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Recognition of Blow Foraminifera Zones in the Tertiary Sediments in F- Well, Niger Delta

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ABSTRACT: Foraminiferal Micropaleontology of Tertiary sediment in F-Well Niger Delta Basin were carried out using foraminiferal biostratigraphy as geologic tools. Sedimentological description was carried out on 679 ditch cutting samples which aided the erection of 103 lithozones. Fifty (50) ditch cutting samples was used with the aim of establishing the Foraminiferal Biozones and age of the well. A total of eighty (80) foraminiferal species were recorded, most of the species recorded are calcareous and arenaceous benthic foraminiferal species. They were about twenty-eight (28) diagnostic foraminifera recognized. The evaluation of these foraminifera species enabled us to recognize the zones. The foraminiferal abundances revealed two bio zones *N4-N3 Planktic zone and N3 – N2 Planktic zone* which were suggested based on index species among the recovered foraminiferal assemblages. *N4-N3 Planktic zone* has a reference interval of 8,000ft – 9,400ft. The top of this zonal interval which ought to be marked by the FDO of *Ammonia becarril* was *absent* but was estimated to be 8,000ft. The base of this zonal interval is marked by the LDO of *Epistominella vitriea* at 9,400ft. *Planktic zone N3 – N2 has a reference interval of* 9,400ft – 10,000ft. The top of this interval is marked by the FDO of *Bolivina imperatrix* at 9,400 ft. The base of this interval is marked by the LDO of *Spirosplectamina wrightii* at 10,000 ft. The studied intervals in the wells are dated Early Miocene - Oligoocene. Using the lithologic and foraminiferal studies, it is inferred that the intervals penetrated by the well correspond to Agbada Formation.

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The study area lies within the Niger Delta Basin, which is situated on the continental margin of the Gulf of Guinea in equatorial West Africa Klett *et al* 1997. The Niger Delta ranks amongst the world's most prolific petroleum producing Tertiary deltas that together account for about 5% of the world's oil and gas reserves and for about 2.5% of the present day basin areas on earth. Biostratigraphy is defined as "the classification of sediment units according to observable variations in fossil content" Lowe JJ and Walker MJC. 1997, enables sediment sequence to be divided into biostratigraphic units or biozones, each characterised by a distinctive fossil assemblage. Foraminiferal has a small size, global ecological extent and rapid evolutionary turnover provide an excellent means of biozonation study, is necessary for correlation, paleoenvironmental reconstruction. It is essential to the petroleum industry as a tool for defining geologic constraints on prediction of exploration risk and modeling reservoir simulation. Deep-water agglutinated foraminifera have been used during hydrocarbon explorations since the 1970's when the first Deep Sea Drilling Programme (DSDP) established their value for both biostratigraphical and palaeoenvironmental studies Gradstein FM and Berggren WA 1981. Planktonic foraminifera are good stratigraphic indicators of the interval covering the Jurassic to present, while benthic foraminifera are found since the Cambrian (Ordovician to Present for calcareous species). They are very good biostratigraphic markers within marine. The use of foraminiferal analysis in this study enables us to determine biostratigraphic zonation of the sediments penetrated by the drill.

Stratigraphy of Niger Delta: *Benin Formation*: This is the uppermost unit in the basin and predominantly (over 90%) sandy with isolated clay/shale intercalations. The sands are coarse grained, granular, poorly sorted, subangular to well rounded. They are white or yellowish-brown and contain thin lignite streaks and wood fragments. The sediments are of continental to deltaic plain origin. The sands and sandstones may represent point bar deposits, channel fills and natural levees, whereas the shales may be interpreted as backswamp deposits or ox-bow fills. The Benin Formation is thicker in the central onshore part of the delta where it reaches about 2,000m (Avbovbo, 1978) and thins outwards towards the delta margins. It ranges in age from Oligocene to Recent.

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Agbada Formation: This unit comprises cyclic sequences of alternating sands (fluviatile, coastal, and fluviomarine) and marine shales. Two (2) distinct intervals are easily recognizable: an upper sandy unit with minor shale intercalations and a more marine lower unit in which the shaly sections become prominent. The sandstones and sands are very coarse to very fine grained, unconsolidated or slightly consolidated and poorly sorted. Lignite streaks are common. The shales are grey and dense at the base becoming markedly sandy and silty upward. The Agbada Formation is up to 4,000m thick in the central part of the delta, thinning seaward and towards the delta margins. Known age ranges from Eocene to Recent.

Akata Formation: This is the basal unit of the Niger Delta complex. It consists of uniformly developed shales deposited in an open marine environment. There is the presence of some sand beds considered to be of continental slope, channel-fills and turbidites (Weber and Daukoru, 1975). The formation is largely undercompacted (overpressured). The actual thickness is not known due to inability to penetrate the formation fully except on the basin flanks. The age span is Eocene to Recent.

*Location of Well***:** F-Well is a well drilled to a total depth of 10,185 feet. It is located in the Greater Ughelli Depo belt of Niger Delta basin defined by the following coordinates: Between Longitude 6^0E and 7^0 E and Latitude 5^0N and 6^0 N.

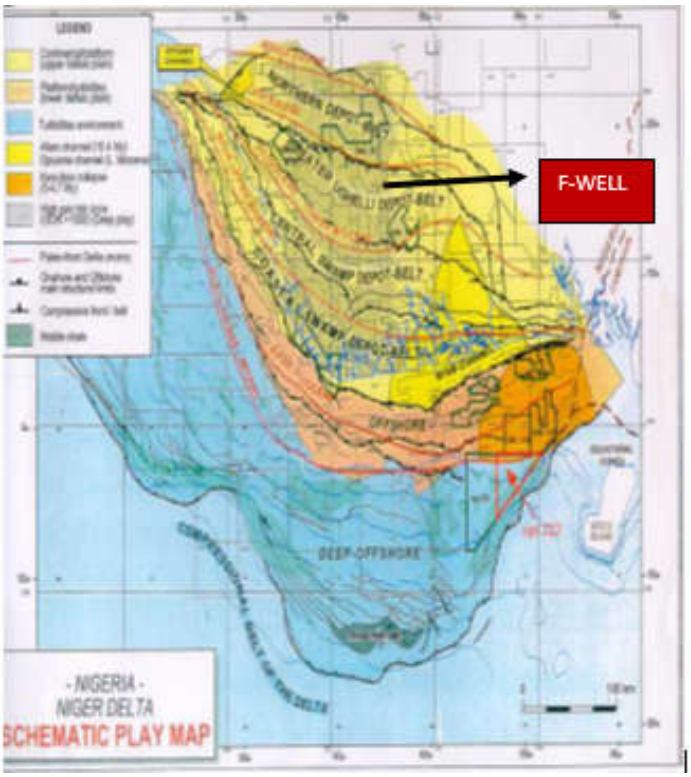

Fig 1: Location Map of F-Well. Source: Nwozor *et al*., 2013

Sedimentology: The sedimentologic description of F-Well was carried out on 679 Ditch Cutting samples with the aid of both visual and a reflected light microscope with the guide of a standard textural comparison chart showing grain sizes, shapes and degree of sorting. The Sedimentological analysis allowed the erection of one hundred and three (103) lithozones of Clayey Sandstone, Sandstone, Sandy Shale, Shale and Shaly Sandstone lithofacies based on the textural properties observed and the identification of minerals which include: Quartz, Iron oxide, and Mica. Fifty (50) Shale and Sandy Shale lithofacies were sampled for Standard Palynology analysis.

MATERIALS AND METHOD

Foraminifera Slide Preparation: Labeling and weighing: 20g of each collected sample was weighed, packaged and labeled accordingly indicating the well name, sample type and depth.

Soaking: Bowls were labeled for indicated sample depths contained and soaked with kerosene for about four (4) hours after which the samples were decanted.

Water was later added to the labeled samples and allowed to stay/ soak overnight.

Wet sieving and Drying: Samples were washed through 230 mesh sieve with 63 micron (um) aperture under running tap water with a shower head. Washed samples were dried on hot plate at about 60°C for about 45minutes.

Dry sieving and Bottling: A set of micro sieves (coarse, medium and fine) was stacked on each other and dried residue for each sample was run through them and sieved manually. The respective fractions were collected and bottled in three (3) already cleansed and properly labeled bottles.

Picking: Each fraction was spread on a gridded foraminifera tray of 4.5 by 6.0cm and moved along definite traverses to pick observed foraminifera under centered binocular microscope. Using a picking needle recognized fossils were picked and placed in the cavity of appropriately labeled slide. The recovered foraminifera were recorded in a picking sheet.

Splitting: This is the sorting/separation and grouping of fossils according to their morphological similarity. Different species are grouped together with the tip of a moistened fine brush and stocked in 10s, 20s, and 50s depending on the richness of the interval on the slide and glued onto the slide with a gum.

Analysis: Identification of the picked foraminifera was done with the aid of type collection and foraminifera album considering the test composition, chambers arrangement, sutures, aperture, habits and ornamentation. The results of the micro fauna analysis are plotted on range and distribution charts to show the sequence of occurrences of the species. The groups of species identified will be described systematically later.

Dating and Biozonation: Age was determined based on the presence of marker species and correlated with the published chronostratigraphy of Haq *et al.,* (1988) and Harland *et al.,* (1990). The F-zones are of immense help in recognizing MFS and in understanding the cycle concept as well as sequence stratigraphy.

Zones were delineated in the well based on the recognition of the last appearance datum and first appearance datum of important diagnostic species. Furthermore/ maximum/minimum fauna abundance/diversity peaks were also employed to assist in the correlation of the determined horizons to global bioevents.

RESULT AND DISCUSSION

Foraminiferal Abundance: A total of Eighty (80) foraminiferal species were recorded, most of the species recorded are calcareous and arenaceous benthic foraminiferal species. Planktic foraminiferal species are generally scarce in the well. The non-recovery of planktic and the general poor recovery of foraminiferal species might be due to environmental factor.

Species recorded include: *Haplophragmoides sp , Bathysiphon sp., Poritextularia panamensis, Haplophragmoides compressa, Trochammina sp, Florilus costiferum, Calcareous indeterminate, Ammobaculites sp., Poritextularia panamensis, Bolivina sp., Arenaceous indeterminate, Calcareous indeterminate, Poritextularia panamensis, Uvigerina sparsicostata, Haplophragmoides narivaensis,Arenaceous indeterminate, Spirosplectamina wrightii, Hanzawaia concentric, Hopkinsina bemoniensis, Brizalina imperatrix, Ostracod, Epistominella vitriea, Hanzawaia concentric, Haplophragmoides narivaensis, Fursenkoina punctata, Valvulineria sp., Fissurina sp., Bathysiphon sp., Hanzawaia concentric.*

Foraminiferal Zonation: The foraminiferal zonation of the well was guided by the works of Blow (1969, 1979).

Though planktic foraminiferal species are generally scarce in the well but benthic foraminiferal species whose stratigraphic distributions have been well established in the Niger Delta and have been caliberated with planktic foraminiferal species were used to assign ages and zonation in this Well. The non-receovery of planktic and the general poor recovery of foraminiferal species might be due to environmental factor.

Important foraminiferal bio-events considered include:

- First Downhole Occurrence (FDO) of chronostratigraphically significant planktic/benthic foraminiferal species.
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- Last Downhole Occurrence (LDO) of planktic/benthic foraminiferal marker species.
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- Foraminiferal abundance and diversity peaks dated with foraminiferal markers species whose stratigraphic ranges are well established in the Niger Delta and worldwide.

Table 1: Foraminiferal distribution chart for F – Well

S/N	DEPTH(FT)	*Haplophragmoides sp*	*Bathysiphon sp.*	*Poritextularia panamensis*	*Haplophragmoides compressa*	*Bathysiphon sp*	*Trochammina sp*	*Florilus costiferum*	*Calcareous indeterminate*	*Ammobaculites sp.*	*Bolivina sp.*	*Arenaceous indeterminate*	*Uvigerina sparsicostata*	*Haplophragmoides nariveiensis*	*Spirosplectamina wrightii*	*Hanzawaia concentric*	*Hopkinsina bemoniensis*	*Brizalina imperatrix*	*Ostracod*	*Epistominella vitrea*	*Spiroplectammina wrightii*	*Ammobaculites sp*	*Furseinkoina punctata*	*Valvulineria sp.*	*Fissurina sp.*	*Ammobaculites agglutinans*	*Anomalina sp.*	*Bolivina dertonensis*	*Cassigerinella chipolleensis*	Biozones
1	2010ft																													BARREN
2	2055ft																													
3	2085ft																													
4	2100ft																													
5	2145ft																													
6	3015ft																													
7	3735ft																													
8	5325ft																													
9	5370ft																													
10	6645ft																													
11	7035ft																													
12	7770ft																													
13	7800ft																													
14	7830ft																													
15	8025ft	1																												N4 – N3
16	8040ft																													
17	8055ft		1																											
18	8070ft			3	1																									
19	8085ft																													
20	8100ft																													
21	8145ft																													
22	8250ft			1		1	1																							
23	8265ft							1	1																					
24	8295ft									1																				
25	8310ft																													
26	8340ft			1																										
27	8370ft																													
28	8385ft										1	1																		
29	8400ft								2																					
30	8430ft																													
31	8460ft	1		1																										
32	8490ft																													
33	8520ft																													
34	8535ft								1				1																	
35	8610ft																													
36	8620ft																													
37	8745ft	1																												
38	8835ft																													
39	8865ft																													
40	9240ft			1								1		1																
41	9480ft			3						1				1	2	3														
42	9540ft													1	1	3	1	1	1	1										N3 – N2
43	9555ft		1	2																2	2	1	1	1	1	1				
44	9660ft	1		2								1		1				1			1						1			
45	9765ft			4				1		1						1					2					1				
46	9855ft	1															1											1	1	
47	9870ft	1																								1				
48	9975ft																													
49	10155ft																													
50	10170ft																													

Table 2: Foraminifera Biostratigraphic summary of the Well

(First Downhole Occurrence of stratigraphically important Foraminifera species)				
Depth (ft)	**Epoch/Period**	**Age (Ma)**	**Zones (Blow 1969, 1979)**	**Significant Foraminifera data**
2,010	*First sample analysed*			
2,010 – 8,000	Indeterminate	-	Indeter-minate	Interval barren of foraminifera species
8,000-9,400	Early Oligocene – Early Miocene	22.2 - 24.3	?N4 – N3	Interval characterized by occurrences of *Spiroplectammina wrightii and Uvigerina sparsicostata.*
9,400 – 10,000	Early Oligocene	24.3 - 33.0	N3 – N2	*Hanzawaia concentrica, Hopkinsina bemoniensis, Brizalina imperatrix and Bolivina dertonensis*

Index species among the recovered foraminifera assemblages have been used in dating and zoning the intervals. Details are given below:

PLANKTIC ZONE N4 – N3
Early Miocene - Oligoocene
Interval: 8,000ft – 9,400ft
Estimated numerical age: 22.2 - 24.3Ma
Definition:
The top of this zonal interval which ought to be marked by the FDO of *Ammonia becarril was absent* but was estimated to be 8,000 ft.
The base of this zonal interval is marked by the LDO of *Epistominella vitriea* at 9,400 ft.
Features:
✓ Interval is characterized by benthic foraminifera species.
✓ Interval characterized by the co-occurrence of *Spiroplectammina wrightii and Uvigerina sparsicostata.* Signifying (?N4-N3) ?Early Miocene - Oligocene age.

PLANKTIC ZONE N3 – N2
Interval: 9,400ft – 10,000ft
Estimated numerical age: 24.3 - 33.0Ma
Definition:
The top of this zonal interval is marked by the FDO of *Bolivina imperatrix* at 9,400 ft.
The base of this zonal interval is marked by the LDO of *Spirosplectamina wrightii* at 10,000 ft.
Features:
✓ Interval is characterized by benthic foraminifera species.
✓ Interval characterized by the co-occurrence of *Hanzawaia concentrica, Hopkinsina bemoniensis, Brizalina imperatrix and Bolivina dertonensis* signifying (N3-N2) Oligocene age.

Conclusion: It is inferred that the intervals penetrated by the well correspond to Agbada Formation. The alternation of shales and sandy shales/mudstones within the sequence provides the combination of source, reservoir and cap rocks essential for hydrocarbon generation, accumulation and trapping.

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REFERENCES

Allmon, WD (1993). In Defense of Paleontology. *Geotimes*. 1-5.

Avbovbo, AA (1978). Tertiary lithostratigraphy of Niger Delta *Am. Assoc. of Petr. Geol. Bulletin*, Vol. 62, 295-306.

Blow, WH (1969). Late Miocene to Recent Planktonic Foraminifera Biostratigraphy", In Brönnimann, P; Renz, HH (Eds.), *Proceedings First Int. Conf. on Planktonic Microfossils*, Geneva, Vol. 1, 199-422.

Blow, WH (1979). The Cenozoic Globigerinida. Leiden, E.J. Brill., Vols 3, 1413.

Bolli, HM; Saunders, JB (1985). Oligocene to Holocene low latitude planktic foraminifera. In Bolli, HM; Saunders JB; Perch-Nielsen, K (Eds.), Plankton Stratigraphy. Cambridge University Press, 155-262.

Chiaghanam, OI; Nwozor, KK; Chiadikobi, KC; Omoboriowo, AO; Soronnadi-Ononiwu, CG; Onuba, LN; Ofoma, AE (2013). Lithofacies, Palynology and Paleoenvironmental Study of Early Campanian to Mid-Maastrichtian Deposits of Udi and Environs. *Int. Journ. of Sci. and Tech*, Vol. 2, 14-16.

Doust, H; Omatsola, E (1990). Niger Delta. *In*:

Edwards, J.D; Santogrossi, PA (Eds.), "Divergent/passive Margin Basins". *Am. Assoc. of Petr. Geol. Bulletin*, Vol. 48, 201-238.

Fadiya, SL (1999). Foraminifera and Calcareous nannofossils biostratigraphy and well log sequence stratigraphic analysis of Opolo-5 and Opolo-6 wells, Niger Delta". Unpublished M.Sc Thesis, Department of Geology, Obafemi Awolowo University, IleIfe. Abstract published in AAPG Bulletin 82(11) 2162.

Gradstein FM; Berggren WA (1981). Flysch-type agglutinated foraminifera and the Maestrichtian to Paleogene history of the Labrador and North Seas. *Marine Micropaleontology*. 6, 211-268.

Haq, B; Hardenbol, J; Vail PR (1987). The Chronology of Fluctuating Sea Level since the Triassic. *J. Science*. .235, 1156-1167.

Kennet, J; Srinivasan, MS (1983). Neogene Planktonic Foraminifera. Hutchinson Ross, New York.

Klett, TR; Ahlbrandt, TS; Schmoker, J; Dolton G (1997). Ranking of the World's oil and gas provinces by known petroleum volumes: *U.S. Geol. Surv*. Open-file Report-97-. 463, CD-ROM.

Kulke, H (1995). Nigeria in Kulke, H (ed) Regional Petroleum Geology of the World. Part II: Africa, America, Australia and Antarctica: Berlin, Gebrüder Borntraeger, 143-172.

Lowe, JJ; Walker MJC (1997). Reconstructing Quaternary Environments''. 2nd Edition. Pearson Education Ltd, Harlow, England.

Lucas, FA; Fregene, TJ (2018). Paleo-environmental Reconstruction of Oligocene to Early Miocene Sediments of Greater Ughelli Depobelt, Niger Delta Basin. *J. Appl. Sci. Environ. Manage*. Vol. 22 (1) 99-102

Nwozor, KR; Omudu, MI; Ozumba, BM; Egbuachor, CJ; Onwuemesi, AG; Anike, OL (2013). Quantitative evidence of secondary mechanisms of overpressure generation: Insights from parts of Onshore Niger Delta, Nigeria. *Petr. Techn. Dev. Jour*., Vol. 3(1), 64-83.

Reijers, TJA; Petters, SW; Nwajide, CS (1997). The Niger Delta Basin. African Basins. Sedimentary Basins of the World, 3 edited by R. C. Selley (Series Editor: K. J. Hsü), 151-172.

Short and Stauble, (1967). Outline of Geology of the Niger Delta. *Am. Assoc. Petr. Geol. Bulletin* 51; Vol .51, (5), 761 - 779.

Stacher, P (1995). Present understanding of the Niger Delta hydrocarbon habitat, *In*: Oti, MN and Postma, G (Eds.), Geology of Deltas: Rotterdam, AA Balkema, 257-267.

Weber and Daukoru. (1975). Petroleum Geological aspects of the Niger Delta 9th World Petroleum Congress, Tokyo, Proc., Vol. 2, 209-221.

Whiteman, AJ (1982). Nigeria: Its Petroleum Geology, Resources and Potential. Graham and Trotman, London. 1-394.