Determination of grain size analysis of beach sediments along location of Kameswaram is studied. For this purpose, mean, standard deviation, skewness, and kurtosis were calculated from the cumulative curves to study the depositional processes. Environment of deposition was studied. Mean size and standard deviation distribution clarifies this observation. Presence of fine sand and well sorted to moderately well sorted nature of sediments. The inclusive graphic skewness (ski) indicates that they are fine skewed to coarse skewed; hence the sediment points to unidirectional transport (channel flow). The kurtosis (Kg) varies from platykurtic to very platykurtic nature. Linear discriminant functions of sediments indicate an Aeolian processes was dominant for the deposition of the fine grained sediments in shallow agitating water from the beach. Based on CM (coarser one percentile value in micron) pattern the sediments fall in rolling and suspension field. The significance of the present study is mainly focused on sedimentological characteristics of the pit samples are vertical size distribution, depositional process, environments and energy conditions of the deposits.

**INTRODUCTION**

Grain size analysis is the quantification of the size of the sedimentary particles. The grain size of sediments depends upon the nature of the source rocks and the transporting agent and hence the size of the sediments reflects the mechanism of erosion and transportation. Grain size studies on recent sediments are to determine the physical effect of the environment of these parameters and to use this information in interpreting the relative timing of deposition. Textural analysis of clastic sediments thus, has been a valuable tool in the reconstruction of their sedimentary processes. Interpretation of grain size distribution has, in general, followed three distinct approaches. The first approaches relates the size distribution to the depositional process i.e., hydrodynamics, which has been advanced by Inmann (1952), Friedman (1967) vilser (1969). The second approach attributes the size distribution of source material and the generative processes that distribute them. The third approach is to make an empirical study of size distribution characteristics of sediments from various geomorphic environments to see their interrelationship. This approach was initiated by Udden (1914) expanded by Folk and Ward (1957), tried to relate the shape of the grain size distribution curve to the specific environment of deposition Cadigan (1961), on the others hand, suggested sediments and their statistical measures reflect the changes in energy level in supply. River sands are typically moderately to poorly sorted (Martins, 2003). Gujar et al. (2007) pointed out that prevailing high energy conditions contributed to the better sorting of sediments within the Vaigai River. The significance of grain size analysis has greatly been emphasized in the recent years towards the evaluation of the environment of deposition and history of transportation of the sediments (Passega, 1977; Tiara and Scholle, 1979; sly et.al, 1983; Folk, 1980; Ishpording and Flowers, 1989; Sundararajan et.al (2009), Lindolm RC 1987; Ramanathan et.al, 2009 venkatramanan (2012).

**Study area**

The study area (fig.1) forms part of Kameswaram, Nagapattinam district. It falls between the latitude N10° 37' 10" and longitude E79° 51' 21" and forms part of survey of India Toposheet No 58N/14 on 1:50,000 scale. Distribution of the Cauvery, Arasalar, Tirumalairajaran, Vellar, Adappar, Vettar and Vedanayar canal are the main rivers flowing in this area. The study area is surrounded by Tanjore district in the west, Cuddalore district in the north, Palk Strait in the south and Bay of Bengal in the east. The geography of the study area comprises of both riverine and marine alluvial deposits. The alluvial deposits of the river Cauvery and its tributaries lie over the Tertiary sandstone. They consist of sand, gravelly sand, clay and sandy clay. The geology of the study area comprises of both riverine and marine alluvial deposits. The thickness of the quaternary sediments increases north of Kollidam River. The sediments have been delineated as alluvial plain deposits (Cauvery formation) of the Cauvery and its distributaries, narrow fluvo marine deltaic plain deposits (Nagapattinam formation) and marine coastal plain...
deposits (East Coast formation). Geological formations are ranging in age from the archean to recent alluvium. The sedimentary section contains a number of transgressive and regressive episodes.

Fig.1 Location Map of the Study Area

MATERIAL AND METHOD

Material for the present study, includes, a total of forty pit samples were collected from the coastal region. The samples were collected in polythene bags from the field by digging pits. Depending on lithological changes and color variations. Initially, 100grams of sample was prepared by removing carbonate and organic matters by treating with 10% dilute HCL respectively. The samples, completely free from carbonate and organic matter was subjected for sieve analysis. The samples were sieved at quarter phi (0.25φ) interval by using the standard ASTM sieve sets on Ro-tap mechanical sieve shaker for about 20 minutes. The weight percentage frequency data obtained from the sieve were converted into cumulative weight percentage and cumulative curves were drawn. The different statistical parameters were calculated by applying Folk and Ward’s (1957) formulae.

In present study grain size analysis of the samples is done to work out frequency distribution statistical size parameters viz, mean, sorting, skewness and kurtosis. Bivariant analysis for the statistical size parameters to see their mutual relationship and usefulness for environment discrimination as well as C-M pattern for environment discrimination as well as C-M pattern for depositional environment and energy condition have been attempted.

RESULT AND DISCUSSION

Grain size analysis and their significance

Graphic Mean

Graphic mean (Mz) is a measure of central tendency. This is calculated by the formula $\phi_{16} + \phi_{50} + \phi_{83} / 3$. The calculated values range from $2.363 \phi$ (fine sand) to $3.013 \phi$ (fine sand). The average mean (fig.2) size is $2.628 \phi$. The dominant fine grained nature of sediments indicates the moderately low energy conditions in the basin of deposition. Fine grained nature of sediments in the study region shows that they were deposited by river processes.

Table 1 Showing Grain size parameter form kameswaram

<table>
<thead>
<tr>
<th>Mean</th>
<th>St.dev</th>
<th>Skw</th>
<th>Kts</th>
</tr>
</thead>
<tbody>
<tr>
<td>min</td>
<td>2.363</td>
<td>0.373</td>
<td>-1.695</td>
</tr>
<tr>
<td>max</td>
<td>3.013</td>
<td>0.652</td>
<td>0.228</td>
</tr>
<tr>
<td>avg</td>
<td>2.631</td>
<td>0.483</td>
<td>-0.092</td>
</tr>
</tbody>
</table>

Graphic Standard Deviation

The graphic standard deviation ($\sigma_1$) is the measure of sorting or uniformity of particles size distribution and it is calculated by the formula $\phi_{84} - \phi_{16} / 4 + \phi_{95} - \phi_{5} / 6.6$. The values obtained range from $0.373 \phi$ (well sorted) to $0.652 \phi$ (moderately well sorted) and average standard deviation (fig.2) value is $0.482 \phi$ in the kameshwaram region.68% of samples fall in well sorted nature. 32% of samples fall in moderately well sorted. Well sorted character of sediments indicates a sudden winnowing or back and forth motion by the depositing agent. The moderately well sorted nature of samples indicates the effect of the back and forth flows of thin sheets of water from breaking waves.

Graphic Skewness

The graphic skewness (Sk1) measures the systematic of the distribution or predominance of coarse or fine-sediments. It is calculated by the formula $\phi_{84} + \phi_{16} - 2(\phi_{50}) / 2 (\phi_{84} - \phi_{16}) + \phi_{95} + \phi_{5} - 2(\phi_{50}) / (\phi_{95} - 2(\phi_{5})$. The negative value denotes coarse skewed material, whereas, the positive value represents more material in the fine-tail i.e. fine skewed. The skewness value ranges from -1.695(coarse skewed) to 0.228 (fine skewed). However, there is a dominance of near-symmetrical category having 55 samples followed by 20samples of fine-skewed category. The coarse-skewed and very coarse skewed categories are represented by13 and 7 samples respectively (Fig.2). In general, the sediments show the tendency of more material in fine tail.

Graphic Kurtosis

The graphic kurtosis (KG) is the peakedness of the distribution and measures the ratio between the sorting in the tails and central portion of the curve. If the tails are better sorted than the central portions, then it is termed as platykurtic, whereas, leptokurtic, if the central portion is better sorted. If both are equally sorted then mesokurtic condition prevails. The values obtained range from 0.757 (platykurtic) to 1.639 (very platykurtic), however, there is a dominance of leptokurtic sediments ranging from 1.111 to1.442, represented by 19
samples (Fig.2). The mesokurtic condition is represented by 11 samples, the platykurtic and very platykurtic conditions are equally represented by 5 samples each. This is having high fraction of fine-grained sediments.

**Linear discriminant function (LDF)**

According to Sahu (1964) in the variations in the energy and fluidity factors seen to have excellent correlation with the different processes and the environment of deposition. All the samples Y1 values are fall under Aeolian processes Y2 values of the samples are indicating that 98% of fall in shallow agitated water and the rest in beach process category. Y3 values all the samples exhibits shallow marine condition of deposition. 95% of Y4 values of sample falls under turbidity deposition and 5% of sample fall in fluvial (deltaic) condition.

**INTER-RELATIONSHIP OF SIZE PARAMETERS**

The inter-relationship of specific size-parameters is significant to interpret various aspects of depositional environment, as the textural parameters of the sediment are often environmentally sensitive (Folk and Ward, 1957; Passega, 1957; Friedman, 1961, 1967; Moiola and Weiser, 1968; Visher, 1969). Mean vs standard deviation plot of the present samples, shows the nature of the sediments are dominantly bimodal, of which, the all samples are fine sand category. Which makes the admixture well sorted to moderately well sorted nature. The mean vs skewness shows bimodel nature. This is due to the mixture of two size classes of sediments. In general, the ideal fractions are nearly symmetrical but the mixing produces either positive or negative skewness depending upon the proportions of size-classes in the admixture.

The present values were mostly falling in the positive skewed zone of the graph; however, a few samples are negatively skewed, in the mean-size range. It clearly indicates the nature of sediments with higher percentage of sand. The relation between mean-size and kurtosis is complex and theoretical. The plot denotes the mixing of two or more size-classes of sediments, which basically affect the sorting in peak and tails i.e. index of kurtosis. It shows that the sediment-admixture is dominated by fine-sand. Similarly, the plot between skewness and standard deviation produce a scattered trend that in the form the skewness is decreases, standard deviation improves and it may be due to two conditions i.e. either unimodal samples with good sorting or equal mixture of two modes (Ashok et al., 2009). The plot between standard deviation and kurtosis, shows most of the samples are leptokurtic and well sorted because the entire samples are fine sand-size sediments. The plot between skewness vs kurtosis depends more or less on equally scattered and it may be due to the dominance of fine sand size sediments. So, in this coastal track, wave regime is characterized by short period waves which gave rise to erosion. Along with high wave energy regime, influx of sediments due to river discharge resulted in fine grained, wellsorted and near symmetrical nature of beach sediments. Well sorting, sorting wash, backwash and high turbulence result in bimodal to trimodel character.

The scatter plotted (Fig.5a) between mean grain size and standard deviation reveals that the grain size increases, which decreases sorting. The concentration of fine grained sediments at kameswaram region shows that they are carried away by the coastal processes. Coarser grain size and poor sorting nature indicate low energy environment. Lower energy levels permit as well as transportation of a much wider range of finer sediments. In the plot mean vs skewness, the mean size decreases, sediments become well sorted as well as more negatively skewed (Fig. 5b). It is noticed that moderately well sorted sediments are more negatively skewed, probably of fluvial origin. The relation between mean vs kurtosis indicates that the most of the samples fall under leptokurtic category (as shown in Fig. 5c). The influence of sediment supply and wave energy on the
mean grain size of the beach sediments is further evaluated in the recent study. All the sediments are fine grain nature. It is may be due to the influence of the turbidity sediment. The plot describing relation between skewness and standard deviation produces a scattered trend (Fig.5d) which shows the increase in skewness leads to decrease in standard deviation. This may be due to the variations under the influence of littoral currents. The plot between standard deviation and kurtosis shows most of the samples are leptokurtic and well sorted because of the dominance of fine sand-size sediments (Fig. 5e). The plot between skewness vs kurtosis (Fig. 5f) shows most of the samples are leptokurtic to near symmetrical.

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 kameshwaram by CM pattern. Parameter C (one percentile of the grain size distribution) and M (Median) were plotted for Phi values of the C and M obtained from the cumulative curves in microns (fig). The relationship 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 into 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 kameshwaram sediments samples fall in bottom suspension and rolling field.

CONCLUSION

Grain size analysis of forty sediment samples shows that the cumulative curves are dominant which indicates the dominance of fine grained nature of the sediments. The graphic mean value indicates the dominance of fine sand particles. The sediments, in general, well sorted to moderately well sorted are dominantly near-symmetrical to fine-skewed in nature. In majority of the cases, both peak and tails are equally sorted giving rise to leptokurtic condition. Various bivariate plots between mean, skewness, kurtosis and standard deviation explain the dynamic process operating in the region together with the influence of turbidity conditions. The bimodal nature of sediment indicates that the sand-size is the principle mode. The sediments are mostly rolled and deposited by traction currents; however, a few samples showing suspension mode. It may be due to more input of fine grained material. Variations of grain size characteristics along this beach are believed to have resulted from wave refraction and long shore currents. This study demonstrates the usefulness of selecting several depths to better understand beach environment of deposition.

References


Passega, R signficance of cm diagrams of sediments deposited by suspension sedimentology 24, 723-733, 1977.


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