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Depositional Environment of Sohnari Member Sandstone of Laki Formation from Southern Indus Basin, Pakistan

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Abstract: The Sohnari member, a clastic unit of generally carbonate Laki Formation is exposed in Lakhra anticline, northwest of Jamshoro town. Seven sandstone samples from Sohnari member at Lakhra anticline were collected for the investigation of its depositional environment. Grain size analysis was carried out through sieving. The sieved data was used for plotting of cumulative curves and measurement of statistical parameters (mean, median, sorting, skewness and kurtosis). Present study shows that the studied sandstone samples are medium to fine grained, moderate to poorly sorted, ranging in skewness from near symmetrical, positive to negative with very Leptokurtic, Leptokurtic and Mesocratic kurtosis. The analysis of grain size parameters indicated fluvial depositional environment of Sohnari member of Laki Formation

Keywords: Southern Indus Basin, Laki Formation, Sohnari Member, Grain Size Analysis, Depositional Environment.

1. INTRODUCTION

The grain size analysis of Sohnari member of Laki Formation (Eocene age) from Lakhra anticline is carried out for the determination of its depositional environment. Sohnari member is exposed in the Lakhra, Jhimpir and Meting areas of Southern Indus Basin. The Sohnari member at Lakhra anticline is composed of sandstone, lateritic clay and gypsiferous shale. Sohnari member sandstone varies in color from dark brown to light brown, yellowish, light yellow, white, pinkish and purple colors, it is loose and in parts consolidated, it contains cross bedding, lamination and ripple marks. Clay varies in colour from reddish brown and dark brown. Besides, it contains coal seams which are being mined at the Sonda and Meting coalfields. The study area is located 80 kilometers, North West of University of Sindh, Jamshoro, on survey of Pakistan Topo sheet No.40 C/2 (Latitude 25° 40' 00"N & Longitude: 68° 10' 00"E) **(Fig.1)**. Laki Formation (Eocene) was redefined by Hunting Survey Corporation (1961), after Noetling (1903) and Blandford (1876). There are two members of Laki Formation; 1- The oldest Sohnari member. 2- The youngest Chat Member (Shah, 2009). The age assigned to Sohnari member is Early Eocene (Ypresian) (Shah, 2009). The present study is intended to identify the depositional environment of the Sohnari member by studying the results of the grains size parameters. Previously, Sohnari member was studied for its coal potential and stratigraphic framework with scanty sedimentological studies. Sanfilipo and Khan (1988), Breyer and McCabe (1986) are good reviewer of the Sohnari member. The upper contact of Sohnari Member with Chat Member is confirmable, whereas the lower contact of the said member with Ranikot Group in unconformable (Shah, 1977 and 1999).

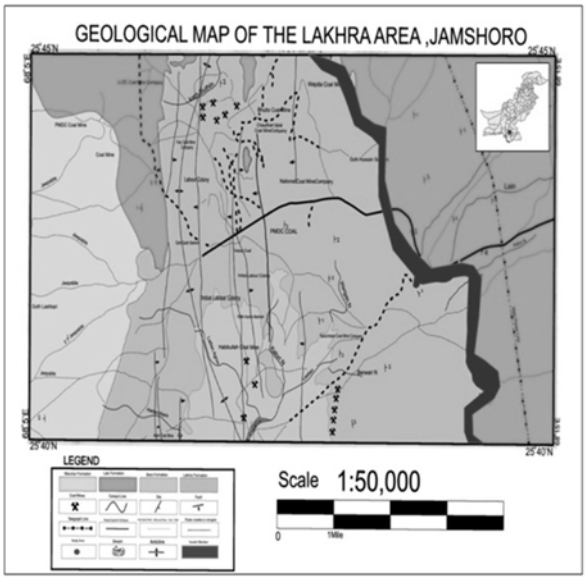

Fig. 1: Geological Map of study area

2. MATERIAL AND METHODS

The section measurement of Sohnari member at Lakhra Anticline was carried out by true thickness method. The total measured thickness of Sohnari member at the studied section is 110 feet. Seventeen (17) rock samples of Sohnari member were collected from the Lakhra anticline section. Seven samples of loose and unconsolidated sandstone were selected for grain size analysis. Udden (1914), Wentworth (1922)

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and Friedman and Sanders (1978) scale of grain size measurement were applied in the present study. The grain size analysis was carried out at the Sedimentological laboratory of Center for Pure and Applied Geology, University of Sindh, Jamshoro. Folk's (1968) procedure was used for processing the grain size data. The sieves of (-1 φ, 0φ, 1φ, 2φ, 3φ and 4φ) with Sieve shaker, Fritch Laborgeratebau, were used for sieving the studied samples.

3. RESULTS AND DISCUSSION

Cumulative curves were produced by plotting the cumulative weight percentage against grade sizes (Boggs, 1987). Cumulative curves are very useful, as they enable the reader to visualize and correlate the data with other samples and notice the errors in weighting by faulty sieves Folk, (1968). The grain size data **(Table 1)** is plotted against the phi values. The grain size data of each fraction is plotted on y-axis and phi values are placed at x-axis. Typically S-shaped curve is formed through this plotting. The slope of the central part of this curve reflects the sorting of the sample. The obtained curves of studied samples are not S shaped and showed moderate to poor sorting of sediments **(Fig. 2)**.

Table -1: Sieved Data of Studied Samples.

Parameters	TPLS-4								TPLS-7							
	Weight of Sample: 100 gram								Weight of Sample: 100 gram							
Phi Value	-2	-1	0	1	2	3	4	Silt/Clay	-2	-1	0	1	2	3	4	Silt/Clay
Weight		2.5	9.7	3.6	31	17.5	27.5	8.2		0.7	5	1.6	72	10	9	1.7
Weight %		2.5	9.7	3.6	31	17.5	27.5	8.2		0.7	5	1.6	72	10	9	1.7
Cumulative Weight %		2.5	12.2	15.8	46.8	64.3	91.8	100		0.7	5.7	7.3	79.3	89.3	98.3	100
Parameters	TPLS-8								TPLS-9							
	Weight of Sample: 100 gram								Weight of Sample: 100 gram							
Phi Value	-2	-1	0	1	2	3	4	Silt/Clay	-2	-1	0	1	2	3	4	Silt/Clay
Weight		2.57	9	3.7	69	7.45	6.9	1.3		1	5	2.8	74	8.6	6.6	2
Weight %		2.57	9	3.7	69	7.45	6.9	1.3		1	5	2.8	74	8.6	6.6	2
Cumulative Weight %		2.57	11.6	15.3	84.3	91.7	98.6	100		1	6	8.8	82.8	91.4	98	100
Parameters	TPLS-10								TPLS-11							
	Weight of Sample: 100 gram								Weight of Sample: 100 gram							
Phi Value	-2	-1	0	1	2	3	4	Silt/Clay	-2	-1	0	1	2	3	4	Silt/Clay
Weight		0.5	6	3.5	74	9	5.7	1.3		1.84	5.91	2.41	69.4	9.76	8.64	2.01
Weight %		0.5	6	3.5	74	9	5.7	1.3		1.84	5.91	2.41	69.4	9.76	8.64	2.01
Cumulative Weight %		0.5	6.5	10	84	93	98.7	100		1.84	7.75	10.2	79.6	89.4	98	100
Parameters	TPLS-12															
	Weight of Sample: 100 gram															
Phi Value	-2	-1	0	1	2	3	4	Silt/Clay								
Weight		0.3	14.6	6	63.8	6.5	6.8	2								
Weight %		0.3	14.6	6	63.8	6.5	6.8	2								
Cumulative Weight %		0.3	14.9	20.9	84.7	91.2	98	100								

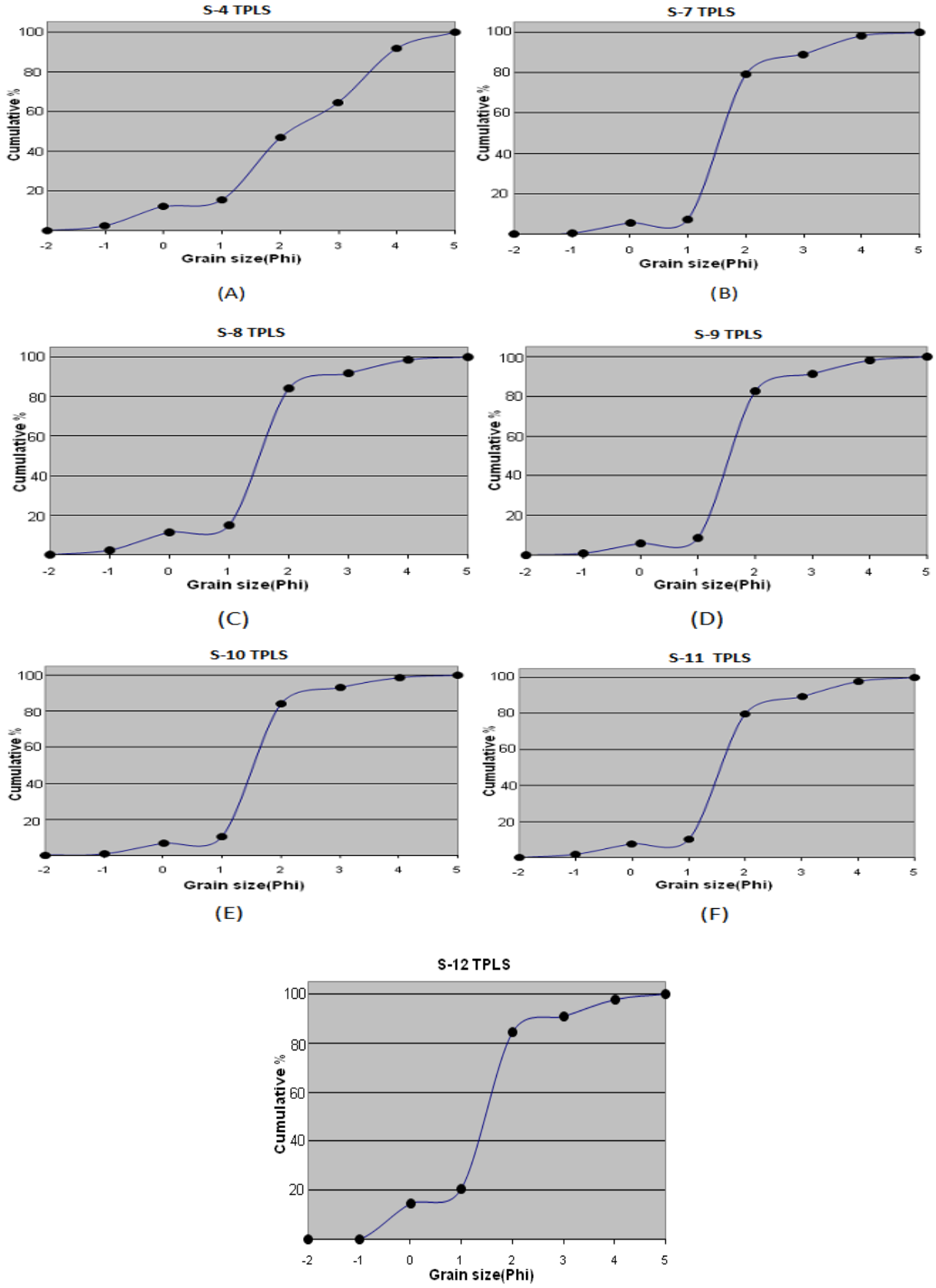

Fig. 2: Cumulative curves of the Sohnari Member of Laki Formation

The statistical parameters are calculated from cumulative curves and tabulated in **(Table 2)**. The mean of studied samples ranges from (85.72%) medium size to (14.28%) fine size. The sorting of the samples ranges from, four (04) samples moderately sorted (57.15%), two (02) samples poorly sorted (28.57%) and one (01) sample moderately sorted (14.28%). The Skewness of studied samples ranges from five (05) samples near symmetrical (71.44%), one (01) sample positive skewed (14.28%) and one (01) sample negative skewed (14.28%). The kurtosis of the studied samples ranges from four (04) samples Very Leptokurtic (57.15%), two (02) samples Extremely Leptokurtic (28.57%) and one (01) sample Mesocratic (14.28%).

Sample No.	Graphic Mean	Median	Sorting	Graphic Skewness (SKI)	Graphic Kurtosis (K)
4	2.2	2	1.39	0.04	1.004
7	1.56	1.5	0.76	0.13	3.03
8	1.46	1.5	0.81	-0.11	2.67
9	1.53	1.5	0.58	0.04	3.03
10	1.53	1.5	0.75	0.015	2.39
11	1.6	1.6	0.88	-0.02	2.87
12	1.16	1.5	1.07	-0.3	2.23

Table-2: Statistical Parameters of studied Samples of Sohnari Member, Southern Indus Basin

There are various other techniques for the determination of depositional environment including grain size distribution of sediments; Folk and Ward (1957), Friedman (1961 and 1967), Moiola and Weiser (1968), Sahu (1964). Boggs (1987) have described that the bivariate diagram of grain size parameters (mean, median, skewness and sorting) helps in the classification of major depositional environments. Graphic mean, skewness and standard deviation (sorting) are the most important parameters which help in the recognition of depositional environment. Two bivariate discriminatory diagrams were used in the present study following Stewart (1958) diagram by plotting skewness and sorting against median **(Fig 3 and Fig. 4)** and Friedman (1967) in which graphic mean and skewness are plotted against the sorting **(Fig. 5 and Fig. 6)**. The result of plotting of data on discriminatory diagrams showed that samples of loose sandstone of the Sohnari member were deposited in fluvial depositional environment. Previous workers including Wnuk *et.al* (1991) stated neritic tidal flat estuarine, coastal swamp depositional environment of Sohnari member of Laki Formation on basis of field characteristics. Wnuk *et.al*. (1991) stated neritic tidal flat, estuarine, coastal swamp and marsh environments and Outerbridge and others (1990) concluded the non-marine to brackish water (estuarine) environment of deposition for Sohnari member.

The results of the present investigation can be concluded as under:

1-The detailed study of the grain size analysis of samples of loose sandstones of Sohnari member indicated that they are composed of the medium to fine grained sediments, with moderate to poor sorting showing potentially fluviatile depositional environment.

2-The bivariate discriminatory diagrams, of Stewart (1958) and Friedman (1967), indicated fluvial nature of sediments

3-It is therefore, concluded that Sohnari member of Laki Formation was deposited in fluvial depositional environment in between two carbonate units, the Lakhra Formation (Paleocene) and overlying carbonate unit of Laki formation (Eocene), potentially marking the emergence of area at the Paleocene and Eocene boundary.

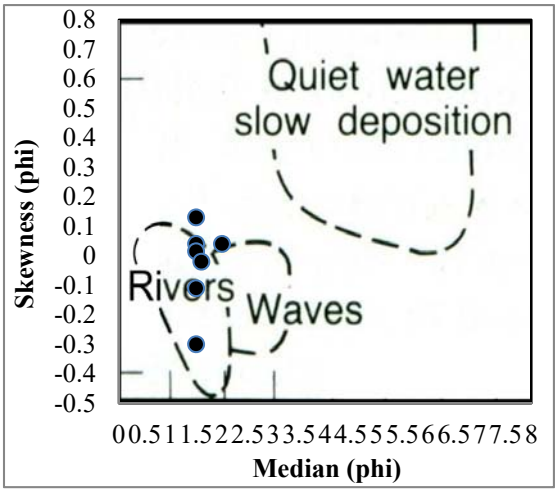

Fig. 3: Interpretation diagram reproduced after Stewart 1958 (Skewness against median)

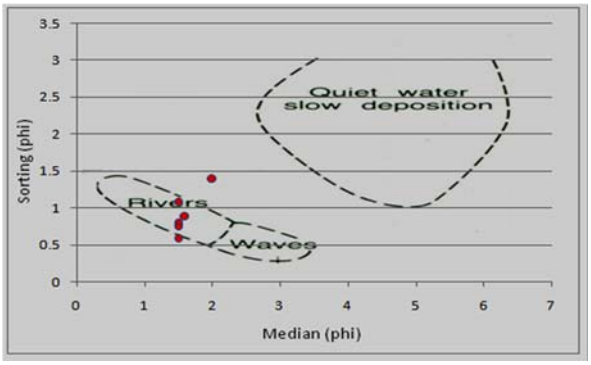

Fig. 4: Interpretation diagram reproduced After Stewart 1958 (Sorting against median)

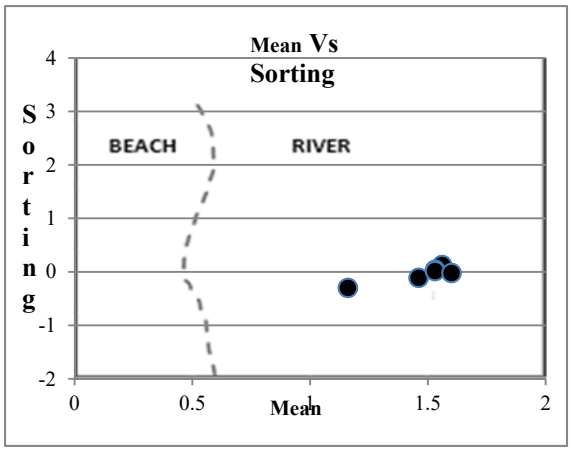

Fig.5: Interpretation diagram reproduced after Friedman 1967 (Mean against Sorting)

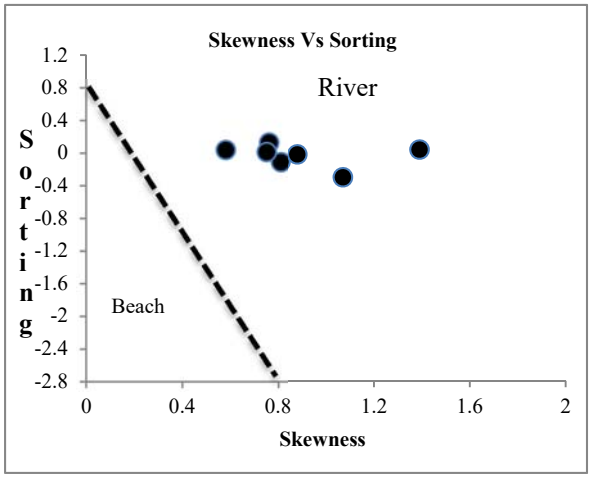

Fig. 6: Interpretation diagram reproduced After Friedman 1967 (Skewness against Sorting)

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