Capítulo 98

Sedimentological Analysis Of Camocim Beach Zone, Ceará

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ABSTRACT

The beaches represent dynamic environments and exchange of energy and matter between the continent and the ocean. The transport of sediments is constant and the features are constituted by unconsolidated materials, being characterized by maintaining fragile structures for the processes of human occupation. From granulometric analyzes performed according to preestablished protocols, it was possible to define the granulometric and chemical composition of the sands of the Barriers Beach and Lighthouse, in the city of Camocim, west coast of the State of Ceará. In the beach zone, subdivided into backshore, foreshore and nearshore, there are lithoctic sands, litobioclastic sands and bioclastic rocks, containing high concentrations of calcium carbonate from organic agents (shells, corals, algae etc.) and inorganic (from the ocean or continents), as well as the erosion of beach rocks.

Keywords: Sedimentological analysis, strip of beach, beach rocks.

1 INTRODUCTION

The beaches are dynamic environments with intense interaction between continental and oceanic agents, usually formed by sandy sediments, which, because they have high mobility, are constantly worked by waves and tides (Costa et al., 2020; Muehe, 1995). Could be classified into two extreme states (reflective and dissipative) and an intermediate, according to the beach morpho dynamics (Muehe, 2001). This environment is subject to a set of dynamic actions, both marine and atmospheric. Suguio (1998) states that it is a perimeter zone of an aqueous body, composed of unconsolidated material, usually sandy or more rarely composed of gravel Abstract

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occupation. From granulometric analyzes performed according to preestablished protocols, it was possible to define the granulometric and chemical composition of the sands of the Barriers Beach and Lighthouse, in the city of Camocim, west coast of the State of Ceará. In the beach zone, subdivided into backshore, foreshore and nearshore, there are litotic sands, lit bioclastic sands and bioclastic rocks, containing high concentrations of calcium carbonate from organic agents (shells, corals, algae etc.) and inorganic (from the ocean or continents), as well as the erosion of beach rocks.

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This research presents a study on the constituent material of the beach area of Camocim, based on the results obtained at the Geological Oceanography Laboratory of the Federal University of Ceará (LOG - LABOMAR/ UFC) and analyzed by the Granulometric Analysis System (SAG) of the Laboratory of Marine Geology of the Fluminense Federal University (Lagemar Uff. The perspective is to classify and characterize the sediments present in this environment, with the objective of providing information about the natural dynamics present there, which can be used to assist the environmental planning of this coastal sector. The area in question will be between Praia das Barreiras (of estuarine characteristics) and Praia do Farol (of oceanic characteristics) (Figure 01).

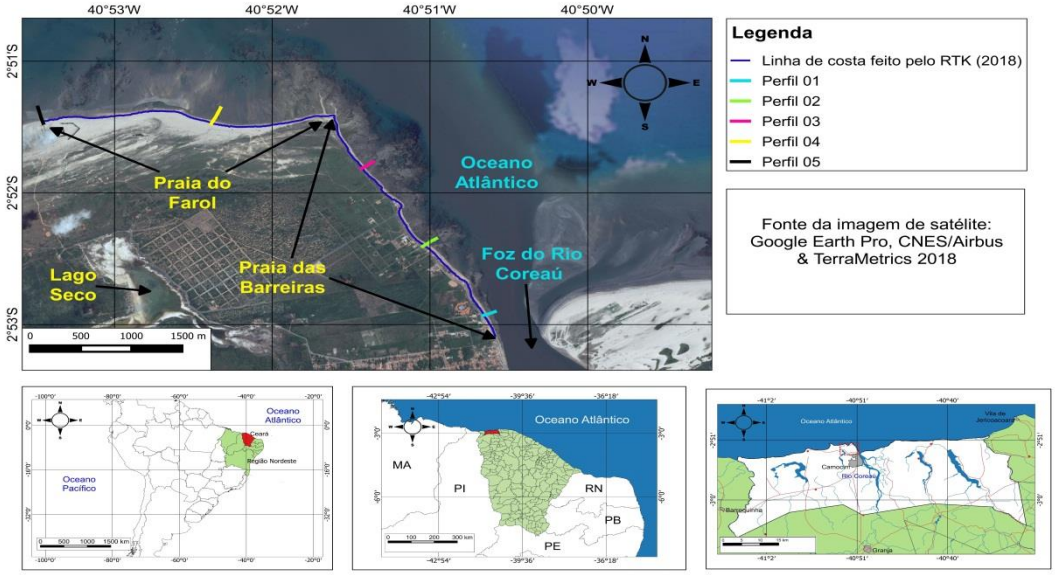


Figure 01: Map of the location of the research area on a national, regional, and local scale. Prepared by the author.

Barreiras Beach has a cliff consisting of rocks of the Indiviso Barriers Formation (sandy clay sands and conglomermatic sandstones) at the top and by the Camocim Formation (coarse orthoconglomerate) in the basal part (Costa *et al*., 1973; Morais *et al*. 2006; Ximenes Neto, 2018) (Figure 02a). The beach strip is narrow, with widths of less than 20 meters in the post-beach area. It is an "urbanized" beach because of its proximity to the urban perimeter. Praia do Farol (Figure 02b) is located in an area of mobile and fixed dune fields, with a more extensive and flat beach strip.

Figure 02a: Left - Cliffs at Praia das Barreiras in Camocim - CE. Scale height (researcher): 1.81m (Marques, 2018).
Figure 02b: Right - Profile 05 at Praia do Farol in Camocim - CE (Marques, 2018).

2 DISCUSSION

3 CHARACTERIZATION OF THE BEACH AREA

According to Queiroz (2014), the beach strip is composed of quartz sands, deposited by the action of the sea. The source of the sediments comes from the continent and the ocean transported by rivers and waves. According to the CPRM classification (2003 and 2010), the beaches in Camocim present unconsolidated sandy materials of variable particle size and with concentrations of heavy minerals in the syphilinous lateritic materials of the Camocim Formation (Morais *et al*., 2006).

The beaches in the State of Ceará have varied widths. Smith and Morais (1984) state that there is a variation of around 1,000 meters, between the low - sea and preamar. Elsewhere, the beach strip is narrow, ranging from 10 to 20 meters. In Camocim, the beaches have on average a width of 145 m.

In general, the beaches in Camocim are characterized by being dissipative (Queiroz, 2014), where the surf zone is wide, with low topographic gradient and high sand stock, being also low the gradient in the beach strip. However, the waves do not maintain high height and there is the presence of sand with fine granulometry. Silva *et al*. (2004) state that generally dissipative beaches are composed of fine sands, presenting large stock of sand in the submerged part.

In Ceará, the beaches suffer the action of the agents of coastal dynamics, which are characterized by the occurrence of marked coastal drift, of east-west dominant direction, by the existence of waves with a maximum height of the order of 1.1 m, by mesotidal tides, with an average amplitude of the order of 2.7 m (Pinheiro *et al*., 2016). They maintain low slope, usually less than 5º (Claudino-Sales et al, 2018).

The stretch area in Camocim presents the formation of *beach rocks, in* which according to Morais *et al*. (2006) it is in recent age (holocene), but "these are sediments of old beaches consolidated by calcium carbonate (CaCO3), supplied by seawater" (MARINO *et al*., 2012, p. 84). Between low and high tide levels, beach rocks surface, in which they have recent diagenesis. According to Malta *et al*. (2017) the *term beach rocks* represents litificated materials in the coastal zone, cemented by silica and calcium carbonate. They

are common at high temperatures, characterized by evaporation of seawater. In Camocim these rocky deposits are classified as sandstone reefs (Claudino-Sales, 2018).

They represent stages of coastal evolution in which, after its formation on the active beach, there would have been a relative retreat of the coastline, being restricted, in general, in the intertidal zones (Mabesoone 1968; Suguio, 2010). They are important geological features for the protection of the coastline.

Muehe (2001) comments that coastal lines such as Camocim where there is the presence of sandy beaches and sedimentary cliffs are susceptible to erosion due to a possible rise in sea level. This adjustment will depend, in this case, on the geomorphological and petrographic characteristics.

If there is sediment loss (sediment volume) that feeds the coastal sector, the shoreline tends to recede, thus configuring the process of erosion, sedimentological changes and the formation of *beach rocks*. If this supply is maintained, stabilization occurs. If there is an increase in the volume of sand in the area, the coastline advances towards the sea (progradation).

4 METHODOLOGIES

In April 2018, data and samples were collected in the area that extends from Praia das Barreiras to Praia do Farol, in Camocim, west coast of the State of Ceará, according to a network of points distributed longitudinally to the beach strip for an extension of 6 km. The equipment used for this survey were GPS and RTK (*Real Time Kinematic*), trimble *brand*. RTK consists of an instrument that provides the delimitation of some points or structures from the cataloguing of the positional data of a real-time GPS in full field exercise. The fieldwork had the participation of researchers from the Institute of Marine Sciences - LABOMAR, federal university of Ceará (UFC).

Topographic profiles of different natural conditions were performed, three of them across the beach strip on the east coast (Praia das Barreiras) and two others on the west coast (Praia do Farol). In all, there are six profiles where sediment collections occurred (five in the beach strip and one at the mouth of the river). Three samples of each profile were collected in the post-beach, stretch and ante-beach zones.

The samples were treated later, in the premises of the Marine Geology Laboratory (LOG) of the Institute of Marine Sciences (LABOMAR - UFC). The samples were washed, washed, weighed and sent to measure the percentage of calcium carbonate in the 0.5 g section of the samples, repeating twice for each sample. The procedure consisted of the application of the modified Bernard calmeter method, in which the samples are attacked with hydrochloric acid (HCL), diluted to 10 % in a system of communicating vessels. 2 g were allocated to obtain the percentage of organic matter, glued in cups and destined for the calcination process in a chamber called muffle (high temperature kiln).

The granulometric analysis was performed in two stages. The first corresponds to dry sieving in the mechanical agitator "ROTAP SIEVE-SHAKER" for a time interval of ten minutes in order to classify according to the granulometric scale of WENTWORTH (1922, *apud* SUGUIO, 1973), and the second to

the submission of data in the Granulometric Analysis System (SAG) of the Laboratory of Marine Geology of the Fluminense Federal University (UFF), for the classification of materials collected in the field.

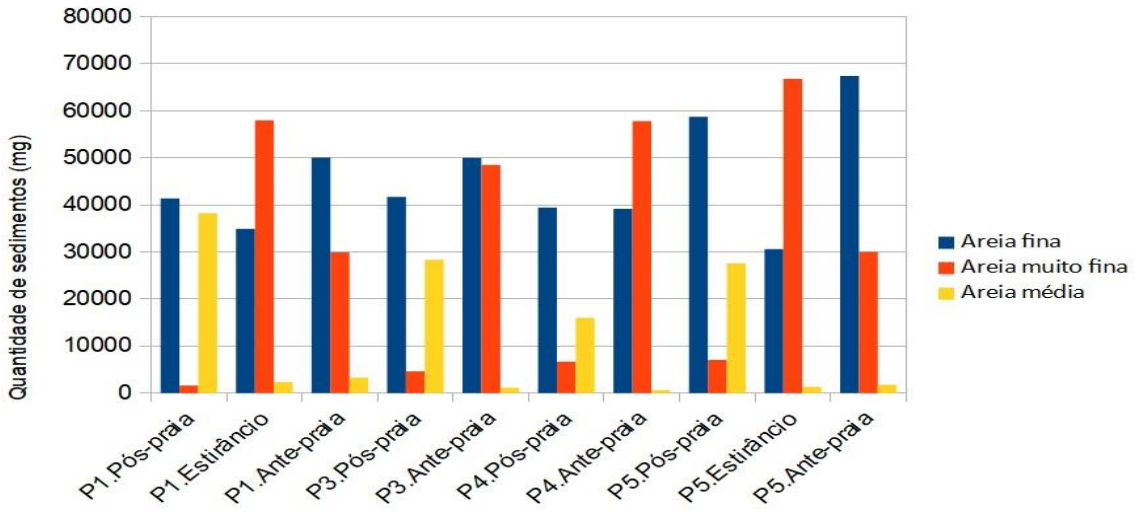
5 FINDINGS

Table 01 shows the laboratory results of the percentage variation in the amount of CaCO3 and organic matter (M.O), thus classifying the sediments presented in the samples collected in the field.

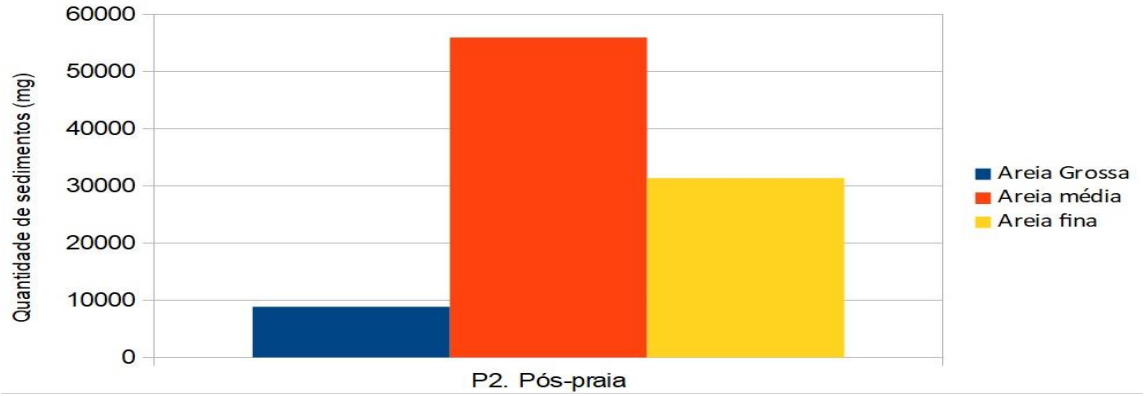
Samples	ΔCaCO3 (%)	ΔMO (%)	Classification
Profile 01 (all profile)	21.22 to 40.71	0,19	Fine to very fine lithoclastic sand
Profile 02 (Post-beach and stretch)	14.09 to 32.7	0.99 to 1.09	Medium , thick and very thick lithoclastic sand
Profile 02 (Ante-beach)			Lithobioclastic sand with granules
Profile 03 (Post-beach and ante-beach)	29.23 to 86.64	3.99 to 4,00	Fine to very fine lithoclastic sand
Profile 03 (Stretch)			Biochloric gravel
Profile 04 (Post-beach and ante-beach)	20.18 to 37,92	1.69 to 2.59	Fine to very fine lithoclastic sand
Profile 04 (Styrecio)			Fine to very fine lithobioclastic sand
Profile 05 (Post-beach and stretch)	8, 87 a 10,43	0.4 to 1,04	Thick to very thick lithoclastic sand
Profile 05 (Ante-beach)			Lithoclastic sand with granule
River canal	13,74	0,69	Lithoclastic sand with granule
Upper channel	19,13	0,75	Fine to very fine lithoclastic sand

Table 01: Measurement of the amount of calcium carbonate and organic matter (M.O) in the profiles of the beach area in Camocim in April 2018.

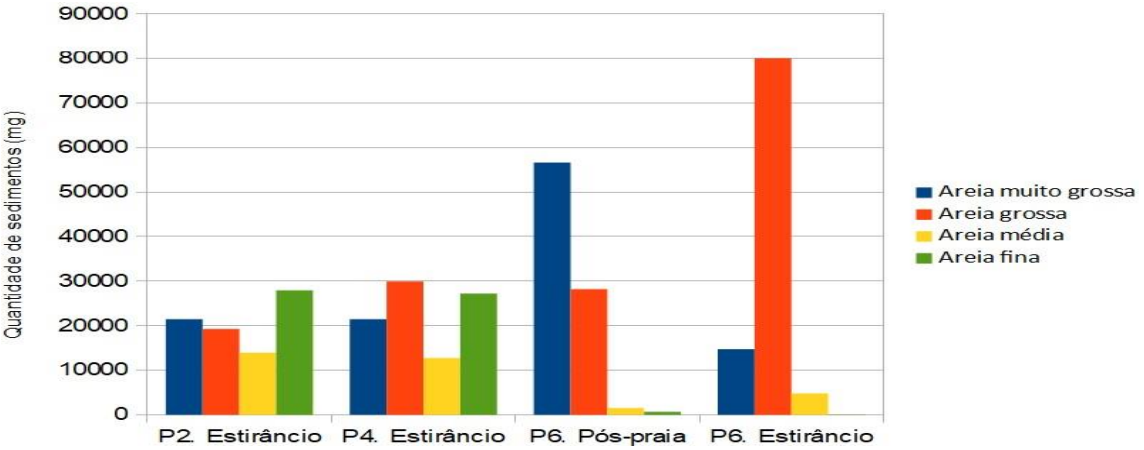
According to the results obtained by the SAG-UFF system, the lithoclastic sands (Graphs 01, 02 and 03) are defined by a granulometry ranging from medium to coarse sand, with moderately to weakly selected grains, ranging from subanguloso to rounded. Fine to very fine lithobioclastic sands (Graph 01) are well selected, while lithobioclastic sands with granules (Graph 04) are composed of very thick sands, poorly selected. The bioclastic gravels (Graph 05) are formed by poorly selected, angled, rounded and spherical grains.



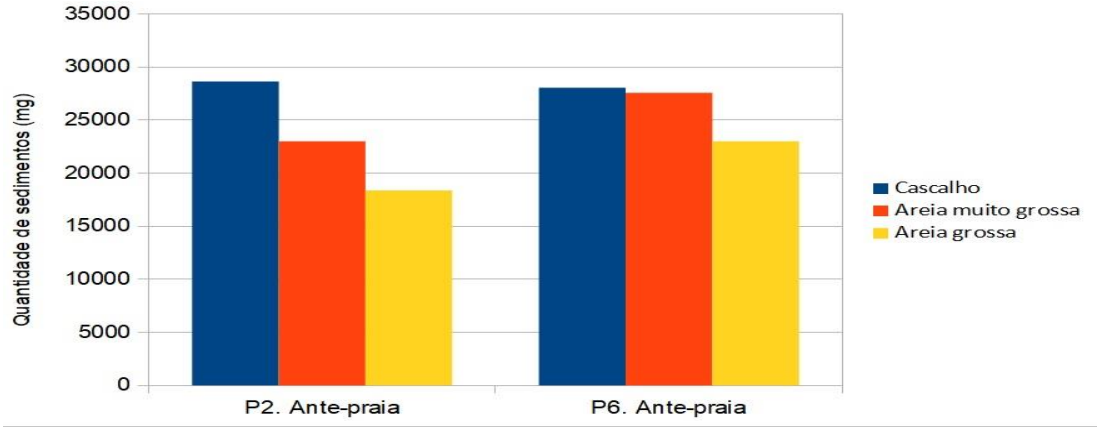
Graph 01: Amount of medium, fine and very fine sand in the lithoclastic and lithobioclastic sands fine to very thin.



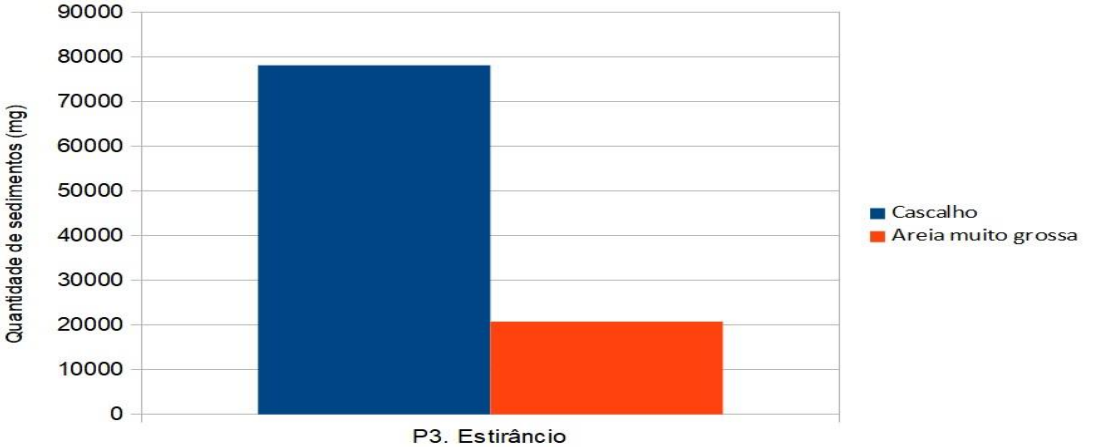
Graph 02: Amount of coarse, medium and fine sand in the medium lithoclastic sands .



Graph 03: Amount of very thick, thick, medium and fine sands in thick to very thick lithoclastic sands.



Graph 04: Amount of gravel, very thick and coarse sand in the lithoclastic and lithobioclastic sands with granules.



Graph 05: Amount of gravel and very coarse sand in the bioclastic gravels.

It is noticed that profile 01 is composed of thin to very fine lithoclastic and lithobioclastic sands, in which they may be related to the dune sands, which happened to be deposited in the main channel of the Coreaú River and were transported to the mouth, presenting a low variation in organic matter. The rocks of the Camocim Formation in the post-beach and *the beach rocks* in the stretch play the function of trapping these sediments, thus causing a silting process at the mouth of the river.

In Praia das Barreiras, the lowest concentrations of organic matter are located in profile 01, presenting 0.19% in the three areas of the beach strip. This result may be related to the fact that this profile is located in an area where there is a constant dynamism between the river and the sea, thus promoting instability in its deposition.

Regarding the results on calcium carbonate variation, it is possible to observe high concentrations of CaCO3 in profile 03, in the stretch and ante-beach areas (89.64 and 29.23, respectively), thus presenting the greatest variation in organic matter and calcium carbonate. This high concentration can be explained by the massive presence *of beach rocks*, in which it presents biochlorástico gravels in the stretch.

With this, we can also verify that in this profile there is a high concentration of organic matter with shells, algae and oysters from the sea, in addition to branches, leaves and seeds of the estuary, presenting high levels in the post-beach and stretch zones (3.99 and 4.0. respectively) and in moderate terms in the ante-beach (1.94). This shows a correlation between calcium carbonate levels and organic matter.

It is also worth mentioning the concentrations of calcium carbonate in profile 01 in the stretch and beach front area, probably due to the same motifs raised in profile 03 with the presence of lithobioclastic sands. In addition, profile 02 (ante-beach) and 04 (in the post beach and stretch areas) also showed significant concentrations of CaCO3 and organic matter, in which the reason may be related to the presence of algae and organic matter from the estuary on the beach rocks.

Profile 04 also stands out for the moderate concentration of organic matter in the stretch and ante-beach zones (1.69 and 2.59, respectively), thus corresponding with the results regarding the amount of CaCO3. On the other hand, in profile 05 there is a low concentration and variation of calcium carbonate.

Being close to Ponta do Trapiá in Praia do Farol, profile 04 presents a higher concentration of organic matter compared to profile 05. On the other hand, the decrease in organic matter from the post-beach to the ante-beach in the two profiles apparently attests to a more intense maritime abrasion, besides representing a more offensive anthropic intervention, such as the constant flow of vehicles, beach tents and sand extraction.

6 CONCLUSIONS

The importance of sedimentological characterization of beaches is not limited only to the quantification of percentage data of calcium carbonate and organic matter. This study becomes essential for a better understanding of geo environmental conditions and their various natural dynamism. Thus, it is necessary that this diagnosis is periodically performed in order to observe the behavior of this natural

system. Factors such as rainfall irregularities and dam constructions in intermittent rivers cause sedimentary deficit to the beaches, influencing physical and chemical changes in sediments deposited in this environment. These changes cause physiographic changes in the profile, modifying the morpho dynamic and hydrodynamic patterns of the coastal zone, thus encouraging an accelerated process of erosion of the shoreline. It is necessary to formulate public policies that can organize the processes of use and occupation of the coastal zone and its surroundings, in order to seek a natural balance in the face of an eminent urban growth.

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