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# MORPHOLOGY, SEDIMENTS, AND DEPOSITIONAL ENVIRONMENTS OF A SMALL CARBONATE PLATFORM: SERRANILLA BANK, NICARAGUAN RISE, SOUTHWEST CARIBBEAN SEA<sup>1</sup>

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**ABSTRACT:** Serranilla Bank (16°N, 80°W) is located on the Nicaraguan Rise, a major structural-topographic high on the Caribbean Plate. This bank is one of several small, detached platforms upon which carbonate accretion is failing to keep pace with Holocene sea-level rise. High-resolution seismic profiling, sediment sampling, SCUBA-diver observations, and dredge hauls show that this relatively deep (10 to 40 m) bank is bounded by steep escarpments, lacks coral-reefs, and has few islands and minimal Holocene sediment cover. Hardgrounds populated by brown algae and sponges predominate in the southeastern sector; sediments are thin and coarse-grained. On the remainder of the bank, *Halimeda*/molluscan-dominated sediments are more common and finer-grained. Sediment cover on about 80% of the banktop is too thin to resolve seismically (< 2 m), though some topographic lows have slightly thicker accumulations that occur as large (3–8 m high) bedforms indicating northwestward transport. The largest field of bedforms is located near the northwestern margin of the platform. Platform-margin sediment deposits are limited in thickness and areal extent. Muds are scarce and are winnowed off-shelf by strong currents. Factors limiting Holocene sediment accretion on Serranilla Bank include the platform's small size, strong currents that promote off-bank sediment transport, rapid flooding during Holocene sea-level rise, lack of active frame-building benthic communities, and ubiquitous bioerosion.

## INTRODUCTION

The Nicaraguan Rise, in the southwest Caribbean (Fig. 1), is a tectonically-derived structure with Jamaica and several carbonate platforms located along its crest (Arden 1975; Case et al. 1984). The platforms of the Rise constitute a major Cenozoic carbonate province, with a shallow-water area approximately 30% that of the Bahamas. These platforms are located in tropical waters remote from terrigenous sediment influx. Yet, instead of having extensive shallow banks or coral atolls, the platforms are relatively deep and, except on Pedro Bank, coral reefs are absent. Although Pedro and Serranilla Banks have islets and banktop shoals, most Nicaraguan Rise bank tops are deeper than 20 m (Fig. 2). These banktop depths contrast sharply with Bahamian platforms (e.g., Little Bahama and Great Bahama Banks), which are known to be actively accreting and maintaining banktop depths within Schlager's (1981) zone of maximum calcium carbonate productivity (less than 10 m). By comparison, banks on the Nicaraguan Rise have not kept up with Holocene sea-level rise and therefore may provide insight concerning processes responsible for drowning of carbonate platforms.

Studies dealing with these banks are few in number. Sediments of Pedro Bank were examined by Zans (1958), Dolan (1972) and Marshall (1976). Wilber (1987) published an abstract in which he briefly discussed morphologies and sediments of five banks along the Rise. More recently, Hallock et al. (1988) and Hine et al. (1988) reported the absence of coral reefs and presence of *Halimeda* bioherms on northern Nicaragua Rise banks west of Pedro Bank. Other studies concentrated on banks to

the south. Milliman (1969) investigated four small atolls east of Nicaragua, and Murray et al. (1982) and Roberts and Murray (1983) studied physical processes and sedimentation on Miskito Bank off the eastern coast of Nicaragua.

In this study we discuss the morphology and Holocene sedimentation of Serranilla Bank, located at approximately 16°N and 80°W in the middle of the Nicaraguan Rise (Fig. 1). The platform is one of the smaller Nicaraguan Rise banks (Fig. 2), about 46 km long in an east-west direction, 38 km from north to south, and with a banktop area of approximately 1100 km<sup>2</sup> (Fig. 3). Although most of the banktop lies below 10 m depth, Serranilla is the shallowest of the Nicaraguan Rise platforms and has several small islands.

## OCEANOGRAPHIC SETTING

The Nicaraguan Rise is located in the tropical western Caribbean. Surface-water temperatures range from 26°C in late winter to 29°C in early autumn. Surface waters have normal marine salinities (36‰) with only minor seasonal fluctuations (Hastenrath and Lamb 1977).

Wind-driven waves and geostrophic currents strongly influence environmental conditions on Serranilla Bank. Eastern and southern margins (Fig. 3) face the easterly Trade Winds (Hastenrath and Lamb 1977) and the north-westward-flowing Caribbean Current (Molinari et al. 1981; Kinder 1983). Trade Winds blow steadily from the east at 5–10 m/s (11–22 mph) nearly year round (Hastenrath and Lamb 1977), except when interrupted by continental frontal systems. These storm systems, which produce northerly winds of up to 20 m/s (44 mph) or more, penetrate the southwestern Caribbean approximately bi-weekly during fall and winter months (DiMego et al. 1976) and temporarily reverse surface-current flow from north-westward to southeastward (Hallock and Elrod 1988; Hal-

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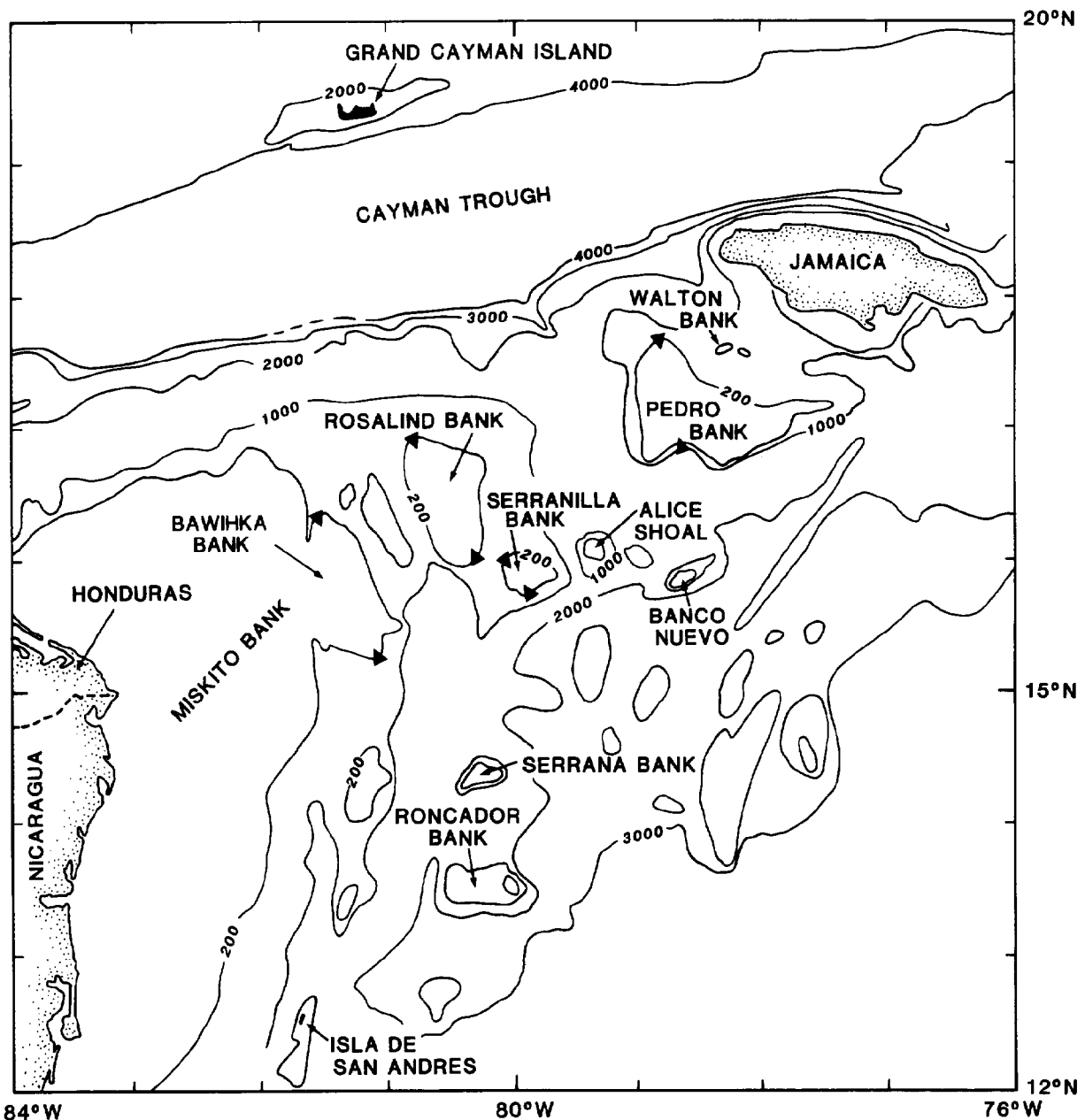


FIG. 1.—Bathymetric map of the central Nicaraguan Rise, including Serranilla Bank. Start and end points of NW-SE bathymetric profiles (see Fig. 2) are noted by black triangles.

lock et al. 1988). Thus, while northern and western margins of Serranilla Bank face away from the prevailing physical energy flux, the northwest margin is frequently “windward” during winter months. Furthermore, tropical cyclones can influence any or all margins; the U.S. National Hurricane Center lists 18 storms that passed within 139 km (75 nautical miles) of Serranilla Bank between 1886 and 1989.

The Caribbean Current, a strong western boundary current, dominates surface circulation and flows northwestward over the Rise (Molinari et al. 1981; Kinder 1983).

Current velocities intensify westward across the Rise: we recorded northeastward flow at velocities up to 15–20 cm/sec on western Pedro Bank and northerly flow at velocities sometimes exceeding 200 cm/sec in the Bawihka Channel and over nearby banks. Acceleration of currents over the Rise induces topographic upwelling, which produces chlorophyll plumes visible in Coastal Zone Color Scanner images (Hallock and Elrod 1988). In the western Caribbean, the chlorophyll maximum occurs in subsurface waters that are approximately 2°C cooler than surface waters (Hallock et al. 1991). Thus, topographically-in-

duced upwelling can raise sea-surface chlorophyll levels threefold or more with minimal temperature perturbations (Hallock and Elrod 1988). Benthic community dominance changes from coral-algal on Pedro Bank to sponge-algal on Serranilla, Rosalind, and other western banks. This change indicates a westward increase in nutrient flux (Birkeland 1988) and probably corresponds to westward intensification of the Caribbean Current and its effects (Hallock and Elrod 1988; Hallock et al. 1988).

#### METHODS

Field sampling was conducted aboard the R/V *Cape Hatteras* in March 1987. High resolution seismic-reflection profiling employed a 3.5 kHz tuned transducer and an electromechanical, broad frequency (0.4–14 kHz) “boomer”-type (O.R.E Geopulse) system. Approximately 260 km of both kinds of data were collected and analyzed (Fig. 4). Additional 3.5 kHz data were collected during sediment sampling. Navigation positions were obtained at 10-minute intervals using the Global Positioning System and SatNav. Bottom samples were collected using a Shipek grab sampler and a rock dredge. SCUBA divers retrieved sediment samples and recorded observations with a 35 mm still camera and an 8 mm underwater video camera. Sediment-sample sites are shown in Figure 3.

Sediment analysis included routine size-fraction and constituent determinations (e.g., see Milliman 1974) on 51 sediment samples (Tables 1–4). Selected grains were also examined in thin section and with SEM.

#### RESULTS

##### *Bank Morphology, Bottom Features, Benthos*

There is an obvious asymmetry to Serranilla Bank: it is shallowest to the south and east, becoming progressively deeper to the northwest (Figs. 2, 3). Banktop depths range from 0 to 50 m. Small islands occur in the southeastern sector where margin slopes are steep, dropping off rapidly from 30 m. A gentler gradient exists in the northwestern portion of the platform; the edge of the banktop occurs in water depths of 40 to 50 m. The platform perimeter features scallop-shaped embayments (Mullins and Hine 1989), which are particularly common along the southern margin.

Seismic profiles (Figs. 5, 6, 7) show that sediment cover is sparse on Serranilla Bank (Fig. 8). Hardgrounds, dominated by fleshy brown algae (e.g., *Sargassum*, *Styopodium*, and *Turbinaria*) (Fig. 9A) and boring sponges (e.g., *Cliona* spp.) (Fig. 9B), prevail over most of the southeastern sector. Isolated corals are present, but are not constructing reefs (Fig. 9C). Bank margins are characterized by rocky substrata, steep and rugged dropoffs, and bank-edge (~40 m) *Halimeda* or sponge-algal bioherms (Fig. 5A, B) with intervening sand pockets. Most seismic lines reveal a drowned terrace at the margin at about 43 m depth (Figs. 5, 6). Small sand deposits were observed along the western and northern margins (Fig. 6A, B).

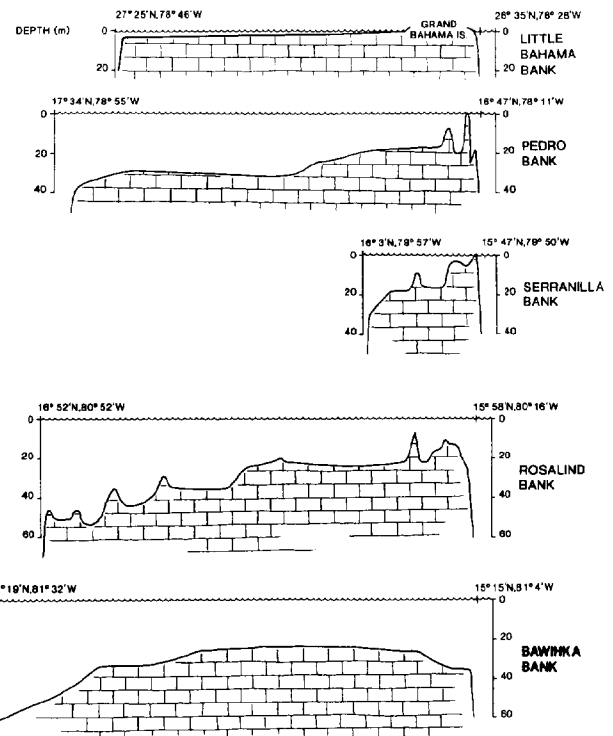


FIG. 2.—NW-SE bathymetric profiles across several platforms of the Nicaraguan Rise (see Fig. 1) for comparison to a similarly oriented profile across Little Bahama Bank. Nicaraguan Rise banktops are considerably deeper than Bahamian counterparts. Platforms along the Rise are shallowest along their southeast-facing windward margins and slope to the northwest. Islands occur on Pedro and Serranilla Banks.

Much of the banktop is flat and relatively featureless, with sediment cover too thin (< 2 m) to resolve seismically (Figs. 5, 6, 7A, 8). Resolvable sediment cover was seen in only 45 km of approximately 240 km of seismic data collected on the banktop (i.e., slightly less than 20%). Where sediment accumulations occur, they are typically in bedforms 3–8 m high, whose asymmetry indicates northwestward transport (Fig. 7B, C). The largest field of bedforms is found in the northwest corner of the platform, covering approximately 60 km<sup>2</sup> (Figs. 7C, 8). Smaller fields, the largest of which is shown in Fig. 7B, occur sporadically on the platform, often associated with slight topographic depressions.

A prominent subsurface rock reflector (Figs. 6A, 7A–C) is commonly seen in banktop seismic data, except in that from the southeast sector. This reflector indicates approximately 8–9 m of bank-top aggradation that may have occurred during an earlier high stand of sea level.

##### *Sediments*

Serranilla banktop sediments are relatively homogeneous, poorly sorted *Halimeda*/molluscan sands (Tables 1–4). Gravels and coarse-grained sands are most common in the southeastern sector. Medium to fine-grained sands are more prevalent within the platform interior and along other margins. Muds typically make up less than 10%,

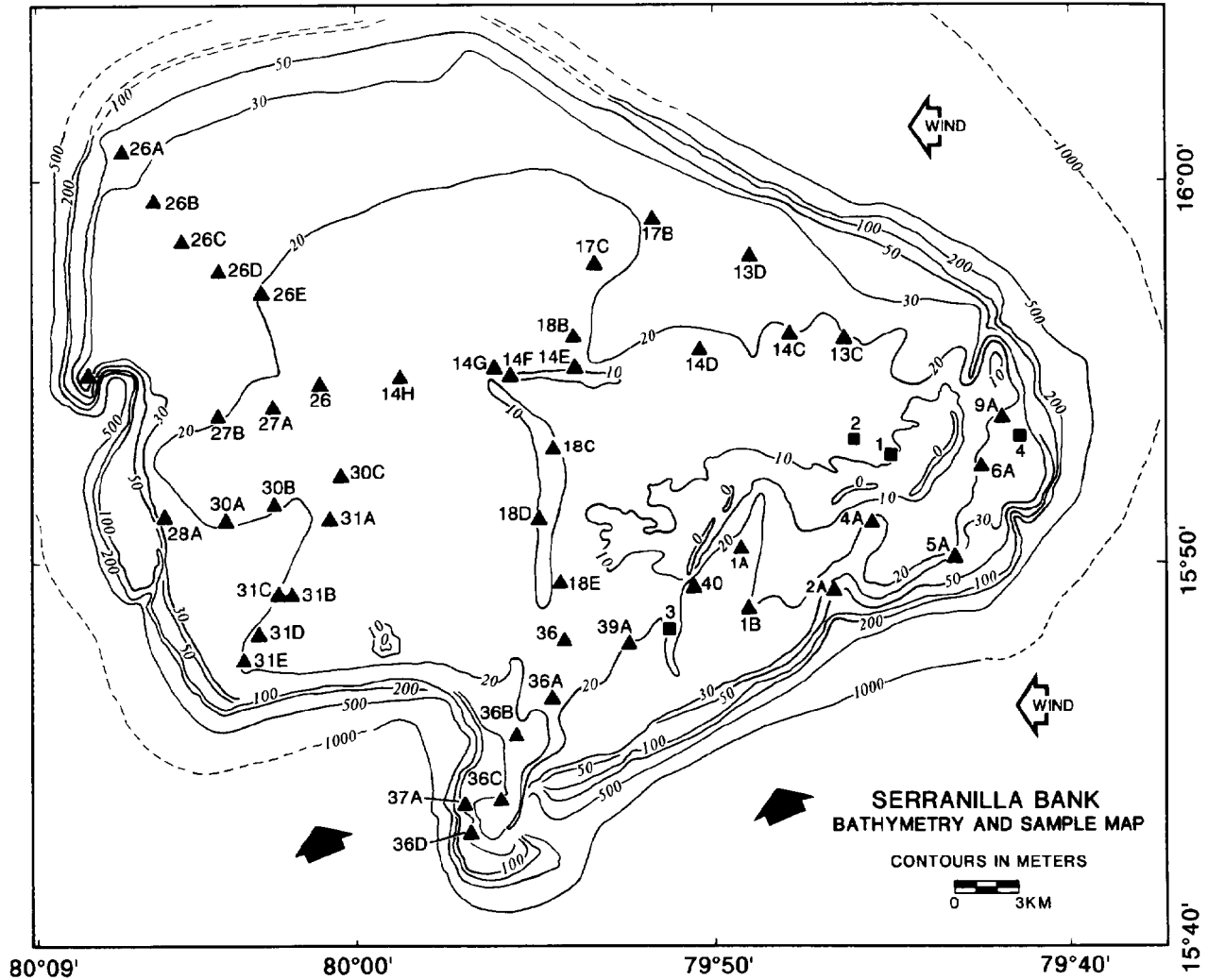


FIG. 3.—Bathymetric map of Serranilla Bank, showing locations of sites sampled in March 1987 with shipek grab (triangles) and by SCUBA divers (squares). Directions of predominant trade winds (open arrows) and predominant currents (closed arrows) are also illustrated.

by weight, of the sediment samples. Grains in both sand and silt sizes are typically extensively microbored (Fig. 10).

Calcareous green algae (predominantly *Halimeda*) and molluscan fragments are the dominant coarse-grained (> 0.5 mm) sedimentary constituents (Tables 2–4), with overall median values of 30–35 and 22–27%, respectively. Cryptocrystalline clasts and benthic foraminifera are also common in these coarse fractions, with median values ranging from 10–14 and 1–8%, respectively. Cryptocrystalline clasts are dull white or grey in color and appear algal-coated at 20–40× magnification; specimens examined in thin section are completely micritized and extensively microbored. Origin of these clasts is undetermined. The presence and abundance of weakly cemented aggregates, sponge-bound aggregates, worm tubes, coralline algal fragments, and “miscellaneous” are highly variable; none have overall median values greater than 2%. Aggregate constituents, whether cemented or not,

include cryptocrystalline clasts and skeletal grains. “Miscellaneous” includes planktonic foraminifera, alcyonarians, bryozoans, echinoids, barnacles, and ostracods. No scleractinian coral debris was observed in constituent analysis or thin sections.

Although multivariate analysis of sediment constituents in the very coarse and coarse sand fractions did not reveal significant trends in constituent distribution, some trends can be discerned. *Halimeda* debris is generally more abundant than molluscan fragments in sediments of the southeastern sector of Serranilla Bank; elsewhere these two dominant constituents are comparably represented. Benthic foraminifera are least common in southeastern-sector sediments. Cryptocrystalline clasts are consistently most common in the central sector, making up roughly 20% of the coarse-grained sands. Although the medians for the three grain-size classes for the southeast sector are lower (10–15%), cryptocrystalline clasts make up more than 40% of these fractions in several samples.

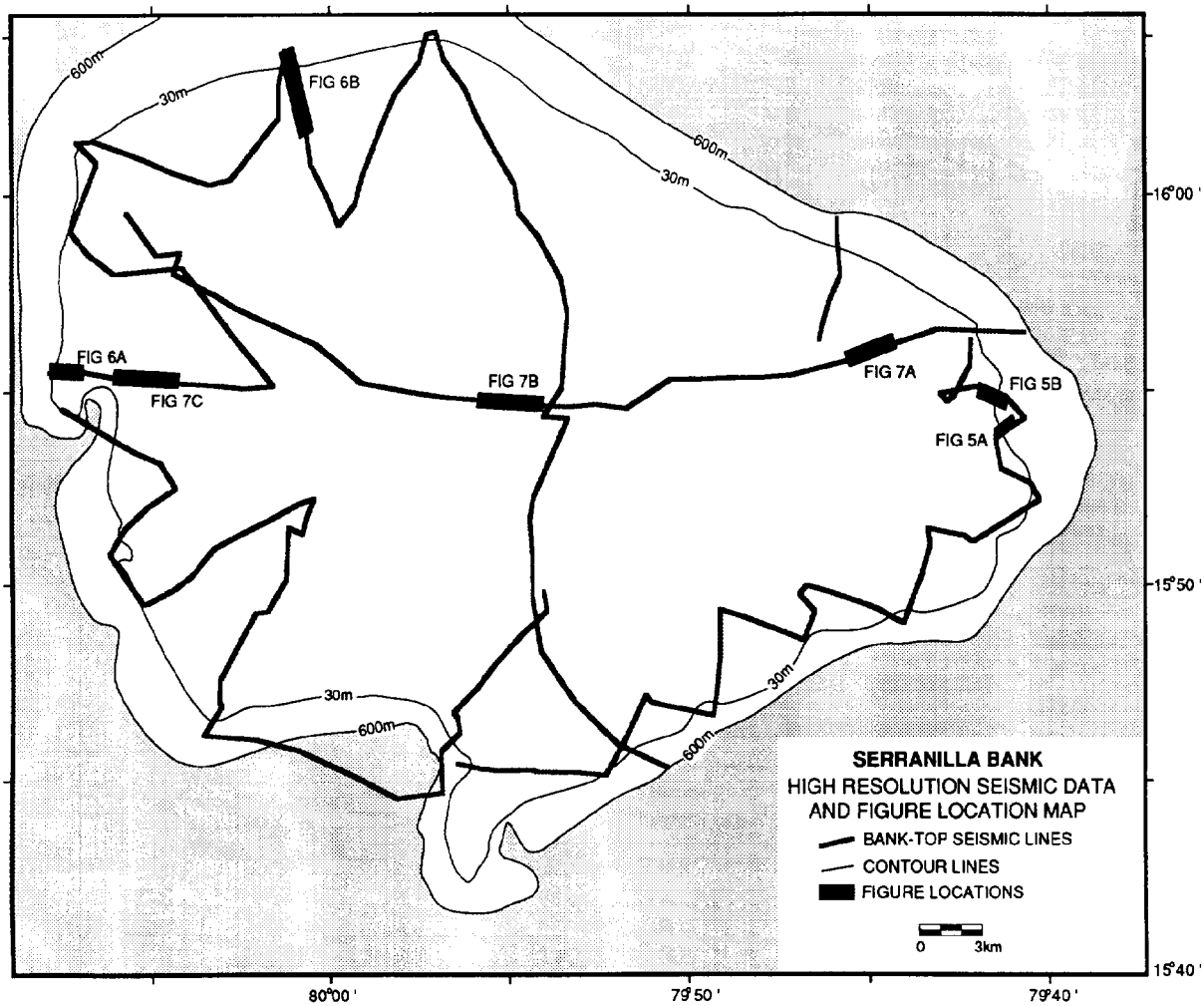


FIG. 4.—Map of Serranilla Bank, illustrating that portion of the cruise track where high resolution seismic data were collected using both 3.5 kHz tuned transducer and an electromechanical, broad frequency (0.4–14 kHz) “boomer”-type (O.R.E. Geopulse) system; approximately 260 km of both kinds of data were collected and analyzed. Locations of high resolution seismic profiles presented in Figures 5–7 are also shown.

Clasts are consistently less abundant in the sediments of the western sector, with median values of 8–10%.

#### DISCUSSION

Serranilla Bank is perhaps more interesting for what it lacks than for what it has. Why does it lack the coral reefs found on nearby Pedro and Serrana Banks? Why does it lack extensive non-skeletal facies common to the Bahama and Serrana Banks (Milliman 1969)? Why is the Holocene sediment cover so thin? These questions can be answered by examining the effects of strong physical-energy flux, banktop depths, and the species dominance within the benthic communities that produce and bioerode the carbonate sediments and substrata of Serranilla Bank.

#### *Physical Energy*

Duration and magnitude of physical-energy flux are major controls on the variability and characteristics of

carbonate-platform margins (Ginsburg et al. 1963; Hine and Neumann 1977; Hine et al. 1981b). Along windward margins, the net energy flux is onto the platform and may foster reef growth, island development, or the formation of sand bodies dominated by skeletal sands (Hine and Neumann 1977; Hine 1983). High-energy reef margins, as found on the Bahama Banks (Newell et al. 1959; Hine et al. 1981b) and Belize (Pusey 1975), are often characterized by well-developed coral-constructional spur and groove structures, distinct biological zonation, and active on-bank sediment transport forming wide, shallow, back-reef flats (Hine and Mullins 1983). Leeward open margins at many sites in the Bahamas (Hine and Neumann 1977; Hine et al. 1981a; Dominguez and Mullins 1988; Wilber et al. 1990) are sites of active off-bank sediment transport. Along such margins, thick (up to 20 m), wedge-shaped bodies of mostly non-skeletal sands have buried earlier Holocene reefs as sea level has risen.

Serranilla Bank is strongly influenced by strong and steady trade winds, the Caribbean Current, northerly win-

TABLE 1.—Grain size analysis of 51 sediment samples from Serranilla Bank. In sizes &gt; 1 mm, &gt; 0.5 mm, &gt; 0.25 mm, &gt; 0.125 mm, and &gt; 0.063 mm, size distribution is greater than that size and less than the next larger sieve size

Sector	Sample No.	Sample wt (g)	Grain size (mm)						
			> 2	> 1	> 0.5	> 0.25	> 0.125	> 0.063	< 0.063
SOUTHEAST	1A	10.72	38.9%	12.9%	26.1%	14.8%	5.7%	1.5%	0.1%
	1B	7.31	13.0%	5.5%	24.8%	37.5%	16.7%	2.3%	0.3%
	2A	17.52	13.7%	22.6%	39.7%	14.8%	2.7%	0.8%	5.8%
	4A	13.88	12.5%	7.6%	32.3%	24.9%	10.1%	1.9%	10.8%
	5A	4.47	5.1%	4.9%	19.0%	43.8%	24.6%	2.2%	0.2%
	6A	36.02	3.1%	20.5%	58.6%	12.2%	1.1%	0.1%	4.5%
	9A	6.37	20.4%	8.5%	18.5%	27.5%	21.0%	3.6%	0.5%
	36	25.99	5.8%	10.6%	52.5%	20.4%	3.8%	1.0%	5.8%
	36A	9.37	9.0%	5.2%	17.4%	35.1%	27.2%	5.7%	0.4%
	36B	12.64	4.1%	3.9%	49.2%	29.0%	3.5%	0.7%	9.7%
	36C	17.48	14.8%	10.2%	42.5%	18.9%	4.2%	0.7%	8.6%
	36D	13.42	9.3%	12.1%	40.1%	28.7%	8.7%	1.0%	0.1%
	37A	20.07	4.4%	11.5%	55.6%	21.9%	1.4%	0.2%	5.0%
	39A	7.86	32.7%	11.2%	28.6%	19.5%	6.6%	1.3%	0.1%
	40	6.84	24.4%	7.0%	23.0%	29.1%	13.7%	2.5%	0.3%
	DS1	23.74	0.2%	2.8%	39.7%	42.8%	10.0%	0.4%	4.2%
	DS2	20.22	0.0%	0.6%	6.5%	62.2%	27.3%	0.9%	2.5%
	DS3	17.25	2.8%	20.9%	59.4%	12.0%	1.4%	0.5%	2.9%
	DS4	20.65	21.8%	25.8%	33.7%	5.4%	0.6%	0.1%	12.6%
CENTRAL	13C	5.7	7.5%	6.8%	29.3%	28.2%	21.2%	6.5%	0.4%
	13D	13.84	2.9%	2.5%	8.3%	30.7%	24.8%	5.1%	25.7%
	14C	8.78	7.1%	7.1%	13.8%	29.7%	29.3%	12.4%	0.7%
	14D	20.89	13.5%	22.6%	35.4%	15.2%	7.5%	1.0%	4.8%
	14E	21.95	2.1%	2.9%	5.4%	21.6%	55.8%	5.3%	6.9%
	14F	9.26	6.9%	1.7%	15.3%	59.6%	13.2%	3.0%	0.2%
	14G	23.88	0.7%	1.8%	4.0%	16.4%	58.0%	12.7%	6.3%
	14H	52.3	4.0%	11.2%	38.5%	29.2%	8.9%	1.5%	6.7%
	17B	10.61	1.1%	1.2%	11.5%	37.9%	30.5%	8.1%	9.6%
	17C	14.44	12.3%	2.7%	4.2%	25.5%	38.4%	8.2%	8.7%
	18B	20.21	5.0%	3.7%	34.1%	38.4%	10.8%	0.4%	7.5%
	18C	19.75	3.2%	9.2%	23.7%	21.3%	26.0%	6.5%	10.2%
	18D	33.16	1.0%	6.0%	24.6%	49.0%	17.2%	0.8%	1.5%
	18E	25.76	16.5%	10.4%	33.6%	26.7%	5.6%	1.3%	5.9%
WEST	26	15.24	7.7%	2.0%	4.5%	27.8%	38.2%	7.6%	12.3%
	26A	37.66	5.8%	10.9%	29.5%	33.3%	10.0%	1.1%	9.4%
	26B	18.3	4.5%	9.5%	22.5%	29.5%	19.1%	3.9%	11.0%
	26C	22.81	0.6%	3.8%	14.9%	22.6%	34.5%	10.2%	13.3%
	26D	36.57	0.2%	9.7%	31.0%	21.8%	22.8%	3.5%	11.0%
	26E	17.56	0.7%	3.1%	15.4%	41.4%	37.1%	2.3%	0.0%
	27A	21.08	2.8%	6.2%	10.7%	27.4%	32.9%	5.7%	14.3%
	27B	14.09	1.3%	3.6%	16.3%	39.5%	36.0%	3.3%	0.1%
	27C	18.85	8.6%	11.1%	38.4%	24.0%	8.3%	2.1%	7.5%
	28A	15.97	0.8%	4.8%	25.2%	36.7%	24.9%	1.4%	6.3%
	30A	9.99	17.8%	12.6%	24.3%	27.3%	13.5%	4.1%	0.3%
	30B	6.69	0.0%	0.0%	9.0%	40.7%	48.4%	1.9%	0.0%
	30C	7.86	3.2%	8.0%	31.0%	34.9%	21.1%	1.7%	0.1%
	31A	12.45	0.4%	1.7%	7.0%	26.1%	56.1%	4.7%	4.0%
	31B	3.72	20.4%	5.1%	8.6%	27.2%	29.0%	9.1%	0.5%
	31C	6.6	2.4%	5.2%	22.9%	38.5%	25.0%	5.9%	0.2%
	31D	4.75	14.9%	4.2%	12.0%	28.2%	30.9%	9.3%	0.4%
31E	10.15	14.1%	9.8%	24.7%	32.6%	15.8%	2.9%	0.2%	
Median (Southeast)			9.3%	10.2%	33.7%	24.9%	6.6%	1.0%	2.9%
Median (Central)			4.5%	4.8%	19.5%	28.7%	23.0%	5.2%	6.5%
Median (West)			3.0%	5.2%	19.4%	28.8%	27.0%	3.7%	2.2%
Median (Overall)			5.1%	6.8%	24.6%	28.2%	19.1%	2.3%	4.5%
Minimum (Overall)			0.0%	0.0%	4.0%	5.4%	0.6%	0.1%	0.0%
Maximum (Overall)			38.9%	25.8%	59.4%	62.2%	58.0%	12.7%	25.7%

ter-wind systems, and probably summer tropical cyclones. Yet this bank differs from many Bahamian banks in its lack of windward coral reefs and accompanying sediments. Its windward margins are deep (30–40 m) and mostly sediment-barren. Platform-margin bioherms (Fig.

5A, B) are similar in depth and benthos to submerged Holocene reefs in the eastern Caribbean described by Macintyre (1972) and to *Halimeda* bioherms on Bawihka Bank described by Hine et al. (1988). Small sand pockets in the lee of these structures indicate limited on-bank

TABLE 2.—Sediment constituents, &gt; 2 mm size fraction, recorded as percent of grains counted

Sector	Sample No.	No. Grains Counted	Molluscan Fragments	Benthic Forams	<i>Halimeda</i>	Cemented Aggregates	Crypto-crystalline Clasts	Worm Tubes	Red Algae	Sponge-bound Aggregates	Miscellaneous
SOUTHEAST	S1A	118	26.3	—	13.6	1.7	28.8	6.8	15.2	—	7.6
	S1B	55	9.1	1.8	43.6	—	9.1	—	10.9	5.5	20.0
	S2A	93	16.1	2.2	62.4	—	19.3	—	—	—	—
	S4A	28	35.7	—	14.3	—	50.0	—	—	—	—
	S5A	11	9.1	—	54.5	—	9.1	—	—	9.1	18.2
	S6A	59	49.1	1.7	33.9	—	13.6	—	—	—	1.7
	S9A	66	19.7	—	43.9	—	13.6	—	—	16.7	6.1
	S36	46	13.0	—	2.2	—	78.3	—	—	—	6.5
	S36A	70	22.9	—	14.3	—	4.3	1.4	—	51.4	1.4
	S36B	41	9.8	—	—	—	82.9	—	4.9	2.4	—
	S36C	38	21.2	—	—	—	28.9	7.9	34.2	2.6	2.6
	S36D	82	11.0	—	—	—	74.4	—	8.5	—	6.1
	S37A	39	10.2	—	—	—	59.0	—	28.2	—	2.6
	S39A	122	11.5	—	—	—	74.5	—	2.5	2.5	9.0
	S40	52	42.2	3.8	—	—	13.5	—	7.7	—	27.0
	DS1	5	60.0	—	—	—	40.0	—	—	—	—
	DS2	0	—	—	—	—	—	—	—	—	—
	DS3	28	21.4	—	—	—	21.4	—	46.5	—	10.7
DS4	103	63.2	—	—	—	22.3	2.9	5.8	—	5.8	
CENTRAL	S13C	28	35.7	7.1	—	—	—	—	—	3.6	25.0
	S13D	61	4.9	4.9	—	—	—	—	—	50.9	1.6
	S14C	92	8.7	23.8	—	—	38.0	1.1	3.3	2.2	3.3
	S14D	108	23.2	—	—	—	18.5	—	—	—	—
	S14E	21	47.6	4.8	—	—	—	4.8	38.0	—	4.8
	S14F	27	7.4	—	—	—	—	—	55.6	7.4	7.4
	S14G	27	25.9	—	—	—	70.3	—	3.8	—	—
	S14H	107	35.6	0.9	—	—	40.2	—	9.3	3.7	8.4
	S17B	9	11.1	33.3	—	—	33.3	—	22.3	—	—
	S17C	47	19.1	36.3	—	—	6.4	2.1	29.8	2.1	2.1
	S18B	20	35.0	—	—	—	35.0	5.0	25.0	—	—
	S18C	65	29.2	32.4	—	—	32.4	1.5	1.5	1.5	1.5
	S18D	25	56.0	8.0	—	—	16.0	4.0	16.0	—	—
S18E	109	21.1	—	—	—	21.1	—	56.9	0.9	—	
WEST	S26	29	20.7	3.4	—	—	—	—	—	17.3	—
	S26A	104	50.0	27.9	—	—	—	—	—	—	1.9
	S26B	87	11.6	19.6	—	—	63.2	1.1	—	3.4	1.1
	S26C	14	35.7	42.9	—	—	14.3	—	7.1	7.1	—
	S26D	17	17.6	47.1	—	—	29.4	—	—	5.9	—
	S26E	19	31.6	—	—	—	52.5	—	5.3	5.3	5.3
	S27A	47	36.2	4.3	—	—	42.5	—	14.9	—	2.1
	S27B	35	8.6	—	—	—	88.5	—	—	—	2.9
	S27C	36	47.2	2.8	—	—	27.8	—	13.9	—	8.3
	S28A	15	46.7	26.6	—	—	20.0	—	6.7	—	—
	S30A	61	11.5	14.8	—	—	26.2	3.3	18.0	—	26.2
	S30B	10	30.0	—	—	—	30.0	—	10.0	—	—
	S30C	43	18.6	2.3	—	—	72.2	—	—	2.3	2.3
	S31A	8	37.5	37.5	—	—	12.5	—	12.5	—	—
	S31B	22	9.1	—	—	—	13.6	—	54.6	—	22.7
	S31C	12	25.0	8.3	—	—	33.3	—	8.3	—	16.8
S31D	27	29.7	—	—	—	14.8	—	18.5	—	25.9	
S31E	102	8.8	—	—	—	72.5	—	1.0	—	10.8	
Median (SE)			16.1	0.0	28.9	0.0	9.1	0.0	0.0	0.0	5.8
Median (Cent)			24.6	4.8	28.7	0.0	19.2	0.0	0.0	0.0	1.5
Median (West)			27.4	3.8	29.7	0.0	7.7	0.0	0.0	1.4	0.5
Median (Overall)			21.6	0.9	30.0	0.0	13.6	0.0	0.0	0.0	1.9
Minimum (Overall)			4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum (Overall)			60.0	47.1	88.5	7.9	78.3	7.1	15.2	51.4	30.0

transport. Northern and western margins are convex seaward and generally lack biohermal structures (Fig. 6). The major similarity to Bahamian systems appears to be off-bank sediment transport. Muds are probably winnowed from banktop sediments by strong currents, as Glaser and Droxler (1991) reported off Pedro Bank and the southern

Jamaica shelf. Where sediments are more than two meters thick, they occur as large bedforms that indicate north-westward movement of banktop sediments (Fig. 7B, C). Small platform-margin sediment bodies (Fig. 6A, B) occur on northern and western margins of Serranilla Bank.

The sedimentary regime on Serranilla Bank is similar



TABLE 3.—Sediment constituents, 1–2 mm size fraction, recorded as percent of grains counted

Sector	Sample No.	No. Grains Counted	Molluscan Fragments	Benthic Forams	<i>Halimeda</i>	Cemented Aggregates	Crypto-crystalline Clasts	Worm Tubes	Red Algae	Sponge-bound Aggregates	Miscellaneous
SOUTHEAST	S1A	100	32.0	4.0	26.0	1.0	27.0	3.0	6.0	—	1.0
	S1B	107	17.8	7.5	42.0	—	8.4	1.9	8.4	6.5	7.5
	S2A	100	9.0	5.0	63.0	2.0	16.0	5.0	—	—	—
	S4A	109	18.2	1.8	29.4	—	45.0	2.8	—	—	2.8
	S5A	117	12.7	2.6	47.0	1.7	7.7	2.6	0.9	23.0	1.8
	S6A	100	20.0	3.0	71.0	—	5.0	1.0	—	—	—
	S9A	106	13.3	10.4	35.8	—	3.8	7.5	0.9	25.5	2.8
	S36	100	30.0	—	18.0	—	51.0	1.0	—	—	—
	S36A	104	14.4	6.7	7.7	1.0	—	5.8	10.6	52.8	1.0
	S36B	106	19.8	1.9	37.8	2.8	22.6	—	4.7	44.9	0.9
	S36C	101	8.9	—	30.7	1.0	57.4	—	2.0	—	—
	S36D	101	30.7	3.0	55.4	—	8.9	1.0	—	—	1.0
	S37A	104	42.3	—	45.2	—	11.5	1.0	—	—	—
	S39A	113	14.2	0.9	62.7	0.9	11.5	1.8	—	8.0	6.2
	S40	104	28.8	1.0	33.6	—	10.6	—	1.0	18.3	6.7
	DS1	102	76.4	1.0	20.6	—	1.0	—	1.0	—	—
	DS2	54	27.8	9.3	46.2	—	16.7	—	—	—	—
	DS3	100	21.0	2.0	45.0	—	27.0	5.0	—	—	—
	DS4	100	60.0	1.0	26.0	—	12.0	1.0	—	—	—
	CENTRAL	S13C	105	22.9	5.7	21.9	—	31.3	2.9	1.0	10.5
S13D		113	12.4	15.9	35.4	—	14.2	—	—	21.2	0.9
S14C		101	5.0	16.8	50.4	—	4.0	4.0	7.9	10.9	1.0
S14D		103	29.1	1.0	18.4	1.0	49.5	1.0	—	—	—
S14E		100	34.0	15.0	22.0	2.0	26.0	—	—	—	1.0
S14F		118	15.3	24.5	14.4	—	22.0	1.7	8.5	13.6	—
S14G		103	53.4	8.7	11.7	—	11.7	2.9	—	7.8	3.8
S14H		110	29.1	1.8	45.5	0.9	20.9	0.9	0.9	—	—
S17B		94	10.6	22.3	29.8	1.1	28.7	1.1	—	5.3	1.1
S17C		100	33.0	27.0	13.0	4.0	16.0	2.0	1.0	—	4.0
S18B		115	21.8	—	67.0	4.3	5.2	—	—	1.7	—
S18C		101	26.7	27.7	29.7	2.0	7.9	—	—	5.0	1.0
S18D		100	27.0	9.0	20.0	11.0	30.0	1.0	—	2.0	—
S18E		102	32.3	1.0	20.6	4.9	39.2	—	—	—	2.0
WEST	S26	112	38.3	11.6	16.1	0.9	6.3	2.7	0.9	20.5	2.7
	S26A	102	52.8	15.7	18.7	1.0	10.8	—	—	—	1.0
	S26B	111	22.5	9.0	51.4	0.9	3.6	0.9	—	9.0	2.7
	S26C	100	20.0	23.0	33.0	1.0	23.0	—	—	—	—
	S26D	103	40.7	26.2	17.4	1.0	8.8	4.9	—	—	1.0
	S26E	106	34.0	8.5	39.6	3.8	14.1	—	—	—	—
	S27A	105	26.7	2.8	27.6	—	41.9	1.0	—	—	—
	S27B	118	37.3	5.9	45.8	5.1	2.6	2.5	—	—	0.8
	S27C	101	42.5	3.0	31.6	1.0	17.9	2.0	—	—	2.0
	S28A	112	28.5	16.1	33.9	6.3	14.3	—	—	—	0.9
	S30A	124	12.9	12.1	43.6	—	9.7	—	0.8	16.9	4.0
	S30B	52	53.8	13.5	30.8	—	1.9	—	—	—	—
	S30C	106	26.5	9.4	53.8	4.7	0.9	0.9	—	—	3.8
	S31A	116	33.7	24.1	28.4	1.7	9.5	—	—	—	2.6
	S31B	99	25.3	12.1	11.1	1.0	17.1	4.1	3.0	25.3	1.0
	S31C	123	13.8	15.4	34.1	—	4.9	4.1	10.6	13.0	4.0
	S31D	107	18.7	1.9	20.6	0.9	6.5	0.9	4.7	44.9	0.9
S31E	104	7.7	—	71.2	—	—	1.0	1.0	11.5	7.6	
Median (SE)			20.0	2.0	37.8	0.0	11.5	1.0	0.0	0.0	0.9
Median (Cent)			26.8	12.0	22.0	1.0	21.5	1.0	0.0	3.5	1.0
Median (West)			31.1	11.8	32.3	1.0	9.2	0.9	0.0	0.0	1.0
Median (Overall)			26.7	6.7	31.6	1.0	11.7	1.0	0.0	0.0	0.9
Minimum (Overall)			5.0	0.0	7.7	0.0	0.0	0.0	0.0	0.0	0.0
Maximum (Overall)			76.4	27.7	71.2	11.0	57.4	7.5	10.6	44.9	7.5

to that of Cay Sal Bank (Hine and Steinmetz 1984), probably in part a result of bank size and location relative to strong western boundary currents (the Caribbean Current and Florida Current respectively). Both lack coral-reef development, have thin to non-existent sediment cover,

and have poorly developed windward- and leeward-margin facies. Grigg and Epp (1989) noted that the depth of drowned Holocene banks is often negatively correlated with summit area; smaller banks are typically deeper. Hine and Steinmetz (1984) suggested that the efficiency

TABLE 4.—Sediment constituents, 0.5–1 mm size fraction, recorded as percent of grains counted

Sector	Sample No.	No. Grains Counted	Molluscan Fragments	Benthic Forams	<i>Halimeda</i>	Cemented Aggregates	Crypto-crystalline Clasts	Worm Tubes	Red Algae	Sponge-bound Aggregates	Miscellaneous
SOUTHEAST	S1A	102	14.7	4.9	27.5	—	35.3	2.9	—	8.8	5.9
	S1B	104	24.2	11.5	28.8	—	6.7	14.4	5.8	6.7	1.9
	S2A	105	11.4	6.6	54.3	1.0	21.0	4.7	—	—	1.0
	S4A	112	8.9	2.7	57.0	3.6	15.2	7.2	0.9	—	4.5
	S5A	100	23.0	7.0	46.0	—	3.0	1.0	—	15.0	5.0
	S6A	100	27.0	2.0	66.0	—	1.0	2.0	—	—	2.0
	S9A	102	10.8	4.8	52.0	—	2.9	6.9	10.8	9.8	2.0
	S36	106	17.9	2.8	24.5	1.9	46.2	—	4.8	—	1.9
	S36A	108	10.2	8.3	28.6	—	—	5.6	20.4	25.0	1.9
	S36B	100	10.0	2.0	59.0	—	24.0	—	2.0	1.0	2.0
	S36C	101	14.9	1.0	36.5	—	44.6	—	2.0	—	1.0
	S36D	109	22.0	5.5	61.4	0.9	2.8	—	2.8	0.9	3.7
	S37A	105	9.5	2.9	41.0	—	43.7	2.9	—	—	—
	S39A	109	20.2	5.5	56.8	—	3.7	2.8	1.8	5.5	3.7
	S40	103	25.2	11.7	41.7	—	8.7	—	1.0	10.7	1.0
	DS1	100	15.0	4.0	26.0	—	53.0	1.0	—	—	1.0
	DS2	106	19.8	8.5	47.1	1.9	13.2	5.7	1.9	—	1.9
	DS3	106	39.0	—	16.2	—	43.8	—	—	—	1.0
	DS4	105	30.5	1.9	31.4	1.0	35.2	—	—	—	—
	CENTRAL	S13C	102	17.6	13.8	30.4	1.0	30.4	2.9	—	1.0
S13D		102	6.9	12.7	53.9	1.0	10.8	2.9	—	10.8	1.0
S14C		119	13.4	16.8	45.4	4.2	0.8	3.4	4.2	8.4	3.4
S14D		106	15.1	0.9	23.6	3.8	50.9	5.7	—	—	—
S14E		106	28.3	4.7	24.5	14.2	28.3	—	—	—	—
S14F		105	12.4	14.3	45.8	—	11.4	1.9	1.0	13.3	—
S14G		101	34.6	5.9	9.9	30.7	11.9	3.0	—	1.0	3.0
S14H		103	26.2	4.8	39.8	1.0	16.5	10.7	1.0	—	—
S17B		97	14.4	24.7	25.8	—	29.9	—	—	3.1	2.1
S17C		105	25.6	30.5	20.0	4.8	15.2	1.0	1.9	—	1.0
S18B		98	11.2	5.1	58.1	3.1	20.5	1.0	—	1.0	—
S18C		105	34.3	21.9	29.5	9.5	3.8	1.0	—	—	—
S18D		101	21.8	—	15.8	25.7	35.7	—	—	—	1.0
S18E		102	21.6	5.9	20.6	—	45.1	3.9	—	2.9	—
WEST		S26	100	16.0	16.0	53.0	2.0	—	1.0	—	10.0
	S26A	107	30.8	20.6	29.9	2.8	10.3	4.7	—	—	0.9
	S26B	104	30.8	18.3	33.7	—	2.9	4.7	—	3.8	5.8
	S26C	103	28.2	16.5	39.7	1.0	13.6	—	—	—	1.0
	S26D	101	41.6	16.8	21.8	6.9	3.0	8.9	—	—	1.0
	S26E	111	32.4	0.9	31.5	18.0	15.4	—	1.8	—	—
	S27A	103	18.4	7.8	34.9	5.8	30.2	2.9	—	—	—
	S27B	103	52.4	3.9	28.2	11.7	—	1.9	—	—	1.9
	S27C	101	26.7	7.9	32.7	1.0	20.8	8.9	—	1.0	1.0
	S28A	100	30.0	8.0	36.0	14.0	10.0	—	—	—	2.0
	S30A	103	16.5	14.5	35.0	1.0	23.3	5.8	—	3.9	—
	S30B	100	27.0	8.0	45.0	14.0	4.0	—	—	2.0	—
	S30C	112	19.6	6.3	43.7	9.8	14.3	3.6	—	—	2.7
	S31A	104	34.5	8.7	19.2	20.2	15.4	1.0	—	—	1.0
	S31B	113	25.7	8.7	17.7	—	26.6	1.8	—	17.7	1.8
	S31C	111	5.4	11.7	71.0	—	1.9	—	6.8	4.8	3.6
	S31D	101	20.8	16.8	28.7	—	5.9	3.0	6.9	14.9	3.0
S31E	103	6.8	3.9	60.4	1.8	—	4.5	5.4	7.2	4.8	
Median (SE)			16.4	4.8	41.7	0.0	15.2	2.0	1.0	0.0	1.9
Median (Cent)			19.6	9.3	27.2	3.4	18.5	2.4	0.0	1.0	0.5
Median (West)			26.8	8.7	34.3	2.4	10.2	2.4	0.0	0.5	1.4
Median (Overall)			21.6	7.8	34.9	1.0	14.3	2.0	0.0	0.9	1.0
Minimum (Overall)			5.4	0.0	9.9	0.0	0.0	0.0	0.0	0.0	0.0
Maximum (Overall)			52.4	30.5	71.0	30.7	53.0	14.4	20.4	25.0	5.9

of sediment removal is inversely related to bank size: the smaller the bank, the shorter the distance from any point on the banktop to the deep sea. Potential for accretion is particularly limited for small banks like Serranilla and Cay Sal that lack reefal rims and are washed by strong western boundary currents.

#### *Benthic Communities and Sediments*

Sponge-algal domination of hard substrata and absence of coral reefs contribute to a sedimentary regime on Serranilla Bank that contrasts with coral-algal reefal sedimentation on nearby Pedro and Serrana Banks. The dif-

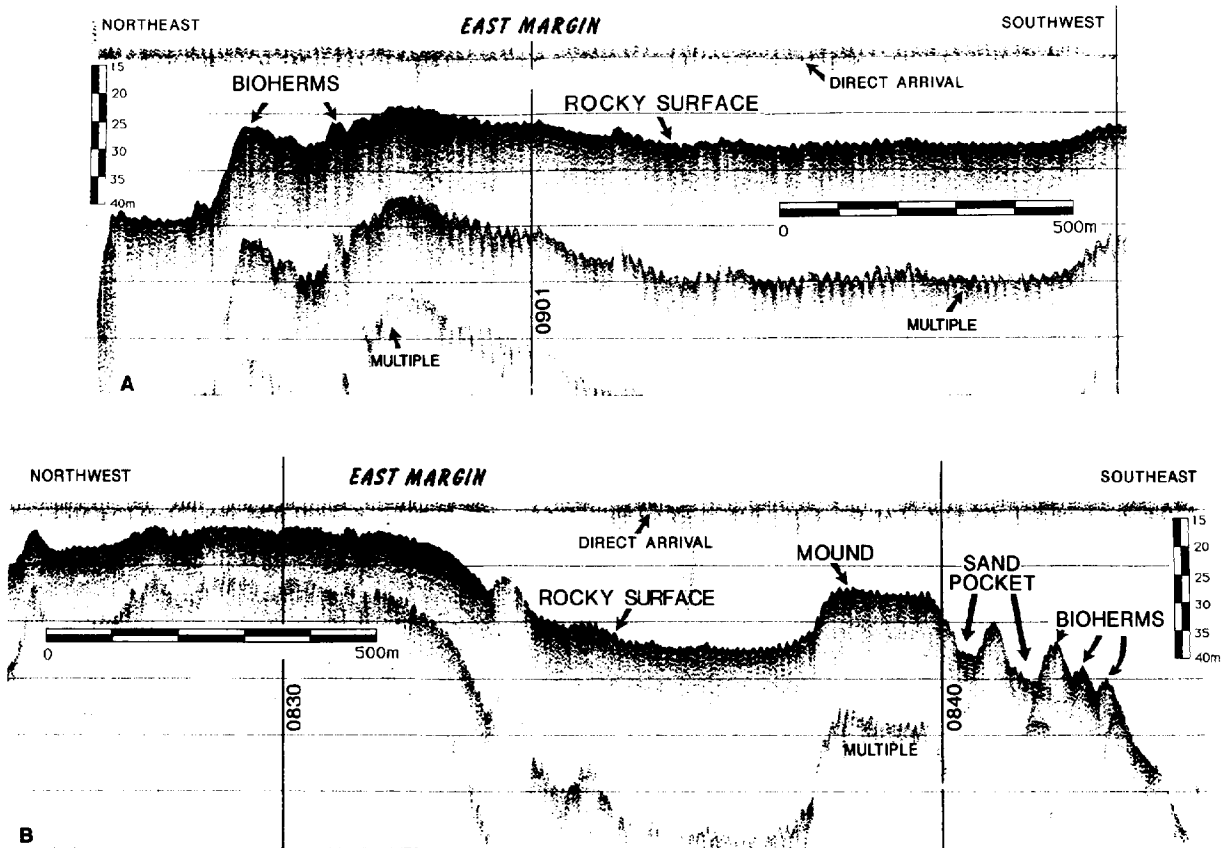


FIG. 5.—High-resolution seismic profiles across the eastern margin of Serranilla Bank (see Fig. 4 for locations). A) Deep (> 40 m) shelf-edge terrace, possible sponge-algal bioherms or relict reefs, and sediment-barren, rocky surfaces. B) Deep shelf-edge bioherms (35–40 m), sand pockets, and a broad mound that lies on strike with the line of small, very low cays.

ferences in benthic communities result from differences in species dominance, not differences in the species composition. The same species are present on shallow carbonate banks throughout the Caribbean; the difference is in the abundance and carbonate productivity of corals relative to the abundance of benthic algae and clionid sponges. For coral reefs to occur, corals and associated organisms must build reefal structures faster than bioeroding organisms and major storms destroy them. The differences in benthic community dominance between Serranilla Bank and reefal banks are consistent with Birkeland's (1988) observations of benthic-community change along a nutrient-input gradient, with dominance by algae and boring sponges indicating higher nutrient resources.

Hallock and Elrod (1988) and Hallock et al. (1988) discussed the lack of reef development on Serranilla Bank and concluded that oceanographic factors, including moderate enrichment of southern Caribbean waters by runoff and upwelling off northern South America, topographically-induced upwelling, and biweekly reversal of surface currents by late autumn, winter, and early spring storms, promote nutrient flux onto the bank. Absence of coral reefs, sponge-algal domination of hard substrata,

ubiquitous bioerosion, and predominance of calcareous algal and molluscan debris in the thin sands of Serranilla Bank fit Hallock's (1988) prediction for a carbonate bank exposed to moderately abundant nutrient resources in a high-energy regime.

Pedro Bank to the east of Serranilla (Dolan 1972), and banks on (Murray et al. 1982; Roberts and Murray 1983) and off (Milliman 1969) the southern margin of the Nicaraguan continental shelf have some coral-reef development, although *Halimeda* may be the more important sediment producer in all cases. Hallock and Elrod (1988) postulated that the more easterly location of Pedro Bank may account for its coral reefs. Pedro Banks is strongly influenced by low-chlorophyll Atlantic water that enters the Caribbean through the Windward Passage between Cuba and Hispaniola. In addition, topographically-induced upwelling around Pedro Bank is less intense than around the more western banks of the Nicaraguan Rise. Banks of the southern margin of the Nicaraguan continental shelf, as well as Roncador Bank and Courtown and Albuequerque Cays off the central Nicaraguan shelf and Serrana Bank, which is south-southwest of Serranilla Bank, also are not exposed to all the oceanographic factors promoting nutrient flux onto Serranilla Bank and its coun-

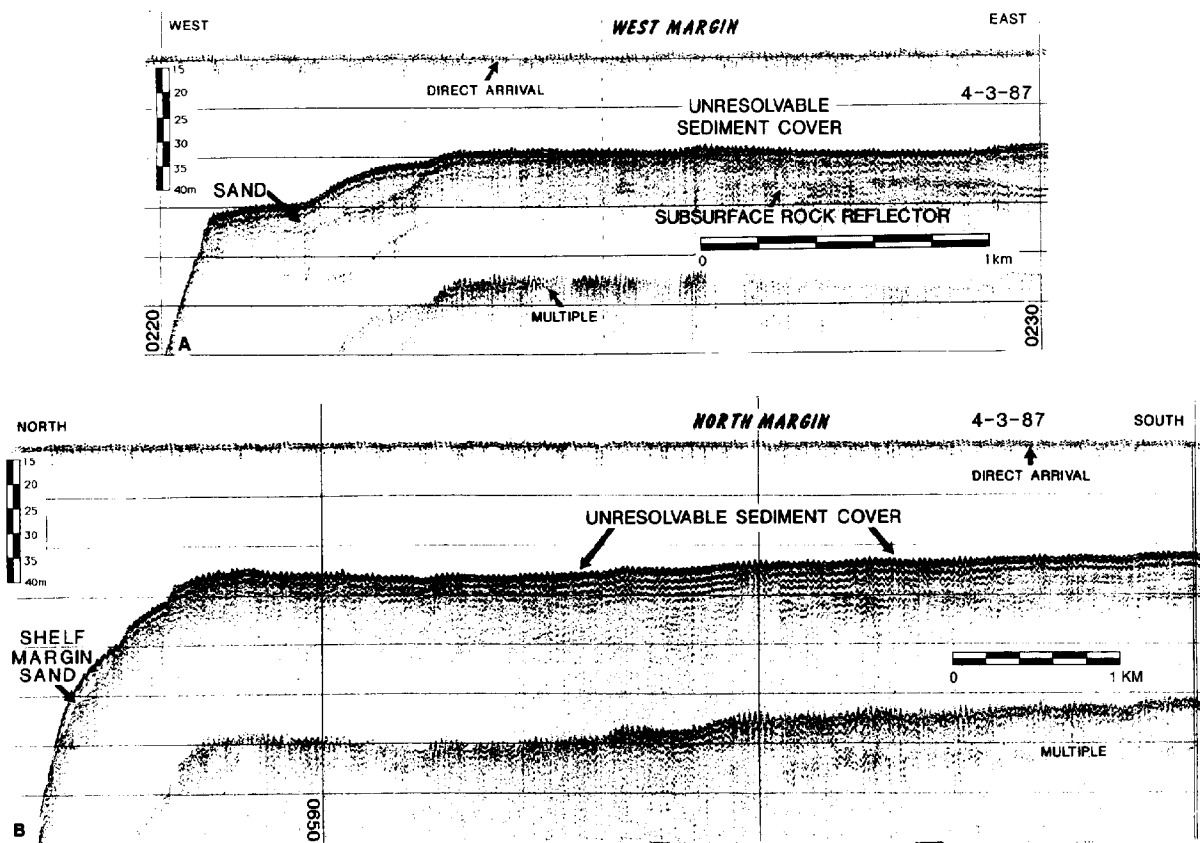


FIG. 6.—Seismic profiles from the western (A) and northern (B) margins of Serranilla Bank (see Fig. 4 for locations). Shelf-margin sand bodies, which probably represent offbank sand transport, are evident; otherwise, sediment cover is too thin to resolve seismically (< 2 m). The lithified sequence labeled “subsurface rock reflector” in profile A may have accreted during the last sea-level highstand in the Pleistocene.

terparts to the west. Because the Nicaraguan Rise constricts and accelerates the north-flowing Caribbean Current more than 100 km downstream (north) of these southerly banks, they are not as prone to topographically-induced upwelling or to eutrophication by current reversal during seasonal storms.

Serrana Bank also has non-skeletal lagoonal sediments, predominantly oolites, cryptocrystalline lumps and pelletoids, that Milliman (1969) suggested are related to a lack of biogenic sedimentation in open lagoonal conditions. Although Serranilla Bank sediments contain a substantial percentage of cryptocrystalline clasts (12–14 wt. % of coarse-sediment fractions), oolites were not seen (Tables 2–4). Dolan (1972) attributed the lack of oolitic facies on Pedro Bank to the limited extent of tidally-influenced or wave-influenced shoals (< 10 m depth); Serranilla Bank similarly has limited shoals.

The makeup and taphonomy of the benthic foraminiferal fauna in banktop sediments of Serranilla Bank also reflect the predominance of relatively deep banktop environments that are exposed to substantial wave and current energy (Triffleman et al. 1991). *Discorbis rosea*, a hyaline species whose test is exceptionally resistant to crushing (Wetmore 1988), dominates the thanatocoeno-

sis. Foraminiferal tests in the sediments are typically damaged by microborings, abrasions, and marginal breakage. This contrasts with high-diversity milioline-dominated assemblages that are typical of Caribbean carbonate banks with more extensive shoals (e.g., Todd and Low 1971; Wantland 1975).

#### *Implications for Interpreting Drowned Platforms*

Holocene flooding history played an important role in determining modern sedimentologic conditions on Serranilla Bank. We reconstructed this history using Digerfeldt and Hendry's (1987) sea-level curves from Negril and Black River, Jamaica, and assumed negligible tectonic subsidence. Serranilla Bank quickly flooded during rapid Holocene sea-level rise; deeper margins and the northwestern sector flooded in succession. By about 8.5 ka, sea level was 13 m below present level, and 85% of the platform was inundated. During this period, sea-level rise exceeded 10 m/1000 yr, a rate in excess of the “keep-up” ability of most Caribbean reefs (e.g., Neumann and Macintyre 1986).

Serranilla Bank does not appear to be presently ac-

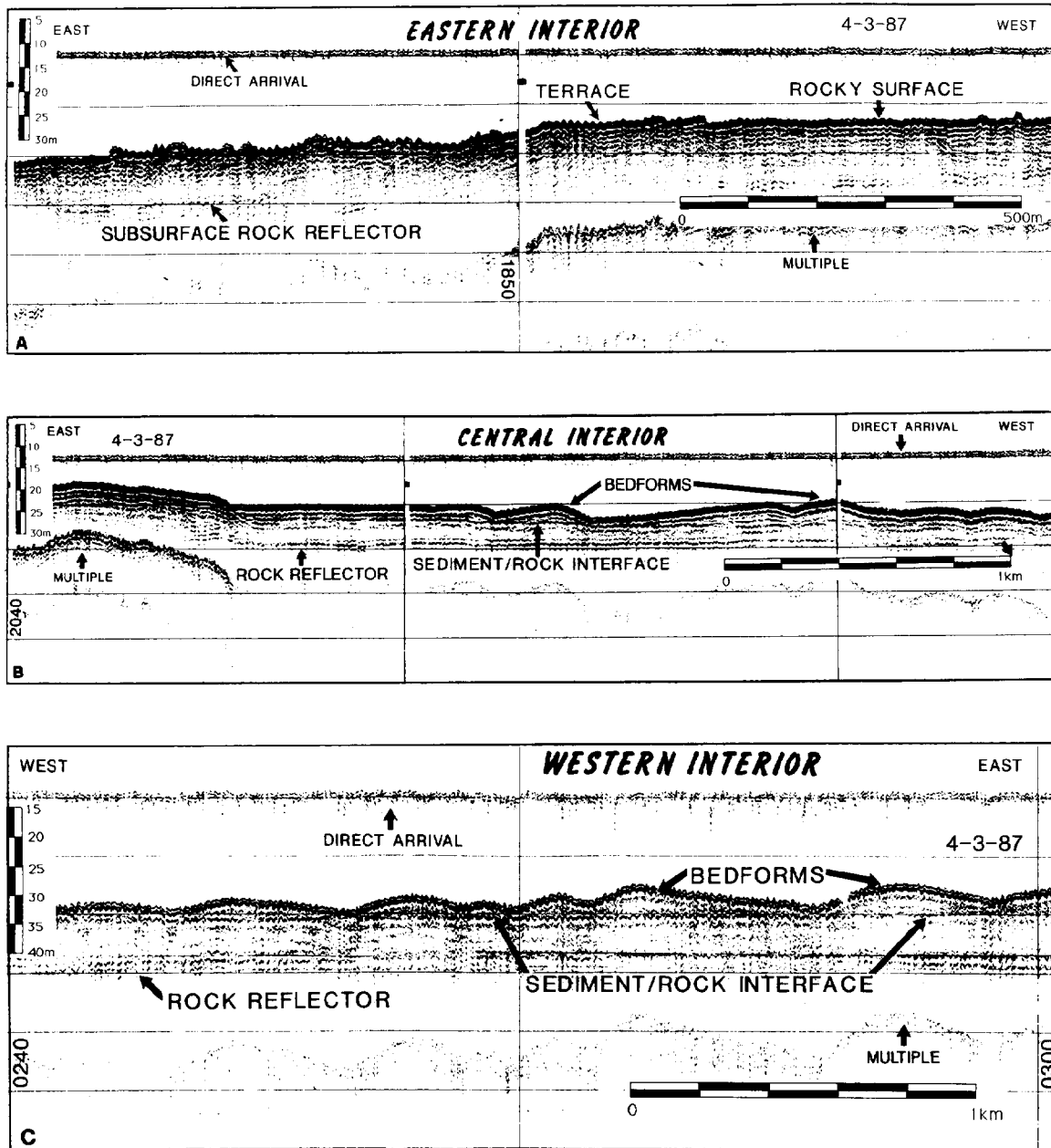


FIG. 7.—Seismic profiles from the interior of Serranilla Bank (see Fig. 4 for locations). A) An extensive sediment-barren rocky surface is seen in the eastern profile. B) In the central profile, sediments that have accumulated in a topographic depression onlap a rocky outcrop. These sediments occur in large (3–8 m high) bedforms whose asymmetry indicates northwestward sediment transport. C) Near the northwestern margin, northwestward sediment transport in large bedforms is also evident. In all three profiles, a subsurface rock reflector below the sediment/rock interface indicates an 8–9 m thick lithified sequence also seen in Figure 6A.

creting. Although the banktop is within the euphotic zone and calcareous algae are abundant, the sparse sediment cover, together with bedform shape and location, indicate active offbank transport to the northwest. The windward margin may be eroding, as it lacks coral reefs and a substantial fraction of hard substratum is occupied by clionid sponges (see Fig. 9B). Such sponges are capable of long-term bioerosion rates of  $7 \text{ kg m}^{-1} \text{ yr}^{-1}$  (Rützler 1975),

which is equivalent to erosion rates of several meters per thousand years. In a relatively high-energy setting like Serranilla Bank, essentially all sponge bioerosion is net loss, because about 90% of the material excavated is silt-sized chips (Neumann 1966) that are readily carried in suspension; the other 10% loss is mostly dissolution. Finally, some of the cryptocrystalline clasts, which make up 10–15% of the coarse sediments (Table 2–4), may be

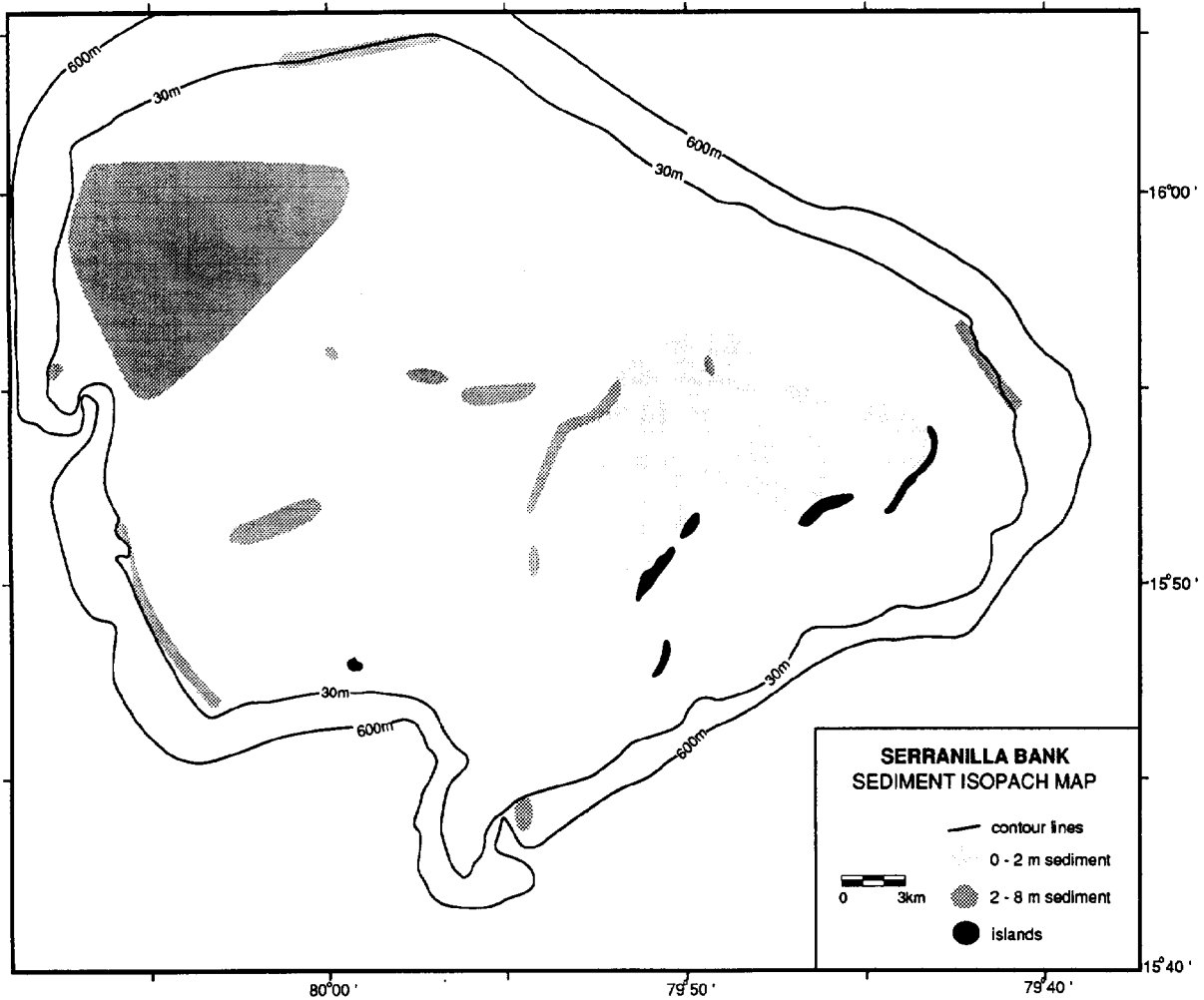


FIG. 8.—Sediment isopach map of Serranilla banktop. Unshaded areas within the 30 m contour represent sediment-barren, rocky surfaces (see Figs. 5A, B, 7A). Lightly shaded areas illustrate possible sediment cover so thin as to be unresolvable seismically (see Fig. 6A, B). Intermediate shading indicates resolvable sediment cover, either bedforms on the platform interior (see Fig. 7A, B) or pockets of shelf-margin sands (see Fig. 6A).

products of erosion. These clasts tend to be most common in sediments of the southeast and central sectors, where hardgrounds are most prevalent.

Thus, are Serranilla and similar nearby banks of the Nicaraguan Rise in the process of drowning? The answer appears to be yes: if present conditions persist, these banks will not keep pace with rising sea level.

In contrast, Pedro Bank, to the east, appears to be a "catch-up" platform (terminology of Neumann and Macintyre 1986). Although Pedro Bank is also shedding shallow-water sediments (Glaser and Droxler 1991), it has active reef development along its southeastern margin (Dolan 1972). Thus, coral-reefal "turn-on/turn-off" conditions (e.g., Buddemeier and Hopley 1988) occur along the Nicaraguan Rise, with Pedro Bank to the east on the "turn-on" side and nearby Serranilla Bank on the "turn-off" side.

If Holocene oceanographic conditions are responsible

for coral-reefal turn-on/turn-off location along the Nicaraguan Rise, paleoclimatic changes associated with Pleistocene glacial advances and retreats may have influenced paleoceanographic conditions sufficiently to shift the turn-on/turn-off point. For example, the prominent subsurface rock reflector recorded seismically on Serranilla banktop (Figs. 6A, 7) indicates aggradation during an earlier sea-level high stand. This aggradation may have occurred during a westward shift of reefal turn-on conditions associated with climatic amelioration during the sea-level highstand associated with interglacial Stage 5E, when sea level was approximately 8 m higher than present. If coral-reefal turn-on/turn-off conditions along the Nicaraguan Rise did respond to Pleistocene paleoceanographic changes, future studies of the rocks and sediments of the Nicaraguan Rise, including Serranilla Bank, may provide a record of the response of carbonate platforms to changes that can determine whether a platform

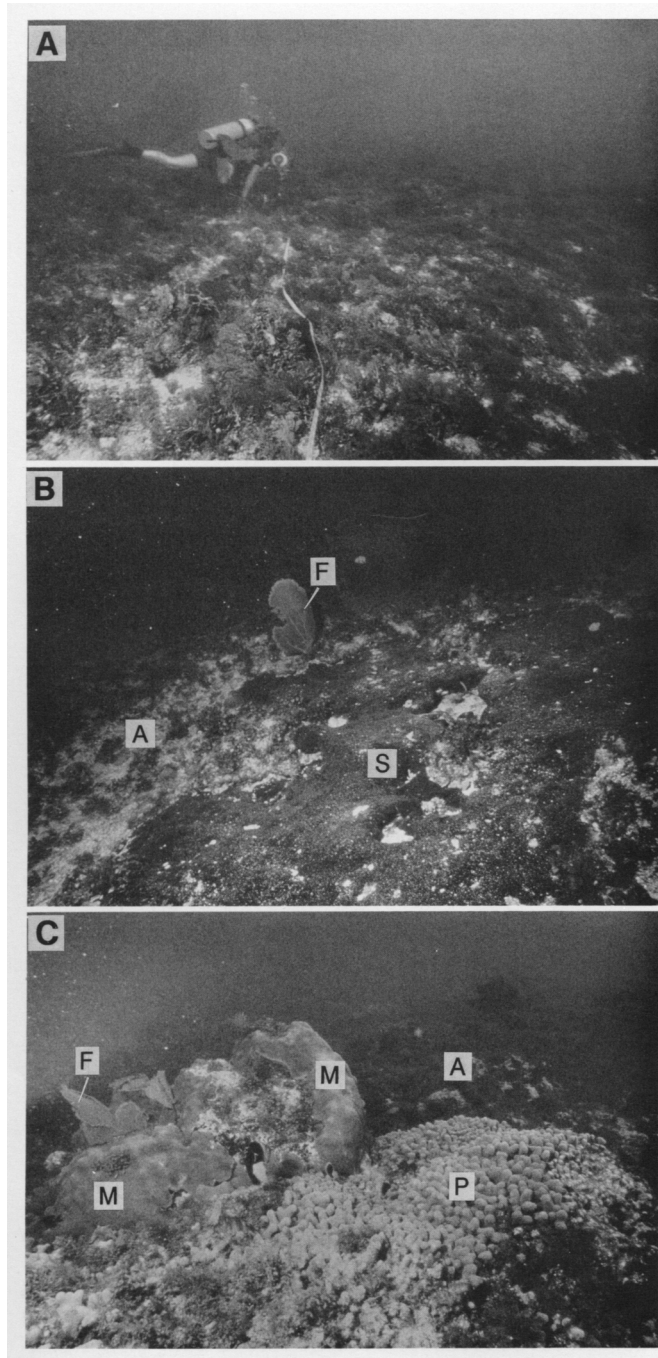


FIG. 9.—Underwater photographs of benthos from Serranilla Bank. **A)** Hardgrounds dominated by fleshy brown algae, including *Sargassum*, *Styopodium*, and *Turbinaria*; *Halimeda* was also common. Note diver and tape measure for scale. (Dive Site 2; see Fig. 3). **B)** Hardground dominated by boring sponge (*Cliona caribbea?*) and fleshy brown algae (A). The encrusting sponge shown (S) covers an area of approximately 30–40 m<sup>2</sup>. Purple sea fan (*Gorgonia ventalina*) is marked (F) to provide relative scale (30–50 cm high and wide). (Dive Site 4, see Fig. 3). **C)** The largest heads of coral seen in four dives on Serranilla Bank: a partially eroded head of *Montastrea annularis* (M) adjacent to a patch of *Porites porites* (P) covering about 10 m<sup>2</sup>. Sea fans provide relative scale (F). Background is dominated by fleshy brown algae (A). (Dive Site 2).

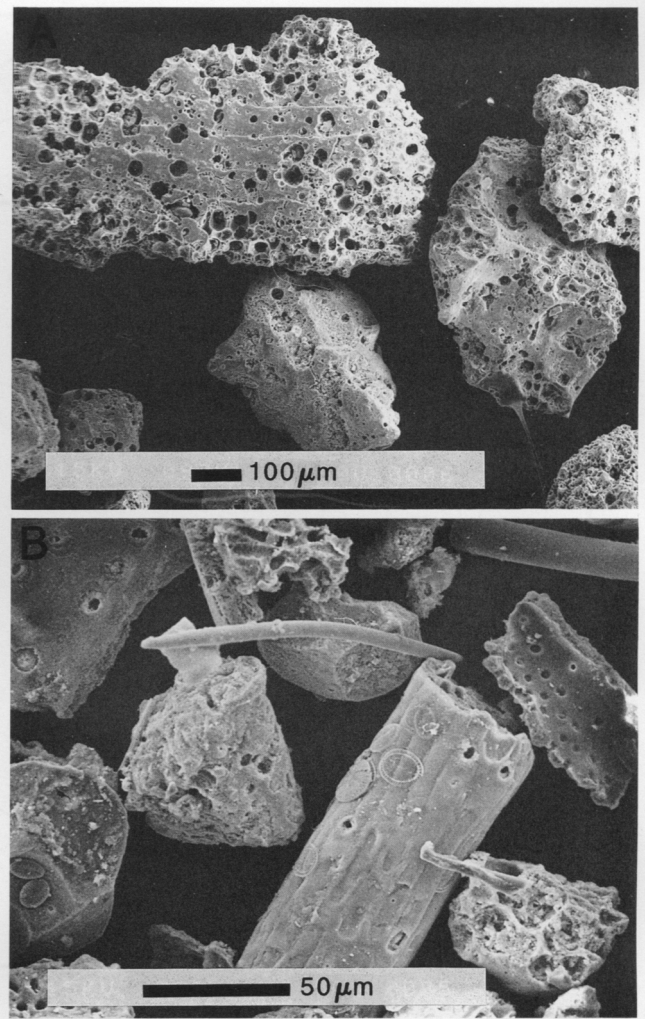


FIG. 10.—SEM photomicrographs of fine sand (A) and silt (B) from Serranilla Bank. Coralline algae and worm tubes are common in the silt-sized fraction. Both sand- and silt-sized grains typically exhibit extensive microbioerosion.

can “catch up” or will “give up” (drown) in response to relative sea-level rise.

#### SUMMARY

Serranilla Bank lacks an actively accreting coral-reefal rim. Bank-top *Halimeda*/molluscan-dominated sediments are thin. Bedform shapes and locations indicate off-bank transport in response to strong easterly trade winds and the northwestward flowing Caribbean Current. Modern sedimentary environments on Serranilla Bank have developed in response to the bank’s small size, rapid Holocene sea-level rise, strong currents, and domination of hard substrata by bioerosional sponge-algal rather than frame-building coral-algal benthic communities. Although the banktop is producing *Halimeda*/molluscan sediments, the bank does not appear to be accreting under present environmental conditions.

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