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Assessment of Reservoir Qualities of The Yolde Formation Along Pantami Stream Channel, Gongola Sub-Basin, Northern Benue Trough, Ne Nigeria

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ABSTRACT

The Yolde Formation conformably overlies the Bima Sandstone. It is Cenomanian in age and marks the onset of marine transgression into the Gongola sub basin of the Benue Trough. Comprises mainly of sandstones, limestone, shales, clays and claystones. The study section exposed about 70m thick of the Yolde Formation along Pantami stream channel, Gombe, Gombe town. Several lithofacies of sandstones and mudstones ware identified. The sandstones vary from very fine, fine, medium to coarse grained. Sedimentary structures identified include parallel, planar cross-beddings, trough cross-beddings and herringbone cross-stratification. Lithofacies analysis shows series of fining and coarsening upward sequences which indicate increase and decrease in depositional energies within the environment. Petrographic analysis shows that the sandstone samples are texturally matured. The Quartz grains are both monocrystalline and polycrystalline in nature while the sub-rounded to rounded nature of the grains suggests that the sediments were transported from a long distance. The framework components of the sandstones based on the QFR plot shows that the sandstones are Quartzarenite, Sublitharenite to Litharenite and Subarkorse to Arkosic in nature. Grainulometric analysis shows that the sandstones are moderately to poorly sorted (1.0-2.0)∂I, the grains sizes are fine to medium (2.7-0.9)MZ platykurtic to very leptokurtic (0.9-1.9)KG and are coarse to strongly fine skewed (0.04-0.6)SKI. From the histograms, the sediments are generally unimodal indicating the same sources of sediments, typical of fluvial environment. Also, the poor sorting and fine skewness is as a result of increase and decrease in depositional energies by river/wave processes which was further buttressed by bivariate plots. Porosity of the samples assessed indicate moderate to good porosity and the permeability assessment indicate moderate to good permeability as well.

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1 INTRODUCTION

The Benue Trough is a major geological structure underlying a large part of Nigeria and extending about 1,000 km northeast from the Bight of Benin to Lake Chad. It is part of the broader West and Central African Rift System.

The trough has its southern limit at the northern boundary of the Niger Delta, where it dips down and is overlaid with Tertiary and more recent sediments. It extends in a northeasterly direction to the Chad Basin, and is about 150 km wide. The trough is arbitrarily divided into Southern, Central and Northern regions, and the Northern region is further subdivided into the Gongola and Yola arms.

The Anambra Basin in the west of the Southern region is more recent than the rest of the trough, being formed during a later period of compression, but is considered part of the Trough.

The Benue Trough was formed by rifting of the central West African basement, beginning at the start of the Cretaceous period. At first, the trough accumulated sediments deposited by rivers and lakes. During the Late Early to Middle Cretaceous, the basin subsided rapidly and was consequently covered by the sea. Sea floor sediment accumulated, especially in the southern Abakaliki Rift, under oxygen-deficient bottom conditions In the Upper Cretaceous, the Benue Trough probably formed the main link between the Gulf of Guinea and the Tethys Ocean (predecessor of the Mediterranean Sea) via the Chad and Iullemmeden Basins. Towards the end of this period the basin rose above sea level, and extensive coal forming swamps developed, particularly in the Anambra Basin The trough is estimated to contain 5,000M of Cretaceous sediments and volcanic rocks. The deposits in the Benue Trough were displaced westwards at this time, causing subsidence of the Anambra Basin.

Stratigraphic sequence in the Gongola Arm comprises the continental Albian Bima Sandstone, the transitional Cenomanian Yolde Formation and the marine Turonian - Santonian Gongila, Pindiga, and Fika Formations (Zaborski, 1997). Overlying these are the continental Campane - Maastrichtian Gombe Sandstone and the Tertiary Kerri - Kerri Formation. In the Yola Arm, the Turonian - Santonian sequence is replaced by the equally marine Dukul, Jessu, Sekuliye Formations, Numanha Shale, and the Lamja Sandstone.

2. LOCATION OF THE STUDY AREA

The study area is located within the Pantami area of Gombe town, Gombe State part of the Gongola arm of the Nothern Benue Trough. The area lies within latitude N10°15’50.4” to N10°16’1.1” and longitude E11°10’4.1” to E11°9’44.6” (Fig 1). Several samples of fresh sandstones units were obtained from the exposed section of the Yolde Formation along the Pantami stream. Based on the general geology of the area, the Yolde formation directly overlies the Bima Formation.

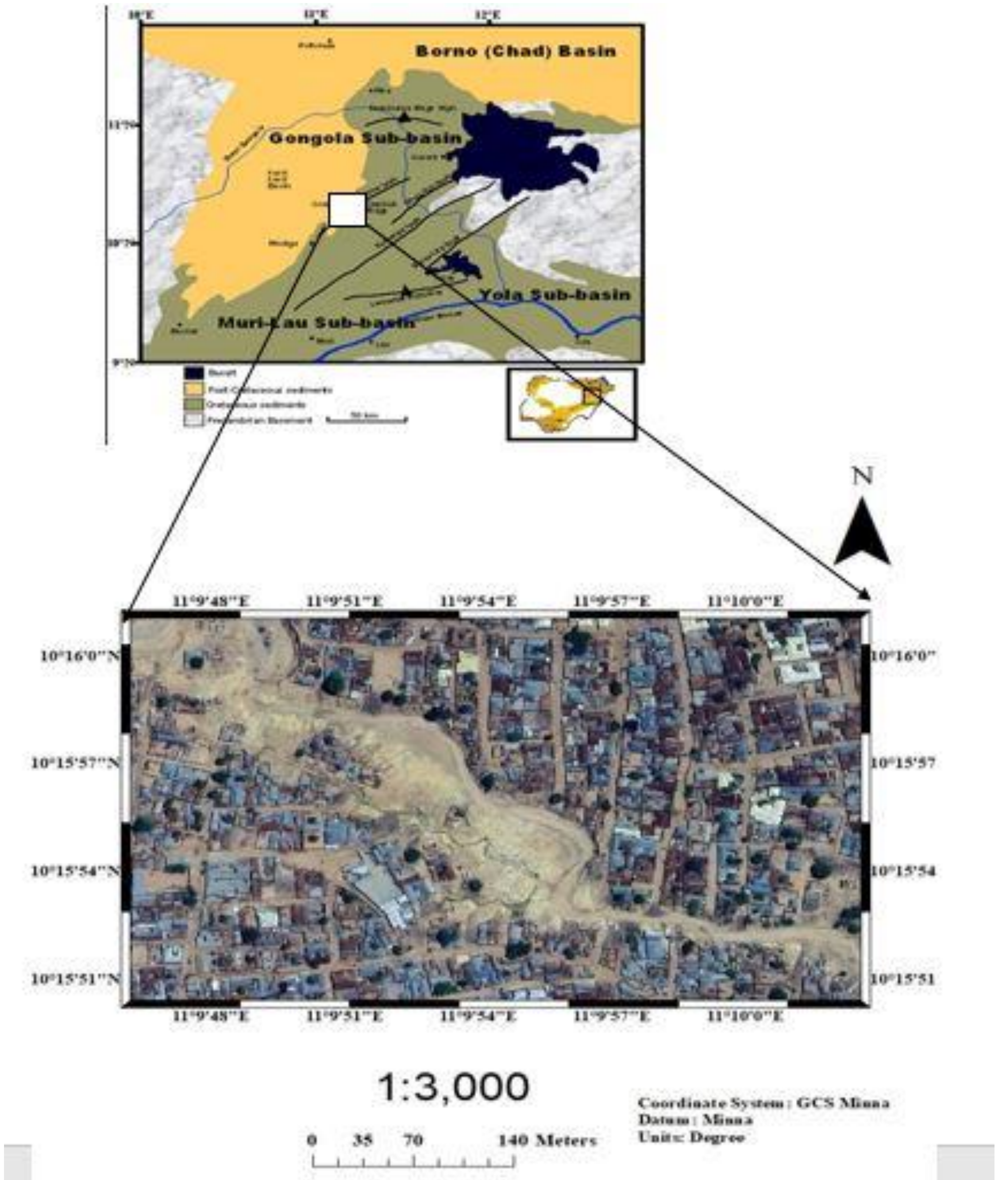


Fig 1: Map of the studied area

3. GEOLOGIC SETTING AND STRATIGRAPHY

The Northern Benue Trough bifurcates into two arms namely; the Gongola Arm and the Yola arm. Some authors (Akande et al., 1998) consider the main (central) arm, Lau Gombe, a sub- basin too, thus amounting to three sub-basins.

Common to the two arms is the Albian Bima Sandstone unconformably overlying the Precambrian Basement. The Bima Formation was deposited under continental conditions namely; fluvial, deltaic and lacustrine conditions. It is made up of coarse to intermediate grained sandstones intercalated with carbonaceous clays, shales, and mudstones. Carter *et al. (*1963) subdivided the Bima Sandstone into Lower, Middle and Upper Bima Members.

The Middle Bima is said to be predominantly shaley with some limestone intercalations and was speculated to have been deposited under a more aqueous anoxic condition (lacustrine, brief marine). Closely related match to this description are the dark, carbonaceous shales within the Bima Sandstone in the section along the river channel to the south of the bridge, 200m just prior to the village of Bambam. Identical shales also occur within massively outcropping units of the Bima Sandstone on the Lamurde anticline (2 km away to the town of Lafiya, via the Gombe - Numan road). Favorable exposures of the Bima Sandstone (excluding the so-called Middle Bima) can be found at Biliri, Filiya and Shani (Obaje, 2009).

The Yolde Formation conformably overlies the Bima Sandstone. It is Cenomanian in age and marks the onset of marine transgression into this portion of the Benue Trough. It was deposited under a transitional/coastal/marginal marine environment and comprises sandstones, limestone, shales, clays and claystones. Type localities of the Yolde Formation are situated along the Valley of Pantami River in Gombe town and in the village of Yolde, 50km before the town of Numan.

On the Gongola Arm, the laterally equivalent Gongola and Pindiga formations and probably younger Fika Shale conformably overlie the Yolde Formation (Obaje, 2009). These formations indicate full marine transgression into the Northern Benue during the Turonian – Santonian times. Lithological compositions of these formations include dark/black carbonaceous shales and limestones, intercalated with pale colored limestones, shales and minor sandstones. The Gongola Formation's typical locality is at the Quarry of the Ashaka Cement Company at Ashaka, while that of Pindiga Formation is at Pindiga village.

The Fika Shale is lithologically composed of bluish-greenish carbonaceous shales which are sometimes pale gypsiferous and highly fissile with periodic limestones in places. It is marine and is typically located at Nafada village along the Gombe – Ashaka road (Obaje, 2009). (Fig 2).

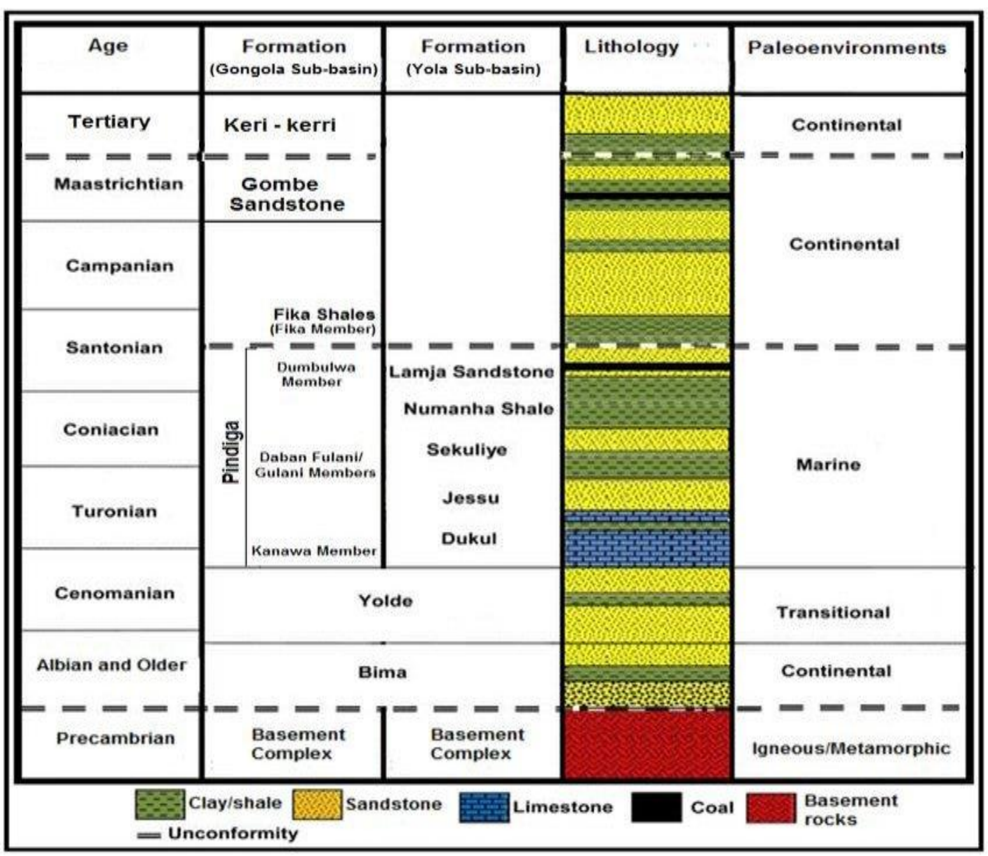


Figure 2: Stratigraphic successions in the Northern Benue Trough (after Lar et al., 2018)

On the Yola Arm, the Turonian - Santonian equivalents of the Gongola and Pindiga Formations are; the Dukul, Jessu and Sekuliye Formations: The Numanha Shale, and the Lamja Sandstone. The Turonian - Santonian deposits in the Yola Arm are lithologically and Palaco-environmentally identical to those of the Gongola Arm, save for the Lamja Sandstone which is predominantly marine sandstone (Obaje, 2009).

The deposition of Dukul, Jessu and Sekuliye Formations under shallow marine neritic shelfal environments was proven by various arenaceous and planktonic foraminifera assemblages recovered from samples obtained from them. The village of Dukul is the type locality of the Dukul Formation. There are also good exposures of Dukul Formation at Bambam and Lakun on the Gombe Yola road. All the other formations (Jessu, Sekuliye, Numanha and Lamja) have their type localities in the villages named after them (Obaje, 2009).

The Santonian period which was marked with folding and deformation in the entire Benue Trough yielded post-folding sediments including the continental Gombe Sandstone of Maastrichtian age and the Keri-Keri Formation of Tertiary age. The Gombe Sandstone lithologically identical to the Bima Sandstone, thus proving the recurrence of the continental Albian palaeo-environmental condition (Obaje, 2009).

The Gombe Sandstone Formation, however, contains coal, lignite, and coaly shale intercalations which in places are very thick. The type locality of the Gombe Sandstone can be found along the bank of Pantami River in Gombe town. It is also well exposed in many parts of Gombe town and Birin Fulani village (Obaje, 2009).

The Keri-Keri Formation is lithologically composed of predominant claystones, with whitish grey sandstones and siltstones. Type Sectional exposures can be found in Gombe Aba, Dukku (not Dukul) and Alkaleri (Obaje, 2009).

3. METHODOLOGY

3.1 Petrographic Analysis

Rock samples were prepared into thin sections and observed under plane paralyzed and cross polarized light using a polarizing microscope. Equipment and material used are: petrographic microscope, electrical hot plate, Canada balsam, glass slide, carborundum powder, araldite and diamond cutter. The rock slides were analyzed under the petrographic microscope to determine the texture, framework minerals (quartz, feldspar and other rock fragments) and other accessory minerals based on their optical properties

3.2 Granulometric Analysis

This method is aimed at investigation individual grains of sedimentary rocks based on their sizes which is interpreted for various sedimentological parameters. Instrument used are, pestle, mortar, brush, electronics weighting machines and mesh size, using the following procedures:

Samples collected were disaggregated by the use of pestle and mortal in a gentle manner to avoid breaking the original grain. A 200g representative sample was weighed by the weighing machine. Each of the samples was then placed in a set of mesh sieves, mounted on a mechanical sieve shaker and allowed to shake for 10 minutes as described by Krumbein and Pettijoin (1983), Folk and Ward (1957). Samples retained on each mesh sieve were then measured using digital weighing machine and kept in a protected cellophane bag to avoid losing the grain particles. The results were tabulated for further analysis. The statistical parameters used as proposed by (folk, 1957) these are: Graphic Mean (Mz), Graphic Kurtosis (KG), Inclusive Graphic Skewness (SK1) and Inclusive Graphic Standard Deviation ($\partial 1$).

3.3 Porosity Test

The samples were oven dried at 105°c for about 4 hours then dried weight was taken for each of the samples. The samples were then immersed in water for 24 hours. The saturated samples were then weighed to give the saturated weight. The porosity was then computed from the test for all the samples using the formula:

Porosity (n) = VT/Vv

VT = Volume of void ratio

Vv = Total volume of rock

3.4 Permeability Test

Consolidated samples were used for the falling head permeability test. The test was carried out according to the standard (BS1377) procedure indicated by Head (1990). Undisturbed core samples of the Yolde Formation were carefully fitted into the cell parameters (core cutters).

The cell parameters were set up by clamping cover plates with tie-rods and wind-nuts and connected to the standpipe panels. The cells were then submerged into the immersion tank to completely saturate the samples.

The standpipe was filled with water from the dearing tank calibrated h1 and h2 (h1, being the initial head of water during the test run measured from the constant level of water from the immersion tank and h2, the final level of water during the test, measured from the same level in millimeters). Water from the standpipe was allowed to pass through each sample by opening the necessary clips and the falling water head that move from h1 to h2 was recorded. The procedure was repeated twice in each case and the average reading is taken. The formula below was used for calculating permeability.

(Coefficient of permeability) KT =
3.4aL/At log (h1/h2) *10^{-5}m/s

Where KT = coefficient of permeability at 30^0c in m/s,

a = cross-sectional area of standpipe used (mm^2),

L = length of sample in cell (mm),

A = cross-sectional area of sample (mm^2),

t = time difference for head of water in standpipe to fall from h1 to h2 (in seconds).

TABLE 1: POROSITY AND PERMEABILITY RANGES

POROSITY (%)		PERMEABILITY (MD)	
LOW	<5	LOW	<100
MODERATE	5-10	MODEATE	101-150
GOOD	11-15	HIGH	>150
HIGH	16-30		
VERY HIGH	>30		

Evaluating methods of oil and gas reservoirs (China), 2011.

4 RESULTS AND DISCUSSION

4.1 Lithostratigraphy

The section has a total thickness of 70M (meters). From the base upward, it consists of very fine to fine overlain by medium to coarse grained sandstone interbedded by grey and purple mudstone which is overlain by intercalation of sandstone and mudstone beds (Plate I and II). Sedimentary structures found within the sandstone beds include bioturbation (Plate III), horizontal planar lamination and planar cross-bedding (Plate IV and V). This bed passes upward into medium trough cross-bedded sandstone with lag deposits at the top, grey to purple clay, medium grained trough cross-bedded sandstone with parallel lamination at the base and light grey mudstone (Plate VI), fine to medium grained trough cross-bedded sandstones, light grey clay, very coarse to coarse grained tabular cross bedded sandstone with ripple marks towards the base. This bed transit into grey clay which passes upward into medium grained sandstone with small scale trough cross-bedding with erosional base, grey to purple mudstone interbedded with medium grained sandstone, medium grained sandstone with nodules, grey clay underlying medium grained sandstone with herringbone cross-bedding which passes upward into purple to grey clay terminating the section.

The upper part of the section is characterized by mainly planar cross-bedded and herringbone cross-stratified sandstone (Plate VII). In a similar way, mudstone is observed to highlight the base of the sand bodies. However, intercalation of sandstone and mudstone is observed from the lower to upper part of the succession and the fining upward sequence is not well developed. Lag deposits are seen to occur at the upper part as well.

4.2 Facies Analysis

Facies analysis is a fundamental sedimentological method of characterizing bodies of sediments and sedimentary rocks with unique physical, chemical and biological attributes relative to the adjacent deposits.

4.2.1 lithofacies

Lithofacies is a mappable subdivision of a stratigraphic unit that can be distinguished by its lithology, texture, mineralogy, grain size, structure and the depositional environment that produced it. From this study, a total number of eleven (11) lithofacies were identified.

Very fine, fine, medium, coarse grained sandstone and mudstone facies were identified. Within the fine grain sandstone, rootlets and bioturbation ware identified in some of the lithofacies. Structures found within some of the fine grain sandstone include horizontal planar lamination. Bioturbation and horizontal planar lamination were found within the medium grained sandstone.

Structures found within some the coarse grain sandstone facies include bioturbation and planar cross-bedding. Also, intercalation of sandstone of varying grain sizes (fine, medium and coarse) and mudstone facies were found. Sedimentary structures found within some of the intercalated medium grain sandstone and mudstone facies include planar cross-bedding and horizontal planar lamination. The intercalated coarse grain sandstone and mudstone facies was found to be horizontally planar laminated.

4.2.2 Facies Association

The studied facies were grouped in order to interpret their environment of deposition and were grouped into eleven (11). These are named (S1 to S11) and are described below:

S1 consist of very fine grain sandstone with rootlets, fine grained sandstone, horizontally planar laminated fine-grained sandstone and mudstone facies. S2 consist of medium grained sandstone with horizontal burrows and planar cross-bedded coarse-grained sandstone. S3 consist of mudstone, fine grained sandstone with horizontal burrows, horizontally planar laminated medium grained sandstone and intercalation of medium grained sandstone and mudstone facies. S4 consist of planar cross-bedded coarse grained sandstone facie. S5 consist of fine-grained sandstone, intercalation of planar cross-bedded medium grained sandstone and mudstone and medium grained sandstone facies. S6 consist of intercalation of fine-grained sandstone and mudstone facies. S7 consist of intercalation of horizontally planar laminated coarse-grained sandstone and mudstone and intercalation of horizontally planar laminated medium grained sandstone and mudstone facies. S8 consist of mudstone, fine grained sandstone and intercalation of horizontally planar laminated medium grained sandstone and mudstone facies. S9 consist of fine-grained sandstone, mudstone and intercalation of fine-grained sandstone and mudstone facies. S10 consist of herringbone cross-stratified medium grained sandstone. S11 consist of fine-grained sandstone, very fine-grained sandstone, intercalation of fine-grained sandstone and mudstone facies.

4.2.3 Environmental Interpretation

S1, S6, S8, S9 and S11 were interpreted to be deposited under lower shoreface environment. S2, S3, S5, S7 and S10 were interpreted to be deposited under upper shoreface environment while S4 was interpreted to be deposited at the shoreline.

Plate I: Intercalation of sandstone and mudstone beds

plate II: Intercalation of sandstone and mudstone beds

Plate III: Sandstone with animal burrows

Plate IV: parallel laminated beds

Plate V: parallel laminated sandstone beds

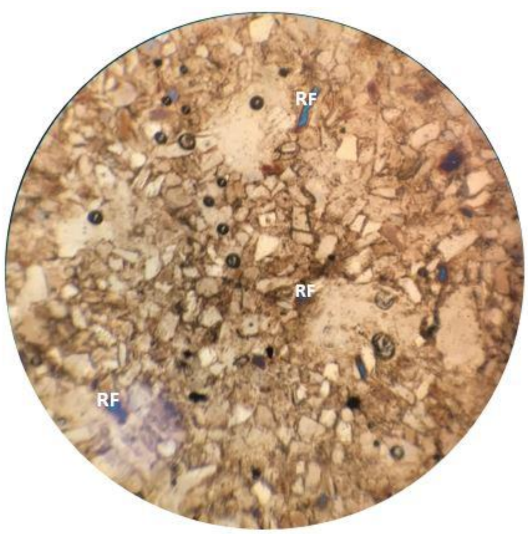
Plate VI: Cross bedded sandstone beds

Plate VII: Herringbone cross-stratification

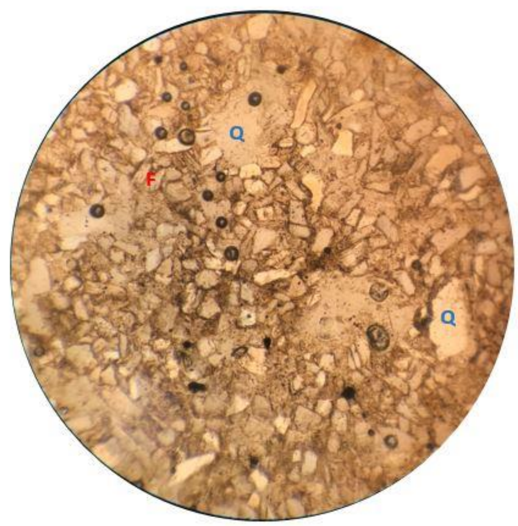
Plate VIII: Paleocurrent measurement

4.3 Petrography

Eight (8) samples were thin sectioned and the slides were petrographically studied. Sample S2 is texturally matured and Sublitharenite in nature, the quartz grains are polycrystalline in nature and some of the factors that will destroy the porosity are sutured grains contact and quartz overgrowth (Plate IX). Sample S5 is texturally matured and Subarkose in nature, the quartz grains are monocrystalline in nature and the factor that will destroy the porosity is sutured grains contact (Plate X). Sample S7 is texturally matured and Litharenite in nature, the quartz grains are polycrystalline in nature and some of the factors that will destroy the porosity include quartz overgrowth and sutured grains contact (Plate XI). Sample S14 is texturally matured and Sublitharenite in nature, the quartz grains are monocrystalline in nature and some of the factors that will destroy the porosity include quartz overgrowth and sutured grains contact (Plate XII). Sample S16 is texturally matured Quartzarenite in nature, the quartz grains are monocrystalline in nature and the factor that will destroy the porosity include sutured grains contact (Plate XIII). Sample S19 is texturally matured and Litharenite in nature, the quartz grains are monocrystalline in nature and some of the factors that will destroy the porosity include sutured grains contact and quartz overgrowth (Plate XIV). Sample S20 is texturally matured and Arkose in nature, the quartz grains are monocrystalline in nature and the factor that will destroy the porosity include sutured grains contact (Plate XV). Sample S22 is texturally matured and Quartzarenite in nature, the Quartz grains are polycrystalline in nature (Plate XVI). The summary of the results are shown on table 6.

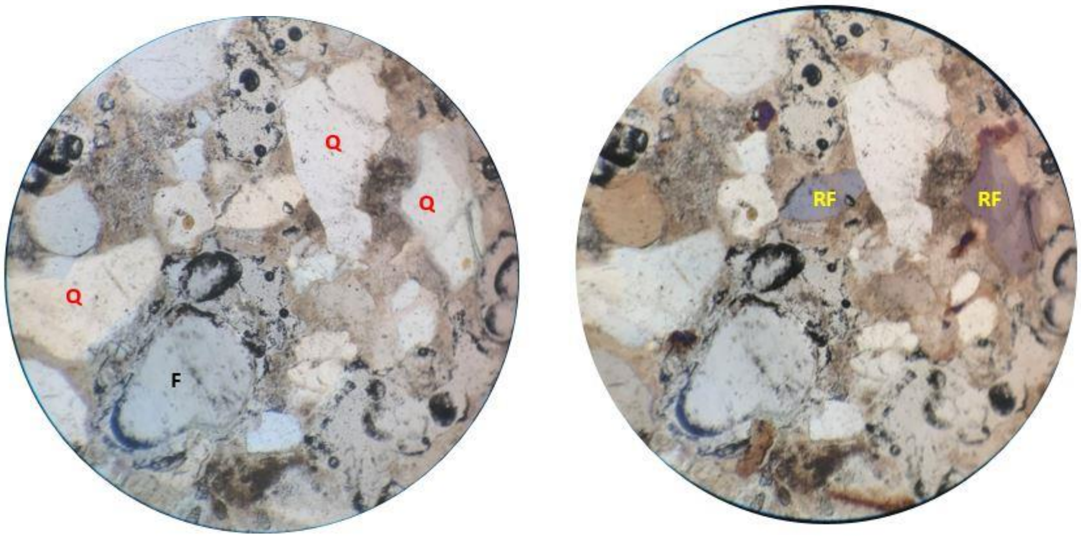


(a)



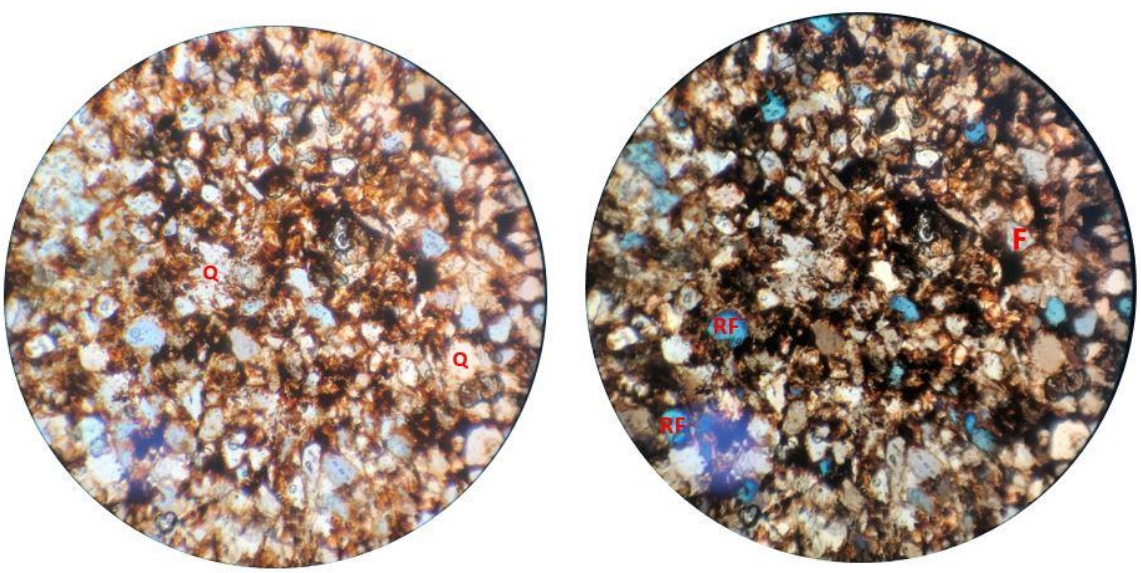
(ai)

Plate IX: (a) sample S2 under plane polarized light, (ai) sample S2 under cross polarized light. [Q=Quartz, F=Feldspar, RF=Rock fragments]. (Magnification ×40)



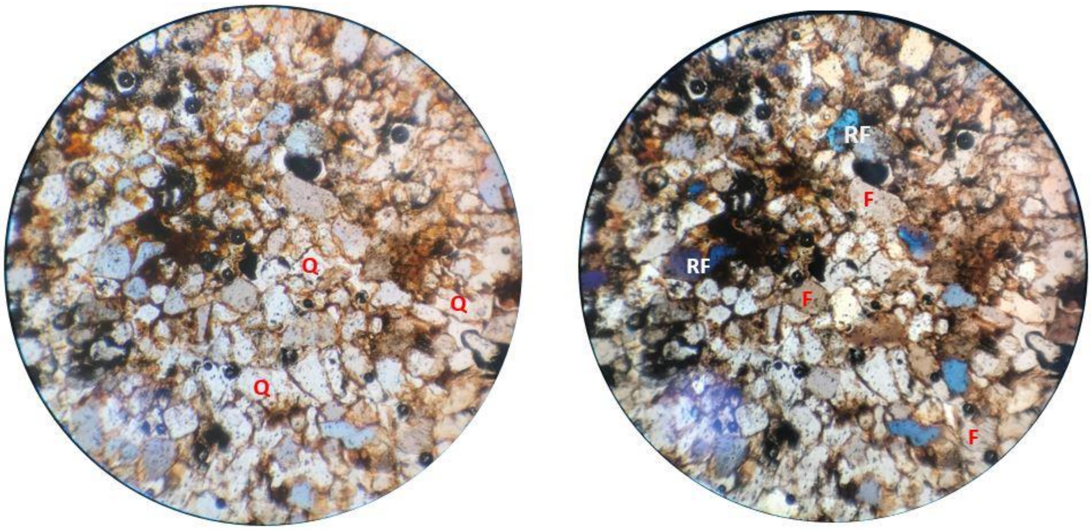
(b) **(bi)**

Plate X:(b) sample S5 under plane polarized light, (bi) sample S5 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)



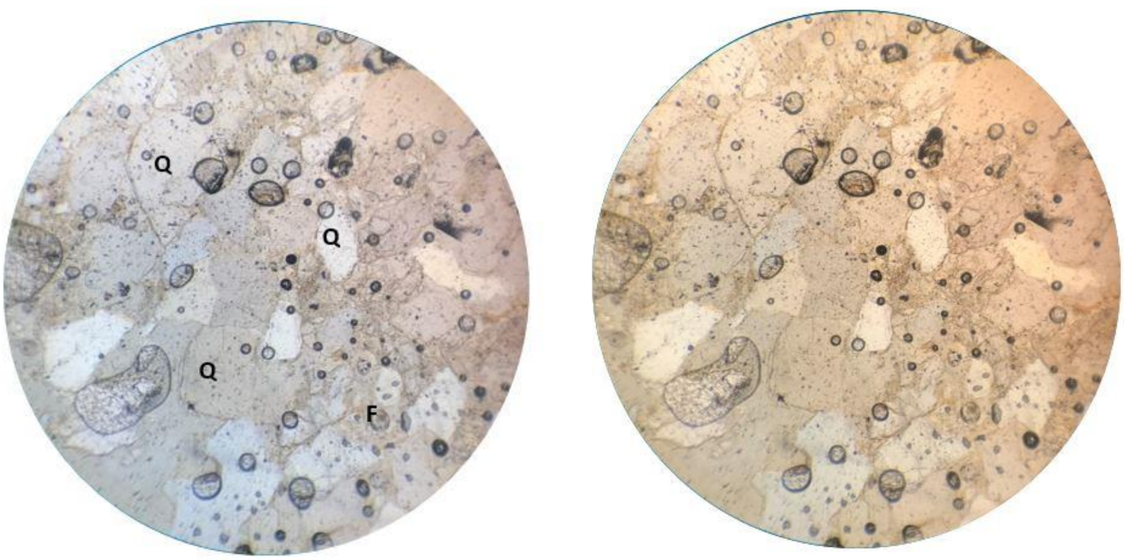
(c) **(ci)**

Plate XI:(c) sample S7 under plane polarized light, (ci) sample S7 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)



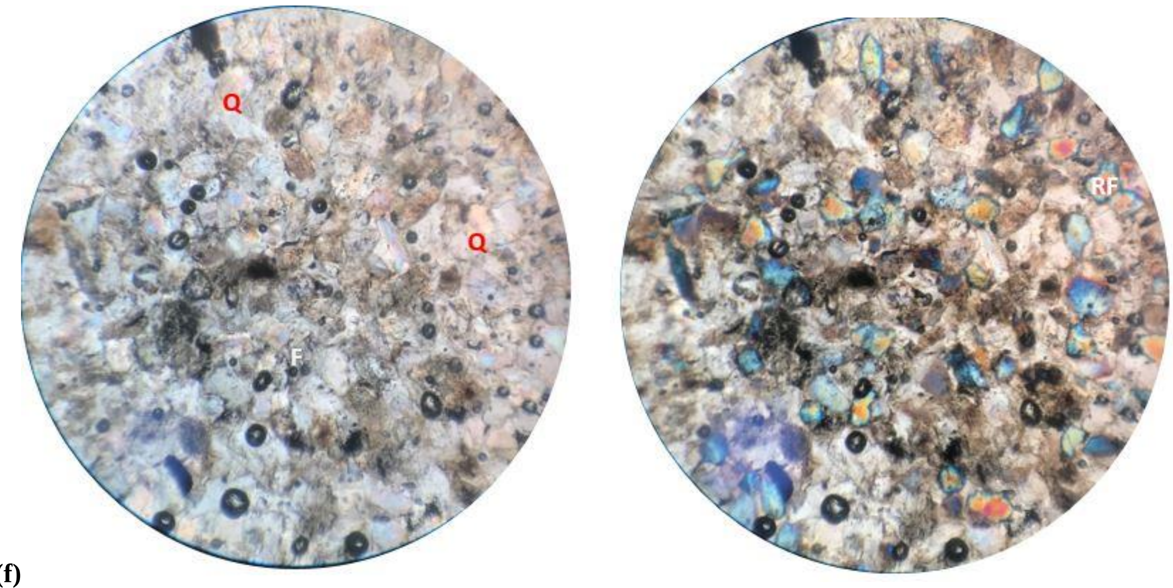
(d) **(di)**

Plate XII:(d) sample S14 under plane polarized light, (di) sample S14 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)



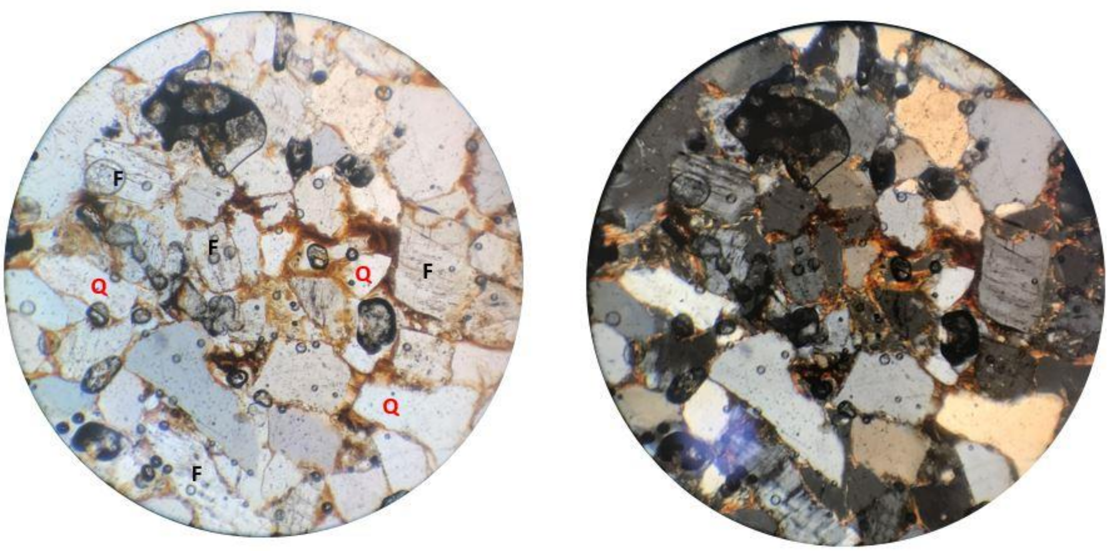
(e) **(ei)**

Plate XIII:(e) sample S16 under plane polarized light, (ei) sample S16 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)



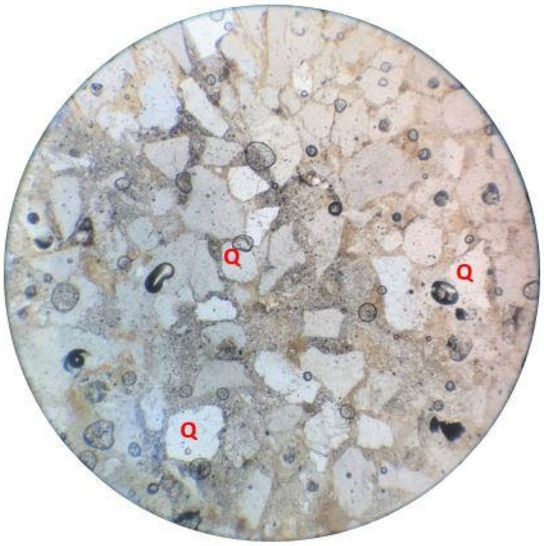
(f) **(fi)**

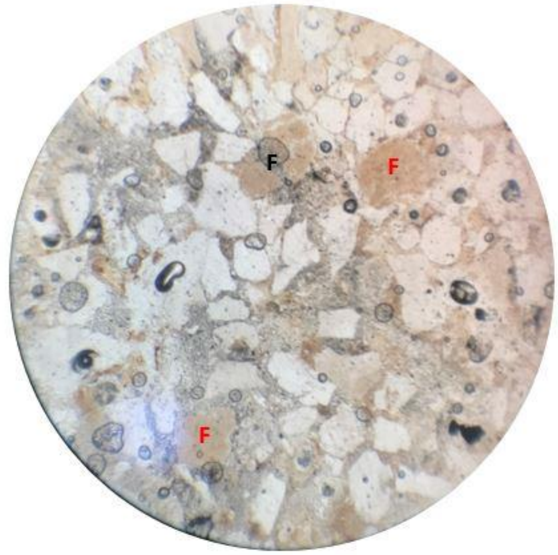
Plate XIV:(f) sample S19 under plane polarized light, (fi) sample S19 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)



(g) **(gi)**

Plate XV: (g) sample S20 under plane polarized light, (gi) sample S20 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)





(h) **(hi)**

Plate XVI:(h) sample S22 under plane polarized light, (hi) sample S22 under cross polarized light. [Q=Quartz, F=feldspar, RF=Rock fragments] (magnification ×40)

TABLE 2: SUMMARY OF PETROGRAPHIC ANALYSIS

Sample no	Framework minerals (%)			Texture			Estimated porosity (%)
	Quartz (Q)	Feldspar (F)	Rock fragment (RF)	Sorting	Roundness	Sphericity	
S2	90	2	8	Well sorted	Well rounded	Low sphericity	10
S5	80	10	10	Moderately sorted	Sub rounded	Moderate sphericity	12
S7	70	5	25	Well sorted	Sub rounded	Moderate sphericity	6
S14	80	7	13	Well sorted	Sub rounded	Moderate sphericity	4
S16	70	20	10	Moderately sorted	Well rounded	Moderate sphericity	10
S19	70	10	20	Moderately sorted	Sub rounded	Moderate sphericity	5
S20	60	35	5	Moderately sorted	Sub rounded	Moderate sphericity	15
S22	90	5	5	Well sorted	Sub rounded	Moderate sphericity	5

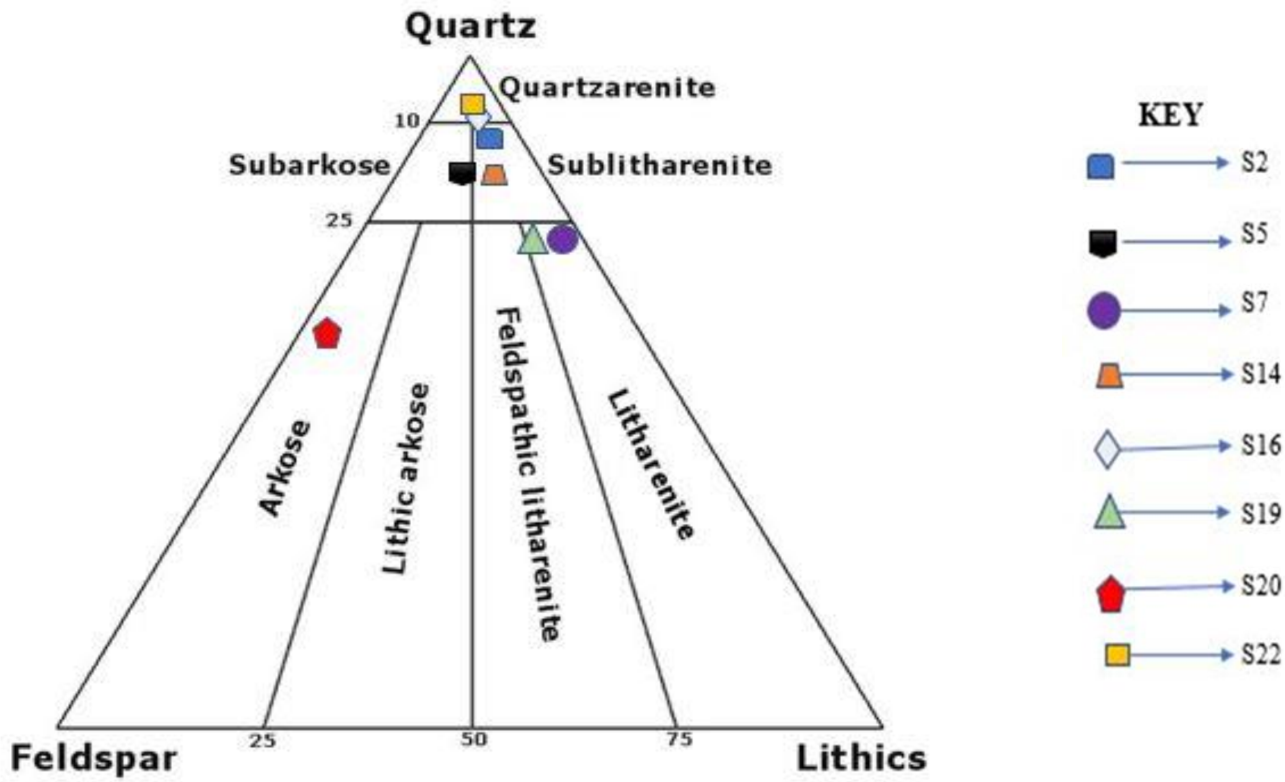


Fig 4: QFR plot showing framework composition of sandstones from Pantami stream channel

4.4 Granulometric Analysis

Nineteen (19) samples were subjected to sieve analysis. The individual weight percent of the material retained on each sieve was determined for each of the sample. The results were used in plotting histograms, cumulative frequency curves and bivariate plots to assist in determining the depositional environment.

The summary of the results of the sieve analysis are shown below;

TABLE 3: SUMMARY OF RESULTS FOR GRANULOMETRIC ANALYSIS

S/N	SAMPLE NO	MEAN (MZ)	KURTOSIS (KG)	STANDARD DEVIATION (∂I)	SKEWNESS (SKI)
1	S2	2.7 Fine sand	1.9 Very leptokurtic	2.0 Poorly sorted	0.1 Near symmetrical
2	S3	2.7 Fine sand	1.8 Very leptokurtic	2.0 Poorly sorted	0.6 Strongly fine skewed
3	S4	2.7 Fine sand	1.9 Very leptokurtic	2.0 Poorly sorted	0.2 Fine skewed
4	S5	1.3 Medium sand	1.2 Leptokurtic	1.0 Moderately sorted	0.4 Strongly fine skewed
5	S6	1.2 Medium sand	1.2 Leptokurtic	1.0 Moderately sorted	0.6 Strongly fine skewed
6	S7	2.1 Fine sand	1.5 Leptokurtic	1.8 Poorly sorted	0.3 Fine skewed
7	S8	0.9 Coarse sand	1.0 Mesokurtic	1.0 Moderately sorted	0.6 Strongly fine skewed
8	S9	1.7 Medium sand	1.2 Leptokurtic	1.0 Moderately sorted	0.1 Coarse skewed
9	S10	1.1 Medium sand	0.9 Platykurtic	1.0 Moderately sorted	0.04 Coarse skewed
10	S11	2.3 Fine sand	1.7 Very leptokurtic	2.0 Poorly sorted	0.7 Strongly fine skewed
11	S14	2.5 Fine sand	1.4 Leptokurtic	1.0 Moderately sorted	0.4 Strongly fine skewed
12	S15	2.3 Fine sand	1.5 Leptokurtic	1.8 Poorly sorted	0.2 Fine skewed
13	S16	1.3 Medium sand	1.1 Mesokurtic	1.0 Moderately sorted	0.3 Fine skewed
14	S19	2.3 Medium sand	1.0 Mesokurtic	1.0 Moderately sorted	0.8 Strongly fine skewed
15	S20	2.3 Fine sand	1.3 Leptokurtic	1.7 Poorly sorted	0.8 Strongly fined skewed
16	S21	0.5 Coarse sand	0.9 Platykurtic	0.7 Well sorted	1.0 Strongly fine skewed

17	S22	2.4 Fine sand	1.4 Leptokurtic	1.8 Poorly sorted	0.3 Fine skewed
18	S23	1.6 Medium sand	1.3 Leptokurtic	1.0 Moderately sorted	0.2 Fine skewed
19	S24	1.6 Medium sand	1.3 Leptokurtic	1.0 Moderately sorted	0.2 Fine skewed

4.5 Porosity and Permeability

TABLE 4: SUMMARY OF PORPSITY AND PERMEABILITY RESULTS

S/N	SAMPLE NO	POROSITY (%)	PERMEABILITY (MD)
1	S2	20 (High)	206 (High)
2	S3	21 (High)	217 (High)
3	S5	24 (High)	236 (High)
4	S6	12 (Good)	242 (High)
5	S7	20 (High)	106 (Moderate)
6	S8	16 (High)	166 (High)
7	S9	12 (Good)	177 (High)
8	S10	6 (Moderate)	77 (Low)
9	S11	16 (High)	331 (High)
10	S14	8 (Moderate)	267 (High)
11	S15	6 (Moderate)	189 (High)
12	S16	19 (High)	360 (High)
13	S19	10 (Moderate)	442 (High)
14	S20	31 (Very high)	282 (High)
15	S21	12 (Good)	141 (Moderate)
16	S22	7 (moderate)	188 (High)
17	S23	16 (High)	119 (High)
18	S24	8 (Moderate)	267 (High)

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The rock samples analyzed from the study locality are texturally matured which ranges from fine to medium grained and are poorly to moderately sorted. Some of the factors that will destroy the porosity and permeability are sutured grain contact and Quartz overgrowth. All the samples assessed have moderate to good porosity and permeability except for one sample which have low permeability to allow and ease the passage of fluid.

5.2 Conclusion

The samples assessed have moderate to good porosity and permeability to allow and ease the passage of fluid.

5.3 Recommendation

More work should be done on the reservoir quality assessment of Yolde formation at various outcropping areas so that a model will be generated and added to the current knowledge on the reservoir potentials of the Cretaceous reservoir basins.

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