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Sedimentological investigations of active beach sand from Gaddani area, Balochistan, Pakistan

S. ARISER, A. H. MARKHAND[++], S. A. SHAIKH, L. QIU*

Centre for Pure & Applied Geology, University of Sindh, Jamshoro, 76080, Sindh, Pakistan.

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Abstract: Studying sand leads to understand the depositional environment of sandstone; sandstones exhibit variety of sedimentary depositional environments, all of them have different physical, chemical, and biological characteristics. Samples of beach sand from Gaddani beach area, Balochistan, Pakistan were collected in order to understand the beach environment. In addition to field observation of primary sedimentary structures the samples were processed for grain size analysis, chemical, and mineralogical studies. The result of sorting and mineral aggregation shows that the environment has strong energy. All the results of above mentioned analysis lead us to conclude that it is beach environment. The increased concentration and shape of quartz in the samples suggest for it being transported from far away and experienced several depositional cycles. The primary structures affirm the bioturbation and graded bedding mechanisms.

Keywords: Beach Depositional Environment, Primary Sedimentary Structures, Beach Sand, Gaddani Beach, Balochistan, Pakistan.

1. INTRODUCTION

Gaddani is a small town and Union Council of Hub Tehsil of district Lasbella, which lies in the southern part of Balochistan, along the coast of Arabian Sea. The population estimate of Gaddani town is about 100,000. The ratio of Muslim population is up to 97% compare to other minorities like Hindu and Christian. Major proportion of population speaks Balochi and Sindhi languages. There is another famous language in the area called Lasi, which is also largely spoken; the source of this language is Sindhi or Jadgali. The Gaddani town is famous in Pakistan because of its beautiful sandy beach and it is also the country's largest ship breaking yard.The area of study lies in the survey of Pakistan Toposheet No. 35 K/12 and the specific location can be accessed at a distance of 48 km northwest of Karachi. Latitude & Longitude values of the area are: 25° 07' 40" Northing, 66° 44' 12" Easting **(Fig. 1).**

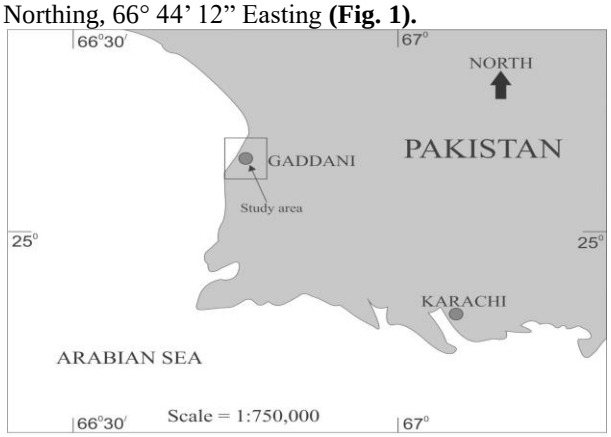

Fig. 1. Location map of Gaddani area, Balochistan, Pakistan.

Present study is focused at depositional environment of beaches, and for the purpose; beach of Gaddani area, Balochistan, Pakistan has been selected.

1.1 Geological background

The Gaddani is a coastal city along the Arabian Sea, so the coastal area of Pakistan receives huge volume of fluvial and alluvial sediments annually, which is transported by number of rivers like; Indus (Sindh), Ulhas, Tapti, Narmda, Hab, Porali, and Hinglo, there are number of other small tributaries, all these agents transport tons of sediments into Arabian Sea. One of major contributor, among all these agents is Indus (Sindh) river, which alone transports about 400-500 MT yearly (Chaudry *et al.*, 2002; Milliman *et al.*, 1984).The outflow area of Indus (Sindh) river and its tributaries is about 551-700 km^2 (Bender *et al.*, 1995; Chaudry *et al.*, 2002). There is huge uncommon variation in the water flow and sediment load, only three months of monsoon season from June to August mark the 60% of the total discharge (Chaudry *et al.*, 2002). The Indus (Sindh) river and its tributaries encounter different types of rocks during their flow towards Arabian Sea, petrologically; the range is composed of igneous, sedimentary, and metamorphic rocks, geochronologically; the range is from Pre-Cambrian to Holocene (Recent) in age. Thus, the sediments of different varieties and nature are found (Bender *et al.*, 1995; Chaudry *et al.*, 2002). Large semidiurnal tides of 1-8 m hit the Arabian Sea (Roonwal, 1997), and those are influenced by monsoon winds seasonal current circulation twice yearly (Chaudry *et al.*, 2002; Cutler and Swallow, 1984; Hastenrath and Greischar, 1989;

[++] Corresponding Author Email: markhand.akhtar@usindh.edu.pk
*School of Earth Sciences and Resources, China University of Geosciences, Beijing 100083, China.

Wyrtki *et al.,* 1971).This environment is in very much favour of reworking, sorting, transport, and accumulation of grains along the coast. It is to be noted that morphology of shore line also influence the trapping of sediments and give them a good environment for the deposition either temporary or on permanent basis along the shoreline. This coastline of Balochistan (Makran) amid study area is under the influence of ongoing active tectonics, where the Arabian Plate is subducting under the Eurasian Plate (Jon and Birnie, 1979; Klaus and Quittmeyer, 1979). This kind of tectonics is also introducing huge volume of sediment shaved off from the undergoing Arabian Plate (White, 1979) to the marginal region, in the form of accretionary prism. There is no any reliable statistical data available about the sediments; those were shaved off tectonically (Kazmi & Jan 1997). Above all, fluvial system for supply of sediments to the Arabian Sea has its own importance.

1.2 Sedimentary structures

Primary sedimentary structures are the only large scale features of sedimentary rocks, which have been used to get data about mechanism of sediment transportation, flow directions of paleo-current, relative water depth and relative current velocities of ancient sedimentary environment(Boggs, 1987). Some of the primary sedimentary structures play important role in the identification of top and bottom of specific layers and that is very much helpful in gathering data about stratigraphic order of layers thus one can conclude either the stratigraphic sequence had been disturbed by tectonic forces in geologic history or not (Billings, 1972). Primary sedimentary structures mostly occur in coarse siliciclastic sedimentary rocks, which are generated by traction transport or turbidity current transport. These structures are also found in non-siliciclastic sedimentary rock. The primary sedimentary structures observed in the field at Gaddani Beach are: (a) Bedding (Specially Graded Bedding), (b) Lamination, (c) Ripple marks, (d) Biogenic structures (Specially Burrowing and Boring)

2. MATERIALS AND METHODS

For the present study the field work was carried out at Gaddani Beach area and a total of five samples were collected (samples are numbered with a prefix of GDN representing Gaddani). One of five samples was selected for XRD analysis while all the five samples were processed accordingly: Washing, Drying, and Sieving: 500 grams of each sample were taken to conduct sieve analysis, in pursuance of this standard mesh sizes (2.00 mm, 1.00 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.0625 mm with a pan at the bottom) were selected for sand samples. For the purpose of determining the mineralogy and sorting sediments were brought under polarizing microscope, and XRD analysis. The sieve analysis data was processed and frequency curves were plotted for each sample and depositional environment is interpreted on the basis of primary sedimentary structures and XRD results. For the X-ray diffraction, D8 Advance model of Bruker AXS diffractometer was used. The sieve analysis result is shown in graphic data presentation and statistical data presentation, The sieve analysis investigations were carried following the principles of Wentworth (1922), Udden (1898), Folk and Ward (1957).

3. RESULTS

The samples taken from the study area were processed accordingly and results obtained are represented in the form of cumulative curves, XRD diffractogram. Since analysis resulted in the better understanding towards the identification of the sands and grading it into medium grained, coarse grained, and fine grained **(Table 1, Fig. 2 and Fig. 3).** The mineralogical investigation of the sand sample by X-ray diffraction indicates the presence of Quartz and Calcite as well as minor amount of heavy minerals **(Fig. 4).**

Table 1. Phi (Grain size) values of sand samples in sieve analysis and cumulative weight percentage of the sample in each sieve. Using such a data cumulative frequency curves are plotted. In sample GDN#3 and GDN#4 some of sieves are empty; it is because the sand in those samples is too fine.

Phi Value (Grain Size)	GDN # 1 (Cumulative Weight Percentage)	GDN # 2 Cumulative Weight Percentage)	GDN # 3 Cumulative Weight Percentage)	GDN # 4 Cumulative Weight Percentage)
-1	0.57	0.892		
-0.75	0.702	1.328		
-0.5	0.898	2.05		
-0.25	1.306	3.02		
0	1.534	3.786		
0.25	1.872	4.961		
0.5	2.474	6.014		
0.75	4.986	8.514		
1	7.124	11.482	0.054	
1.25	12.166	14.328	0.22	
1.5	26.062	18.678	0.826	
1.75	44.2	24.948	2.834	
2	61.6	30.752	8.498	0.45
2.25	80.8	51.786	34.3	5.902
2.5	91.6	79.518	70.956	32.742
2.75	96.532	89.8	87.678	61.724
3	97.768	93.6	93.586	80.536
3.25	98	96.754	96.366	88.928
3.5	98.108	98.348	98.096	94.676
3.75	98.114	98.772	99.088	98.078
4	99.1	98.82	99.34	98.8
4.5				99.09

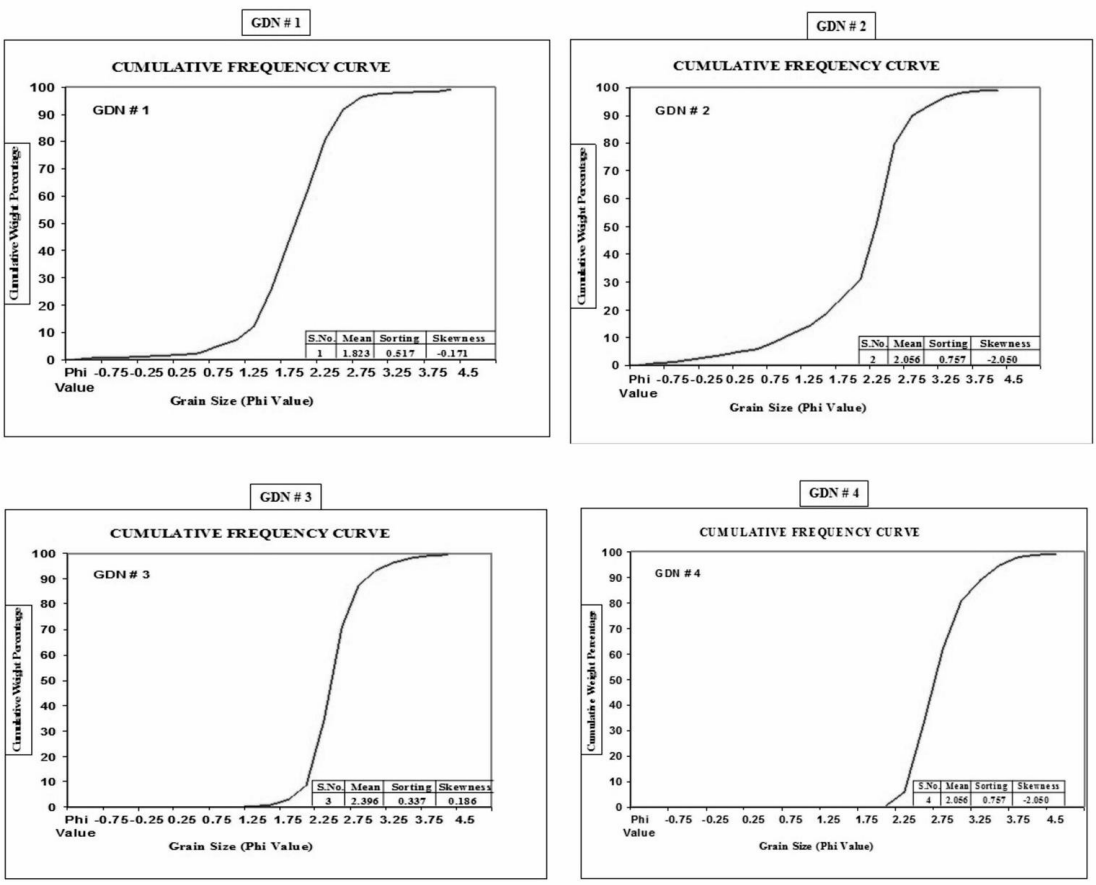

Fig. 2. Cumulative frequency curves of samples on individual basis showing the sand's cumulative weight percentage against phi (Grain size) value.

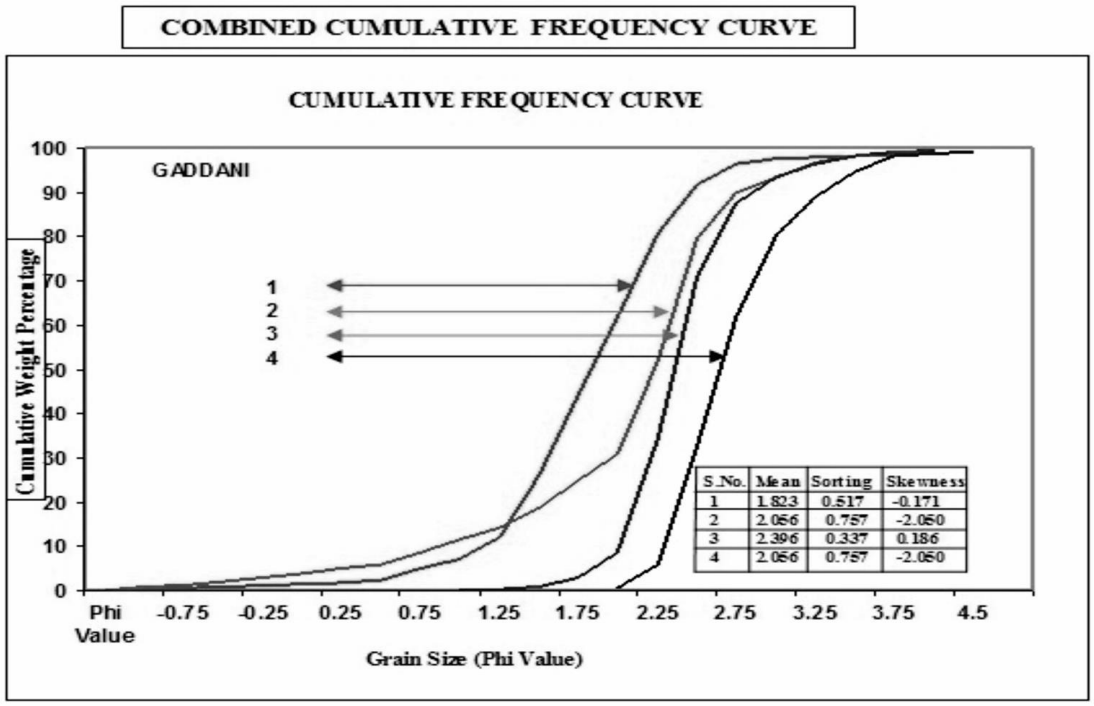

Fig. 3. Combined cumulative frequency curve for all the studied samples.

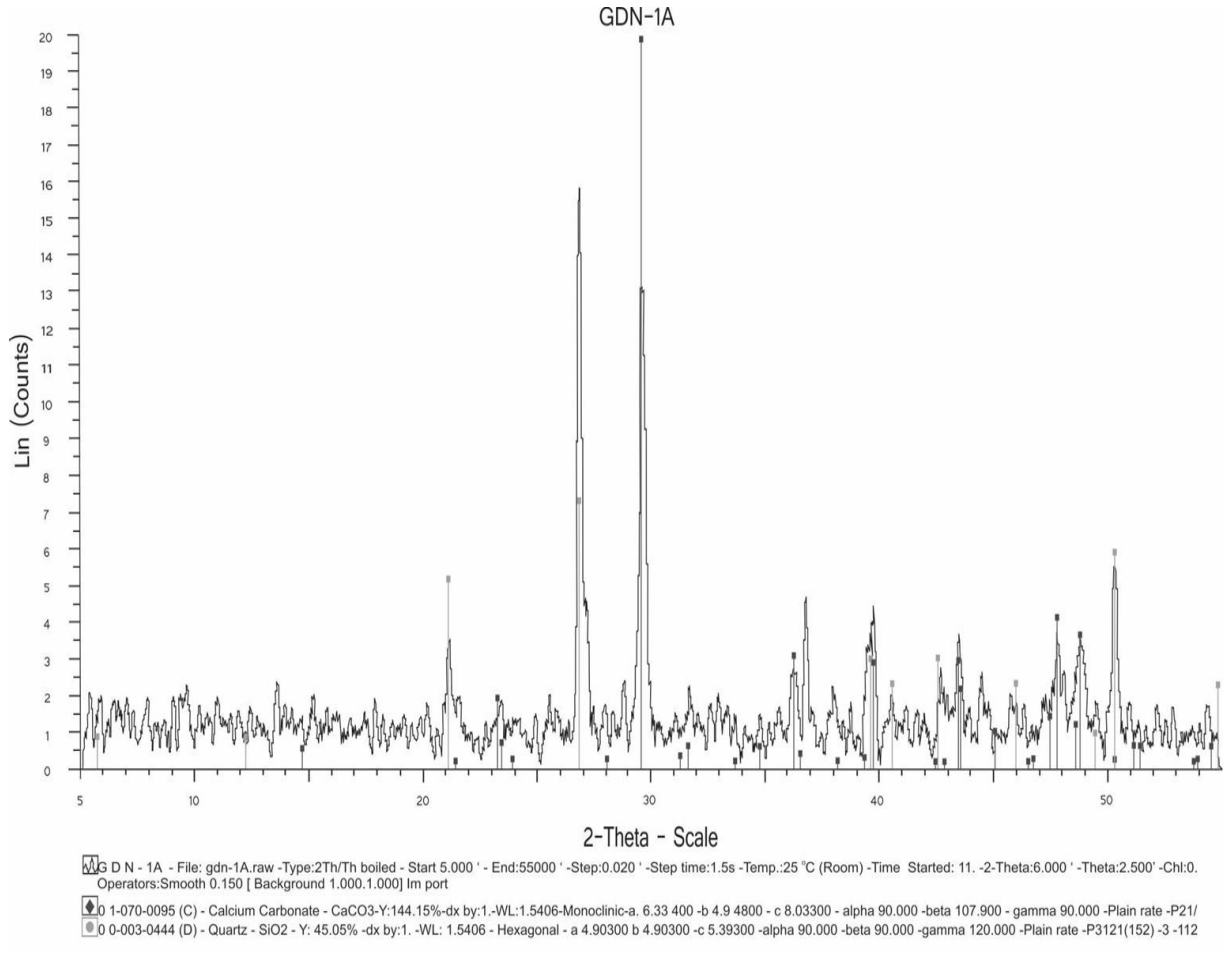

Fig. 4. XRD diffractogram of sample GDN-1A showing the concentration of different minerals specially; Quartz and Calcite.

4. DISCUSSION

The sieve results gave clue regarding the sorting of the material, on the basis of above mentioned sieving results the beach sands are categorized as moderately to well sorted medium to fine sand containing laminations, asymmetrical ripple marks, and graded bedding.

The mineralogical investigation of the sand sample by X-ray diffraction indicates the presence of Quartz and Calcite as well as minor amount of heavy minerals. The strong characteristic peaks are indicating that the proportion of mineral in the sample is high and it is also well crystallized. The presence of Quartz in the sand sample is indicated by its characteristics peak position at 26.660 2θ and 20.850, 2θ. Quartz showed very strong peaks suggesting that it is well crystalline and also its higher concentration in the studied sample. Higher amount of Quartz in the sediments, according to Baig (1982) may be due to near shore type of deposition. The grains of Quartz in the sample are fine and sub-rounded, suggesting that Quartz experienced many cycles of sedimentation and have travelled over long distances.

The structures found at the Gaddani beach represent the velocity of water and tidal fluctuation *i.e.* lamination on the beach side represents the periodic or daily variation in water column, graded bedding is characteristic feature of turbidities deposited from decelerating density current, so decelerating flows engender the graded beds also occur in tidal flats and shallow marine platform. Bioturbation structures are common in middle and lower shoreface deposits and in sediments of transition zone between the beach and the open shelf.

5. CONCLUSION

The results lead to interpret that depositional environment of the processed samples have strong energy. Primary sedimentary structures; those found in the field (as explained earlier) completely lead to conclude that the environment is of transitional zone. It is extracted from XRD diffractogram that Quartz has very good crystalline structure, which only appears in the strong energy environment. The cumulative

frequency curves also have very good shapes indicating depositional environment of strong energy. The increased concentration and shape of quartz in the samples suggest for it being transported from far away and experienced several depositional cycles. The primary structures affirm the bioturbation and graded bedding mechanisms.

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REFERENCES:

Baig, M.A.A., (1982). The geochemistry and mineralogy of sediments of the oxford clay and kellaways formations from southern England. Unpubl. Ph.D Thesis, Southampton University.

Bender, F. K. and H. A. Raza. (1995). (Eds). Geology of Pakistan. Berlin: Gebruder Borntgraeger.

Boggs, S. (1987), Principle of Sedimentology and Stratigraphy. Merill Publishing Company, Columbus, Toronto, London, Melbourne.

Chaudry, M. A., M. Q. Memon, M. Danish, (2002). Heavy Minerals Concentration along the Baluchistan Coast, Pakistan from Gadani to Phornala, National Institute of Oceanography, Karachi, Pakistan, Marine Georesources and Geotechnology, 20:73–83.

Cutler, A. N. and J.C. Swallow, (1984). Surface currents of the Indian Ocean. Compiled from the historical data achieved by the meteorological office. Bracknell, U.K. Institute of Oceanographic Sciences, Wormley, U.K. Report 187.

Hastenrath, S. and L. Greischar. (1989). Climatic atlas of the Indian Ocean, Part III; Upper ocean structure. Madison: University of Wisconsin.

Jackson, J.O and P.G., Fookes, (1974). The relationship of the estimated former burial depth of lower oxford clay to some soil properties. Q. J. Eng. Geol. Vol. 7: 137-139.

Jon, D. and R. W. Birnie. (1979). Segmentation of the Quaternary subduction zone under the Baluchistan region of Pakistan and Iran. 319– 324 in A. Farah and K. A. De Jong (Eds.), Geodynamics of Pakistan.

Klaus, H. J. and R. C. Quittmeyer. (1979). The Makran region of Pakistan and Iran; Trench-arc system with active plate subduction. Pp. 305– 318 in A. Farah and K. A. De Jong (Eds.), Geodynamics of Pakistan.

Milliman, J. D., G. S. Quraishee, and M. A. A. Beg. (1984). Sediment discharge from the Indus River to the ocean past, present and future. Pp. 65– 70 in B. U. Haq and J. D. Milliman, (Eds.), Marine Geology and Oceanography of Arabian Sea and Coastal Pakistan.

Roonwal, G. S. (1997). Marine mineral potential in India's Exclusive Economic Zone; Someissues before exploitation. Marine Geores and Geotech. 15:21– 32.

White, R. S., (1979). Deformation of Makran continental margin. Pp. 295– 304 in A. Farah and K. A. De Jong, (Eds.), Geodynamics of Pakistan.

Wyrtki, K., E. B. Bennett, and D. J. Rockford, (1971). Oceanographic atlas of the International Indian Ocean Expedition. Washington, D.C.