Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 48 (3) 633-638 (2016)

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Textural Evaluation of Nari Formation, Laki Range, Southern Indus Basin, Pakistan

Q. D. KHOKHAR[++], A. A. A. D. HAKRO, S. H. SOLANGI, I. SIDDIQUI, S.A. ABBASI

Centre for Pure and Applied Geology, University of Sindh, Jamshoro

Received 1st July 2015 and Revised 28th May 2016

ABSTRACT: Textural evaluation of Nari Formation based on the grain size analysis is carried out in order to identify its textual signatures and depositional environment. Nari Formation, potential hydrocarbon and water reservoir is exposed at Kari Buthi Section, Northern Laki Range, Southern Indus Basin. Twenty two (22) loose and friable sandstone samples of Nari Formation are selected for sieving. The cumulative curves are produced from sieved data and various statistical parameters (mean, median, sorting, skewness and kurtosis) are derived from the cumulative curves. The outcome of the textural evaluation shows that the studied sandstone samples are dominantly fine to medium grained, mainly poorly sorted but at places shows moderate to well sorting, the skewness ranges from near symmetrical, positive to negative with varying Leptokurtic, Platykurtic, Mesokurtic, and Very Leptokurtic. The textural evaluation of Nari Formation sediments indicate the deposition in fluvial-deltaic depositional environment

Keywords: Southern Indus Basin, Nari Formation, Grain Size Analysis, Depositional Environment.

1. INTRODUCTION

Textural evaluation though grain size analysis is useful procedure in multiple sedimentological studies, such as determination of environment of deposition and facies characterization, interpretation of coastal stratigraphy, sea level fluctuations, transportation and depositional processes of sediments etc. Friedman (1967), Tucker (1991) and Solangi (1992). In present study twenty two (22) friable sandstone samples of Nari Formation are selected for grain size analysis by adopting the Folk (1968) procedure. Nari Formation exposed at Kari Buthi Section **(Fig. 1)** is composed of sandstone interbedded with shale and limestone at its basal part. The sandstone is light to pale brown, greenish brown and greenish grey. It is fine to coarse grained, thin bedded, massive, contains cross beds. In parts contains conglomeratic channel deposits. Shale is yellowish brown, greenish, reddish brown, flaky, calcareous and arenaceous. The limestone is yellowish brown, massive, fossiliferous incorporating silty and clay material at the basal part. Nari Formation was named by Williams (1959) for lithology exposed at Gaj River section (26^{o} 56' 12" N; 67^{o} 10' 10" E) in correspondence to Blanford's (1876, 1879) Nari series. It has conformable upper contact with Gaj Formation and lower contact with Kirthar Formation. Based on the fauna, HSC (1961) assign Oligocene age to the formation. The study area is located 15 km South West of Sehwan town , District Jamshoro, on survey of Pakistan Toposheet No.35 N/15 (25° 40' 00" N; 68° 10' 00"E). Previously, the data on textural evaluation of Nari formation is lacking, therefore, present study is proposed to characterize its grain size parameters.

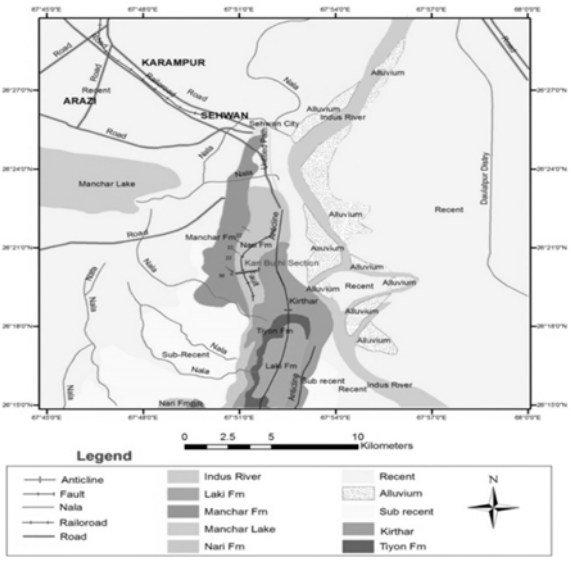


Fig. 1: Location and Geological Map of Study area modified after HSC (1961)

2. MATERIAL AND METHODS

Kari Buthi section is measured with measuring tape, Brunton compass and true thickness methods. The Total thickness of Nari Formation at Kari Buthi Section is 137 meters. Thirty four (34) representative samples of Nari

[++]Corresponding Author: Email: khokhar.qamar@usindh.edu.pk

Formation from all the identified lithofacies at Kari Buthi Section were collected. The twenty two (22) loose and friable sandstone samples were selected for grain size analysis. The grain size measurement is made on the scales of Udden (1914) & Wentworth (1922) and Friedman & Sanders (1978). The studied samples are processed at Sedimentological Laboratory, Centre for Pure and Applied Geology, University of Sindh, Jamshoro. The grain size evaluation is carried out by adopting the procedure of Folk (1968). The set of sieves (-2φ,-1φ, 0φ, 1φ, 2φ, 3φ and 4φ) are used for sieving on Fritch Laborgeratebau sieve shaker.

3. RESULTS AND DISCUSSION

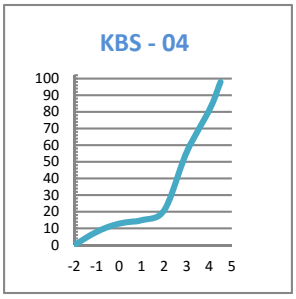
Cumulative curves of friable sandstone sample of Nari Formation are formed by placing grade size of sediments on x-axis against cumulative weight percentage on y-axis, Boggs (1987) **(Table 1)**. The outcome of the data plotting is the typical S-shaped curves. The central slope of the curve reflects sorting, the steep slope suggests well sorted sediments where as gentle slope indicates poorly sorted sediments **(Fig. 2)**.

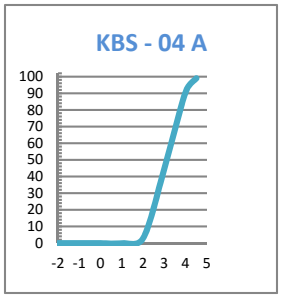
The cumulative curves are used to calculate statistical parameters of studied samples and some are tabulated in **(Table 2)**. The obtained results of various parameters are correlated with the standard statistical parameters chart, Folk (1966). The result of graphic mean indicates that sandstone of Nari Formation is dominantly fine sand (64%) along with (27%) medium to (9%) very fine sand. Generally, the sediments deposited in deltaic to lower reaches of stream are fine to medium sands. The results of sorting of studied samples range from (45%) poorly sorted, (27%) moderately well sorted, (18%) moderately sorted, (5%) well sorted and (5%) poorly sorted. The dominantly poor sorting of studied sediments is due to impersistent depositional processes, characteristics of fluviatile depositional environment along with the deltaic influence as indicated by some portion of moderate to well sorted sediments. The studied sediments show mixed values of skewness varying from -0.513φ to 0.848φ. Out of which (27%) are Symmetrical, (23%) are Negative, (23%) are Very Positive (18%) are Positive and (9%) are Very Negative, indicative of fluvial to deltaic depositional environment.

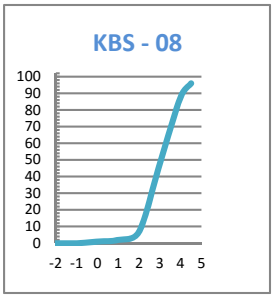
Table (1): Sieved Data of Nari Formation Samples at Kari Buthi Section

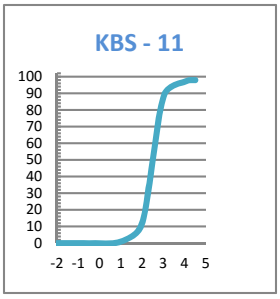
Sample No: 04				Sample No: 04 (A)				Sample No: 08				Sample No: 11			
Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams			
Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%
-2	0 g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%
-1	8g	8%	8%	-1	0g	0%	0%	-1	0g	0%	0%	-1	0g	0%	0%
0	5g	5%	13%	0	0g	0%	0%	0	1g	1%	1%	0	0g	0%	0%
1	2 g	2%	15%	1	0g	0%	0%	1	1g	1%	2%	1	1g	1%	1%
2	6 g	6%	21%	2	3g	3%	3%	2	5g	5%	7%	2	11g	11%	12%
3	35 g	35%	56%	3	42g	42%	45%	3	41g	41%	48%	3	76g	76%	88%
4	25 g	25%	81%	4	46g	46%	91%	4	40g	40%	88%	4	9g	9%	97%
Pan	17 g	17%	98%	Pan	8g	8%	99%	Pan	8g	8%	96%	Pan	1g	1%	98%
Sample No: 13				Sample No: 14				Sample No: 17				Sample No: 18 A			
Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams			
Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%
-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%
-1	0g	0%	0%	-1	2g	2%	2%	-1	0g	0%	0%	-1	1g	1%	1%
0	1g	1%	1%	0	6g	6%	8%	0	1g	1%	1%	0	6g	6%	7%
1	1g	1%	2%	1	2g	2%	10%	1	2g	2%	3%	1	35g	35%	42%
2	10g	10%	12%	2	6g	6%	16%	2	50g	50%	53%	2	45g	45%	87%
3	71g	71%	83%	3	38g	38%	54%	3	38g	38%	91%	3	7g	7%	94%
4	13g	13%	96%	4/	35g	35%	89%	4	6g	6%	97%	4	3g	3%	97%
Pan	1g	1%	97%	Pan	9g	%	98%	Pan	1g	1%	98%	Pan	1g	1%	98%
Sample No: 19				Sample No: 20A				Sample No: 20 B				Sample No: 21 A			
Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams			
Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%
-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%
-1	0g	0%	0%	-1	0g	0%	0%	-1	0g	0%	0%	-1	0g	0%	0%
0	2g	2%	2%	0	1g	1%	1%	0	2g	2%	2%	0	2g	2%	2%
1	1g	1%	3%	1	3g	3%	4%	1	15g	15%	17%	1	1g	1%	3%
2	5g	5%	8%	2	67g	67%	71%	2	59g	59%	76%	2	16g	16%	19%
3	73g	73%	81%	3	23g	23%	94%	3	15g	15%	91%	3	65g	65%	84%
4	16g	16%	97%	4	3g	3%	97%	4	6g	6%	97%	4	11g	11%	95%
Pan	2g	2%	99%	Pan	1g	1%	98%	Pan	2g	2%	99%	Pan	0g	0%	95%
Sample No: 21 B				Sample No: 24				Sample No: 26				Sample No: 27			
Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams			
Phi Val	Weight	Weight %	Cumulative%	Phi Val	Weight	Weight %	Cumulative%	Phi Val	Weight	Weight %	Cumulative%	Phi Val	Weight	Weight %	Cumulative%

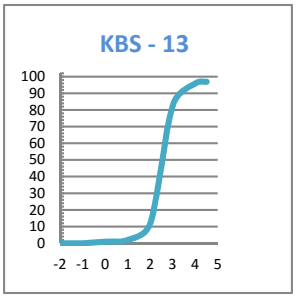
ue				ue				ue				ue			
-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%	-2	0g	0%	0%
-1	0g	0%	0%	-1	6g	6%	6%	-1	2g	2%	2%	-1	0g	0%	0%
0	1g	1%	1%	0	13g	13%	19%	0	5g	5%	7%	0	2g	2%	2%
1	0g	0%	1%	1	8g	8%	27%	1	4g	4%	11%	1	7g	7%	9%
2	18g	18%	19%	2	9g	9%	36%	2	12g	12%	23%	2	22g	22%	31%
3	61g	61%	80%	3	34g	34%	70%	3	58g	58%	81%	3	57g	57%	88%
4	13g	13%	93%	4	23g	23%	93%	4	14g	14%	95%	4	9g	9%	97%
Pan	1g	1%	94%	Pan	6g	6%	99%	Pan	5g	5%	100%	Pan	3g	3%	100%
Sample No: 29				Sample No: 30				Sample No: 31				Sample No: 32			
Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams				Weight of sample: 100 Grams			
Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative%
-2	0g	0%	0%	-2	0g	0%	0%	-2/	0g	0%	0%	-2	0g	0%	0%
-1	1g	1%	1%	-1	2g	2%	2%	-1	5g	5%	5%	-1	3g	3%	3%
0	7g	7%	8%	0	10g	10%	12%	0	15g	15%	20%	0	10g	10%	13%
1	2g	2%	10%	1	5g	5%	17%	1	7g	7%	27%	1	6g	6%	19%
2	10g	10%	20%	2	8g	8%	25%	2	11g	11%	38%	2	8g	8%	27%
3	36g	36%	56%	3	22g	22%	47%	3	23g	23%	61%	3	35g	35%	62%
4	33g	33%	89%	4	43g	43%	90%	4	29g	29%	90%	4	32g	32%	94%
Pan	9g	9%	98%	Pan	10g	10%	100%	Pan	9g	9%	99%	Pan	6g	6%	100%
Sample No: 33				Sample No: 34											
Weight of sample: 100 Grams				Weight of sample: 100 Grams											
Phi Value	Weight	Weight %	Cumulative%	Phi Value	Weight	Weight %	Cumulative %								
-2	0g	0%	0%	-2	0g	0%	0%								
-1	1g	1%	1%	-1	0g	0%	0%								
0	10g	10%	11%	0	5g	5%	5%								
1	6g	6%	17%	1	2g	2%	7%								
2	12g	12%	29%	2	11g	11%	18%								
3	24g	24%	53%	3	37g	37%	55%								
4	26g	26%	79%	4	31g	31%	86%								
Pan	19g	19%	98%	Pan	14g	14%	100%								

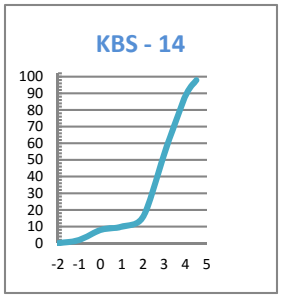


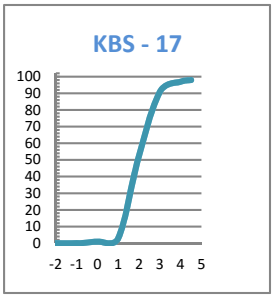


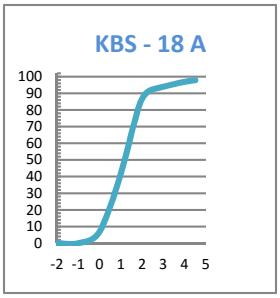












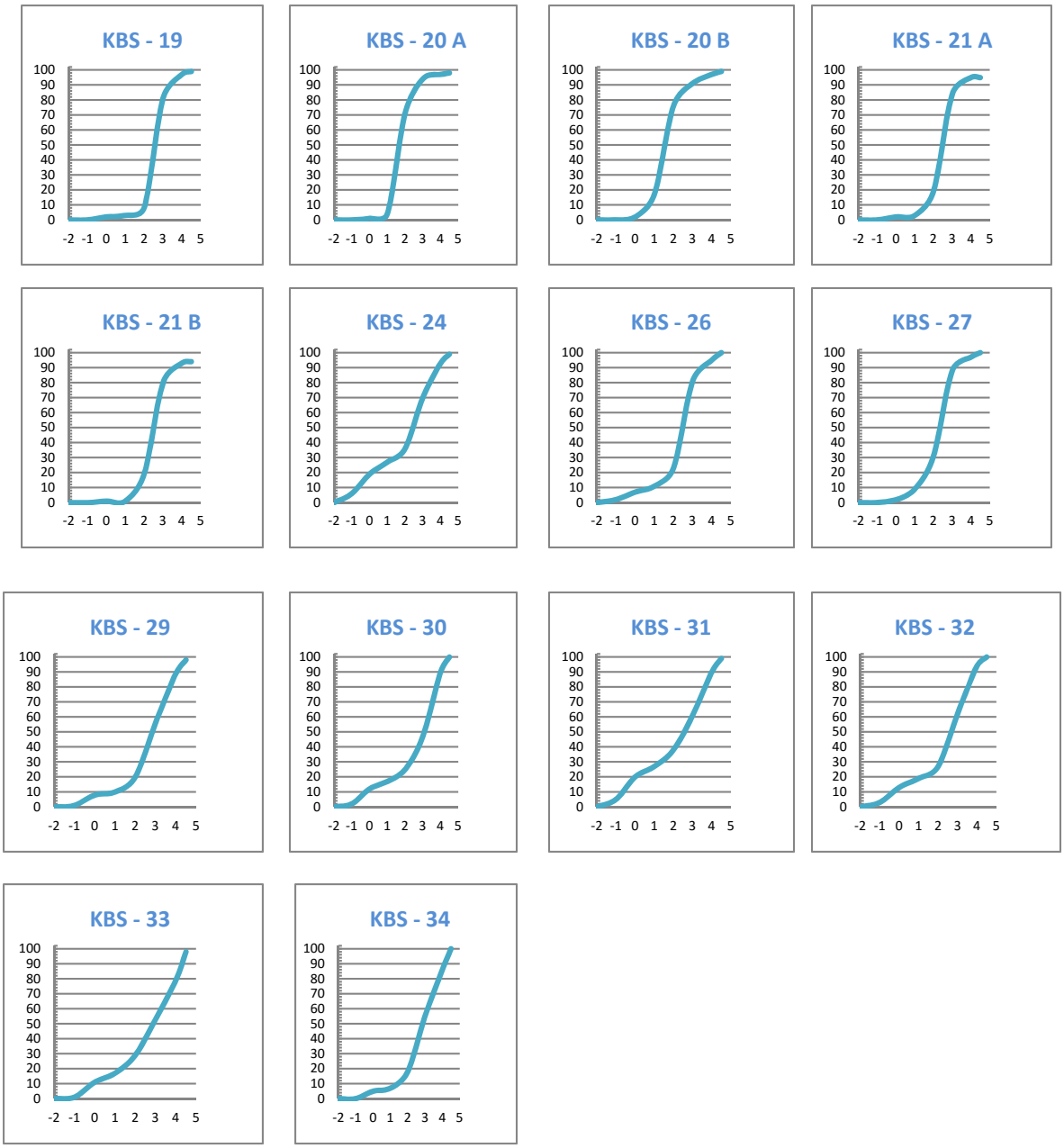


Fig. 2: Cumulative curves of Nari Formation Samples at Kari Buthi Section

Table (02): Statistical parameters of Nari Formation samples at Kari Buthi Section

S.No	Sample No.	Graphic Mean (φ)	Median	Inclusive Graphic Standard Deviation or Sorting	Graphic Skewness (SKI)	Graphic Kurtosis (KG)
1	KBS – 04	2.8	2.83	1.543	0.848	1.52
2	KBS - 04 A	3.1	3.1	0.666	0.02	0.82
3	KBS -08	3.08	3.05	0.776	0.068	0.9
4	KBS -11	2.5	2.5	0.456	0.026	1.15
5	KBS -13	2.54	2.52	0.556	0.151	1.38
6	KBS -14	2.9	2.9	1.164	0.21	1.49
7	KBS -17	1.98	1.91	0.683	0.186	0.88
8	KBS -18 A	1.12	1.18	0.9	0.062	1.22
9	KBS -19	2.58	2.56	0.521	0.193	1.17
10	KBS -20 A	1.76	1.68	0.607	0.289	1.17
11	KBS -20 B	1.6	1.54	0.811	0.366	1.67
12	KBS -21 A	2.46	2.48	0.696	-0.225	1.65
13	KBS -21 B	2.5	2.5	0.696	0.081	1.38
14	KBS -24	1.89	2.42	1.765	-0.389	0.91
15	KBS -26	2.68	2.46	1.218	-0.131	2.24
16	KBS -27	2.22	2.33	0.791	7.95	1.28
17	KBS -29	2.8	2.81	1.233	-0.333	1.44
18	KBS -30	2.57	3.06	1.496	-0.513	1.23
19	KBS -31	1.97	2.55	1.825	-0.387	0.76
20	KBS -32	2.25	2.67	1.525	-0.403	1.33
21	KBS -33	2.63	2.87	1.567	-0.305	0.98
22	KBS – 34	2.88	2.84	1.151	0.13	1.25

Bivariate diagram are useful means of representing sieve data for environmental analysis as statistical parameters are plotted against each other for better distribution of depositional environments, Folk and Ward (1957), Friedman (1961, 1967), Moiola and Weiser (1968), Sahu (1964). Boggs (1987). In present study two bivariate discriminatory diagrams are used Stewart (1958) interpretation diagram by plotting skewness and sorting against median **(Fig. 3 and Fig. 4)** and Friedman (1967) in which skewness is plotted against the sorting **(Fig. 5)**. The results of plotting of data on discriminatory diagrams show that Nari Formation deposited in fluvial to deltaic depositional environments.

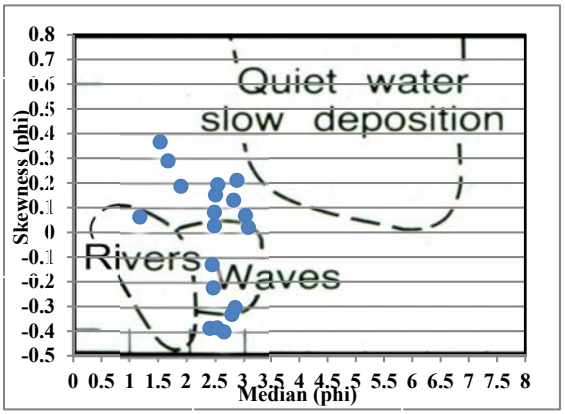


Fig. 4: Bivariate plot of Nari Formation sediments (After Stewart 1958)

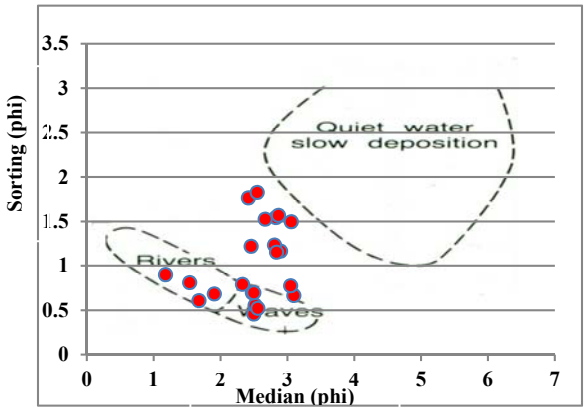


Fig. 3: Bivariate plots of Nari Formation Sediments (After Stewart 1958)

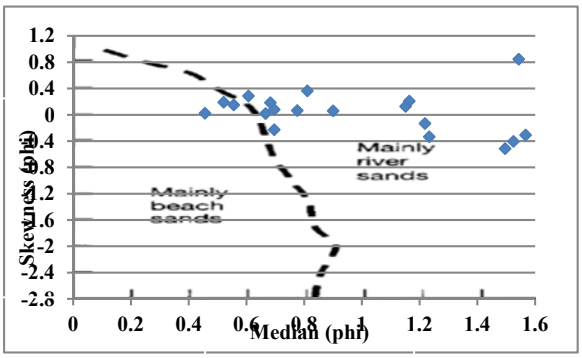


Fig. 5: Bivariate plot of Nari Formation sediments (After Friedman 1967).

4. CONCLUSION

The detailed textural evaluation of loose and friable sandstone of Nari Formation indicates dominantly fine to medium grained sediments, with varying proportion of poor, moderate to well sorting of sediments. The textural signatures of Nari Formation indicate its deposition in fluvial to deltaic depositional environment. Additionally fluvial to deltaic nature of studied sediments is confirmed by the discriminatory diagrams, of Stewart (1958) and Friedman (1967). It is therefore, concluded that Nari Formation at Kari Buthi Section deposited in the fluvial to deltaic depositional environments.

5. ACKNOWLEDGEMENT

Mr. Makhdoom Naseeruddin Farooque Siddiqui is thanked for arranging our stay at Sehwan Town. The role of undergraduate geology students (Mr. Jamshed Ali Shaikh, Mr. Sajjad Ali Abbasi Kalhoro, Mr. Manzoor Ahmed Chachar, Mr. Ihsan ul Haq Abbasi, Zulfiquar Ali Soomro, Muhammad Younis Chachar and others) is highly appreciated for their field and lab assistance.

REFERENCE:

Blanford, W. T., (1876). On the geology of Sind. Ibid., Rees., Vol. 9, 8-22.

Blanford, W. T., (1879). The geology of western Sind. Ibid., Mem., Vol. 17, 1 -196.

Boggs, S. J., (1987). Principles of Sedimentology and Stratigraphy, Fourth edition, University of Oregon.

Friedman, G. M., (1967). Dynamic processes and statistical parameters compared for size frequency distribution of beach and river sands, Journal of Sedimentary Petrology, Vol. 37, No.2, 327-354.

Folk, R. L., M. C. Ward, (1957). Brazos River bar: A study of the significance of grain size parameters. Journal of Sedimentary Petrology, 27, 3-26.

Folk, R. L., (1966), A review of the grain size parameters. Sedimentology, 73-93.

Folk, R. L., (1968). Petrology of sedimentary rocks, The Universty of Texas.

Friedman, G. M., (1961). Distinction between (sic) dune, beach and river sands from their textural characteristics: Jour. Sedimentary Petrology, Vol. 31, 514-529.

Friedman, G. M., (1967). Dynamic processes and statistical parameters compares for size frequency distribution of beach and river sands. Journal Sed. Pet., 37, 327-354.

Friedman, G. M., J. E. Sanders, (1978). Principle of Sedimentology. John.Wiley and Sons Inc.792.

Hunting Survey Corporation (1961). Reconnaissance geology of part of west Pakistan (Colombo plan cooperative project); Canada Govt. Toronto. 550.

Moiola, R. J., D. Weiser, (1968). Textural parameters: An evolution. Journal of Sed. Pet., 38, 45-53.

Sahu, B. K., (1964). Depositional Mechanism from the size analysis of clastic sediments. Journal Sed. Pet., 34(1), 78-83.

Solangi, H., Sarfaraz, (1992). Geophysical / Sedimentological studies of a Quaternary tidal delta system, Ph. D. thesis, University of Walves, U.K., 90.

Stewart, H. B., (1958). Sedimentary reflections of Depositional Environment in San Miguel Lagoon, Baja California, Mexico, Bull. Amer., Ass., Petrol, Geologist, Vol., 42. No.11 (November, 1958), 2567-2618.

Tucker, M., (1991). Sedimentary Petrology. An introduction to the origin of sedimentary rocks, Blackwell's Scientific, Oxford, Ed. 2nd, 260Pp.

Udden, J. A., (1914). Mechanical composition of clastic sediments. Bulletin of the Geological Society of America, 25: 655-744.

Wentworth, C. K., (1922). A scale of grade and class terms for clastic sediments. Jour. of Geol, 30, 377-392.

Williams, M. D., (1959). Stratigraphy of the Lower Indus Basin, West Pakistan. World Petroleum Cong., 5th New Your, Proc., Sec, I, 19, 377-390.