

Influence of Water Depth and Hydrodynamics on Habitat and Facies Distribution in a Tropical, Mixed Carbonate-Siliciclastic Lagoon, Little Laughlands, Jamaica

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Abstract

Lagoons along the northern coast of Jamaica are in many aspects similar to “classical”, windward carbonate-producing lagoons of the Bahamas but are unique in their riverine input of older carbonate and non-carbonate particles derived from the island interior. In this study, we focus on the Little Laughlands Bay (~600 ha), a shallow (<3 m) lagoon behind red algae- and coral-dominated barrier reef with one major perennial and one smaller ephemeral freshwater inflows. In addition to evaluating the influence of water depth and hydrodynamics on habitat and facies diversity, the auxiliary goals of the study were to assess the bulk sediment stable isotope values, and test the applicability of high-resolution drone imagery in construction of habitat and facies maps in tropical shallow-marine, mixed carbonate-siliciclastic settings. Bulk sediment samples (n=39) were collected along 11 shoreline-to-reef transects and analyzed (granulometry, petrography, X-ray diffraction, and stable-isotope analysis). An unmanned aerial vehicle was deployed in order to obtain a high-resolution photomosaic (altitude 100 m, 503 images) of the study area. Eight distinct lagoon-floor habitats were identified, including river wash, mangrove mud, turfgrass sandy mud, seagrass meadow, sparse seagrass with sand patches, skeletal sandy shoal, non-skeletal sandy shoal, and reef flat. The coarsest (very fine gravel) and best (well) sorted grains are extraclasts that make up the bulk of the river wash habitat. The reef flat, although the highest-energy habitat, is made up of poorly to moderately sorted fine to very coarse

sand (and coarse coral rubble) particles, predominantly red algae, corals, and intraclasts. The finest, poorly to moderately sorted sediment (very fine to fine sand) makes up the mangrove mud habitat. The central part of the lagoon is the least affected by the riverine sediment input and evinces clear arrangement of habitats by water depth and/or hydrodynamic regime; this arrangement gets blurred towards freshwater inflows where several habitats occur at similar depths, suggestive of facies mosaics. In terms of carbonate polymorphs, low-Mg calcite predominates in river washes, and its abundance gradually decreases reefwards. High-Mg calcite and aragonite predominate in reef flat, seagrass meadow, sparse seagrass with sand patches, and sandy skeletal shoal habitats. Stable isotopic composition of bulk sediment samples is reflective of the influence of diagenetically-modified older limestones from the island interior. Both carbon- and oxygen-isotope values gradually increase towards the reef crest where they reach values comparable with the lower ranges of values from similar modern settings. The results emphasize the importance of marine and freshwater hydrodynamics in governing the habitat distribution in the shallow, mixed carbonate-siliciclastic shallow photic zone.