STRATIGRAPHY OF BIDA FORMATION, BIDA BASIN, NIGERIA

E.A. OKOSUN[1], A. I, GORO[2], S. B. OLOBANIYI[3], P.D. SHEKWOLO[4], & J.E. NWOSU[5]
[1,2&5]*Department of Geology, Federal University of Technology, Minna, Nigeria*
[3]*Department of Geology, Delta State University, Abraka, Nigeria*
[4]*Shell Petroleum Development Company (SPDC), Port-Harcourt, Nigeria*

ABSTRACT

Outcrop and subsurface analysis of the sediments of Bida Formation based on inferred environment of deposition allowed the definition of five facies (1) aluvian fan facies which dominate in the northern part of the basin and consists of conglomerates and sandstones of debris flow and flood plains; (2) lacustrine facies characterized by siltstones, sandy mudstones, silty mudstones and mudstones. (3) fluvial facies recognized by their basal conglomerates, coarse-grained channel sandstones and fine to medium grained bar top sandstones organized in to series of fining upward successions. (4) flood plain facies with horizontally laminated fine-grained sandstones, siltstones and mudstones and (5) mire facies characterized by peat/lignite beds. Some of these lithofacies are being recognized in the Formation for the first time. It is also demonstrated that the alluvial fan facies represent the proximal element while the medial element is characterized by braided and meandering river deposits and the lacustrine deposits form the bulk of the distal fan element of the fluvial Bida Formation. Palynoflora studies suggest that sedimentation ensued in the basin probably before the Campanian due to the presence of Classopollis-Circulina.

INTRODUCTION

Several papers have been published by geologists over the decades on continental environments. Deposits within continental environments are usually recognized by their lack of marine fossils and the predominance of siliclastic rocks (Boggs 1995). Taken as a whole the abundance of continental deposits is less compared to marine and marginal marine deposits in the geological record but they form the bulk of the Bida Formation.

The stratigraphy of Bida Basin has been described by several workers. Most of the work prior to the work of Adeleye and Dessauvagie (1972) assigned different names to the sedimentary fill of Bida basin. Falconer (1911) referred to the sandstones, grits, conglomerate and ironstones of the Bida as Lokoja series. These sediments were also referred to as Nupe Sandstones for all sediments outcropping between Lake Kainji and Lokoja-Basange beds (Russ 1930, Tattam 1944). Adeleye and Dessauvagie (1972) identified four lithostratigraphical units and named them from the base as Bida Sandstones Formation; Sakpe Ironstones Formation; Enagi Siltstones Formation and Batati Ironstones Formation (Fig.2)

1. The Bida Formation – directly overlies the basements complex rocks and consists of rounded to sub-rounded coarse conglomerates, clay-sandstones admixture and cross stratified sandstones with locally scattered pebbles, cobbles and boulders (Adeleye; 1973). The Bida Formation was considered as lateral equivalent of Lokoja Formation.

2. Sakpe Formation - overlying the Bida formation and consists of geothitic, oolitic and pisolitic ironstones of about 5m maximum thickness (Adeleye 1973).

3. Enagi Formation – laminated to thinly laminated or massive siltstones. The sediments are called Patti Formation at the southern part of the basin.

4. Batati Formation – generally massive with occasional thin to thick, flat bedding. They are predominantly oolitic with ferruginous mudstones, sandstones and shelly beds (Adeleye, 1973).

The aim of this paper is to present a synthesis of the main results of detailed facies analysis of the Bida Formation based on examination of subsurface data from shallow water boreholes covering large part of the basin, field outcrop data from selected, sedimentological data using sieve analysis and review of either works.

GEOLOGICAL SETTING

The Bida basin (variously called Nupe Basin or Middle Niger basin) is a gently down warped trough situated between Sokoto and Anambra basins (Fig. 1). The origin of the basin as proposed by Whiteman (1982) is a simple cratonic sag based on field relationship and lack of fault scarp. He however, did not rule out the possibility of a rift origin based on the gravity an aeromagnetic data. Adeniyi (1984) suggested a rift origin. Braide (1990) viewed the Bida basin as a pull-apart structure (strike-slib basin) which had undergone phases of transtension and basin in filling but little internal deformation due to reactivation of basement faults (Zaborski, et al. 1998). Recently the Bida basin is believed to be part of the Western Central African Rift System, which was initiated by the breakup of the Gondwanaland in the Early Cretaceous (Genik, 1992). According to Whiteman (1982) "Gravity measurements (Ojo and Ajakaiye 1976) indicate that the basin fill exceeds 900m but is probably less than 2000m" but more recently, spectral determination of depth to buried magnetic rocks under the basin indicated two areas with thicknesses up to 4.7km (Udensi & Osazuwa 2004).

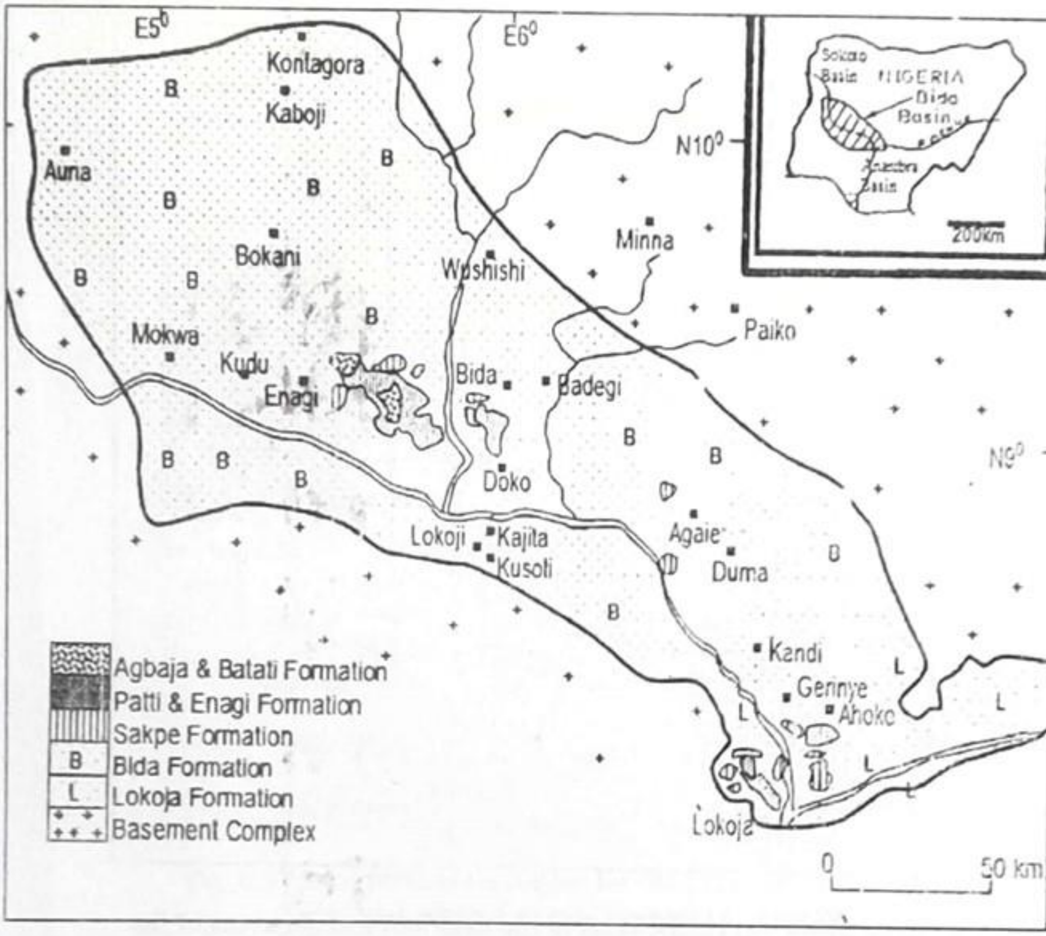

Fig.1: Simplified Geological Map of Bida Basin (Modified From Adeleye, 1976) Showing Location of Outcrops and Shallow Water Boreholes.

METHODOLOGY

A reconnaissance survey covering the entire basin was carried out. Available good exposures of Bida Formation were logged. Also logged were shallow water boreholes covering large part of the basin from northwest to southeast in order to reveal the sub-surface lithology of Bida formation (Fig 2). Sediment samples were collected and processed for grain size distribution analysis, and petrographic studies.

FACIES ANALYSIS

Five main interpretative facies can be recognized within the Bida Formation outcrops based on the environment of deposition: (1) Alluvial fan (2) Lacustrine (3) Fluvial channel (4) Flood plain and (5) Mire.

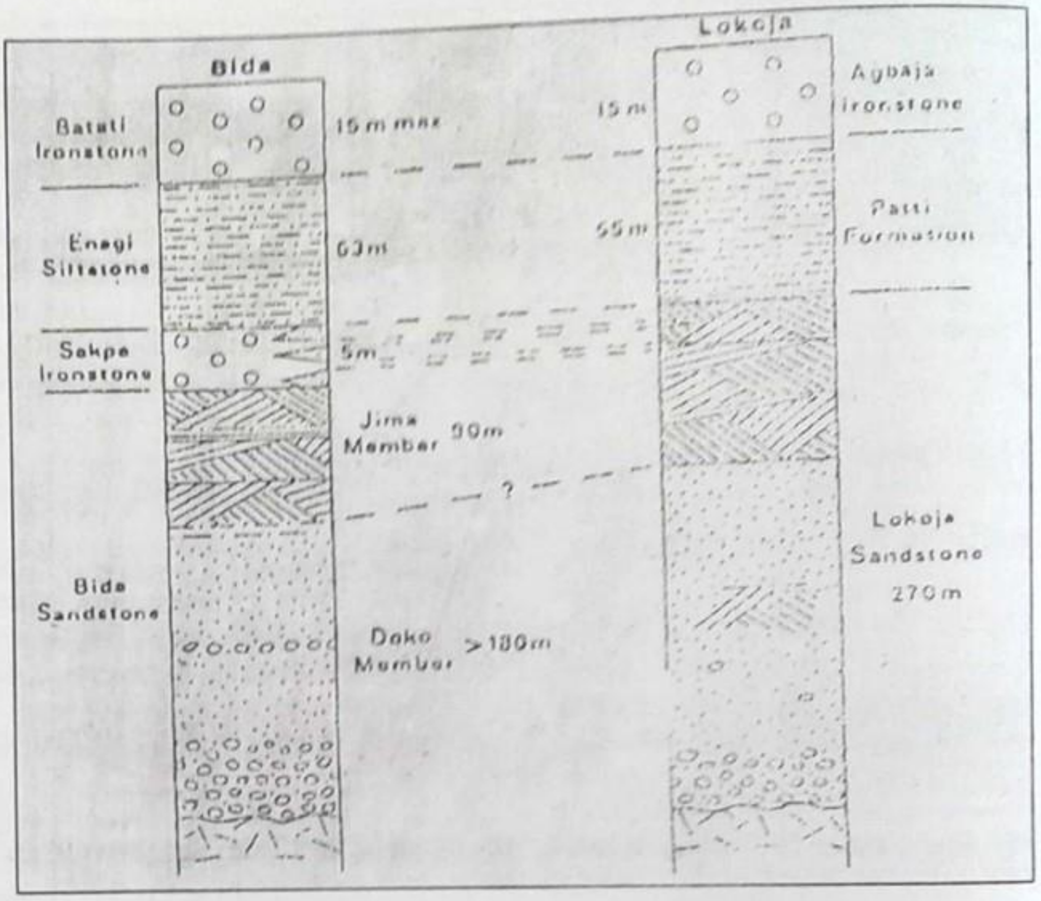

Fig.2: Lithostratigraphical subdivisions in the Bida and Lokoja areas of the Bida Basin; not to scale, thickness as indicated (after Adeleye, 1973) Adapted from Zaborsky, 1998).

Alluvial Fan Facies

The Alluvial fan facies comprise the lowermost and coarsest representative of the Bida formation. Outcrops of this facies are found at the northern parts of the basin. Conglomerates, breccias and sandstones make up this facies.

Conglomerates and Breccias – The conglomerates are found either directly overlying the basement complex records or forming the basal parts of sandstone units. The conglomerates directly overlying the basement complex rocks consist of massive, poorly sorted sub-angular to sub-rounded, matrix-supported (clast-supported in some places) basal conglomerates and breccias with clasts up to cobble size (Fig. 3). The clasts are extraformational quartz and the matrix is composed of fine to coarse-grained sands with clays and ironstones. Minor friable sandstone interbeds are common. The basal units are interpreted as debris flow deposits (Nemec & Steel, 1988) while the interbedded sands may be interpreted as flood plain/soil deposits. The second category of conglomerates that form basal parts to pebbly sandstones may represent channel lag units associated with stream floods (Fig 3).

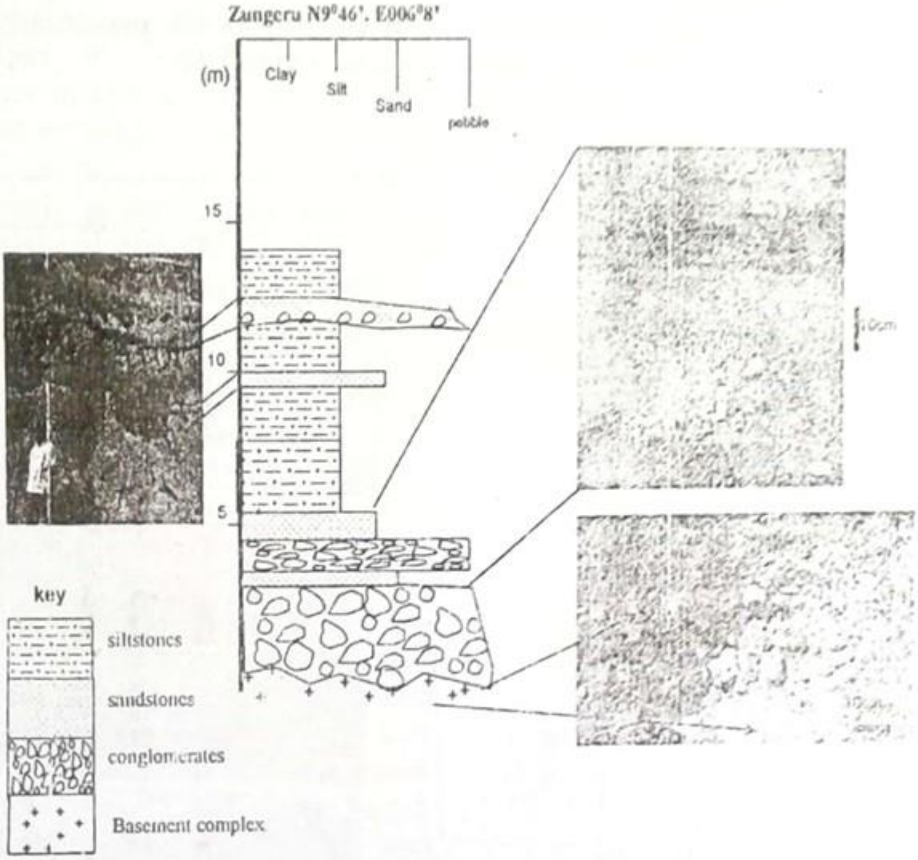

Fig.3: Typical vertical succession for the proximal alluvial fan Bida Formation along a stream channel in Zungeru.

Sandstones – sandstones consist of thin (less than 1m) laterally continuous, pebbly, medium to coarse-grained sandstones, and moderately well sorted fine to medium-grained sandstones. The pebbly sandstones have well developed basal conglomerates overlying erosional base. They probably represent stream flood deposits, which are usually confined to channels (Fig 3).

Lacustrine Facies

Siltstones, sandy and silty mudstones make the bulk of the lacustrine facies. They occur interbedded with the alluvial fans in the north (Fig. 3) and predominate at the southern part of the basin (Fig 6).

Siltstones – occur as laterally extensive beds capped by sandstone units in the north and interbeded with sandstones and mudstones towards basin centre. Braide, (1992) described and interpreted similar beds as lacustrine deposits.

Mudstones – they generally increase in thickness from north to south and usually interbeded with sandstones, siltstones and mire facies (Fig 6). Sandy and silty mudstones are distinguished.

Fluvial Channel Facies

The Fluvial channel facies is composed of conglomerates, coarse-grained sandstones (pebbly), coarse-grained sandstones and medium-grained sandstones organized into fining upwards cycle (Fig 3 & 4).

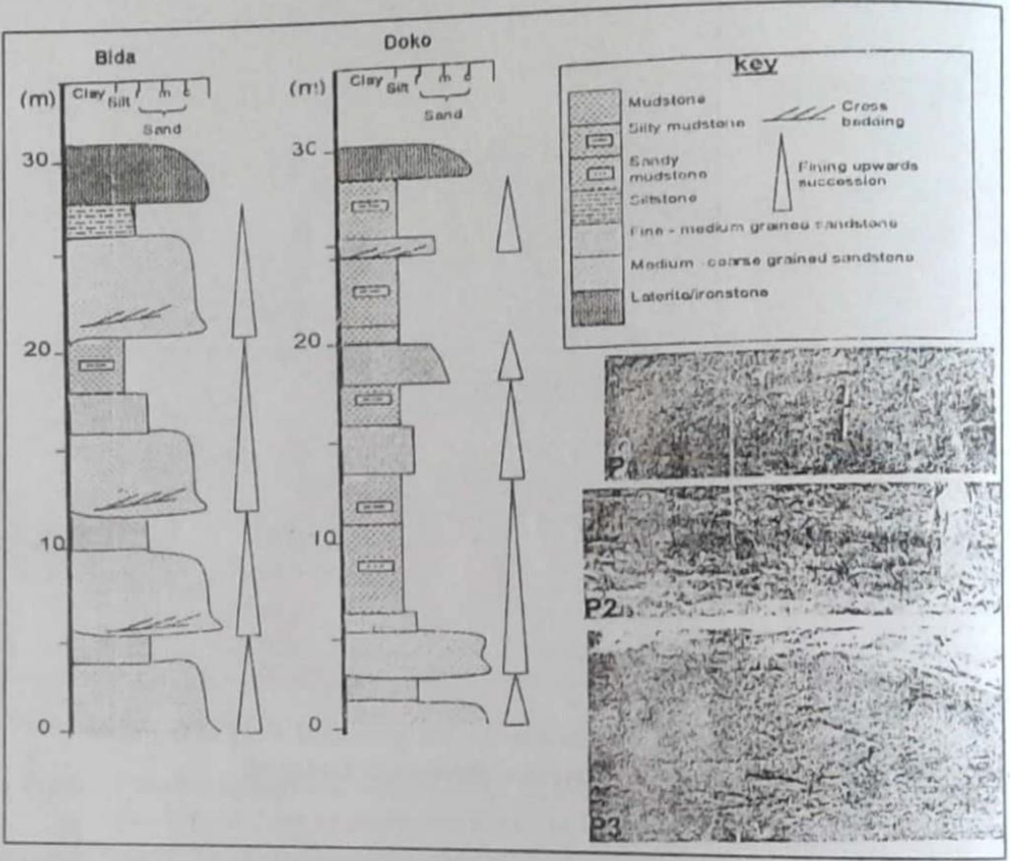

Fig.4: Sedimentary section of Bida Formation around Bida and Doko showing erosive based fining upwards cycle. P1, P2 & P3 are pictures from Doko (N8o56' E5o57') of flood plain mudstones, fine and medium-grained bar top sandstones and cross-bedded coarse grained, pebbly channel bar deposits respectively.

Conglomerates – The conglomerates occur at the basal part of the fining upward successions usually 20-50cm thick. They are yellowish, often poorly sorted, massive to crudely horizontally stratified and usually overlying low relief erosion surface (Fig 5). They have a pebbly, coarse to medium-grained sandstone matrix and may be clast or matrix supported and show rare imbrications. The sediments are extra formational in origin with average mineralogical composition of 70% quartz, 28% feldspar and 1% rock fragment. The dominant feldspar is plagioclase of andesine-oligoclase composition. Microcline is subordinate in occurrence. Rock fragments measure up to 20cm in diameter. The conglomerates ~~represent~~ usually grade upwards into pebbly, coarse-grained sandstones. The

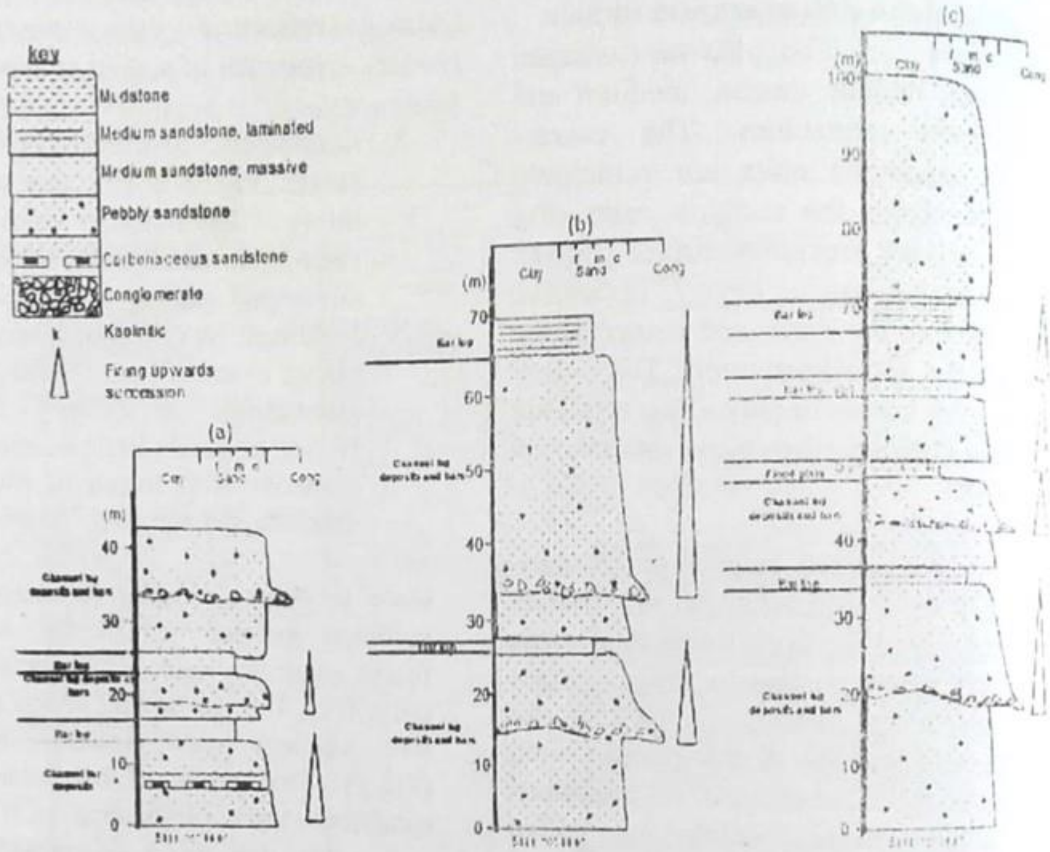

Fig.5: Sedimentary sections of Bida Formation showing typical erosive-based fining upwards cycles with well developed basal conglomerates. (a) 2km southwest of Kajita (b). 2km east of Lokoji (c). 2.5km northeast of Kusoti.

Floodplain Facies

The flood plain facies consists of fine-grained sandstones, siltstones and mudstones with sheet like geometries.

Fine-grained sandstones and siltstones

Fine-grained sandstones and siltstones are commonly found as discontinuous beds within the mudstones (Fig 4b). They consist of white grey; arkosic to subarkosic often massively bedded sandstones with thicknesses between 0.8 and 1m. Quartz grains dominate the framework, the feldspars consist of microcline and plagioclase of andesine to oligoclase composition. The matrix is clay. Hematite and ilmenite are th dominant heavy minerals with mino amount of zircon.

Mudstones - The mudstone beds appe massive or sometimes horizontall laminated with colours ranging fro white to grey to dark grey; they exhib sharp contacts with adjacent lithologie and show normal grading from sand mudstones to silty mudstone an sometimes to mudstone proper. Rootle and biogenic structures are often presen the rootlet are more common in the les sandy ones (silty mudstones an mudstones).

Sand grains are predominantly quartz with minor feldspar. Pyrite is of common occurrence in the carbonaceous mudstones. Heavy minerals are mainly hematite with subordinate zircon and topaz.

The fine-grained sandstones and siltstone beds record flood plain sedimentation resulting from overbank flood events (McKee, Crosby and Berryhill, 1967) and the mudstones represent quieter water conditions of suspended sediment fallout from a standing body of water following flooding event (Julie and Adrian, 1993).

Mire facies

This comprise brown to black, peat and lignite beds not exceeding 0.4m. They are found interbedded with siltstones and mudstones (Fig 6).

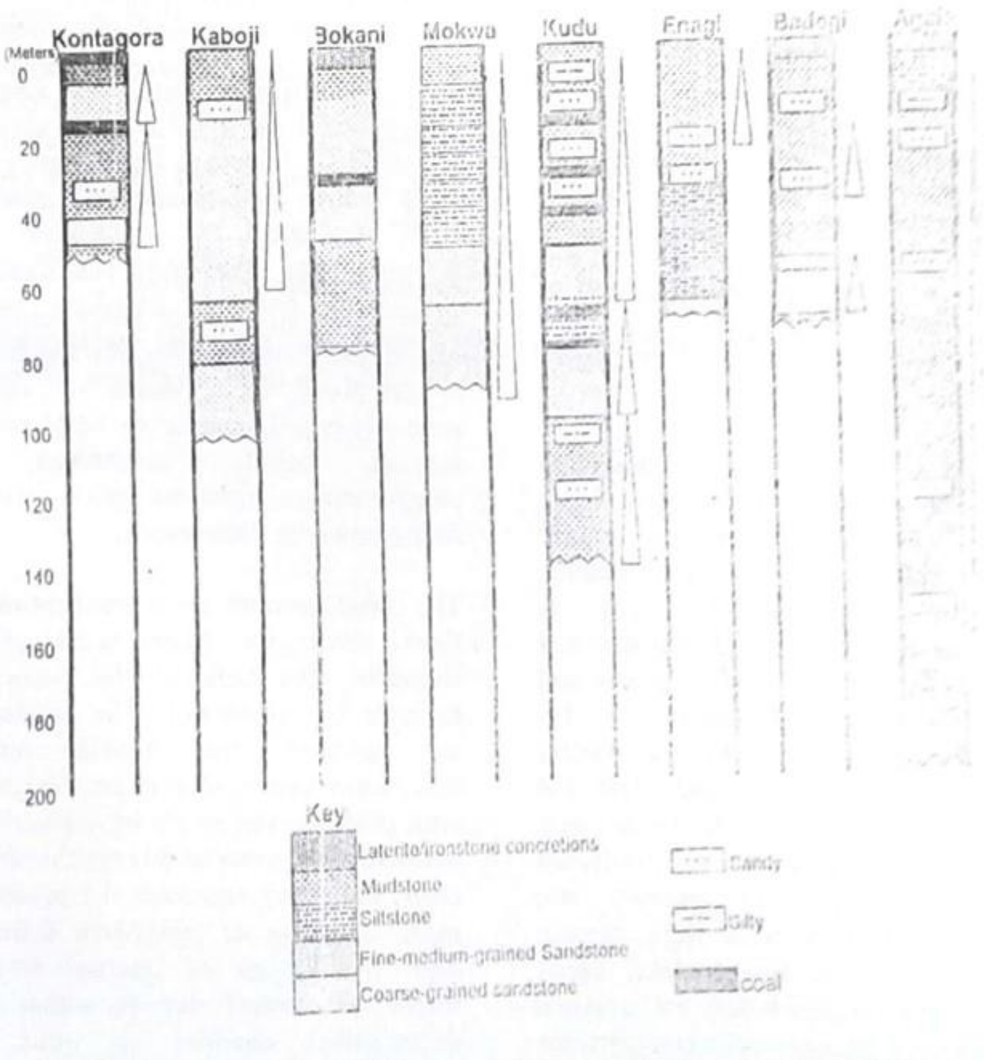

Fig.6: Vertical profile of Bida Formation from Shallow water Boreholes

Laterites and oolitic beds are common in Bida Formation. They are randomly distributed (not restricted to any of the facies) occurring in form of rubbles, boulders and concretions with matrix made up of limonite and quartz. Wood and clastic grains often constitute the nucleus to the ooliths.

In order to reveal the vertical lithological successions of Bida Formation and how it varies in different parts of the basin, some well exposed sections are described in detail (Fig 3, 4 & 5).

Zungeru (N9°49' E9°43')

A stream channel at Zungeru exposed the contact of the Bida Formation with the underlying basement rocks. A log section (Fig 3) shows many of the typical lithological features of the lower part of Bida Formation. These successions characterize most of the Northern part of the basin.

From the base, overlying the basement rocks are debris flow deposits 3-5m thick, consisting of massive, poorly sorted, sub-angular to sub-rounded, matrix-supported (clast-supported in some places) basal conglomerates and breccias (Fig. 3) with pebble, gravel and cobble sized clasts. Between 0 to 1m from the basement rocks the matrix consists of sands, silts and mud but changes to fine to coarse sands with gravel sized reddish brown ironstones above. They thin out laterally and become interbeded with light brown, friable fine to medium-grained sands (Fig.3). The conglomerates are overlain by 3-5m thick laterally extensive siltstone with 0.5 – 1m sandstone interbeds.

Bida (N9°04' E6°00')

A 30m thick section at Bida comprises series of four erosive-based channel fill units each 6-m thick (Fig.4). Here, the three main lithologies observed are cross-bedded coarse-grained sandstones, fine to medium-grained sandstones and siltstones. More than 60% of the section consists of the coarse-grained sandstones. The cross-bedded coarse-grained sandstone units indicate part of a bar within the channel and the cross beds record the migration of in-channel bars. Fine grained sandstones and siltstones units (with sharp contacts) above the cross stratified coarse grained sandstones recorded the presence of fluctuations of flow stage within the channels (Jones, 1955).

Kajita, Lokoji and Kusoti

About 100m of exposed Bida Formation was logged at Kusoti (Fig.5c). the section is composed of a series of stacked erosively-based, coarse to very coarse-grained, pebbly, sandstones and conglomerates organized into a series of fining upwards successions.

The conglomerates are a few centimeters thick above the basal scout of the channels. The bulk of the succession consists of sandstones. The sandstones are massive (no visible internal structures), coarse to very coarse grained with pebbles. The mode of deposition of massive sandstones of this type is still not clear; they may represent the product of rapid dumping of sediments following high flow stage or internal structure might be unseen due to either post-depositional changes or grain size uniformity (Julie & Adrian 1883). The massive sandstones are overlain by laminated fine-grained sandstones and sometimes mudstones.

Subsurface sections

Shallow water boreholes covering most part of the basin (Fig.6) showed all the vertical subsurface lithological succession of the Bida Formation. Some of the boreholes penetrated up to 150m. The lithologies vary from coarse-grained sandstones, fine-medium-grained sandstones, siltstones sandy mudstones, silty mudstones, mudstones and Peat/lignite beds.

Thick siltstones beds forming part of fining upward units are found overlying the sandstones especially at Mokwa and Enagi. The siltstones are usually overlain by mudstones. In Kudu and Bokani, Peat/lignite beds occur interbedded with the siltstones and mudstones. Observations from the first 100m show that the sandstone units dominate in the northern part while to the south around Agaie, the mudstones predominate.

At Tawari (Fig.) in the southern part of the basin, analysis of the interbeded peat/lignite, siltstones and carbonaceous mudstones revealed a diversified palynofora assemblage ranging from good to well preserve. These include pollens of Triorities, Classpollis-Circulina, colonies of Botryococus and isolated Tasamanacea. There are also a few unidentified palynomorphs possibly remnants of Dinoflagellate-cysts (Jardine & Magloire, 1965).

SEDIMENTOLOGY

Grain size analysis of outcrops around Lokoja and Kajita area (Fig. 1,5) provide information about depositional processes and fluid flow conditions during the deposition of the various sandstones of the Bida Formation.

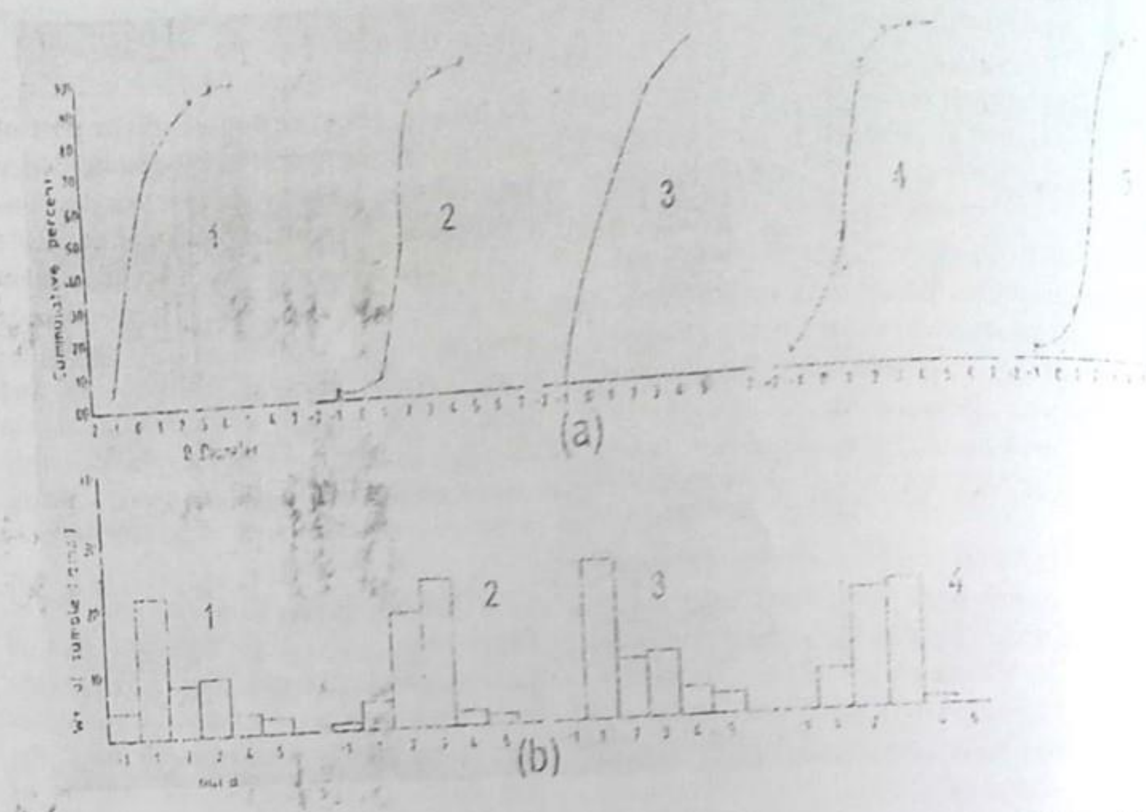

Fig. 7: Plots of Sieve Analysis Results of Bida Formation, Sandstones from Kajita and Lokoji.

a). **Cumulative percentage curves**
1. Coarse to very coarse grained, pebbly sandstones from Kajita
2. Massive medium-grained sandstones from Kajita
3. Coarse grained Carbonaceous sandstones from Kajita
4. Coarse-grained pebbly sandstones from Lokoji
5. Coarse-grained pebbly sandstones from Lokoji

(b) **Histograms of size distribution**
1. Coarse to very coarse-grained, pebbly, sandstones from Kajita
2. Massive medium-grained sandstones from Kajita
3. Coarse-grained carbonaceous sandstones from Kajita
4. Coarse-grained, pebbly, sandstones from Lokoji

Summary of average values of the grain size parameters (Table 1& Fig. 7) shows that all the coarse-grained sandstones are poorly sorted and strongly fine skewed. This is characteristic of river and sand deposits where silt and clay grains were not removed by the currents, but trapped between larger grains (Tucker, 1994). The coarsest-grained sediments are found at the base of the channel and correspond to the period of the highest discharge when the channel is newly formed. The fine and medium grained sandstones are generally moderate to moderately, well-sorted and strongly fine skewed. They may correspond to depositions during periods of waning flow condition on channel bar tops or floodplains.

Table 1: **Summary of grain size parameters for sandstones of Bida Formation at Kajita, Lokoji and Kusoti**

Sandstones	Md	M	So	Sk
Pebbly, Coarse-grained sandstones	0.40	0.65 Coarse Grained	1.30 Poorly sorted	0.52 Strongly fine skewed
Massive, Coarse grained sandstones	0.50	2.30 coarse grained	0.60 Poorly sorted	0.51 strongly fine skewed
Carbonaceous	1.10	1.50 coarse grained	1.35 Very poorly sorted	1.27 strongly fine skewed
Laminated, Medium-grained	2.4	2.30 Fine-medium grained	Moderately well sorted	3.14 Strongly fine skewed
Massive, Medium-grained sandstones	2.05	2.05 fine-medium grained	0.81 moderately sorted	2.17 strongly fine skewed
Fine-grained sandstones	2.85	2.87 Fine-grained	0.61 moderately well sorted	3.72 Strongly fine skewed

DISCUSSION

Sedimentation within fault bounded intractonic basins are often closely linked to alluvial fan systems. The tectonic control on sedimentation and facies distribution in Bida Basin has been documented (Braide, 1992). Fluvial basins can be classified based on the nature of proximal, medial and distal elements. According to Allen & Allen (2004), tectonically active basins commonly have alluvial fans as proximal elements are characterized by braidplains and high sinuosity alluvial systems of transverse and longitudinal type, and distal elements may be lake margins, terminal fans and sabkhas, deltas or estuaries. The conglomerates, sandstones and siltstones of Bida Formation around Kontagora, Zungeru and other marginal parts of the basin can be said to represent the proximal fan. This view is further strengthened by the observation that down to the basement boreholes in some areas slightly further into the basin do not encounter the conglomerate beds (Shekwolo, 1991).

Outcrops around Kajita (middle part of the basin) show typical erosive-based fining upward cycles with well-developed basal conglomerates indicative of braided river deposit. Earlier works in the area (Braide 1992, Ladipo et al. 1994) advanced models suggesting alluvial fall setting for the sediments of Bida Formation. Within this environment, sediments characteristics of braided stream (Adeleye 1974, Olobaniyi 1988) and meandering stream (Adeleye 1974) have been described. These sediments show their best development in the medial part (Allen & Allen, 2004) or distal part (Boggs, 1995) of alluvial basins. The predominance of finer-grained sediments to the south around Agaie and Duma may correspond to the distal part of the alluvial basin.

A comparison of previously documented palynoflora association in mudstones from Tawari village (Fig.1) and other studies from the African-South American flora province during the Cretaceous (Jardine and Magloire1965) suggest that the sandstones of Bida Formation were laid down during the middle Cenomanian to Lower Maastritchian times. According to Jardine and Magloire, the pollen Triorities first occurred during Middle to Upper Cenomania while the pollen Classopollis-Circulina became extinct at the end of Cenomanian. Although the sediments of Bida Formation and its lateral equivalent (Lokoja Formation) have been assigned to the Late Campanian (Murat 1972, Whiteman, 1973), Campanian-Mastritchian (Adeleye 1972) and Mastritchian (Jan du Chen etal 1978). The present work suggests sedimentation ensued in the basin probably before the Campanian due to the presence of Classopollis-Circulina. This view was previously expressed by Whiteman (1982) because interpretation of magnetic data suggests a sediment thickness in excess of 3000m beneath the Bida area, further work is yet needed in this direction to adequately evaluate the age of the basin.

CONCLUSION

Detailed examination of surface and subsurface sediments of Bida Formation made it possible to distinguish the vertical succession into alluvial, lacustrine, fluvial, flood plain and mire facies. This study in addition gave an insight into the nature of the proximal, medial and distal elements of the dominantly fluvial sediments of Bida Formation. Grain size analysis indicates that the sandstones are generally poorly sorted and strongly fine skewed which is characteristics of fluvial sedimentation where silt and clay grains were not removed by the currents, but trapped between larger grains.

The documented facies are: alluvial fan facies found in the northern part of the basin and consist of debris flow conglomerates and breccias interbeded in some places by flood plain sandstones; lacustrine facies made up of siltstones, sandy mudstones, silty mudstones and mudstones; fluvial facies with channel lag conglomerates, channel pebbly coarse-grained sandstones and medium to fine-grained bar top sandstones, flood plain facies consisting of fine fine-grained sandstones, siltstones and mudstones; and mire facies composed of peat and lignite usually interbeded with siltstones and mudstones.

The proximal element is represented by alluvial fan facies while the medial element is dominated by fluvial and flood plain facies in form of braided and meandering river systems and the lacustrine facies dominated the distal element of the alluvial basin.

The present work suggests sedimentation ensued in the basin probably before the Campanian due to the presence of Classopollis-Circulina.

It has been shown from the study that detailed outcrop facies analysis complimented with subsurface data from shallow water boreholes can be used to gain insight into the lithostratigraphic succession of the Bida Formation given that core, wire line logs and seismic data are not available in this area.

REFERENCES

Adeleye D. R. 1972. Stratigraphy and Sedimentation of the Upper Cretaceous Strata around Bida Nigeria. Ph.D thesis, University of Ibadan.

Adeleye, D.R. 1973. Origin of Ironstones: an example from middle Niger valley, Nigeria. *Journal of sedimentary petrology.*,43:709 – 727.

Adeleye, D.R. 1974. Sedimentology of the Fluvial Bida Sandstones (Cretaceous), Nigeria. *Sedimentary* Geology. 12, 1-24.

Adeleye, D.R. and Dessauvagie, TFJ., 1972. Stratigraphy of the Middle Niger Embayment near Bida, Nigeriia. *African Geology,* 181-186, University of Ibadan Press.

Adeniyi, J.O. 1984. Geophysical investigation of the central part of Niger State, Nigeria. Ph.D Dissertation: Madison, Wisconsin, University of Wisconsin, pp.181.

Allen, P. A & Allen, JR. 2004. Basin Analysis: Principles and applications. *Blackwell Publ.* pp.549.

Boggs, S., 1995. Principles of Sedimentology and Stratigraphy. *Prentice Hall, Englewood Cliffs,*NJ. PP.774

Braide, S.P., 1990. Paleotectonic and paleogeographic setting of Bida sedimentary basin (Upper Cretaceous) in central Nigeria. Publication *Occasionelle Center International Formation Echanges Geologiques* 1990/22, 267-270

Braide, S.P., 1992. Alluvia Fan Depositional Model in the Northern Bida Basin. *Min. Geol.* 28, 65-73

Bull, W.B. 1972. Recognition of Alluvia Fan Deposits in the Stratigraphic record in Recognition of Ancient Sedimentary Environments. (Humblin, W.K. and Rigby J.K.I eds). *Soc. Econ. Paleon and Min. spec. Pub.*16. 63 – 83.

Falconer, D.J. 1911. The Geology and Geography of Northern Nigeria. *Macmillian, London.*

Genik, G.J., 1992. Regional framework, structural and petroleum aspects of Rift Basins in Niger, Chad and

Central African Republic (CAR). Tectonophysics, 213, 169 – 185.

Jan Du Chen R. E., Adegoke, O.S., Adeniran, S.A. and Peters, S.W., 1978. Palynology and Espanolo di Micropalentologia 10, 379 – 393.

Jardine, S.; Magloire, L.; 1965. Palynologie et stratigraphy du cretace Des Bassins du Senegal et Cote d'voire. Coll. Int. du Micropalentologie, Dakar, 6-11,5,1963. BRGM 32 187 – 247.

Jones, H.A., 1958. The Oolitite Ironstones of Agbaja Plateau, Kabba Province. *Records Geol. Surv. Nig.* 20-43.

Julie A.J. and Adria J.H. 1993. Reservoir characteristics of a braid plain depositional system: the Upper Carboniferous Pennat Sandstone of South Wales. In: North, C.P. & Prosser, D.J. (eds), 1993, *Characterization of Fluvial and Aoelian Reservoirs,* Geological Society Special Publication No 73, pp.143-156

Ladipo, K.O., Akande, S.O and Mucke, A.; 1994. Genesis of Oolitic Ironstones from the Middle Niger Sedimentary Basin: Evidence from sedimentological. Ore microscopy and Geochemical Studies. *Jour. Min. Geol.* 30, 161-168.

Mckee, E.D., Crosby, EJ & Berryhill, H.L. 1967. Flood deposits, Bijou creek, Colarado, June 1965. *Journal of sedimentary petrology,* 37, 829-951.

Murat, R.C., 1972. Stratigraphy an Paleogeography of the Cretaceo and Lower Tertiary of Souther Nigeria. In African Geolog (Dissauvagie T. F. J. an Whiteman A.J. eds) Ibada University Press, 251-266

Nemec, W., & Steel, R.J. (eds) 1988. Fa Deltas: Sedimentology an Tectonic Settings. *Blackie* London.

Ojo, S.B. and Ajakaiye, D.E., 197 Preliminary Interpretation o Gravity Measurements in th middle Niger Basin Area. I Geology of Nigeria (Kogbe C.A eds). Elizabethan publishing Co Lagos. 295-307

Olobaniyi, S.B. 1988. A geological stud of part of South-Central Bid Basin. M.Sc. Thesis, Universit of Ilorin.

Rust, B.R., and Koster, E.H., 198 Coarse alluvial deposits in Facie models (Walker R.G. eds Geoscience Canada. 53-69.

Russ, W., 1930. The Minna-Birnin Gwa Belt. Part 3b- Report Geol. Sur Nig. 12. Whiteman A.J., 197 Geology and Hydrocarb prospects of Nigeria. Vol. 1& exploration Consultant Lt Marlowe England 1-27.

Shekwolo, P.D. 1991. Region Hydrogeology of Bida Bas Unpl. Ph.D Thesis. Ahmadu Be University, Zaria. Nigeria

Tattam, C.M., 1994. A Review Nigerian Stratigraphy. Ann

Report Geological Survey Nigeria. 1943, 46 – 65.

Tucker, M. E. 1994. Sedimentry Petrology. *Blackwell sci. publ.* pp.260

Udensi, E.E. and Osazuwa, I.B. 2004. Spectral Determination of Depth to Buried Magnetic Rocks Under the Nupe Basin, Nigeria. NAPE Bulletin, Vol.17, No. 1. pp.22-27.

Whiteman A.J. 1973. Geology and Hydrocarbon Prospects of Nigeria. Vol. 1&2. Exploration Consultant Ltd. Marlowe England.

Whiteman, A.J., 1982. Nigeria: its petroleum geology, resources and potential. 1, 176. *Graham Trotman* London.

Zaborski, P. Ugodulunwa, F. Idornigi, A. Nnabo, P. and Ibe, K. 1998. Stratigraphy and Structure of the Cretaceous Gongola Basin, northeast Nigeria, *Bulletin Centres Reserches Exploration Production Elf-Aquitaine* 21 (for 1997), 153 -185.