.314
3-4	81.125	0.879	2.356	2.583	0.900	-0.747	5.762
3-5	85.300	15.233	2.571	2.911	1.045	-0.771	5.022
3-6	74.396	1.858	1.121	1.421	1.243	-0.177	2.066
3-8	73.186	4.472	2.521	2.872	1.155	-0.835	5.160
3-9	88.119	1.622	2.002	2.493	1.226	-0.515	3.033
4-1	89.146	4.090	1.059	1.144	1.322	0.046	2.108
4-2	86.476	2.640	2.475	2.879	1.029	-0.616	3.813
4-3	78.260	1.470	2.744	2.936	0.790	-1.127	10.069
4-4	83.133	1.250	2.471	2.663	0.740	-0.356	3.202
4-5	75.735	1.070	2.402	2.573	0.772	-0.305	2.903
4-6	84.087	0.970	1.910	1.908	0.697	-0.120	2.756
4-8	79.110	1.380	2.769	2.930	0.679	-0.692	5.510
6-1	96.205	2.080	2.694	2.882	0.859	-1.079	8.771
6-2	84.975	2.200	1.788	1.658	1.159	-0.116	2.381
6-3	84.857	1.200	1.043	1.382	1.319	-0.172	1.831
6-4	72.895	5.220	2.725	2.876	0.768	-1.303	11.551
6-5	76.277	1.590	2.359	2.437	0.587	-0.718	7.513
6-6	78.508	4.990	2.487	2.605	0.602	-0.754	7.533
6-7	81.312	1.190	0.862	1.024	1.216	0.010	2.065
6-8	86.277	4.430	2.078	2.269	0.947	-0.598	4.431
6-9	72.988	1.220	1.923	1.960	0.722	-0.545	6.056
7-1	79.843	1.620	2.529	2.548	0.598	-0.332	5.778

NUM	TWEIGHT	%FINE	MEAN	MEDIAN	S	SKEW.	KURT.
7-2	81.363	0.000	2.110	2.186	0.570	-0.434	5.073
7-3	79.329	0.000	1.881	1.903	0.530	-0.283	4.562
7-4	71.432	0.890	1.397	1.398	0.433	0.102	3.644
7-5	79.959	0.880	1.073	1.155	0.767	-0.134	2.905
7-6	79.283	1.310	1.157	1.208	0.841	-0.038	2.983
7-7	77.829	1.810	0.771	0.753	0.964	0.064	2.812
7-8	76.712	1.450	1.240	1.393	0.910	-0.260	3.221
7-9	84,018	1.120	0.824	0.978	1.046	-0.090	2.256
7-10	77.770	2.120	0.957	0.982	0.996	0.032	2.804
7-11	73.672	1.250	0.740	0.751	0.877	-0.030	2.614
8-1	82.505	2.630	1.879	1.863	0.747	-0.155	4.027
8-2	77.782	1.830	1.776	1.827	0.543	-0.761	8.809
8-3	85.019	5.710	1.940	1.970	0.678	-0.511	6.204
8-4	85.659	1.620	1.858	1.892	0.588	-0.470	7.299
9-1	89.552	2.830	0.639	0.777	1.064	-0.029	2.311
9-2	78.624	13.34	2.137	2.397	1.067	-0.640	4.546
9-3	89.952	3.820	2.222	2.257	0.758	-0.250	3.987
9-4	73.914	0.880	1.864	1.909	0.520	-0.384	4.881
9-5	80.045	1.520	0.736	0.784	0.847	-0.055	3.202
9-6	83.088	1.280	1.756	1.795	0.675	-0.530	6.180
9-7	80.553	1.060	1.567	1.654	0.731	-0.550	5.366
9-8	80.875	1.660	0.861	0.771	0.888	0.225	3.587
9-9	76.283	2.220	1.119	1.252	0.970	-0.166	2.710
9-10	83.154	1.090	1.971	2.009	0.596	-0.726	8.608
9-11	88.031	1.040	1.547	1.641	0.688	-0.502	4.893
9-13	94.401	0.960	1.358	1.485	0.729	-0.345	3.469
10-1	84.514	4.090	2.621	2.779	0.758	-0.897	8.135
10-2	85.692	1.180	1.891	1.919	0.622	-0.407	5.927
10-3	78.581	9.690	2.531	2.777	0.981	-0.907	6.678
10-4	94.409	1.190	2.103	2.160	0.362	-0.698	8.038
10-5	85.476	1.170	1.636	1.747	0.812	-0.589	5.053
11-1	87.455	1.210	0.807	0.886	0.917	-0.096	2.917
11-2	76.817	0.850	0.833	0.842	0.836	-0.017	2.631
11-3	92.586	0.910	0.922	0.835	0.831	0.133	2.735
11-4	83.648	1.320	0.493	0.469	1.221	0.113	1.837
11-5	85.042	0.820	0.762	0.923	0.861	-0.208	2.686
11-6	92.210	1.550	1.589	1.530	1.141	-0.016	2.195
11-8	91.162	6.040	2.510	2.677	0.857	-0.477	4.127
11-9	87.554	1.180	2.346	2.419	0.585	-0.848	9.863
11-10	82.317	1.190	0.746	0.768	0.818	0.039	2.981
11-11	91.797	0.000	1.313	1.508	0.934	-0.342	3.133
12-1	82.861	1.240	2.235	2.259	0.555	-0.331	4.630
12-2	85.585	1.080	2.470	2.616	0.557	-0.950	9.715
12-3	91.589	2.190	2.237	2.448	0.844	-0.866	6.765
12-4	79.176	0.750	1.234	1.292	0.786	-0.076	3.037
12-5	85.690	0.850	1.087	1.173	0.850	-0.121	2.918
12-6	77.058	0.920	1.038	0.956	0.931	0.073	2.674
12-7	87.807	5.370	2.499	2.702	0.880	-0.770	6.071
12-8	88.152	0.960	1.300	1.389	0.798	-0.301	3.960
12-9	90.255	1.460	0.328	0.185	0.899	0.389	3.365
12-10	93.119	1.550	1.732	1.881	0.875	-0.565	4.580
12-11	76.368	1.590	1.970	2.168	0.919	-0.789	5.381
13-1	92.860	22.660	2.205	2.474	0.974	-0.736	5.331
13-2	88.594	1.090	2.038	2.074	0.638	-0.459	5.177
13-3	91.244	1.240	1.817	1.922	0.707	-0.397	3.775
13-4	81.959	0.960	1.151	1.170	0.760	-0.039	2.841

NUM	TWEIGHT	%FINE	MEAN	MEDIAN	S	SKEW.	KURT.
13-5	84.220	1.100	0.960	0.909	0.780	0.055	2.647
13-6	87.086	1.280	1.237	1.376	0.908	-0.138	2.395
13-7	86.441	1.720	0.497	0.401	0.851	0.261	3.136
13-8	72.699	2.160	0.288	0.232	1.008	0.275	2.757
13-9	83.230	2.530	1.492	1.674	1.111	-0.327	2,741
13-10	88.430	1.390	1.146	1.334	0.937	-0.241	2.648
14-1	89.852	1.070	1.812	0.612	0.728	-0.607	4.933
14-2	79.776	1.490	1.323	0.725	0.725	-0.297	4.001
14-3	83.936	1.230	1.554	1.624	0.639	-0.438	4.727
14-5	85.973	1.110	1.067	1.140	0.749	-0.182	3.131
14-6	83.401	1.290	0.969	1.096	0.850	-0.230	2.972
14-7	91.743	6.450	0.986	0.089	0.832	-0.251	2.934
14-9	88.166	4.520	0.667	0.613	0.860	0.210	3.365
14-10	88.924	9.100	0.627	0.612	0.943	0.137	2.844
15-2	82.317	0.880	1.390	1.538	0.734	-0.560	4.331
15-3	81.087	1.140	1.573	1.763	0.794	-0.701	5.037
15-4	88.470	0.870	1.302	1.448	0.912	-0.382	3.523
15-5	89.851	1.420	2.318	2.239	0.462	-0.390	7.340
15-6	85.596	0.960	1.396	1.473	0.790	-0.349	4.131
15-7	92.750	0.910	1.327	1.430	0.724	-0.372	4.043
15-8	97.785	6.120	1.407	1.585	0.962	-0.597	4.207
15-9	85.578	13.000	0.601	0.525	0.990	0.341	3.695
15-10	91.430	2.600	1.684	2.019	1.206	-0.392	2.611
16-1	90.928	0.890	1.493	1.676	0.813	-0.574	4.149
16-2	88.375	1.020	1.733	2.278	1.224	-0.608	3.211
16-3	87.875	0.960	2.071	2.155	0.518	-0.862	8.631
16-4	84.199	1.160	1.920	1.939	0.341	-0.360	8.368
16-5	91.547	1.000	1.927	1.943	0.470	-0.663	9.168
16-6	79.662	1.020	1.538	1.637	0.617	-0.824	7.406
17-1	83.863	1.281	2.352	2.388	0.386	-0.258	4.784
17-2	85.253	1.102	2.116	2.146	0.472	-0.573	7.419
17-3	84.903	0.000	1.970	2.017	0.598	-0.508	5.466
17-4	82.032	1.053	1.861	1.917	0.540	-0.415	4.844
17-5	93.830	1.040	2.376	2.441	0.414	-0.524	5.731
17-6	86.229	1.144	1.645	1.731	0.583	-0.735	6.797
17-7	85.846	1.620	2.021	2.211	0.867	-0.742	5.377
17-8	86.272	1.405	0.827	0.933	0.847	-0.151	2.470
17-9	90.479	1.132	0.480	0.477	0.741	0.169	3.674
18-1	88.164	2.041	2.348	2.446	0.471	-0.961	9.567
18-2	88.260	1.094	2.394	2.495	0.464	-0.927	9.135
18-3	88.654	4.274	2.452	2.492	0.350	-1.169	20.046
18-4	88.350	1.126	2.003	2.117	0.708	-0.860	7.373
18-5	95.331	1.073	1.447	1.528	0.793	-0.406	3.920
18-6	93.122	1.265	1.214	1.350	0.951	-0.224	2.940
18-7	84.460	2.352	1.089	1.328	0.945	-0.357	2.828
18-8	80.197	1.959	0.580	0.571	0.869	0.163	3.102
19-1	86.551	6.386	1.888	1.942	0.502	-0.902	10.428
19-2	84.918	11.500	2.416	2.461	0.429	-1.703	24.800
19-3	90.394	0.000	0.671	0.695	1.038	0.017	2.188
19-4	84.435	1.031	1.518	1.651	0.738	-0.774	5.784
19A-1	88.582	1.302	2.236	2.363	0.582	-0.632	5.458
19A-2	86.649	3.617	2.565	2.694	0.664	-0.960	8.962
19A-3	90.146	1.395	1.666	1.662	0.696	-0.253	4.409
19A-4	78.838	1.705	2.626	2.682	0.442	-0.101	2.512
19A-5	88.933	1.417	1.378	1.557	0.909	-0.423	3.638
19A-6	82.456	3.507	2.567	2.811	0.933	-1.113	8.153

NUM	TWEIGHT	%FINE	MEAN	MEDIAN	S	SKEW.	KURT.
19A-7	83.252	1.239	2.246	2.228	0.459	-0.480	9.238
20-1	87.818	1.860	2.189	2.331	0.787	-0.516	4.530
20-2	86.440	2.338	2.154	2.499	1.141	-0.630	4.080
20-3	89.468	1.810	2.269	2.354	0.683	-0.782	8.298
20-4	84.937	1.592	1.795	1.901	0.805	-0.438	4.290
20-5	84.696	1.839	2.341	2,526	0.812	-0.655	5.451
20-6	81.975	2.356	1.616	1.740	0.742	-0.376	3.677
20-7	90.405	1.521	1.689	1.855	0.801	-0.610	5.035
20A-1	81.602	1.155	1.336	1.498	0.806	-0.267	2.917
20A-2	89.880	1.393	2.178	2.276	0.607	-0.606	5.892
20A-3	90.204	1.255	1.015	1.060	0.833	-0.109	2.868
20A-4	69.122	1.332	2.086	2.208	0.788	-0.762	6.303
20A-5	72.957	1.508	2.025	2.117	0.723	-0.584	5.249
20A-6	74.337	1.258	0.965	1.030	0.781	-0.200	3.286
20A-7	96.361	1.982	2.584	2.651	0.711	-0.862	7.712
21-1	88.129	1.372	2.377	2.528	0.668	-0.590	5.409
21-2	93.631	0.903	0.638	0.547	0.787	0.287	3.419
21-3	81.511	1.006	1.257	1.369	0.788	-0.170	2.661
21-4	96.401	1.167	0.884	0.960	0.847	-0.165	2.638
21-5	89.461	1.054	1.039	1.022	0.805	-0.001	2.836
21-6	91.926	1.202	1.011	0.978	0.806	0.009	2.883
21-7	87.864	1.350	1.019	1.109	0.907	-0.185	2.870
21A-1	88.603	1.682	1.020	0.988	1.266	0.012	1.835
21A-2	80.999	1.552	1.562	1.690	0.835	-0.340	3.511
21A-3	91.426	4.082	2.575	2.715	0.750	-0.738	6.632
21A-4	85.996	1.248	1.164	1.260	0.867	-0.188	3.032
21A-5	87.284	1.457	1.488	1.563	0.691	-0.339	4.275
21A-6	95.094	1.955	0.489	0.423	0.982	0.214	2.768
21A-7	99.714	1.310	1.145	1.223	0.767	-0.225	3.570
22-1	89.425	2.517	1.273	1.356	0.572	-0.433	5.031
22-2	84.741	0.036	0.814	0.831	0.824	-0.022	3.344
22-3	83.851	1.235	1.866	1.978	0.785	-0.455	4.117
22-4	89.490	0.000	1.452	1.590	0.180	-0.372	3.530
22-5	91.652	1.480	1.812	2.097	1.037	-0.663	4.194
22-6	83.355	1.513	1.169	1.386	1.004	-0.231	2.520
22-7	90.213	1.367	1.478	1.689	0.892	-0.437	3.405
22A-1	88.151	8.951	1.965	2.188	1.024	-0.362	2.915
22A-2	83.960	1.464	1.618	1.805	0.868	-0.590	4.343
22A-3	86.404	1.244	2.021	2.082	2.672	-0.663	6.091
22A-4	87.496	1.320	2.080	2.128	0.671	-0.590	6.268
22A-5	87.705	1.156	0.406	0.433	0.990	0.104	2.379
22A-6	89.722	1.361	0.934	1.069	1.124	-0.107	2.248
22A-7	90.197	2.639	0.420	0.365	1.205	0.213	2.240
23-1	87.187	4.450	1.653	1.687	0.791	-0.191	3.504
23-2	88.926	1.500	2.487	2.578	0.546	-0.691	7.901
23-3	84.900	1.354	1.189	1.192	0.746	-0.019	3.484
23-4	83.161	1.531	1.212	1.394	1.012	-0.142	2.433
23-5	92.852	1.281	1.853	1.903	0.601	-0.584	7.292
23-6	84.000	2.631	2.111	2.191	0.672	-0.482	5.635
23-7	83.459	2.336	2.386	2.467	0.621	-0.800	8.936
23A-1	91.858	1.316	1.502	1.560	0.641	-0.322	4.489
23A-2	91.380	1.371	0.894	1.041	0.904	-0.227	2.807
23A-3	86.984	1.844	2.266	2.320	0.638	-0.438	5.332
23A-4	89.439	1.754	0.860	0.819	0.944	0.021	2.357
23A-5	90.399	1.441	1.160	1.245	0.889	-0.126	2.656
23A-6	86.114	3.284	1.211	1.233	1.354	-0.047	1.841

NUM	TWEIGHT	%FINE	MEAN	MEDIAN	S	SKEW.	KURT.
23A-7	87.553	1.506	1.754	1.795	0.538	-0.507	6.703
24-1	91.582	1.090	1.015	1.072	0.772	-0.124	3.079
24-2	89.732	1.280	0.533	0.484	0.741	0.169	3.392
24-3	85.139	1.110	1.461	1.525	0.677	-0.246	3.815
24-4	91.953	1.270	1.501	1.572	0.762	-0.332	4.010
24-5	88.708	1.580	1.335	1.472	0.826	-0.373	3.541
24-6	93.365	1,210	1.253	1.324	0.784	-0.190	3.260
24-7	83.923	1.410	1.507	1.606	0.708	-0.320	3.732
25-1	87.041	1.050	1.586	1.648	0.586	-0.313	4.127
25-2	89.442	1.430	1.706	1.833	0.765	-0.519	4.381
25-3	94.790	1.080	1.613	1.682	0.666	-0.410	4.566
25-4	94.095	2.210	1.622	1.668	0.577	-0.452	5.761
25-5	87.692	1.440	1.818	1.887	0.709	-0.435	4.858
25-6	79.442	1.120	1.457	1.518	0.715	-0.231	3.936
25-7	91.914	1.190	1.491	1.584	0.644	-0.471	4.829
26-1	87.256	1.060	1.230	1.326	0.761	-0.219	3.196
26-2	85.038	1.060	1.401	1.539	0.738	-0.342	3.265
26-3	86.358	1.500	1.934	1.948	0.648	-0.375	5.311
26-4	83.796	1.090	1.607	1.634	0.609	-0.317	4.628
26-5	90.593	0.850	1.300	1.313	0.707	-0.053	3.573
26-6	90.761	1.050	0.799	0.978	0.952	-0.219	2.386
26-7	80.097	1.480	1.885	1.982	0.824	-0.556	4.932
27-1	89.151	1.334	1.650	1.749	0.693	-0.510	4.927
27-2	89.180	1.174	1.639	1.694	0.583	-0.421	5.215
27-3	91.442	1.070	1.758	1.803	0.636	-0.385	4.626
27-4	86.645	0.912	1.672	1.722	0.697	-0.318	4.053
27-5	93.186	1.191	1.282	1.393	0.707	-0.400	4.031
27-6	86.077	1.187	1.606	1.621	0.513	-0.309	5.553
27-7	86.884	1.122	1.344	1.396	0.684	-0.233	4.031
28-1	86.503	1.000	1.734	1,753	0.566	-0.187	3.746
28-2	82.843	1.000	1.586	1.606	0.570	-0.201	4.217
28-3	92.589	1.110	1.223	1.253	0.703	-0.153	3.359
28-4	85.188	1.110	1.427	1.505	0.670	-0.267	3.526
28-5	94.167	1.030	1.199	1.353	0.836	-0.306	3.130
28-6	70.488	0.870	0.955	1.125	0.899	-0.217	2.493
28-7	108.793	1.130	1.795	1.835	0.582	-0.445	5.733

APPENDIX III

Running averages (four point) of Textural and Heavy Mineral Data

NUM	MEAN	STANDARD DEVIATION	WT. % HEAVY 2-3 PHI	MINERALS IN 3-4 PHI*	WT. % FINES
1	1.930	0.934	0.145	0.882	2.545
2	1.553	0.923	0.116	1.213	2.698
3	1.716	0.907	0.167	1.264	2.546
4	1.863	0.796	0.186	1.691	2.229
5	1.668	0.780	0.296	2.073	2.423
6	1.708	0.729	0.314	2.455	2.639
7	1.683	0.760	0.386	2.700	2.779
8	1.606	0.803	0.434	3.480	2.436
9	1.557	0.820	0.389	3.548	2.464
10	1.300	0.841	0.743	3.827	2.314
11	1.353	0.827	0.831	4.486	2.682
12	1.408	0.791	0.944	7.893	2.512
13	1.522	0.725	0.956	10.414	2.074
14	1.663	0.701	0.608	10.424	1.790
15	1.708	0.660	0.404	10.948	2.185
16	1.738	0.661	0.248	7.254	2.444
17	1.805	0.716	0.212	4.279	2.661
18	1.818	0.730	0.283	3.813	2.547
19	1.706	0.761	0.424	3.003	1.655
20	1.532	0.814	0.474	2.843	1.636
21	1.383	0.797	0.604	3.481	1.440
22	1.249	0.843	0.471	3.173	1.734
23	1.416	0.821	0.537	3.035	2.000
24	1.602	0.812	0.477	2.755	1.960
25	1.521	0.811	0.540	3.952	1.992
26	1.587	0.744	0.774	4.464	1.677
27	1.488	0.753	0.850	5.245	1.415
28	1.357	0.703	0.926	6.365	1.248
29	1.368	0.687	0.901	6.014	1.182

*INDICATES DATA CALCULATED FOR ONE SAMPLE PER TRANSECT.

APPENDIX IV

Modal analyses of the 2-3 Phi Heavy Mineral Fraction. Abbreviations are as follows: Op-opaques; Lu-leucoxene; Ru-rutile; Sp-sphene; Ky-kyanite; Tour-tourmaline; St-staurolite; Zr-zircon; Ep-epidote; Sill-sillimanite; Amph-amphibole; Gr-garnet; Wt%HM-weight percent heavy minerals within the above grain size fraction; 0000...-indicates lack of data.

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
1-1	15.3	00.0	03.3	00.0	28.3	31.8	12.9	05.2	01.4	00.4	00.0	00.9	0.583
1-2	15.9	00.0	03.9	00.0	29.4	33.9	09.5	07.4	00.0	00.0	00.0	00.0	0.572
1-3	21.6	01.0	05.7	02.0	22.9	24.4	10.0	09.1	03.3	00.0	01.0	00.0	0.056
1-4	28.7	00.0	08.7	05.9	16.5	11.3	17.5	03.5	02.9	03.5	01.0	00.4	0.098
1-5	34.1	00.0	05.1	00.5	22.8	17.3	14.3	04.5	01.1	00.5	00.0	00.0	0.102
1-6	28.6	00.0	03.6	00.0	22.4	23.5	14.0	06.8	00.5	00.5	00.0	00.0	0.048
1-7	56.9	00.0	02.4	00.0	13.4	15.2	09.7	02.4	00.0	00.0	00.0	00.0	0.096
1-8	16.3	00.0	00.0	00.0	28.0	35.2	16.3	03.6	00.0	00.6	00.0	00.0	0.138
1-9	25.3	00.5	04.2	02.9	19.5	13.4	19.0	05.8	05.8	03.8	00.0	00.0	0.024
1-10	15.9	00.0	02.6	00.0	28.6	34.7	15.9	02.0	00.0	00.6	00.0	00.0	0.764
1-11	24.9	00.5	04.5	00.5	20.9	15.2	22.8	10.2	00.0	00.5	00.0	00.0	0.400
2-2	12.8	00.6	06.1	00.0	23.2	39.2	11.9	05.7	00.6	00.0	00.0	00.0	0.055
2-3	19.3	00.0	05.1	00.0	13.4	31.9	20.7	08.1	01.4	00.0	00.0	00.0	0.031
2-4	14.5	00.0	01.5	00.0	27.0	37.0	16.6	03.1	00.0	00.0	00.0	00.0	0.079
2-5	14.6	00.0	02.0	00.0	24.7	39.4	14.1	04.5	00.0	00.5	00.0	00.0	0.158
2-6	18.4	00.0	05.4	00.5	31.1	27.7	12.4	03.0	01.4	00.0	00.0	00.0	0.152
2-7	17.1	00.0	03.6	00.0	32.0	27.4	16.0	03.6	00.6	00.0	00.0	00.0	0.187
2-8	17.9	00.0	03.4	00.4	24.8	29.1	19.5	04.3	00.4	00.0	00.0	00.0	0.164
2-9	10.9	00.0	03.7	00.0	30.0	37.3	15.5	02.7	00.0	00.0	00.0	00.0	0.264
2-10	12.0	00.5	01.5	01.5	31.3	32.3	16.1	04.1	00.0	05.0	00.0	00.0	0.154
3-4	16.0	01.5	03.0	03.5	28.0	22.5	10.0	07.5	04.0	03.5	00.5	00.0	0.051
3-5	32.5	00.5	03.5	03.0	23.0	20.5	03.5	05.0	02.0	06.5	00.0	00.0	0.112
3-6	17.0	00.5	03.1	00.5	27.2	22.7	20.1	04.0	01.5	03.6	00.0	00.0	0.182
3-7	21.0	00.0	02.0	03.5	22.5	21.0	17.5	03.0	03.5	07.0	00.0	00.0	0.177
3-8	23.1	01.4	00.4	02.5	24.7	24.2	15.9	00.4	03.3	03.8	00.0	00.0	0.081
3-9	22.5	01.0	01.5	02.5	29.5	31.5	06.0	01.0	01.5	03.0	00.0	00.0	0.057
4-1	34.5	00.5	01.0	01.0	19.0	14.5	17.5	04.0	04.0	04.0	00.0	00.0	0.078
4-3	33.0	00.0	00.5	01.5	33.0	11.8	14.8	03.4	00.5	01.5	00.0	00.0	0.038
4-4	26.6	00.5	00.0	01.0	28.1	18.6	14.1	05.5	01.0	04.0	00.5	00.0	0.109
4-5	27.4	00.6	02.0	00.0	39.2	14.5	09.8	01.5	01.1	01.5	02.6	00.0	0.069
4-6	39.5	00.0	10.3	00.0	21.0	10.9	14.1	02.7	01.8	00.5	00.0	00.0	0.063
4-7	27.9	00.0	07.0	00.0	26.7	15.2	14.0	04.7	00.0	03.4	00.0	01.2	0.123
4-8	76.7	00.0	01.0	00.5	12.5	02.9	05.5	01.0	00.0	00.0	00.0	00.0	0.016
6-1	40.7	02.3	01.1	00.0	23.3	15.2	11.6	02.3	00.0	03.4	00.0	00.0	0.008
6-2	43.6	00.0	00.7	00.0	22.9	16.8	13.0	01.5	00.0	01.5	00.0	00.0	0.136
6-3	38.2	00.7	06.3	00.0	19.6	11.0	18.8	05.4	00.0	00.0	00.0	00.0	0.272
6-4	24.5	01.0	01.0	03.6	28.1	21.9	09.9	01.5	01.5	06.3	00.5	00.0	0.026
6-5	18.6	00.9	00.9	01.9	36.3	25.5	09.4	02.9	01.9	00.9	00.5	00.0	0.024
6-6	24.8	01.9	02.5	00.0	37.1	16.4	11.8	03.0	01.9	00.5	00.0	00.0	0.088
6-7	39.9	00.5	03.6	00.5	19.7	15.7	11.7	02.5	04.5	01.1	01.1	00.0	0.233
6-8	26.3	00.5	04.5	01.0	21.9	18.4	18.0	03.4	03.9	01.0	00.0	01.0	0.224
6-9	26.3	01.0	05.0	00.5	23.8	18.0	16.5	03.9	02.4	02.0	00.0	00.5	0.312
7-1	24.9	00.0	04.0	00.5	25.3	26.4	16.8	01.1	00.0	01.1	00.0	00.0	0.145
7-2	36.0	00.0	04.0	00.0	27.0	10.5	17.5	03.0	01.0	01.0	00.0	00.0	0.085

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
7-3	32.9	00.0	04.1	00.6	23.2	12.4	21.6	02.6	01.5	01.1	00.0	00.0	0.113
7-4	45.6	00.0	05.1	01.1	17.1	09.3	17.1	02.6	01.1	01.1	00.0	00.0	0.303
7-5	37.5	01.0	09.8	00.4	19.0	09.8	13.2	08.3	01.0	00.0	00.0	00.0	0.446
7-6	27.3	01.6	07.6	00.5	24.2	13.2	21.3	01.1	02.5	00.5	00.0	00.5	0.581
7-7	42.1	01.6	02.1	02.1	16.4	07.3	13.6	11.6	01.1	01.1	01.1	00.0	0.349
7-8	39.5	02.0	06.0	00.5	19.5	08.0	16.0	06.5	00.5	00.5	00.0	01.0	0.656
7-9	39.7	00.6	04.7	01.1	16.0	10.3	18.0	06.1	01.5	02.1	00.0	00.0	0.518
7-10	24.5	01.5	05.0	00.5	24.0	16.5	17.5	07.0	01.0	00.5	01.5	00.5	0.213
7-11	47.0	00.5	02.0	00.5	19.5	07.5	13.0	06.0	02.5	01.0	01.0	01.0	0.329
8-1	32.1	00.0	00.4	01.0	25.7	13.6	20.9	05.4	01.0	00.0	00.0	00.0	0.371
8-2	36.8	00.5	00.0	01.5	21.6	10.0	13.9	02.4	06.7	01.5	04.3	00.0	0.124
8-3	34.6	00.0	00.0	02.8	18.7	17.2	13.6	01.0	04.7	02.4	04.7	00.4	0.080
8-4	25.5	03.0	01.0	05.0	24.5	19.0	13.5	04.0	02.0	00.0	01.5	01.0	0.164
9-1	38.4	04.8	00.0	15.8	13.9	11.6	10.1	02.8	00.9	00.4	00.0	00.9	0.671
9-2	28.4	00.0	00.5	08.5	24.9	21.4	07.9	00.5	02.0	03.4	02.0	00.5	0.126
9-3	30.9	00.0	00.5	14.2	18.3	11.0	10.5	01.6	06.2	01.6	04.1	01.0	0.124
9-4	29.9	00.0	00.5	11.9	24.9	11.4	12.5	00.5	03.9	02.4	02.0	00.0	0.204
9-5	59.4	00.0	04.9	01.5	09.8	05.8	06.8	07.4	02.5	00.0	00.5	01.5	2.733
9-6	32.1	00.0	02.0	02.0	27.0	18.3	09.1	03.0	03.6	00.6	00.0	02.0	0.247
9-7	36.1	00.0	02.6	00.5	28.1	09.0	16.0	03.1	03.1	00.5	00.0	01.0	0.192
9-8	38.3	00.0	02.7	01.0	20.3	06.3	13.8	10.7	05.4	00.6	00.0	01.1	0.356
9-9	35.2	00.0	05.5	00.5	21.6	16.5	15.6	00.5	03.6	00.5	00.0	00.5	0.223
9-10	22.3	00.0	05.9	00.0	29.2	18.9	19.3	01.9	01.4	01.0	00.0	00.0	0.217
9-11	23.8	00.0	02.4	00.0	35.3	17.5	18.9	01.0	01.0	00.0	00.0	00.0	0.419
9-13	32.1	01.0	03.4	01.5	21.4	10.7	21.4	05.4	02.4	01.0	00.0	00.0	0.635
10-1	50.5	00.0	01.1	13.2	15.7	09.1	05.1	01.6	01.6	02.5	00.0	00.0	0.138
10-2	35.6	00.4	02.9	04.4	20.0	14.2	15.6	04.4	01.4	01.0	00.0	00.0	0.345
10-3	27.1	00.0	02.0	30.5	11.8	10.9	10.3	00.9	02.4	02.5	00.9	00.5	0.097
10-4	38.7	00.0	01.5	06.8	20.5	12.3	09.8	03.5	03.5	02.5	00.9	00.0	0.299
10-5	33.2	00.0	02.0	31.3	18.0	05.9	03.5	01.0	02.5	02.9	00.4	00.0	0.220
11-1	60.1	00.0	01.6	06.8	09.3	03.6	13.9	03.1	01.1	00.0	00.0	00.0	0.662
11-2	40.9	00.0	02.0	11.2	15.3	09.1	10.8	07.7	01.0	01.0	00.0	01.0	0.645
11-3	40.3	01.6	02.6	15.9	17.9	08.7	09.7	01.6	01.0	01.0	00.0	00.0	0.420
11-4	30.6	01.9	04.6	10.6	14.4	11.6	09.3	11.6	00.0	05.6	00.0	00.0	0.285
11-5	41.2	01.6	02.2	27.8	08.4	05.0	06.6	00.6	03.4	03.4	00.0	00.0	1.720
11-6	23.9	06.6	04.2	08.9	10.8	10.8	16.5	13.1	00.0	05.1	00.0	00.0	0.252
11-8	44.2	02.6	02.6	03.6	18.6	13.5	08.5	03.1	02.1	01.5	00.0	00.0	0.080
11-9	31.8	01.4	01.9	04.3	24.2	15.1	14.7	00.9	01.9	03.8	00.0	00.0	0.167
11-10	44.4	00.4	11.2	01.4	15.0	04.9	15.0	06.2	00.9	00.4	00.0	00.0	1.590
11-11	22.4	03.3	03.8	03.3	17.8	15.4	22.8	06.1	01.1	04.2	00.0	00.0	0.457
12-1	25.4	01.4	03.2	00.0	25.4	11.2	11.2	02.9	02.9	05.7	10.8	00.0	0.083
12-2	18.3	00.0	02.1	02.1	21.3	12.0	14.9	02.1	00.4	12.0	14.9	00.0	0.109
12-3	22.9	01.7	03.9	02.2	22.4	07.9	13.3	00.8	03.9	06.6	13.7	00.4	0.093
12-4	19.7	00.0	05.0	01.7	23.3	15.9	23.8	03.3	00.0	02.8	04.5	00.0	0.940
12-5	19.5	00.0	04.1	01.4	21.8	11.7	29.8	01.8	00.0	10.0	00.0	00.0	0.695
12-6	40.4	00.0	08.9	01.6	09.9	09.9	07.9	16.3	01.6	02.1	00.5	01.0	0.542
12-7	20.0	02.2	01.1	07.4	21.1	20.6	19.4	01.8	01.8	02.9	01.8	00.0	0.058
12-8	31.2	02.3	11.3	00.5	16.1	07.2	11.8	13.0	00.9	00.0	00.0	01.4	0.776
12-9	35.0	04.4	04.4	04.4	22.8	10.0	07.2	03.8	03.4	03.4	00.6	00.6	0.186
12-10	32.9	01.4	05.8	00.9	17.9	10.6	19.3	07.7	02.0	00.9	00.0	00.4	0.273
12-11	38.9	01.0	03.8	01.0	15.9	06.1	16.9	10.8	03.2	01.0	01.0	00.4	0.395
13-1	33.5	00.0	03.0	01.1	18.3	16.8	09.2	02.1	05.1	03.6	07.7	00.0	0.176
13-2	39.8	00.5	06.7	01.0	18.1	05.7	18.1	02.4	01.5	01.0	04.7	00.5	0.445
13-3	37.0	00.5	07.0	01.5	24.0	08.5	12.0	01.5	05.0	00.5	02.0	00.5	0.340
13-4	42.3	00.0	05.1	00.4	14.6	07.0	18.3	03.2	05.1	01.9	01.9	00.0	0.405
13-5	33.2	00.4	07.8	02.0	26.3	05.3	14.4	05.3	01.4	01.0	01.4	01.0	0.252

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
13-6	34.8	00.0	02.9	00.0	28.9	10.9	14.4	03.9	02.0	00.5	01.0	00.5	0.397
13-7	48.9	00.5	03.6	01.1	12.1	06.5	10.1	07.6	05.1	00.5	04.0	00.0	0.497
13-8	60.4	00.0	01.8	00.0	15.1	09.5	09.5	01.8	01.8	00.0	00.0	00.0	0.171
13-9	45.1	00.0	04.7	02.5	13.8	05.1	20.6	03.5	04.7	00.0	00.0	00.0	0.210
13-10	35.8	00.6	09.3	07.3	17.7	10.8	05.1	07.3	03.1	00.6	02.6	00.0	0.376
14-1	40.5	00.0	03.3	01.8	17.5	13.2	12.8	00.5	01.5	00.9	06.2	01.8	0.354
14-2	48.8	00.0	05.5	01.5	19.9	05.5	06.9	02.9	04.5	01.0	02.0	01.5	1.688
14-3	37.4	01.9	04.3	00.0	16.5	06.4	14.1	04.3	09.2	01.5	03.0	01.5	0.631
14-5	38.9	03.8	04.8	01.4	13.9	01.9	10.6	06.8	11.1	00.0	03.8	02.8	2.417
14-6	48.3	01.5	02.9	00.0	15.4	06.2	07.2	04.3	10.0	00.0	03.8	00.5	3.308
14-7	44.1	01.3	03.1	00.0	18.1	05.5	04.5	01.9	10.5	00.0	08.1	02.7	2.081
14-8	31.8	00.0	02.1	00.0	20.0	08.8	06.6	02.1	11.8	01.0	13.4	02.5	00000
14-9	38.2	02.5	02.5	02.5	23.7	04.5	02.5	03.4	10.9	00.5	06.5	02.5	0.777
14-10	46.4	01.6	05.1	03.6	17.2	05.6	07.6	02.5	05.6	01.1	03.6	00.5	0.565
15-2	46.6	00.5	04.2	00.0	18.1	05.8	11.4	01.0	05.8	02.3	04.2	00.0	1.291
15-3	31.0	01.4	02.9	00.0	29.5	05.8	17.1	00.5	04.2	02.9	04.2	00.5	0.767
15-4	42.0	01.0	01.0	03.1	28.5	05.0	07.5	02.0	07.5	01.5	01.0	00.0	2.363
15-5	25.5	01.5	00.9	07.1	20.8	07.1	16.9	01.8	08.1	05.6	04.8	00.0	0.271
15-6	43.5	01.2	00.5	01.7	19.4	06.5	13.5	02.4	03.5	03.5	02.9	01.2	1.297
5-7	29.7	00.0	05.0	01.2	38.0	06.3	07.6	00.7	03.8	05.7	01.9	00.0	1.167
15-8	27.4	00.4	03.2	01.3	23.1	05.6	19.9	01.3	06.9	04.1	06.4	00.0	0.571
15-9	38.6	00.4	00.4	01.4	24.2	03.8	15.0	00.9	09.2	00.9	03.8	00.9	0.884
15-10	16.6	00.9	00.9	00.0	23.7	13.0	04.4	00.0	12.1	02.2	25.5	00.4	0.202
16-1	37.9	00.0	00.5	00.0	22.0	11.5	07.7	02.8	05.5	00.0	06.4	01.3	0.411
16-2	27.0	01.0	06.0	00.0	21.0	12.0	10.5	06.0	06.0	02.0	08.0	00.5	0.367
16-3	35.0	00.0	01.8	00.0	23.0	10.6	09.7	00.9	11.5	02.7	04.1	00.4	0.464
16-4	48.5	00.0	04.9	00.0	15.6	06.8	15.6	00.4	04.5	00.9	01.9	00.5	2.769
16-5	35.7	00.0	03.9	00.5	21.5	09.8	14.3	00.5	05.8	01.9	05.8	00.0	0.376
16-6	48.1	00.5	07.9	00.0	17.8	05.0	09.0	03.0	05.0	00.5	03.0	00.5	2.570
17-1	25.2	00.0	00.0	00.0	31.0	17.0	14.5	00.0	05.8	01.9	04.3	00.0	0.199
17-2	31.7	00.0	02.0	00.0	30.8	10.2	12.6	01.0	02.5	02.0	07.4	00.0	0.268
17-3	23.8	00.0	01.0	00.0	31.9	11.0	15.8	01.0	07.1	02.3	05.3	01.0	0.216
17-4	29.7	00.0	01.9	00.0	28.6	08.3	14.1	00.4	04.9	03.4	06.8	01.9	0.371
17-5	20.6	00.0	01.4	00.0	25.2	22.5	10.1	00.0	09.7	00.5	08.8	01.4	0.228
17-6	32.6	00.0	03.0	00.0	29.6	08.4	14.2	00.9	04.3	02.4	03.9	00.5	0.791
17-7	29.0	00.0	02.0	00.0	24.5	13.0	05.5	01.5	08.0	04.0	12.5	00.0	0.177
17-8	42.7	00.0	01.4	00.0	22.0	04.2	07.6	02.3	09.9	01.0	08.5	00.4	0.773
17-9	51.1	00.0	01.6	00.5	13.7	05.6	08.5	01.1	10.1	01.1	05.6	01.6	0.397
18-1	31.1	00.0	04.7	00.0	25.1	17.4	14.2	01.3	01.3	01.8	02.1	00.8	0.216
18-2	28.6	00.0	03.0	00.4	23.7	19.9	16.1	02.4	01.5	01.0	03.4	00.0	0.074
18-3	29.4	00.0	08.4	00.0	23.8	14.6	16.7	03.1	01.4	01.0	01.4	00.0	0.381
13-4	26.2	00.9	04.6	00.9	22.5	17.1	13.8	01.8	02.7	01.8	07.4	00.0	0.127
18-5	35.1	00.9	06.1	00.0	26.0	07.5	14.7	02.3	02.3	00.5	02.8	01.4	0.230
18-6	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0.158
18-7	30.6	00.5	04.5	00.0	19.3	14.4	15.3	03.4	04.5	00.5	07.0	00.0	0.353
18-8	39.1	01.9	05.0	00.0	14.4	08.5	08.5	02.5	07.0	00.5	11.3	01.4	0.429
19-1	29.1	01.0	05.4	00.0	22.4	17.9	16.1	01.0	02.4	01.5	01.9	01.5	0.268
19-2	34.2	01.0	05.5	00.0	21.6	14.6	13.0	02.1	03.6	01.0	01.5	02.1	0.161
19-3	37.4	02.0	02.4	00.0	22.8	14.9	12.5	01.0	01.0	05.0	00.0	01.0	0.048
19-4	31.1	00.9	02.4	00.0	25.4	12.9	14.4	04.1	03.7	01.3	03.7	00.0	0.179
19A-1	25.4	00.5	02.4	00.0	29.6	22.9	10.0	00.5	00.0	05.2	03.3	00.0	0.040
19A-2	35.6	00.4	03.5	00.0	24.9	15.1	09.8	00.4	02.0	04.4	02.9	01.0	0.065
19A-3	35.7	00.9	04.3	00.0	27.7	09.0	12.3	03.8	03.0	00.9	03.4	00.0	0.249
19A-4	12.6	00.4	00.0	00.0	22.3	21.8	10.3	01.0	07.9	03.7	19.0	01.0	0.017
19A-5	40.2	01.9	05.6	00.0	18.4	07.1	08.6	02.8	02.8	01.4	10.0	00.9	0.607
19A-6	24.4	01.7	02.3	00.0	21.3	08.8	11.5	01.3	07.9	03.1	16.9	00.8	0.044

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
19A-7	37.8	00.5	01.8	00.0	20.8	09.5	09.9	01.5	07.5	01.5	08.5	00.9	0.386
20-1	31.0	00.0	04.9	00.0	28.1	14.5	11.2	01.4	02.5	02.5	04.3	00.0	0.124
20-2	27.7	00.0	05.0	00.5	25.1	19.1	10.6	01.5	02.6	04.5	03.6	00.0	0.058
20-3	22.6	00.0	00.7	00.0	39.2	14.6	14.6	00.7	00.7	03.8	03.8	00.0	0.037
20-4	30.1	00.4	05.8	00.4	30.5	10.7	11.7	01.5	02.4	01.0	05.4	00.0	0.288
20-5	29.6	01.1	00.5	00.0	31.3	10.5	12.7	01.1	02.2	05.8	05.3	00.0	0.072
20-6	33.5	01.0	04.9	00.0	23.7	08.3	15.0	03.0	03.8	01.9	04.3	00.4	0.376
20-7	42.7	00.4	05.7	00.0	21.1	07.0	07.6	02.3	04.7	00.4	05.7	02.3	0.708
20-8	34.9	00.0	04.5	00.0	32.3	06.7	12.8	03.4	01.2	02.9	01.2	00.0	00000
20A-1	37.2	00.0	04.1	00.0	33.0	06.8	10.6	04.1	01.4	01.9	01.0	00.0	0.991
20A-2	31.3	00.4	03.0	00.0	28.2	11.9	16.7	01.7	02.2	01.3	02.6	00.4	0.398
20A-3	29.1	00.0	03.8	00.0	36.3	09.5	10.9	03.0	02.5	02.5	02.0	00.5	0.819
20A-4	29.3	00.0	05.3	00.5	27.1	13.1	14.9	01.3	02.4	01.6	04.5	00.0	0.265
20A-5	21.8	00.4	04.2	00.4	27.4	13.8	15.5	02.1	04.2	00.8	08.4	00.8	0.258
20A-6	36.6	00.3	03.5	00.3	26.2	07.7	12.5	02.2	03.8	00.9	04.4	01.2	0.915
20A-7	17.9	00.7	02.1	01.0	26.9	14.4	08.7	00.0	07.7	02.8	17.4	00.3	0.065
21-1	26.2	01.0	02.4	01.4	30.5	13.7	12.0	00.3	04.1	02.4	05.5	00.3	0.203
21-2	44.2	01.5	08.3	00.4	19.3	06.8	10.3	04.3	01.5	00.8	02.4	00.0	1.340
21-3	37.0	00.0	06.0	00.0	23.5	07.0	13.0	03.5	03.5	00.8	05.3	00.5	0.737
21-4	31.5	00.4	02.7	00.4	35.1	09.9	13.1	02.4	00.8	02.7	00.8	00.0	0.380
21-5	33.7	00.5	02.3	00.0	29.1	10.9	16.3	02.3	01.9	00.5	02.3	00.0	0.596
21-6	34.0	00.0	01.7	01.7	27.1	11.3	15.7	03.3	00.4	00.4	04.0	00.4	0.665
21-7	40.5	00.0	02.7	01.4	28.4	08.1	13.0	03.2	00.9	00.5	00.9	00.5	1.174
21A-1	25.9	00.9	01.9	01.4	25.0	11.1	16.8	01.9	07.7	03.3	03.8	00.0	0.150
21A-2	27.6	00.5	00.5	00.5	37.6	08.8	17.1	01.7	01.7	03.1	01.4	00.0	0.335
21A-3	17.3	00.5	00.5	01.0	33.6	20.8	16.4	00.5	01.9	05.0	02.5	00.0	0.119
21A-4	37.2	01.0	00.0	00.4	33.4	09.7	13.0	01.4	02.8	01.0	00.0	00.0	0.649
21A-5	40.7	00.9	00.5	00.5	28.8	10.4	13.1	02.1	01.7	00.9	00.5	00.0	0.524
21A-6	40.6	00.5	00.0	01.5	27.5	05.4	14.7	02.5	02.5	02.9	00.9	00.9	0.321
21A-7	39.0	00.9	00.0	00.5	25.8	12.6	15.3	01.8	00.5	01.4	01.8	00.9	0.708
21-1	29.6	00.8	02.5	09.3	33.9	07.2	09.7	02.2	01.3	00.8	02.5	00.0	2.023
22-2	39.7	00.0	04.2	00.0	25.2	05.6	15.3	06.3	01.7	00.3	01.7	00.3	1.185
22-3	32.5	00.0	04.1	01.3	21.6	08.3	14.5	06.3	04.1	00.9	05.9	00.5	0.568
22-4	25.9	00.0	03.0	00.0	32.7	09.4	15.6	01.7	03.6	01.2	05.8	00.9	0.489
22-5	26.9	00.0	02.5	00.5	28.9	10.7	22.7	01.7	03.8	00.0	02.0	00.5	0.162
22-6	32.5	01.0	02.8	01.0	27.9	10.1	20.1	03.6	00.5	00.5	00.0	00.0	0.572
22-7	36.6	01.0	02.3	01.0	30.0	11.0	11.9	01.4	02.3	01.4	01.0	00.0	0.290
22A-1	21.1	03.2	00.0	42.7	14.6	06.1	07.6	00.4	01.4	00.0	02.9	00.0	0.217
22A-2	28.9	01.0	01.5	03.9	27.8	09.5	10.9	10.4	02.0	00.5	02.9	00.5	0.459
22A-3	24.7	01.0	02.4	03.3	29.0	10.7	15.0	01.0	03.8	03.3	06.1	00.0	0.120
22A-4	22.9	01.0	02.4	00.4	26.7	14.4	21.5	01.4	01.8	01.4	05.6	00.4	0.222
22A-5	33.7	01.0	01.4	01.0	26.4	08.7	17.8	04.5	02.2	01.8	01.0	00.5	0.354
22A-6	44.2	00.4	00.4	01.0	24.8	06.8	14.5	04.3	01.5	01.0	00.4	00.4	0.268
22A-7	37.7	00.5	01.6	00.5	25.7	07.9	01.6	01.6	03.1	04.1	00.0	00.0	0.195
23-1	37.4	00.0	02.9	05.0	22.3	10.0	11.9	05.0	02.0	01.0	02.0	00.5	0.460
23-2	24.1	00.9	01.4	01.9	28.8	18.2	15.3	00.9	03.3	01.9	02.4	00.4	0.055
23-3	27.4	00.5	03.5	00.8	20.8	05.3	15.3	17.4	06.0	00.8	01.8	00.5	1.300
23-4	30.8	00.0	02.8	00.0	23.3	07.9	19.2	11.6	02.4	00.0	01.8	00.0	0.457
23-5	29.8	00.9	02.0	00.0	32.2	12.2	18.0	01.7	00.9	00.0	02.4	00.0	0.616
23-6	23.2	02.8	01.0	01.8	36.5	14.7	11.9	01.3	02.2	01.3	02.2	01.0	0.150
23-7	23.1	03.8	01.7	00.7	29.0	12.3	16.7	00.7	03.8	01.0	06.6	00.3	0.121
23A-1	30.6	04.6	01.9	00.9	26.3	12.9	16.6	02.8	02.4	00.9	00.0	00.0	0.636
23A-2	30.0	02.3	01.6	01.9	28.8	07.3	15.3	08.1	02.7	00.7	00.3	00.7	0.753
23A-3	33.5	00.9	03.3	01.5	27.9	08.9	14.6	02.4	02.4	03.8	00.0	00.9	0.186
23A-4	28.7	01.9	02.4	00.4	28.7	07.9	18.1	04.6	03.2	02.8	00.4	00.9	0.384
23A-5	28.4	03.6	00.9	01.4	24.3	13.9	19.3	02.7	03.6	01.4	00.0	00.5	0.251

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
23A-6	31.5	01.5	02.1	01.0	24.1	07.0	11.6	02.1	03.1	14.1	02.1	00.0	0.125
23A-7	35.0	01.5	01.0	01.5	31.6	09.2	12.2	03.8	01.9	01.5	00.4	00.4	0.736
24-1	25.0	02.2	01.8	01.8	34.3	07.9	17.1	04.8	01.4	03.9	00.0	00.0	4.354
24-2	30.2	02.6	01.5	00.5	33.6	05.5	18.1	03.6	03.1	01.5	00.0	00.0	0.750
24-3	30.6	02.3	01.9	00.5	32.3	07.9	16.9	01.0	02.3	02.9	00.0	01.4	0.429
24-4	23.7	01.3	02.8	00.4	34.3	12.5	12.5	01.9	03.2	06.1	01.3	00.0	0.416
24-5	27.8	00.0	00.9	00.9	42.2	08.5	14.8	01.3	02.2	01.3	00.0	00.0	0.259
24-6	30.1	01.0	02.0	00.0	26.8	10.5	16.7	04.3	03.8	02.9	01.0	01.0	0.367
24-7	37.4	03.0	01.2	01.2	30.5	09.9	13.3	00.9	01.2	01.2	00.0	00.0	0.481
25-1	28.1	04.1	02.7	01.3	25.0	14.1	20.9	03.1	00.5	00.0	00.0	00.0	1.155
25-2	27.8	03.0	01.7	00.8	29.1	09.7	16.3	05.2	01.7	03.0	00.0	01.3	0.498
25-3	30.7	01.8	01.8	02.2	28.1	12.6	17.2	00.9	01.4	03.1	00.0	00.0	0.708
25-4	29.6	04.0	02.4	00.0	28.8	08.4	19.6	01.6	01.6	02.4	00.0	01.6	1.636
25-5	30.2	01.9	03.5	00.7	30.9	08.6	16.1	01.5	01.9	03.5	00.0	00.7	0.288
25-6	36.6	01.1	01.9	00.8	33.4	06.7	15.2	01.9	00.0	01.6	00.0	00.8	1.999
25-7	41.2	02.1	02.4	01.3	27.1	07.9	13.5	01.3	01.6	00.8	00.0	00.8	2.089
26-1	33.5	05.1	01.5	00.0	34.5	09.9	11.8	02.4	00.5	00.5	00.0	00.5	1.271
26-2	27.3	02.3	02.7	00.9	30.0	08.7	21.3	00.9	03.1	00.9	00.0	01.9	1.036
26-3	23.2	02.2	01.3	00.0	33.7	16.9	16.5	01.3	02.8	00.5	00.0	01.3	0.341
26-4	36.2	02.2	01.8	00.5	31.7	11.4	12.3	02.8	00.9	00.5	00.0	00.0	0.828
26-5	38.6	02.3	01.9	01.4	28.6	06.6	13.8	04.7	00.5	00.5	00.0	01.0	1.060
26-6	33.4	01.4	02.9	03.2	30.9	06.6	15.9	03.8	00.4	01.0	00.0	00.4	0.641
26-7	27.4	02.8	01.9	00.0	26.9	16.6	13.4	00.4	04.6	04.1	00.9	00.9	0.107
27-1	35.6	01.4	01.8	01.8	31.8	06.1	13.6	03.3	01.0	02.8	00.0	01.0	0.820
27-2	31.3	01.9	01.4	00.0	31.8	00.9	17.6	02.8	00.0	00.9	00.0	01.9	0.987
27-3	37.3	02.0	01.0	00.0	31.1	06.2	17.2	00.5	02.4	01.0	01.0	00.5	0.460
27-4	27.3	01.5	01.5	00.5	32.0	11.4	16.2	05.2	02.0	01.5	00.0	01.0	0.368
27-5	31.4	02.2	02.2	00.4	31.9	08.1	20.6	02.2	00.0	00.4	00.0	00.4	1.106
27-6	31.1	03.7	01.8	01.4	30.7	11.1	14.5	04.7	00.4	00.4	00.0	00.0	0.730
27-7	26.3	03.8	01.9	01.4	35.6	09.6	15.0	03.8	00.0	02.3	00.0	00.0	0.747
28-1	33.9	02.4	01.5	01.0	30.1	05.8	16.5	05.4	01.9	01.5	00.0	00.0	0.516
28-2	33.1	02.9	02.4	01.5	26.5	04.8	22.6	04.8	00.0	01.0	00.0	01.0	1.332
28-3	32.9	03.2	01.3	00.9	24.1	10.0	17.6	05.6	02.4	00.9	00.0	01.3	0.678
28-4	35.0	02.7	02.3	00.5	26.4	06.3	15.5	09.5	01.3	00.5	00.0	00.0	1.303
28-5	37.7	02.3	01.3	01.9	22.3	07.3	21.3	04.1	04.1	00.5	00.0	00.0	1.148
28-6	35.5	01.8	01.8	00.8	26.0	04.3	17.4	05.6	00.8	04.3	00.8	00.8	0.939
28-7	34.6	03.2	01.4	00.9	28.4	10.3	16.3	03.6	00.5	00.5	00.0	00.5	0.450

APPENDIX V

Modal Analyses of the 3-4 Phi Heavy Mineral Fraction. Abbreviations are as follows: Op-opaques; Lu-leucoxene; Ru-rutile; Sp-sphene; Ky-kyanite; Tour-tourmaline; St-staurolite; Zr-zircon; Ep-epidote; Sill-sillimanite; Amph-amphibole; Gr-garnet; Wt%HM-weight percent heavy minerals within the above grain size fraction.

SAMP	OP	LU	RU	SP	KY	TOUR	ST	ZR	EP	SILL	AMPH	GR	WT%HM
1-5	21.1	11.1	02.9	02.5	21.1	06.4	08.9	20.0	00.4	01.3	00.0	04.3	1.29
2-5	29.1	07.4	04.7	04.1	19.0	06.5	11.9	08.9	01.2	01.7	00.0	04.7	1.12
3-5	24.4	14.7	04.9	02.0	23.5	06.8	13.7	07.8	01.4	01.0	00.0	00.0	0.33
4-5	34.7	19.6	03.5	01.4	19.0	04.9	09.2	06.8	01.0	00.0	00.0	00.0	0.78
6-5	25.9	06.6	02.4	02.4	26.5	10.8	12.7	03.1	02.4	07.2	00.0	00.0	2.62
7-6	36.5	02.9	03.5	01.2	24.7	08.8	07.1	12.4	01.7	01.2	00.0	00.0	1.33
9-4	35.6	13.8	02.2	02.2	17.8	05.8	06.6	04.4	00.4	10.2	00.0	00.8	2.31
10-5	41.8	00.0	02.9	04.5	20.9	01.5	14.9	07.4	00.7	03.4	00.0	01.5	4.15
11-5	28.5	07.0	06.5	10.0	11.0	07.5	07.5	21.5	00.0	00.0	00.0	00.5	2.31
12-5	35.4	03.8	08.7	02.4	11.0	05.7	07.7	23.4	01.0	00.0	00.5	00.5	5.16
13-5	46.1	04.1	08.3	03.2	12.7	04.1	08.7	09.5	01.0	00.5	01.8	00.0	2.58
14-5	43.4	03.4	07.7	00.5	21.4	04.2	05.3	06.6	02.9	02.3	02.3	00.0	5.26
15-5	47.3	00.0	03.1	00.0	27.2	04.5	07.6	03.1	04.0	00.5	02.6	00.5	4.95
16-5	48.1	04.8	01.9	00.0	16.8	03.8	15.3	07.7	00.4	00.9	00.0	00.0	18.7
17-5	50.2	02.9	03.3	00.0	19.5	04.0	08.5	07.7	00.8	02.9	00.4	00.0	12.7
18-5	39.9	04.5	01.4	01.4	17.0	02.8	11.4	08.3	01.4	11.0	01.0	00.0	5.30
19-4	50.5	02.9	03.5	00.5	10.7	01.5	04.9	08.8	00.0	16.6	00.0	00.0	7.04
19A-5	35.9	01.9	05.4	01.5	08.8	04.3	03.4	08.8	01.9	25.2	03.0	00.0	4.00
20-5	34.5	03.3	03.3	00.0	30.3	04.7	06.0	04.7	06.6	03.3	03.7	00.0	0.77
20A-5	33.2	01.3	03.2	00.0	19.4	12.4	06.0	08.3	03.2	11.5	01.3	00.0	3.44
21-5	36.5	01.3	06.0	00.0	18.2	06.4	11.5	08.7	01.8	08.3	01.3	00.0	3.80
21A-5	59.9	02.5	01.4	01.0	10.9	01.9	10.4	07.0	03.0	01.9	00.0	00.0	3.36
22-5	54.3	03.3	02.8	00.5	10.8	03.2	09.7	08.7	02.2	03.2	01.0	00.0	3.32
22A-6	59.1	02.0	03.0	01.0	11.2	02.6	10.2	07.1	01.6	02.0	00.0	00.0	2.21
23-5	59.0	03.0	01.0	00.0	13.0	05.5	09.0	06.0	01.0	02.5	00.0	00.0	3.25
23A-5	51.4	04.3	02.7	01.0	11.4	05.4	09.1	08.6	01.6	03.2	01.0	00.0	2.24
24-5	53.0	04.9	03.8	01.4	09.2	06.4	09.2	05.8	01.9	02.4	01.9	00.0	8.11
25-5	55.2	03.0	00.9	00.0	12.8	08.4	12.4	04.5	00.9	02.0	00.0	00.0	4.25
26-5	55.3	02.8	02.2	01.0	10.5	06.4	12.7	06.4	01.3	01.3	00.0	00.0	6.37
27-5	50.5	03.9	01.9	01.0	11.8	09.4	10.8	08.5	01.0	00.0	01.0	00.0	6.72
28-5	43.8	03.1	02.7	01.7	14.2	09.3	10.7	08.4	02.7	03.1	00.4	00.0	6.70

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STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Elton J. Gissendanner, *Executive Director*

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BUREAU OF GEOLOGY
Walter Schmidt, *Chief*

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HEAVY MINERAL RECONNAISSANCE OFF THE COAST OF THE APALACHICOLA RIVER DELTA, NORTHWEST FLORIDA

by

Jonathan D. Arthur
Joseph Applegate

Shekhar Melkote
Thomas M. Scott

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