TEXTURAL CHARACTERIZATION OF COASTAL SEDIMENTS ALONG THONDI TO MANALMELKUDI, TAMILNADU COAST, EAST COAST OF INDIA

Tamil Selvan.K.R[1]

Department of Geology, Jawahar Science College, Neyveli, India

krtjsc@gmail.com

ABSTRACT

Particle size characterizations of beach sediments along Thondi coast was carried out in the present study. The main objective of this work is to identify the textural behaviour of beach sediments and how wave energy correlates with grain size distribution. Grain size characteristics such as Mean, kurtosis, skewness and satandard deviation were estimated. The entire coastal area was characterized as well sorted, moderately well sorted and moderately sorted sediment environments. Sediments were identified as fine skewed to coarse skewed with platykurtic, mesokurtic and leptokurtic characters. Grain characteristics varied spatially and temporally along with beach orientation, foreshore slope with wave action and skewness correlates with shoreline changes. In some coastal tract having the negative skewness along the study region, but not very significant. The study depicts that the sedimentary coastal environment were influenced by the relatively medium wave action and some places were observed high wave action. From this study, it was concluded that the beach erosion, accretion, and stability of beaches are controlled by strong hydrodynamic and hydraulic process.

Keywords; Grain size, kurtosis, leptokurtic, hydrodynamic

I. INTRODUCTION

Grain size studies of beach sediments provide a wealth of information on the intrinsic properties of sediments and their depositional environment. Further, they help to probe into the nature and energy flux of the multifarious agents transporting the sediments. Grain size, refers to the diameter of individual grains of sediment, or the lithified particles in clastic rocks, and is one of the most fundamental physical properties in sedimentology. The determination and interpretation of particle grain size has fundamental role in hydrological, geomorphological and sedimentological (Friedman and Sanders, 1978, Goudie1981) studies.

The analysis of sediment is an essential requirement to understand their mechanism of transportation and deposition. Textural parameters are primarily related to mode of transportation and energy condition of the transporting medium. Grain size analysis is one of the important and widely used sedimentological tools to unravel the hydrodynamic conditions of aquatic environments. The grain size distribution, its properties and the statistical parameters worked out from size population are the basic requirements in the understanding of the abiotic fabric of aquatic ecosystems (Allen and Duffy, 1998; Bhat et al., 2002; Nageswara Rao et al., 2005; Kroon et. al., 2008). Careful examination of granulometric parameters and their proper evaluation using standard methods could be used in the discrimination of various depositional environments (Allen, 1970; Goldberg, 1980; Poppe et al., 2000; Woodruff et. al 2001; Selvaraj and Ram Mohan 2003).

In the present study from each auger sample from beach Low tide have been analyzed in 17 locations to understand the grain size variation. The grain size values have been averaged for preparing frequency curve distribution. The results of the textural parameters were given in table.

II. Study area

The study area lies between Thondi to Manalmelmkdi in the Palk strait of Bay of Bengal, Tamil Nadu over a length of about 43km. Located between the latitude 9º 44' to 10º 3' N and longitude 79º 2' to 79º 15' E (Figure). The area is covered in the survey of India toposheet No. 58 O/1, 58 O/2 and 58 N/4, 58 N/8 in the scale of 1:50,000. The river Vellar, Pattiyaru, Periyaru, Koluvan, Rajamanthan and Pamparu are draining through the study area. The study area falls within the districts of Ramanathapuram and Pudukkottai.

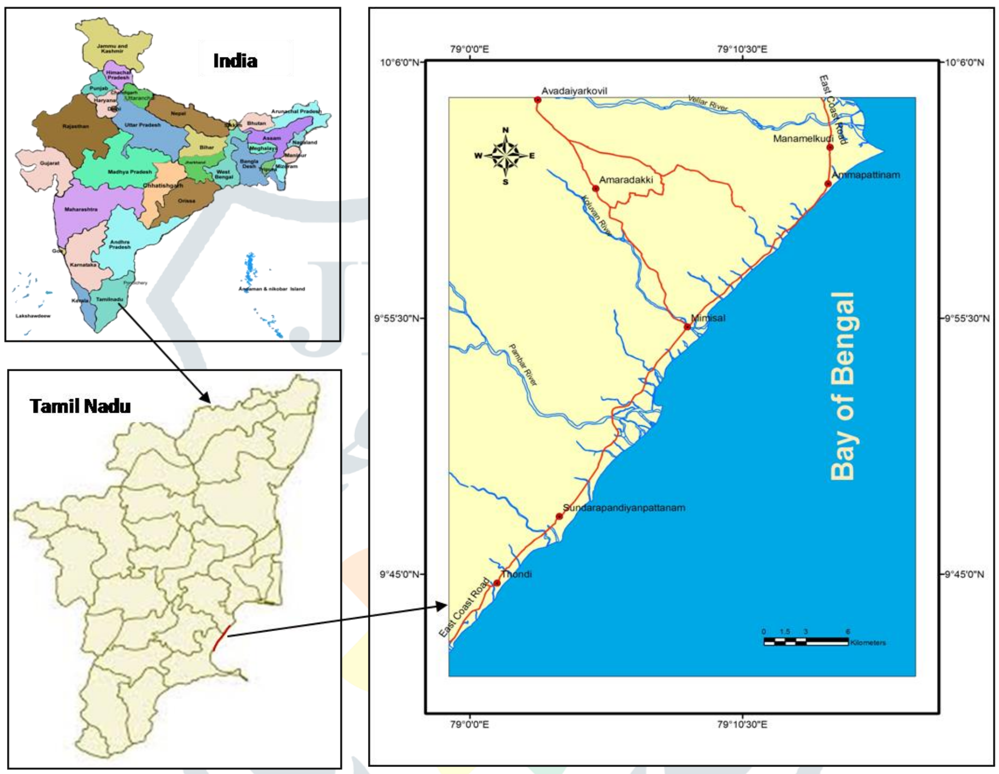

Figure 1 Study Area.

III. Materials and Methods

The methods of study broadly divided in to field and laboratory investigation, which includes survey, auguring the c samples up to 1meter depth (as top, middle and bottom), in the field.

The sediment samples were dried in the hot-air oven under 60ºC to remove the moisture. From the dried samples, 100gm was taken by the conning and quartering method to ensure uniformity of the sample. The samples were soaked in water for overnight and stirred up by mechanical stirrer intermittently to disaggregate the samples and to remove the clay fractions. The stirred samples were decanted repeatedly using distilled water until clear water was obtained. The samples were dried and weighed, the weight loss is noticed. As the samples were found to be rich in organic matter, they were treated with 30% by volume of H2O2. After washing the samples with distilled water, they were dried and weighted. The weight loss was accounted for the total organic matter. Then the samples were treated with 1:1 HCL to dissolve and to remove calcareous shelly fragments present in the sediments. After proper washing and drying, the samples were weighed and the weight loss was taken as weight of carbonates.

Sieving was carried out in ASTM sieve at 1/2ϕ intervals for about 20 minutes in Ro-top sieve shaker. The sieve material in each fraction were collected and weighed. The weights of the individual fraction were tabulated for granulometric analysis. The sieve fractions were kept separately for heavy mineral studies.

It is an essential part to understand the mode of transportation and depositional environment of sediments. Using graphic (Folk and Ward, 1957) and moment methods (Friedmen, 1961, 1967) the weight percentage of data of sample were processed by using modified programme of Schlee and Webster (1967). From the statistical parameters, frequency curves, bivariant plot, Energy process diagram, CM diagrams and variance diagrams were drawn to infer the dynamics, transportation and deposition mode.

1V.Result and discussion

The grain size parameters viz., Mean size (MZ) Standard deviation (бi), Skewness (Ski) and Kurtosis (KG) of percentile values derived from the cumulative curves following Folk and Ward (1957) and the moment technique based upon grouped data (Friedman, 1967) are most widely used. The statistical parameters of the sediments of different environment of Beach from Thondi to Manamelkudi, Low tide.

Table; 1 Textural parameters low tide

Location No	ME-Q	MSD-Q	MCD-Q	MSK	MKU	MED-Q	M-Q	SD-Q	SK	KU	FP-Q
1	1.51	0.94	0.71	0.87	4.75	1.59	1.43	0.82	-0.15	0.95	0.02
2	0.74	0.67	0.35	1.17	3.48	0.45	0.63	0.64	0.78	0.73	0
3	1.04	0.7	0.29	0.82	3.33	0.85	0.83	0.69	0.36	0.8	0.01
4	1.23	0.73	0.16	0.41	2.83	1.14	1	0.7	-0.04	0.8	0.01
5	0.72	0.55	0.16	1	2.82	0.57	0.71	0.61	0.38	1.16	0.01
6	0.69	0.63	0.47	1.92	9.29	0.44	0.48	0.52	0.74	0.71	0
7	1.44	0.68	0.4	1.27	8.11	1.42	1.2	0.62	0.06	1.74	0.03
8	1.6	1.26	7.28	3.6	20.37	1.6	1.27	0.62	-0.54	1.42	0.02
9	1.48	0.94	0.18	0.21	2.02	1.47	1.33	1	0.12	0.69	0.01
10	0.85	0.65	0.49	1.75	16.37	0.73	0.74	0.61	0.29	0.66	0.01
11	1.55	0.82	0.09	0.17	3.47	1.64	1.33	0.88	-0.26	1.49	0.01
12	1.63	0.63	0.11	0.45	4.83	1.65	1.45	0.6	-0.25	2.17	0.04
13	0.96	0.79	0.54	1.09	3.95	0.75	0.78	0.77	0.42	0.96	0.01
14	1.1	0.69	0.1	0.3	2.57	1.15	0.96	0.69	-0.12	0.63	0.01
15	0.92	0.55	0.08	0.47	7.52	1.03	0.79	0.52	-0.4	0.67	0.01
16	1.53	0.52	0.03	-0.19	5.59	1.6	1.43	0.47	-0.43	1.43	0.05
17	1.31	0.66	0.09	0.33	8.66	1.44	1.05	0.68	-0.24	0.87	0.01
Min	**0.69**	**0.52**	**0.03**	**-0.19**	**2.02**	**0.44**	**0.48**	**0.47**	**-0.54**	**0.63**	**0**
Max	**1.63**	**1.26**	**7.28**	**3.6**	**20.37**	**1.65**	**1.45**	**1**	**0.78**	**2.17**	**0.05**
Mean	**1.19**	**0.74**	**0.99**	**1.002**	**6.965**	**1.137**	**1.01**	**0.67**	**0.05**	**1.08**	**0.01**

The mean size of low tide sands at MR. Pattinam, Muthukuda, Palakudi, Vannichipattinam and Ammapattinam exhibits coarse sand nature indicates high energy environments (Figure). The mean size of the low tide sands fluctuates from 0.48ϕ to 1.45ϕ to the alternate locations attribute fluctuation in energetic conditions. The coarseness nature of sand attributed to the removal of the fine fraction in high energetic environment.

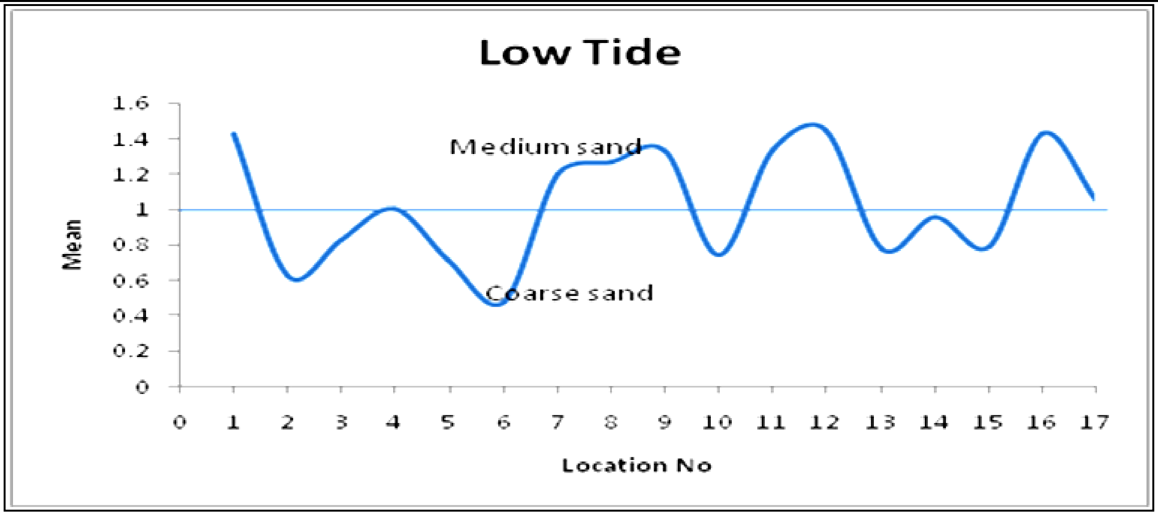

Figure 2

The mean value of the beach ranges from 0.48φ to 1.78φ indicating the beach of entire study area falls in the category of coarse to medium sand.

Standard deviation (бi)

The standard deviation value of low tide sands ranges from 0.47φ to 1φ. In the verbal scale proposed by Folk and Ward (1957), they are of moderately sorted to very well sorted type.

It is noted that the sorting improves with the lowering of the mean size. As a result the beaches having medium sand (1ϕ to 2ϕ) exhibit well sorted nature (0.47ϕ to 1.0ϕ). This indication has also been noted by Inman (1952), Friedman (1967) and Petijohn (1984).

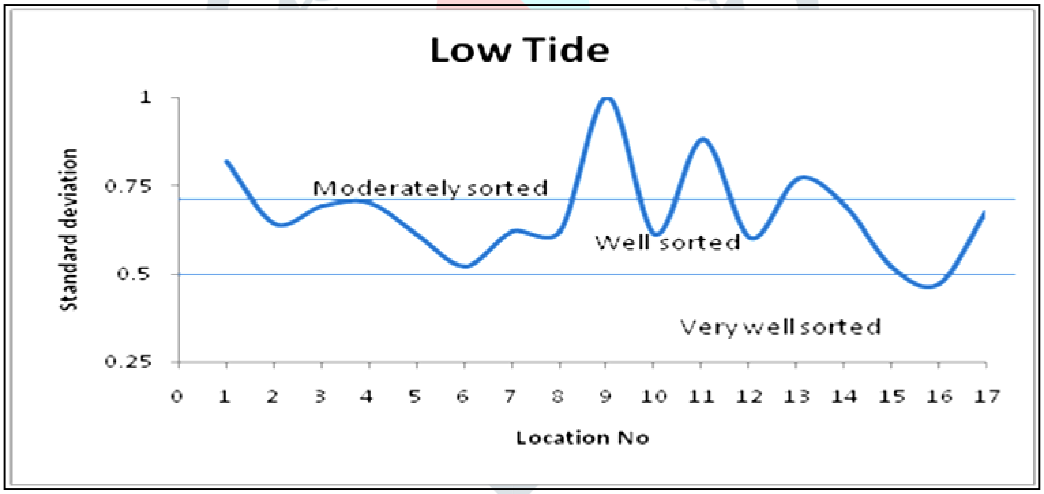

Figure 3

Skewness (Ski)

The skewness value for low tide sands ranges from -0.54 to 0.78. The values of the sediments falls within the field of very coarse skewed to very fine- skewed nature. The very fine skewed nature in the study area indicates the sediments were inputs through different rivers. The dominants of negative skewness evidence the prevalence of high energy condition in the beaches.

Figure. Variogram skewness diagrams of textural parameters

The reason for negative skewness of low tide region in the Velangudi (-0.15), Pudupattinam (-0.54), Ayyampattinam (-0.26), Kottaipattinam (-0.25), Avadiyarpattinam (-0.43) and Manamelkudi (-0.24), has assigned to the removal of fine grained particles by winnowing action for the lack of tail at the fine grained end.

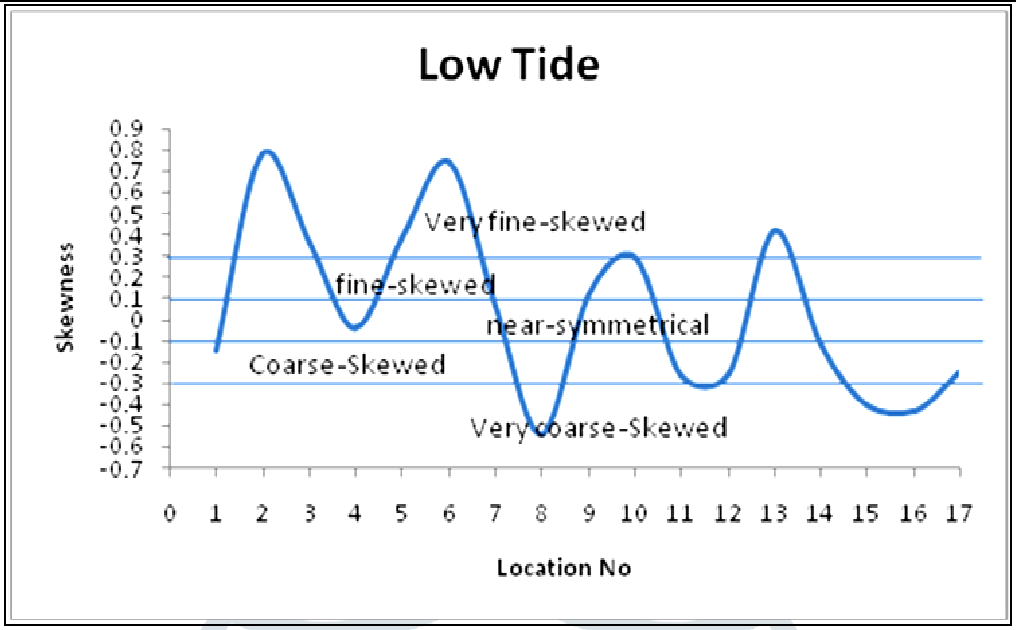

Figure 4

Kurtosis (KG)

The low tide sands exhibits the Kurtosis values from 0.63 to 2.17 falling very platykurtic to very leptokurtic. Most of the locations have values of platykurtic and mesokurtic indicating the concentration of equal proportion of two modes.

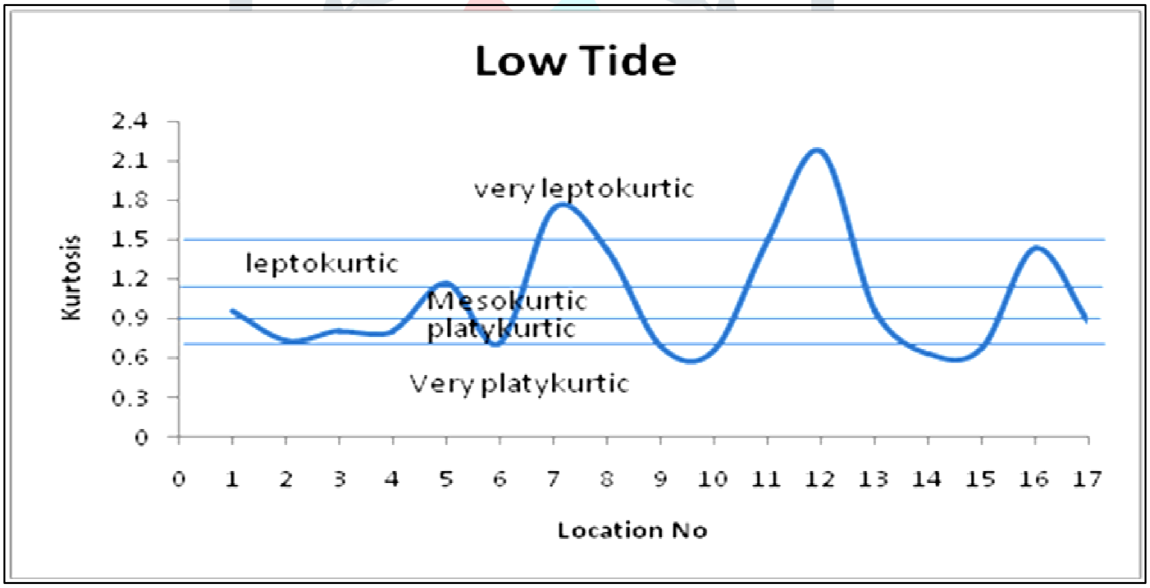

Figure 5

The very leptokurtic nature in Arasanagaripattinam (1.74) and Kottaipattinam (2.71) and leptokurtic nature in SP. Pattinam (1.16), Arasanagaripattinam (1.74), Gopalapattinam (0.69) and Ayyampattinam (1.49) is due to better sorting of medium fractions.

Multigrain multivariant discriminant functions (V1 and V2)

Rigorous statistical method of multi group, multi variant linear discriminent function proposed by Sahu (1964) was applied for discriminating the depositional environment of the beach sand collected from low tide. When the values of discriminant functions of V1 and V2 table were ploted on the multigroup, multi variant, discriminant diagram (figure).

Table; 2

L. No.	Low tide	
	V1	V2
1	2.07	0.37
2	1.74	0.30
3	1.76	0.30
4	1.69	0.27
5	1.77	0.65
6	1.49	0.35
7	2.15	1.19
8	1.79	0.85
9	2.24	0.01
10	1.53	0.22
11	2.29	0.73
12	2.31	1.59
13	1.93	0.36
14	1.55	0.11
15	1.16	0.22
16	1.73	1.05
17	1.64	0.33

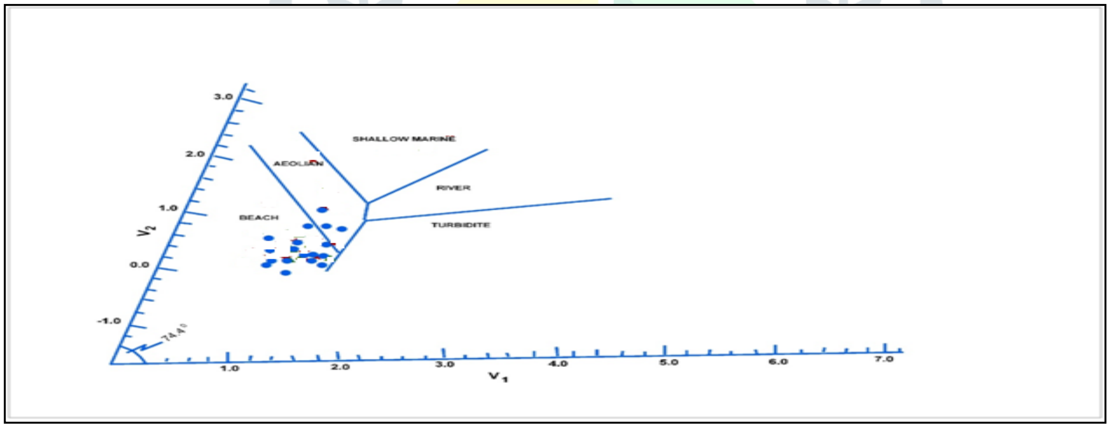

Figure 6

Multigrain multivariant discriminant functions (V1 and V2)

C-M- Pattern

In the present study, CM pattern was made by following Passega (1957, 1964), and Passega and Byramjee (1969). The CM plot at the present study shows that most of the Beach sand Low tide fall in the intermediate position between PQ (Figure). Clustering is imported due to lack of difference in the hydrodynamic regimes prevailing in the area. The samples have first percentile value falling within the field of 200 to 800, reflects suspension and rolling mode of transportation history, indicating unfussiness of hydrodynamic process operating in this system. The PQ segment exhibits that the Beach sand was underwent the Rolling and suspension current, which are the prime factors for transportation.

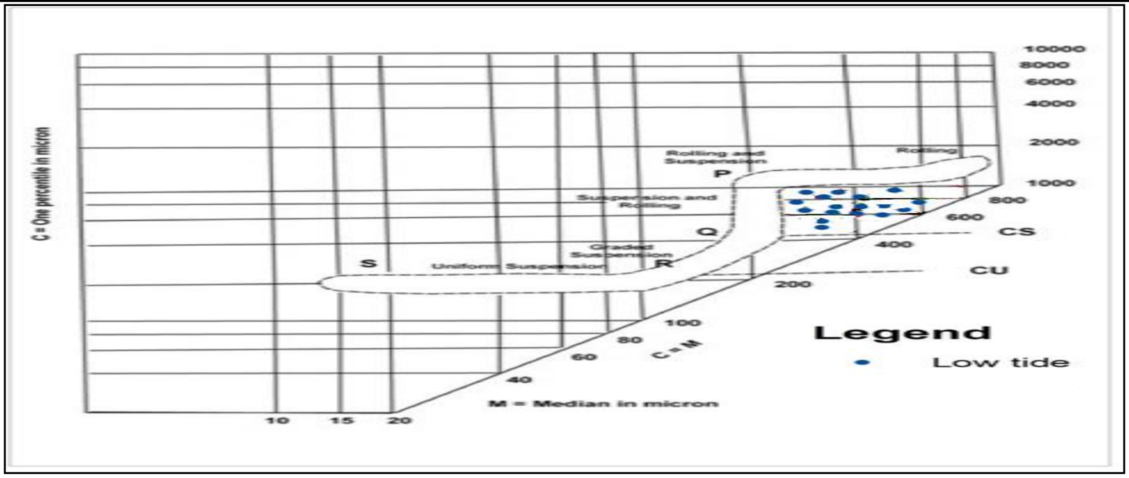

Figure 7 CM- Patten

Sediment classification

Traditionally, geologists have divided sediments into four size fractions that include gravel, sand, silt, and clay and have classified these sediments based on ratios of the various proportions of the fractions. Definitions of these fractions have long been standardized to the grade scale described by Wentworth (1922), and two main classification schemes by Sheppard (1954) and Folk (1954) have been generally adopted to describe the approximate relationship between the size fractions.

The classification of the Beach sand Low tide was performed using Shepard and Folks trilinear classification. The sand, silt and clay percentage and its corresponding.

Shepard's Classification

Based upon the proportions of sand- silt- clay sized particles, the Beach sand sediments were classified according to Shepard's diagram. Shepard's diagram is an example of a ternary diagram - a device for graphing a three-component

Table; 3 Shepard's and Folk's classification from Low tide

Location No.	Sand	Silt	Clay	Shepard	Folk
1	98.29	1.70	0	sand	sand
2	100	0	0	sand	sand
3	99.97	0.02	0	sand	sand
4	99.94	0.053	0	sand	sand
5	100	0	0	sand	sand
6	100	0	0	sand	sand
7	99.49	0.50	0	sand	sand
8	100	0	0	sand	sand
9	99.93	0.06	0	sand	sand
10	100	0	0	sand	sand
11	99.66	0.33	0	sand	sand
12	99.96	0.03	0	sand	sand
13	99.91	0.08	0	sand	sand
14	100	0	0	sand	sand
15	100	0	0	sand	sand
16	100	0	0	sand	sand
17	100	0	0	sand	sand

system summing to 100%. In this case, the components are the percentages of sand, silt, and clay comprising a sediment sample. Each sediment sample plots as a point within or along the sides of the diagram, depending on its specific grain size composition. A sample consisting entirely of one of the components, 100% sand, for example, falls at the same-named apex. A sediment entirely lacking in one of the components falls along the side of the triangle opposite that apex. The rest fall somewhere in-between.

To classify sediment samples, Shepard (1954) divided a ternary diagram into ten classes. Shepard's diagram follows the conventions of all ternary diagrams. For example, Shepard's "clays" contain at least 75% clay-sized particles. "silty sands" and "sandy silts" contain no more than 20% clay-sized particles, and "sand-cilt-clays" contain at least 20% of each of the three components. Grain size distributions of Beach sand tightly in sand variable (Figure.). Thus, the sand is dominance of sand fractions.

V.CONCLUSION

The mean value of the beach ranges from 0.48φ to 1.78φ indicating the beach of entire study area falls in the category of coarse to medium sand. The winnowing action and high energy wave being responsible for the coarse sand to medium grain size in the beach environment. The prominent littoral drift noticed in the region is also responsible for the changes in the coarse to medium size of the beach sediments. Overall the beach sands exhibits moderately very well sorted characteristics having the standard deviation values between 0.22φ to 1φ. Since the removal of particular size fraction by the action of waves leads to the enrichment of coarse to medium sand in the beach environment. As a result, the beach sand exhibits moderately well sorted nature. The skewness value for the overall beach sand ranges from -0.5 to 0.78. The values of sediments fall within very coarse- skewed to very fine- skewed nature. The very fine- skewed nature, in the study area indicatesthe sediments were inputsthrough differentrivers. The dominance of negative skewness evidences the prevalence of high energy condition, in the beaches. The extremely leptokurtic nature in the Narendal, Ayyampattinam and Kottaipattinam exhibits that these locations are experiencing high energy situate and the sediments are of better sorted in type. Most of the samples were falls within Platykurtic to leptokurtic nature and indicates that the concentration of one dominant and other subordinate population. Rigorous Statistical method of multi group, multivariant linear discriminant functions of V1 and V2 for discriminating the depositional environment of the beach sand collected from low tide, high tide and Berm. Were plotted on the multi group multivariant discriminant diagram. The samples from beach sand (Low tide, High tide and Berm) were predominantly fall in the field of Bech and Aeolian deposition, very few samples fall in the field of shallow marine deposition. The Passega diagram shows the sediments are generally considered as mixture of two to three log-normal subpopulation produced chiefly by three modes of transportation: rolling, saltation and suspension.

The CM plot at the present study shows that most of the Beach sand Low tide fall in the intermediate position between PQ segment which exhibits that the beach sand was underwent the Rolling and suspension current, and are the prime factors for transportation. Clustering is imported due to lack of difference in the hydrodynamic regimes prevailing in the area. The samples have first percentile value falling within the field of 200 to 800, reflects suspension and rolling mode of transportation history, indicating unfussiness of hydrodynamic process operating in this system. The classification of the Beach sand was performed using Shepard and Folks trilinear classification. The sand, silt and clay percentage and its corresponding Shepards and Folks nomenclatures the Beach sand were plotted and is clustered tightly in sand variable. Thus, the Beach sand is dominance of sand fractions.

VI. REFERENCE

1. Friedman GM and Sanders JE, (1978). Principle of Sedimentology. Wiley New York, 792.p.
2. Goudie A, (1981). GeomorphQlogical Techniques. 395 pp., George Ailen and Unwin, Boston grain-size analysis. Sedimentology, V.27, pp. 231-232.
3. Allen J R L and Duffy M J, (1998). Temporal and spatial depositional patterns in the Severn estuary South-western Brita in: Intertidal studies at spring-neap and seasonal scales, 1991-1993. Mar. Geol, pp.147-171.
4. Bhat M S, Chavadi V C and Hegde V S, (2002). Morphological and textural characteristics of Kudle beach. Karnataka Central west coast of India. J Geol. Soc. India V.59, pp.125-131.
5. Nageswara Rao P V, Suryam R K and Ranga Rao V, (2005). Depositional environment inferred from grain size parameters of the beach sediments between False Devi points to Kottapatnam Andhra Pradesh coast. Jour .Geol .Soc. India, V.65, pp.317-324.
6. Kroon A, Larson M ,Moller I, Yokoki H, Rozynski G, Cox J and Larroude P, (2008). Statistical analysis of coastal morphological data sets over seasonal to decadal time scales. Coast. Eng. V.55, pp. 581-600.
7. Allen J R L, (1970). Physical Processes of sedimentation. (George Allen and Unwin Ltd. Unwin University Books London). 248.p.
8. Goldberg R, (1980).Use of grain size frequency data to interpret the depositional environments of the Pleistocene Pleshet Formation Beer Sheva. Israel. Jour. Sed. Petrol, V.50. pp.843-856.
9. Poppe J L, Knebel J H, Mlodzinska J Z, Hastings E M and Seekins A B, (2000). Distribution of surficial sediments in Long Island Sound and adjacent waters: texture and total organic carbon. Jour. Coast. Res,V.16, pp.567-574.
10. Woodruff J D, Geyer W R, Sommerfield C K and Driscoll N W, (2001). Seasonal variation of sediment deposition in the Hudson River estuary. Mar. Geol. No.179, pp.105-119.
11. Selvaraj, K and Ram Mohan, V (2003). Textural variation and depositional environments of inner shelf sediments, off Kalpakkam, southeast coast of India. Jour. Geol. Soc. India, V. 61, pp. 449 – 462.
12. Folk, R.L and Ward, M.C. (1957). Brazos river bars: a study in the significance of grain size parameters. Jour. Sed. Petrol. V.27, pp. 3-27.
13. Friedman GM, (1961) .Distinction between dune beach and river sands from their textural characteristics. Jour. Sediment. Petrol, V.31, pp. 514–529.
14. Friedman GM, (1967). Dynamic processes and statistical parameters compared for size frequency distribution of Beach River sands. Jour. Sediment. Petrol, V.37, pp. 327 -354.
15. Folk, R.L and Ward, M.C. (1957). Brazos river bars: a study in the significance of grain size parameters. Jour. Sed. Petrol. V.27, pp. 3-27.
16. Inman, D.L. (1952). Measures for describing the size distribution of sediments. Jour. Sed. Petrol. V.22, pp. 125-145.
17. Pettijohn FJ, (1984). Sedimentary rocks. 3rd Ed., CBS publication and distributors, Delhi. 628 p.
18. Sahu BK, (1964). Depositional mechanism from the size analysis of clastic sediments. Jour. Sed. Petro, V.34, pp. 73-83.
19. Passega , (1957). Texture as characteristic of clastic deposition. Amer.Asso petro Geol, V.41 (9), pp.1952-1984.
20. Passega R, (1964). Depositional mechanism from the size analysis of clastic sediments. Tulsa,USA. Jour.of Sedimentary Petrology,V.34(1), pp. 73-83.
21. Passega R. and Byramjee R. 1969. Grain size image of clastic deposits, Sedimentology, Vol.13, pp. 180-190.
22. Wentworth CK, (1922). A scale of grade and class terms for clastic sediments. Jour. of Geo, V.30, pp.377-392.