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Textural Characteristics of Coastal Sediments between Gosthani and Champavathi River Confluence, East Coast of India

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Abstract

The studies on textural characteristics are valuable information to understand the source for the evolution of coastal sand environments. A total of seventy one sediment samples from twenty traverses of costal sediments in between Gosthani River mouth in south and Champavathi River in the north confluence (Lat.17°52'-18°.02' N; Long.83°26'-83°36'E) has been carried out. The coastal sediments are medium to fine grained (1.68 – 2.80Ø), very well sorted to moderately well sorted (0.26Ø – 0.67Ø), strongly coarse to fine skewed (-0.63to 0.31Ø) and pltykurtic to leptokurtic (0.74Ø – 1.27Ø) in nature and deposited in moderate to high energy environment conditions with dominate rolling, bottom and graded suspension mechanisms. The observations are supported by the frequency distribution curves, CM plots and scatter plots between parameters conforming the bimodal nature to dominant fine sand in different microenvironments (dune, backshore, berm, and foreshore). These textural parameters have been further examined to understand the hydrodynamic conditions of the depositional environments.

Keywords: *Textural parameters, coastal sediments, Dune, Backshore, Berm, Foreshore*

1. Introduction

The 20 km study area (83°26'- 83°36'E longitudes and 17°52'-18°.02' N latitudes) extends from the Gosthaniriver in the south to the Champavathi river in the north. The area has different geological and geomorphic features generated by the rivers, small creeks, altered coastal trends, and dynamics seasonal winds. The ephemeral Gosthani and Champavathi rivers originated in Ananthagiri hill (1275m) ranges of Eastern Ghats constitute the drainage system. These rivers carry huge amount of sediments and debouncing in to the Bay of Bengal at Bhimunipatnam and Konada respectively in the the study area. The present study deals with the textural characteristics of coastal sands between Gosthani River and Champavathi rivers confluence in order to understand sediment depositional environments and the depositional patterns of the sediments in the study area. The grain size characteristics of the sediments in the coastal areas are influenced of by various transporting and depositional agents such as rivers, rivulets, streams, waves and currents, sea level oscillations, shoreline configuration, winds, etc. and the distance from the shoreline, distance from the source material, nature of the source material and topography of the area. Earlier many attempts have been made by several sedimentologists (Udden, 1914; Mason and Folk, 1958; Friedman, 1961, 1967; Sahu, 1964; Veerayya and Varadachari, 1975; RamamohanRaoet.al., 1982; JagannadhaRao and Krishna Rao, 1984; DhanunjayaRao et al., 1989; Frihy et al., 2005; Hanamgoda, and Chavidi, 1997; Mohan and Rajamanickam, 1998; PrabhakaraRao et al., 2000; NageswaraRao et al., 2005; Rajesh et al., 2007; Ergineet.al., 2007; Ramanathan et ai., 2009; Rajasekhara Reddy et al., 2011; Ganesh et al., 2013; KarunaKarudu et al., 2013) to differentiate the sediments of various environments such as fluvial, fluviatile, estuarine and other coastal environments. The present study is based on such interpretations to improvise the understanding of the depositional environments and depositional process of the sediments in the study area.

2. Materials and Methods

A total of seventy one surficial sediment samples were collected in microenvironments viz. foreshore, berm, backshore and dune along twenty traverses with an interval of 1 km (I, II, III…..XX from south to north) perpendicular to the coast. The sample stations are shown in Fig. 1. The textural parameters data was given in the Tables 1 and 2. About one kg of sample is collected by using a PVC pipe of 3 inches diameter and 40cm in length penetrated into the sediments layers to depth of 40cm, taking all possible care against contamination. The sediment samples are repeatedly washed with distilled water for removal of salts and then dried. After drying, a sub sample weighing about 100grams is obtained by

coning and quartering; to remove carbonate and organic matter samples were treated with 10% dilute HCl and 6% H_2O_2 respectively and then dried. These samples were subjected to sieving with ASTM test sieves of 8˝diameter, with successive sieves stoked at ½ Ø intervals for 10-20min. The grain size data obtained was used to determine the Mean size (Mz), Standard deviation (σ_I), Skewness (SK_I) and Kurtosis (K_G) based on method given by Folk and Ward (1957) and G-Stat software (Dinesh, 2009). Frequency curves scatter plots and CM diagrams were drawn and data was analyzed.

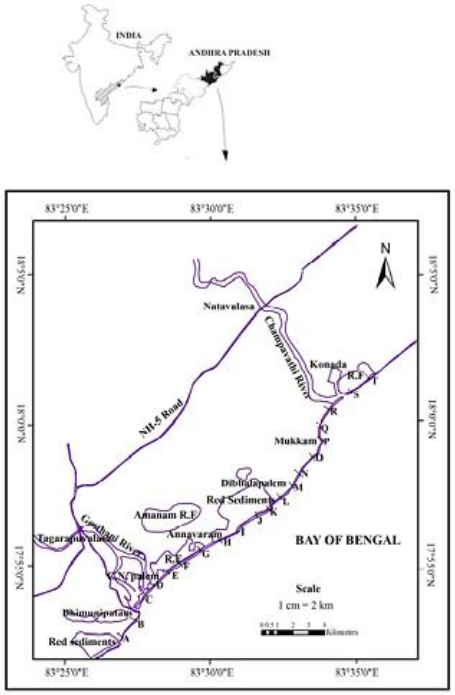

Figure 1 Sample location map of study area.

3. Results and Discussion

The detailed representation of these textural parameter in term of grain size analysis, and CM diagrams have been presented and data are analyzed.

Grain Size Analysis

Mean size (Mz)

The graphic mean size is the average size of the sediment represented by Ø mean size and it is an index of energy conditions. The average values show the dominance of fine sediments in all micro environments; the sediments of dune (1.78Ø -2.76Ø), backshore (1.69Ø -2.69Ø), berm (1.69Ø -2.61Ø) and foreshore (1.69Ø -2.69Ø) environments are in medium to fine size. It indicates the high energetic conditions of transportation in the coastal sediments (Folk and Ward (1957). The variations in Ø mean size is a reflection of the differential energy conditions of the depositing media and indicates average kinetic energy of depositing agent (Sahu, 1964).

Standard Deviation (σ_I)

The graphic standard deviation (σ_I) measures sorting of sediments and indicate the fluctuations in the energy conditions of depositional environment but it does not necessarily measure the degree to which the sediments have been mixed (Spencer, 1963). Standard deviation of the present samples range in between 0.26Ø-0.62Ø, with an average of 0.53Ø is within the range of well sorted. The sediments of dune, back shore, berm environments are moderately well sorted and fore shore sediments are well sorted nature. The Moderately well sorted nature can be attributed to partial winnowing action and addition of sediments in beach environment by aeolian process (RamamohanRao et.al., 1982; NarayanaRao et.al., 1991; Angusamyet.al., 2006; Rajesh et.al., 2007).

Skewness (SK_I)

The graphic skewness measures the symmetrical of the distribution, i.e. predominance of coarser or fine-sediments. The negative value denotes coarser material in coarser-tail i.e., coarse skewed, whereas, the positive value represents more fine material in the fine-tail i.e., fine skewed. Skewness value ranges in between -0.63 Ø and 0.31 Ø with an average of -0.07 Øpositive skewness of sediments indicates the deposition of the sediments in sheltered low energy, whereas negative skewness of sediments indicate deposition at high energy environments (Rajasekhara Reddy et.al., 2011). The negative skewness shown by majority of the samples of the study area indicates high energy nature of the beach deposits in general (Friedman, 1961) and multidirectional sediment transport(Martins 1965)

Kurtosis (K_G)

The graphic kurtosis is the peakedness of the distribution and measures the ratio between the sorting in the tails and central portion of the curve. The values of graphic kurtosis ranges from 0.74 Ø to 1.27 Ø, with an average of 0.94 Ø. The most of the samples are fall under mesokurtic nature. Friedman (1962) suggests that extreme high or low values of kurtosis imply that part of the sediments achieved its sorting elsewhere in a high energy environment. The variation of kurtosis values is reflection of the flow characteristics of the depositional medium (RamamohanRao et.al., 1982; Seralathan and Padmalal, 1994; Hanamgond et.al., 1998).

C M diagrams

The CM patterns of the sediments are useful for analyzing transportation mechanism, depositional environment with respect to size, range and energy level of transportation and also are the determining process and characteristic agent that are responsible for the formation of clastic sediments. The present study is an

attempt to identify the modes of transportation and deposition of sediments between Bhimunipatnam to Konada coast different microenvironments viz. dune, backshore, berm, foreshore sediments by CM patterns.

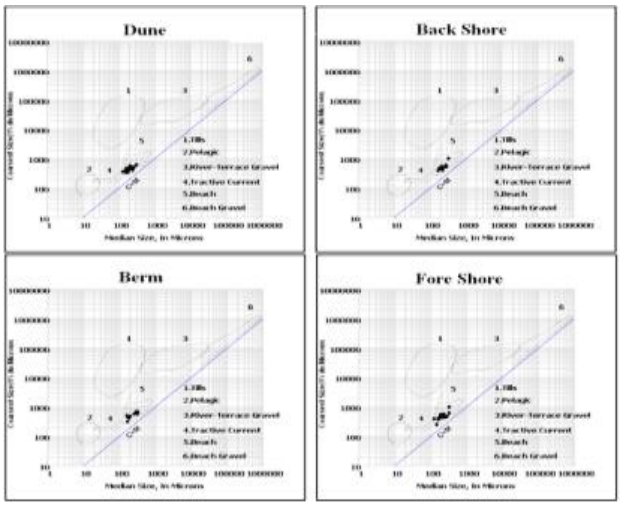

Figure 2 The basic CM pattern of coastal sediments between Gosthani and Champavathi river mouth

The present interpretation based on Passega (1957, 1964) interpreted the distinct pattern of CM plots in terms of different modes of transportation by plotting coarsest first percentile value of the sediments (C) is plotted against the median diameter (M) on a double logarithmic paper. Visher (1969) explained a log normal sub populations within the total grain size distribution curves as representing suspension, saltation and surface creep or rolling modes of transportation mechanisms. The relation between C and M is the effect of sorting by graded turbulence. The C-M plots (Figure 4A and 4B) shows that most of the samples formed by two different depositional conditions. The sediment samples of C-M plots (Fig. 4A) from dune, backshore, berm and foreshore fall in region of 4 and 5 which indicates high tractive and beach currents of deposition and most of the samples fall in the OP, PQ regions (Fig. 4B) which indicates that, part of the load is rolled sediments followed by bottom and graded suspension, representing their deposition through tractive currents. In general, this may be comparatively more percentage of medium to fine sand grained material (Rajasekhara Reddy et al., 2011; Bull, 1962; Passega and Byramjee, 1969).

Conclusions

The textural parameters of coastal sediments between Gosthani to Champavathi river confluence indicate medium to fine sand (1.68Ø – 2.80Ø), well sorted to moderately sorted (0.26Ø -0.67Ø), coarse skewed to fine skewed (-0.63Ø to 0.31 Ø), pltykurtic to leptokurtic (0.74 Ø -1.27 Ø) in nature.The wide variation of mean size indicates differential energy conditions at different locations. Whereas, the variation sorting values indicate continuous addition of finer to coarser material in varying proportion at different locations. Frequency distribution curves and scatter plots drawn between different textural parameters clearly establish that the sediments are bimodal and composed of mainly fine sand. The C-M plots indicate that the transportation is mainly in two different depositional conditions, viz. bottom and graded suspension for coastal sediments. This study the usefulness of selecting several stations for better understanding beach environment of deposition.

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