Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 1, p. 40-56, 2016
http://www.innspub.net

INNSPUB
RESEARCH PAPER

OPEN ACCESS

Sediments grain size analysis from the Eastern Makran coast line area, Pakistan

Syed Waseem Haider*

National Institute of Oceanography, Karachi, Pakistan

Article published on July 13, 2016

Key words: Grain Size analysis, Makran coastal area, Statistical parameters.

Abstract

The grain size analysis for the surficial sediment samples from Sur Bandar, Koh Mehdi, Ganz, Pishukan, Gwader and Jiwani area of Balochistan was carried out. Eighteen stations marked on the ground for the collection of sediment samples. A 3-Dimensional Mechanical Sieve shaker Octagon Digital shaker was selected for the grain size analysis. Probability paper prepared for cumulative frequency curve by plotting grain size (in phi scale) versus cumulative percent. Cumulative frequency curve used to obtain the phi value of the percentiles 5%, 16%, 25%, 50%, 75%, 84% and 95% from the plot. These phi values were used in calculation of some important statistical parameters just like mean, kurtosis, skewness and standard deviation. Graphic mean distribution of grain size for the analyzed sediments suggested that most of samples are very fine to fine grained sand with only two being medium grained sand. Standard deviation explain the sorting of the grain size of the sediment sample which are very well sorted to moderated sorted with few poorly sorted. Skwness showed that particle population are very fine skewed to very coarse skewed. The results of kurtosis explained that 11 % of sediment samples are in category of extremely Leptokuritc, 38.8 % are very Leptokurtic, 16.6% are Leptokuritc, 16.6 % are very Platykurtic and 11% are Mesokurtic. Physical characteristic of the samples shows that 91.3% to 100% are sand in the samples and 0 to 8.7 % are Silt/Clay.

***Corresponding Author:** Syed Waseem Haider ✉ waseem551@gmail.com

Introduction

Particle size is an important textural parameter of clastic rocks because it supplies information on the conditions of transportation, sorting, and deposition of the sediment and provides some clues to the history of events that occurred at the depositional site prior to final indurations. Determining the sizes of the discrete particles that constitute a sedimentary rock can be difficult, particularly if the rock is firmly indurated (cemented, compacted, and lithified). Various methods of measuring grain-size distribution have been devised; likewise several different grade-size schemes exist. Sedimentology defines the grain-size distribution in the sedimentary deposits with reference to environmental interpretation.(Patric and Donald, 1985).The grain size distribution is a simple and informative test executed to classify soils. (Fredlund *et al.,* 2000).

For siliciclastic sedimentary rocks, some important standard statistical measures are conventionally used for grain-size distribution.(1) mode, the most frequently occurring particle size or size class, (2) median, the midpoint of any grain-size distribution,(3) mean, an estimate of the arithmetic average particle size, (4) sorting or standard deviation a measure of the range , scatter, or variation in grain size, (5) skewness, the degree of symmetry or asymmetry of gain-size distribution, which is in turn a function of the coincidence or noncoincidence of mean , median, and mode, and (6) Kurtosis (peakedness) of a grain-size distribution, which compares sorting in the central portion of the population with that in the tails. Depositional environment of sediments widely study by the textural attributes of sediments, mean, sorting, skewness and kurtosis. (Angusamy and Rajamanickam, 2006).

Many researchers have been done systematic granulometric studies of east and west coasts of India (Ramanathan *et al.,* 2009; Anithamary *et al.,* 2011; Rajiamanickam and Gujar, 1984, 1993; Chaudhri *et al.,* 1981; Rao *et al.,* 2005, Angusamy and Rajamanickem, 2006, 2007; Suresh Gandhi *et al.,* 2008) but there is very limited literature is available on the concentration and distribution of surficial sediment of Makran coastal area of Pakistan. (Choudry *et al.,* 2010). The aim of this paper to present the results of grain size analysis of surficial sediment from the Sur Bandar, Koh Mehdi, Ganz, Pishukan, Gwader and Jiwani area along the eastern Makran Coast of Pakistan.

Materials and methods

Study Area

Makran coastal area of Baluchistan has a length of 600 Km from Hub River to the Dasht River near the Iranian border (Delisle *et al.*, 2002). Makran coastal belt has narrow continental shelf which is less than 25 Km and a steep continental slope which is approximately 90 km wide- (Rad *et al.,* 2000). The study area covers from Jiwani to Sur Bandar along makran coast of Pakistan (Fig. 1). Sediment sample stations in the major areas are define in the Table 1.

Table 1. General distribution of sediment sample station among the major areas from the Sur Bandar to Jiwani.

Site of Sample Collection	Total Stations	Station No.
Gwader East Bay	3	1,2,3
Gwader West Bay	5	6,7,8,9,10
Koh Mehdi	1	4
Sur Bandar	1	5
Pishukan	3	16,17,18
Ganz	3	13,14,15
Jiwani	2	11,12

Sampling Techniques

Balochistan's shores have beautiful sandy beaches. Rocky shores and cliffs are widespread in Balochistan (Baloch *et al.*, 2014). Conglomerates of soft mudstone and sandstone are played main role in the formation of Rocky shores and cliffs in this region, which are highly vulnerable to erosion (Akhtar *et al.*, 2013). Headlands are common prominent feature in Jiwani, Pisukan, Gawadar, Rasjaddi and Ormara, and alluvial deposits are interfered as low-lying places between the headlands.

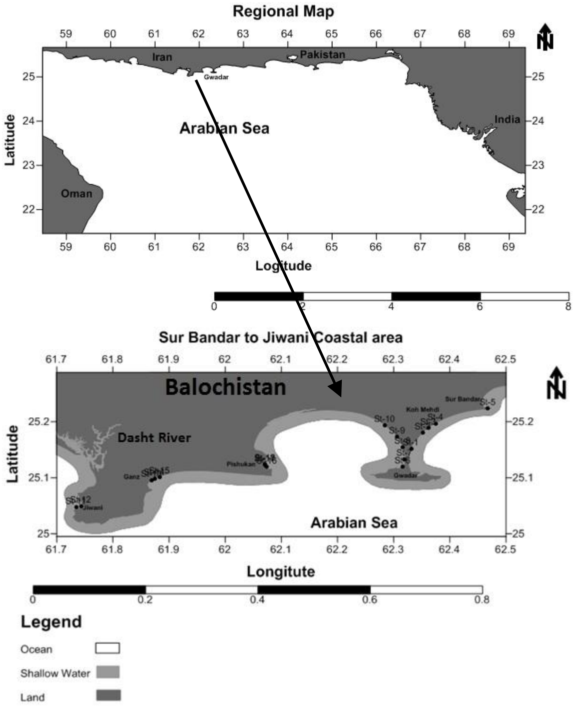


Fig. 1. Showing study area.

Locations of Six major areas where the sediment samples were collected along the Markran coastal area show in (Fig. 2 and 3). They are Sur Bandar, Koh Mehdi, Ganz, Pishukan, Gwader and Jiwani. Global Positioning System (GPS) receiver are used for the recording the location of each sampling point. A field Survey conducted for the collection of sediment sample at the rim, wet area, and dry area from the select banks area. 54 sediment samples were collected in this study area. It means that 3 sediment samples from each of the 18 sampling station along the entire course of the coastal area of Makran. The locations of sampling stations were also depending on the terrain and accessibility in this remote area. 1 Kg samples were collected from the each sample location. Zip able plastic bags were used for the packing of each sample then they tied labelled and transported to National Institute of Oceanography (NIO) laboratory and leaved under the sunlight for 7th hours.

Grain-Size Analysis

Many interpretation and analytical techniques are in practice to calculate the grain size distribution. Two of them are popular to determine the grain sizes, one of them is called sieving and other is called settling tube technique. The sieving method works on the assumption that sediment grains are spherical. Stoke's law are used in the settling tube technique. This technique used to measure the settling velocity of grains in the medium, and translate this to size scale (Fay, 1989; Baba and Komar, 1981; Komar and Cui, 1984).

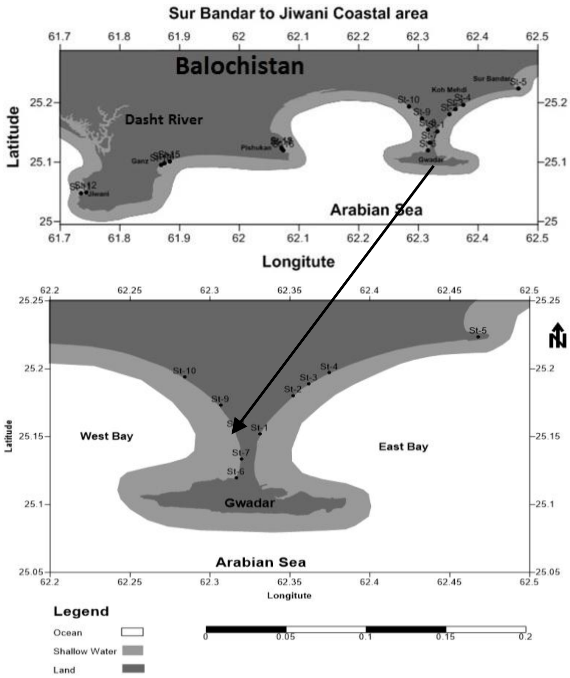


Fig. 2. Showing sampling points ST-01 to ST-10.

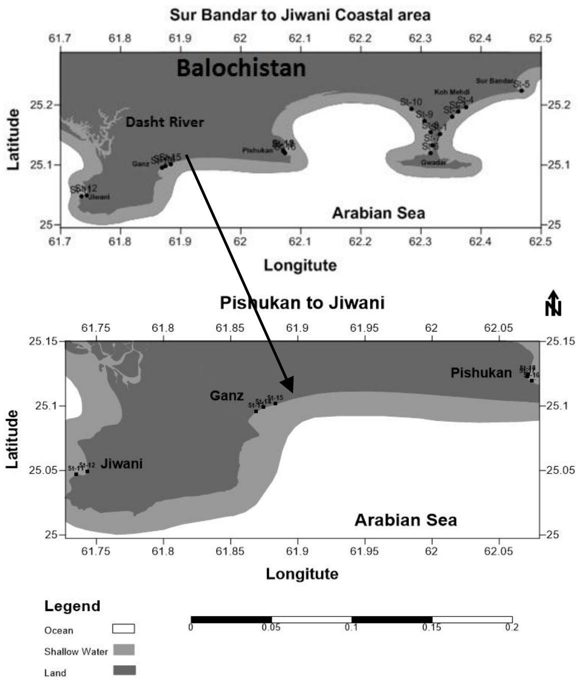


Fig. 3. Sampling points ST-11 to ST-18.

Surficeal sediment samples collected along the selected area of coastal belt of Makran Coast. Their analyzation processes were carried out in the Geology Laboratory of the Geology and Geophysical Section of National Institute of Oceanography. The Individual grain size of sediment samples were measured in this analysis. These samples put in the Oven at the 250°C where they were air dried and stored in moisture free environment. Octagon Digital shaker was selected for the analysis of sediment sample by using 3D Digital sieving method.

Each sample of 500 grams was disaggregated using a porcelain mortar and pestle. After the disaggregation of samples were properly mixed and split into quartes. National Institute of Oceanography (NIO) has two balances first one is Electronic Balance (ESJ210A) and second is Libror AEU-130 with a precision 0.011 gram. Octagon Digital shaker equipped with a set of England mesh sieves of 1.00, 0.50, 0.25, 0.125, 0.063 mm and a receiving pan. Each sample was then sorted into this set of sieves. The fraction retained in each sieve and the pan was weighted in one of the NIO's balance and its weight recorded and tabulated. The percentage aggregate was expressed in percentage.

The individual sample weight and cumulative weight percentage were calculated and recorded in tabular form. The grain size was plotted on the x-axis and Cumulative frequency curve was plotted on the y-axis, in this way a pictorial chart created (Fig. 8 and 9) where histogram views the grain size distribution and individual sample weight (in %) of each sample (Fig. 4 and 5). Prepared the probability graph paper by plotting of cumulative frequency curve (ogive) and grain size in phi scale (Fig. 6 and 7) . (Inman, 1952; Trask, 1932; Folk and Ward, 1957; Friedman and Sanders, 1978). Ogive curve provides the value of phi in 5%, 16%, 50%, 75%, 84% and 95%. These phi values are used for the calculation of following statistical parameters define in the equation in Folk & Ward, 1957. These equations are related to the Mean, median, standard deviation, skewness and kurtosis.

Median: It is mark at the middle of the cumulative curve which shows the diameter of the grain.

Graphic mean.

$$M_z = \varphi(16+50+84) / 3$$

Sorting – Inclusive Graphic Standard Deviation

$$\Phi(84-16)/4 + \varphi(95-5)/6.6$$

< Φ 0.35	Very well sorted
Φ 0.35 to Φ 0.5	Well sorted
Φ 0.50 to Φ 0.71	Moderately well sorted
Φ 0.71 to Φ 1.0	Moderately sorted
Φ 1.0 to Φ 2.0	Poorly sorted
Φ 2.0 to Φ 4.0	Very poorly sorted
> Φ 4.0	Extremely poorly sorted

Inclusive graphic skewness

$$S_k = [(\Phi16 + \Phi84 - 2\,\Phi50) / 2\,(\Phi84 - \Phi16)] + [(\Phi5 + \Phi95 - 2\,\Phi50) / 2\,(\Phi95 - \Phi5)\,]$$

Φ 1.0 to Φ 0.3	Very fine skewed
Φ 0.3 to Φ 0.1	Fine skewed
Φ 0.1 to Φ -0.1	Near Symmetrical
Φ -0.1 to Φ -0.3	Coarse-skewed
Φ -0.3 to Φ -1.0	Very coarse skewed

Graphic Kurtosis

$$K_G = (\Phi95 - \Phi5) / 2.44\,(\Phi75 - \Phi25)$$

< Φ 0.67	Very Platykurtic
Φ 0.67 to Φ 0.90	Platykurtic
Φ 0.90 to Φ 1.11	Mesokurtic
Φ 1.11 to Φ 1.50	Leptokuritc
Φ 1.50 to Φ 3.00	Very leptokurtic
> Φ 3.00	Extremely leptokurtic

Results

Graphic representative such as frequency curve and histogram of the data produced the mean grain size, sorting, kurtosis, median and Skewness. The histogram plots (Fig. 4 and 5) show the frequency of grains in each size class. The cumulative frequency curves (Fig. 6 and 7) give a direct impression of the grain size distribution (Fig. 8 and 9).

Mostly sediment samples have a unimodal and bimodal behaviour except few one which show relatively polymodal behaviour that mean sands were derived from a more than one source area.

During present research following results of sediment sample obtain by the statistical parameters.

Graphic mean

Stations ST-01, ST-02 and ST-03 of Gwadar east Bay has very fine sand, Koh medi in the ST-04 showes fine sand. ST-05 in Sur Bander has very fine sand. ST-06 is the only Gwadar west bay station which have medium size sand and remaining Stations ST-07, ST-08, ST-09 and ST-10 have very fine sand.

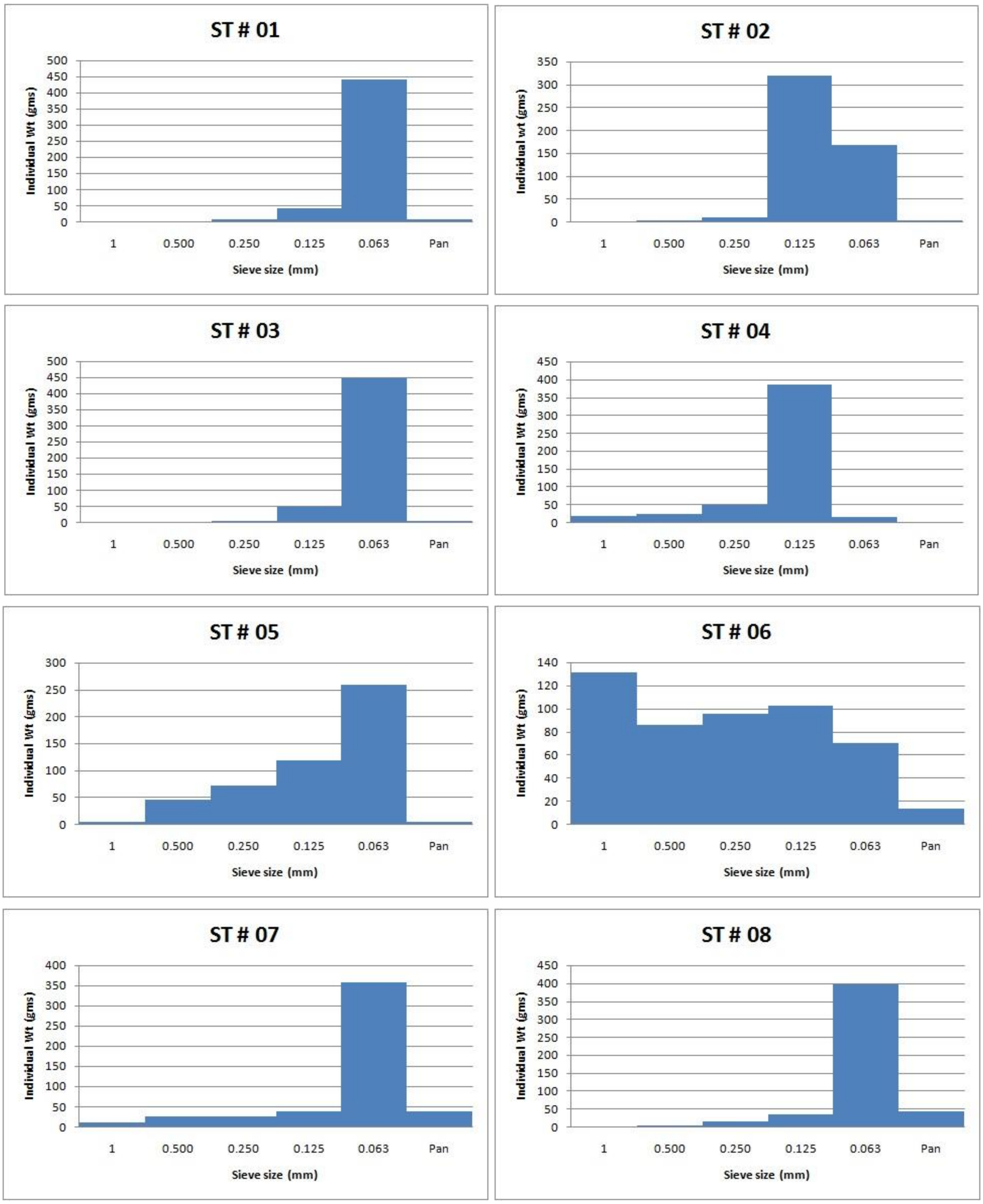


Fig. 4. The histogram plot from ST-01 to ST-08.

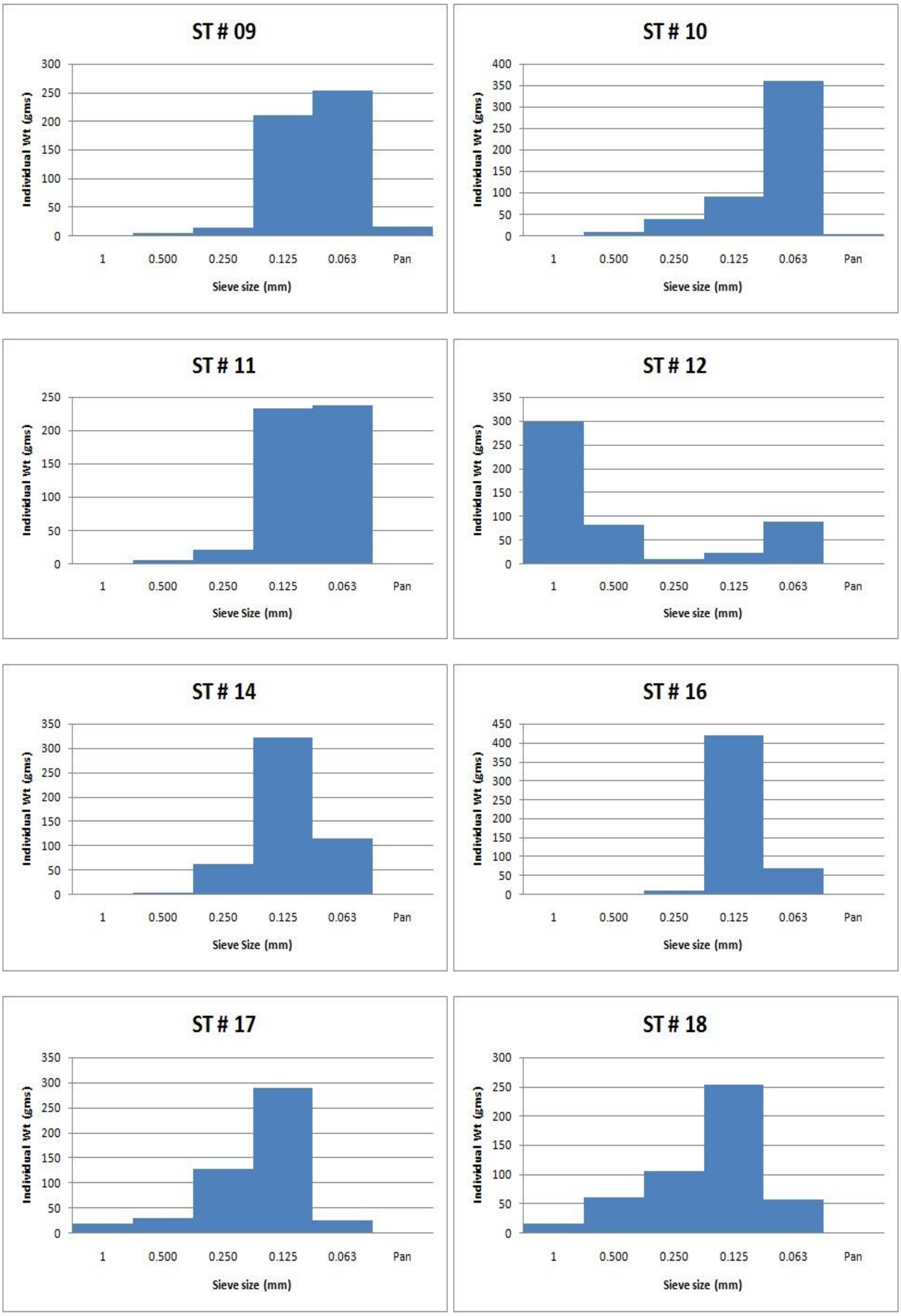


Fig. 5. The histogram plot from ST-09 to 12, 14, 16-18.

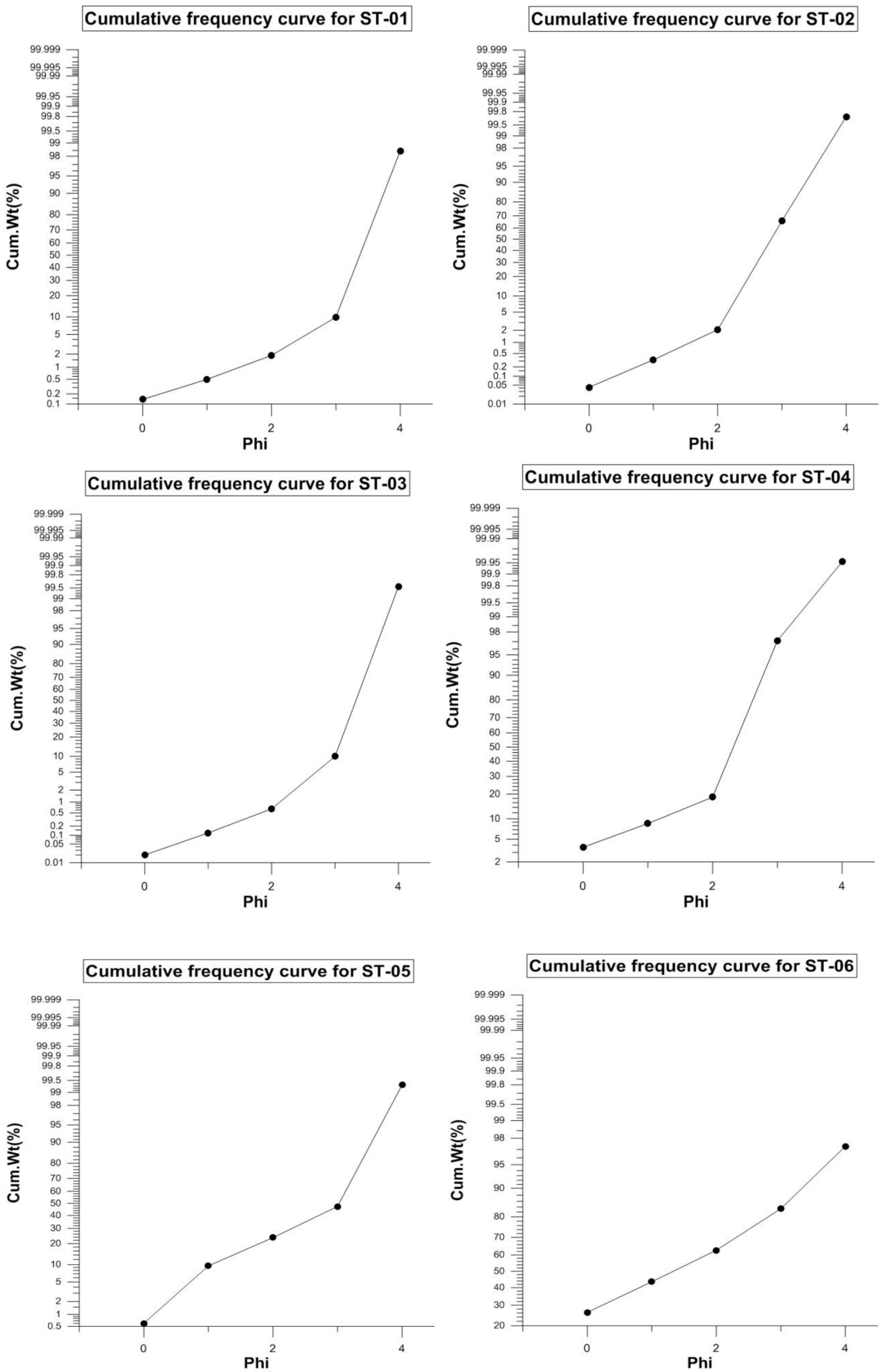


Fig. 6. Cumulative frequency Curve from ST-01 to ST-06.

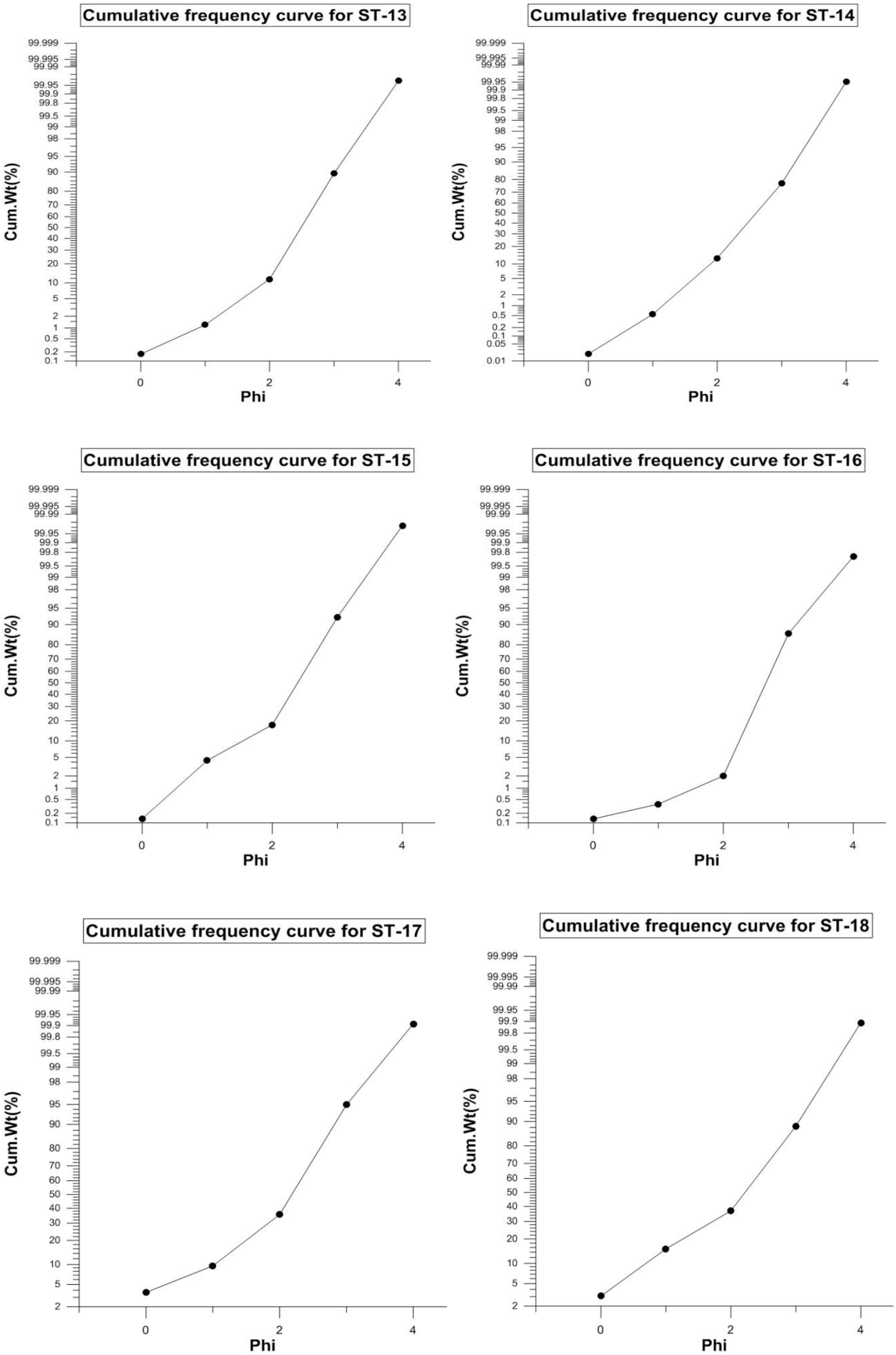


Fig. 7. Cumulative frequency Curve from ST-13 to ST-18.

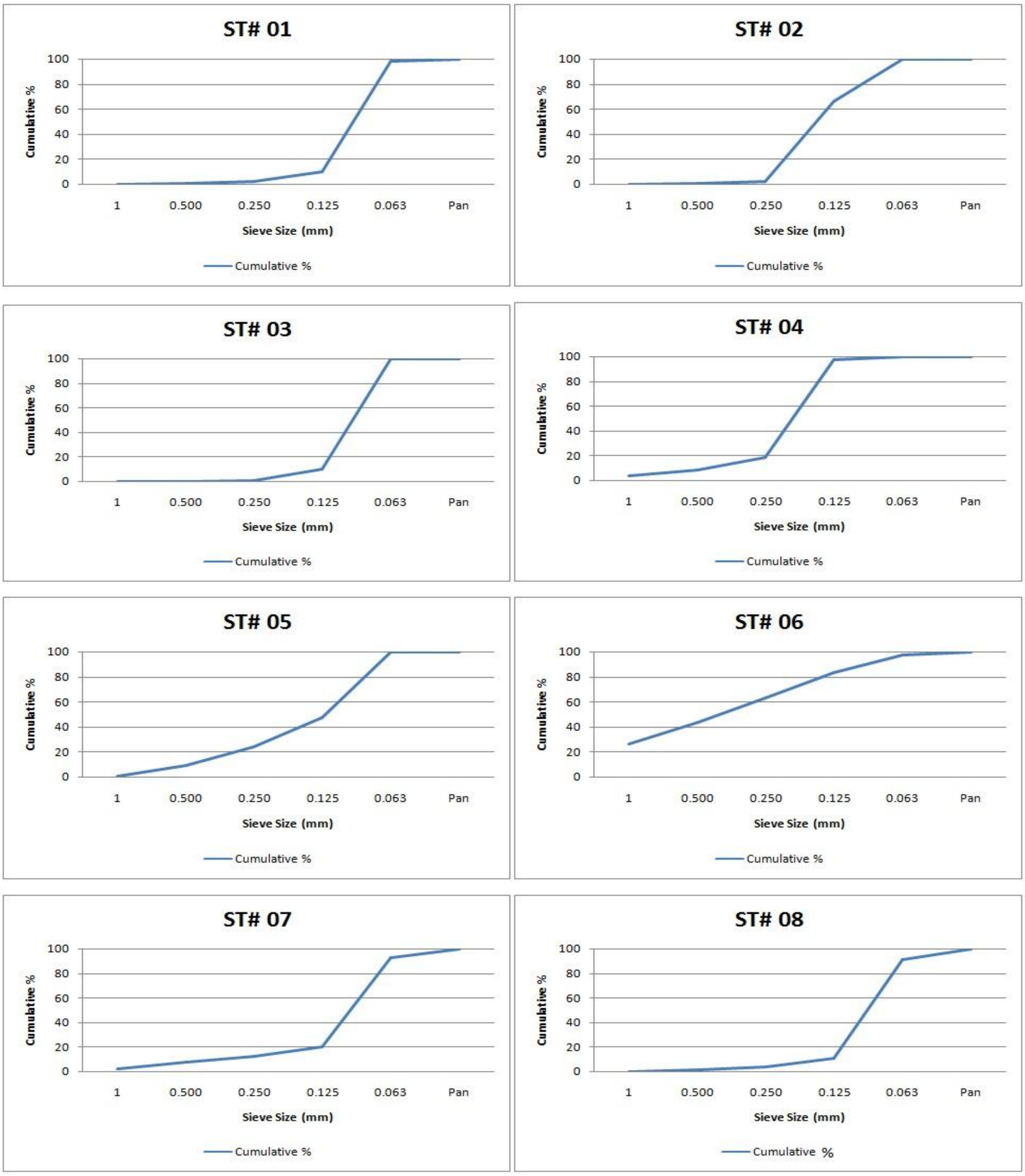
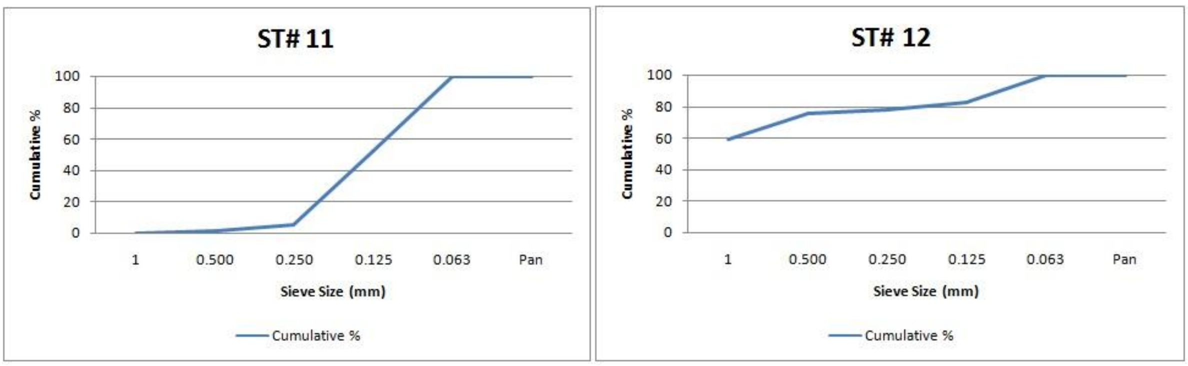


Fig. 8. The Cumulative frequency curve from ST-01 to ST-08.



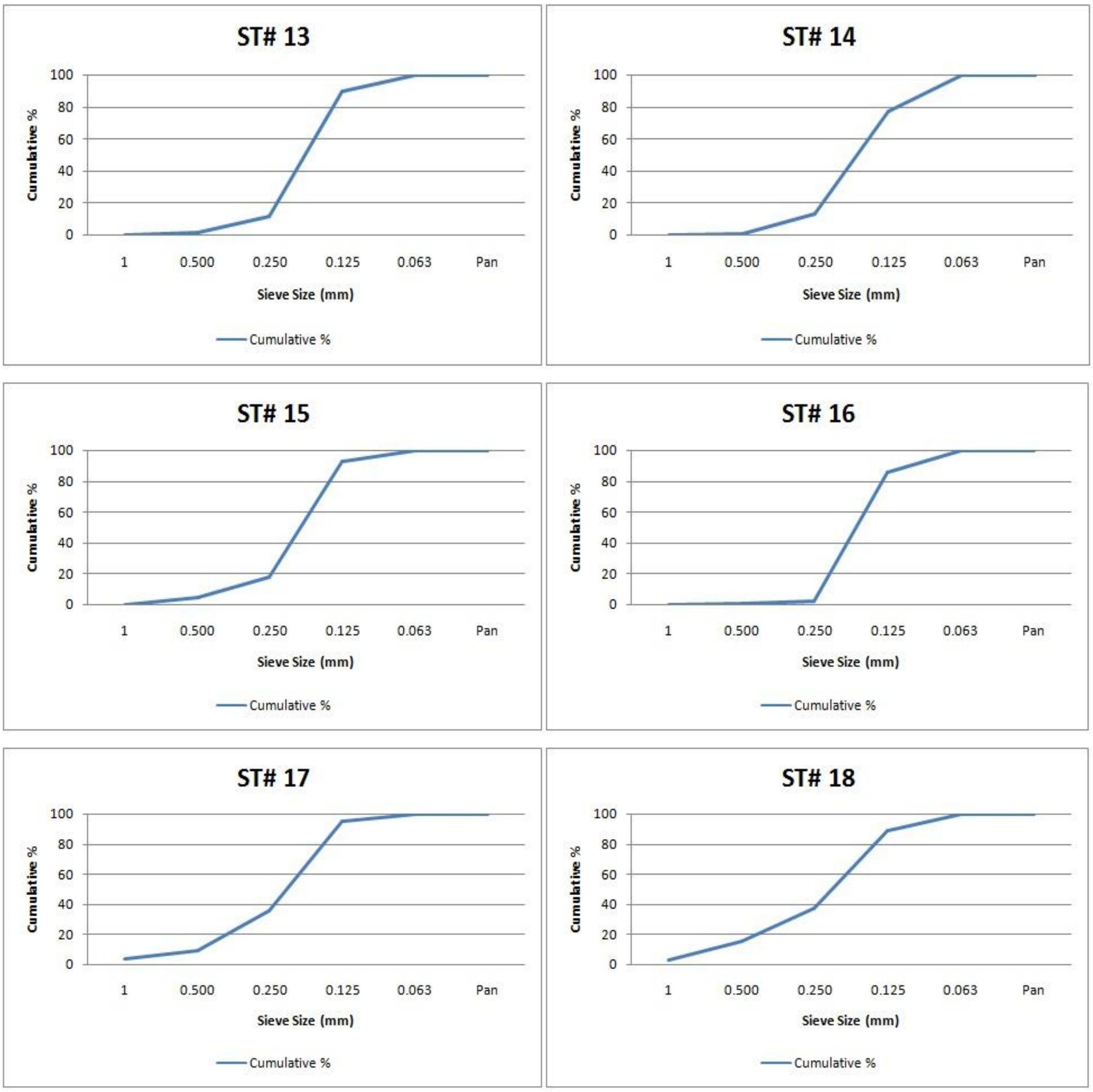


Fig. 9. The Cumulative frequency curve from ST-11 to ST-18.

ST-11 of the Jiwani has very fine sand while ST-12 reveals medium size sand. Stations ST-13, ST-14 and ST-15 belong to Ganz, they have fine sand. Pishukan has Stations ST-16, ST-17 and ST-18 which indicated find sand in the Pishukan.

Sorting

Stations ST-01 and ST-03 of Gwadar east Bay are very well sorted and ST-2 has grains moderately well sorted. ST-04 of Koh mehdi has moderately well sorted in particles. ST-05 in Sur Bander has poorly sorted grains. Gwadar west Bay has a variety in sorting.

ST-08, ST-09 and ST-10 of Gwadar west bay are moderately well sorted in particle while ST0-07 of Gwader west bay has moderately sorted grains and ST-6 of Gwader west bay has poorly sorted in particle.

ST-11 of Jiwani has moderately well sorted particle while ST-12 of Jiwani has poorly sorted grains. Ganz has ST-14 and ST-15 which are moderately well sorted grains. Which ST-13 of Ganz has well sorted particle. ST-17 and ST18 belong to Pishukan, both have moderately sorted grains and ST-16 of Pishukan has very well sorted particle.

Skewness

Stations ST-01 and ST-03 of Gwadar east Bay are coarse skewed and ST-02 of Gwadar east Bay has fine skewed. ST-04 belong to Koh mehdi and has very coarse skewed. ST-05 of Sur Bander is very coarse skewed. ST-07, ST-09 and ST-10 belong to Gwadar west Bay shows very coarse skewed while ST-06 of Gwadar west Bay is symmetrical and ST-08 of Gwadar west Bay is fine skewed.

ST-11 and ST-12 of Jiwani are fine skewed. ST-13 of Ganz is symmetrical and ST-14 of Ganz shows fine skewed while ST-15 of Ganz indicates very coarse skewed. ST-17 and ST-18 of Pishukan are very coarse skewed.

Kurtosis

Stations ST-01 and ST-03 of Gwadar east Bay are very Leptkurtic while ST-02 of Gwadar east Bay is very Platykuritc. Koh mehdi in ST-04 shows very Leptokurtic. Sur Bander in ST-05 indicates Mesokurtic. ST-07 and ST-08 belong to Gwadar west Bay are extremely Leptokurtic and ST-06 and ST-09 of Gwadar west Bay are very Platykurtic. ST-10 of Gwadar west Bay is mesokurtic.

ST-11 of Jiwani is Platykurtic and ST-12 of Jiwani is Leptokuritc. ST-13, ST-14 and ST-15 of Ganz demonstrate very Leptokurtic. ST-16 of Pishukan shows very Leptokurtic while ST-17 and ST-18 of Pishukan indicate Leptokurtic.

Sediment sample collected along the coast of Balochistan region in six areas which are contained in eighteen sample stations. Statistical analysis of Gwadar east Bay shows very fine sand, grains are very well sorted to moderately well sorted .This region has very fine skewed to coarse skewed and Leptokurtic to Platykurtic. Gwader west bay indicates very fine sand to medium size sand. Particle are poorly sorted to moderately well sorted, this area has symmetrical to coarse skewed and Leptokurtic to Platykurtic. Jiwani demonstrates very fine sand to medium sand. Grains are poorly sorted to moderately well sorted. This region has very fine skewed to fine skewed and Leptokurtic to Platykurtic. Ganz reveals fine sand. Particles are moderately well sorted to well sorted. This area has symmetrical to very coarse skewed and Leptokurtic. Pishukan shows fine sand. Grains are moderately sorted to very well sorted. This region has fine skewed to very coarse skewed and Leptokurtic.

Discussion

Depositional environment of Sediment deposition in beaches depending on a number of factors such as host rocks in the province, climate conditions at that time in the area, agents and transportation and hydraulic condition during deposition (Borreswar, 1957). The sediments input into the sea from the river will be redistributed by waves and currents according to their size, densities and shape. (Kumar and Wang, 1984). The concentration of sediments depend on the hydrodynamic conditions like wave energy , long shore current and wind spread which control littoral transport, sorting and deposition of sediments in suitable location (Rao *et al.* 2001).

Correlation between transport processes/depositional mechanisms of sediments and size parameters has been established by exhaustive studies from ancient and many modern sedimentary environments (Suresh Gandhi *et al.,* 2008; Wang *et al.,* 1998; Friedman. 1967; Valia and Cameron, 1977; Ramamohanarao *et al.,* 2003; Asselman, 1999; Anithamary *et al.,* 2011; Mason and Folk, 1958; Folk and Ward, 1957; Visher, 1969; Malvarez *et al.,* 2001). There is very limited literature is available on the concentration and distribution of surficial sediment of Makran coastal area.

Grain size analysis provided the statistical parameters for sediment samples and plotting of cumulative frequency and histogram prepared by these statistical parameters. From this graphical plotting, Statistical size frequency parameters such as the graphic mean (mean size), skewness and sorting and kurtosis were calculated using various percentile values (Table 2).

Table 2. Percentile value for grain size analysis.

Sample Location	5%	16%	25%	50%	75%	84%	95%
ST-01	2.7	3.19	3.3	3.53	3.78	3.81	3.95
ST-02	2.21	2.5	2.6	2.85	3.12	3.3	3.78
ST-03	2.8	3.1	3.2	3.3	3.45	3.52	3.7
ST-04	0.55	1.8	2.1	2.31	2.6	2.7	2.91
ST-05	0.75	1.6	2.1	3.1	3.3	3.42	3.69
ST-06	-1	-1	-0.05	1.3	2.5	3.0	3.71
ST-07	0.7	2.6	2.05	3.4	3.65	3.8	4.1
ST-08	2.22	3.1	3.2	3.45	3.73	3.9	4.1
ST-09	2.08	2.5	2.7	3.05	3.4	3.55	3.85
ST-10	1.67	2.42	2.85	3.2	3.4	3.5	3.7
ST-11	1.7	2.25	2.45	2.9	3.2	3.32	3.58
ST-12	-1	-1	-1	-1	1.7	3.01	3.35
ST-13	1.6	2.1	2.2	2.5	3.75	2.9	3.2
ST-14	1.62	2.08	2.22	2.6	2.95	3.1	3.34
ST-15	1.05	1.85	2.1	2.4	2.67	2.81	3.1
ST-16	2.1	2.3	2.4	2.6	2.82	2.95	3.3
ST-17	0.3	1.35	1.7	2.2	2.52	2.7	3.05
ST-18	0.25	0.95	1.5	2.2	2.65	2.9	3.22

Graphic Mean

The mean size can be define as the available materials has a size range and current velocity or turbulence of the transporting medium has an amount of energy which has an impacted to the sediment.

Analysed sediments are divided in to the grain size distribution and the mean value of the distribution is 2.857. Graphic mean distribution has sediments spread from 1.030 to 3.724. This shows that sand is very fine to fine grained sand with only two being medium grained sand. This result is supported the interpretation of depositional environment of the sediments was very low energy. When transportation medium has a tendency to decrease in energy, the result shifted to becoming the finer sediments in the deposition. (Folk, 1974, Eisema, 1981)

Sorting

Sorting is defined by the standard deviation. It is used to measure range of the grain size distribution with respect to mean.

One of the most useful grain size data is sorting, which provide the information about the effectiveness of depositional in medium in different grain size classes.

Mean value of the standard deviation is 0.718 and the range of the standard deviation is from 0.286 to 1.6193 in the analysed sediments. Various environment of sand can be predicate by various rang of sorting in sandstones (Freidman, 1961a). It is explain in the Table 3. Present research supported that most of samples are very well to moderate sorted with few sample are poorly sorted (Table 4). This is predicting that low to fair energy current (Fridman 1961a; Blott and Pye 2001).

Skewness

Depositional process can be indicating by skewness. Symmetry of the distribution can be measure by this method. Skewness is directly related to the fine and coarse tails of the size distribution so it is useful in environmental analysis, Such as indicative of energy of deposition.

Finer grain sizes indicate towards the positive values in the skewness and coarser grain sizes indicate towards the negative values. Here analysed sediment sample has a values range from -0.701 to 0.8424 thus skweness supported the statement that sediments are very fine to very coarse skewed in population of particles. Analysed sediment samples has a tendency toward the finer grain size, to it may be river sediments.

Table 3. Classification of Sands (Friedman, 1961a; Blott and Pye, 2001).

Ranges of Values of Standard Deviation (Φ units)	Sorting class	Environments of sandstones
<0.35	Very well sorted	Coastal and lake dunes; many beaches (foreshore) common on shallow marine shelf.
0.35 – 0.50	well sorted	Most beaches (foreshore); shallow marine shelf, Many inland dunes
0.50 – 0.80	moderately well Sorted	Most inland dunes; most rivers; most lagoons, distal marine shelf
0.80 – 1.40	Moderately Sorted	Many glacio- fluvial settings; many rivers; some lagoons; some distal marine shelf.
1.40 – 2.00	Poorly sorted	Many glacio-fluvial settings
2.00 – 2.60	Very poorly sorted	Many glacio-fluvial settings
> 2.60	Extremely Poorly sorted	Some glacio-fluvial settings

Kurtosis

Kurtosis has a value range from 0.5897 to 5.2441. Kurtosis shows that sediment sample are predominantly leptokurtic (Table 4) and it is divided in term of percentage in such a way that 11% of sediment sample are extremely Leptokurtic, 38.8% are very Leptokurtic, 16.6% are Leptokurtic, 16.6% are very Platykurtic, 11% are Mesokurtic. This is suggested tidal or fluvial environment that shows sands are river deposited.

According to Friedman (1962) low or extreme high value of kurtosis involve that part of sediment achieved it sorting elsewhere in high-energy environment. Any change in flow characteristic of the depositing medium can be predicted by the variation in the kurtosis. (Baruah *et al.*, 1997; Ray *et al.*, 2006) and the prominent of finer size of platykurtic nature of sediments reflects the maturity of the sand. This may be due to the accumulation of sediment grain size by compaction, and the variation in the sorting values are likely due to continuous addition of coarser/finer material in varying proportions(Ramanathan *et al.* 2009).

Table 4. Summary of results obtained from grain size analysis and its interpretation.

Sample	Mean Φ	Mode Φ	S.D Φ	Skewness Φ	Kurtosis Φ	Interpretation
ST-01	3.707	3.731	0.294	-0.297	1.820	Very fine sand, very Well sorted, coarse Skewed, very Leptokurtic
ST-02	3.068	2.737	0.505	0.498	0.613	Very fine sand, Moderately Well sorted, Very fine Skewed, very Platykurtic
ST-03	3.704	3.731	0.286	-0.292	1.773	Very fine sand, very Well sorted, Coarse Skewed, Very Leptokurtic
ST-04	2.489	2.737	0.617	-0.654	2.884	Fine sand, Moderately Well sorted, Very Coarse Skewed,

Sample	Mean Φ	Mode Φ	S.D Φ	Skewness Φ	Kurtosis Φ	Interpretation
						Very Leptokurtic
ST-05	3.020	3.731	1.013	-0.701	1.055	Very fine sand, poorly sorted, very Coarse Skewed, Mesokurtic
ST-06	1.658	-0.243	1.574	0.019	0.626	Medium sand, Poorly sorted Symmetrical, very Platykurtic
ST-07	3.443	3.731	0.992	-0.446	5.244	Very fine sand, Moderately sorted, very Coarse skewed, Extremely Leptokurtic
ST-08	3.724	3.731	0.584	0.127	4.012	Very fine sand, Moderately well sorted, Fine skewed, Extremely Leptokurtic
ST-09	3.333	3.731	0.532	-0.414	0.590	Very fine sand, Moderately well sorted, Very Coarse skewed, Very Platykurtic
ST-10	3.395	3.731	0.642	-0.655	1.042	Very fine sand, Moderately well sorted, Very Coarse skewed, Mesokurtic
ST-11	3.128	3.731	0.612	0.166	0.802	Very fine sand, Moderately well sorted, Fine skewed, Platykurtic
ST-12	1.030	-0.243	1.619	0.842	1.398	Medium sand, Poorly sorted, Very fine skewed, Leptokurtic
ST-13	2.733	2.737	0.428	-0.010	2.507	Fine sand, Well sorted, Symmetrical, Very Leptokurtic
ST-14	2.969	2.737	0.615	0.253	2.204	Fine sand, Moderately Well sorted, Fine skewed, Very Leptokurtic
ST-15	2.525	2.737	0.573	-0.319	2.475	Fine sand, Moderately well sorted, Very coarse skewed, Very Leptokurtic
ST-16	2.774	2.737	0.306	0.286	1.726	Fine sand, Very well sorted, Fine Skewed, Very Leptokurtic
ST-17	2.374	2.737	0.756	-0.459	1.143	Fine sand, Moderately sorted, Very coarse Skewed, Leptokurtic
ST-18	2.357	2.737	0.845	-0.396	1.146	Fine sand, Modertely sorted, Very Coarse skewed, Leptokurtic

Grain size distribution shows unimodal and bimodal with a few have nearly polymodal reveals that sand were not derived single source area.

Adjoining nearby Eastern side of the study area (Boundewari and Sonmiani) supported the above mention result in this way that Aeolian and marine actions have a significant role and concentration of the sediments depend on the shape of coastal geomorphology. The sediment distribution pattern suggests that settling velocity, current, specific gravity difference and differential transport have a important role in their distribution. (Choudry *et al.*, 2010).

Conclusion

Sedimentological studies have been used to research the origin of the sediment sample. Research shows that sample have unimodal and bimodal frequency distribution, which means sediment samples have not single provenance. Statistical texture studies indicate that sediments has medium to fine grained sand fraction, which provide the information that the sediments were deposited under low energy condition. Sediments shows very well sorted to moderate sorted, indicating texturally sub-matured to matured sediment of a fluvial or tidal environment.

References

Akhtar MK, Shuhab DK, Huseyin B, Aimal KK. 2013. Newly discovered mud volcanoes in the Coastal Belt of Makran, Pakistan-tectonic implications. Arab Journal of Geosciences **11**, 4899-4909. DOI 10.1007/S12517-013-1135-7

Angusamy NG, Rajamanickam. 2001. Mineralogy and chemistry of ilmenite from the beach placers of Mandapam to Kanyakumari region, Tamil Nadu. Handbook of Placer Mineral Deposits, New Academic Publishers, Delhi **1**, 158-170.

Angusamy NG, Rajamanickam. 2006. Depositional environment of sediments along the southern coast of Tamil Nadu India. Oceanologia **48(1),** 87-102.

Angusamy NG, Rajamanickam. 2007. Coastal processes of Central Tamil Nadu, India; clues from grain size studies. Ocenologia **49(1),** 41-57.

Anithamary I, Ramkumar T, Venkatramanan S. 2011. Grain size characteristics of coleroon estuary sediments, Tamilnadu, east coast of India. Carpathian Journal of Earth and Environmental Science **6(2),** 151-157.

Asselman NEM, 1999. Grain size trends used to assess the effective dishcharge for flood plain sedimentation. River Wall, the Netherlands. International Journal of Sediment Research **69**, 51-61.

Baba J, Komar PD. 1981. Measurements and analysis of settling velocities of natural quartz sand grains. Journal of Sedimentary Petrology **51,** 631-640.

Baloch AH, Rehman H, Saeed M, Kalhoro MA, Buzdar MA. 2014. The Curious Case of Mangroves Forest at the Sonmiani bay Area, Lasbela District, Pakistan: A review. Lasbela University Journal of Science and Technology **3,** 61-74.

Baruah J, Kotoky P, Sarma J. 1997. Textural and geochemical study on river sediments; a case study on the Jhanji River, Assam. Journal Indian Association of Sedimentoloists **16**, 195-206.

Blott SJ, Pye K. 1984.GRADSTAT: A grain size distribution and statistics package for the analysis of unconsolidated sediments. Earth surfaces processes and landforms **26**, 1237-1248 .

Borreswar RC. 1957. Beach erosion and concentration of heavy minerals. Journal sedimentary Petrology **27**, 143-147.

Chaudhri RS, Khan HMM, Kaur S. 1981. Sedimentology of beach sediments of the West coast of India. Sedimentary Geology Journal **30,** 79-94.

Choudry MAF, Nurgis Y, Hussain A, Abbasi HN. 2010, Distribution and percentage of Heavy Mineral along Makran Coasline of Pakistan. American Journal of Scientific Research **11**, 86-91.

Deslisle G, Rad VU, Andruleit H, Daniels CHV, Tabrez AR, Inam A. 2002. Active mud volcanoes on and offshore eastern Makran, Pakistan. International Journal of Earth Sciences (Geologische Rundschas) **81**, 93-110. DOI 10.1007/S00531 0100203.

Eisema D. 1981. Supply and deposition of suspended matter in the north sea. special publication of the International association of Sedimentologists **5**, 415-428.

Fay MB. 1989. Grain-size analysis program package, Department of Geology, University of Dar es Salaam, Tanzania.

Folk RL, Ward WC. 1957. Brazos river bar: A study in the significance of grain size parameters. Journal of Sedimentary Petrology **27**, 3-26.

Folk RL. 1974. Petrology of sedimentary rocks. Austin Texas: Hemphili Publication, Company 182.

Fredlund MD, Fredlund DG, Wilson GW. 2000. An equation to represent grain size distribution. Canadian Geotechnical Journal **37,** 817-827. http://dx.doi.org/10.1139/t00-015

Friedman GM, Sanders JE. 1978. Principles of Sedimentology, Wiley, New York 792 .

Friedman GM. 1961a. Distinction between dune beach and river sands from textural characteristics**.** Journal of Sedimentary Petrology **31**, 514-529.

Friedman GM. 1961b. On sorting, sorting coefficients and the log normality of the grain-size distribution of sandstones. Journal of Geology **70**, 737-753.

Friedman GM. 1967. Dynamic processes and statistical parameters compared for size frequency distribution of beach river sands. Journal of Sedimentary Petrology **37**, 327-354.

Gandhi SM, Solai A, Chandrasekaran K, Rammohan V. 2008. Sediment characteristics and heavy mineral distribution in Tamiraparani estuary and off Tuticorin, Tamil Nadu- SEM studies. E-journal Earth Science India **1(III),** 102-118

Inman DL. 1952. Measures for describing the size distribution of sediments. Journal of Sedimentary Petrology **22**, 125-145.

Jones HA, Hockey RD. 1964. The geology of South western Nigeria. Bulletin, Geological Survey 31-100.

Komar PD, Cui B. 1984. The analysis of grain-size measurements by sieving and settling-tube techniques. Journal of Sedimentary Petrology **54**, 603-614.

Malvarez GC, Cooper JAG, Jackson DWT. 2001. Relationship between waves induced currents and sediment grain size on a sandy tidal flat. Journal of Sedimentary Petrology **71**, 705-712.

Mason C, Folk RL. 1958. Differentiation of beach, dune and Aeolian flat environments by size analysis, Mustang Island, Texas. Journal of Sedimentary Petrology **28**, 211-226

Patric M, Donald B. 1985. The effects of sediment transport on grain size distribution. Journal of Sedimentary Petrology **55(4),** 0457-0470 .

Rad UV, Berner U, Delisle G, Dosse-Rolinski H, Fechner N, Linke P, Luckge A, Roeser HA, Schmaljohann R, Wiedicke. 2000. Gas and Fluid venting at the Makran accretionary wedge off Pakistan. (Geo-Marine letter 2000) Springer-Verlag **20**, 10-19.

Rajamanickam GV, Gujar AR. 1984. Sediment depositional environment in some bays on the Central West Coast of India. India Journal of Geo-Marine Sciences **13**, 53-59.

Rajamanickam GV, Gujar AR. 1993. Depositional processes inferred from the log probability distribution. In; Jhingran V (ed) Recent researches in sedimentology. Hindustan Publishing Corporation. Delhi, 154-164.

Ramamohanarao T, Sairam K, Venkateswararao Y, Nagamalleswararao B, Viswanath K, 2003. Sedimentological characteristics and depositional environment of Upper Gondwana rocks in the Chintalapudi sub-basin of the Godavari valley, Andhra Pradesh, India. Journal of Asian Earth Sciences **21**, 691-703.

Ramanathan AL, Rajkumar K, Majumdar J, Singh G, Behera PN, Santra SC, Chidambaram S. 2009. Textural characteristics of the surface sediments of a tropical mangrove Sundardban ecosystem India. Indian Journal of Geo-Marine Sciences **38(4),** 397-403.

Rao PS, Ramaswamy V, Thwin S. 2005. Sediment texture, distribution and transport on the Ayeyarwady continental shelf, Andaman Sea. Marine Geology **216(4),** 239-247.

Rao RG, Sahoo P, Panda NK. 2001. Heavy mineral sand deposit of Orissa. Exploration and Research for atomic Minerals **13**, 23-52.

Ray AK, Tripathy SC, Patra S, Sarma VV. 2006. Assessment of Godavari estuarine mangrove econsystem through trace metal studies, Environment International Journal **32**, 219-247.

Trask PD. 1932. Origin and Environment of Source Sediments of Petroleum. Gulf Publishing Company, Houston 323.

Valia HS, Cameron B. 1977. Skewness as paleo environmental indicators. Journal of Sedimentary Petrology **4**, 784-793.

Visher GS. 1969. Grain Size distribution and depositional process. Journal of Sedimentary Petrology **39,** 1074-1106.

Wang P, Davis RA, Kraus NC. 1998. Cross shore distinction of sediment texture under breaking waves along low energy coasts. International Journal of Sediment Research **68,** 497-506.