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A study on textural characteristics of the Palar River sediments, Sadurangapattinam to Mamandur, Kanchipuram District, Tamil Nadu, India

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Abstract

Being study on textural characteristics is to understand the source of evolution for sediments under river environment. The work carried out is to characterise its textural properties of river debris and how its flood energy interact with granule transportation. Granule properties such as mean, sorting, kurtosis and skewness were predicted accounting modernized version of the GRADISTAT software. The sediment samples shows having very coarse sand to medium sand with unimodal and bimodal nature. The studied area shows entire river area described as poorly sorted, moderately well sorted and moderately sorted debris surroundings. Debris was classified as coarse skewed to symmetrical with platykurtic, mesokurtic and leptokurtic properties. Based on the CM (Coarser one percentile value in micron) pattern, the debris falls in wheeling and suspension range. Granules are sub-angular to sub-rounded. Majority of granules shows low to medium sphericity. The interrelationship of various textural parameters appears to be normal thereby, suggesting that the original texture of the sediments and by implication, original detrital modes are preserved and have not been affected by diagenetic processes.

Keywords: Granule analysis, GRADISTAT, River debris, Palar River.

Introduction

One of the maximum important natural properties of sediments and regularly used parameter for considerate the cases involving its conveying and impeachment of debris are the granule size[1-6]. Grain intensity parameter of mean size from medium to very coarse silt has demonstrated to be suitable part of the speed of the depositing flow[7]. Geologist studies the sediments grain size data to infer on the movements of outward actions relevant to the changing status of conveying and impeachment. River debris originate from the adjacent surface revealed igneous, volcanic and sedimentary boulders. Some of these are quickly corroded, whereas others, notably the Crystalline and metamorphic boulders are altered and carried by tributaries. Supplementary sources of river debris are soils which rooted their mineral content (with some alteration) from bedrock or which in the tropic may repose totally of freshly formed minerals[8]. Grain size is the maximum elemental natural equity of sedimentary deposits[9-10]. Granule size studies give meaningful indications to the debris origin, transportation past events and depositional conditions[1,11,12]. Roundness of grains is a function of transportation action on the debris furnished by the sourceress. Roundness follows abrasion history, which in shift anticipates the diverse geologic curb such as relief, kind of source rock, distance and mechanism of transportation and mineralogy of the grains. Russell and Taylor[13] proposed five roundness classes but their class limit was not systematically chosen and the arithmetic means of the class intervals were used as midpoints. Sphericity cases go into detail how approximately proportionate, the three dimensions of the substance are. Wentworth[14] made the first quantitative study of shapes. Later Wadell[15] defined sphericity. Carver[16] used another measure to determine sphericity. Thus, the familiarity of sediment size and coarseness limitations is particular improved appliances to differentiate assorted depositional environments of recent as well as older debris[3,4,6,17]. In the present study of observation, the grain size limitations were used to interpret sediment movement in Palar River.

Study area: The study area is settled in Kancheepuram District, Tamil Nadu, India and is placed 75 km south of Chennai city (Figure-1). The eastward side of this range is bordered by the Bay of Bengal. The maximal heat mod this range is about 42◦C the time between the months of May and June and the minimal heat is about 21˚C reported the time between the months of December and January. The southwest inundation (June–September), the northeast inundation (October–December) and the progress season give 40%, 51% and 9% respectively, of the total year end rainfall (1167 mm/year) in the survey area. This area is approximately splited into two halves by the Palar river which is a periodic river and flows the time between the months of November, December and January. The Kancheepuram district is principally made up of hard rock and sedimentary formations overlaid by alluvium. Soils have been classified into: clayey soil, red sandy or red loamy, red sandy brown clayey soil and alluvial soil. The boulder mass consists of quartz, feldspar, biotite and pyroxene. The shale and clay of Gondwana age occur on the bank of Palar River. Geology of the study area resides of Archean basement at the bottom, which is along with Charnockites rocks.

Materials and methods

Around forty surface debris samples were poised from Palar River; debris was bagged in fresh barren polythene kits for laboratory investigation. The samples stations are acclaimed with the use of Global Positioning System Model (Megallan) acceptor. Total 100g sample samples obtained by coning and quartering; to eliminate carbonate and organic matter samples were considered with 10% dilute HCl and 6% H_2O_2 respectively and then dried. These samples were manipulated to sift with ASTM test sieves, with consecutive sieves stoked at ½ Ø intervals for 10- 20 min for sift in Ro-tap sieve shaker. The sifted substances were collected and weighed. The sediment transportation is presented distinctly as aggregate percentage contour with phi (φ) scale and the analytical limitations such as central impulse (mean, mode and median), standard deviation (sorting), skewness and kurtosis were calculated by using GRADISTAT[18] and G-Stat software[19]. Roundness can be described as a relation at intervals the sharpness of the edges and corners[20]. Waddel[15] has defined roundness as the average semi diameter of incurvation of the edges of the grain image divided by the radii of the maximal carved ring for a two-dimensional image of the grain. Quantitatively, truthful roundness is mostly declared through the Waddel formula: Roundness = $\sum (r/R)/N$ where, r is the semi diameter of curvation of grain edges, R is the semi diameter of the biggest carved circle and N is the count of edges. The sphericity is a measure of how nearly balanced the axial dimensions of a grain are, a very different concept to roundness, but commonly confused with that shape attribute. The sphericity is an outer area of a grain prorated into the outer area of a sphere of the similar volume. It is defined by Wadell, Sphericity = $3\sqrt{Is/L2}$. Where, I is the limit of the transitional axis of a grain, S is the limit of the short axis of the grain and L is the long axis of the grain. The two most widely used verbal classifications and quantitative graphical representations of sphericity are the Zingg[21] diagram and the Sneeden and Folk[22] diagram, both of which are based on ratios of I, S and L.

Results and discussion

The result of coarseness investigation of the samples was used to determine the statistical parameters and is presented in Table-1. Assorted limitations particularly, mean size; sorting, skewness and kurtosis are used to calculate aggregate density distribution[23,24,1]. The values of the coarseness limitations and granule transportation of the debris were calculated by the formulae followed by Folk and Ward[2]. The frequency curves results of textural analysis reveal that 25% of the samples are unimodal, 65% of them are bimodal and 10% are trimodal, in nature, its indicates that the multisource of sediments.

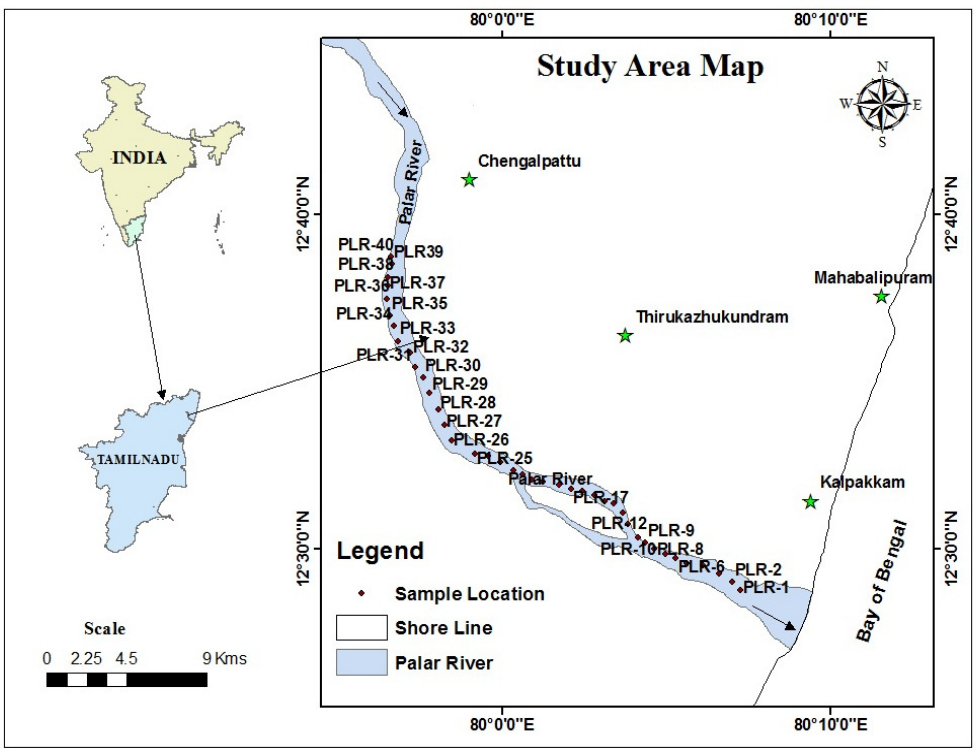

Figure-1: Location Map of the study area.

Graphic Mean (Mz): Mean size illustrates the central impulse or the moderate size of the debris and in conditions of energy. It illustrates the moderate kinetic energy quickness of impeachment agent[25]. Mean size of the debris are moved by the source of amount, transporting medium and the energy circumstances of the depositing surrounding. Mean value ranges from -0.58 to 1.78, with moderate 0.45 (Table-1, Figure-2). The average amount displays the influence of coarse sand size debris and the vacation contains of little volume of very coarse sand and medium sand. More so, 22.5% of the boulders in the study area are very coarse granules, 60% are coarse granules, and 17.25% medium granules. This follows impeachment under moderate to high energy[26-27]. Coarser debris in high flood energy surrounding, strong winnowing must have eliminated the fine sediments[28-29]. This is also evidence by the erosive of the waves. The fluctuations in Phi mean size acknowledge the prong energy status, appearing in their deposition[30-31].

Table-1: Grain size parameters of Palar river estuary sediment samples.

Mean	Sorting	Skewness	Kurtosis	Remarks
0.23	0.75	-0.11	1.15	Coarse Sand, Moderately Sorted, Coarse Skewed, Leptokurtic
1.222	0.979	0.02	0.875	Medium sand, Moderately sorted, Symmetrical, Platykurtic
1.778	0.688	0.018	1.026	Medium sand, Moderately well sorted. Symmetrical, Mesokurtic
1.117	0.981	0.032	0.952	Medium sand, Moderately sorted, Symmetrical, Mesokurtic
1.086	0.515	-0.167	1.193	Medium sand, Moderately well sorted, Coarse skewed, Leptokurtic
0.614	0.808	-0.092	1.147	Coarse Sand, Moderately Sorted, Symmetrical, Leptokurtic
-0.311	0.757	-0.174	0.853	Very coarse sand, Moderately sorted, Coarse skewed, Platykurtic
-0.199	1.091	-0.115	0.835	Very coarse sand, Poorly sorted, Coarse skewed, Platykurtic
0.756	0.72	-0.03	1.038	Coarse sand, Moderately sorted, Symmetrical, Mesokurtic
1.34	0.934	-0.017	0.887	Medium sand, Moderately sorted, Symmetrical, Platykurtic
1.214	0.686	-0.083	0.991	Medium sand, Moderately well sorted, Symmetrical, Mesokurtic
0.456	1.076	0.161	1.2	Coarse sand, Poorly sorted, Fine skewed, Leptokurtic
1.287	0.9	0.083	1.139	Medium sand, Moderately sorted, Symmetrical, Leptokurtic
0.661	0.944	-0.095	1.171	Coarse sand, Moderately sorted, Symmetrical, Leptokurtic
-0.174	0.83	-0.144	1.193	Very coarse sand, Moderately sorted, Coarse skewed, leptokurtic
0.694	0.836	-0.273	1.197	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
0.332	1.45	0.29	1.02	Coarse sand, Poorly sorted, Very fine skewed, Mesokurtic
0.829	0.752	-0.124	1.23	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
0.43	0.814	-0.18	1.11	Coarse sand, Moderately sorted, Coarse skewed, Mesokurtic
0.442	0.779	-0.237	1.86	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
-0.038	0.885	-0.182	1.049	Coarse sand, Moderately sorted, Coarse skewed, Mesokurtic
0.715	0.836	0.17	1.267	Coarse sand, Moderately sorted, Fine skewed, Leptokurtic
0.327	0.946	-0.099	1.059	Coarse sand, moderately sorted, Symmetrical, Mesokurtic
0.429	0.816	-0.129	1.129	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
0.67	1.12	0	1.142	Coarse sand, Poorly sorted, Symmetrical, Leptokurtic
0.455	0.997	0.011	1.221	Coarse sand, Moderately sorted, Symmetrical, Leptokurtic
0.573	0.555	-0.082	1.031	Coarse sand, Moderately well sorted, Symmetrical, Mesokurtic
0.415	0.769	-0.128	1.133	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
-0.163	0.992	-0.086	1.202	Very coarse sand, Moderately sorted, Symmetrical, Leptokurtic
-0.075	0.891	-0.177	1.119	Very coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
-0.584	0.81	-0.226	0.858	Very coarse sand, Moderately sorted, Coarse skewed, Platykurtic
0.496	0.821	-0.127	1.206	Coarse sand, Moderately sorted, Coarse skewed, Leptokurtic
0.726	1.011	0.167	1.115	Coarse sand, Poorly sorted, Fine skewed, Leptokurtic
0.071	0.967	-0.016	1.14	Coarse sand, Moderately sorted, Symmetrical, Leptokurtic
0.187	1.154	0.035	0.973	Coarse sand, Poorly sorted, Symmetrical, Mesokurtic
0.331	0.975	-0.027	1.051	Coarse sand, Moderately sorted, Symmetrical, Mesokurtic
-0.281	0.779	-0.098	1.008	Very coarse sand, Moderately sorted, Symmetrical, Mesokurtic
0.107	1.169	-0.126	1.184	Coarse sand, Poorly sorted, Coarse skewed, Leptokurtic
-0.256	0.831	-0.095	0.843	Very coarse sand, Moderately sorted, Symmetrical, Platykurtic
-0.054	0.871	-0.129	1.156	Very coarse sand, Moderately sorted, Coarse skewed, leptokurtic

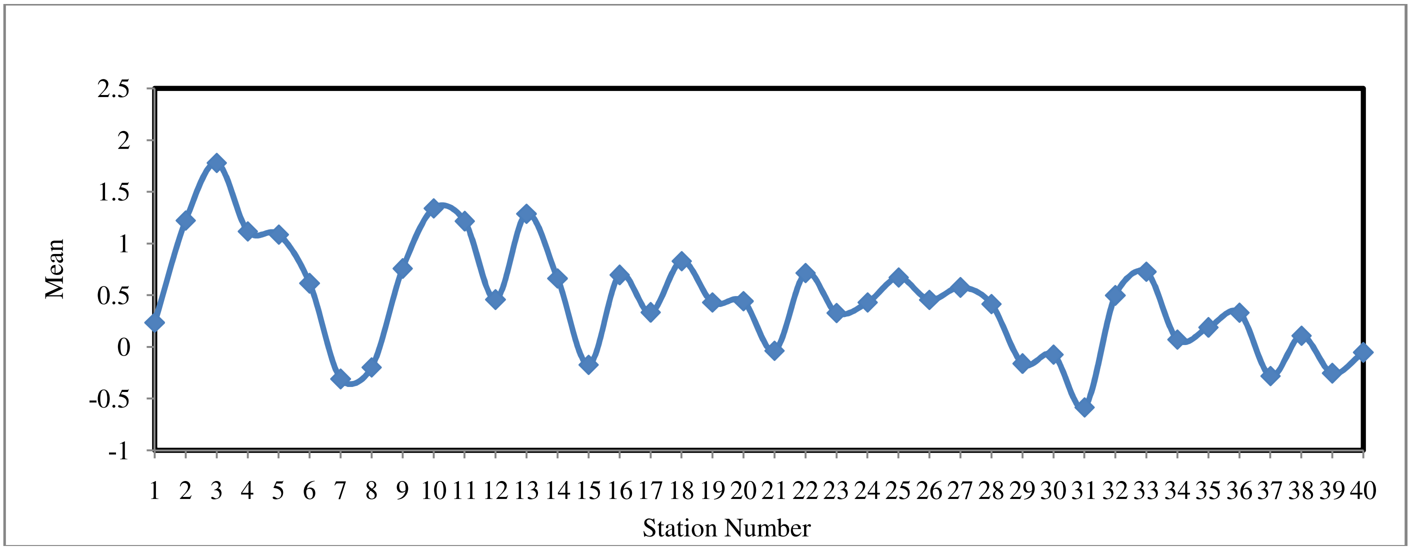

Figure-2: Mean showing the trends of all the samples.

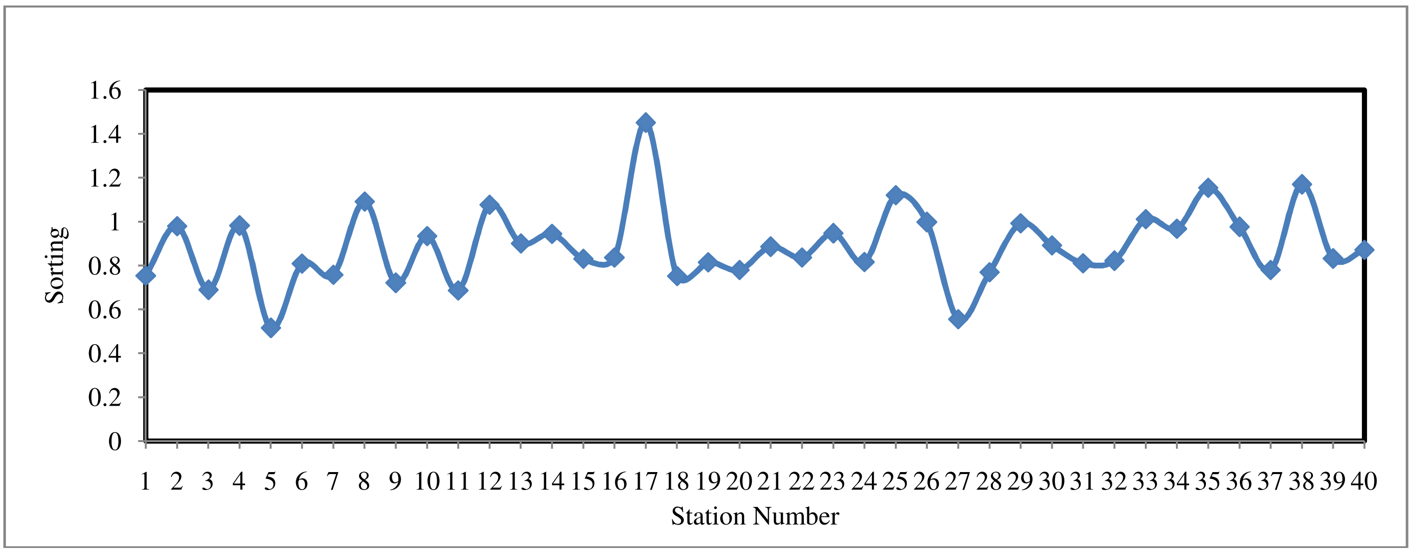

Figure-3: Standard Deviation showing the trends of all the samples.

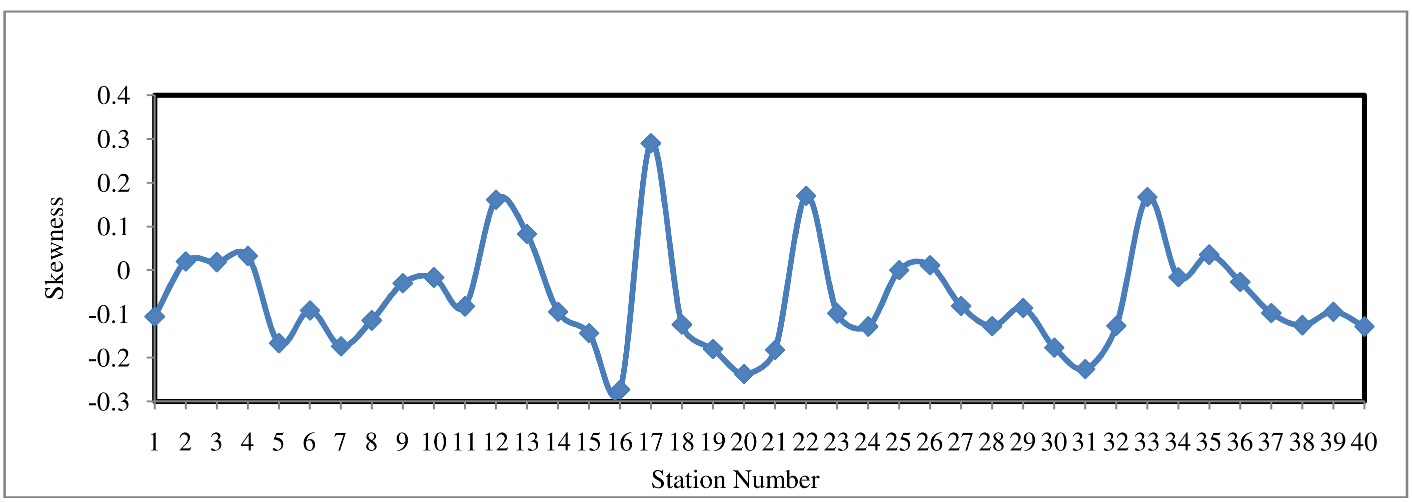

Figure-4: Skewness showing the trends of all the samples.

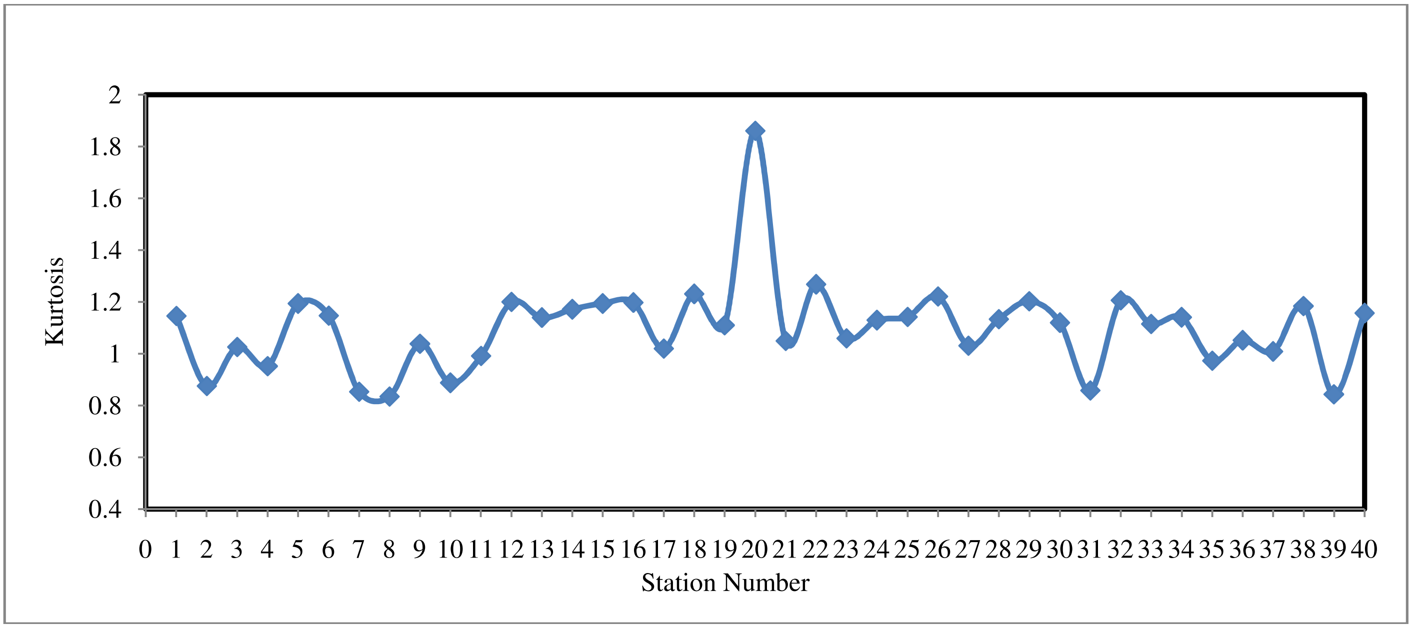

Figure-5: Kurtosis showing the trends of all the samples.

Standard Deviation (δI): Standard deviation parts the sorting of grains and illustrates the variation in the aggressive energy or acceleration conditions of the impeachment agent[25,32]. The standard deviation values of the debris ranged at intervals 0.52 to 1.45 φ with moderate value of 0.89 φ (Table-1, Figure-3). The sorting of granules ranges from poorly sorted, moderately sorted and moderately well sorted nature. Around 10% of the samples decline in moderately well sorted description, 72.5% moderately sorted, and remaining samples exhibits 17.5% poorly sorted nature. The moderately well sorted nature of debris illustrates the movements of heavy energetic conditions of the impeachment promoters or prevalence of active energy situations in the basin[33]. The fluctuations in the sorting amounts are likely as long as continuous inclusion of finer/coarser sediments in shifting proportions.

Skewness (SKI): The graphic skewness is the part of symmetrical distribution, i.e. predominance of coarse or well-made debris. It is used to complete the symmetry of the paramount part of the transportation. It reflects the symmetry or asymmetry of the recurrence transportation of the debris. Skewness amount ranges amongst -0.27 to 0.29 with an moderate of -0.06 (Table-1, Figure-4). The values indicate fine skewed 10%, coarse skewed 42.5% and Symmetrical 47.5% category, perfect skewness of debris illustrates the impeachment of the debris in protected depressed intensity, whereas unfavorable skewness of debris illustrate impeachment at high intensity surroundings. Perfect skewness of sediments indicates the deposition of the debris in protected depressed intensity, whereas unfavorable skewed sediments illustrate impeachment at high intensity surroundingss[34]. It also follows an unidirectional present and deposition for the sandstones[35,36].

Kurtosis (KG): The striking kurtosis is the peakedness of the transportation and parts the ratio at intervals the sorting in the tails and paramount segment of the arch. An amount of striking kurtosis ranges from 0.84 Ø to 1.86 Ø, with moderate of 1.11 Ø. The samples decline down mesokurtic (30%), leptokurtic (55%) and of platykurtic nature (15%) (Table-1, Figure-5). Friedman (1961)[37] recommends that acute big or small amounts of kurtosis associate that factor of the sediments completed its sorting somewhere in a high energy surrounding. The mesokurtic to leptokurtic description of debris refers to the continuous inclusion of well-made or coarser grains after the scatter action and holding of their original aspects meanwhile deposition[38]. This strongly recommends a fluvial or tidal surrounding, supporting that the sands are river impeachment.

Bivariant Plots: Bivariant diagram between positive limitations are also useful to understand the intensity circumstances, intermeadiate of conveying, mode of impeachment etc. Passega[39], Folk and Ward[2] and alternatives portrayed that these tendency and correlation presented in the bivariate diagram might illustrate the method of impeachment and in turn aid in determining the surroundings. However, Mason and Folk[3], Friedman[4] alleged to form the differentiation amongst aeolian, beach and stream debris established on these scatter diagram. An experiment has been formed to apply these scatter diagram in the Palar river debris. The scatter plot of standard deviation vs. skewness (Figure-6) also supported to characterize as a separate cluster. The study region shows the influence of fluvial and beach environments. The energy processes of Palar river samples falls in both river processes and inner shelf processes (Figure-8). The bivariant diagram of mean vs. standard deviation (Figure-7) shows that the debris is moderately well sorted fluvial environment. This plot clearly indicates these sediments are the influence of fluvial environment because the river input is more than the littoral current.

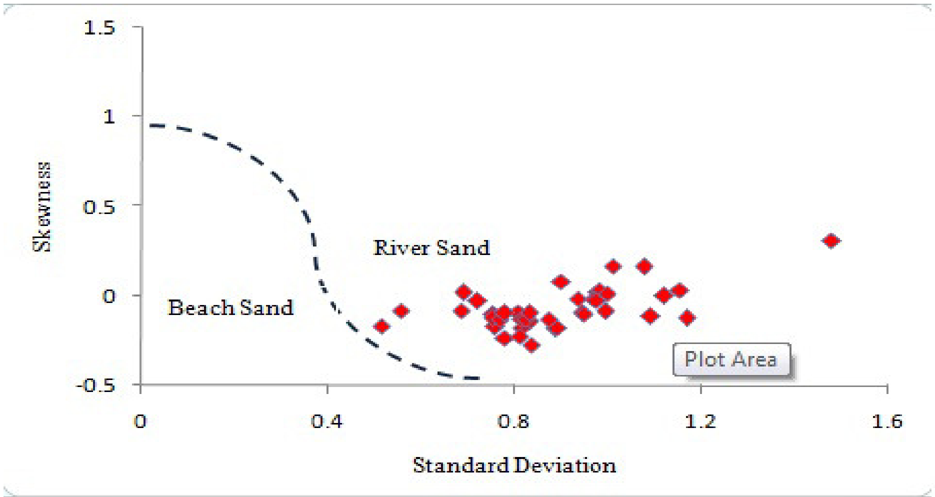

Figure-6: Standard Deviation vs Skewness.

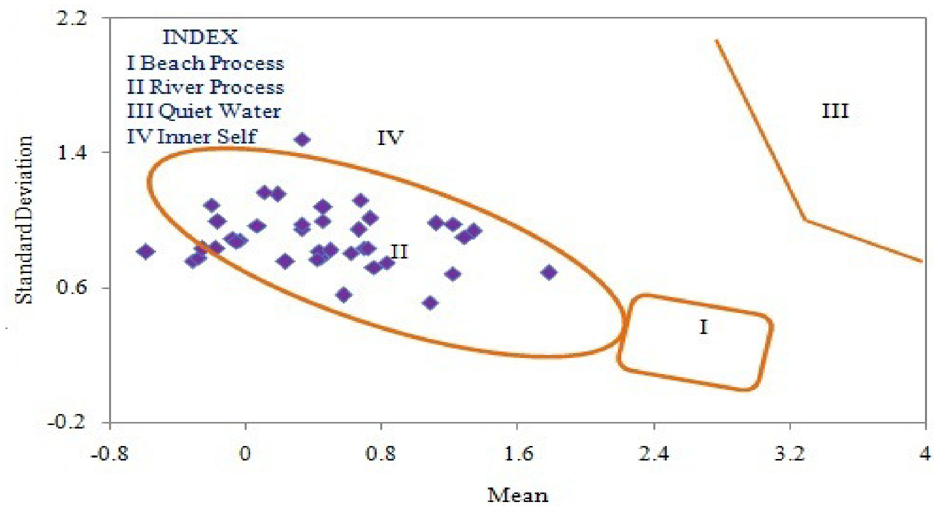

Figure-7: Mean vs. Standard deviation (after Stewart 1958).

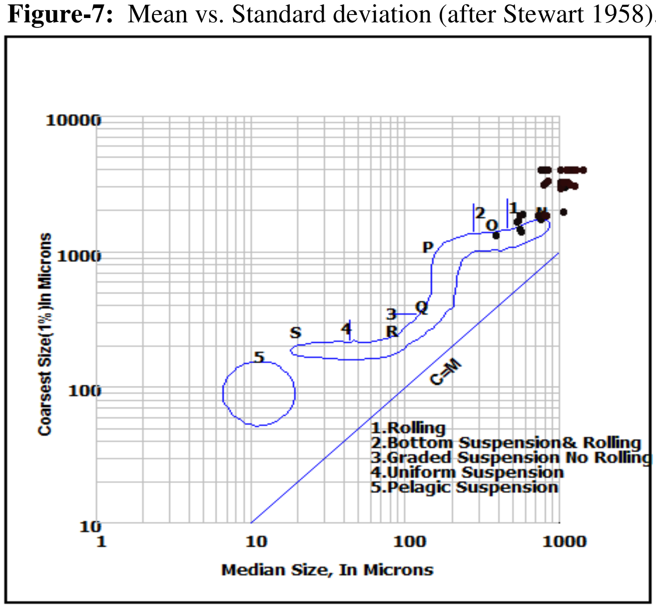

Figure-8: CM pattern of the Sediments of Palar River.

Hydrodynamic Condition (CM-Pattern): The CM patterns of the sediments are useful for investigating conveying mechanism, impeachment surrounding with consideration to size, range and energy level of conveying and also are the definitive case and distinctive agent that are answerable for the pattern of clastic sediments. Passega[39] was introduced CM pattern diagram to assess the hydro-energetic forces employed at the time of impeachment of the granules. It is according to ‘C’ i.e. coarser one percentile value in micron and ‘M’ i.e. median value in micron on log possibilty scale. Being diagram is formed and explained following Passega[39,40] and Passega and Byramjee[41]. The relationship at intervals C and M is the effect of sorting by underlying turbulences. The good interaction at intervals C determined by only one percent by weight of sample and M, which represent granules as a whole, shows the rigor of the control of sedimentation by underlying turbulence. CM pattern diagram views an entire model of tractive current (depositional process) as shown by Passega[40] which consists of several segments such as NO, OP, PO, OR and RS showing different forms of debris convey. Most of the samples decline in NO region. Few samples deposited as rolling while rest of the sediments decline in graded suspension no rolling condition (Figure-8).

Roundness and Sphericity: Roundness illustrates the degree of abrasion of clastic fragments. It may provide indication of time or distance of transport. The grain is angular when it is freshly introduced (unless recycled) and becomes progressively rounded due to transportation. Roundness is entirely contrasting aspect when correlated to sphericity, shape and size. In order to maintain an improved accuracy, a scan of 300 individual granules in each fraction has been studied. The roundness is found to have been influenced by the composition, cleavage, fracture, size, shape, the medium of transportation and the energy with which the transportation was carried out. The percentage of contrasting class of grains with differences in roundness substantiates the role of multi-source in outlook of noticeable percentage of angular, sub-angular sub-rounded, rounded and well-rounded grains in the same fraction. The average of roundness values in the study area indicates a predominance of sub-rounded class grains representing to a level of 33.03%, sub-angular 28.65%, and angular 16.94%, very angular 11.07%, rounded 7.89% and well-rounded granules are 2.52% (Table-2). The most commonly used method of determining the sphericity is through visual comparison. For the present study, the comparison chart given by Krumbein and Sloss[5] was used for the classification of sand into three classes, high, medium and low sphericity. The mean sphericity values mostly medium sphericity 0.67%, low sphericity 0.11% and high sphericity 0.90% followed by (Table-3).

Table-2: Roundness of Palar River sediments.

Sample No.	Very Angular (0.12-0.17)		Angular (0.17-0.25)		Sub-Angular (0.25-0.35)		Sub-Rounded (0.35-0.49)		Rounded (0.49-0.70)		Well-Rounded (0.70-1.0)		Total Grains	Mean Roundness
	N	%	N	%	N	%	N	%	N	%	N	%		
PLR-1	8	9.64	14	16.87	27	32.53	24	28.92	9	10.84	1	1.21	83	0.46
PLR-3	6	8.11	11	14.87	29	39.19	19	25.68	5	6.76	4	5.41	74	0.24
PLR-5	12	15.19	16	20.25	18	22.79	27	34.18	3	3.80	3	3.80	79	0.37
PLR-7	11	17.46	8	12.70	26	41.27	15	23.81	2	3.18	0	0.00	63	0.38
PLR-9	13	12.04	15	13.89	32	29.63	37	34.26	11	10.19	0	0.00	108	0.51
PLR-11	16	12.31	18	13.85	38	29.23	36	27.69	17	13.08	5	3.85	130	0.27
PLR-13	9	7.03	24	18.75	33	25.78	42	32.81	14	10.94	6	4.69	128	0.41
PLR-15	2	2.78	16	22.22	19	26.39	22	30.56	13	18.06	0	0.00	72	0.27
PLR-17	5	13.89	6	16.67	11	30.56	14	38.89	0	0.00	0	0.00	36	0.61
PLR-19	4	8.33	7	14.58	16	33.33	18	37.50	1	2.08	0	0.00	48	0.83
PLR-21	8	14.55	9	16.36	14	25.46	19	35.55	5	9.09	0	0.00	55	0.45
PLR-23	2	7.41	4	14.82	9	33.33	12	44.44	0	0.00	0	0.00	27	0.25
PLR-25	7	10.29	10	14.71	18	26.47	21	30.88	12	17.65	0	0.00	68	0.27
PLR-27	15	12.82	18	15.39	28	23.93	36	30.77	14	11.97	6	5.13	117	0.32
PLR-29	9	11.69	12	15.58	19	24.68	31	40.26	6	7.79	0	0.00	77	0.39
PLR-31	5	12.20	9	21.95	12	29.27	15	36.59	0	0.00	0	0.00	41	0.35
PLR-33	15	12.30	26	21.31	27	22.13	38	31.15	12	9.84	4	3.28	122	0.57
PLR-35	6	10.35	9	15.52	15	25.86	19	32.76	6	10.35	4	6.90	58	0.49
PLR-37	8	12.31	11	16.92	14	21.54	17	26.15	8	12.31	7	10.77	65	0.41
PLR-39	4	10.81	8	21.66	11	29.73	14	37.84	0	0.00	0	0.00	37	0.61

Table-3: Sphericity of Palar River sediments.

Sample. No	Low Sphericity (0.0-0.3)		Medium Sphericity (0.3-0.9)		High Sphericity (>0.9)		Total grains	Mean Sphericity
	N	%	N	%	N	%		
PLR-1	21	28.916	38	45.783	24	25.301	83	0.67
PLR-3	19	39.189	26	35.135	29	25.676	74	0.77
PLR-5	17	41.772	29	36.709	33	21.519	79	0.33
PLR-7	20	32.353	26	38.235	22	29.412	63	0.67
PLR-9	24	42.593	38	35.185	46	2.222	108	0.36
PLR-11	42	36.154	41	31.538	47	32.308	130	0.33
PLR-13	38	35.938	44	34.375	46	29.688	128	0.76
PLR-15	20	38.889	24	33.333	28	27.778	72	0.24
PLR-17	11	33.333	13	36.111	12	30.556	36	0.12
PLR-19	14	33.33	18	37.5	16	29.167	48	0.16
PLR-21	13	36.364	2	40	20	23.636	55	0.11
PLR-23	4	44.444	11	40.741	12	14.815	27	0.90
PLR-25	14	42.647	25	36.765	29	20.588	68	0.66
PLR-27	36	33.333	42	35.897	39	30.769	117	0.39
PLR-29	24	32.468	28	36.364	25	31.169	77	0.67
PLR-31	10	34.146	17	41.463	14	24.39	41	0.67
PLR-33	30	38.525	45	36.885	47	24.59	122	0.69
PLR-35	12	43.103	21	36.207	25	2.069	58	0.33
PLT-37	19	29.231	27	41.538	19	29.231	65	0.65
PLR-39	7	35.135	17	45.946	13	18.919	37	0.33

Conclusion

Sedimento logical studies have been used to find out the origin of the debris. The nature of sediments bimodal and unimodal recurrence distribution illustrates a single and multi-origin for the debris. Coarseness investigation pinpoint that the debris fit to the very coarse to medium grained sand fraction, recommending that the sediments were impeachment of under high energy condition, with the debris being poorly sorted to moderately well sorted, showing texturally immatured to sub-matured debris of a fluvial surrounding. The sediments are dominantly near-symmetrical to coarse-skewed in nature. Kurtosis (KG) samples fall in leptokurtic, mesokurtic and platykurtic nature of distributions. The CM pattern diagram illustrate that the Palar river debris sustained the wheeling and bottom suspension downward tractive current. The bulk amount of grains shows low to medium sphericity and is sub-angular to sub-rounded nature of the sediments.

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