United States Department of the Interior

Geological Survey

Characterization of sediments from the base and top of the West Florida Escarpment

by

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Open-File Report 87-196

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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ABSTRACT

Sedimentological and geophysical data show that the sediments at the base of the West Florida Escarpment are flat-lying hemipelagic carbonate oozes, derived primarily from the shelf and upper slope, interbedded with massive siliciclastic Mississippi Fan sediments. Petrographic and scanning electron microscope (SEM) examination of the hemipelagic sediments indicate that bioerosion by Cliona sponges or boring clams, mussels, or barnacles is not presently a significant process on the West Florida Escarpment upslope from the core sites. However, the presence of angular limestone fragments and calcareous, glauconitic clasts within the fine-grained abyssal floor sediments suggests that an erosional process is active on the consolidated sections of the adjacent slope. The lithologies of the cores and SEM examination of the foraminifera show that the dark, grayish-brown silty clay is not the insoluable residue of the hemipelagic calcarenite after the diagenetic dissolution and removal of carbonate.

INTRODUCTION

The West Florida Escarpment is the steep lower portion of the slope that separates the shallow shelf carbonate platform from the deep abyssal plain of the Eastern Gulf of Mexico. The escarpment, which was formed from sediments associated with vertical reef growth during Cretaceous to Miocene times (Antoine and others, 1967; Uchupi and Emery, 1968), has been shaped by erosional processes that are responsible for its present day appearance (Freeman-Lynde, 1983). The escarpment extends from the Straits of Florida north to the DeSoto Canyon and ranges in relief from about 2500 m west of the Florida Keys to nearly 1000 m near the DeSoto Canyon.

During October and November 1983, aboard the USNS LYNCH, the U.S. Geological Survey collected nine cores from the base and top of the escarpment (Figs. 1 and 2). The cores were taken to determine (1) the source of the sediments deposited at the base of the escarpment and (2) the sedimentological processes affecting this deposition. This report also includes sections of high-resolution seismic-reflection profiles that were collected aboard the USNS LYNCH along three transects made across the southwestern Florida outer shelf and slope and used for citing and morphologic information.

METHODS

The piston cores were collected with an Alpine Geophysical corer fitted with a 1364-kg core weight (Table 1). Plastic liners having internal diameters of 89 mm were used within the core barrels. Core sites were selected and target feature morphology was confirmed by high-resolution seismic-reflection profile data obtained using a tuned (3.5-kHz) transducer and a 30-kJ sparker. Navigation was performed using a Northstar 6000 Loran C receiver (Digital Marine Equipment Corp., Bedford, MA).

The cores were later described and sampled in the laboratory. A split from each sample was mounted and x-rayed as a randomly oriented powder. The clay fraction from each sample, separated by centrifuge, was mounted on a silver filter as an oriented aggregate. Each oriented clay mount was subjected to four treatments to determine which clay minerals were present: air-drying, glycolation with ethylene glycol, heating to 400 °C, and heating

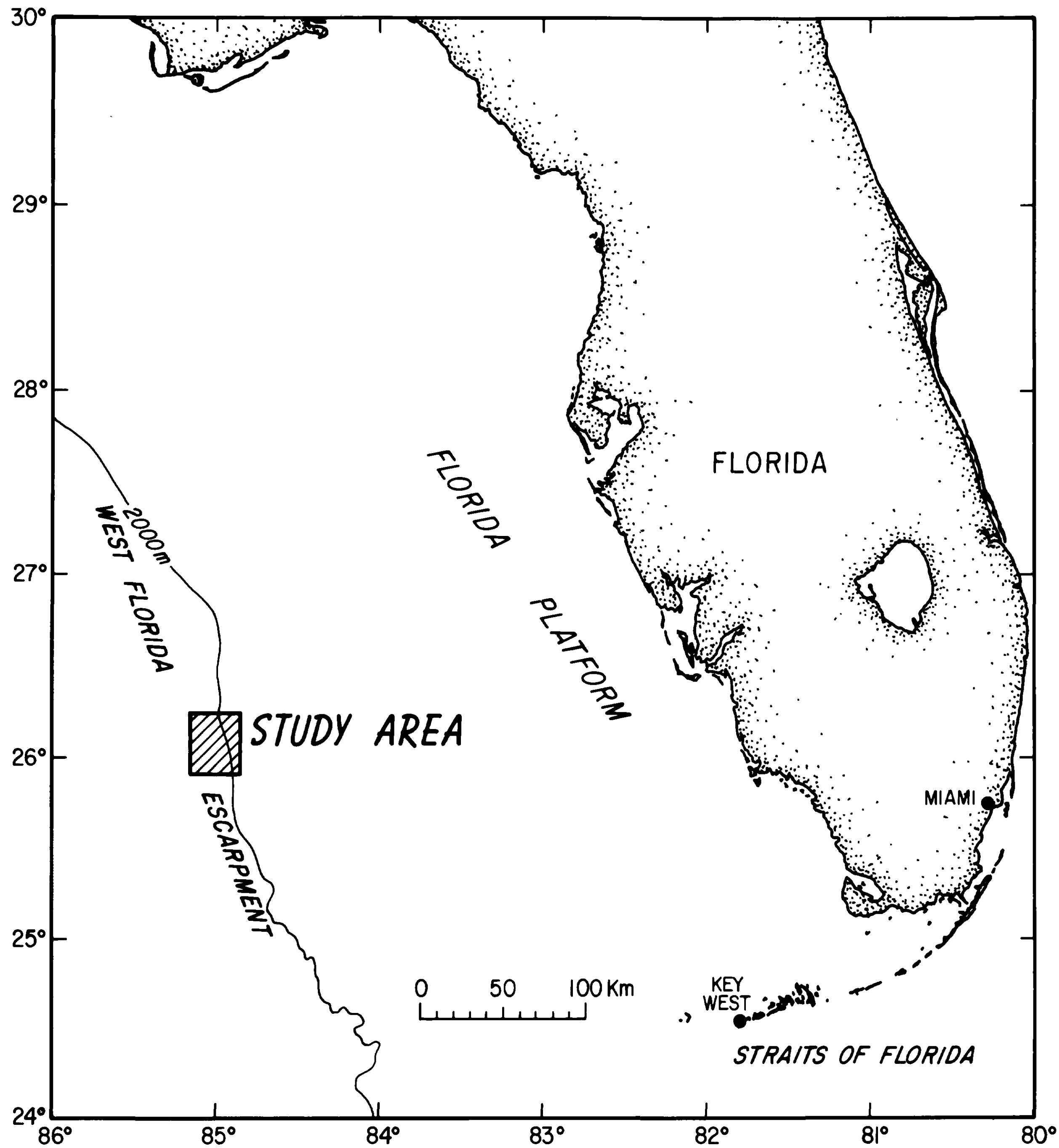


Figure 1. Map showing the location of the study area along the West Florida Escarpment.

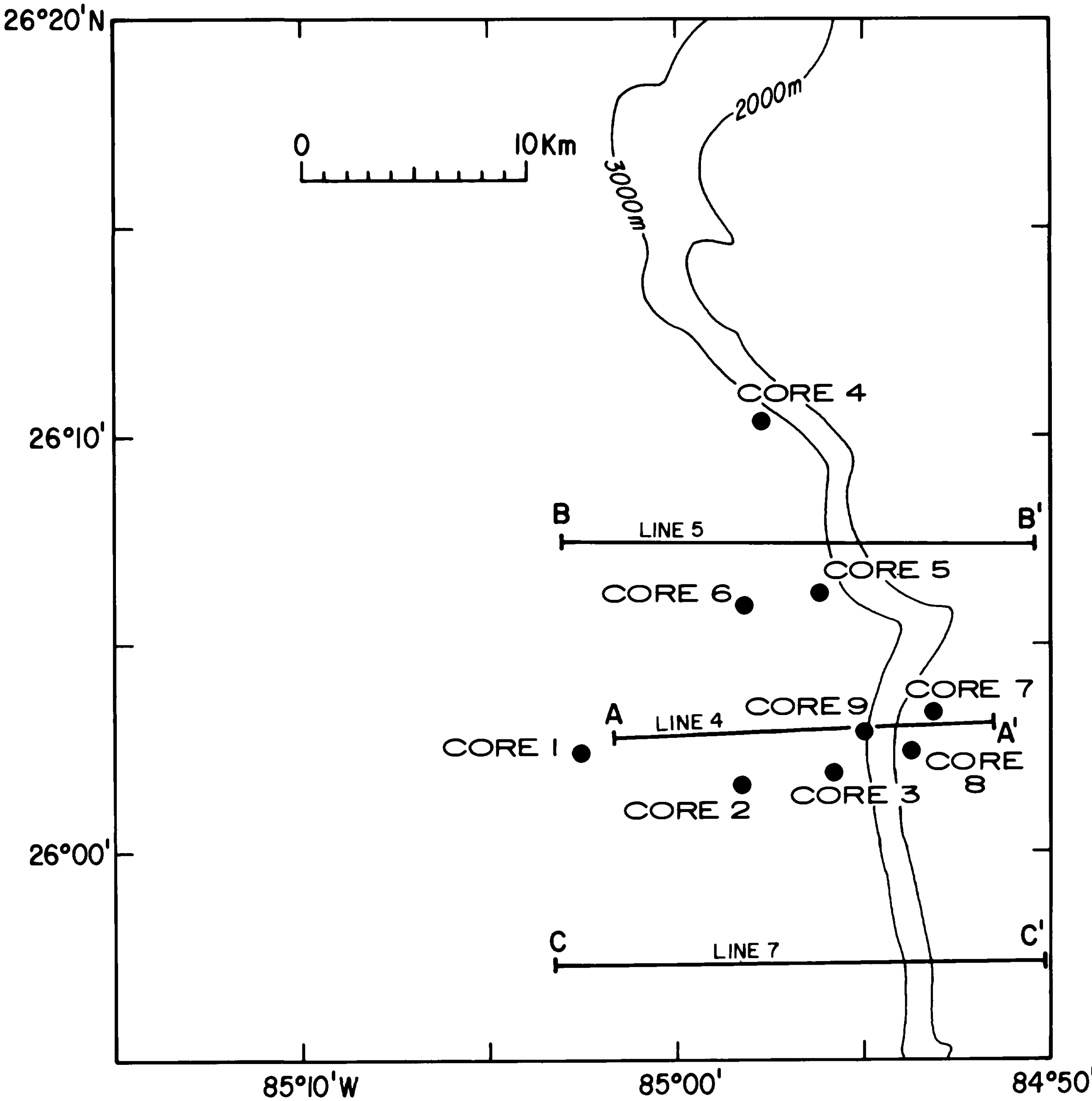


Figure 2. Map showing the location of core sites and high-resolution seismic-reflection profiles within the study area.

STATION NO.	CORE TYPE	WATER DEPTH (m)	RECOVERED LENGTH (cm)	LATITUDE (N)	LONGITUDE (W)	LORAN TIME DELAYS	
CORE 1	PC	3329	35	26° 02.44'	85° 02.58'	13541.8	45048.4
CORE 2	PC	3300	181	26° 01.69'	84° 58.28'	13557.0	45021.0
CORE 3	PC	3296	197	26° 01.94'	84° 55.82'	13566.9	45008.3
CORE 4	PC	3288	44	26° 10.79'	84° 57.72'	13576.9	45061.2
CORE 5	PC	3296	304	26° 06.27'	84° 56.19'	13573.9	45030.8
CORE 6	PC	3300	176	26° 05.97'	84° 58.22'	13565.5	45040.8
CORE 7	GC	1690	152	26° 03.41'	84° 53.13'	13580.0	45000.0
CORE 8	GC	1830	60	26° 02.48'	84° 53.76'	13575.8	44999.2
CORE 9	PC	3290	70	26° 02.95'	84° 54.50'	13573.9	45005.6

Table 1. Sample site information for the USNS LYNCH 83-1 cruise. CORE TYPE: PC= piston core; GC= gravity core. Additional Secondary Phase (ASF) corrections have been used to adjust the latitudes and longitudes presented here.

to 550 °C. The samples were x-rayed after each treatment. The data from the oriented and randomly oriented aggregate mounts were combined and semiquantitative estimates of the minerals present were made by comparing the sample diffraction peak intensities with the intensities recorded from a collection of external standards. Relative percentages of the clay minerals were estimated by a method described by Biscaye (1965). These semiquantitative estimates are generally considered to be accurate to within 10 percent of their actual values; however, values of components present only in smaller amounts (<10%) may have considerably greater error. Values generated by x-ray diffraction are in relative percent of the crystalline material. A split was taken from each sample and mounted as a smear slide. These slides were used to check the semiquantitative diffraction results, to detect amorphous phases or minerals present in trace amounts, and to examine the biological debris.

A scanning electron microscope was used to check for foraminifera dissolution and debris suggestive of bioerosion by Cliona sponges. Specimens of Globigerinoides ruber, which were handpicked from the sediments just above and below the lithologic boundary in core 4 (fig. 4), were examined for evidence of dissolution. This species was chosen because it is the most common foraminifera in the surficial calcarenite and is also present in the underlying silty clay. Care was taken to select specimens of roughly equal size and the same species; both rose colored and white forms were examined. A quantitative energy dispersive x-ray spectrographic analysis (EDS) was performed using the SEM to determine the chemical composition of a fragment of ferromanganese crust found in core 9.

LITHOLOGY AND MINERALOGY

The lithologic descriptions of the cores collected for this study are shown in Figures 3, 4, 5, and 6. All cores from below the escarpment (cores 1-6 and core 9) penetrated a soupy light gray to grayish-brown calcareous sand-silt-clay to sandy-silt surficial layer. This layer, which varies from 4 cm thick in core 6 to 32 cm thick in core 5, is usually massive but does contain some silt- and sand-rich lenses and thin, faint layers of the underlying dark, grayish-brown silty clay. Carbonates, mainly low-magnesium calcite and aragonite, make up a major portion of the surficial layer. Minor amounts of high-magnesium calcite and dolomite were also found throughout cores 7 and 8 from above the escarpment and within the surficial calcareous layer in the cores taken at the base of the escarpment. The sand-sized fraction of this surficial sediment is composed mainly of foraminifera tests and coccolith debris with minor amounts of limestone fragments as well as pteropod, ostracod, and mollusk shell hash. The fine fraction contains a clay mineral assemblage of smectite, illite, and kaolinite together with trace amounts of chlorite and mixed-layer illite-smectite (Table 2) . Quartz and feldspar occur mainly in the silt fraction. Much of the carbonate in the fine fraction is composed of coccolith debris. The bulk of this material is very similar to the sediment encountered throughout the two cores from the upper slope above the escarpment and to sediments described earlier as the West Florida Mud Facies (Doyle, 1983). This similarity suggests that the surficial layer is composed of sediment swept off the edge of the West Florida Platform by slumps and storm-induced current action. The boundary at the base of this layer is abrupt and probably represents an erosional unconformity.

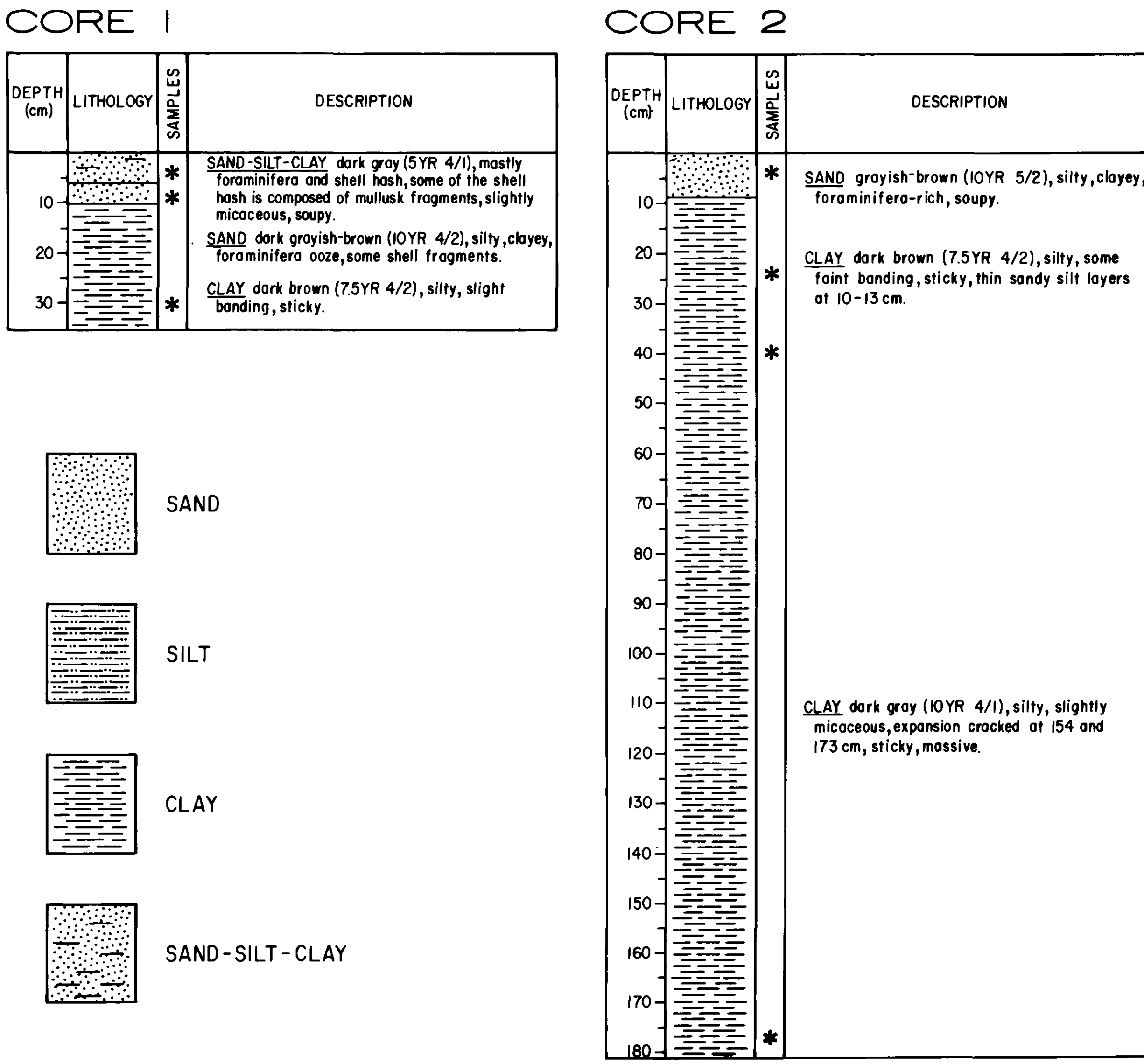


Figure 3. Lithologic sections, core descriptions, and sample locations in cores 1 and 2. Labeled blocks are the key to the lithologic symbols.

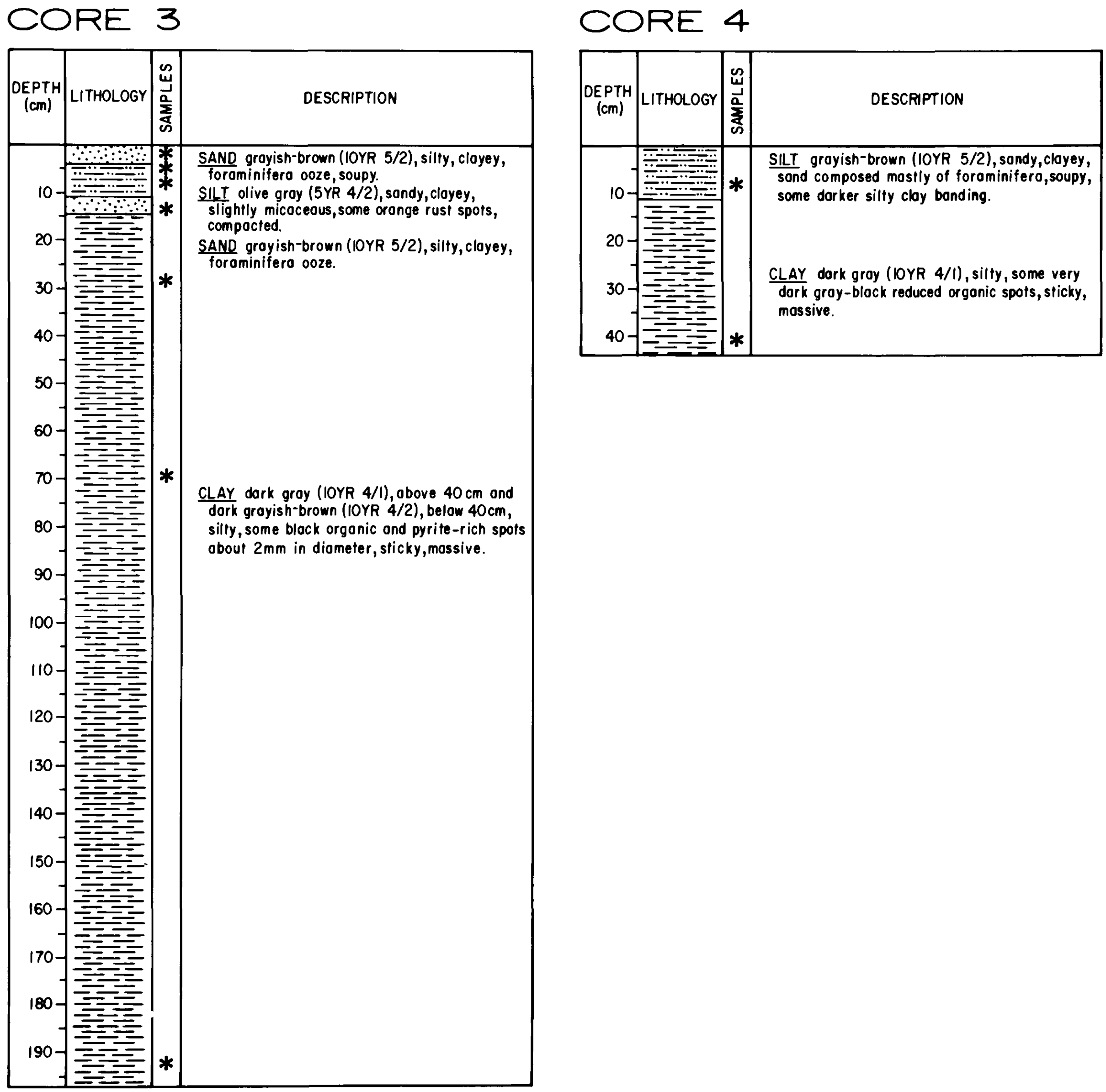
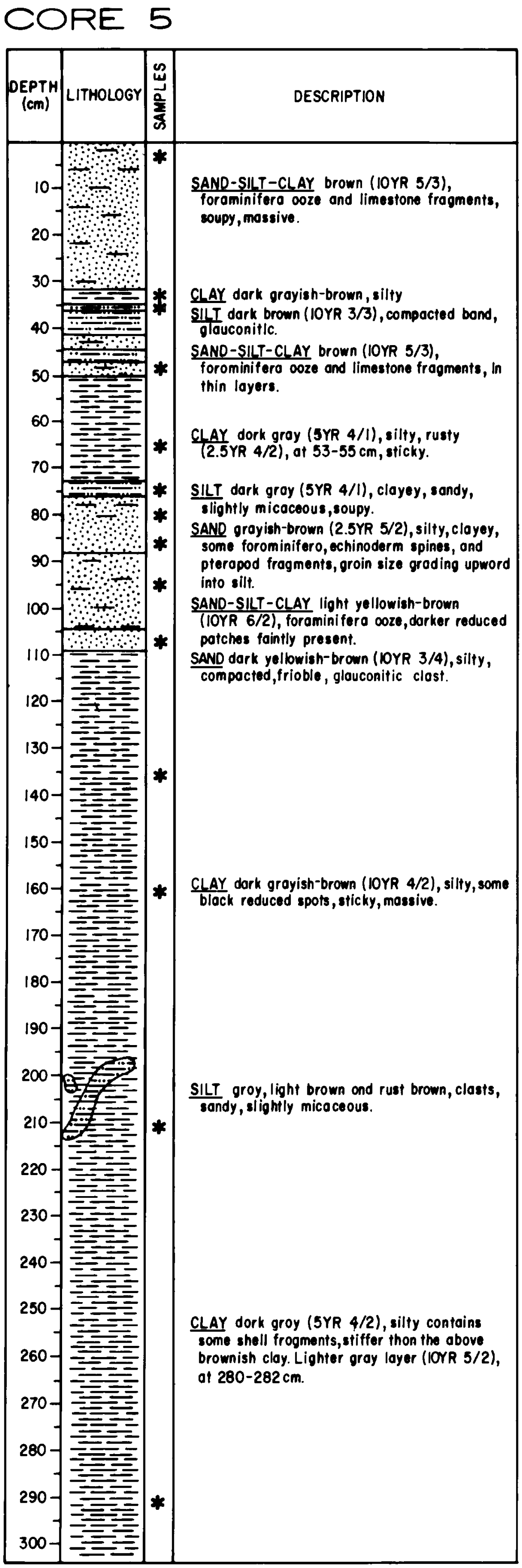


Figure 4. Lithologic sections, core descriptions, and sample locations in cores 3 and 4.



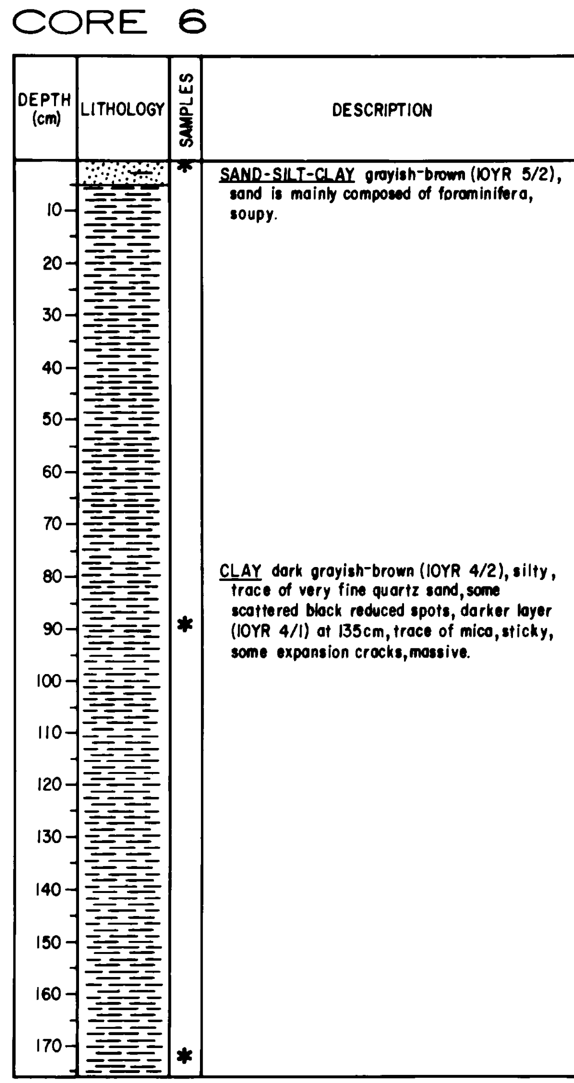


Figure 5. Lithologic sections, core descriptions, and sample locations within cores 5 and 6.

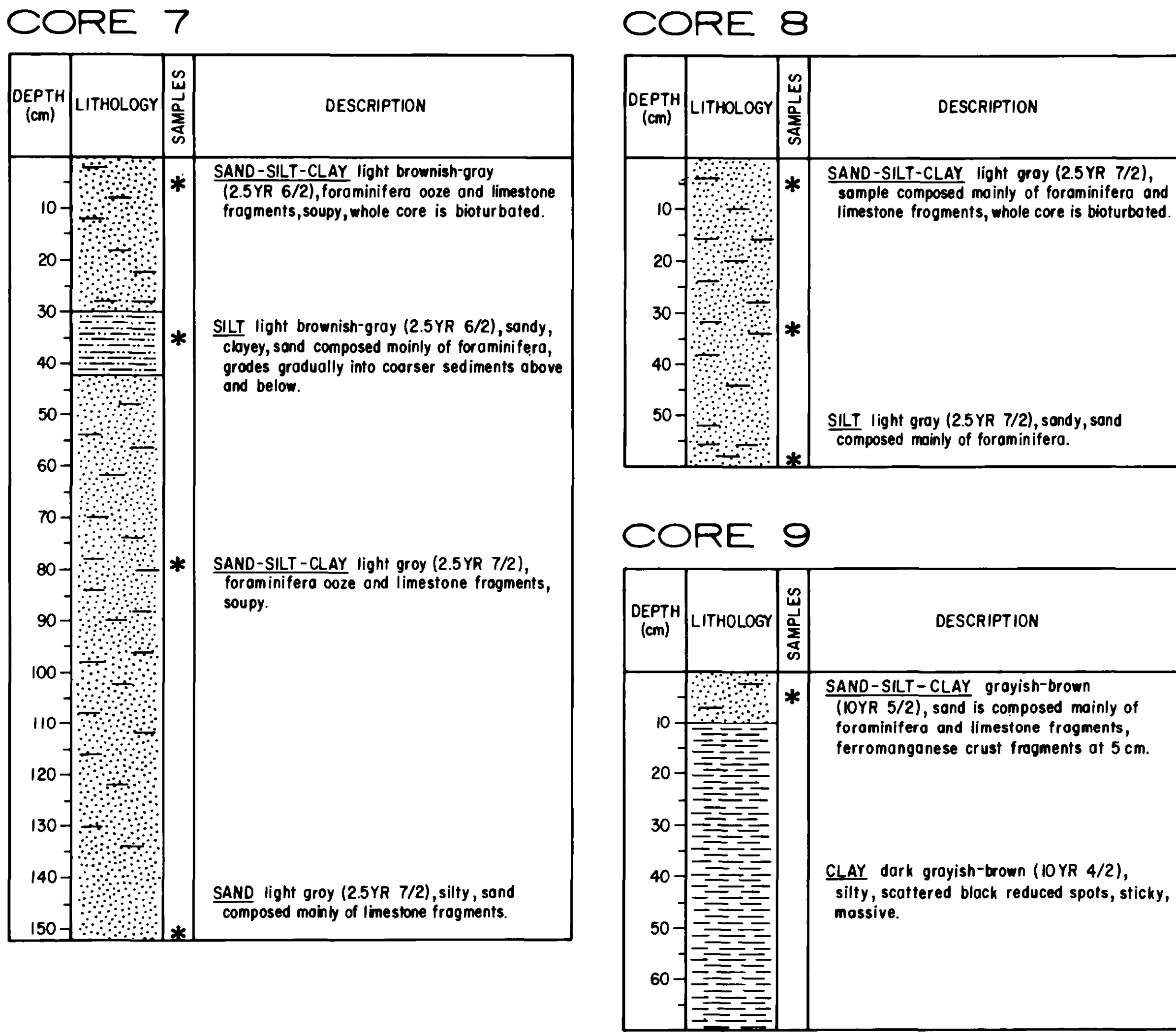


Figure 6. Lithologic sections, core descriptions, and sample locations in cores 7, 8, and 9.

SAMPLE	SMC	M/L	CHL	I/M	KAO	GLA	QTZ	FEL	ARA	CAL	DOL	HAL	ZEO	PYR	GOE	AMP	COMMENTS
CORE 1																	
4CM	15	T	T	2	1	1	47	9	3	14	5	T		1		T	SILTY SAND; FORAM. OOZE
8CM	9	T	T	2	T	T	29	7	3	43	4	T	T				SILTY SAND; FORAM. OOZE
30CM	42	T	6	14	7		14	6		5	5	T					SILTY CLAY
CORE 2																	
3CM	14	T	T	4	1	T	39	8	2	22	7	T				T	SILTY SAND; FORAM. OOZE
23CM	50	T	4	10	6	T	15	6		3	5	T		T			SILTY CLAY
59CM	37	T	3	13	5		24	5		5	7	T	T	T		T	SILTY CLAY
177CM	38	T	3	11	4		23	9	T	2	8	T	T	T			SILTY CLAY
CORE 3																	
1CM	17	T	T	5	1	T	10	3	2	57	3	T					SAND SILT CLAY; FORAM. OOZE
4CM	14	T	T	3	1	T	38	13	4	13	8	T	4				SAND SILT CLAY; FORAM. OOZE
8CM						1	47	15		5	8	T	1			T	SILT; L.S.=22%
12CM	22		2	6	3	T	10	2	1	53	T	T					SAND SILT CLAY; FORAM. OOZE
18CM	39	1	6	18	8		19	5		4	5	T					SILTY CLAY
69CM							16	5		3	2	T	T				SILTY CLAY; L.S.=73%
197CM	48		5	14	6		13	5		7	2	T				T	SILTY CLAY
CORE 4																	
8CM	24	T	1	6	5	T	8	3	10	37	4	T				T	SAND SILT CLAY; FORAM. OOZE
40CM	44	T	6	13	7		15	6	T	3	5	T					SILTY CLAY
CORE 5																	
3CM	20	T	1	5	5		8	2	2	57	T	T		T			SAND SILT CLAY; FORAM. OOZE
32CM	40	T	4	8	5		16	5	T	19	2	T					SILTY CLAY
34CM	34	T	1	4	3	29	14	6		7	1	T	T				SAND SILT CLAY; RUST COLORED
48CM	32	T	2	9	6	T	13	5		27	4	T					SAND SILT CLAY; FORAM. OOZE
66CM	48		3	10	4		19	5		4	4	T	T	T			SILTY CLAY
74CM	20	T	1	5	4	T	34	12	5	12	6	T		T			SILT; TOP OF TURBIDITE
80CM	18		T	4	2	T	35	10	2	20	7	T	T	T			SILTY SAND; MID TURBIDITE
86CM						T	9	3	12	58	6	T		T			SILTY SAND; BOT. TURB.; LS=11%
95CM							8	2	6	48	4	T					SAND SILT CLAY; FORAMS.; L.S.=32%
107CM	9	T	T	2	1	54	12	3		T	1	T			16		SILTY SAND;RUST COLORED
136CM	41	2	6	10	7		18	6		3	6	T		T			SILTY CLAY
161CM	36	T	4	15	6		20	9		3	5	T		T			SILTY CLAY
211CM	14		T	3	1	T	52	14		2	11	T	T			T	CLAYEY SILT
291CM	31	T	4	12	6		22	8		4	10	T		T			SILTY CLAY
CORE 6																	
1CM	29	T	4	16	11	T	16	5	3	9	4	T		T		T	SAND SILT CLAY; FORAM. OOZE
89CM	31	1	9	22	11		14	5		2	4	T					SILTY CLAY
170CM	36	2	5	18	7		16	5		3	7	T	T				SILTY CLAY

Table 2. X-ray diffraction analyses of cores collected at the base of the West Florida Escarpment. SMC= smectite, M/L= mixed layer illite-smectite, CHL= chlorite, I/M= illite/mica, KAO= kaolinite, GLA= glauconite, QTZ= quartz, FEL= feldspar, ARA= aragonite, CAL= calcite, DOL= dolomite, HAL= halite, ZEO= zeolites, PYR= pyrite, GOE= goethite, AMP= amphibole. Verbal designations for the grain sizes were determined from smear slides. T: <1%; blank indicates mineral not detected.

SAMPLE	SMC	M/L	CHL	I/M	KAO	GLA	QTZ	FEL	ARA	CAL	DOL	HAL	ZEO	PYR	GOE	AMP	COMMENTS
CORE 7																	
5CM	10	1	T	4	3		1	T	29	49	T	1					SAND-SILT-CLAY; MG-CALCITE= 11%
152CM	6	T	T	1	1		T		25	66	T	1					SILTY SAND
CORE 8																	
5CM	4	1	T	3	2		2	T	22	64	T	T					SAND-SILT-CLAY; MG-CALCITE= 1%
60CM	9	2	1	8	6		5	T	13	53	T	1					SANDY SILT

Table 2 cont. X-ray diffraction analyses of cores collected at the top of the West Florida Escarpment. SMC= smectite, M/L= mixed layer illite-smectite, CHL= chlorite, I/M= illite/mica, KAO= kaolinite, GLA= glauconite, QTZ= quartz, FEL= feldspar, ARA= aragonite, CAL= calcite, DOL= dolomite, HAL= halite, ZEO= zeolites, PYR= pyrite, GOE= goethite, AMP= amphibole. Verbal designations for grain size were determined from smear slides. T: <1%; blank indicates mineral was not detected.

The sticky, plastic, dark, grayish-brown silty clay that underlies the foraminiferal ooze is very cohesive, which probably prevented deeper penetration by the coring device. This sediment contains a clay mineral assemblage dominated by smectite, illite/mica, kaolinite, and chlorite with minor amounts of mixed-layer illite-smectite. These data correlate well with the clay mineralogy for Mississippi Fan sediments reported by Huang and Goodell (1970), and indicate a Mississippi River source for these sediments. All of the cores taken at the base of the escarpment are within previously reported estimates of the outer boundary of Mississippi Fan deposits (Worzel and Bryant, 1973). Slightly higher concentrations of chlorite are reported in these samples because silt-sized chlorite flakes, which were observed in the smear slides, are included in the diffraction data. The silty clays contain much less calcite and aragonite but more dolomite than the overlying foraminifera-rich sediments. Minor amounts of pyrite and dark-stained concentrations of hydrotriolite were detected in the dark grayish brown silty clay. Traces of quartz, feldspar, and heavy minerals were observed in virtually all of the smear slides as coarse silt and very-fine, sand-sized detrital grains.

Although several thin (<2 cm) sandy or silty layers were encountered in the dark grayish-brown silty clay, only one thick turbidite was penetrated by the cores. This turbidite, which was found between 72 and 109 cm of core 5, graded upward from silty sand to clayey silt but contained no internal bed forms. The sediment that composes this turbidite is similar in appearance and composition to, but more compacted than, the surficial foraminifera ooze. At the base of the turbidite, core 5 penetrated a dark, yellowish-brown, compacted, clayey silt clast (105-109 cm). The clast is friable, about 2 to 3 cm thick, and composed largely of partially oxidized glauconite, it probably came from the face of the escarpment and represents deposition during the higher flow regimes of the turbidity current. Other clasts of semiconsolidated silt occur in core 5 (34-37 and 195-214 cm) but are not associated with the deposition of sandy, unconsolidated calcareous sediments. Any finer sediments involved in the events that emplaced the clasts found between 34 to 37 cm and 195 to 214 cm may have been differentially winnowed away and deposited elsewhere by currents in the water column during transit to the bottom. The large size of the clasts and their semiconsolidated nature eliminate the possibility of long-distance transport and indicate that these clasts also came from the face of the escarpment.

FORAMINIFERA DISSOLUTION

The specimens of Globigerinoides ruber collected from near the calcarenite/silty clay boundary showed no evidence of solution effects (Fig. 7). The quality of preservation was good and many individual specimens from both above and below the boundary still possess spines. However, the quality of preservation decreases slowly with depth in the core starting at about 10 cm below the calcarenite/silty clay boundary, where SEM micrographs reveal moderate dissolution by exfoliation and pitting of the external test surfaces on some of the specimens (Fig. 8).

GEOCHEMISTRY

The quantitative EDS microprobe analysis of a ferromanganese crust is presented in Table 3. This crust, which partially coated a fragment of

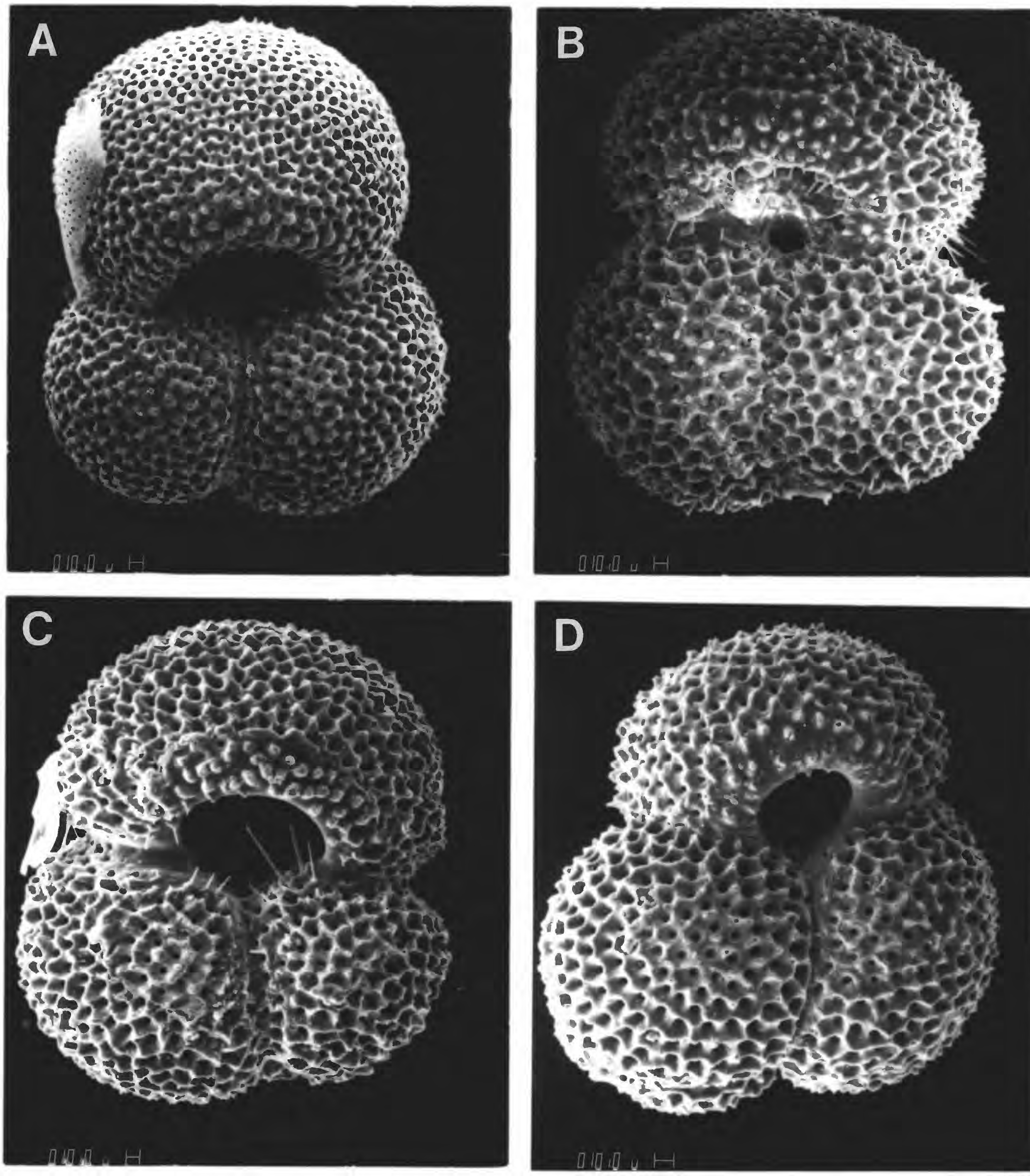


Figure 7. Scanning electron micrograph of the foraminifera Globigerinoides ruber. Micrographs show the overall good quality of preservation both above and below the calcarenite/silty clay boundary in core 4. A) Rose colored form, 7-8 cm; B) White form, 1-2 cm; C) Rose colored form, 13-14 cm; D) White form, 13-14 cm.

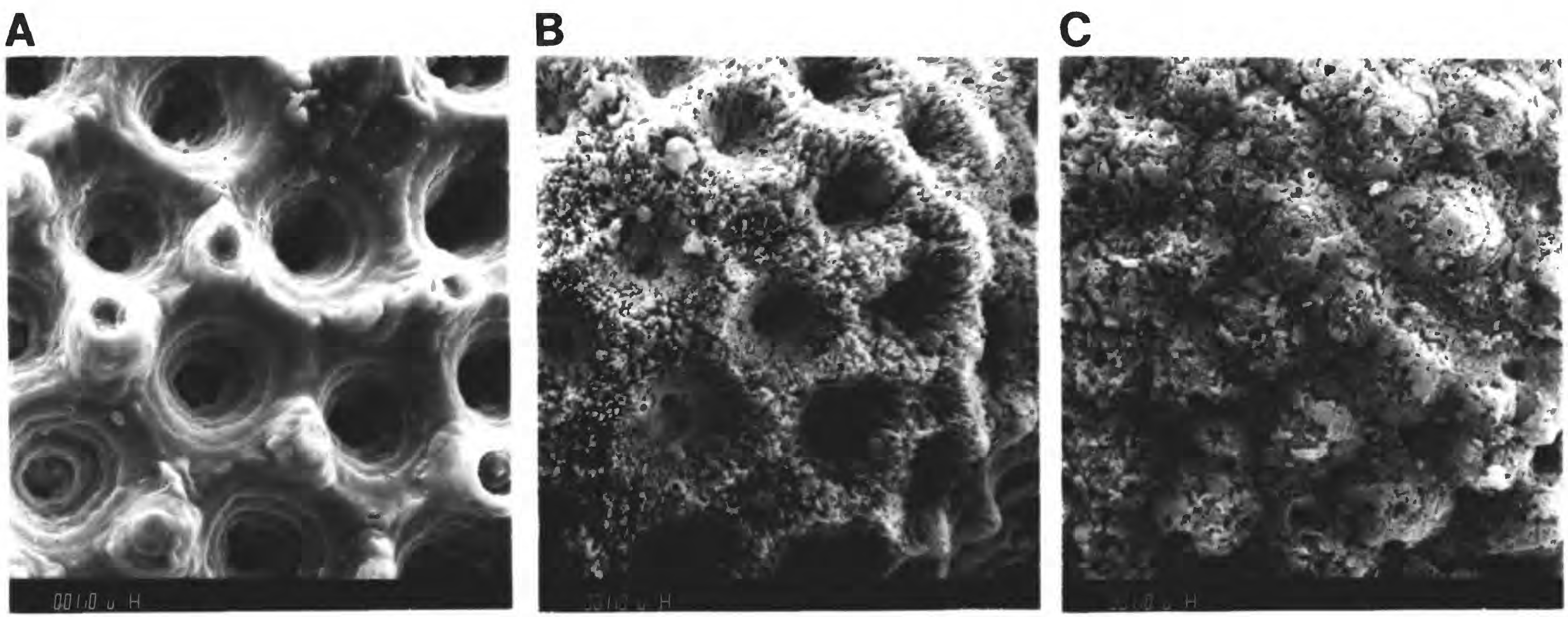


Figure 3. Scanning electron micrographs showing the effects of dissolution on the surface texture of foraminifera tests in core 4. (A) Relatively smooth, well-preserved surface around pores, Globigerinoides ruber, 7-8 cm. (B) Pitted surface, Globigernoides ruber, 26-28 cm. (C) Exfoliated surface, unidentified, fragmented form, 26-28 cm.

Table 3. Energy-dispersive microprobe analysis of a ferromanganese crust fragment from core 9 (5 cm depth).

COMPONENT	WEIGHT PERCENT[a]
SiO_2	16.42 +/- 0.81
TiO_2	0.87 +/- 0.13
MnO_2	16.12 +/- 0.81
Al_2O_3	5.09 +/- 0.41
Fe_2O_3	39.42 +/- 0.82
Co_3O_4	0.06 +/- 0.08
CaO	3.29 +/- 0.21
MgO	3.34 +/- 0.44
BaO	0.21 +/- 0.31
K_2O	0.37 +/- 0.11
Na_2O	1.33 +/- 0.43
Cl	0.17 +/- 0.15
F	see note [b]
CO_2	see note [b]
P_2O_5	4.63 +/- 0.52
SO_3	0.75 +/- 0.26
H_2O+	7.93[c]
Total	100.00[d]

[a] Mean values, plus or minus one standard deviation, for 6 analyses performed at scattered locations around the coated portion of the fragment.

[b] Combined F and CO_2 content is equal to or less than 2.6 weight percent (see text).

[c] The bound water content is calculated from an empirically determined relationship between H_2O^+, MnO_2, and Fe_2O_3 contents (see text).

[d] Normalized total. F and CO_2 contents are not accounted for in the normalization procedure (see text).

limestone and averaged 59 um in thickness, was retrieved from the 5 cm depth interval in core 9. The size (5 mm) and angularity of the fragment and the fresh nature of the uncoated portion of the limestone indicate that the fragment was probably chipped off the escarpment.

Ferromanganese crusts are hygroscopic and normally contain a variable amount of interstitial water (approximately 10 to 13 by percent weight). However, because EDS analysis is performed under a vacuum in the SEM, the ferromanganese material loses this absorbed water and the data, which are reported in the table, are free of hygroscopic water. X-ray microanalyses of these very porous materials result in summations that total less than unity. Furthermore, it is unclear whether the totals are less than unity solely because of the porosity of the material or also because the EDS detector cannot register x-rays from elements that have atomic numbers lower than sodium. The EDS data was normalized to 100 percent after calculating a probable crystalline (bound) water content (listed in Table 3 as H_2O+) from the following relationship derived from chemical data on ferromanganese crusts from the Atlantic and Pacific Oceans (F.T. Manheim and R.F. Commeau, unpublished data).

$$\text{Percent } H_2O^+ = \frac{\text{Weight Percent } MnO_2 + \text{Weight Percent } Fe_2O_3 \text{ Weight}}{7}$$

Where weight percent MnO_2 plus weight percent Fe_2O_3 is the total manganese oxide and ferric components measured in the ferromanganese crust sample.

The F and CO2 concentrations could not be measured using the EDS technique and are not accounted for in the normalization procedure. Therefore, the values for the components listed in Table 3 are slightly higher than the amounts actually present. Using stoichiometric relationships between the F, CO_2, P_2O_5, and CaO components within the phosphorite and calcium carbonate phases generally known to be present within ferromanganese crusts (Manheim, 1986 and references therein) and using the P_2O_5 and CaO values listed in Table 3, we calculate F plus CO_2 contents are <2.6 percent. Although the assignment of values for F and CO, can not be made because of the uncertainty regarding the distribution of P_2O_5 between Fe and Ca, the values for the other listed components are too high by no more than 2.6 percent relative. For example, SiO_2 at 16.42 weight percent may actually be as low as 15.99 weight percent.

The values listed in Table 3 for SiO_2 (16.42 weight percent), P_2O_5 (4.63 weight percent), and Fe_2O_3 (39.42 weight percent) are higher than average values measured in crusts from the Blake Plateau or the Mid-Pacific seamount area (Manheim and others, 1983; Manheim, 1986). We infer that this is due to admixture of the crust with silicates and a partial association of iron with a phosphate phase such as strengite or tinticite. Low Co_3O_4 and high P_2O_5 contents suggest local diagenetic origin (Manheim, 1986). Other possible mineral phases within the ferromanganese crust fragment which seem to be reflected in the chemical data include varying amounts of clays, carbonate fluorapatite, calcite, aragonite, vernadite (δMnO_2), and goethite.

GEOPHYSICAL DATA

The three seismic profiles transecting the West Florida Escarpment (Figs. 9, 10, 11) show an average incline of 39° to 45° for the steeper, lower portion of the slope. Because of the escarpment's steep nature, the seismic

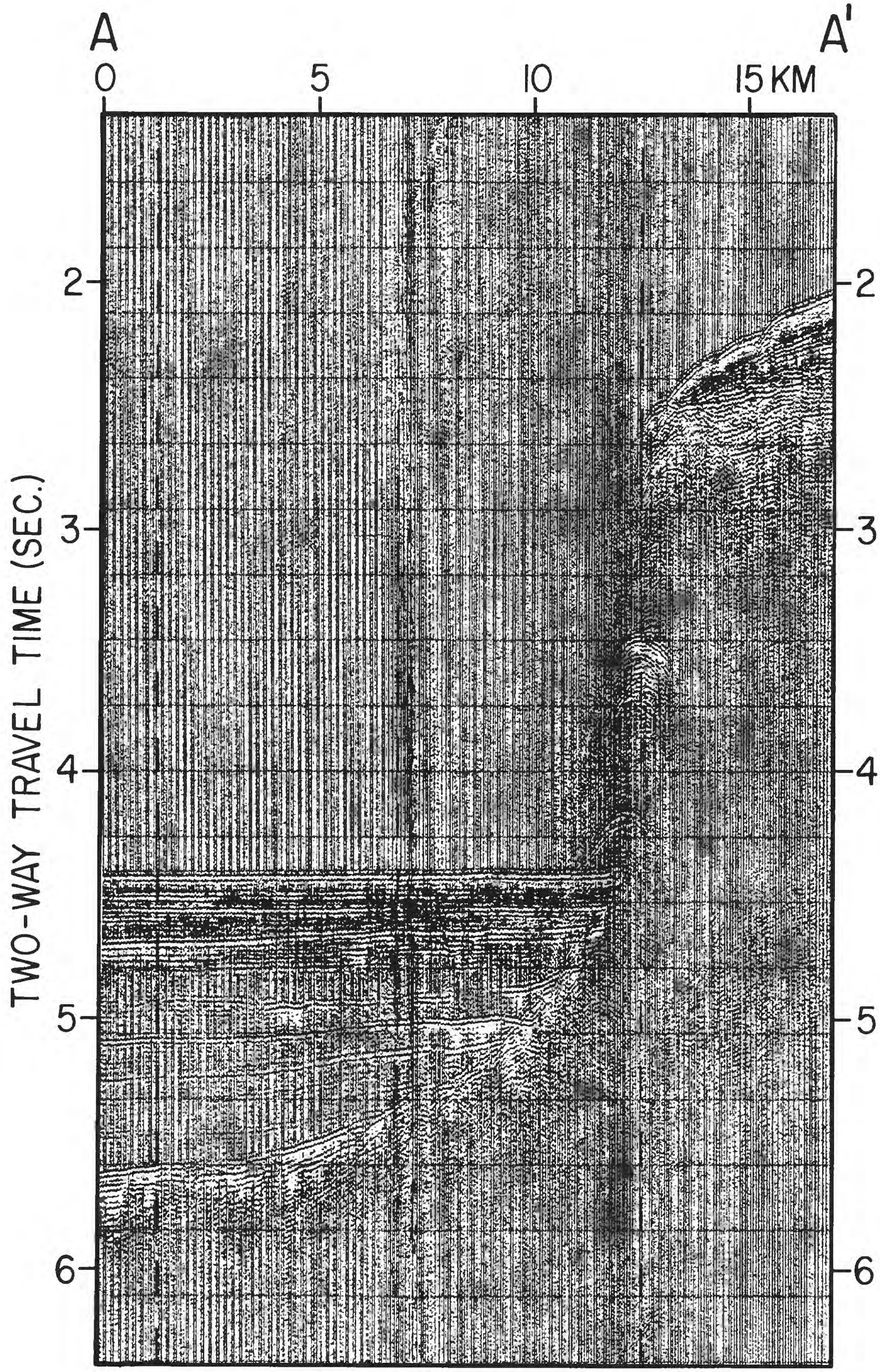


Figure 9. Seismic-reflection profile (30kJ sparker) across the West Florida Escarpment. Profile shows the character of the sediment on the upper slope, the escarpment face, and the sediment adjacent to the platform.

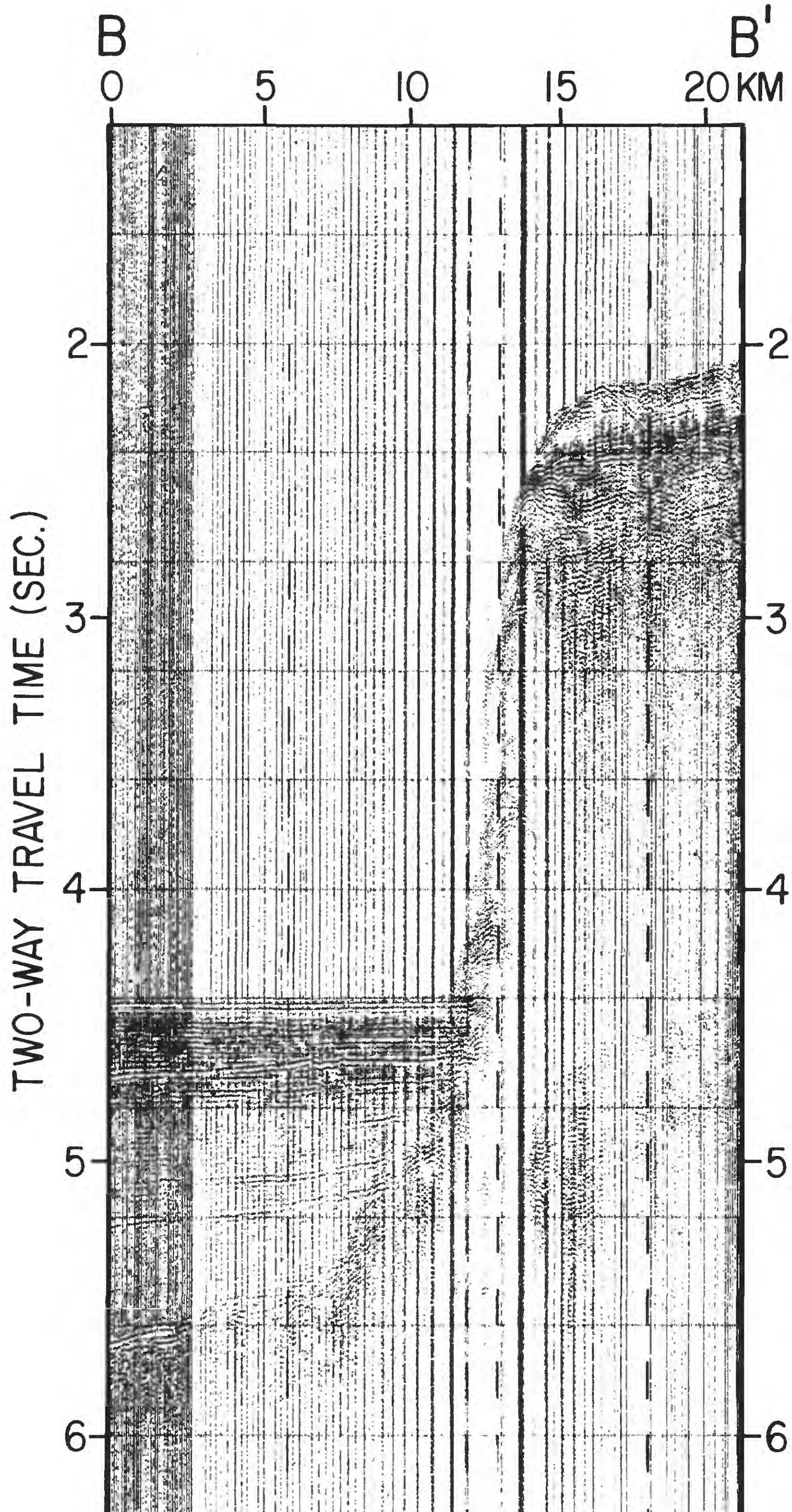


Figure 10. Seismic-reflection profile (30kJ sparker) across the West Florida Escarpment. Profile shows the character of the sediment on the upper slope, the escarpment face, and the sediment adjacent to the platform.

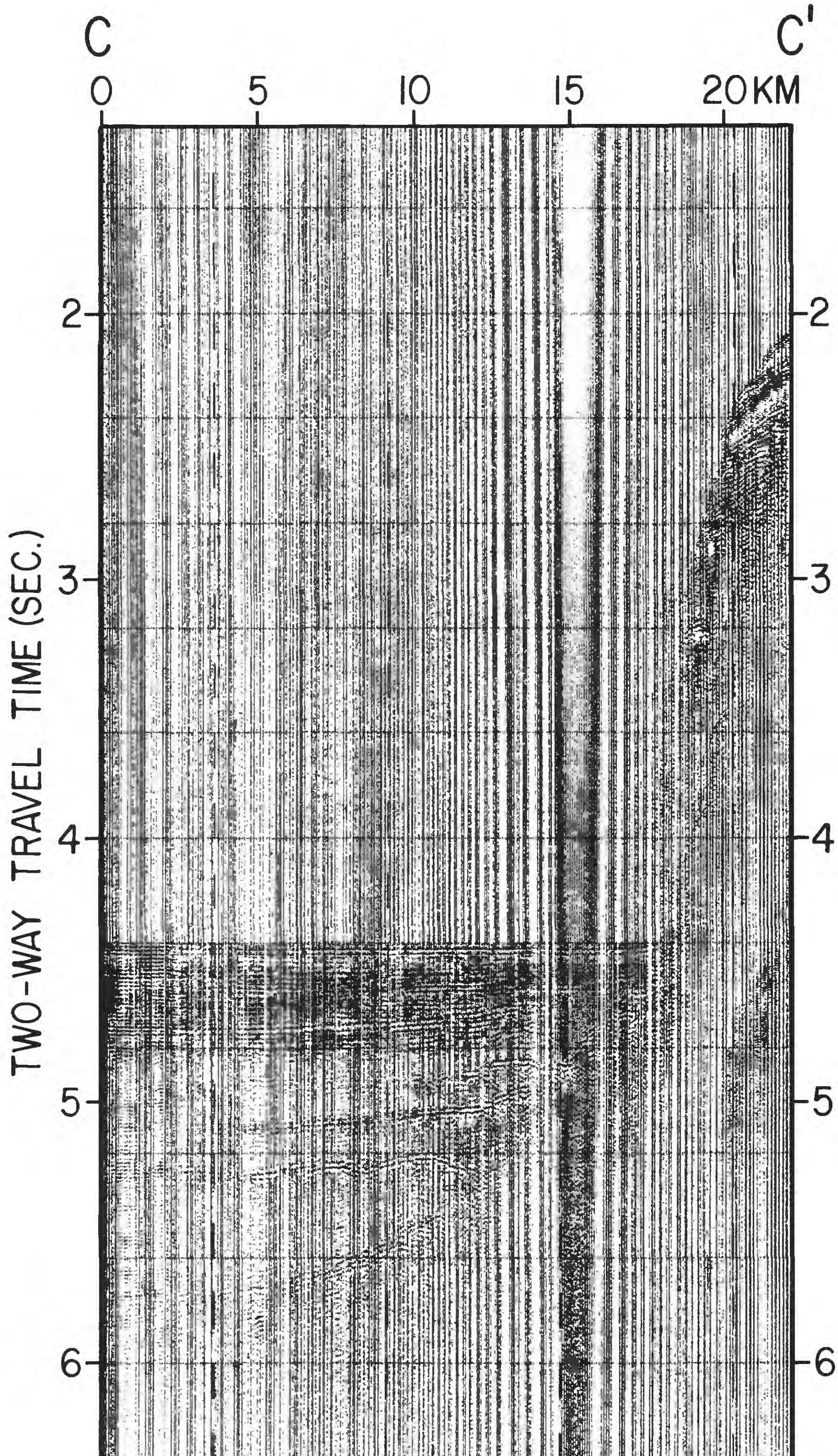


Figure 11. Seismic-reflection profile (30kJ sparker) across the West Florida Escarpment. Profile shows the character of the sediment on the upper slope, the escarpment face, and the sediment adjacent to the platform.

return and hence the geologic information on these portions of the profiles is scarce or of poor quality. The profiles also show the flat-lying hemipelagic sediments, comprised of Florida Platform carbonates and distal Mississippi Fan siliciclastics, present at the base of the escarpment. The face of the escarpment, which continues beneath these hemipelagic sediments, changes gradient and becomes almost horizontal. No extensive talus piles buried beneath the hemipelagic sediments at the base of the escarpment, such as those previously reported further to the south (Bryant and others, 1969), were observed in the seismic records.

COMMENTS

The face of the West Florida Escarpment is characterized by the dominance of fine-grained peritidal and lagoonal lithofacies and a paucity of forereef and reef deposits, which indicates that the slope has undergone significant erosion (Freeman-Lynde, 1983). Several processes, which may act in combination, have been suggested as possible mechanisms controlling the erosion of limestone escarpments (Freeman-Lynde and Ryan, 1985; Halley and others, 1983; and Paull and others, 1984). These processes include (1) dissolution by cold, corrosive bottom or interstitial waters, (2) spalling of decompression joint blocks, (3) removal of sediment by abyssal currents, (4) down canyon transport of carbonate sands, (5) tectonic activity, and (6) bioerosion.

The relative effects of these mechanisms on the West Florida Escarpment are unknown, but we have attempted to evaluate the possible contribution of bioerosion. Marine rock boring and burrowing organisms have been shown to cause extensive erosion of carbonate sediment. Some of these organisms include: the siliceous sponge _Cliona_ (Futterer, 1974), the lepadomorph barnacle _Lithotyra_ (Ahr and Stanton, 1973), the mussel _Lithophaga_, and the clam _Penitella penita_ (Evans and LeMassurier, 1972). The cored sediments were examined for evidence of activity by one or more of these organisms. Although no identifiable boring-barnacle, mussle, or clam shells were found in the sediments, trace amounts of sponge spicules were observed in the smear slides of the foraminifera-rich sand-silt-clay and sandy silt. However, SEM examination of the fine fraction (20-63 μm) revealed none of the round limestone particles possessing convex basal surfaces with concave roof and edge surfaces previously reported (Futterer, 1974) as debris created by _Cliona_ sponges. Because all of the above-mentioned organisms are generally significant agents of bioerosion only at depths of less than 1000 m (Freeman-Lynde and Ryan, 1985) and because no evidence of their activity was found at the core sites, we believe that bioerosion by these organisms is not a significant erosional process on the West Florida Escarpment near these core sites.

Earlier work by Huang and Goodell (1970) on the eastern Mississippi cone has suggested that the underlying dark, grayish-brown silty clay is the insoluble residue of the overlying hemipelagic calcarenite. They reported that the mechanism controlling this lithologic change was the diagenetic dissolution and removal of carbonate by acidic conditions related to the degradation of organic matter associated with sulfate-reducing bacteria. However, several results from this study show that this process is not controlling the change in lithologies at the base of the escarpment: (1) SEM examinations of foraminifera tests collected from near the calcarenite/silty clay boundary show no evidence of attack by carbonate dissolution. (2) The change in lithology between the surficial calcarenite and the underlying silty clay is quite abrupt. If the dissolution of carbonates was removing the foraminifera and thereby increasing the relative percent of the siliciclastic fraction, we would expect the transition to be more gradual. (3) The presence of calcareous microfossil-rich turbidites within the dark, grayish-brown silty clay of core 5 argues against the dissolution of carbonate. If dissolution was the controlling process, the carbonate in these turbidites should have dissolved before the deposition and dissolution of any carbonate in the overlying silty clay. (4) The surficial calcareous layer penetrated at the bottom of the escarpment is similar in microfossil content, Holocene age, and mineralogy to the sediments collected in the cores from the top of the escarpment. The presence of higher kaolinite/chlorite ratios within the calcarenite relative to the silty clay suggests that the provenance of this upper layer is substantially different from that of the material reported on the eastern Mississippi Fan away from the escarpment.

The size, angularity, and fresh nature of the limestone fragment discussed in the geochemical section of this report indicates that it was not transported for any great distance and, therefore, was probably chipped off the escarpment. Although we could not determine what mechanism removed the fragment from the escarpment, its presence in the sediments of core 9 suggests that erosion of the escarpment is continuing.

ACKNOWLEDGMENTS

We thank F.T. Manheim and M.H. Bothner for reviewing the manuscript and C.W. Poag for his help in the identification of the foraminifera.

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