SEDIMENTOLOGY AND PETROGRAPHY OF GOMBE FORMATION AND KERRI-KERRI FORMATION IN THE UPPER BENUE TROUGH

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BY

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A RESEARCH PROJECT SUBMITTED TO THE GEOLOGY PROGRAMME SCHOOL OF SCIENCE ABUBAKAR TAFAWA BALEWA UNIVERSITY BAUCHI IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF TECHNOLOGY (B.TECH) IN APPLIED GEOLOGY

MARCH, 2008.

ABSTRACT

The Gombe Formation in the study area consists of sandstone and mudstone. Granolumetric and facie analysis hence shown that the sandstone is medium grained, moderately sorted and was deposited in a transitional to marine environment.

The Kerri-Kerri Formation in the study area also consists sandstone and mudstone sequence. Granolumetric and facie analysis have shown that it is poorly sorted and was deposited in a continental environment (fluvial).

CERTIFICATION

This Research project report in Geology and the Sedimentary Petrography and grain analysis of Kerri-Kerri and Gombe Sandstone within Gombe local Government Area in Bauchi and Gombe state (Sheet) was prepared by Edward O. Amanambu, following an intensive independent field work exercise carried out. This has been read certified as meeting the standard in partial fulfillment for the award of Degree of Bachelor of Technology (B. Tech) in Applied Geology.

Geology Programme of Abubakar Tafawa Balewa University Bauchi and is approved for its contribution in scientific knowledge.

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EXTERNAL SUPERVISOR:

NAME:…………………………………

SIGNATURE:…………………………

DATE:…………………………………

DEDICATION

I dedicate this work to the Almighty God and to my Family especially, my mother, thanks for your support.

ACKNOWLEDMENT

I give thanks to the almighty God for his protection and his grace and mercies on me.

My sincere gratitude to my Supervisor; Mr. T.P Bata for his advice, support, encouragement, assistance, his patients and understanding during the courses of this work. I say thank you and God bless you and your endeavors.

I also acknowledge all member of staff of the geology programme, Prof. E.F.C Dike, Prof. D.M Orazulike, Mr. N.K Samila, Mr M.B Abubakar, Mr. A.S Maigari, Mr. H. Ahmed, Mr I.M Tahir, Mr. A. Tukur and Mr. Bassey. Your impacted knowledge will always be green in me.

My appreciation also goes to my course mate and Friends Innocent .A, Daniel. O, Tousin O., Chike. O, Edwin. E, John. O, Christopher. U, Christy. O and Michelle. E. Thanks for being there.

To my lovely sisters; Uzomaka and Uju. I will always appreciate your support and love. To you big girl Chiamaka, I love you. Finally to my Dad and my lovely mom, I LOVE YOU Dearly.

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CHAPTER ONE

1.0 GENERAL INTRODUTION

The Benue Trough has been one of the major focal centre of Nigerian Geology which has attracted the attention of so many studies because of its economic mineralization, petroleum potential and the controversies surrounding it's origin and evolution.

Workers such as (Benkhelil 1987), Dike E.F.C 1993, Guirard 1990, Obaje and Abba 1996, Offodile 1976, 1687, Ogoh 1990, Peters 1978, 19801991, Peters and Ekweozor 1978,1980,1982, Reyments 1965, Zaborski et al 1997 have contributed detained information on the Benue Trough: There are skill controversies on it's origin and evolution.

In view of this, therefore the study of the sedimetology and petrography of the Gombe Formation and Kerri – Kerri Formation within Gombe Town, and Bauchi Towns, will subsequently contribute to the existing data base on the formation upon which future research work can be based.

1.1 AIMS AND OBJECTIVES

The objective of this projects /Thesis is to undertake a detained sediment logic and lithostratigraphic study and to also understand the Petrographic characters of the Gombe Sandstone and the Kerri – Kerri Formation found around Gombe local Government Area in Gombe state and Bauchi State, which will also lead to the Interpretation of the depositional environment of these formations.

Finally, it is done in partial fulfillments of the requirement for the award of a Bachelor Degree in Technology (B. Tech) in applied Geology, Abubakar Tafawa Balewa University Bauchi.

1.2 LOCATION AND ACCESSIBILITY OF THE STUDY AREA

The area under study is located within Gombe Local Government Area in Gombe State and Bauchi State.The area is located within the Gongola arm of the Upper Benue Trough in Nigeria on sheet 153NW.

Access of the area is mainly through footpaths, cattle trails, dry stream channels and major road in Gombe Area. Fig.1

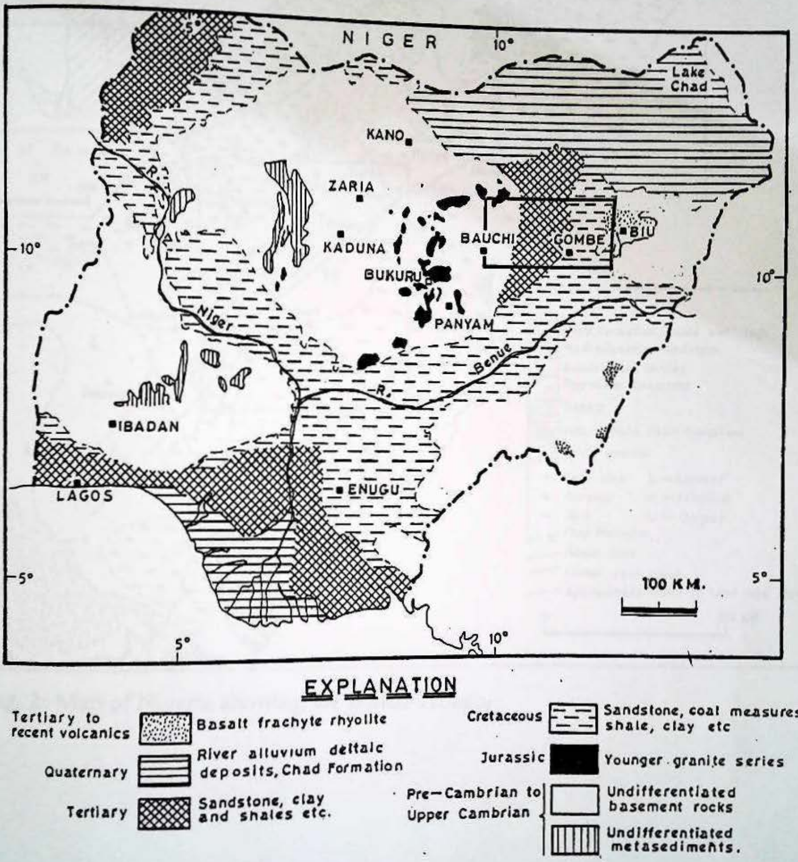

Fig. 1: Map of Nigeria showing the study area

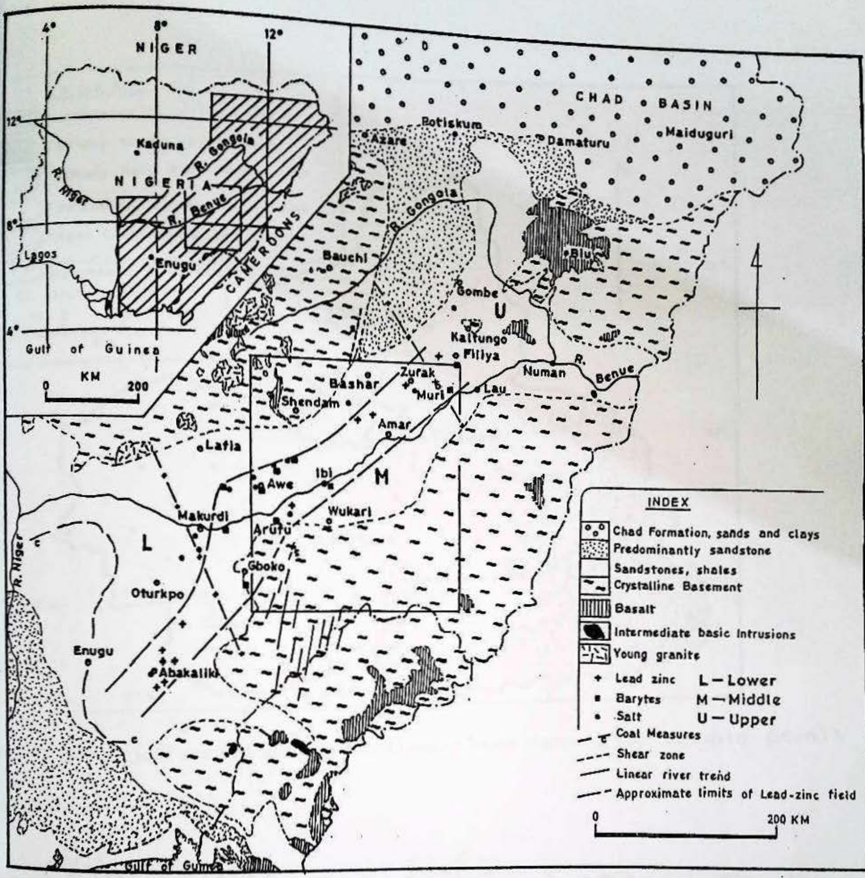

Fig. 2: Map of Nigeria showing the Benue Trough

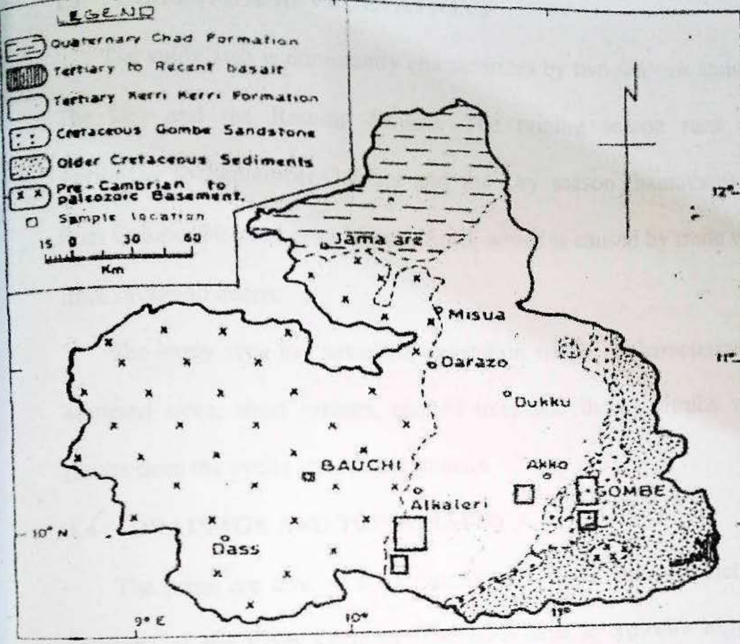

Fig. 3 Geological map of Bauchi and Gombe State showing the sample points after BSADP, (1983).

Older Cretaceous sed. — expansiate pls.

1.3 CLIMATE AND VEGETATIONS

The study area is dominantly characterizes by two seasons annually: The Dry and the Raining Season. The raining season runs from April/May to September/October and the Dry season (hamathan) runs from October/November to March /April, which is caused by trade winds from savannah desert.

The study area has savannah vegetation which is characterized by scattered trees, short grasses, stunted trees and thorny shrubs which results from the cyclic variation in climate.

1.4 DRAINAGE AND TOPOGRAPHY

The areas are drained by a meandering river / stream which is a tributary of the River Gongola. The study area is typically hilly and elevated in most areas.

1.5 HUMAN GEOGRAPHY

The study areas are sparsely populated within settlements. The major occupation of the populace around the area are pastoral farming which involves rearing of livestock and cultivation of crop like guinea corn soya beans and maize etc The common language spoken in the area is Hausa

1.6 PREVIOUS WORKS

Gombe Sandstone and the Lamja Sandstone area thought to be lateral equivalent of each other. Gombe Sandstone consist of 300m of well bedded fine to medium grain Sandstone, silt stone and shales with poor quality coal in the Upper part. It is thought to be equivalent in the Lau Basin to the Lamja Sandstone which is similar in character and not well exposed.

Falconer (1911) described the Gombe Sandstone as "Gombe grits and clays" and he considered it to be of Eocene age. The Gombe Sandstone however is unconformably over lain by Kerri-Kerri Formation (Carter et al 1963).

The Upper Benue valley, the Lamja Sandstone and the Gombe Sandstones terminates the Sedimentary succession.

Falconer (1911) first named the formation and considered it to be of Eocene age. Carter et al, (1963) studied the formation in details and described the formation as a continental sequence of flat-lying grits, sandstone and clays. They showed that the formation was deposited under a wide range of conditions they type section at Kudi varies in thickness from a few meter near its western boundary with the basement example to about 221 meters central and eastern portions.

Grant et al (1972) noticed that the Neogene trachyte and Phonolite plugs emplaced 22 – 11 million years ago are widespread in the Benue Valley but not have been seen to cut the Kerri-Kerri formation. They inferred that the formation post dates the emplacement of volcanic.

Burke and Whiteman (1973) suggested that the Kerri-Kerri sediments were derived from erosion at the Jos Plateau uplift. Dessauvagies (1975) assigned the Neogene age to the Kerri-Kerri formation.

Adegoke et al, (1978) based on Paleontogical data conclusively showed that the Formation is Paleocene in age. They also (1986) described they Kerri-Kerri formation as that-lying to gently dipping basal conglomerate grits, sandstone, silt-stones and clay which uncomformably over steps the cretaceous sediments to the east and the Basement complex to the west. Their study slowed that quartz was the main mineral constituent with Feldspars, iron-cement, kaolinite and occasional heavy minerals.

Dike (1992) interpreted the Kerri-Kerri formation from Sedimentologic and structural bases as a slightly asymmetric grabber characterized on its margin by complement any normal faults trending N15^{0}E to N30^{0}C. He recognized alluvial fans, fan delta, braided streams. marginal lacustrine, and central axial plain environment. He later gave a detailed lithostratigraphic analysis of the Formation showing that the lithology was characterized by medium to coarse grained sands, siltstone and clay. Bata (2004) and Bata et al (2008) also confirmed that the Kerri-Kerri Formation around Mainamaji was deposited in a fluvial setting, and it consists of three main lithofacies: the mudstone – clay stone facies, the siltstone facie and the sandstone facies, and it was sourced from the granitic basement underlying it.

CHAPTER TWO

LITERATURE REVIEW

2.1 OUTLINE GEOLOGY OF THE BENUE TROUGH

Benue Trough of Nigeria is a rift Basin in the Central West Africa that extends North–Each (NNE) to South – South - West (SSW). For about 800km I length and 150km in with consisting of a Geological linear stretch of sedimentary Basins running northeast from about the present confluence of the Niger and Benue rivers, and bonded roughly of the basement complex areas in the North and South of the river Benue (Fig2). The Northern end is Y shaped with the East – West Trending Gongola arm. The southern limit is the southern boundary of the Chad Basin (Benkhelil 1987).

The elongated Trough – like Basin is continuous with the coastal Basin and in fact has been currently described as a long arm of the Nigeria coastal Basin (Reyment 1965).

This striking elongated appearance of the Basin tends to suggest some kind structural control for the sedimentary area, and has led to a number of propositions on us origin. It has a kind of rift structure due to major fault along it carter et al (196). Burke et al (1971) contended that the Benue rift first opened in the cretaceous (Fig2) and was then followed by seduction and a closing episode.

Sedimentation within the Trough resulted from a number of transgressive and regressive phases which was influenced by combined effect of eustatic rise in sea level and local diastrophism (Petters 1978). The Benue Trough is divided into three main areas.

- The Upper Benue Trough
- The Middle Benue Trough
- The Lower Benue Trough

The Lower Benue Trough includes two main structural units: The $N60^0E$ trending Abakaliki uplift and the Anambra syncline trending $N30^0E$ (Ofodile 1989).

The Middle Benue Trough Occupies the linear portion of the Benue Trough. The major structural element is the Keana Anticline. It is flanked to the North by a deep Basin called Kadarko Basin (Benklit 111 19870 and southwards by the Wuri Kari Basin both of which are slightly deformed.

The Upper Benue Trough is the northern Y shaped apart of the Basin and can be subdivided into three sub–Basins, the Yola arm, the Gonola arm and the main arm (Offodile 1987, Benkhelil 1989, Guirard 1990, 1993, Dike 2002). Also some Author recognized two arms for the Upper Benue Trough, the Gongola arm and the Yola arm (Obahe 1999, Petters 1982.

2.2 STRATIGRAPHY OF THE UPPER BENUE TROUGH.

The Upper Benue Trough was first mapped by (Falconer 911). However, the first major work done was by (carter et al 1963). The Upper Benue Trough as separated from the Chad Basin by Zambuk ridges, which stretches northeast – southwest, running from Zambuk to Biu plateau. Between the Upper Benue and the Zambuk uplift there are changes in the thickness, from the more argilleous materials in the Benue Basin to more arenaceous of the ridge.

Stratigraphy description of sediment in the Upper Benue Trough has been presented by Reymant (1965) Offodile (1967), Dike (1993), Zaborski et al (1997), Dike (2002), among others. Since the stud area is located within the Gongola arm of the Upper Benue Trough, the only details of the stratigraphy succession of the Gongola arm of the Upper Benue Trough are discussed. Table 1: Shows the correlation of the stratigraphic succession in the Upper Benue Trough.

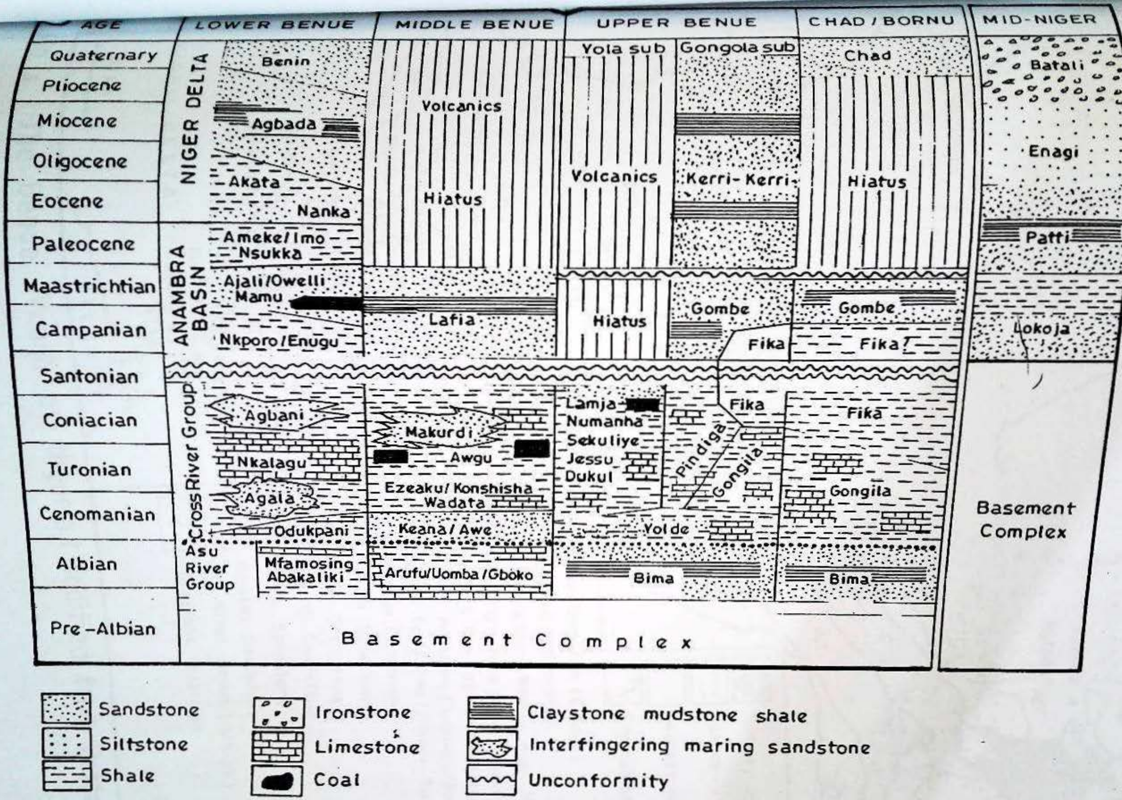

Table 1 Showing stratigraphic succession in Benue Trough

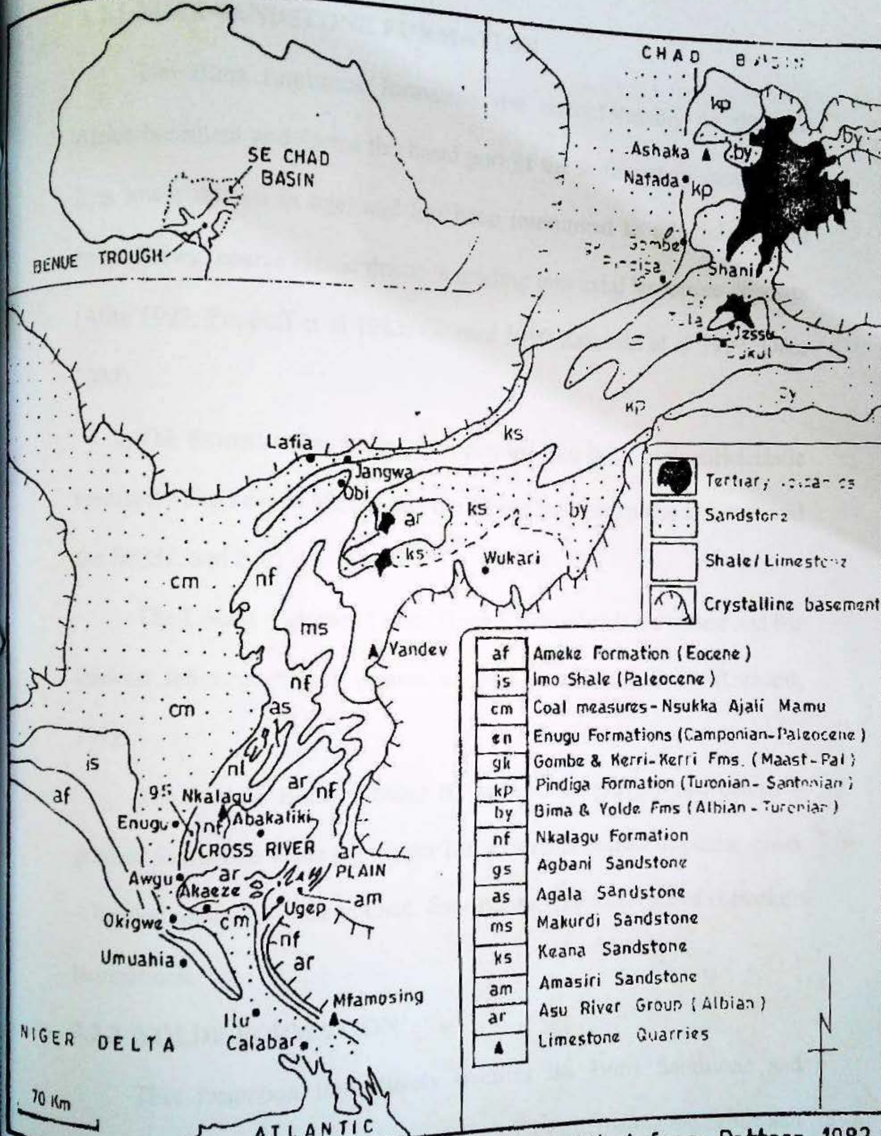

Fig. 4 The Benue Trough of Nigeria (modified from Petters, 1982).

2.2.1 BIMA SANDSTONE FORMATION

The Bima sandstone formation rest unconformably on the pan Africa basement and forms the basal part of the sedimentary succession. It is lower Albian in age, and has been interpreted as alluvial fan and braided river, coarse clastic deposits grading into axial lacustrine deposits (Allix 1993, Poppoff et al 1983, Guirard 1990 Zaborski at al 1997, Dike 2002).

The formation has been sub – divided into three main siliciclastic members. The Lower, Middle and the Upper Bima members also referred the B1,B2, and B3.

The Coarse – grained Lower Bima B1 member is the oldest and the thickest sedimentary unit present in the Upper Benue Basin (Guirard, 1992.

The Middle Bima member B2 consists of gravely and coarse – grained Sandstone while the Upper Bima member consist of planar cross – bedded medium – fine grained. Sandstones with intervals of convolute laminations.

2.2.2 YOLDE FORMATION

This formation immediately overlies the Bima Sandstone and consists of thirty bedded Sands one followed by alternating mudstone and shaly Limestone (Offodile, 1992)

Earlier (Falconer, 1911) recognized a transitional group of sediment, which mark the transition between continental Bima Sandstone and marines shale's sedimentation. Yolde Formation marks the transition from the continental to marine sediments (Kogbe 1972)

2.2.3 PINDIGA FORMATION

Pindiga Formation represents a marine sequence in the Gongola arm of the Upper Benue Trough. It is a lateral equivalent of Dikul, Jessu, Sekuliye Numanha and Lamja Formation in the Yola arm of the Upper Benue Trough (This formation overlies the Yolde Formation, which consist of Fossilferous Limestone and shale with interbred of sandstone. Siltstone and shale Limestone in it's Upper part (Carter et al, 1968. This Formation represents a full marine incursion into the Upper Benue Trough, during the Turonian – santonian times (Obaje etal 1997) and the type locality is at the indigo village with a thickness about 200m.

2.2.4 GOMBE SANDSTONE

The Gombe Sandstone is the topmost unit of the cretaceous sediments in the Gongola arm of the Benue Trough. It overlies the Pindiga Formation in stratagraphy sequence and it is the lateral equivalent of the Lamja Sandstone and the Lausub – Basin

(Falconer, 1911) described the Gombe Sandstone as "Gombe grits and clays" and he considered it to be of Eocene age.

The Gombe Sandstone however is unconformably overlain by Kerri -Kerri Formation (Carter et al 1963)

2.2.5 KERRI-KERRI FORMATION

The Kerri-Kerri Formation was first name and dated as Eocene by Falconer (1911).He correlated it with cretaceous Sandstones in Lokoja and Sokoto Basins shell B.P Petroleum Development Company Palynologists, based on carbonaceous materials from a borehole at Dukku, dated the Formation as Paleocene and later a younger age.

The Formation is unaffected by folding but dips gently to the North and Northeast below the Chad Formation(Dike 1998), it is a continental sequence which was deposited under a wide range of conditions Lacustrine and Deltaic type sediments from the most frequently reoccurring strata (Carter et al 1963).

CHAPTER THREE

METHOD OF STUDY

3.1 LITHOFACIES LOGS

Lithofacies is the term used and derived from sedimentary rocks. Lithofacie is a body of rock types with specified characteristics and in other words it is refers to as bed or strata.

During the fieldwork exercise 8 samples taken of the Gombe and 5 samples of the Kerri – Kerr Formation and three geological sections were measured within Gombe Town in Gombe State.

Samples collected labeled and bagged for granulometric analysis and Tin sectioning

3.2 GRANULOMETRIC ANALYSIS

Sedimentologists have different techniques to determine the particle size of sediments one of the most commonly used technique is the sieve analysis method only the sandstone samples were prepared for sieve analysis.

A total of five samples where selected and carefully crushed using special mortar and rubbed – padded pestle, one at a time to obtain 250 grains of loose samples.

Each of the samples was then placed in a Ro – Tap sieve shaker, and sieved for 10minutes using standard sieves, as described by Krumbein and Pettijohn (1938), Folk and Ward (1957) and Folk (1966) Samples were then measured using a digital weighing machine and kept in a well protected cellophone bag to word loosing the grain particles.

3.3PETROGRAPHY

A total of eight samples were selected for the sectioning friable and less indurate samples were impregnated with reason, while indurate once were simply cut and mounted on slides with araldite and Canada balsam sections were out and polished The slides were examined under plane polarized light and across nicols of the petrologic microscope to estimate the petrography parameters.

3.4 DETERMINATION OF DEPOSITONAL ENVIRONMENT

The depositional environment result from the analysis and interpretation of lithofacie, facie sequence granuloetric date and interpretation from sand population plots (Fig 11a – 11e)

The sieve analysis data as summarized on the table were further compared with bivariate plot of mean size against stand and deviation (Sorting) after fried man (1980, 1967), Miola and Wiser (1963)

CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 FACIES ANALYSIS

Facies is the sum total of the lithological and paleontological aspects of a stratigraphic unit. Gressly (1838). Facies refers to the lithologics and biologic characteristic of sedimentary deposit imported by the processes operating in the depositional environments. Hence, the gradation transition from one place to another represents environments that were one adjacent laterally. The main objective of facie analysis is to provide a facie model, which is used to give a hypothesis of the environments in .which deposition of rock under study took place.

This is presented in vertical profiles called sections, the lithofacie encountered in the study are as seem in figure 5 – 7 comprises of mudstone fames and Sandstone of Gombe Sandstone and Kerri – Kerri Formulation.

The lithofacies logs are presented in Fig 5 to 7

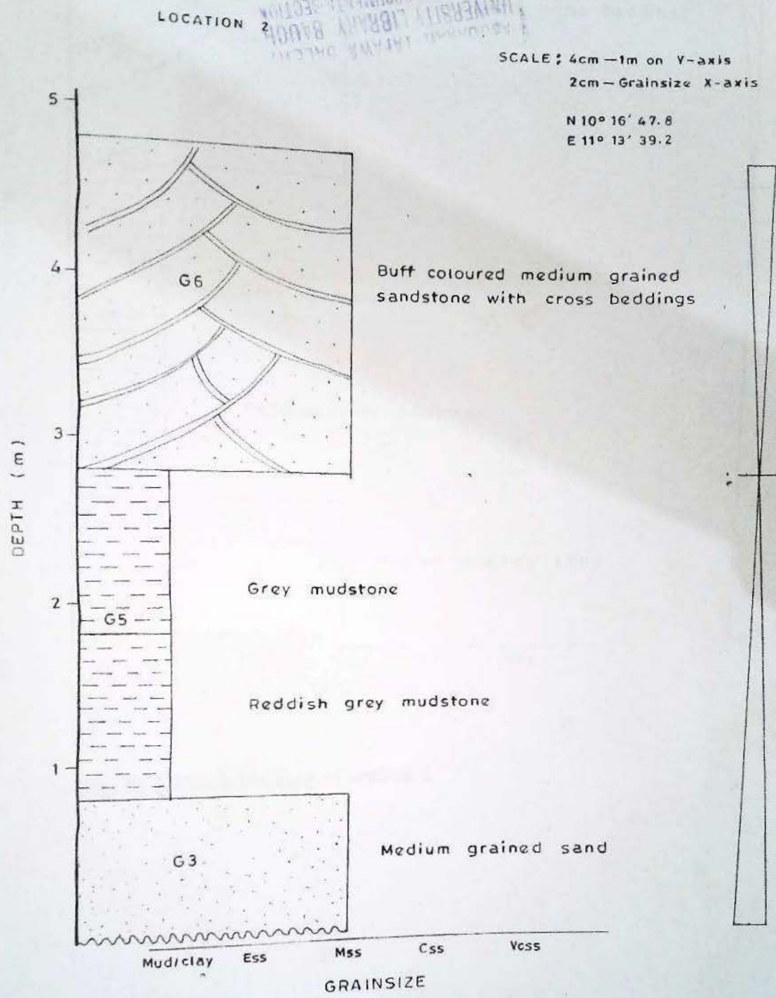

Fig. 5: Lithofacies Log of section 1

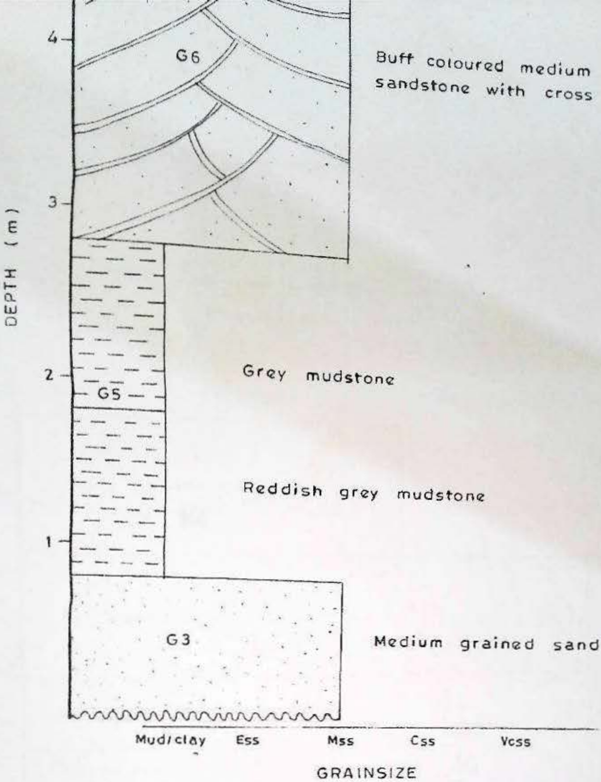

Fig. 5: Lithofacies Log of section 1

GRAINSIZE

Fig. 6: Lithofacies Log of section 2

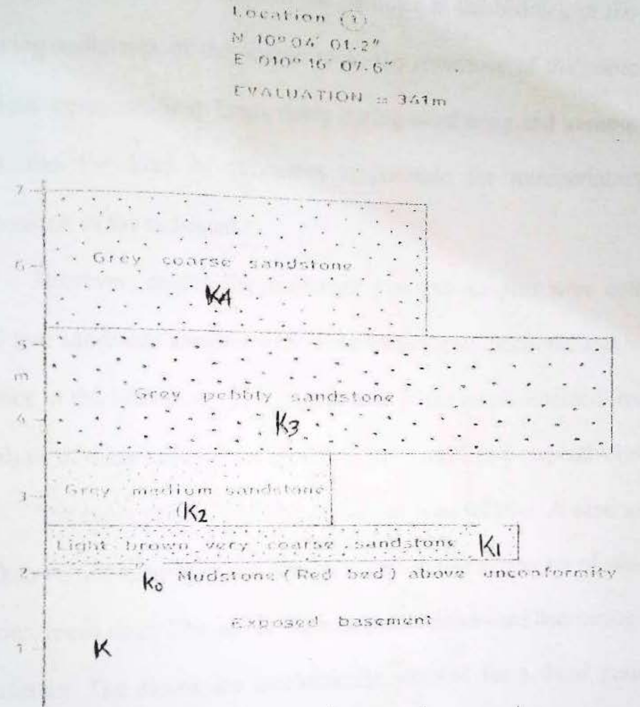

Fig. 7: Lithofacies Log of section 3

4.2 GRANULOMETRIC ANALYSIS

The presentation of the granulometric analysis results reflects the availability of different sizes of the particles in the bedrock or the pre – existing sediments of the source rock, the resistance of the particles of various composition to break down during weathering and transportation and also the kind of processes responsible for transportation and deposition of the sediment.

However, during the fieldwork exercise samples were collected and four sandstone samples were sieve by using an electronic mechanical device in the laboratory. The presentation of the result obtained from the analysis of these samples are shown on table and figure respectively.

The basis principle of this technique is as follows. A sand sample of known and measured and weight is passed through as set of sieves of known mesh sizes. The sieves are arranged in downward decreasing mesh diameters. The sieves are mechanically vibrated for a fixed period of time. The weight of sediment retained or each is measured and converted into a percentage of the total sediment sample. The method is quick and sufficiently accurate for most purpose. Essentially it measures the maximum diameter of a sediment grain.

Both graphic and statistical methods of data presentation have been developed for the interpretation of sieve data .The percentage of the samples in each class can be shown graphically in a histogram. Another, method of graphic display is the cumulative curve or cumulative arithmetic curve, cumulative curves are extremely useful because many sample curves can be plotted on the same graph and differences in sorting are at once apparent. The closer a curve approaches the vertical the better sorted it as a major percentage of sediment occurs in one class. Significant percentages of course and time end members should up as horizontal limbs at the ends of the curve. The calculated results of the weight percents were used to construct or plot cumulative frequency curve and histogram respectively. (Figure 8a, b, and 9a, b, c, d, e).

The second aspect of sieve analysis is its sorting or the measure of degree of scattering sorting is the tendency for the grains to all is of one class of grain size. Several formulae have been used to define this parameter for a sample.

The third property of grain size frequency curve is termed "Kurtosis" or the degree of "peakedness" Curves which are more peaked than the normal distribution curves, are termed "leptokurtic" those which are saggier than the normal are said to be "platykurtic".

The fourth property of a sieve analysis is it's skew ness, or degree of lop – sidedness. Sample weighted towards the coarse and member are said to be positively skewed (lop – sided towards the negative Phi vales samples weighted towards the fine end are said to be negatively skewed (lop – sided toward the positive phi valued.

The four statistical measurements for sieved samples consist of a measure of central tendency (Including medium, mode and mean, a measure of the degree of scatter or sorting, kurtosis the degree of peaked ness, and skew ness the lop – sidedness of the curve.

Finally, the graphic mean, standard deviation (sorting) – skew ness and kurtosis were the calculated for each. Sample analyzed using the relationships and folk and ward (1957) which enabled the result in

Base on the of the granulometic analysis are given in table 2 to 6 and table 7.

Table 2:

Result of sieve analysis of Sample G3 initial weight =150grams

Sieve size (mm)	Phi(ø)	Weight retained	Individual weight (%)	Cumulative weight	Cumulative weight (%)
4.75m	-225	- -	- -	- -	- -
3.35mm	-175	0.1	0.06	0.1	0.06
2.36mm	-1.25	0.7	0.46	0.8	0.52
1.18mm	-0.25	9.7	6.47	10.5	6.99
0.85mm	0.25	14.1	9.41	24.6	16.40
0.425mm	1.25	57.4	38.31	82.0	54.71
0.3mm	1.75	26.8	17.89	108.8	72.6
0.212mm	2.25	17.5	11.68	126.3	84.28
0.106m	3.25	0.4	0.26	126.7	84.54
PAN	PAN	23.1 149.8	15.42	149.8	99.76

Table 3:

Results of sieve analysis of Sample G6 initial weight =150grams

Sieve size (mm)	Phi(ø)	Weight retained	Individual weight %	Cumulative weight	Cumulative weight %
4.75mm	-225	--	--	--	--
3.35mm	-175	--	--	--	--
2.36mm	-1.25	0.00	0.00	0.00	0.00
18mm	-0.25	0.6	0.4	0.6	0.4
0.85mm	0.25	3.2	2.13	3.8	2.53
0.425mm	1.25	31.5	21	35.3	23.53
0.3mm	1.75	34.5	23	69.8	46.53
0.212mm	2.25	36.9	24.63	106.7	71.16
0.106m	3.25	23.1	15.42	129.8	86.58
PAN			13.35	149.8	99.93

Table 4:

Result of sieve analysis for sample K1 initial weight = 200grams

Mesh size (mm)	Phi(ø)	Weight Retained	Cumulative weight	Weight percentage	Cumulative weight percentage
4.75	-2.25	124.3	124.3	62.15	62.31
3.35	-1.75	2.2	126.5	1.10	63.41
2.36	-1.25	4.7	131.2	2.35	65.76
1.18	-0.25	21.1	152.3	10.55	76.34
0.850	0.25	14.1	166.4	7.05	83.41
0.425	1.25	17.5	183.9	8.75	92.18
0.300	1.75	3.7	187.6	1.85	94.04
0.212	2.25	2.3	189.9	1.15	95.19
0.106	3.25	4.6	194.5	2.30	97.49
0.075	3.75	1.8	196.3	0.90	98.40
0.063	4.00	1.8	198.1	0.90	99.30
Pan	Pan	1.4	199.5	0.70	100

Table 5:

Results of sieve analysis for sample K2 Initial weight 200grams

Mesh size (mm)	Phi(ø)	Weight Retained	Cumulative weight	Weight percentage	Cumulative weight percentage
4.75	-2.25	0.0	0.0	0.0	0.0
3.35	-1.75	0.0	0.0	0.0	0.0
2.36	-1.25	12.5	12.5	6.25	6.27
1.18	-0.25	0.6	13.1	0.30	6.57
0.850	0.25	16.9	30.0	8.45	15.04
0.425	1.25	70.6	100.6	35.30	50.43
0.300	1.75	40.5	141.1	220.25	70.73
0.212	2.25	19.3	160.4	9.65	80.40
0.106	3.25	21.4	181.8	10.70	91.13
0.075	3.75	11.8	193.6	5.90	97.04
0.063	4.00	3.0	196.6	1.50	98.55
Pan	Pan	2.9	199.5	1.45	100

Table 6:

Results of sieve analysis Sample K3 initial weight =200grams

Mesh size (mm)	Phi(ø)	Weight Retained	Cumulative weight	Weight percentage	Cumulative weight percentage
4.75	-2.25	5.7	5.7	2.85	2.85
3.35	-1.75	7.9	13.6	3.95	6.80
2.36	-1.25	20.8	34.4	10.40	17.21
1.18	0.25	80.9	115.3	40.45	57.68
0.850	0.25	33.2	148.5	16.60	74.29
0.425	1.25	25.0	173.5	12.50	86.79
0.300	1.75	6.0	179.5	3.00	89.79
0.212	2.25	4.6	184.1	2.30	92.10
0.106	3.25	8.2	192.3	4.10	96.20
0.075	3.75	3.9	196.2	1.95	98.15
0.063	4.00	1.4	197.6	0.70	98.85
Pan	Pan	2.3	199.9	1.15	100

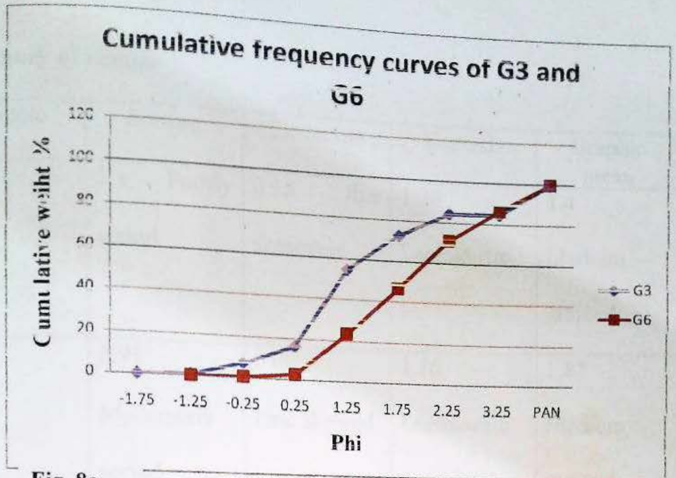
Cumulative frequency curves of G3 and G6
Cumulative weiht %
120
100
80
60
40
20
0
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
PAN
Phi
G3
G6

Fig. 8a

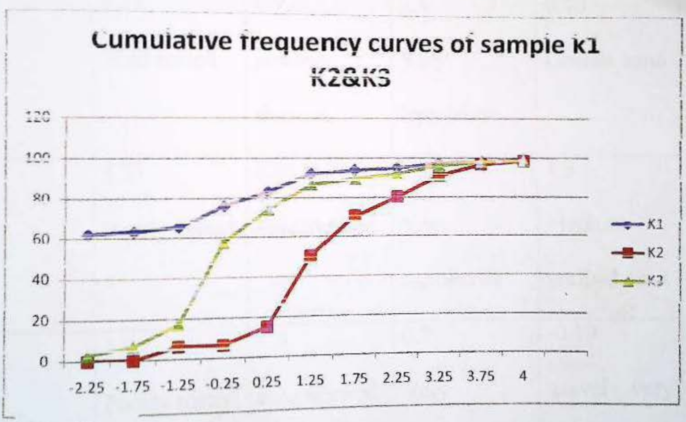
Cumulative frequency curves of sample k1 K2&K3
120
100
80
60
40
20
0
-2.25
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
3.75
4
K1
K2
K3

Fig. 8b

Table 7:

Summary of results

Sample	Sorting	Skweness	Kurtosis	Graphic mean
G3	1.1 Poorly sorted	0.15 fine skewness	1.28 Leptokurtic	1.4 Medium grained
G6	0.91 Moderately sorted	0.08 Fine skewed	1.16 Leptokurtic	1.87 Medium grained
K1	0.38 Well sorted	0.97 positive skewed	2.1 Very leptokurtic	0.10 Coarse sand
K2	1.31 Poorly sorted	0.01 Fine skewed	1.6 Very leptokurtic	1.3 Medium grained sand
K3	1.9 Poorly sorted	1.0 Fine skewed	0.7 Very Platykurtic	-0.19 gravel very coarse

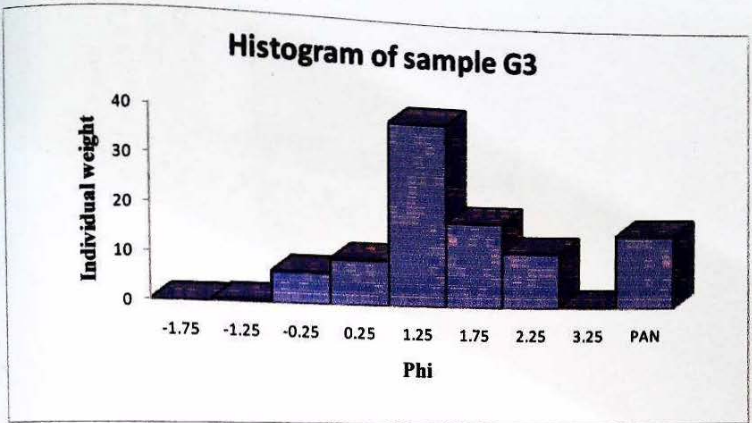
Histogram of sample G3
Individual weight
40
30
20
10
0
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
PAN
Phi

Fig. 9a

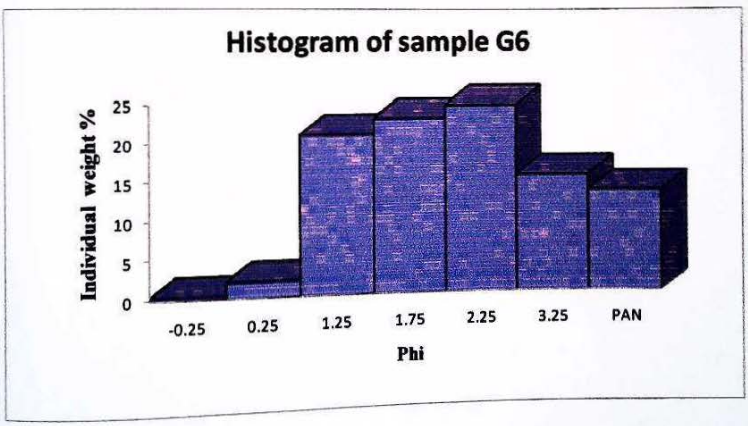
Histogram of sample G6
Individual weight %
25
20
15
10
5
0
-0.25
0.25
1.25
1.75
2.25
3.25
PAN
Phi

Fig. 9b

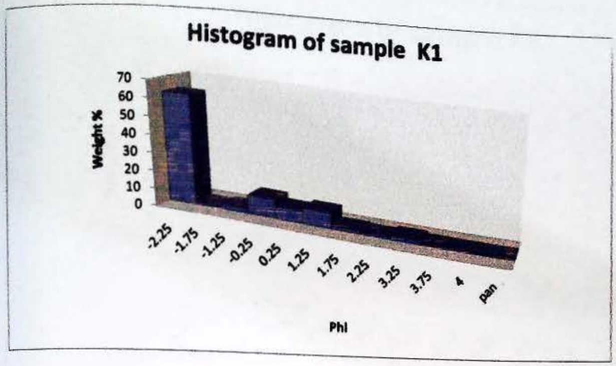
Histogram of sample K1
Weight %
70
60
50
40
30
20
10
0
-2.25
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
3.75
4
pan
Phi

Fig. 9c

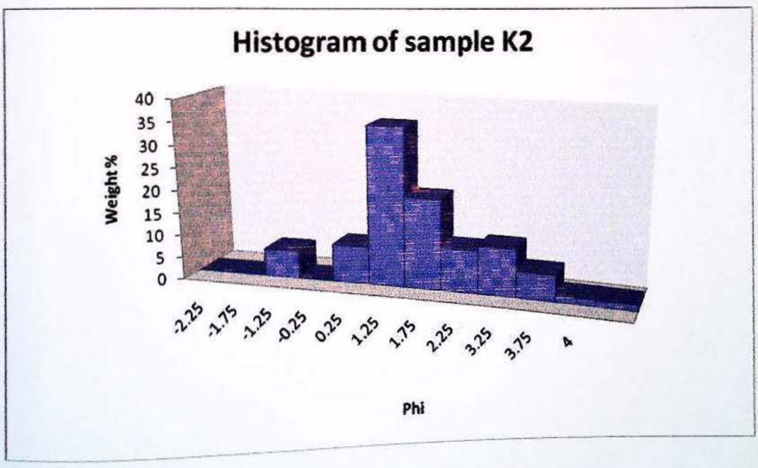
Histogram of sample K2
Weight %
40
35
30
25
20
15
10
5
0
-2.25
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
3.75
4
Phi

Fig. 9d

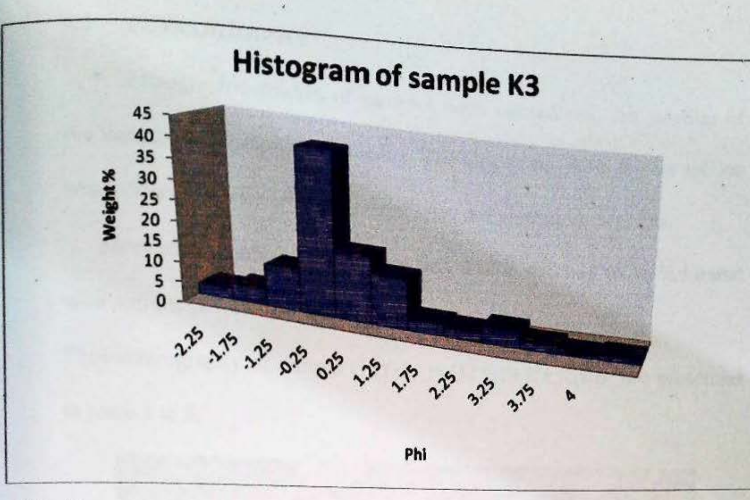
Histogram of sample K3
Weight %
45
40
35
30
25
20
15
10
5
0
-2.25
-1.75
-1.25
-0.25
0.25
1.25
1.75
2.25
3.25
3.75
4
Phi

Fig. 9e

4.3 PETROGRAPHY

Petrographic studies of samples were carried out, thin section of the various Petrographic parameters. The side gotten from the tin section were observed under cross polarized light and presented on pages.

Most of the samples were loose and friable and had to be indurated with araldite before they were cut into tin sections.

Photomicrography of sample G4,G5,G6,G7,G13,K1,K,Ko are presented in plate 1 to 8.

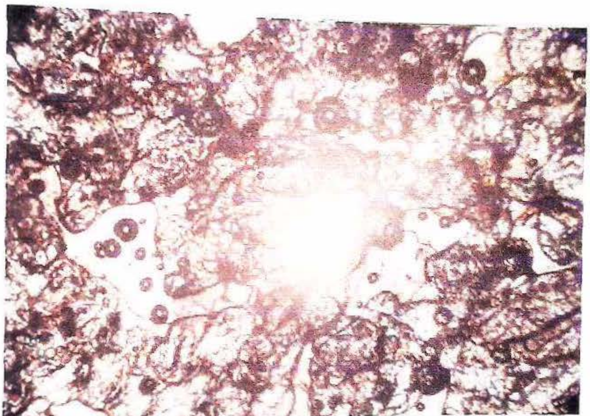

PLATE 1 PHOTOMICROGRAPH OF G4 VIEWED UNDER CROSS POLARIZER X10 COMMON MINERALS ARE QUARTZ AND FELDSPAR

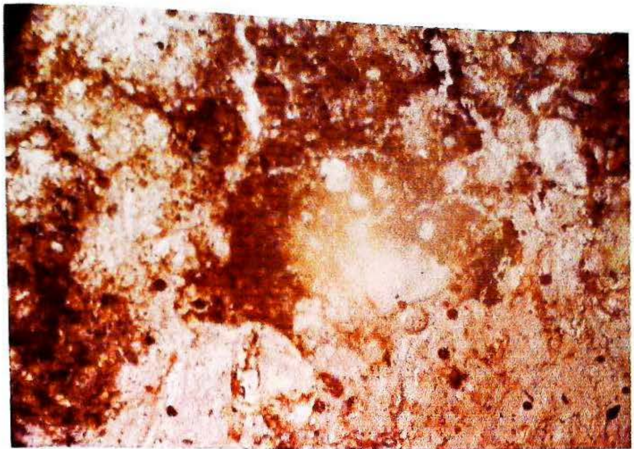

PLATE 2 PHOTOMICROGRAPH OF G5 VIEWED UNDER CROSS POLARIZER X10 COMMON MINERALS ARE QUARTZ AND FELDSPAR

PLATE 3 PHOTOMICROGRAPH OF G6 VIEWED UNDER CROSS POLARIZER X10 COMMON MINERALS ARE QUARTZ FELDSPAR AND CLAY MINERALS

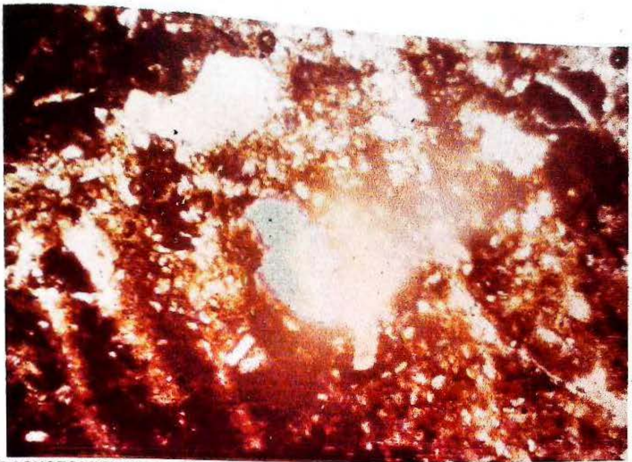

PLATE 4 PHOTOMICROGRAPH OF G7 VIEWED UNDER CROSS POLARIZER X10 COMMON MINERALS ARE QUARTS AND FELDSPAR

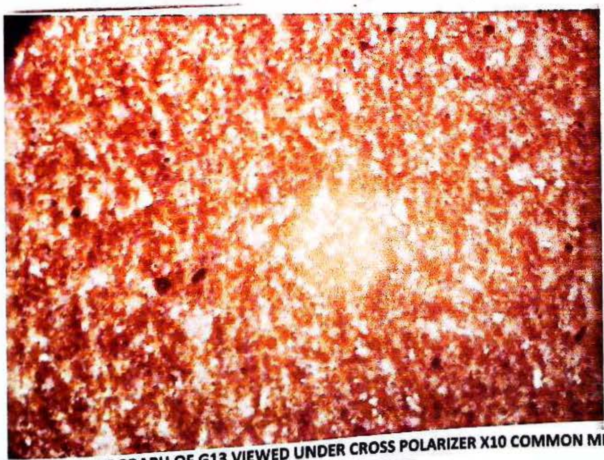

PLATE 5 PHOTOMICROGRAPH OF G13 VIEWED UNDER CROSS POLARIZER X10 COMMON MINERALS ARE QUARTZ AND FELDSPAR

Plate 6 Photomicrograph of sample K1 which represent very coarse sandstone, with a lot of matrix. Common minerals are: Quartz, Feldspar, Mica and clay minerals. Magnification X10

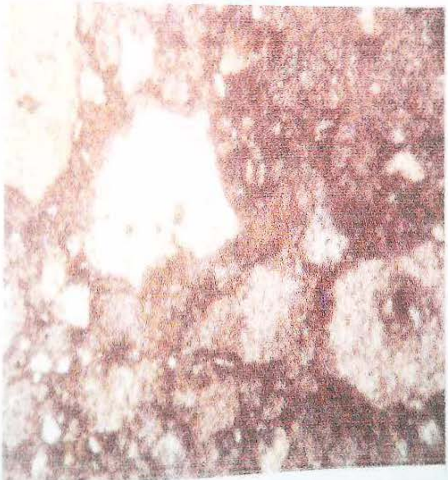

Plate 7 Photomicrograph of sample K_o which represent mudstone. Common minerals are: Heamatite, and clay minerals. Magnification X10

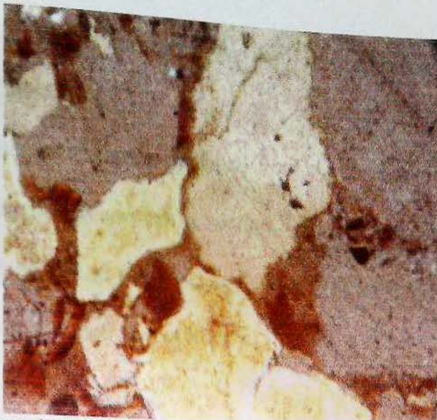

Plate 8 Photomicrograph of sample K which represent basement. Common minerals are: Quartz, Feldspar and Mica. Magnification X10

4.4 RESULTS FOR INTERPRETATION OF DEPOSITIONAL ENVIRONMENT

The results of these depositional environments were obtained by following the method described in section 3.4. The results from graphic mean, standard deviation (sorting) and skewness were used in plotting Bivariate diagrams, which is presented in Fig 10a, b & c.

CHAPTER FIVE

5.0 DISCUSSION

5.1 FACIES ANALYSIS

The aim of Facies analysis is to produce a Facies model which is used to give a hypothesis of the environment in which deposition of rocks under study took place. The lithofacies encounter in the study areas are presented in vertical profile and indentified in fig 5 to 7. Figure 5 is the lithofacies log of section 2. In this such we have a fining upward sequence. This depletes a decrease in energy of the transporting medium from channel to the flood plain. The total height of the exposure measured was at 1.41meters with no distinctive colour observed.

Figure 6 is the lithofacie log of section 5. It shows a repetitive stratification with fining upward sequence of sandstone fining to thinly interbedded mudstone. This depicts an alternation from high to low energy of the fluvial system. The total height of the exposure measured was 4.77meters with distinctive colour in mudstones i.e. from Reddish grey to grey and Buff coloured medium grained sandstone with cross beddings.

Figure 7, is the lithofacies log of section 1. It shows a stratification of coarsen upward sequence of sandstone. This indicates increase in energy of the transporting medium. The total height of the exposure is 7meters.

GRANULOMETRIC ANALYSIS

The summary of the results of granulometric analysis is presented in table 6

Table 2, figure 8a, and 9a are the granulometric data of sample G3. The histogram of sample shows that most of the sample are in the center of the plot indicating medium grain sample. This is supported by the graphic mean 1.17 which is medium sand. The histogram also shows more than one peak.

Table 3, figure 8a and 9b are in granulometric data of sample G6. The histogram of sample shows that center indicating medium grain sample. This is supported by the graphic mean of 1.87 which is a medium sand. The histogram also show more than one peak.

Table 4, figure 8b and 9c, are the granulometric data of sample K1. The histogram of the samples are mostly towards the left of the plot indicating coarse grained sample. This is supported by graphic mean of 0.10 coarse grain. The histogram also shows 1 peak.

Table 5, figure 8b and 9d granulometric data of sample K2. This histogram of the grains are mostly in the center of the plot indicating medium grained sample. This is supported by the graphic mean 1.3 which is medium sand. The histogram also shows more than one peak.

Table 6, figure 8b and 9e are the granulometric data of sample K3. The histogram of the grains is mostly towards the left indicating coarse grained sample. This is supported by the graphic mean of -0.19 very coarse sand. The histogram also shows more than one peak.

5.3 PETROGRAPHIC ANALYSIS

As mentioned in section 4.3 most of the samples had to be indurated with araldite and so for such samples they appear to have an opaque background.

Plate 1, is the photomicrograph of sample G4. This sample is a mudstone. It consists of mostly clay mineral.

Plate 2, is the photomicrograph of sample G5.The sample is a mudstone. It consists of mostly clay minerals.

Plate 3, is the photomicrography of G6 From the result of granolumetric analysis the sample is moderately sorted. The sample is moderately sorted. It consists of mostly quartz, feldspar and clay minerals.

Plate 4, photomicrograph of G7 From the result of granulometric analysis is moderately sorted consist of quartz and feldspar common minerals are quarts and feldspar

Plate 5, is the photomicrograph of sample G13. This sample is a mudstone. It consists of mostly clay minerals.

Plate 6, is the photomicrograph of sample k1.From the result of granolumetric analysis, the sample is well sorted. It consists mostly of quartz, feldspar, mica and clay minerals.

Plate 7, is the photomicrograph of sample Ko. The sample is a mudstone. It consists of mostly Heamatite and Clay minerals.

Plate 8, is a photomicrograph of sample K. The sample is a basement. It consists of quartz, feldspar and mica.

5.4 ANALYSIS OF DEPOSITIONAL ENVIRONMENT

5.4.1 BIVARIATE PLOT

This bivariate plot as seen in figure 10a, b, and c, which were constructed from data obtained from granulose after the works of Friedman (1961 and 1967) Moiola and Weiser (1968 suggested that the Gombe Formation was probably deposited in transitional environment while the Kerri-Kerri Formation was deposited in a fluvial setting.

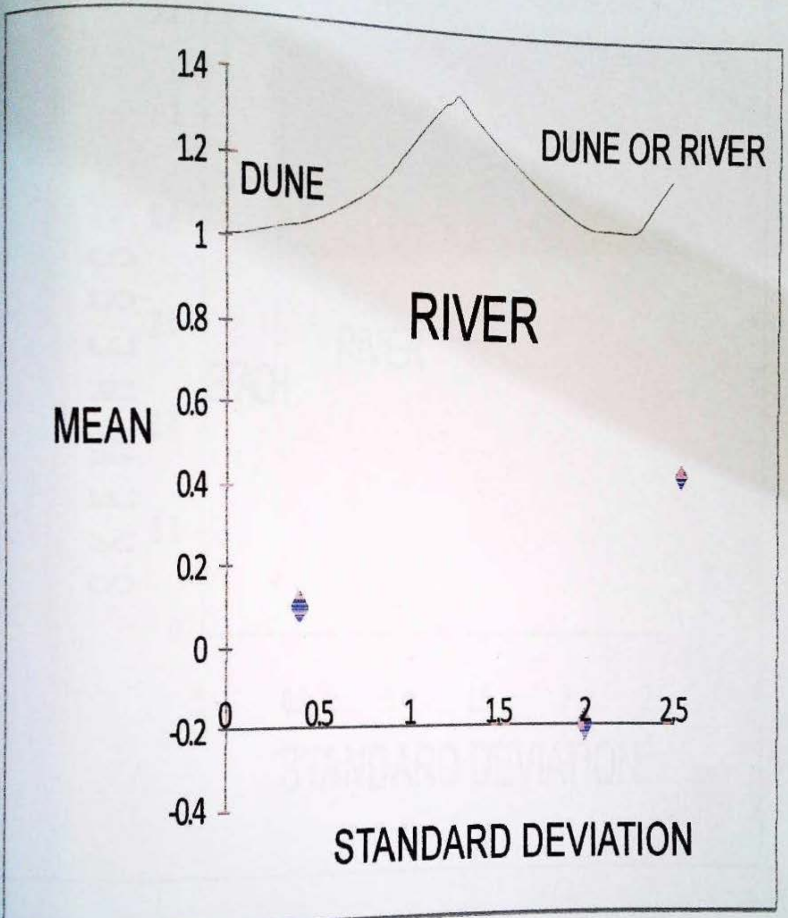

Fig. 10a BIVARIATE PLOT OF MEAN SIZE AGAINST STANDARD DEVIATION AFTER FRIEDMAN (1961) AND(1967).

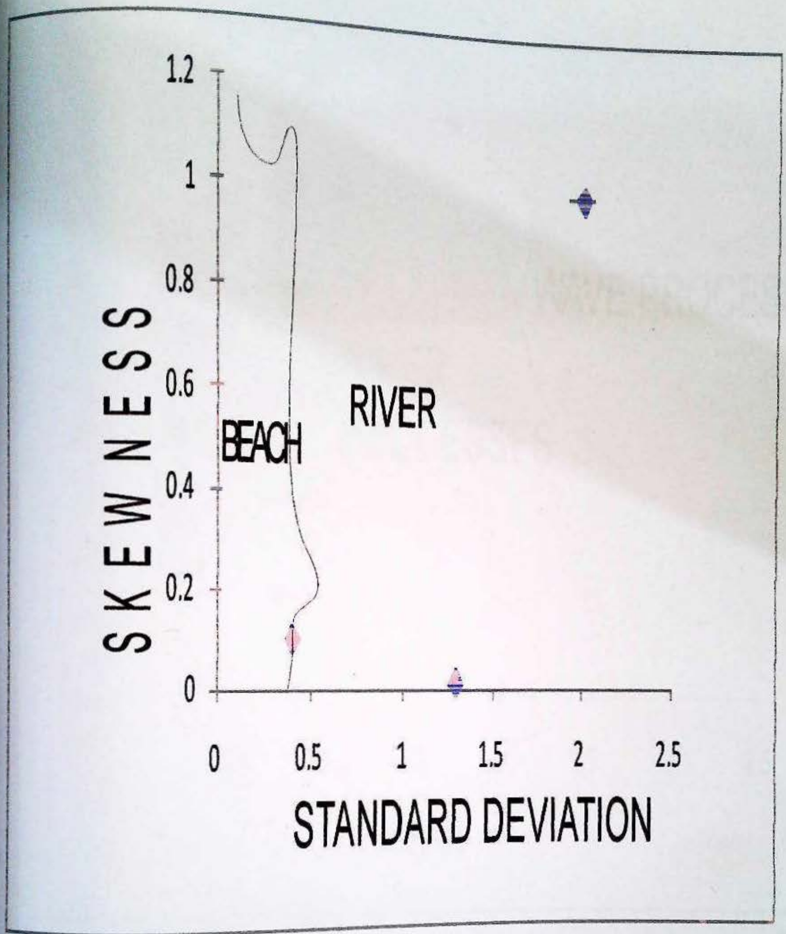

Fig. 10b: Bivariate plot of skewness against standard deviation after Freidman (1967)

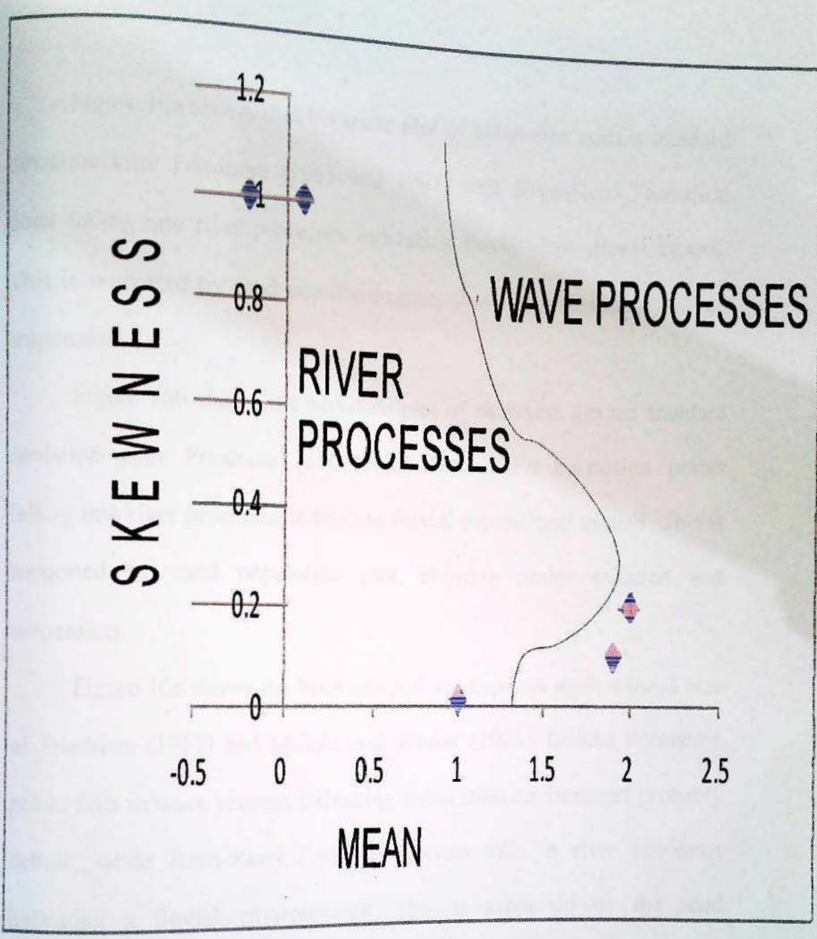

Fig. 10c: Bivariate plot of skewness against mean size after Freidman (1961) and Mioila and Weiser (1968)

Figure 10a shows that bivariate plot of mean size against standard deviation after Friedman (1961 and 1967) with Kerri-Kerri Formation point failing into river processes indicating fluvial depositional system. This is supported by sand population plot, showing grains saltation and suspension.

Figure 10b shows the bivariate plot of skewness against standard deviation after Friedman (1967).With Kerri-Kerri Formation points falling into river processes indicating fluvial depositional system. This is supported by sand population plot, showing grains saltation and suspension.

Figure 10c shows the bivariate plot of skewness against mean size of Friedman (1961) and Moiola and Weiser (1968). Gombe Formation points falls in wave process indicating transitional environment probably deltaic, while Kerri-Kerri Formation points falls in river processes indicating a fluvial environments. This is supported by the sand population plots which show saltation and suspension populations which again suggests fluvial depositional environment.

5.4.2 SAND POPULATION PLOTS

The sand population plots as presented 10a, 10b, 10c, 10d and 10e shows that the grains were transported by means of suspension for finer grains and saltation for coarse, heavy grains. This again suggests that grains of the Gombe Formation which are labeled with the letter `G`, were transported and deposited by wave processes probably in a deltaic depositional environment, while sands of the Kerri-Kerri Formation which are carrying the `K` labeling were transported and deposited by river processes which is interpreted as fluvial depositional environment..

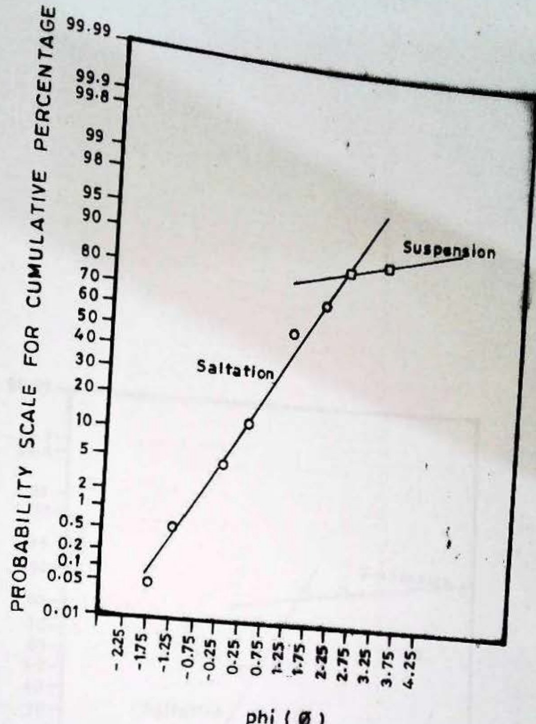

Fig. 11a Sand population plot for sample G3

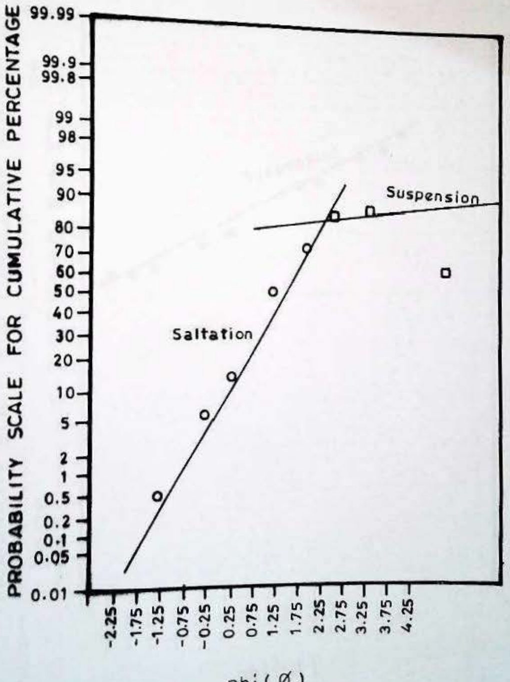

Fig. 11 b Sand population plot for sample G6.

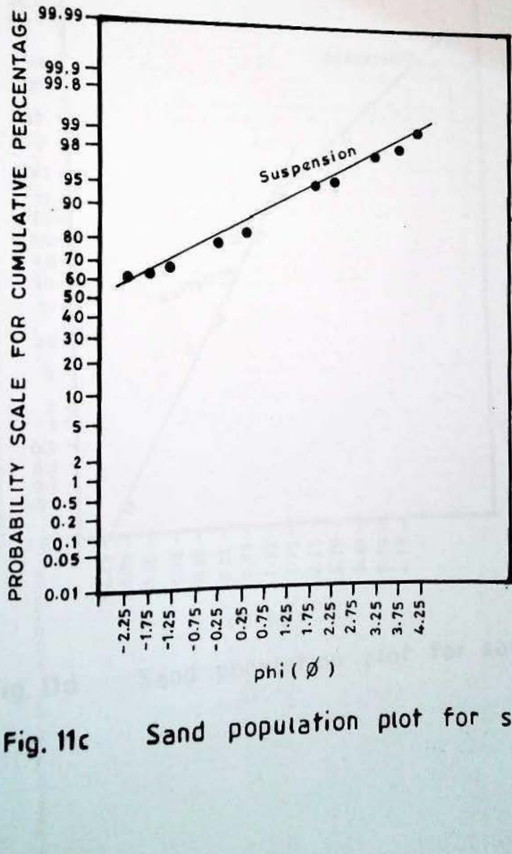

Fig. 11c Sand population plot for sample K1.

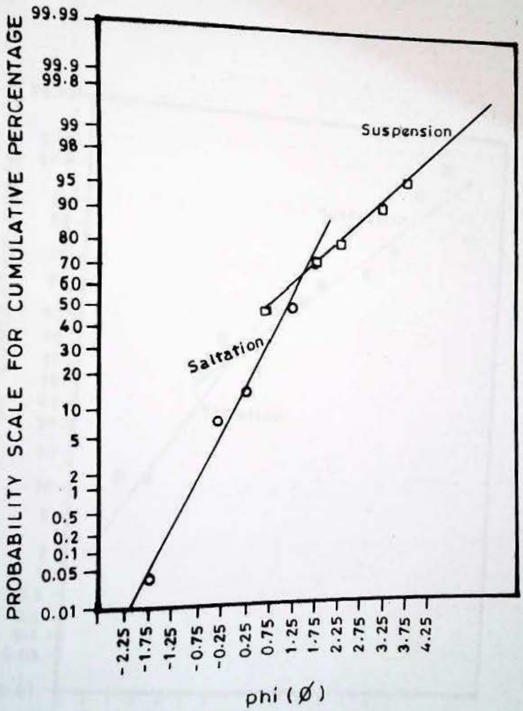

Fig. 11d Sand population plot for sample K2.

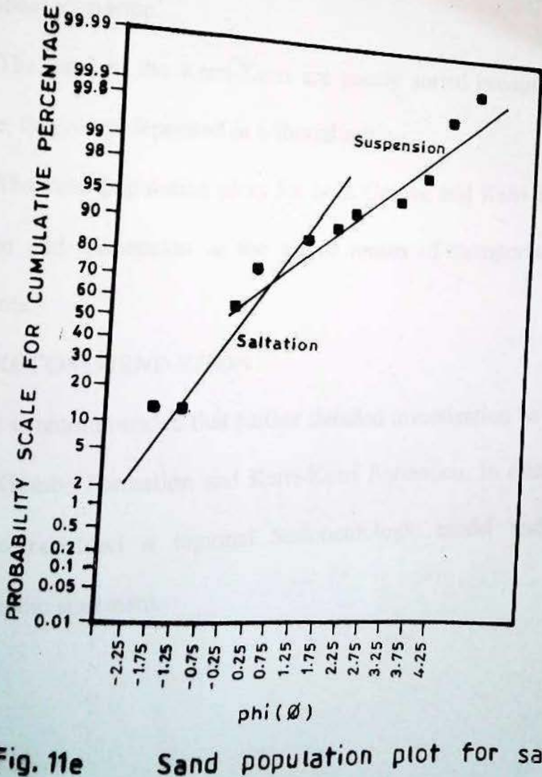

Fig. 11e Sand population plot for sample K3.

CHAPTER SIX

6.1 CONCLUSION

From Facies analysis, granulometric and Petrographic studies, there are similarities between Gombe Formation and Kerri-Kerri Formation i.e. They consist mainly of sand of different sizes and clay stone/ or mudstone. However, the sands found in the Gombe are better sorted. This is because the environment of deposition of the Gombe is transitional to marine.

The sand in the Kerri-Kerri are poorly sorted because unlike the Gombe, they were deposited in a fluvial setting.

The sand population plots for both Gombe and Kerri-Kerri shows saltation and suspension as the major means of transportation of the sediments.

6.2 RECOMMENDATION

It is recommended that further detailed investigation be carried out on the Gombe Formation and Kerri-Kerri Formation. In other areas, in order to construct a regional Sedimentologic model and obtain a Petrographic statement.

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