Depositional Environments of the Turner Hole Reef Complex

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INTRODUCTION

Along the southeastern corner of St. Croix, the coast is divided into a series of approximately kilometer-long embayments separated by points of the Cretaceous Caledonia Formation. Generally, a narrow barrier reef bridges the gap between points and forms a protected lagoon behind. In front of the reefs, the shelf extends offshore for approximately 5 km. The reef-crest communities vary greatly from bay to bay, depending on wave exposure and the age of each reef. For a general description of these reefs, The reader is referred to Adey (1975).

One such system, located in Turner Hole (Fig. 1, 2a), has been a site for West Indies Laboratory class activities since the early 70's. Since 1979, the author has used the area for class exercises in which undergraduate students have mapped and sampled the lagoon using a variety of techniques. The following description is based largely on the results of those exercises along with observations and measurements of the author over the past decade.

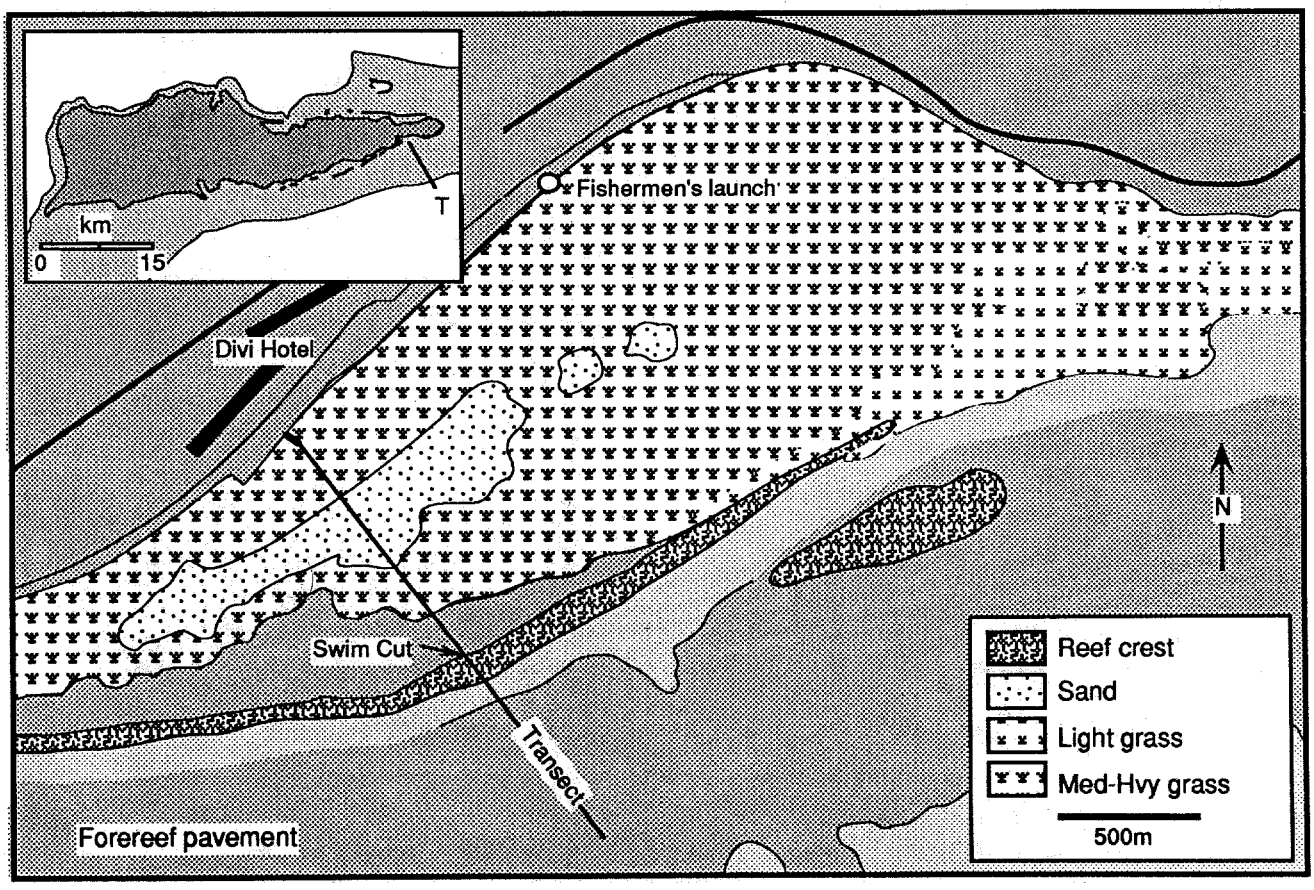


Figure 1. *Maps showing the location of features described in this paper. Benthic communities of the reef-lagoon complex and the transect of Figures 3-5 are included on the main map. The swim-cut through the reef crest is located in a direct line with the westernmost seawall on the Divi Hotel beach. The inset shows the location of Turner Hole and the transect of Figure 6.*


A

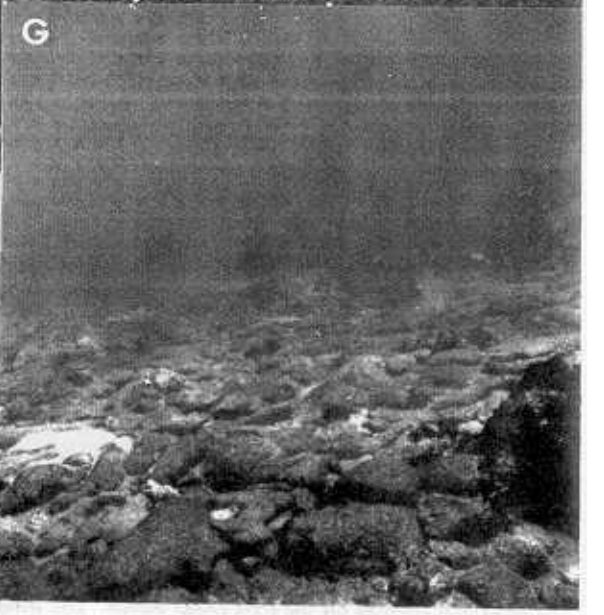

B


C


D


E


F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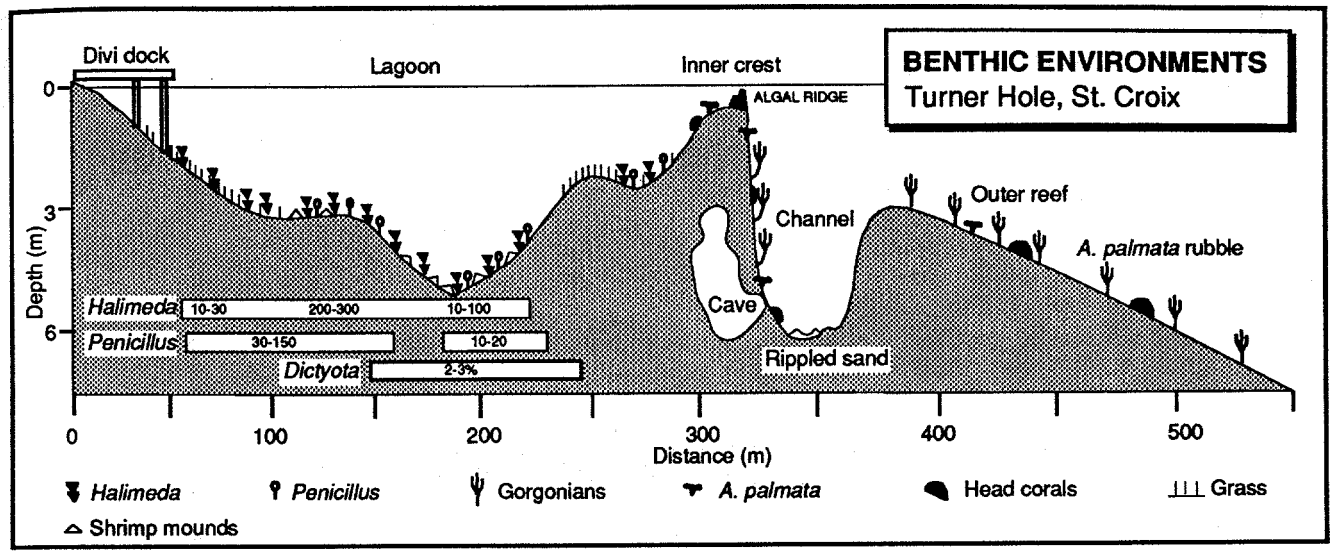

Figure 3. *Transect summarizing the inshore benthic environments of the Turner Hole complex. The profile is located in Figure 1.*

The site was chosen for several reasons. First, it is "typical" of the reef-lagoon systems found along the east end of the St. Croix. Second, the scale of the shelf makes this an excellent area to explain the processes and facies distributions of a carbonate coastal system in a setting where spatial relationships can be easily viewed. The varied environments that can be examined make this an excellent site for study by beginning students and advanced researchers alike.

DEPOSITIONAL ENVIRONMENTS

Lagoon

The lagoon is almost 1000 m long and approximately 300 m wide over most of its length (Fig. 1). The distribution of benthic cover is summarized in Figure 3. Most of the bottom is covered by the seagrasses *Thallassia testudinum* and *Syringodium filiforme* occuring in beds of varying density (Fig. 2b). *Halimeda, Penicillus* and various species of turf-like algae are also locally abundant within the grassbeds. In the deeper portions of the lagoon, areas of open sand or thin grass cover are dominated by 10- to 20-cm high mounds formed by *Callianassa* sp. (Fig. 2c). As these shrimp process sediment to obtain food, coarser sand and gravel are sequestered in chambers beneath the sediment surface; finer sand and mud are pumped up through an intricate tunnel system and are deposited in conical mounds. This process is important as a mechanism of sediment transport in lagoonal and open-shelf environments around the island (Hubbard *et al.,* 1981; Roberts *et al.,* 1982; Roberts, this volume).

Lagoonal sediments are medium to fme sand (1.5-3.0 phi; 0.13-0.35 mm). The finest sediments occur in the central portion of the lagoon (Fig. 4). Sorting is generally moderate (ca. 0.75 phi), and is poorest just off the beach and in the backreef. Dominant sedimentary constituents include coral, coralline algae, *Halimeda* and mollusc fragments. Coral dominates throughout, with the exception of *Halimeda* in the mid-lagoon region. The localized importance of *Halimeda* closely mimics the live distribution of this important alga in the bay (Fig. 3). Terrigenous sediment is generally confined close to shore.

Figure 2. *(Facing page) Photographs from the Turner Hole area.* ***A****. Aerial photograph of the reef and lagoon (transect in black. View is toward the east.* ***B****. Grassbeds within the lagoon.* ***C.*** *Mounds produced by the burrowing shrimp Calianassa sp.* ***D****. Underwater photograph of the backreef.* ***E****. Photograph of a cave wall showing in-place A.* palmata. ***F.*** *Large, coarse-grained ripples in the channel fronting the eastern reef.* ***G****. Rubble-dominated forereef pavement comprised of broken and cemented branches of A.* palmata.

Reef

The reef actually consists of two shore-parallel bathers (Figs. 1, 2a, 3). According to Adey (1975), these Holocene features reach 15-18 m in thickness (Fig. 5). The backreef is dominated by exposed pavement which separates widely scattered corals (Fig. 2d). The more important corals include *Porites astreoides, Montastrea annularis, Diploria* sp., and *Siderastrea sp.* Other benthic components include widely scattered (and usually dead) colonies of *Acropora palmata, Agaricia sp.,* the hydrozoan *Millepora,* and various zoanthids. Sediment cover is thin and confined to small pockets within the reef surface. Broken and cemented coral fragments are an important part of the pavement fabric.

The crest of the inner ridge is dominated by *Millepora* and ridges of *Lithophyllum congestum* and *Porolithon*

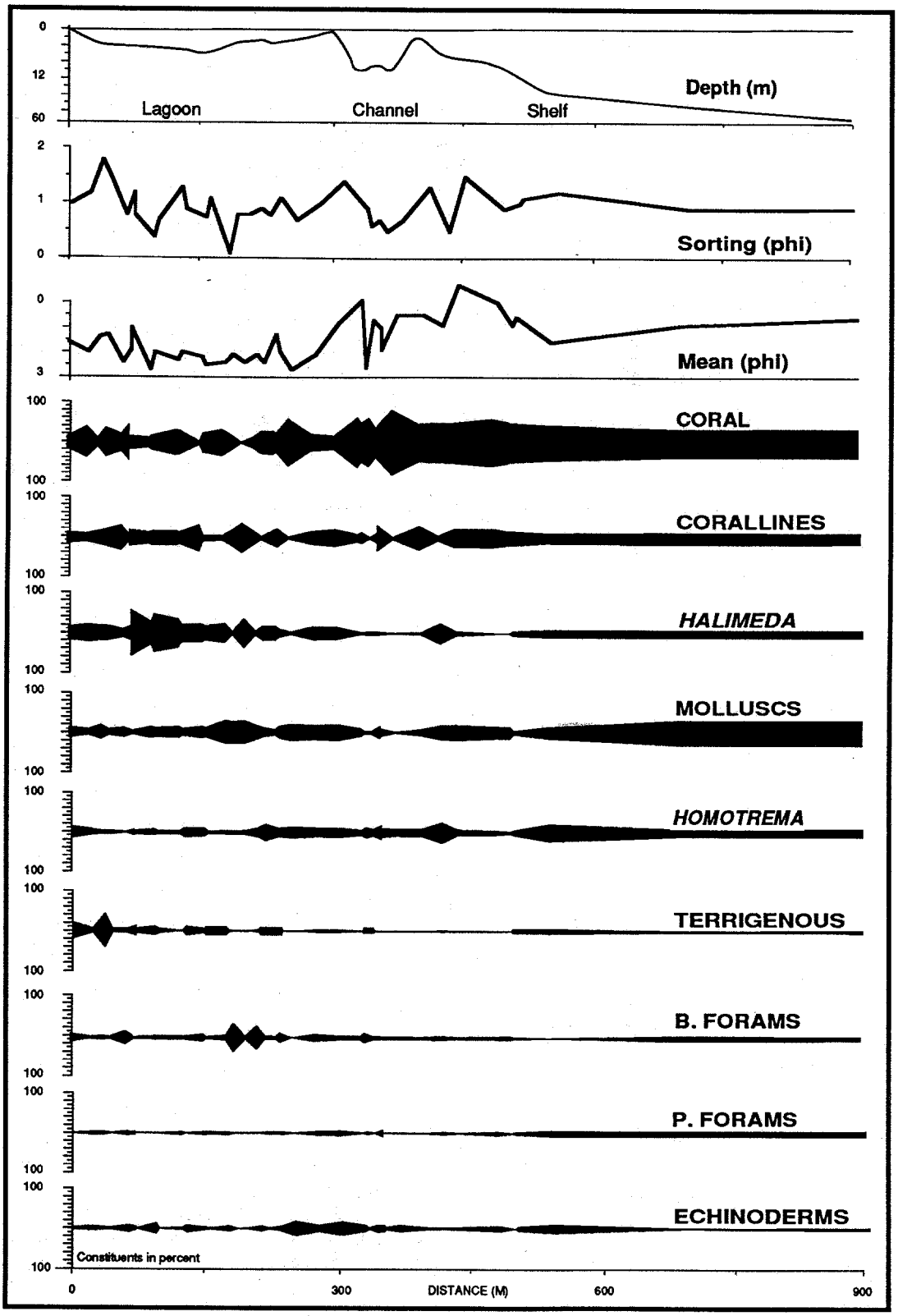

Figure 4. *Sedimentary constituents along the inshore Turner Hole transect. See Figure 1 for location. Constituent data in this figure are derived from thin sections point-counted by WIL geology students over the past decade. Size and sorting are derived from their sieve analyses.*

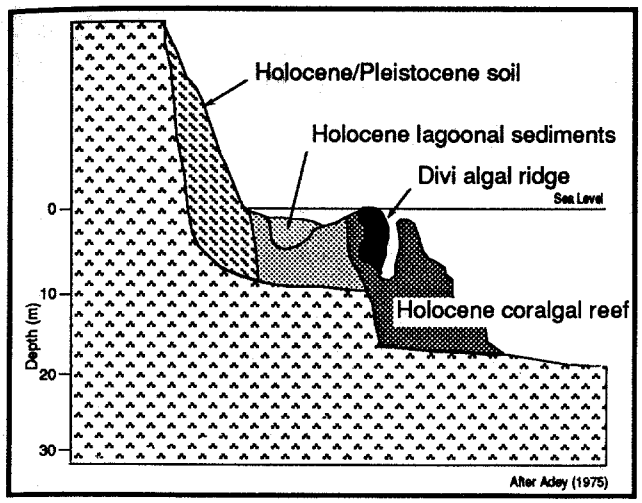

***Figure 5**. Cross-section through the Turner Hole reef--lagoon complex. After Adey (1975).*

pachydermum, typical of high-energy Caribbean reefs. Scattered colonies of A. *palmata* occur just behind. Coralline algae encrust much of the exposed pavement and constitute an important part of the accreting reef fabric. Along the near-vertical reef face, *Millepora, Diploria* sp. and occasional colonies of A. *palmata* occur. Most of the reef front is comprised of coralline algae that has overgrown broken and toppled branching and head corals. At the base of the reef there are numerous caves formed as intervening channels and broken blocks have beenovergrown by corallines. One of these caves extends uninterrupted for at least 50 m parallel to the present reef front. Along the inner cave walls, in-place branches of A. *palmata* remain, overgrown by coralline crusts (Fig. 2e).

The inner and outer reefs are separated by a narrow sand and gravel-filled channel. The bottom is often covered by large, coarse-grained ripples (Fig. 2f) a response to active waves that frequent the area.

Coral cover on the seaward reef mound is sparse. Ubiquitous fragments of broken *A. palmata* (Fig. 2g) are all that remain of a once-thriving stand of branching corals that were destroyed in 1979 by Hurricanes David and Frederic (Rogers et al., 1982). The toppled branches are held in place by submarine cements and overgrowths of coralline algae. Scattered colonies of both branching and head corals have started the process of recolonization, but the present-day forereef community is dominated by gorgonians and soft algae (primarily *Padina* and *Udotea).*

The Offshore Shelf

Seaward of the barrier reef, a broad shelf extends nearly 5 km to the south. Along most of this distance, water depths average 20-25 m (Fig. 6). Sediment cover is generally thin (less than 0.3 m), but reaches thicknesses of 1 m in a channel that drains sediment derived from Lang Bank to the east (the South Shore Sand Body of Hubbard et al., 1981; see Fig. 7). Sediments are generally moderately or poorly sorted, medium-coarse sand (Fig. 7).

Near the shelf break, a persistent shelf-edge reef occurs in water depths of 25-50 m. A sediment-filled "moat" of varying width generally separates this feature from the upper shelf (see Fig. 11 in the Modern Carbonate Environments paper that introduces this section of the guidebook). Coral cover on this reef rarely exceeds 10%, and is dominated by *Montastrea annularis, Agaricia* sp. and several other deeper-water coral species, along with various sponges and soft corals. Much of this deeper reef is a cemented pavement that is either exposed or covered by only a thin veneer of sediment. Weakly oriented channels cut downslope across most of this feature. At some locations, well-defined and meandering channels have been observed at depths of approximately 40 m.

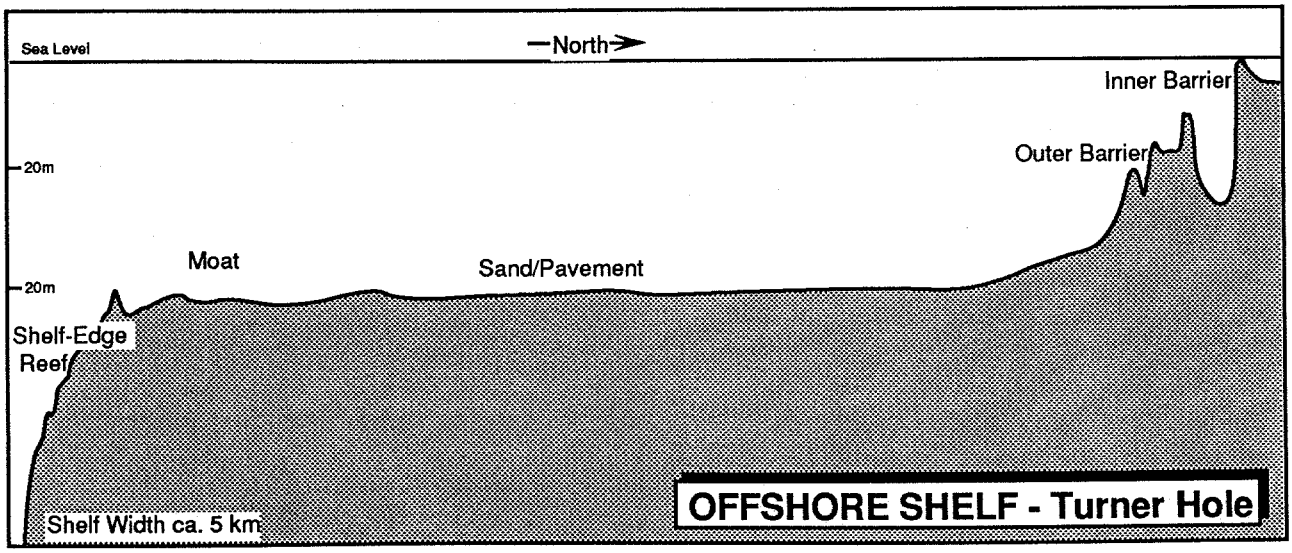

***Figure 6.** Bathymetric profile across the southeastern shelf of St. Croix. The profile is located on Figure 1.*

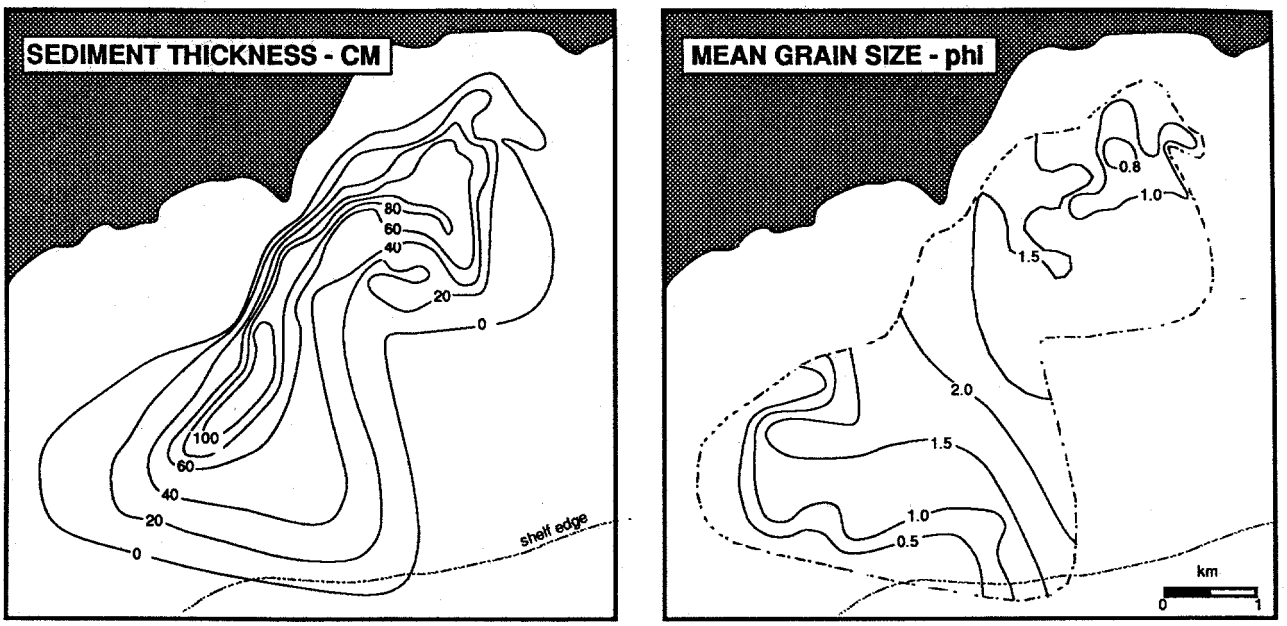

Figure 7. *Sediment distribution in the South Shore Sand Body off Turner Hole. After Hubbard* et al. *(1981).*

WHERE TO GO

Easy access is afforded to the beach from the Divi Hotel (arrangements should be made ahead of time, especially if you plan to use SCUBA). Swimming straight out from the dock will place you on the transect shown in Figure 3. It is an easy swim to the backreef. On calm days, it is possible to swim through a very narrow cut in the reef crest (see Figure 1 for details on the location of this cut). Otherwise, it is necessary to exit the lagoon through the broad channel that separates the two reefs. This requires a very long swim, and a boat is recommended. A small fishermen's launch is maintained about 0.5 km east of the Divi Hotel and can be used for boat access to the bay. The caves should be avoided unless you have prior experience in cave diving and bring proper safety lines to guide you back to the entrance.

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