GEOLOGY AND STRATIGRAPHY OF AJAKA AND ENVIRON IN THE NORTHERN KOGI DISTRICT OF KOGI STATE, NIGERIA

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Abstract: **The stratigraphy and paelodepositional environment of the Ajaka area were analysed using a detailed study of outcrops. Results show that two major lithostratigraphic units outcrop in the area; dominantly conglomerate unit which can be subdivided into the paraconglomerate and the orthoconglomerate subunits, and the massive sandstone unit. The paraconglomerate consist of matrix-supported, sub rounded to rounded and poorly sorted conglomerate. The paraconglomerate facies is interpreted to have been deposited in a debris flow based on its poor sorting, absence of stratification and lack of fossil. The orthoconglomerate facies are clast-supported, subrounded to rounded, poorly sorted and contain quartz and feldspar. Such framework-support rock that suggests transportation by rolling and accretion of clast along bed. The matrix of very coarse sandstone is thought to have been transported in suspension simultaneously with bed-load rolling of the large clasts. The graded bedding of this facies indicates deposition from a single current as the energy and flow strength diminished. The massive sandstone facies consists of fine-to-coarse grained massive sandstone. The sand grains are angular to subrounded and poorly to moderately sorted. This facies is interpreted to have formed as a result of transport and deposition by short-lived mass flows. Indications from pebble analysis show that the pebbles of the study area were essentially shaped by fluvial process. Sieve analysis of sand-size particles indicates that the sandstone is largely fluvial deposits. The palynological analysis, indicate the presence of Retidiporites miniporatus, Hexaporotricolpites emelianova and Buttinia andreevi, which all are indicative of the Maastrichtian age bracket in the geological time scale. This evidence thus suggests that the outcrops of Ajaka and environs are Maastrichtian in age.**

Keywords: **Maastrichtian in age, sandstone, Environmental Indications and paraconglomerate.**

1. INTRODUCTION

Structural settings:

As recognized by Murat (1972), the megatectonic setting in the southern domain of the Benue Trough was a longitudinally faulted crust whose eastern half subsided preferentially to become the Abakaliki sub-basin (or the southern Benue Trough). The western fragment remained a stable platform (Fig. 1) up to the Santonian as was illustrated by Oti (1990). Thus the subsided eastern part becomes an important depocentre relative to the platform which received only a veneer of clastic and chemical sediments. Following the Santonian folding and uplift, the main depocentre in the southern Benue Trough, i.e. the Abakaliki area, became flexurally inverted, displacing the depocentre to the west and northwest and in the process, creating the Anambra Basin . Ojoh (1990) had noted that basin subsidence in the southern Benue Trough was spasmodic, being a high rate in pre-Albian time, low in the lower Cenomanian, and very high in the Turonian, which was related to the Important phase of platform subsidence. This is thought to be the actual time of initiation of the Anambra Basin creation, a process that gained momentum in the Coniacian and climaxed during the

Santonian thermotectonic event. Thus the localized subsidence on the western reach of the southern Benue Trough and the continued sea level rise into the Coniacian, led to the installation of the Anambra Basin (Ojoh, 1990). It should be noted however, that sedimentation started as far back as Turonian or even earlier on the shallowly submerged Anambra Platform. The rate of westward migration of the depo axis was of the order of 10 km/my or 1 cm/ year (Ref), and gradually effected the tectonic inversion between the Abakaliki region and the Anambra Basin.

As already stated, the sediment-filled depression in the Afikpo area is considered a part of the Anambra Basin. The area was involved in the tectonic inversion that produced the depocentre to the west of the Abakaliki Anticlinorium. Using palynofloral *Syncolporites lisamae* subtiles and *Auriculdites* sp. to Ojoh (1990) determined that Sedimentation in that area, which is centred to the south of southeast of Abakaliki, is dated to have commenced in the Santonian into the Campanian. In the southern Nigeria stack, the Anambra Basin is sandwiched between the Benue Trough and the Niger Delta. The main implication of this is that, after the Santonian thermotectonic event, there must have been a thermal decay, i.e a detumescent stage that produced a sag on which at least part of the Anambra Basin became superimposed. In the same manner, the establishment of the Niger Delta sedimentary regimen from the Paleocene must have taken advantage of continued thermal sag. According to Mckenzie (1978), there is usually a distinct thermal sag stage involved in post-rift basin formation in response to the cooling and contraction of the lithosphere and the asthenosphere that were thermally perturbed during the earlier rifting process. The isostatic response to such cooling is a flextural subsidence of the crust, such that magnetism would rapidly decrease and then cease altogether, such as was developed along the western margins of the Benue.

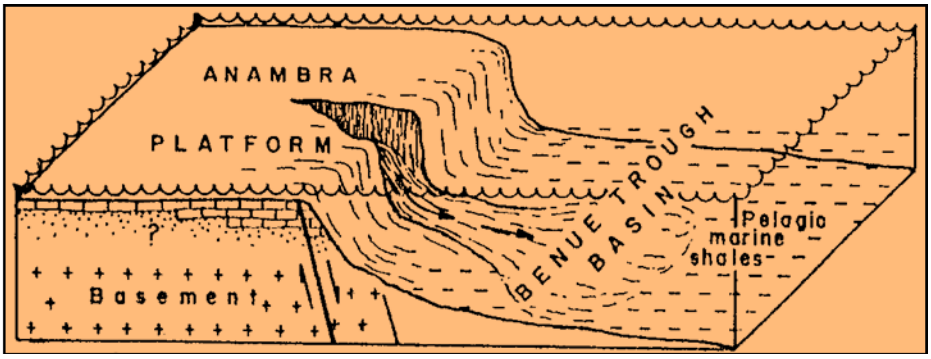


Fig. 1: Conceptual model of the relationship between the Anambra platform and the Benue Trough in the Albian to Santonian (after Oti,1990)

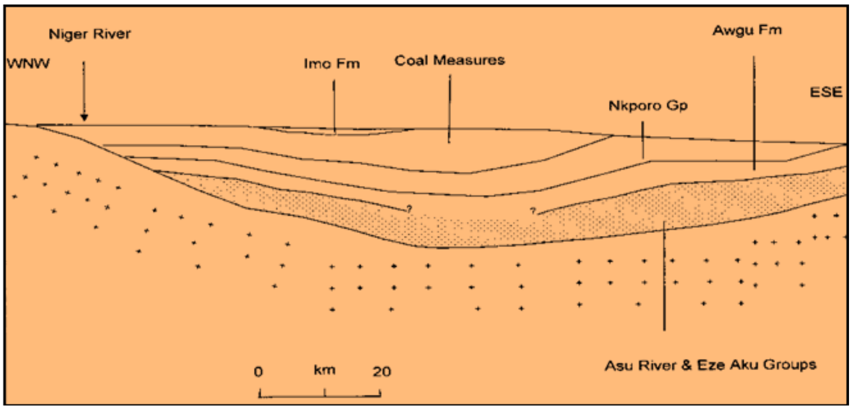


Fig. 2: WNW-ESE sections the Anambra Basin fill as a broad shallow synclinal succession overlying the units of the southern Benue Trough (after Benkhelil, 1988).

Stratigraphic Settings:

The Anambra basin is a continental large scale intra-plate tectonic range structure, which is part of the mid-African rift system initiated in the latest Jurassic to early cretaceous and it is related to the opening of central and south Atlantic ocean (Murat, 1972). The development and evolution of the tectonics, of Anambra basin, and its stratigraphic setting is better appreciated by reviewing developments in the depositional area since early cretaceous structural unit of the southeastern Nigeria as represented by Murat, (1972).

Age	Basin	Stratigraphic Units						
Thanetian	Niger Delta	Imo Formation						
Danian								
Maastrichtian	Anambra Basin	Coal Measures	Nsukka Fm					
			Ajalli Fm					
			Mamu Fm					
Campanian		Nkporo Fm	Nkporo Shale	Enugu Fm	Owelli Ss	Afikpo Ss	Otobi Ss	Lafia Ss
Santonian	Southern Benue Trough	Awgu Fm						

Table 1: The lithostratigraphic units of the Anambra Basin (After Nwajide 1990)

Description of study area:

The study area lies between latitude N 07^0 10^1, N 07^0 17^1 and longitude E 006^0 42^1 and E 006^0 50^1 (Fig. 1). It covers Emachi, Ibochi Ofeke, Itobo, Ojiapata, and Okpo Iyokolo.

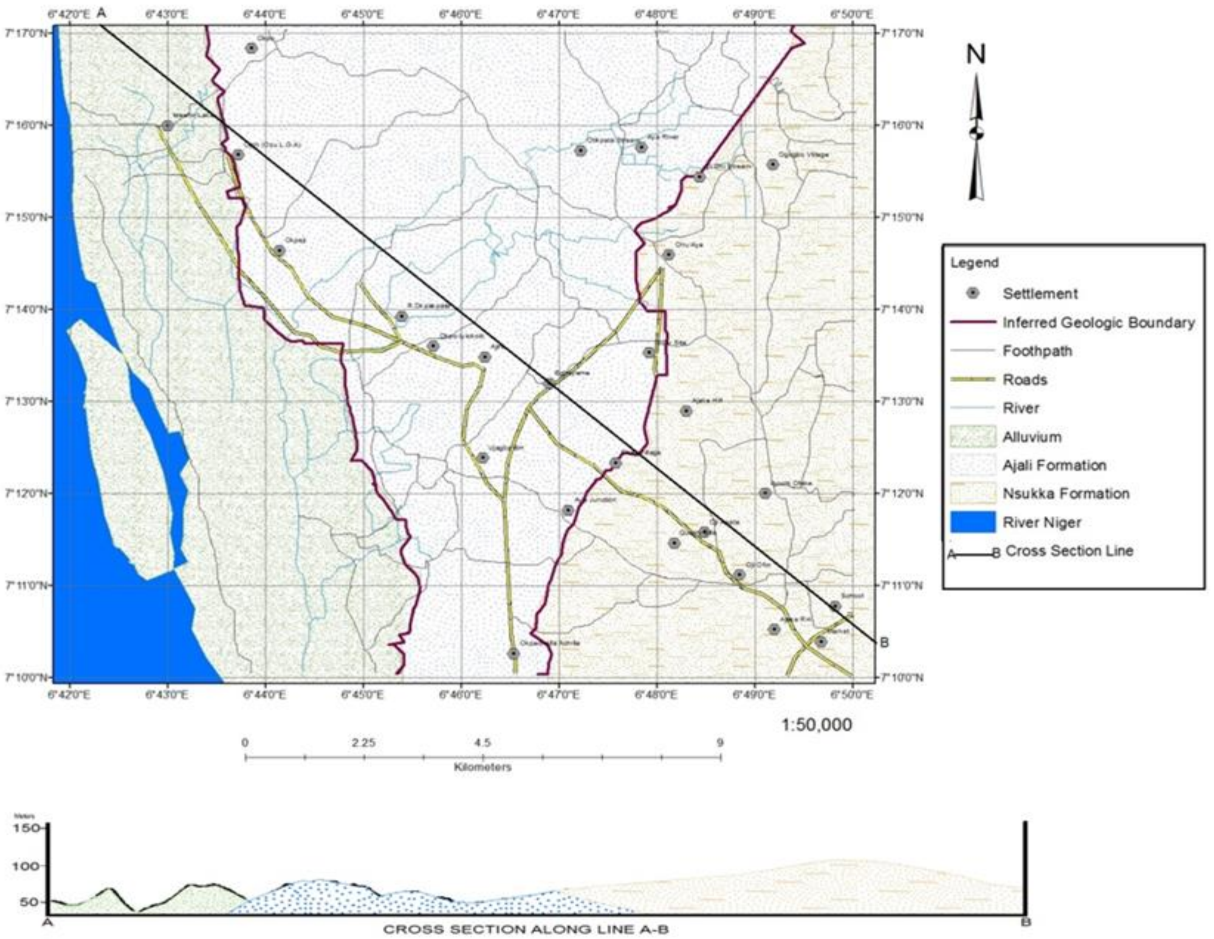


Fig. 3: Map of the study area (Modified from sheet 267)

The dominant physiographic features of the Anambra Basin area are the cuesta topography and the presence of segments of the arterial Niger-Benue drainage system. Other topographic features include inselbergs, plateaus, and rolling plains. The cuesta is a ca. 500km long asymmetrical ridge whose crest describes a laterally inverted sigmoid and can be traced northwards from Idah on the left bank of River Niger. The topography of the study area is undulating. The land rises from about 300 and 930 meters above sea level in the uplands.

The predominant topographic feature found in the study area is the Ajaka hill, which have the highest elevation of 850-930 meters. Rocks of varying susceptibility to erosion occur in the area. The resistant rocks are seen around Ajaka and Okpeji area. While the rocks that are susceptible to erosion are seen basically around Okpo-iyiokolo and Egbayeme area.

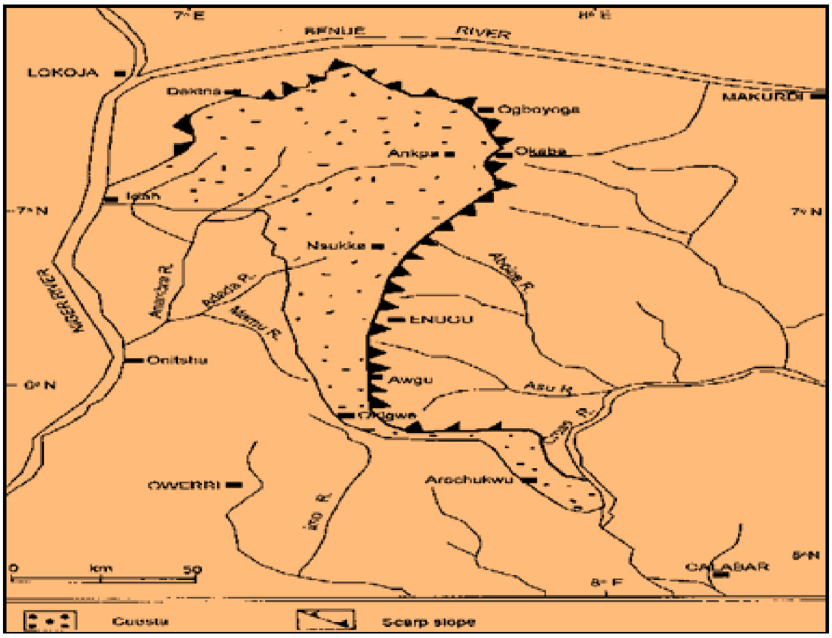


Fig. 4: The cuesta topography of south-eastern Nigeria (after Umeji, 1980)

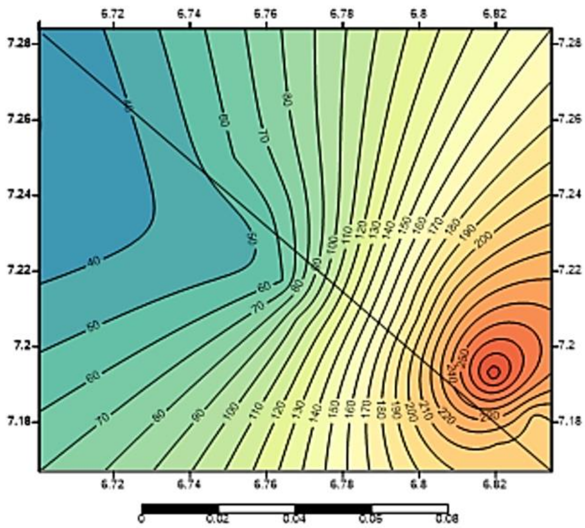


Fig. 5: The Contour Map of the study area (Nzewi, 2016)

The drainage of the study area is controlled by its topography. It is drained by River Aya, Iyi-ohi, oyogbo and otikapata. The drainage system in the study area is characterized by dendritic drainage pattern

The drainage density on terrains underlain by the Ajali sandstone in the study area is generally low. This may be due to the ease of infiltration that greatly reduces overland flow. Another perspective is that the water table is generally low, because of the absence of impermeable Formation to restrain downward flow. Again due to ease and great depth of infiltration, such that springs are rare, and rivers are therefore relatively rarely generated.

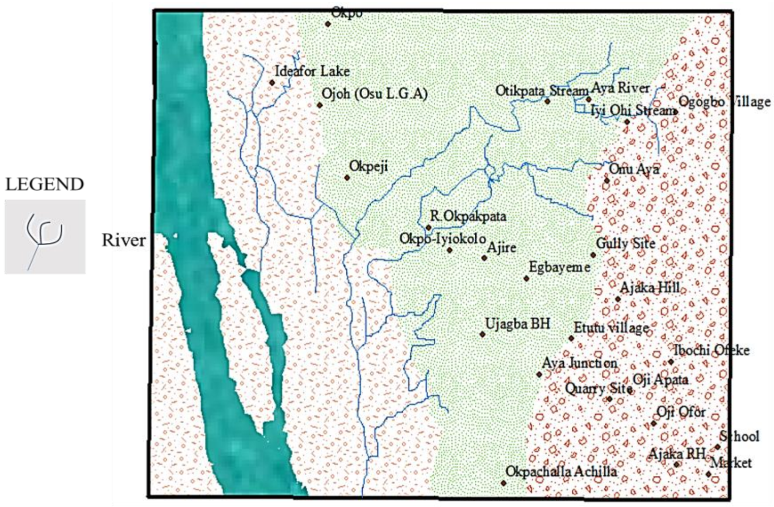


Fig. 6: The drainage map of the study area. (Modified from sheet 267)

The study area lies within a zone of tropical climate characterized by two main seasons; the rainy and dry season. And has an annual rainfall of between 1,100mm and 1,300mm. The rainy season lasts from April to October. The dry season, which lasts from November to March, is very dusty and cold as a result of the northeasterly winds, which brings in the harmattan. The temperature of the study area varies in magnitude according to the period of the year; The minimum and maximum temperatures average 25^{0}c and 32^{0}c respectively. . The daily mean humidity varies from 40% to 92%; it is generally high during the early hours of the day (Egboka, 1993).

3. METHODOLOGY

One of the best methods of collecting field data of sedimentary rocks used is to construct a graphic log of the section of interest (Tucker, 1981, 1982). Observation and logging of the lithologic units was the major procedure used in this detailed study. A graphic log gives a visual impression of the section. It makes the comparison and correlation of different geologic sections possible. Thus, repetition cycles and general trends are revealed.

Logging of the geologic sections was done starting from the base of each section then upwards. During this process I (the logger) moved horizontally and laterally to check for lithologic changes. Graphic logs were drawn in the field using appropriate vertical scale for the sediment thickness (usually in meters) and horizontal scale for sediment grain size. Certain features of outcrops were recorded in the field during each logging. They include: Color, Bed/rock layer thickness, Composition/texture (grain sizes), Sedimentary structures, Fossils, Nature of bed contacts, Remarks

The various locations/stations within the study area were identified on the base map. Contacts between lithologic units were delineated by lithology, variation in vegetation and relief. At the end for each outcrop study, samples were collected, bagged and labelled appropriately for laboratory analysis. The samples were collected for better identification of the various rock types.

4. RESULTS AND DISCUSSIONS

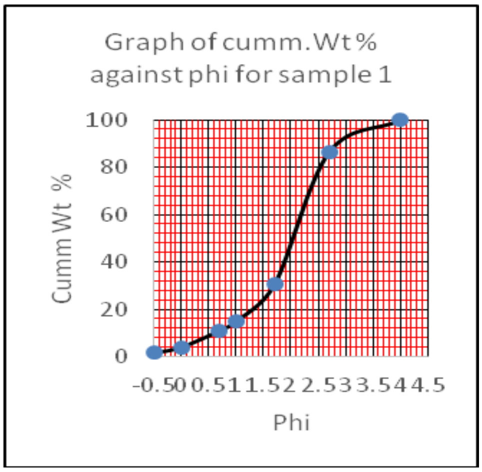
A total of eight outcrops were mapped in the course of the study which are majorly the Ajali Sandstone, Nsukka Formation, and the Alluvium. Below are the results from sieve analysis and pebble morphometry.

Table 2: Cumulative weight data for Samples 1 and 2

Phi	Wt. on sieve	Cumm wt.	Cumm wt. %	Phi	Wt. on sieve	Cumm wt.	Cumm wt. %
-0.5	0.8	0.8	1.6	-0.5	0.1	0.1	0.2
0.0	1.2	2.0	4.0	0.0	0.65	0.75	1.5
0.7	3.5	5.5	11.0	0.7	5.5	6.25	12.5
1.0	2.0	7.5	15.0	1.0	4.15	10.4	20.8
1.7	1.75	15.25	30.5	1.7	21.8	32.2	64.4
2.7	28	43.25	86.5	2.7	16.0	48.2	96.4
4.0	6.65	49.9	99.8	4.0	1.7	49.9	99.8
Pan	0.1	50.0	100	Pan	0.1	50.0	100

Table 3: Cumulative weight data for Sample3

Phi	Wt on sieve	Cumm wt	Cumm wt%
-0.5	1	1	2
0.0	3.25	4.25	8.5
0.7	6.0	10.25	20.5
1.0	4.05	14.3	28.6
1.7	15.6	29.9	59.8
2.7	14.85	44.75	89.5
4.0	4.35	49.1	98.2
Pan	0.9	50.0	100



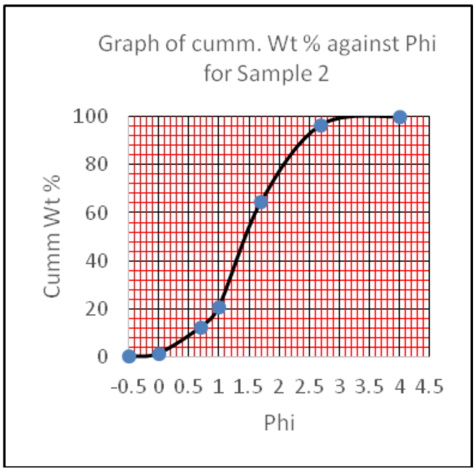


Fig : Cumulative frequency plot of Particle size distribution for samples 1 and 2

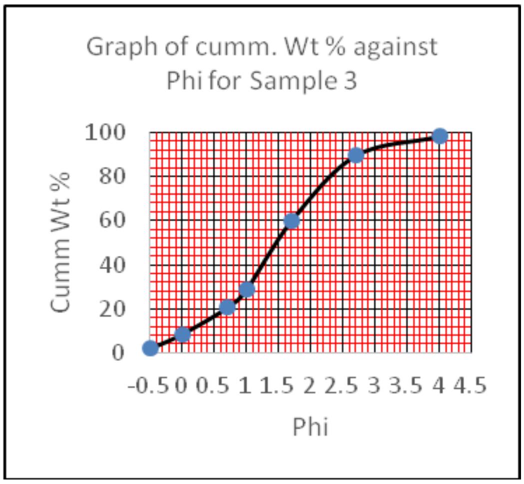


Fig : Cumulative frequency plot of Particle size distribution for sample 3

Based on the plots of cumulative weight percent data against grain size on both log probability scale, statistical sediment parameters were obtained (Table).

Table 4: The Computed grain size parameters derived from Cumulative frequency plots (Ogive)

Sample NO.	MEAN SIZE (M_z)		SORTING (σ_1)		SKEWNESS (Ski)		KURTOSIS (K_G)	
	M_z	Verbal term	(σ_1)	Verbal term	(Ski)	Verbal term	(K_G)	Verbal term
1.	1.87	Medium Sand	1.48	Poorly Sorted	-0.158	Negatively Skewed	1.243	Leptokurtic
2.	1.48	Medium Sand	1.2	Poorly Sorted	0.113	Positively Skewed	1.281	Leptokurtic
3.	1.42	Medium Sand	1.05	Poorly Sorted	-0.102	Negatively Skewed	1.230	Leptokurtic

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4.1 Environmental Indications

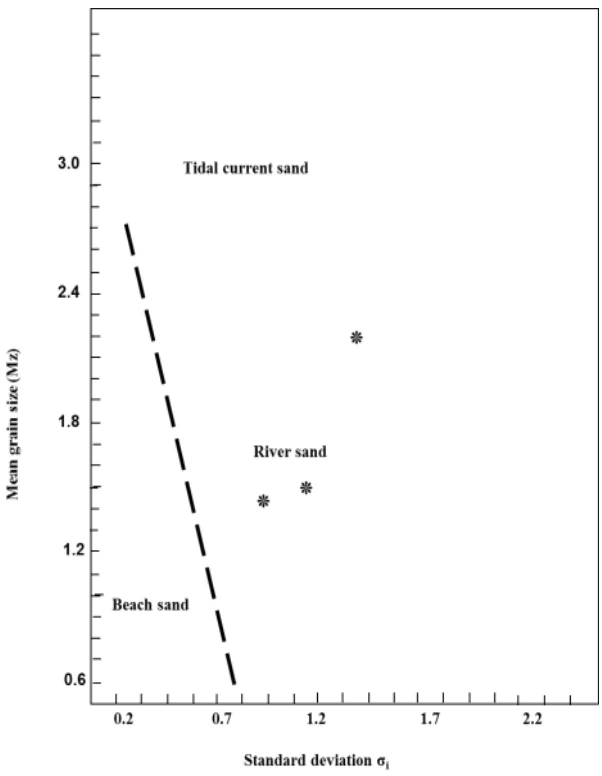
Univariate parameters: Extraction of information pertaining to depositional processes from grain-size data is not new. The method have been reviewed by Passega (1957); Stewart (1958); Mason and Folk (1958); Friedman (1961, 1967); Klovan (1966); Moiola and Weiser (1968); Amaral and Pryor (1977); Cant (1982).

The observed coarsening-upward trends from outcrop 6 is interpreted as reflecting progressive shallowing of the depositional environment (Reineck and Singh, 1975), and associated winnowing action of current. The dominance of medium grain-size suggests moderate hydraulic energy. The finning-upward motif shown by the samples is attributable to fluvial processes, and probably may be the result of lateral migration of fluvial channels (Pettijohn 1975, p.551). The observed abrupt variation in mean size may be related to rapid changes in hydraulic energy commonly associated with tidal action (Valai and Cameron, 1977; Obi, 1998). Fluctuation from moderately sorted to well sorted sands can be attributed to differences in water turbulence, and variability in otherwise generally smooth, stable current velocity (Amaral and Pryor 1977, p.49).

Trends in skewness are also significant. Duane (1964) demonstrated that the winnowing action of waves and tidal currents produces coarsely skewed (i.e. negatively skewed) sands in the littoral and tidal inlet environments. In sheltered, quiet water areas, and in deep water, where bottom currents or wave-base surge does not disturb bottom sediments, the skewness of sand is fine.

Indications from Bivariate plots:

Bivariate plots have also been found useful in differentiating adjacent environments. A plot of skewness against standard deviation differentiates river and beach sands whereas plots of mean-size against standard deviation distinguish between river and beach sands. The best separation is achieved using a combination of standard deviation and skewness. These shows that beach sand are usually well sorted and negatively skewed, whereas river sands also exhibit positive skewness but are finer than beach sands.



Cross plot of mean size against standard deviation(After Lui and Xia, 1989) for sand samples from the study area

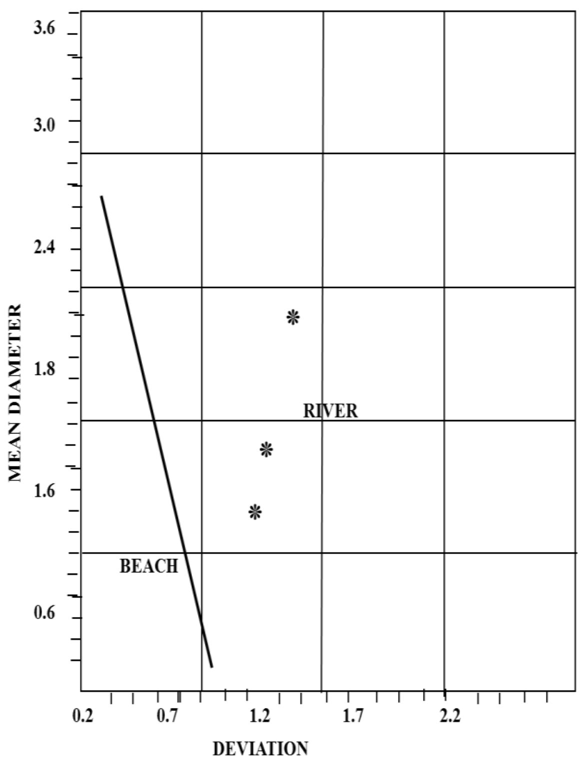


Fig. 4.6 Plot of mean size against standard deviation for sand-size particles of the study area (After Moiola and Weiser, 1968)

Figure : The plot of mean size against standard deviation

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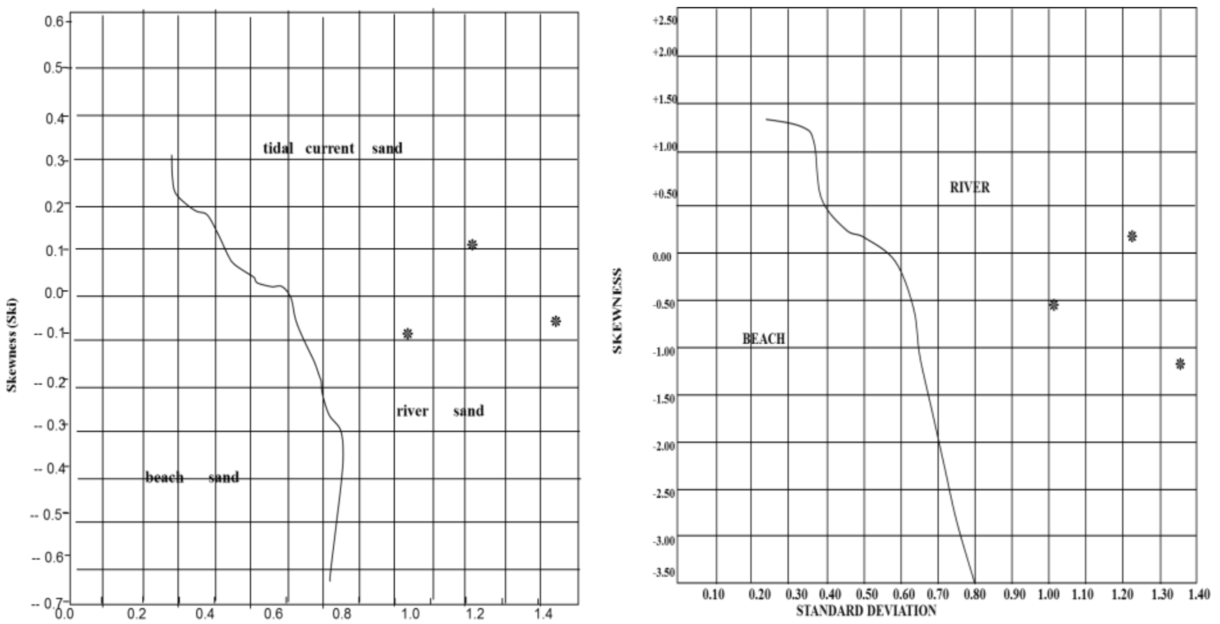

Cross plot of skewness against standard deviation (After Lui and Xia, 1989)

Fig.4.5.-Plot of skewness against standard deviation to distinguish between adjacent environments in the study area (After Friedman, 1961)

Figure: The plot of skewness against standard deviation

Indications from Multivariate Analysis

Several discriminant functions have been established by multivariate analysis in order to distinguish between adjacent mechanisms and environments having closely similar energy conditions. It is possible to distinguish between Aeolian, marine, fluvial and turbidity current mechanisms and between littoral and shallow agitated water environments within the spectrum of marine depositional processes. Some of the functions are as follows.

i. Y beach: shallow marine = $15.6534M_z + 65.7091\sigma^2 + 18.1071Ski + 18.5043K_G$. Y less than 65.3650 would indicate beach deposition and Y greater than 65.3650 indicates shallow marine deposition.

ii. Y shallow marine: fluvial = $0.2852M_Z - 8.7604\sigma^2 - 4.8932Ski + 0.0482K_G$ Y less than – 7.419 would indicate fluvial deposition and Y greater than – 7.419 indicates shallow marine deposition.

Table 5: Indication from Multivariate Analysis (Ogive)

Sample no.	Y beach: Shallow marine	Y shallow marine: Fluvial
1.	193.34 Shallow marine	-17.95 Fluvial
2.	143.54 Shallow marine	-12.81 Fluvial
3.	115.58 Shallow marine	-8.81 Fluvial

Table 6: The pebble result

S/ NO.	L (cm)	I (cm)	S (cm)	MPS	OPI	FLATNESS INDEX	S/L	I/L	(L-I)/(L-S)	Roundness
	3.98	2.17	2.75	0.95669652	1.40609017	69.0954774	0.69095477	0.54522613	1.47154472	0.97
	3.9	1.75	2.7	0.82221353	1.86574074	69.2307692	0.69230769	0.44871795	1.79166667	0.78
	3.7	1.86	2.54	0.978703	1.58226989	68.6486486	0.68648649	0.5027027	1.5862069	0.77
	3.94	2.1	2.63	0.94203129	1.35515049	66.751269	0.66751269	0.53299492	1.40458015	0.89
	3.47	2.03	3	0.8510642	2.96549645	86.4553314	0.86455331	0.58501441	3.06382979	0.98
	4.35	1.54	3.11	0.93023894	2.4703091	71.4942529	0.71494253	0.35402299	2.26612903	0.96
	3.67	1.52	1.86	0.85278341	1.35720014	50.6811989	0.50681199	0.41416894	1.1878453	0.78
	2.65	1.65	2.5	0.82646249	2.53666667	94.3396226	0.94339623	0.62264151	6.66666667	0.89
	3.2	1.37	2.9	0.94253458	2.17931034	90.625	0.90625	0.428125	6.1	0.98

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	2.3	1.14	2.1	0.98923761	2.8047619	91.3043478	0.91304348	0.49565217	5.8	0.99
	2.3	1.57	1.7	0.92844629	0.96960784	73.9130435	0.73913043	0.6826087	1.21666667	0.87
	3.5	1.49	2.9	0.87268282	2.43965517	82.8571429	0.82857143	0.42571429	3.35	0.77
	5	2.13	3.13	0.97255243	1.65297022	62.6	0.626	0.426	1.53475936	0.76
	3.6	1.65	2	0.87651196	1.29375	55.5555556	0.55555556	0.45833333	1.21875	0.75
	2.8	1.31	2.4	0.81623343	2.7625	85.7142857	0.85714286	0.46785714	3.725	0.70
	3.03	1.33	2.37	0.91703678	2.65381665	78.2178218	0.78217822	0.43894389	2.57575758	0.83
	2.9	2	2.1	0.91271853	0.86309524	72.4137931	0.72413793	0.68965517	1.125	0.84
	2.71	1.72	2.23	0.92181121	1.89882287	82.2878229	0.82287823	0.63468635	2.0625	0.98
	2.68	1.27	1.5	0.87112672	1.24158192	55.9701493	0.55970149	0.4738806	1.19491525	0.97
	3.5	1.53	2.55	0.96685884	2.15995872	72.8571429	0.72857143	0.43714286	2.07368421	0.87
	3.66	1.46	2.98	0.98449399	2.35945519	81.420765	0.81420765	0.3989071	3.23529412	0.98
	2.95	1.67	2.23	0.90312968	1.69033383	75.5932203	0.7559322	0.56610169	1.77777778	0.87
	4.4	1.25	3.28	0.85062853	2.10213415	74.5454545	0.74545455	0.28409091	2.8125	0.80
	3.2	1.2	1.73	0.92028073	1.59175809	54.0625	0.540625	0.375	1.36054422	0.88
	3.75	1.8	2.5	0.97467258	1.59	66.6666667	0.66666667	0.48	1.56	0.88
	3.3	1.4	2.54	0.81774264	2.5984252	76.969697	0.76969697	0.42424242	2.5	0.90
	2.63	1.5	2.16	0.95751572	2.31860717	82.1292776	0.82129278	0.57034221	2.40425532	0.94
	4.78	1.93	2.9	0.96962454	1.67457814	60.6694561	0.60669456	0.40376569	1.51595745	0.77
	2.67	1.31	2.6	0.94562709	1.4381868	97.3782772	0.97378277	0.4906367	19.4285714	0.76
	3.23	1.7	2.3	0.98764623	1.60820477	71.2074303	0.7120743	0.52631579	1.64516129	0.78
	3.83	1.6	2.63	0.84119222	1.9781052	68.6684073	0.68668407	0.41775457	1.85833333	0.79
	4.25	1.72	3.1	0.99547382	2.33064516	72.9411765	0.72941176	0.40470588	2.2	0.66
	3.1	1.74	2.53	0.85870923	2.3108661	81.6129032	0.81612903	0.56129032	2.38596491	0.87
	2.6	2.02	2.5	0.85970528	2.512	96.1538462	0.96153846	0.77692308	5.8	0.78
	3.87	1.6	2.23	0.92952183	1.53437056	57.622739	0.57622739	0.41343669	1.38414634	0.98
	3.5	1.6	2.31	0.98403824	1.66157372	66	0.66	0.45714286	1.59663866	0.87
	3.9	1.5	3	0.85441567	2.81666667	76.9230769	0.76923077	0.38461538	2.66666667	0.77
	3.7	1.55	2.36	0.99029259	1.73159626	63.7837838	0.63783784	0.41891892	1.60447761	0.76
	3.85	2.25	3.7	0.86480547	1.5788288	96.1038961	0.96103896	0.58441558	10.6666667	0.66
	3	1.1	2	0.86622456	2.1	66.6666667	0.66666667	0.36666667	1.9	0.87
	3.2	2	2.49	0.98947822	1.52949827	77.8125	0.778125	0.625	1.69014085	0.87
	3.4	1.5	2.5	0.97013018	2.19111111	73.5294118	0.73529412	0.44117647	2.11111111	0.90
	3.44	2	3.15	0.82982424	2.87662835	91.5697674	0.91569767	0.58139535	4.96551724	0.78
	3.04	1.5	2	0.95726398	1.49076923	65.7894737	0.65789474	0.49342105	1.48076923	0.77
	2.9	1.2	1.8	0.97646179	1.68434343	62.0689655	0.62068966	0.4137931	1.54545455	0.87
	3.2	1.94	2.66	0.84456913	2.20551378	83.125	0.83125	0.60625	2.33333333	0.76
	2.8	1.6	1.7	0.86405213	0.97326203	60.7142857	0.60714286	0.57142857	1.09090909	0.75
	3.42	1.5	2.12	0.95686672	1.57597968	61.9883041	0.61988304	0.43859649	1.47692308	0.77
	2.07	1.33	1.64	0.99225182	1.54105218	79.2270531	0.79227053	0.64251208	1.72093023	0.76
	2.4	1.1	1.9	0.9994406	2.65263158	79.1666667	0.79166667	0.45833333	2.6	0.70
Total				45.8839771	96.70588394	3703.124239				

Environmental Indications:

Univariate pebble parameters: Table (xx) shows the critical values for pebble form indices as established by previous workers for fluvial and surf processes. Several workers have demonstrated the usefulness of pebble form indices in paleo-environmental interpretation.

Table 7: Limits of form indices for fluvial and surf processes

Indices	Fluvial	Surf	Reference
MPS	More than 0.65	Less than 0.65	Dobkins and Folk (1970
OPI	More than –1.5	Less than –1.5	Dobkins & Folk (1970)
FI	More than 45%	Less than 45%	Stratten (1974)

From the table above it can be delineated that the Maximum projection sphericity of pebbles is greater than 0.65 its implication is that they were deposited in Fluvial dominated environment. Also oblate prolate index values are greater than -1.5 which also indicates a fluvial environment. The flatness index also greater than 45% which also shows that it is fluvial deposit. The environment of deposition could be of a rapid sedimentation and a high energy environment.

Indication from Bivariate plot

Discrimination of environments using bivariate plots of pebble indices has been employed on ancient and recent gravel deposits with much success (Luttig, 1962; Sames 1966; Dobkins and Folk, 1970; Stratten, 1974; Els, 1988; Obi, 1996). Plots of MPS vs OPI, and FI vs MPS are commonly used to discriminate fluvial and beach processes. The plot of sphericity against oblate prolate index by dobkins and folks (1970) suggest that the study area were formed mainly in fluvial setting.

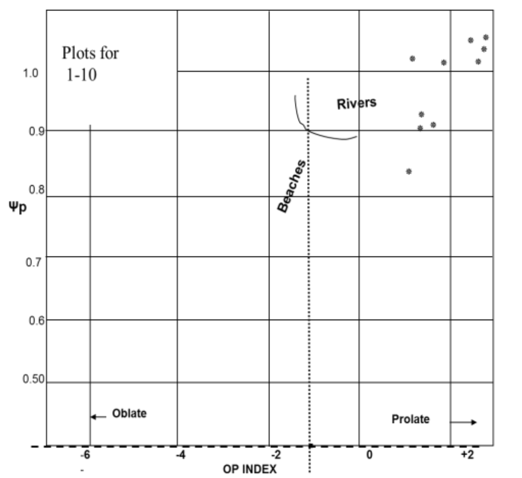

Fig: 4.7 A plot of ***Sphericity*** against Oblate ***Prolate Index*** for pebbles of the study area. Each point is the average of ten pebbles (After Dobkins and Folk, 1970)

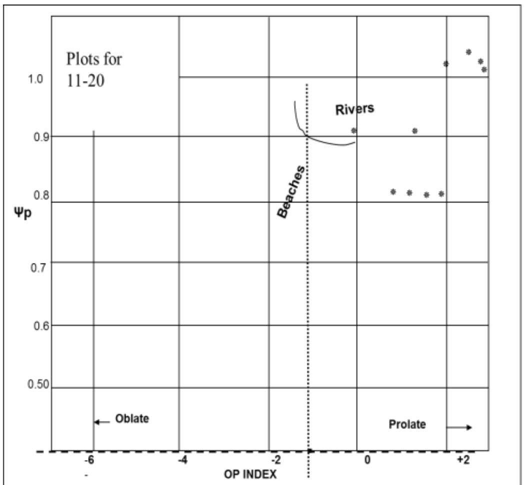

Fig: 4.8 A plot of ***Sphericity*** against Oblate ***Prolate Index*** for pebbles of the study area. Each point is the average of ten pebbles (After Dobkins and Folk, 1970)

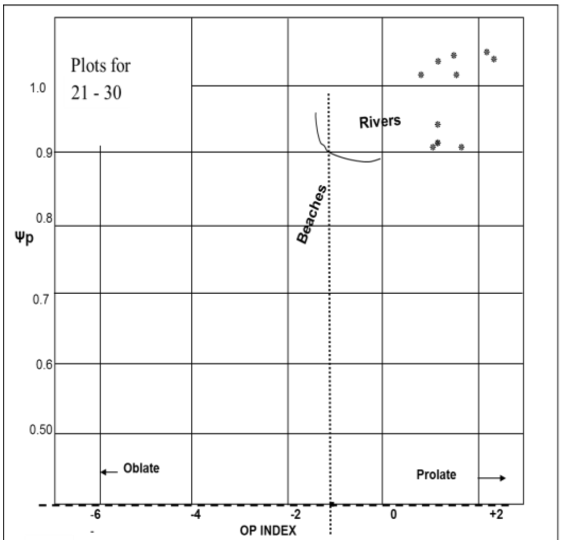

Fig 4.9 A plot of ***Sphericity*** against Oblate ***Prolate Index*** for pebbles of the study area. Each point is the average of ten pebbles (After Dobkins and Folk, 1970)

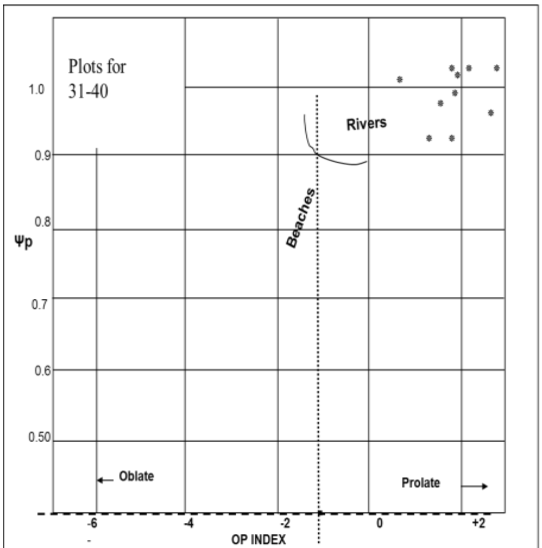

Fig. 4.10 A plot of ***Sphericity*** against Oblate ***Prolate Index*** for pebbles of the study area. Each point is the average of ten pebbles (After Dobkins and Folk, 1970)

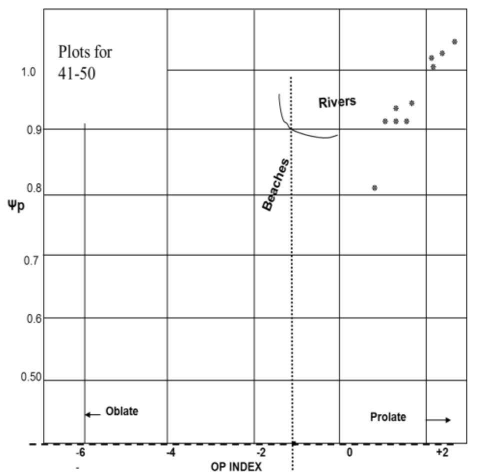

Fig 4.11 A plot of *Sphericity* against Oblate *Prolate Index* for pebbles of the study area. Each point is the average of ten pebbles (After Dobkins and Folk, 1970)

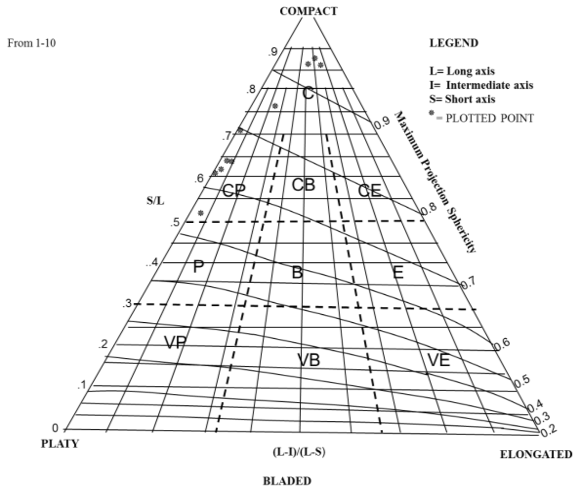

Fig. 4.12 Sphericity-form diagram for pebble shapes in the study area

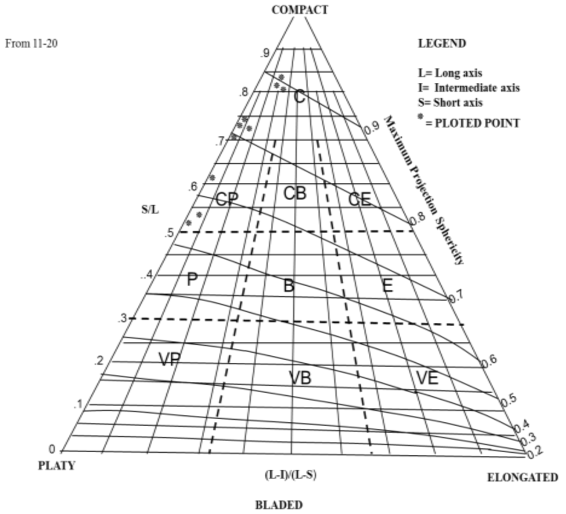

Fig. 4.13 Sphericity-form diagram for pebble shapes in the study area

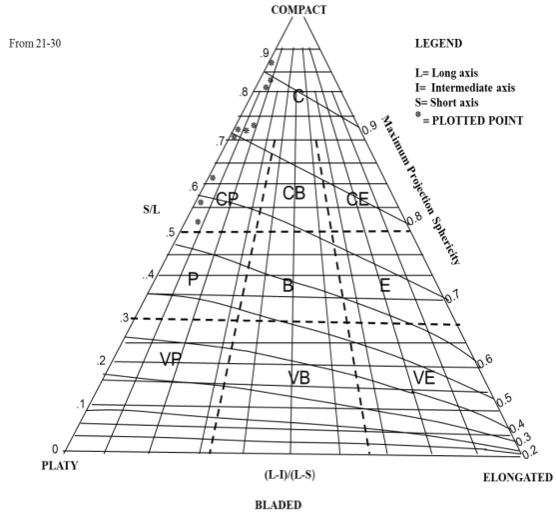

Fig. 4.14 Sphericity-form diagram for pebble shapes in the study area

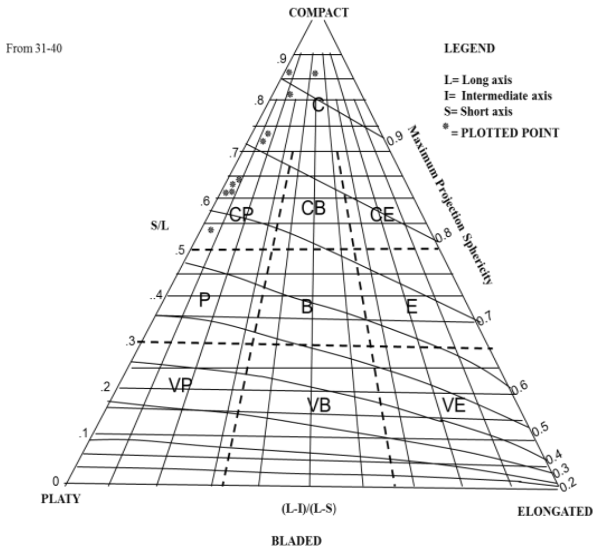

Fig. 4.15 Sphericity-form diagram for pebble shapes in the study area

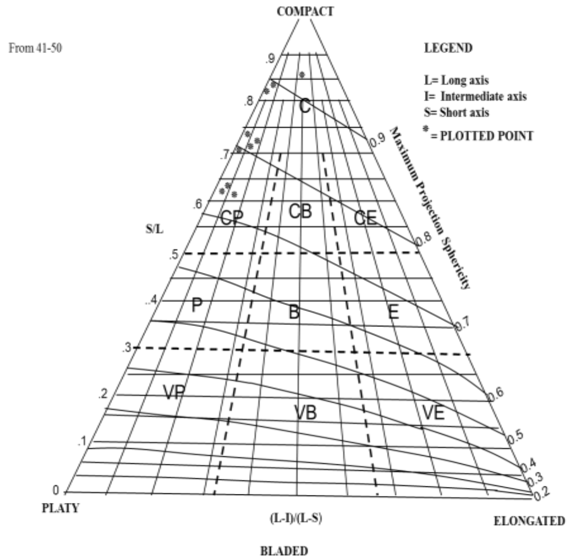

Fig. 4.16 Sphericity-form diagram for pebble shapes in the study area

Pebble form

Certain form classes (Sneed and Folk, 1958) are known to occur much more frequently in one environment than they do in another. For example the three shape classes known to be most diagnostic of beach action are the *Platy*, *Very Platy*, and *Very Bladed*, whereas forms most diagnostic of river action are the *Compact*, *Compact Bladed*, and *Compact*

Elongate (Dobkins and Folk, 1970). Therefore it can be inferred that the pebbles picked in **outcrop 7** and **8** are of river action.

5. CONCLUSION

Detailed field descriptions and stratigraphic analysis have provided basis for the depositional interpretation of the sedimentary rocks outcropping in Ajaka area of Kogi State.

Stratigraphic correlation of outcrop reveals two (2) major lithofacies which are The Massive Sandstone lithofacies and The Conglomerate lithofacies. The conglomerate is further divided into two facies which are the Paraconglomerate and the Orthoconglomerate.

The paraconglomerate consists of matrix-supported, which ranges from 1.2 meters to 3 meters thick. Clasts range from 0.5cm to 2cm in diameter. They are subrounded to rounded and poorly sorted. The paraconglomerate is interpreted as debris flow mode of origin based on the coarseness of the paraconglomerate facies, its poor sorting and absence of stratification and lack of fossil. The absence of preferred fabric means that the clasts were restricted in movement relative to each other.

The orthoconglomerate facies consists of clast supported, but have presence of little clayey sand separating the two clast. The clast ranges from 0.4cm to 8cm in diameter and has the thickness of 1.28m-2.5m. It is subrounded to rounded, poorly sorted and contain quartz and feldspar. The orthoconglomerate can be interpreted based the presence of framework support which may be due to the rolling and accretion of clast along a bed. The matrix of very coarse sandstone is thought to have been transported in suspension simultaneously with bed-load rolling of the large clasts. The essentially unstratified nature of the conglomerate or paucity of imbricated fabric indicate that bed load rolling of clasts is in equilibrium with ambient flow condition was limited.

The graded bedding of this facies indicates deposition from a single current as the energy and flow strength diminished. The presence of plant fragment was deposited following a flash flood which carries different kind of sediment, which made the conglomerate to be poorly graded.

Indication from pebble Analysis shows that the pebbles of the study area were essentially shaped by fluvial process. Evaluation of sand-size particles indicates that the Sandstone is largely fluvial deposits, probably the result of lateral migration of fluvial channels.

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