RESEARCH ARTICLE

GRAIN SIZE DISTRIBUTION AND DEPOSITIONAL ENVIRONMENT OF COASTAL SEDIMENTS AT PONNAIYAR AND GADILAM ESTUARY, EAST COAST OF INDIA

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ABSTRACT

Grain size distributions of vertical sediments are generally reveals medium to fine grained nature of sediments. The standard deviation (δ1) indicates that the samples are well sorted nature. The graphic skewness (ski) indicates that they are near symmetrical and fine skewed. The kurtosis (Kg) values of the sediments vary in leptokurtic nature. All the samples show marginal marine conditions. During this period the sediments were deposited predominantly by Aeolian and beach process under shallow agitating environment and carried by turbidity action. The significance of the present study is mainly focused on vertical size distribution, depositional process, environments and energy conditions of the deposits.
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INTRODUCTION

Grain size distribution studies of beach sediments provide a wealth of information on the intrinsic properties of sediments and their depositional environment. Systematic granulometric studies of east and west coast of India have been carried out by many researchers (Rajamanickam and Gujar. 1984, 1985, 1993; Chaudhri *et.al* 1981, Rao.*et.al* 2005, Angusamy and Rajamnickam 2006, 2007, Ramanathan *et.al* 2009, Suresh Gandhi *et.al* 2008, Anithamary *et.al* 2011). The beach sediments play a vital role in the depositional history of a region (Angusamy N G and Rajamanickam 2007). Geology and climatic conditions play a vital role to control the sediment dynamic nature of the river (Venkatramanan *et.al* 2011). The sediments may be derived from offshore and catchments area deposits of the clay and silt, and evidence was found to suggest that these deposits are being eroded by tidal currents (Venkatramanan *et.al* 2012).

Study Area

The study area (Fig:1) falls between Ponnaiyar (N 11º46'19" and E79º47'42") the total drainage area of river is 14,885sq.km and Gadilam estuary falls in between N11 º44'11" and E79º47'12". The total area of the basin is about 1,394sq.km. It falls in survey of India toposheet no 58 M\14 is surrounded by Bay of Bengal in the east. The climate, size and shape of the depositional basin are also greatly influences the different geomorphologic units. The study area enjoys the humid tropical climate; the humidity varies from 66 percent to 80 percent. Soil type of the study area is black soil is the predominant soil type in this district accounting for 45.2% of the total area under agriculture. Red Loam and red sandy soil

are the other types of soil prevalent in the area. The stratigraphy of the study area indicates older sedimentary rocks of the cretaceous age and younger sedimentary of mio-pliocene age.
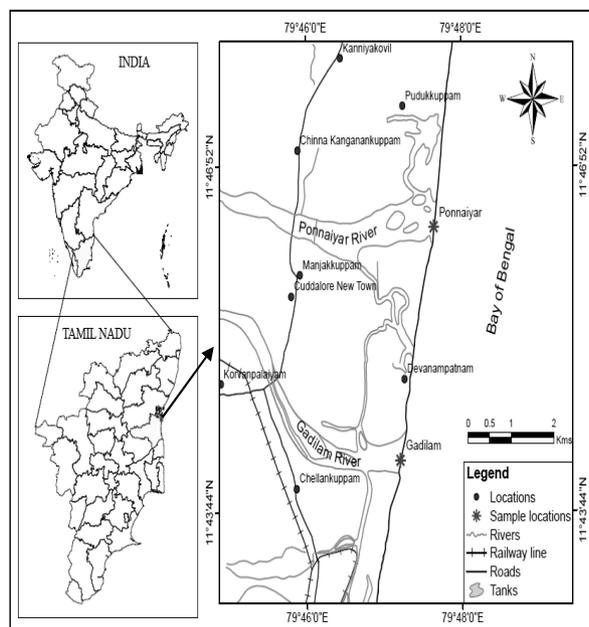

Fig.1 *Location Map of the Study Area*

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METHODOLOGY

The sediments were collected at Ponnaiyar and Gadilam estuary by making 1m x 1m pit near the shore and sub sampling was made at 2cm interval in different location. 52 samples were collected in clean dry polythene bags for laboratory analysis. In order to obtain the representative samples for the sieve analysis the dried samples were subjected to conning and quartering. The samples are washed acid treated with 10% HCl and dried. The weighed samples were sieved on ASTM from +2 to -325 mesh size were used to ¼ phi intervals (Folk R L and Ward M C 1957). The sieved materials were weighted separately and fraction was properly tabulated and the sands of the respective fraction were kept for further studies. The samples were separated for light and heavy minerals by using bromoform (Sp.gr.2.89) following standard procedures. The statistical parameters such as graph mean (MZ), inclusive standard deviation (σ_1, inclusive graphic skewness (Sk_I), inclusive graphic kurtosis (K_G) were calculated following the technique proposed by folk and in ward (1957). The calculated statistical values were interpreted for sahu's (1964) linear discriminate function to find out the verification in energy and the fluidity factors which seems to have excellent correlation with different process mode of deposition the mode of transportation has interpreted using CM-plot as suggested by Passage (1957) and Passage and Byramjee (1969).

RESULT AND DISCUSSION

Textural attributes of sediments viz. mean (Mz), Standard deviation (σ_1), Skewness (Sk_i) and Kurtosis (K_G) are widely used to reconstruct the depositional environments of sediments and sedimentary rocks (Angusamy N G and Rajamanickam V 2006). Correlation between size parameters and transport processes/depositional mechanisms of sediments has been established by exhaustive studies from many modern and ancient sedimentary environments (Folk and Ward, 1957; Mason and Folk, 1958; Friedman, 1961, 1967; Visher, 1969; Valia and Cameron, 1977; Wang, *et. al,* 1998; Asselman, 1999; Malvarez, *et.al.*, 2001, Ramanamohanarao *et.al* 2003, Suresh Gandhi 2008, Anithamary *et.al* 2011). The mean size (fig 2) values of ponnaiyar region (Table 1) grain size distribution shows the dominance of fine sand category. The fine grain nature indicates the moderately low energy condition in the basin of deposition. The Gadilam estuary samples (fig 3) ranged from medium sand category. Medium sand may be due to limited inputs and weak wave energy conditions. The sorting values (fig 2 & 3) of both Ponnaiyar and Gadilam estuary samples fall in well sorted (Table 1). The well sorted character of sediments indicates the winnowing or back and forth motion by the depositing agent. Ponnaiyar estuary dominance of near symmetrical values is observed (Table 1). This is may be due to the mixing of bimodal sources. Gadilam estuary (fig 3) dominance in fine sand positively Skewness values indicate low to moderate energy condition of estuary environment deposition. The kurtosis (fig 3 & 4) measure the ratio of sorting on both locations shows leptokurtic nature of sediments (Table No1). The leptokurtic nature of sediments indicates the higher kurtosis values on the mixing of a predominant population with very minor amounts of coarser and finer materials (Mason and Folk, 1958, Prabhakara Roa et.al, 2001). The leptokurtic behavior of the sediments also indicates the variation of the energy condition of the environmental setup of deposition of the sediments.

Table 1 Showing Grain size parameter form Ponnaiyar and Gadilam

AREA		Mean	Sorting	Skewness(Ski)	Kurtosis(KG)
Ponnaiyar	Max	2.5	0.671	0.190	1.662
	Min	1.71	0.054	-1.007	0.830
	Avg	2.102	0.469	-0.097	1.115
Gadilam	Max	2.133	0.638	1.085	2.049
	Min	1.467	0.277	-0.045	0.649
	Avg	1.800	0.436	0.214	1.170
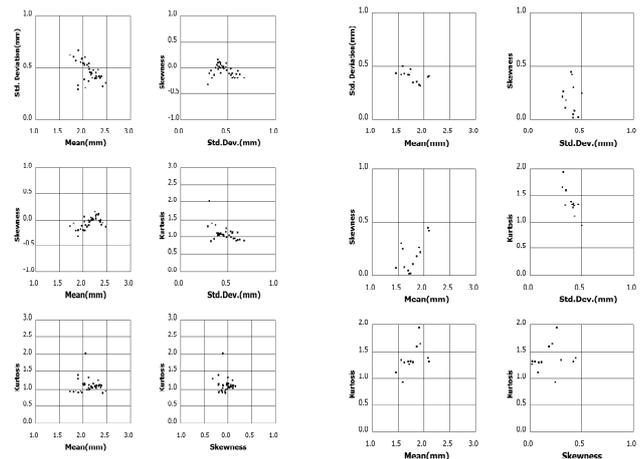
Fig. 2 scatter plots in Ponnaiyar   Fig. 3 scatter plots in Gadilam

DEPOSITIONAL ENVIRONMENT

According to Sahu's (1964) the variations in the energy and fluidity factors seem to have excellent correlation with the different processes and the deposition environment. Ponnaiyar estuary (fig 4) most of the Y1 values fall under Aeolian processes and some of the values falls in beach process. Gadilam estuary (fig 5) most of the Y1 values fall under beach processes and rest of the values falls in aeolian process. Y2 values of the samples in Ponnaiyar indicating that 67% fall in shallow agitated water and the rest in beach process category. Y2 values of the samples in Gadilam indicating that 62% fall in beach process and the rest in shallow agitated water category. Ponnaiyar and Gadilam estuary Y3 values show that all the samples exhibits shallow marine condition of deposition. In Ponnaiyar 99% of Y4 values of sample falls under turbidity deposition and 1% of sample fall in fluvial (deltaic) condition. Gadilam Y4 values of sample falls on 98% turbidity deposition except 2% of samples under fall fluvial (deltaic) condition of deposition.

CM PATTERN

Grain size parameter and plots of CM patterns helps to distinguish between the sediments of different environments of fluvial and deltaic deposits (Passega, 1964, Visher, 1969). In the present study an attempt has been made to identify the modes of deposition of sediments of the Ponnaiyar and Gadilam estuary (fig 6 & 7) by CM pattern. Parameter C (one percentile of the grain size distribution) and M (the Median) were plotted for Phi values of the C and M obtained from the cumulative curves in microns. The relation ship between C

and M is the effect of sorting by bottom turbulences. The good correlation between C determined by only one percent by weight of sample and M, which represent grain size as a whole, shows the precision of the control of sedimentation by bottom turbulence. CM pattern is subdivided in to three segments namely PQ, QR and RS. PQ indicates coarse grain transported by rolling, QR indicates parallel to line C=M represents the main channel deposits and RS indicates the roll of uniform suspension in the transporting sediments. The plotted result of Ponnaiyar and Gadilam river sediments samples indicates bottom suspension and rolling.
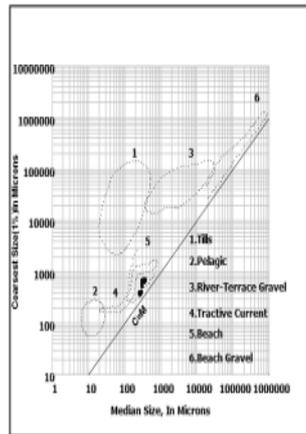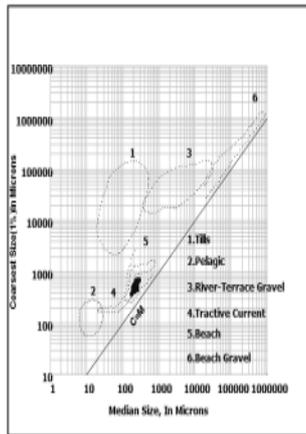

Fig 4 Depositional Environment in Ponnaiyar
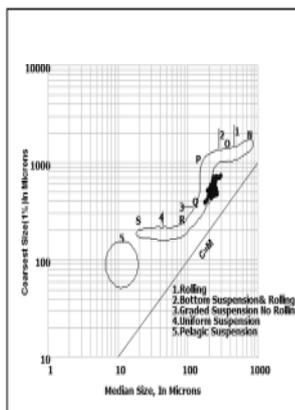

Fig 5 Depositional Environment in Gadilam

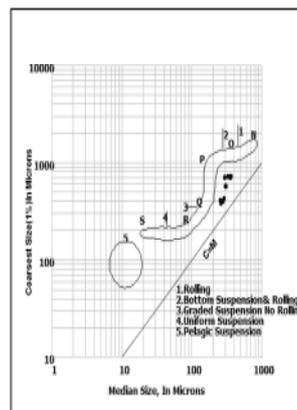**Fig 6** Showing on C-M plot for Ponnaiyar

Fig 7 Showing on C-M plot for Gadilam

CONCLUSION

Grain size analysis of 52 samples representing fine grained nature. The sediments are generally, well sorted, near symmetrical and fine skewed nature. Both peak and tails are equally sorted giving rise to leptokurtic condition. From the energy process discriminate functions of the sediments were deposited predominantly by aeolian and beach process under shallow agitating environment and carried by turbidity action. The result indicates most of the sediments were deposited by fluvial processes then by marine influence under a near shore whirl pool agitating environment. CM- plots indicates the samples are fall in bottom rolling suspension field.

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