Geol. Bull. Univ. Peshawar, 1991, Vol. 24, pp. 99-108

PETROLOGY AND THE GRAIN SIZE CHARACTERS OF THE PAB SANDSTONE OF PARTS OF THE LORALAI AND KHUZDAR DISTRICTS OF BALUCHISTAN

AKHTAR MOHAMMAD KASSI, AMJAD RASHID QURESHI,
MOHAMMAD AHMAD FAROOQUI & DIN MOHAMMAD KAKAR

Department of Geology, University of Baluchistan, Quetta

ABSTRACT

Sandstone samples obtained from parts of the Pab Sandstone (Late Cretaceous) of Loralai and Khuzdar Districts were studied under polarizing microscope and classified as quartz arenite, lithic arenite and sub-lithic arenite which have been derived most probably from a mixed acid igneous and metamorphic terrain. On the basis of high maturity, subrounded to well rounded nature of quartz grains, presence of calcareous fossil fragments and high values of sorting coefficient, it may be suggested that the formation may have been deposited in shallow marine (most probably beach) conditions.

INTRODUCTION

The term Pab Sandstone was introduced by Vredenburg (1908), the name derived from Pab Range in Kirther Province. Williams (1959) designated the Somalji trail west of Wirahab Nai across the Pab Range as type locality.

The formation consists of quartzose sandstone of white, creme and reddish brown colours which weathers yellowish brown, fine to coarse grained, moderately to well sorted, subrounded to well rounded, thick bedded and commonly cross stratified. Some marl and argilaceous and siliceous limestone is also intercalated with the sandstone. Shale is very subordinate.

The formation is widely developed in the studied areas (Fig. 1) which lies within the Axial Belt, although, it is very highly developed in the Sulaiman and Kirther Provinces. It conformably overlies the Fort Monro Formation in the Sulaiman and Kirther Provinces and overlain by the Khadre Formation of Ranikot Group. Stratigraphic position of the Pab Sandstone in the studied areas is shown in Table 1.

TABLE 1. STRATIGRAPHIC POSITION OF THE PAB SANDSTONE IN LORALAI AND KHUZDAR DISTRICTS.

Group	Formation	Lithology	Age
	Dungan Formation	Limestone, nodular to massive, fossiliferous, dark gery, brown, cream, with subordinate shales.	Paleocene
	Pab Sandstone	Quartzose sandstone of cream, white and light grey colours.	Late Cretaceous
	Parh Limestone	Limestone, light gery, white, cream, hard, porcelaneous.	Late Cretaceous
	Goru Formation	Limestone interbedded with shales of greenish grey and maroon colours.	Early Cretaceous
Parh Group	Samber Formation	Shales and siltstones brownish grey, pale green, belemnitic, Glauconitic.	Early Cretaceous
		Unconformity	
	Shirinab Formation	Limestone, dark gery, thin to medium bedded, interbedded with dark gery shales.	Early to Middle Jurassic

The present paper is intended to describe the petrology and grain size parameters of the Pab Sandstone and an attempt has been made to interpret the provenance and depositional environments based on petrology and grain size parameters. Samples for the analysis were taken from Shehan Rud, (Fig. 1), about 6.5 km northeast of Murgha Kibzai 100 km northeast of Loralai on Loralai-Musa Khel

road, from Siazgi 61 km northwest of Loralai, from Gunga Kili nearly 11 km west of Khuzdar and Siman 10 km west of Pir Umar and 40 km south of Khuzdar.

PETROLOGY AND PROVENANCE

Study of the Pab Sandstone under polarizing microscope shows that the Pab Sandstone consists mainly of quartz with minor amount of orthoclase, microcline, perthite, and white mica. Among rock fragments, quartzite, acid igneous fragments and organic matter are present in minor amounts. In samples of the Murgha Kibzai and Siazgi areas of Loralai Districts limestones and calcareous fossil fragments (mostly foraminifera) are very common. Among the heavy minerals apatite, epidote, tourmaline, rutile and picotite are present. It may be observed that samples of the Murgha Kibzai and Siazgi areas have higher proportions of limestone and fossil fragments.

The undulatory and coarsely polycrystalline nature of quartz grains alongwith the mentioned minerals and rock fragments suggest a mixed and metamorphic source area where quartzite, gneisses and perhaps granites were exposed. The limestone and calcareous fossil fragments, which in some samples exceed the mineral and rock constituents, have intrabasinal derivation.

CHARACTER OF QAURTZ GRAINS

As quartz is the most common mineral it was desirable to study character of the quartz grains in detail by taking guidence from the work of Blatt & Christie (1963) and Blatt (1967). Blatt (1967) afetr a thorough study of the characters of quartz grains and their relationship with the grain size parameters suggest that:

a) For any grain size polycrystalline quartz grains derived from gneisses will be more finely crystalline than those derived from plutonic rocks. For example, a medium sand size grain in a sandstone formed of six or more apparently different crystals is very likely to have been drived from a foliated metamorphic rock. If formed of less than six crystals, it probably had its origin in a massive plutonic rock.

b) Many polycrystalline quartz grains derived from foliated rocks are formed of elongated crystals.

c) A feature apparently peculiar to metamorphic polycrystalline quartz grains is the presence of two distinctly different sizes of quartz crystals within a grain.

Quartz grains were studied in 12 different thin sections of the Pab Sandstone which were mostly of medium to very coarse grained textures. 100 grains were counted

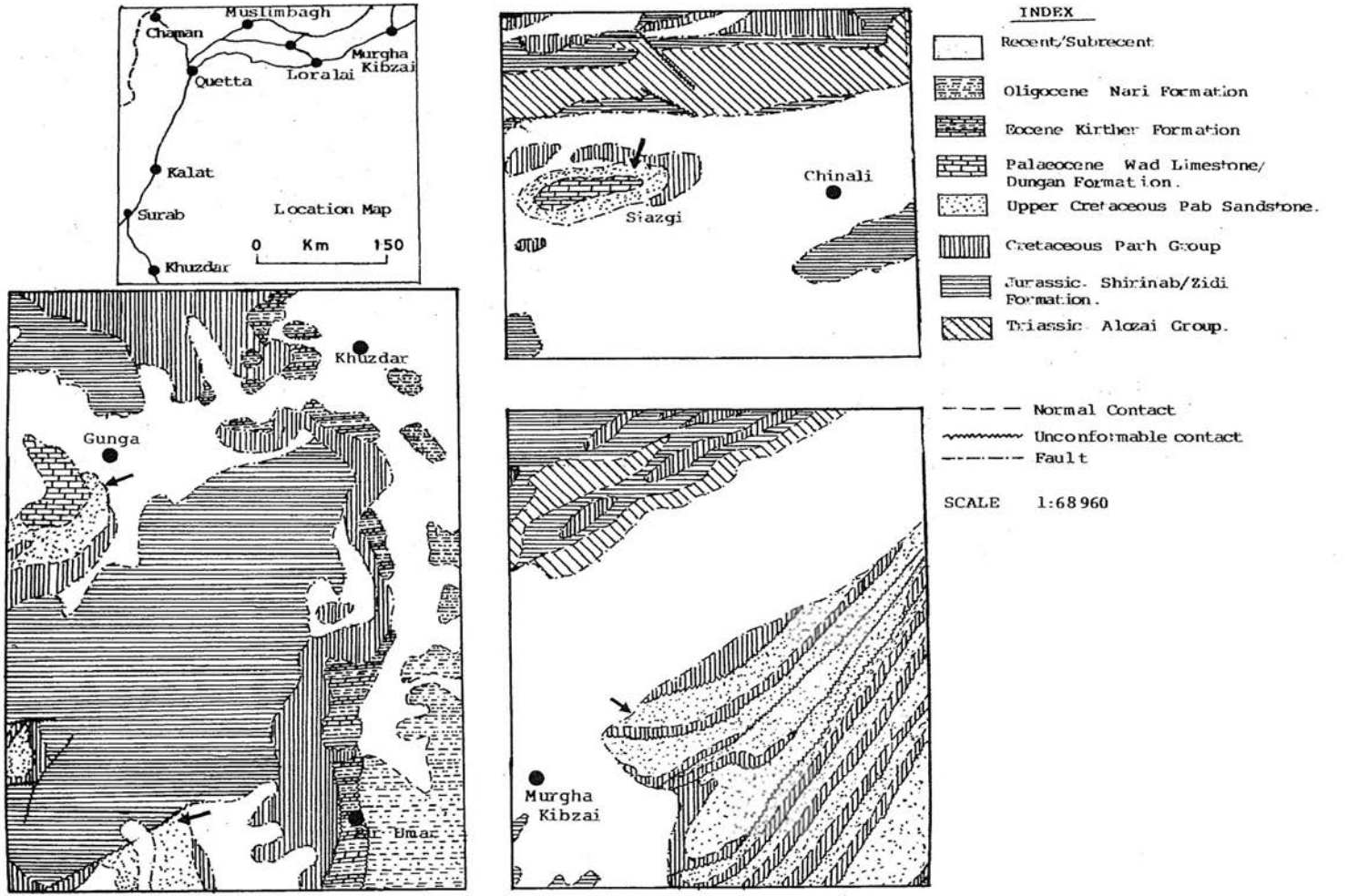

Fig. 1. Location and geological maps of the Murgha Kibzai, Siazgai, Gunga Kili and Siman areas. Arrows indicate studied sections.

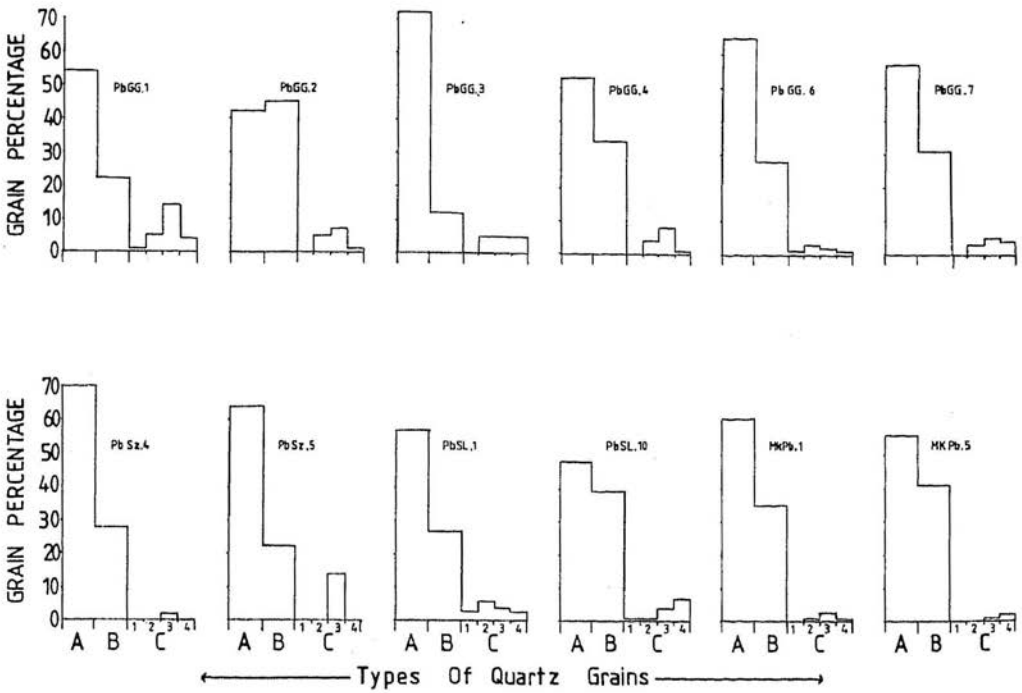

Fig. 2. Types of quartz grains in Pab Sandstone. A: Undulatory, B: Nonundulatory, and C: Polycrystalline (C1: Elongated, C2: Granular, C3: Coarsely Crystalline, and C4: Finely Crystalline).

in each thin section by an automatic Swift Point Counter and classified into undulatory, nonundulatory and polycrystalline types (Blatt and Christie, 1963; Blatt, 1967). The polycrystalline grains were further classified into elongated, granular, coarsely crystalline and finely crystalline varities (Fig. 2). It may be observed that in majority of the samples (11 out of 12) undulatory extinction dominates (range: 42 to 73 %) over nonundulatory extinction (range: 12 to 45 %). Although polycrystalline grains are the least abundant their proportion (2-24 %) is highly significant in majority of the samples. Among polycrystalline types medium size grains comprising of less than six crystals are more common than those of the finely crystalline grains. Polycrystalline grains heving preferred orientation of crystals are also present in subordinate proportions to those having granular texture.

RESULTS OF POINT COUNTING

500 points were counted in 20 samples of the Pab Sandstone by a Swift Automatic Point Counter in appropriate samples and classified into quartz, feldspar, quartzite, limestone, fossil fragments, acid igneous fragments, cement and matrix. Results of the counts were plotted (Fig.3) in the classification scheme of Dott (1964). Results show

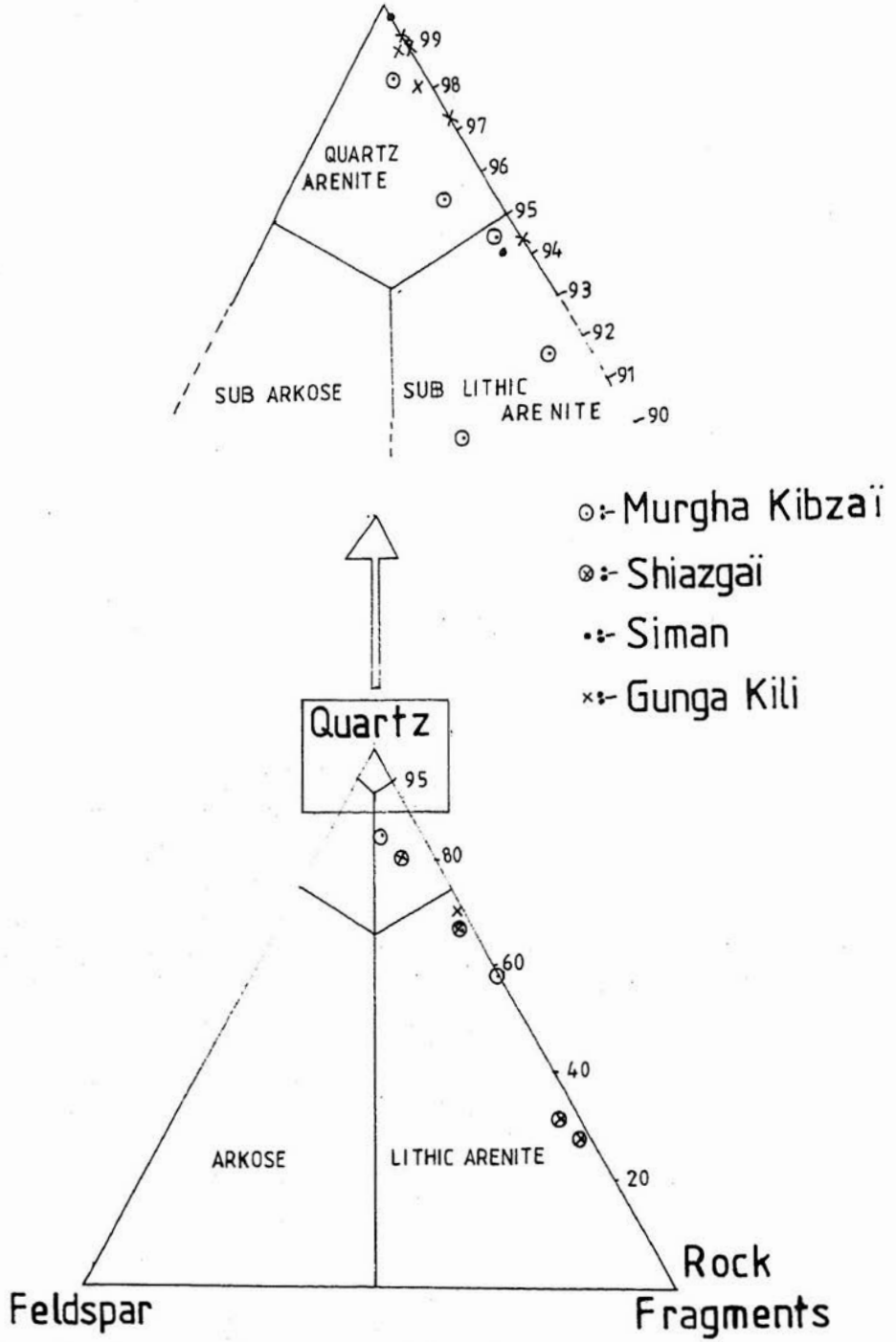

Fig. 3. Plot of point counting results into the classification scheme of Dott (1964). Three end members are Q: quartz, quartzite and acid igneous fragments, F: feldspar, and RF: rock fragments (mostly limestone and fossil fragments).

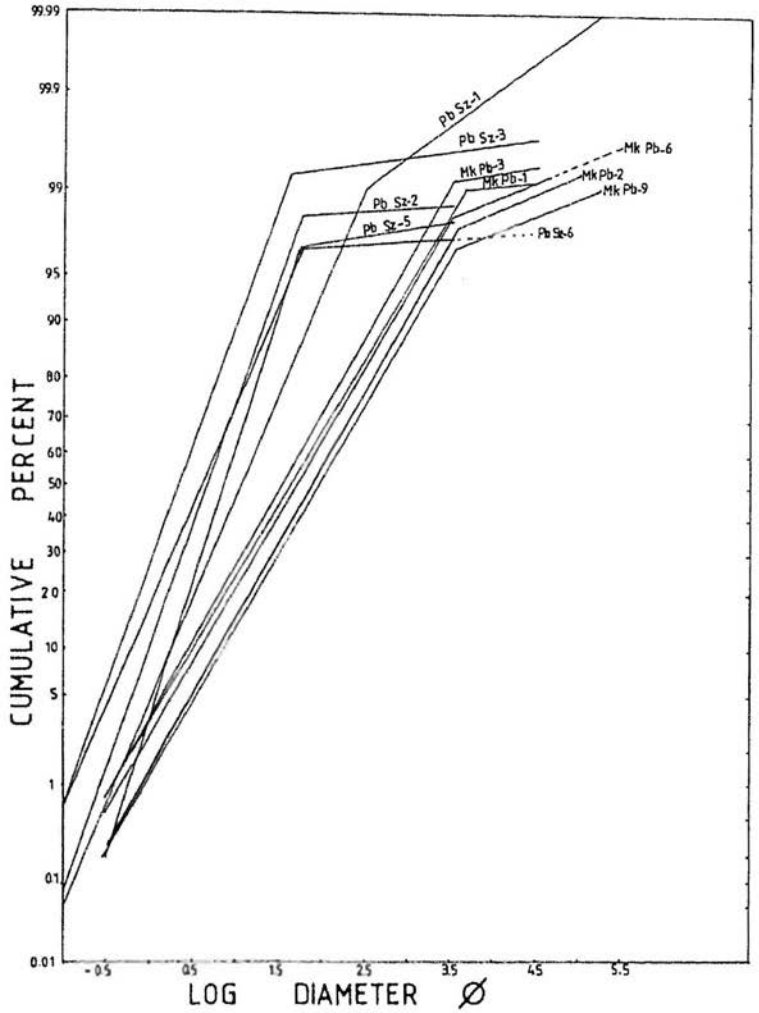

Fig. 4. Cumulative curves of the analysed samples of the Pab Sandstone.

that the Pab Sandstone in general is very rich in quartz, very poor in feldspar, rich in rock fragments and according to Dott's (1964) classification it may be classified as quartz arenite, sub-lithic and lithic arenite. It may be observed that in certain samples, mostly those of the Shiazgai area, limestone and fossil fragments are dominant over other rock fragments, a character which most appropriately categorises them as calclithite according to Folk's (1968) classification.

The Pab Sandstone of the Gunga Kili and Siman areas of Khuzdar District has the highest proportion of quartz and lowest proportion of feldspar. 6 out of 8 samples obtained from these areas fall into the field of quartz arenite and remaining into

TABLE 2. GRAPHIC PARAMETERS (AFTER FOLK & WARD, 1957).

Sample No.	Mz	σ i	Sos	SKi	αs	KG	Md	Mo
PbSz-1	1.020	0.578	1.000	0.045	0.00	1.024	1.05	1.50
PbSz-2	0.650	0.480	0.755	0.049	0.15	0.884	0.65	0.50
PbSz-3	0.333	0.527	0.875	0.037	0.05	1.024	0.35	1.50
PbSz-5	0.876	0.477	0.750	0.083	0.04	0.945	0.83	0.50
PbSz-6	0.566	0.622	1.025	0.032	0.05	0.988	0.55	0.50
MkPb-1	1.650	0.856	1.140	0.007	0.05	0.973	1.65	2.50
MkPb-2	1.860	0.839	1.385	0.008	0.01	0.987	1.87	2.50
MkPb-3	1.516	0.821	1.350	0.015	0.00	1.005	1.50	2.50
MkPb-6	1.700	0.978	1.825	0.166	0.85	1.300	1.70	2.50
MkPb-9	1.950	0.849	1.400	0.000	0.00	0.981	1.95	2.50

Abbreviations: Mz=Mean Grain size, σ i=Inclusive graphic standard deviation, So_s=Simple sorting measure, αs=Simple skewness measure, Ski=Inclusive graphic skewness, KG=Kurtosis, Md=Median, Mo=Mode.

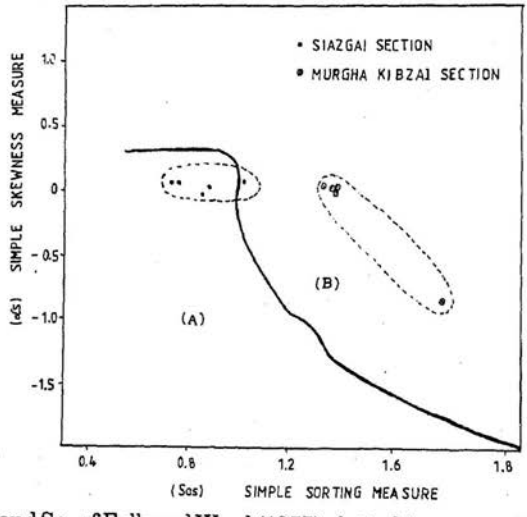

Fig. 5. Parameters αS and So_s of Folk and Ward (1957) plotted in scatter diagram after Friedman (1967). Field A to the left side of the dotted line represents zone of tow-way flow on beaches and field B represents one way flow chan nels of river.

sublithic arenite field (Fig.3). On the contrary, samples of the Murgha Kibzai area of Loralai District have comparatively high proportion of feld spar, however, they also fall into the quartz arenite and sub-lithic arenite fields.

GRAIN SIZE ANALYSIS AND RESULTS

Grain size analysis of five samples each of the Siazgai and Murgha Kibzai areas of the Loralai Districts were carried out by the sieving method. Samples were disaggregated by treating them with 10 % HCl and the acquired sand was washed by distilled water and dried oven at 30 C. 15 to 40 grams of samples were used in analyses depending on the available quantity.

Results of the analysis were furnished in terms of weight percentages, cumulative weight percentages and cumulative curves (Fig. 4) prepared using phi scale of size units Parameters like mode (Mo), median (Md), graphic mean (Mz), simple sorting measure (Sos), inclusive graphic standard devaition (oi), inclusive graphic skewness (Ski), simple skewness measure (αs), and graphic kurtosis (KG) were calculated using Folk and Ward's (1957) formulae.

Results of the analyses (Table 2) show that the mode value range between 0.5 and 2.5 and median between 0.35 and 1.95. Inclusive graphic standard deviation range between 0.47 and 0.98 suggesting that the sand is moderately to well sorted. Inclusive graphic skewness vary between -0.166 and 0.083 which in general is a nearly symmetrical trend. Graphic kurtosis measure varies between 0.88 and 1.02 showing that curves are mesokurtic.

Simple skewness measure of the analysed samples were plotted (Fig. 5) against simple sorting measure (Sos), a plot suggested by Friedman (1967) to differentiate river sand from the beach sand. It may be observed that five samples of the Shiazgai section fall within or near the field of beach sand, whilst the other five samples of Murgha Kibzai section behave differently and fall within the field of river sand which is probably due to the influence of a river discharging into the marine conditions. Nature of the cumulative curves and their mesokurtic behaviour show that the coarse and fine populations are unequally mixed.

DISCUSSION

The Pab Sandstone by nature is moderately to well sorted, symmetrical and mesokurtic. Plot of skewness and sorting (Fig. 5) go in favour of the beach conditions although there may be some influence of river in the Murgha Kibzai area. It has been argued (Mason and Folk, 1958; Friedman, 1967) that beach sediments tend to be negatively skewed and leptokurtic. The Pab Sandstone, on the contrary, behaves differently which may be due to other influences.

Samples of the Siazgai and Murgha Kibzai areas are rich in limestone/fossil fragments (mostly foraminifera), otherwise their mineral content and texture show high degree of maturity. On the other hand, sandstone of the Khuzdar area are highly rich in quartz and siliceous fragments and deficient in limestone/fossil fragments.

Therefore, on the basis of both combined grain size and petrographic characters such as high maturity, moderate to well rounded nature of quartz grains, high values of sorting coefficient and presence of calcareous fossil fragments, it may be suggested that the Pab Sandstone was deposited in shallow marine, most probably beach conditions, although river influence may also be noticed, as suggested by some of the grain size analyses.

CONCLUSIONS

Following conclusions may be drawn from the foregoing account of petrographic and grain size analyses:

1) The Pab Sandstone (Late Cretaceous) is classified as quartz arenite, sublithic arenite and lithic arenite and derived from an acid igneous and metamorphic terrain.

2) On the basis of petrographic and grain size characters it may be suggested that the Pab Sandstone has been deposited in shallow marine (most probably beach) conditions.

REFERENCES

Blatt, H., 1976. Original characteristics of clastic quartz grains. J. Sediment. Petrol. 37, 1-27.

Blatt, H. & Christie, J.M., 1963. Undulatory extinction in quartz of igneous and metamorphic rocks and its significance in provenance studies of sedimentary rocks. J. Sediment. Petrol. 33, 559-579.

Dott, R.H., 1964. Wacke, greywacke, and matrix - What approach to immature sandstone classification? J. Sediment. Petrol. 34, 625-632.

Folk, R.L., 1968. Petrology of sedimentary rocks. Austin, Tex., Hemphills, 124 pp.

Folk, R.L. & Ward, W.C., 1957. Brazes River Bar: A study in the significance of grain size parameters. J. Sediment. Petrol. 22, 125-145.

Friedman, G.M., 1967. Dynamic processes and statistical parameters for size frequency distribution of beach and river sands. J. Sediment. Petrol. 37, 327-354.

Mason, C.C. & Folk, R.L., 1958. Differentiation of beach and eolian flat environments by size analysis, Mustang Island, Texas. J. Sediment. Petrol. 28. 211-226.

Vredenburg, E.W., 1908. The Cretaceous orbitoids of India. India. Geol. Surv. Mem. Recs. 36, 171-213.

Williams, M.D., 1959. Stratigraphy of lower Indus basin, West Pakistan. World Petorleum Cong. 5th, New York, Proc. L, Paper 19, 337-390.