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# Siliciclastic-carbonate transitions along shelf transects through the Cayos Cochinos Archipelago, Honduras

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**Abstract:** The Honduran Caribbean shelf possesses all of the conditions necessary for deposition of both carbonate and siliciclastic sediments within a relatively limited area. However, what is revealed in two cross shelf transects through the Cayos Cochinos Archipelago is not a simple shore to shelf edge gradual transition between siliciclastic and carbonate shelf environments. Rather there is lateral as well as cross-shelf variability, in addition to variability in the nature of the sediments within both the siliciclastic and carbonate settings. Strong terrestrial influence is restricted to a narrow nearshore siliciclastic belt less than 10 Km in width, with abundant organic-rich siliciclastic mud, and a low proportion of biogenic, predominantly molluscan, carbonate grains. At the outer edge of this belt, there is a transition zone of coarse siliciclastic sands that are likely the result of longshore transport. The mid and outer shelf areas have carbonate bottom sediments, where biogenic material is mostly derived from reef coral fragments and *Halimeda* flakes in varying proportions. Results from this study and others in the area indicate that the transition between siliciclastic and carbonate shelf environments is rather complex, with lateral and cross-shelf variability related to the effects from the freshwater discharge from rivers, the wind/wave-driven longshore currents, and the geomorphology and topography of the shelf.

**Key words:** Central American shelf, siliciclastic sediments, carbonate environments.

Sedimentation on continental shelves is controlled by an inter-relation of terrestrial sediment supply, water temperature, nutrients and clarity, and coastal current regimes. Siliciclastic sedimentation is enhanced by tectonic uplift, high rainfall, and the proximity of major river outlets. Carbonate sedimentation is enhanced by clear, nutrient-poor, warm waters; conditions under which carbonate secreting organisms are most productive. In certain tropical settings, including that of the Honduran shelf, all of these conditions are met within a relatively limited area, resulting in an array of coexisting siliciclastic and carbonate sediments.

The more extensively studied shelf sediments of the Antilles and the Bahamas banks give an impression of predominantly carbonate sedimentation in the Caribbean area (Hine & Neumann 1977). However, work along the Nicaraguan coast by Owens & Murray (1978) and Roberts & Murray (1983), and in Belize (summarized by Purdy *et al.* 1975) emphasizes that mixed carbonate-siliciclastic regimes are present on Central American shelves. Here, the drainage of fresh water from large watersheds strongly influences the inner shelf: diluting salinity, increasing abundance of plankton due to the land-derived dissolved nutrients, and releasing large loads of terrigenous siliciclastic sediments into the inner-shore, reducing the penetration of light and thus decreasing carbonate production.

Beyond this basic scenario, there is increasing information suggesting that transitions from siliciclastic-to-carbonate environments might adopt different patterns depending on the local hydrographic scenarios (Murray & Young 1985). In their work on the Miskito Bank off the Caribbean coast of Nicaragua, Murray *et al.* (1988) documented the presence of a baroclinic coastal current that limited the extent of siliciclastic deposition to a 30 Km inshore band. In this paper, we add new information to the knowledge of the continental shelf in the western Caribbean and give a cross-shelf description of the siliciclastic to carbonate environments adjacent to the Cayos Cochinos Archipelago, Honduras. Recently, this archipelago has been established as a new Biological Reserve by the Honduran Government.

Several questions regarding the sedimentology of the Cayos Cochinos Archipelago are discussed here, including:

(a) What is the nature and distribution of sediments across the shelf? (b) What organisms are responsible for the production of biogenic carbonate in surface sediments along these cross-shelf transects? (c) Is the textural and mineralogical composition of these sediments a reliable indicator of environmental forces controlling the local sedimentology, as suggested by Lees (1975)? (d) How does this siliciclastic to carbonate sediments transition compare with other tropical mixed sediment shelves, in particular with the neighboring Nicaraguan Miskito Bank (Roberts & Murray 1983, Murray *et al.* 1988)?

## REGIONAL SETTING

Two cross-shelf sampling transects were run through the Cayos Cochinos Archipelago, located on the northern Honduran shelf, western Caribbean at 16° N (Figs. 1 and 2). The Archipelago includes two high islands (maximum altitude 142 m) and a dozen small sand keys, surrounded by extensive seagrass beds and coral reefs (including patch reefs and solid fringing reef frameworks to a depth of 40 m). Climatology in this area is affected by the seasonal easterly tradewinds which define the eight months rainy season and the dry season which coincides with the northern hemisphere winter (Sadler *et al.* 1987). Rainfall exceeds 2000 mm year$^{-1}$ and the air temperature stays warm throughout the year, ranging between 25-29° C. Mainland coastal areas are forested with humid tropical vegetation (Holdrige 1971) though there is some agriculture along the coastal plain and along Río Aguan (Portillo 1976).

The surface water mass of the Caribbean Sea has characteristics very similar to those of the adjacent Equatorial Atlantic, in which the upper layer is warm and of high salinity (Wust 1964). This surface water flows into the Caribbean through the Lesser Antilles as the Caribbean Current (Stalcup & Metcalf 1972), and also through other passages among the Greater Antilles. There is a well described counterclockwise gyre developed from the Caribbean Current off the coast of Nicaragua which flows to the southwestern Caribbean (Gordon 1967, Kinder *et al.* 1985). According to the Atlas of Pilot Charts for the Caribbean (US-Defense Mapping Agency 1990), the northern shelf of Honduras is affected by another, still smaller, counterclockwise current (stronger from January to March, sluggish otherwise), whose flow directly bathes the offshore Bay Islands and possibly the Cayos Cochinos Archipelago on the outer shelf as well (Fig. 1). Along the coast the wave-dominated delta morphologies, with sand bars extending to the west, suggest a predominantly E-W longshore current, likely driven by the Trade Winds. The area is influenced by a series of short rivers draining the coastal mountains (average elevation 600 m, peaks around 1200-1500 m), but more importantly by the major Río Aguan that runs south of the coastal Cordillera Nombre de Dios, along an extensive fault, draining much of northern Honduras to the interior of the small coastal watershed.

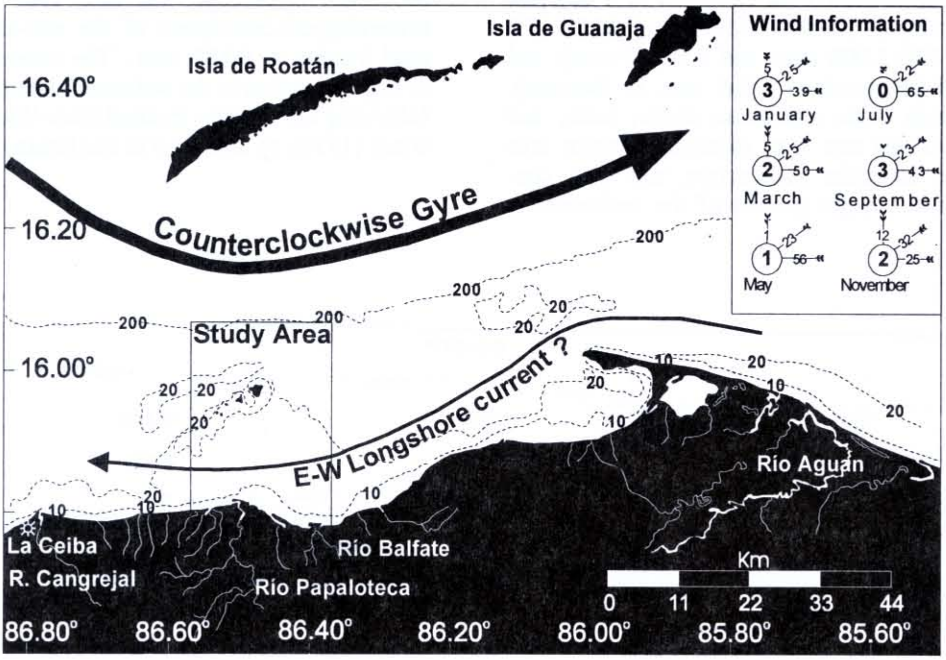


Fig. 1. General map of the northern coast of Honduras. The Couterclockwise Current affects the Bay Islands, and the E-W longshore current. Inset: the study area encompassing the Cayos Cochinos Archipelago, and wind information. The N-E wind component information is based on the U.S. Defense Mapping Agency Pilot Chart for the Caribbean (1990): arrows angle indicates the wind direction; the length of shaft (up to 29% - then equal length) indicate the percent frequency of wind from that direction; the number of feathers shows the average force of wind on the Beaufort scale; and the Fig. in the center of the circle gives the percentage of calms.

The geology of the northern coast of Honduras consists of a Caribbean coastal plain of Quaternary sediments and a northern Cordillera of Paleozoic schists, gneisses, phyllites, and Cretaceous/Tertiary granitic intrusions (Mills *et al.* 1967, Weyl 1980, Donnelly *et al.* 1990). The Quaternary shelf sediments are underlain by these same Paleozoic metamorphics, with the exception of some serpentinite diápirs possibly related to the nearby transform boundary of the Caribbean Plate. The small coastal rivers appear to incise the metamorphics of the northern Cordillera (Nombre de Dios), as well as the younger coastal sediments (Donnelly *et al.* 1990). The Río Aguan, which follows the major NE-SW trending Aguan Fault, cuts through Paleozoic metamorphics, quartzites, Cretaceous marbles, and Tertiary/Cretaceous sands derived from silicic plutons (Burkart 1994, Weyl 1980).

## METHODS

Bottom sediment samples from 19 sampling sites on the shelf transects through the Cayos Cochinos Archipelago, Honduras, were collected during a cruise aboard the STRI's Research Vessel Urracá from April 30 to May 5, 1995. The closest sampling site to the shoreline was 3 Km (8 m depth) and the farthest was at the shelf edge (205-225 m depth) almost 30 km offshore (Fig. 2). Samples were collected using a Petersen type grab with 30 cm x 30 cm sampling area. A minimum of three grab-sample replicates were collected at each site. Immediately after the collection, samples were stored in PVC vials 4.5 cm in diameter and 6.0 cm in length, and frozen at -5° C for their analysis at STRI's marine laboratory in Panamá. Grain size analysis of sediments was performed by the wet sieving, drying and weighing of the samples, following Buchanan

(1984). Sediments were classified in 4 different sand fractions (0.063-0.125 mm, 0.125-0.250 mm, 0.250-1.000 mm, and > 1.000 mm), and as mud (sediments < 0.063 mm in diameter). Fragments from calcareous shells, tests, and algae >0.250 mm were sorted into major taxa using a binocular microscope, and then converted into weight percent of the sediment. A binocular microscope was also used for the mineralogical description of the non-carbonate sand fraction > 0.125 mm. The concentration of organic carbon in the sediments was analyzed following the titration method from Walkley & Black (1934), as indicated in Buchanan (1984).

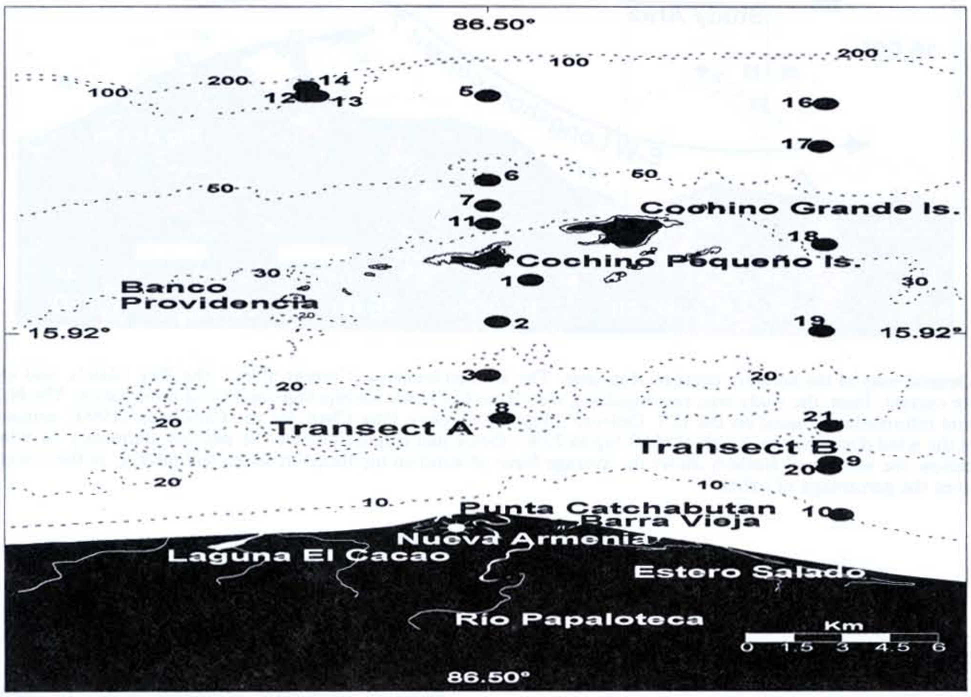


Fig. 2. Cross-shelf sampling transects in the Cayos Cochinos Archipelago where marine bottom sediments were collected during April 30 to May 5, 1995.

With this method the organic matter is oxidized with potassium dichromate and concentrated sulfuric acid, and the excess of dichromate is titrated with a solution of ferrous ammonium sulphate. The results from the Walkley & Black (1934) analysis of organic carbon can be comparable to data from a LECO carbon analyzer (Gaudette *et al.* 1974). The percentage of carbonate in the sediments was calculated from the weight loss after the dried and pulverized sample is treated with hydrochloric acid (2N) to dissolve the carbonate (Barnes 1959).

## RESULTS

Our results show cross-shelf gradients in percent carbonate, grain size, percent organic carbon (Fig. 3), and composition of sand fractions in the bottom sediments in Cayos Cochinos Archipelago (Fig. 4). In general, samples from transect A and transect B showed a similar trend in the concentration of carbonate (Fig. 3a). The carbonate fraction in transect A ranged from 65% in sediments collected 7 Km off the shoreline to 85% 27 Km offshore. The carbonate fraction of these sediments is high in samples relatively close to the coastline, suggesting limited terrigenous influence. Weight percent of carbonate in sediments from transect B was less than 10% in samples collected at 3 Km off the coastline, and steadily increased toward the edge of the outer-shelf, where it contributed almost 80% of the sediment weight.

The greatest concentration of mud is along the coast, with a sharp decrease in the overall abundance immediately offshore (Fig. 3b). In contrast to the common nearshore terrestrial mud, there are biogenic carbonate mud deposits in the mid-shelf and outer-shelf areas.

The concentration of organic carbon ranged between 0.1% to almost 1.4% and is directly related to the weight-percent of mud in the sediments (Figs. 3b and 3c). Note that the upper limit of these concentrations are due to the replicates from sample 19 (Fig. 3c). This site is likely responsible for the mid-shelf disparity in the concentration of organic carbon between the two transects. Samples from site 19 were mostly composed of biogenic carbonate mud collected near a coral reef patch.

The abundance of biogenic sand-sized grains was minimal in the nearshore, and those present were largely limited to mollusks and forams (Fig. 4). In contrast, biogenic fragments, mostly debris from corals and calcareous algae proved to be important carbonate contributors to the offshore sands (Fig. 4). Mollusc shells contribute a minor amount to all carbonate assemblages in these samples, with a fairly even distribution with the exception of a decrease in the inner to mid-shelf area. Mollusks are the most frequent biogenic sand-sized grains observed in the siliciclastic sediments. There is a small, but regular, contribution to the sediments of echinoderm tests, primarily in the mid-shelf section of transect A. Coral debris in sediment from the mid-shelf area from transect A accounts for as much as 40% of the sediments weight in the vicinity of Cochino Pequeño Island. However, the abundance of coral derived particles in transect B, upstream from the archipelago, is much less (Fig. 4). The most important contribution from corals occurs in the mid-shelf area, and then decreases toward the edge of the outer-shelf. In both transects the proportion of sand-sized particles derived from flakes of the calcareous algae *Halimeda* increase in the outer-shelf. Overall remains from *Halimeda* accounts for most of the sand-sized carbonate grains on this shelf. However, sediments from sites 12, 13, and 14 (transect A) have a mix of *Halimeda* sands and *Penicillus* mud-sized carbonate particles. Included within the category of others are: foraminifers, sponge spicules, bryozoans, and non-biogenic particles.

TABLE 1

*Summary of non-carbonate sand (> 0.125 mm) mineralogy in siliciclastic samples from Cayos Cochinos Archipelago.*

| Sample site | Carbonate | Organic | Mud (%) | Lithic fragments | Chlorite | Quartz grains | Feldsparg |
|---|---|---|---|---|---|---|---|
| 8 | 58.23 | 0.50 | 6.41 | not present | not present | common | common |
| 9 | 31.52 | 0.29 | 6.13 | not present | rare | abundant | abundant |
| 10 | 7.86 | 0.64 | 55.64 | abundant | common | not present | not |
| 20 | 15.98 | 0.93 | 75.57 | abundant | rare | rare | rare |
| 21 | 47.98 | 0.91 | 14.26 | not present | not present | rare | rare |

The mineralogy of the sediments indicates that the siliciclastic sand-sized component is limited to the nearshore samples and characteristics of these grains varied among the few samples where present (Table 1). The most landward site on transect B (site 10) is characterized by lithic fragments (loosely lithified sandstone) and green phyllosilicates (possibly chlorite), as components of the fine sand fraction (0.125-0.250 mm). The second site (20) on the eastern transect (B) has fine sand composed predominantly of lithic fragments. The third site (9) contains a significant proportion (approx. 50%) of coarse sub-angular quartz and sub-rounded feldspar sand, and rare phyllosilicates. The fourth site (21) shows occasional quartz and feldspar grains in the fine sand fraction. The initial station on the westward transect A (8) also contains significant quartz and feldspar grains, but in the medium-fine sand fractions (as opposed to the coarse fraction of transect B).

A cluster analysis using the single linkage method (Systat 1996) grouped the samples on the base of the weight percent of carbonate, the concentration of organic carbon, and the weight percent of mud in sediments. Three main groups resulted:

(a) The siliciclastic environment comprised by samples collected at sites 10 and 20 (Fig. 5). Common characteristics for these samples are the high weight percent of siliciclastic mud (Fig. 6a), the low weight percent of carbonate sediments (7.86 - 15.98%), the high concentration of organic carbon (among the highest found at 0.64 - 0.93%), and the abundant lithic fragments (Table 1). This cluster of samples is indicative of coastal sediments under strong terrestrial influence.

(b) The transition from siliciclastic-to-carbonate sediments included samples collected at sites 8, 9, and 21. In these samples carbonate concentrations ranged from 30% to almost 60%, and quartz and feldspar grains range from common to abundant (Table 1), which still is indicative of some important terrestrial influence (though a distinct influence from that seen in group (a). The sediment grain-size classes are more evenly distributed in these samples (Fig. 6b) and biogenic carbonate sands ranging between 0.063 - 1.0 mm represents nearly 80% of the sediment composition.

(c) The carbonate environment included samples from the mid-shelf and outer shelf areas, where sediments have the highest carbonate weight percent, and the textural composition has relatively high proportion of coral and *Halimeda* coarse-to-fine sands (Fig. 6c), although some deposits of biogenic carbonate muds are present in the mid-shelf area (see Figs. 2a and 2b). This group could be further subdivided into a mid-shelf group that shows immediate reefal influence from the Cayos Cochinos (sites 2, 7, 19, 11, 1) and a predominantly outer shelf group that shows less reefal influences (sites 13, 3, 6, 17, 18, 5, 14, 11). Site 12 may group with the mid-shelf due to its high coral content suggesting the presence of a patch reef.

According to the characteristics of the sediments discussed above, transitions from siliciclastic to carbonate sediments in both transects are described as follows:

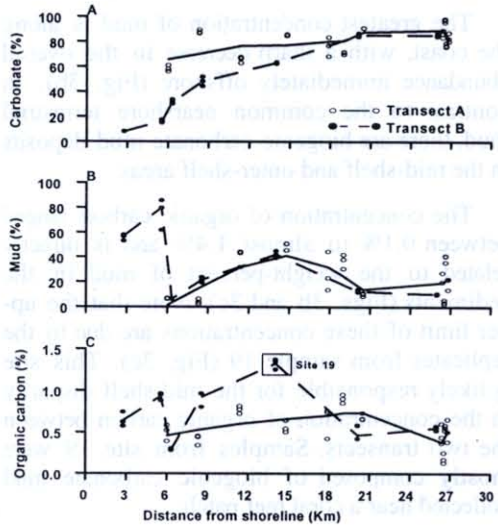


Fig. 3. Cross-shelf distribution of (A) carbonate, (B) mud, and (C) organic carbon in marine bottom sediments in Cayos Cochinos Archipelago. Lines are best fitted using the Lowess smoothing method.

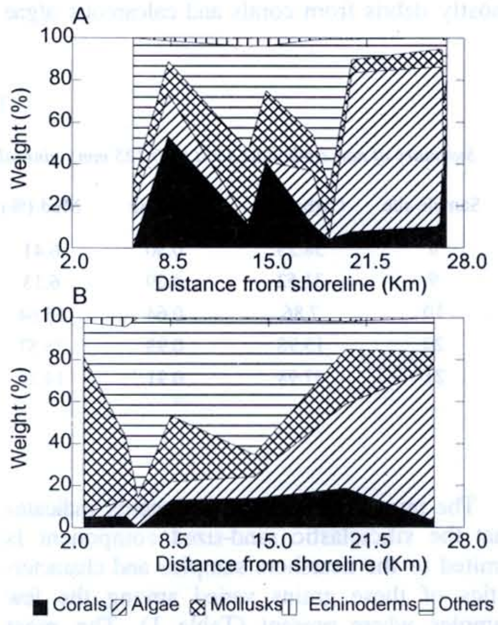


Fig. 4. Sand-sized biogenic constituents (> 0.250 mm) in marine bottom sediments collected along the cross-shelf transects through the Cayos Cochinos Archipelago. (A) Transect A, (B) Transect B.

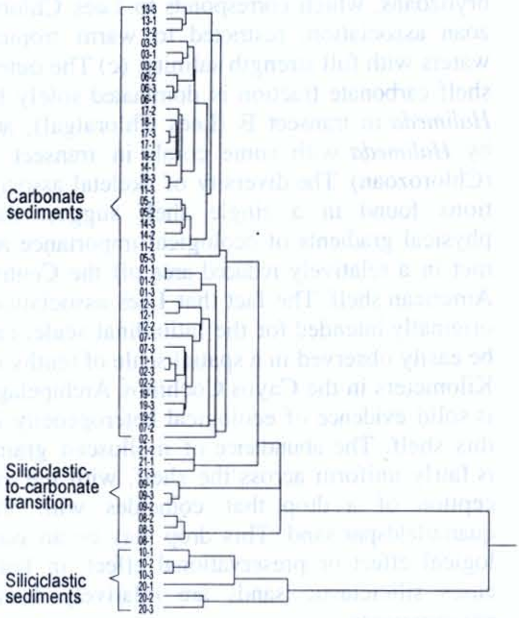


Fig. 5. Cluster analysis based on the weight percent of carbonate, mud, and organic carbon in marine bottom sediment samples collected along the cross-shelf transects through the Cayos Cochinos Archipelago. Three replicates, indicated from 1-3 after the site number, were collected at each sampling sites.

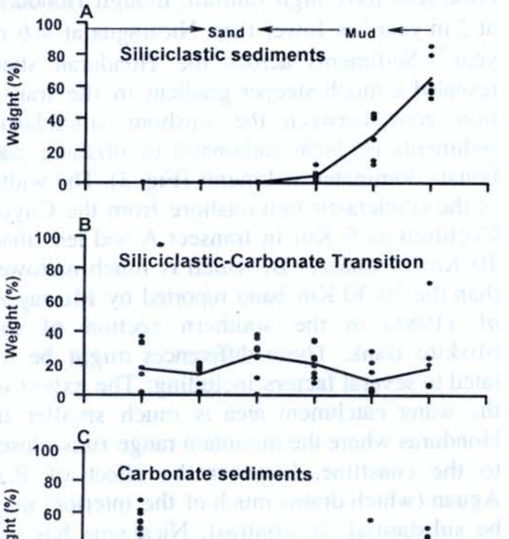


Fig. 6. Results from the sieve analysis of marine bottom sediments collected along the cross-shelf transects through the Cayos Cochinos Archipelago. (A) granulometry of bottom sediments from the siliciclastic zone; (B) granulometry of bottom sediments from the siliciclastic-carbonate transition zone; and (C) granulometry of bottom sediments from the carbonate environment. Lines are best fitted using the Lowess smoothing method.

Transect A starts with a mixed carbonate and silicate fine sand of the transition zone composed of quartz and feldspar grains and rare mollusc fragments. The mid-shelf zone is characterized by abundant mud-sized carbonate particles from *Penicillus*, dead *Halimeda* fragments and few branching bryozoans, with some bits of gorgonians and corals (*Agaricia tenuifolia*, *Porites divaricata*?) also present. The outer-shelf zone is characterized by abundant *Halimeda* sands (and live *Halimeda* and *Penicillus*), however some other elements are common, i.e. fleshy macroalgae, gorgonians, free living corals (*Manicina*), small branching corals, bryozoans, echinoderms (*Eucidaris*), and several species of mollusks.

In transect B, sediments from the inner-shelf zone were mostly dark muddy sands of terrigenous origin (lithic fragments and chlorite) that included small amounts of forams and mollusks. The transition zone consists of quartz and feldspar sands, little mud, and few biogenic grains. The mid-shelf zone has sandy mud sediments, with high concentration of carbonate, and scattered evidence of patch reefs, macroalgae (*Sargassum*), massive sponges and *Halimeda*. The outer-shelf sediments are mostly characterized by coarse *Halimeda* sands.

## DISCUSSION

What is revealed in the results of this study is not a simple shore to shelf edge gradual transition between siliciclastic and carbonate shelf environments. Rather there is lateral as well as cross-shelf variability, in addition to variability in the nature of the sediments within both the siliciclastic and carbonate settings.

Siliciclastic sediments appear to have two distinct sources, with hydrodynamic sorting acting as an agent of selective deposition. The loosely lithified sandstone lithic fragments and chlorite particles of site 10 suggest a proximal source due to their friability and chemical instability. They were probably locally derived from the coastal deposits and metamorphic bedrock that the Balfate, Lis, Papaloteca, and other smaller rivers erode (Fig. 1). On the other hand, the sub-rounded coarse quartz and feldspar sand that dominates site 9 is likely a submature sediment from a larger river such as Río Aguan that has been transported longshore. The delta that has been transported longshore. The delta of the Río Aguan in fact shows a distinct wave-dominated form, with bars extending to the west indicating significant westward longshore transport. Site 8 further supports this idea of longshore transport, as it also contains quartz and feldspar sands, though here a smaller proportion of the sediment is siliciclastic and it is of fine sand size (the coarse fraction of this sample is carbonate). Occasional quartz and feldspar grains are found in sites 20 and 21, which are both near site 9. Site 20 also shows occasional chlorite grains and thus is receiving limited transport from both sides. Sites 19 and 3 do not show any sign of sand-sized siliciclastic grains, and thus the transition from siliclastic to carbonate sediments is over a fairly narrow area. There is however, active mixing of siliciclastic and carbonate grains within the transition zone, apparently maintained by a coast-parallel current (*c.f.* Mount 1984).

The highest concentration of organic carbon in sediments is related to fine grains (mud), particularly in the band of siliciclastic sediments, suggesting the terrestrial influence determines the level of organic matter in the nearshore sediments. A similar conclusion was reached by Sussko & Davis (1992) from the study of a siliciclastic to carbonate transition in southwest Florida. However, the high concentration of organic carbon (1.3-1.4%) measured in biogenic carbonate muds collected at site 19 is likely related to the organic production from the nearby coral reef environment in this part of the mid-shelf area.

Generally, the agreement of the taxonomic assemblages with the environmental groupings of the cluster analysis (Fig. 5) matches the relationships discussed in Lees (1975). Accordingly, the distribution of carbonate grains can be divided into three broad zones on the basis of taxonomic composition: (a) The carbonate fraction of the nearshore sites (10, 20, 9, 8, and 21), including those from the siliciclastic to carbonate transition, is dominated by the remains of mollusks and forams, with subsidiary echinoderm fragments and sponge spicules. This corresponds to Lees (1975) Foramol skeletal grain association, which in turn is correlated with lower salinities under tropical conditions, usually related to nearshore areas affected by river discharge. (b) The mid-shelf carbonate fraction is dominated by *Halimeda*, corals, and bryozoans, which corresponds to Lees Chlorozoan association, restricted to warm tropical waters with full strength salinity. (c) The outer-shelf carbonate fraction is dominated solely by *Halimeda* in transect B (Lees Chloralgal), and by *Halimeda* with some corals in transect A (Chlorozoan). The diversity of skeletal associations found in a single shelf suggest that physical gradients of ecological importance are met in a relatively reduced area off the Central American shelf. The fact that Lees association, originally intended for the latitudinal scale, can be easily observed in a spatial scale of tenths of Kilometers in the Cayos Cochinos Archipelago is solid evidence of ecological heterogeneity in this shelf. The abundance of molluscan grains is fairly uniform across the shelf, with the exception of a drop that coincides with the quartz/feldspar sand. This drop may be an ecological effect or preservational effect: in both cases siliciclastic sands are relatively harsh environments.

Comparing these results to those of Roberts & Murray (1983) from the Miskito Shelf of Nicaragua, we find that both Honduras and Nicaragua have high rainfall, though Honduras at 2 m year$^{-1}$ is lower than Nicaragua at 4-6 m year$^{-1}$. Sediments across the Honduran shelf revealed a much steeper gradient in the transition zone between the onshore siliciclastic sediments (< 50% carbonate) to offshore carbonate dominated sediments (Fig. 3). The width of the siliciclastic belt onshore from the Cayos Cochinos is 6 Km in transect A and less than 10 Km in transect B, which is much narrower than the 20-30 Km band reported by Murray *et al.* (1988) in the southern section of the Miskito Bank. These differences might be related to several factors including: The extent of the water catchment area is much smaller in Honduras where the mountain range runs closer to the coastline, however the effect of Río Aguan (which drains much of the interior) may be substantial. In contrast, Nicaragua has extensive coastal plains. The eroding hinterland is dominated by Paleozoic metamorphics in northern Honduras and Tertiary volcanics in eastern Nicaragua. The attitude of the coasts is also in contrast: Honduras running E-W, while Nicaragua runs N-S, which results in a different net effect on the coastal wind/wave-driven currents. The resulting longshore current in Honduras runs E-W close to the coast under the influence of the onshore NE tradewinds (see

W-E gyre current seen offshore. Thus a relatively narrow belt of murky and low salinity coastal water flowing parallel to the coastline is likely formed. The Nicaraguan longshore current runs N-S (Roberts & Murray 1983) which is the same direction as the counterclockwise gyre that forms off the Caribbean current and heads south down the edge of the Nicaraguan shelf. The transition of siliciclastic to carbonate sediments may be confined to this belt, and beyond this facies carbonate environments flourish. Finally, the geomorphology and topography of the shelves has an influence on the production of carbonate sediments. Honduras's northern shelf is narrow (~30 Km) with a gentle slope, and great part of it is likely to be under high oceanic influence. Nicaragua's eastern shelf by contrast ranges from 20 Km to 250 Km wide, and given its shallow nature the terrestrial input has a greater impact on the shelf.

All of these are elements that may affect the type and total amount of sediment delivered to the coast, however, these results, as well as work in progress in Honduras, Nicaragua, and Panama by the present authors, and by Best & Kidwell (1995) and Best (1996) in Caribbean Panama, strongly suggests such mixed siliciclastic/carbonate sediment types are perhaps the norm for Central America.

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## RESUMEN

La plataforma continental de Honduras en el Caribe posee todas las condiciones necesarias para la deposición de sedimentos de carbonato y siliciclásticos dentro de un área relativamente pequeña. Sin embargo, las observaciones realizadas en dos transectas perpendiculares a la costa sugieren que en el Archipiélago de Cayos Cochinos no existe una simple transición gradual entre ambientes siliciclásticos y de carbonato. Se observa variabilidad lateral y perpendicular a la costa, en adición a la variabilidad en el origen de los sedimentos dentro de los ambientes siliciclásticos y de carbonato. La fuerte influencia terrestre está limitada a una angosta banda siliciclástica con menos de 10 Km de ancho, con fangos siliciclásticos ricos en materia orgánica y con poca presencia de partículas de carbonato biogénico, que se derivan de los moluscos. En el borde externo de esta banda, ocurre la transición hacia los sedimentos siliciclásticos más gruesos posiblemente como consecuencia del transporte costero. Las áreas intermedias y externas de la plataforma continental tienen sedimentos de carbonato, en los cuales el material biogénico mayormente se deriva de fragmentos de corales y restos de *Halimeda* en proporción variable. Los resultados de este y otros estudio realizados en el área, indican que la transición entre ambientes siliciclásticos y de carbonatos es compleja, con variaciones laterales y a lo largo de la plataforma, que están relacionadas a la descarga de aguas de los ríos, las corrientes costeras producidas por vientos/olas, la geomorfología y topografía de la plataforma.

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