

Textural Analysis of Coastal Sands from Ramakrishna Beach - Bhimunipatnam tract (Visakhapatnam) East Coast of India

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ABSTRACT

This paper presents textural analyses; study of Particle-size distribution parameters, Mean size (M_z), Standard Deviation (σ), Skewness (Sk) and Kurtosis (K_G) pertaining to beach sands of Ramakrishna beach-Bhimunipatnam tract, East coast of Visakhapatnam, Andhra Pradesh. As part of this study, detailed textural characteristics of 23 representative samples from nine traverses of coastal sediments in different environments (Backshore, Foreshore, Dune, Berm) which lies between 17°46'-17°54' latitudes and 83°21'-83°27' longitudes have been carried out. By treating with sieves of different size, the samples for textural analyses have been divided into nine (18,25,35,45,60,80,120,170,230) fractions. Statistical studies indicate that the coastal sediment average values are mean size (0.55 to 2.34), Standard Deviation (0.42 to 0.99), Skewness (- 0.53 to .27) and Kurtosis (- 0.41 to 1.64). Scatter Plots are used to know the interrelation ship and geological significance of the size parameters. Frequency distribution curves and scatter plots drawn between different grain size parameters clearly establish that the nature of the sediments is dominantly unimodal of which, the dominant constituent is medium sand in various microenvironments i.e. backshore, foreshore, dune and Berm.

Key words: Textural analysis, Backshore, Foreshore, Dune, Berm, East Coast.

INTRODUCTION

Particle-size distributions (PSDs) are fundamental physical properties of soil and are typically presented as the percentage of the total dry weight of soil occupied by a given size fraction. This property is commonly used for soil classification and for the estimation of some hydraulic properties (Campbell and Shiozawa, 1992).

Grain size distribution is an important parameter that has been widely used by sedimentologists to elucidate transport dynamics. Sediment texture refers to the shape, size and three-dimensional arrangement of the particles that make up sediment. The grain size distribution is affected by the nature of source material, distance from the source and shoreline, topography and transport mechanisms and the mechanical processes involving prolonged action of the waves.

Hence, grain size analysis provides important on various sedimentological conditions (Mahadevan and Anjaneyulu, 1954; Folk and ward, 1957; Carver 1971; Friedman, 1961, 1967; Ramasastry and Myrland, 1959; Ramamohan Rao et al., 1982; Bull, 1962; Bhat et al., 2002; Jagannadha Rao and Krishna Rao, 1984; Jagannadha Rao, et al., 2013; Dhanunjaya Rao et al., 1989; Reddy and Malathi 2002; Mohan and Rajamanickam, 1998; Mohan, 2000; Nageswara Rao et al., 2005; Rajesh et al., 2007; Ergine et al., 2007; Ramanathan et al., 2009; Rajasekhara Reddy and Karunakarudu, 2011; Ganesh et al., 2013; Karunakarudu et al., 2013). Further, the study

of grain size characteristics are valuable to understand the source for the evolution of coastal sand environments. Role of transporting and depositional agents such as rivers, rivulets, streams, waves and currents, sea level oscillations, shoreline configuration, winds, etc. and aspects like the distance from the shoreline, distance from the source material, nature of the source material and topography of the area influence the grain size characters (Bangaku Naidu et al., 2016). Earlier, many attempts have been made by several sedimentologists (Udden, 1914; Mason and Folk, 1958; Friedman, 1961, 1967)

Sahu, 1964; Veerayya and Varadachari, 1975; Ramamohan Rao et al., 1982; Jagannadha Rao and Krishna Rao, 1984; Dhanunjaya Rao et al., 1989; Frihy et al., 1995,2002; Hanamgond and Chavidi, 1997; Mohan and Rajamanickam, 1998; Reddy and Malathi 2002; Nageswara Rao et al., 2005; Rajasekhara Reddy and Karunakarudu, 2009; Jagannadha Rao et al., 2016; examined variations in grain size characteristics of different beach environments in east coast and established the relationships between slope angle and mean grain size, for Pudimadaka and Pentakota beaches and concluded that the slope angle increases with increase in grain size. Grain size data was used to understand the micro level variations in the depositional environments along the north of Pondicherry and Ennore coasts by Mohan and Rajamanickam (1998) who concluded that the dune samples represent unimodal and others show bimodal to polymodal source of influence. Mohan, (2000) studied the Quaternary land forms to evaluate the variation

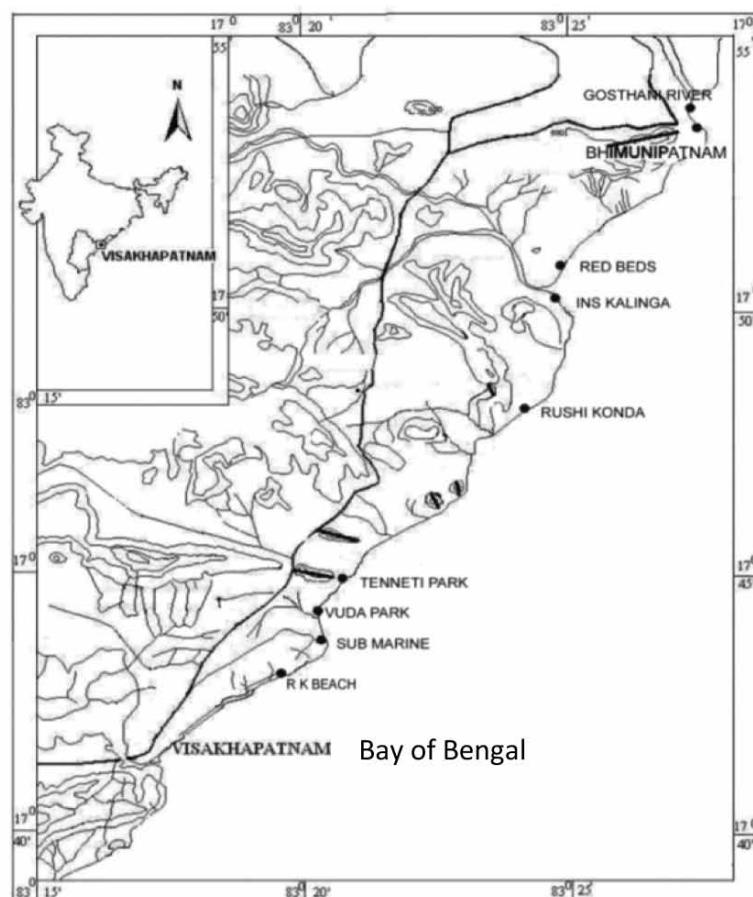


Figure 1. Sample locations of the study area Ramakrishna beach (R.K. Beach) to Bhimuniapatnam.

in the distribution of grain size and depositional processes along the coastal sub-environments, along the coast between Vedaranyam and Rameshwaram, Tamil Nadu.

Mahadevan and Anjaneyulu (1954); Mahadevan and Nageswara Rao (1950) compared the grain size distribution between the beach and sand dredged sands from the entrance of the harbor channel of Visakhapatnam, east coast of Andhra Pradesh. Perhaps this was the first report of the beach sands granulometry from the Indian subcontinent. Later, Sastry et al., (1979) examined configuration changes and variation in grain size parameters to understand the erosional and depositional processes along Visakhapatnam Bhimuniapatnam coast and noticed accretion from January to August and erosion during September and December. Chandramohan et al., (1981) studied the erosional and depositional environments at Visakhapatnam beach and observed erosion during South west monsoon and deposition during North East monsoon (calm weather period). The present study deals with the grain size distribution of coastal sands between Ramakrishna Beach to Bhimili confluence with an objective to understand sediment depositional environments and the depositional patterns of the sediments in the study area.

Study Area

The area under investigation lies between latitudes N 17° 46' and N 17°54' and longitudes E 83° 21' and E 83° 27' covering parts of the Survey of India toposheet No: 65 O/6. The area from Ramakrishna Beach to Bhimili is situated to the south of Visakhapatnam, Andhra Pradesh, India (Figure 1). Ramakrishna Beach-Bhimili tract appears like a Basin, and it is bounded by Kailasa, Yarada and Narvahill ranges on North, South, West, respectively and East by Bay of Bengal. It has an undulating topography with a height of 4 to 50 m above MSL (excluding hills).

Geology and Geomorphology of the Study area

The study area is characterized by the Garnet-sillimanite biotite gneiss (khondalites), hypersthene granites (charnockite), garnetiferous granite (leptynite) of the Precambrian Eastern Ghat Granulite Belt (EGMB), Quartzite and pegmatite are other rock types that occur as bedded and banded as well as massive Formations. This area covered with denudational hills of range between 30 to 594m Kailasa and Yarada are extending nearly east to

west, and thus deviate from the NE-SW trend of Eastern Ghats. The geomorphic features resulted from coastal and landward processes (Jagannadha Rao et al., 2012). The sediments are the prominent features and attain a height of 30 meters above the sea level. The drainage pattern of the study area is controlled mainly by the Gosthani River.

Materials and Methods

A total of 23 sediment samples are collected by pushing down a PVC tube (60 mm dia) along 9 Traverses from Ramakrishna Beach to Bhimili in different microenvironments, i.e. dunes, back shore, fore shore and berm. A representative portion of the sediments weighing 100 gm from the bulk sediment samples and are separated by coning and quartering procedure. 100 gm of sample is soaked in distilled water to dissolve the salts, then in H_2O_2 to remove carbonates and in HCl to remove shell material for 12 hours, respectively. After that the wet sediment is dried in oven with $110^\circ C$. The dry samples is placed in the uppermost sieve in a set of stacked sieves. The samples are subjected to grain size analysis by standard Ro-Tap sieve shaker at $\frac{1}{2} \Phi$ intervals of ASTM meshes (Hegde et al., 2006).

Sieve analysis

Sieving is commonly used in determining the grain size distribution of sand. For sieving analysis we are using ASTM (American Society of Testing Materials) meshes. The dry sample is placed in the upper most sieve in a set of stacked sieves. The stack of sieves arranged in order so that the coarsest sieve at the top with finer ones below is placed in Ro-Tap sieve shaker (the mesh numbers are 18, 25, 35, 45, 60, 80, 120, 170, 230, -230 respectively) after 10-15 minutes of shaking the sand that has collected on each sieve and the pan is removed and weighed. From those we had found the weight percentage of each fraction from the sample and then cumulative weight percentage of the sample. The cumulative weight percentages were plotted on probability arithmetic graphs. Thus obtained Φ_5 , Φ_{16} , Φ_{25} , Φ_{50} , Φ_{75} , Φ_{84} , Φ_{95} values. These values are used to compute the textural parameters like mean size (M_z), Standard Deviation (S_d), Skewness (Sk_1), and Kurtosis (K_G) according to the formula of Folk and Ward (1957).

RESULTS AND DISCUSSIONS

Textural Studies

The data generated from the grain size analysis data was used to compute textural parameters like graphic mean size, graphic standard deviation, graphic skewness and graphic

kurtosis according to the formulae of Folk and Ward (1957), all the statistical analysis data shown in (Table 1).

In Backshore environments, the standard deviation varies from (0.44Φ to 0.74Φ) with mean size (1.02Φ to 2.3Φ). The skewness and kurtosis are varies from (-0.48Φ to 0.23Φ), (0.79Φ to 1.60Φ). In Berm environment, the standard deviation varies from (0.40Φ to 0.98Φ) with mean size 1.3Φ the skewness and kurtosis are varies from (-0.18Φ to 0.15Φ), (0.48Φ to 0.68Φ). In the Fore shore environment, the standard deviation varies from (0.56Φ to 0.99Φ) with mean size 1.25Φ the skewness and kurtosis are varies from (-0.53Φ to 0.57Φ), (0.41Φ to 1.36Φ).

Scatter plots between certain parameters are also helpful to interpret the energy conditions, transportation, mode of deposition etc. Passega (1957); Visher (1969); Martins (1965); Folk and Ward (1957) and others described that these trends and interrelationship exhibited in the scatter plots might indicate the mode of deposition and in turn aid identifying the environments. However, Mason and Folk (1958); Friedman (1961) claimed to establish the differentiation between Aeolian, beach and river sediments based on these Scatter plots.

The Scatter plot between Mean size VS Standard deviation (Figure 2a) of the present samples shows the clustering of values near the extreme end of right limb of inverted V-shaped established trend of (Hough, 1942; Inman, 1949, 1953; Griffiths, 1951; Folk and Ward, 1957; Folk, 1959; Walger, 1961 and Hubert, 1961; Seralathan and Padmalal, 1994). The nature of the sediments is dominantly unimodal of which, the dominant constituent is medium sand. The silt is subordinate, making the admixture moderately sorted. The Scatter plot between Mean size and Skewness (Figure 2b) clearly brings out the values, some areas are positively skewed area and some areas are negatively Skewed (Folk and Ward, 1957). It further indicates a unimodal nature of sediments with higher percentage of medium sand and subordinate silt. The relation between Mean size VS Kurtosis (Figure 2c) values indicates a dominance of platykurtic category followed by mesokurtic. The plot between Standard deviation VS Skewness (Figure 2d) shows moderately sorted and positively and negatively skewed sediments. The plot between Standard deviation VS kurtosis (Figure 2e) shows that the majority of samples are of platy to mesokurtic nature, moderately sorted and of medium sand size. Plots of skewness VS kurtosis (Figure 2f) are effective tool in ascertaining the textural aspects and interpreting the genesis of sediments as reflected in the normality of their size distribution.

According to Duane (1964) and Cronan (1972) negatively skewed grain size curves are indicative of areas of erosion or non-deposition, where as positively skewed curves indicated deposition. The results indicate most of

Table 1. Statistical analysis of beach sands of different micro-environments of study area, (1, 2, 3, 4, 5,6,7,8, &9) are the station numbers. Mean size, standard deviation, skewness and kurtosis of all micro-environment samples is in (phi) value.

Location	S. No	Environment	Mean size	Standard deviation	Skewness	Kurtosis
RKB	1	Fore Shore	1.02	0.82	-0.14	0.41
SM	2	Fore Shore	1.25	0.99	-0.12	0.62
VP	3	Fore Shore	0.55	0.59	0.57	0.65
TP	4	Fore Shore	1.24	0.59	-0.39	1.23
RS	5	Fore Shore	1.77	0.71	0.02	1.01
INS	6	Fore Shore	1.75	0.60	0.01	1.32
RB	7	Fore Shore	2.34	0.59	-0.53	1.36
GR	8	Fore Shore	1.27	0.80	0.01	0.89
BHI	9	Fore Shore	2.2	0.56	0.12	0.87
R.KB	1	Back Shore	1.84	0.54	0.18	0.85
SM	2	Back Shore	1.75	0.74	-0.19	0.93
VP	3	Back Shore	1.02	0.56	-0.33	0.96
TP	4	Back Shore	1.95	0.49	0.11	0.88
RS	5	Back Shore	2.08	0.62	-0.14	0.79
INS	6	Back Shore	2.3	0.50	-0.10	0.87
RB	7	Back Shore	1.92	0.45	0.23	1.50
GR	8	Back Shore	1.52	0.59	-0.48	1.64
BHI	9	Back Shore	2.04	0.44	0.07	1.21
RK	1	Berm	1.64	0.42	0.15	0.48
SM	2	Berm	1.30	0.98	-0.18	0.55
VP	3	Berm	0.88	0.70	-0.18	0.68
INS	1	Dune	2.28	0.48	0.16	0.97
RB	2	Dune	2.05	0.55	0.27	0.82

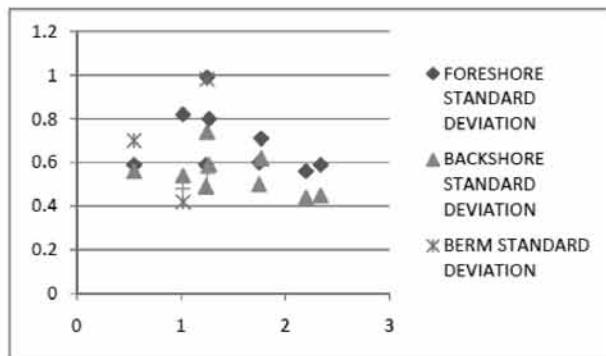


Figure2(a). Mean size vs Standard Deviation.

the sediments are well deposited. Some negatively skewed sediments indicate non-deposition. Therefore the positive

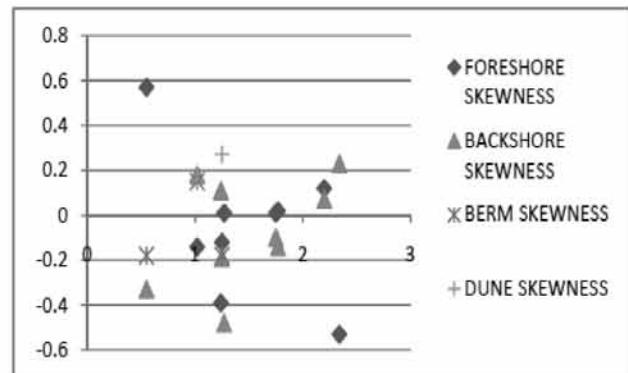


Figure 2(b). Mean size vs Skewness

skewness of these dements indicate the grains are medium to fine grained.

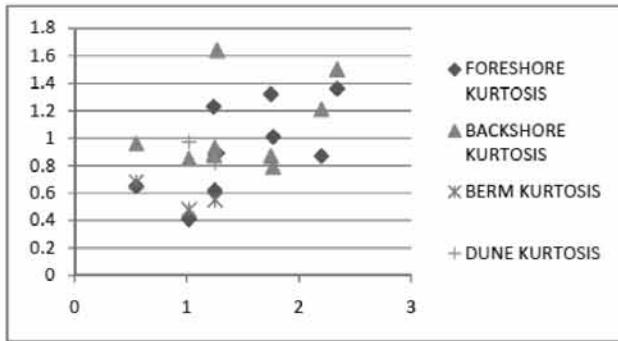


Figure 2(c). Mean size vs Kurtosis

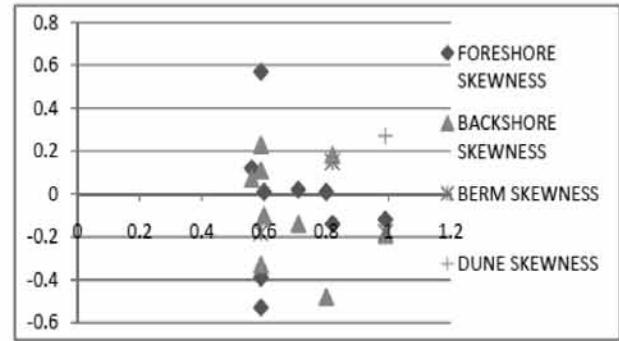


Figure 2(d). Standard Deviation vs Skewness

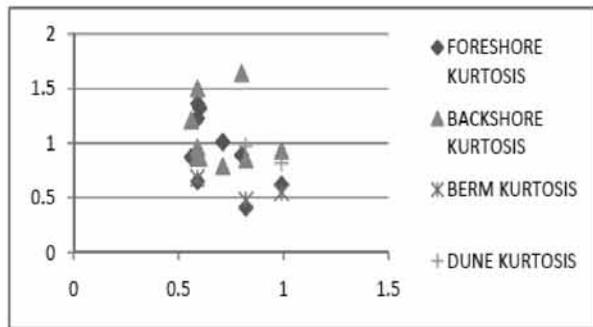


Figure 2(e). Standard Deviation vs Kurtosis

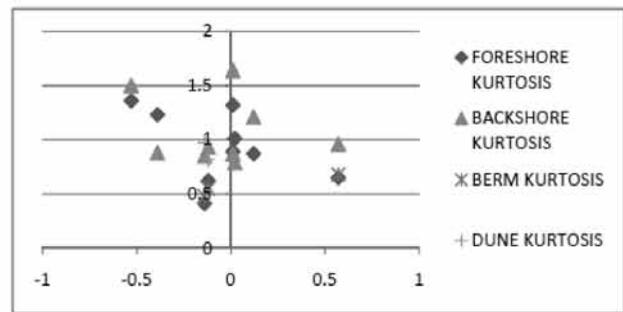


Figure 2(f). Skewness vs Kurtosis

Figure 2. (a, b, c, d, e, f) Scatter Plots.

CONCLUSIONS

Textural analyses data of the coastal sand from Ramakrishna Beach - Bhimunipatnam tract, Visakhapatnam east coast, reveal that the source of the beach sediments are from the adjoining hill ranges made of granulite facies of rocks that are part of the Precambrian Eastern Ghat Granulite Belt (EGMB). This area covers two important hill ranges one is Kailasa Ranges another one is Yarada Ranges. The altitude of these hills range between 30m to 594m above mean sea level. Frequency distribution curves and scatter plots drawn between different grain size parameters clearly establish that the nature of the sediments is dominantly unimodal of which, the dominant constituent is medium sand in various microenvironments i.e. backshore, foreshore, dune and Berm. The sands of the dune environment are fine and very fine-grained, dominantly well sorted followed by moderately sorted populations of positively skewed and Platykurtic nature. In back shore environment, fine and very fine sands are abundant than medium grain sands. In berm area the sediments are fine sands and negatively skewed sands, platykurtic. The foreshore regions were covered with fine and very fine sands and these are equally populated by well sorted and

moderately sorted nature, negatively skewed, leptokurtic to platykurtic sands.

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Compliance with ethical Standards

The authors declare that they have no conflict of interest and adhere to copyright norms.

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“The most important thing about global warming is this. Whether humans are responsible for the bulk of climate change is going to be left to the scientists, but it's all of our responsibility to leave this planet in better shape for the future generations than we found it”.

Mike Huckabee

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