FORAMINIFERAL BIOSTRATIGRAPHY AND PALEOENVIRONMENTAL STUDY OF THE SEDIMENTS PENETRATED WITHIN THE INTERVAL OF 6030FT. TO 11115FT. OF ASH-3 WELL IN THE GREATER UGHELLI DEPOBELT, NIGER DELTA BASIN

Itiowe Kiamuke and Lucas Frank Adebayo

Department of Geology, University of Benin, Benin City, Nigeria Email: <u>kiamukeitiowe@yahoo.com</u>; <u>drfalucas@gmail.com</u>)

Received: 05-11-19 *Accepted:* 16-11-19

ABSTRACT

Foraminifera biostratigraphy and paleoenvironmental study was carried out on sediments penetrated by Ash-3 Well in the Greater Ughelli Depobelt, Niger Delta. The aim of this study is to erect a foraminifera zonation and carry out paleoenvironmental study of Ash-3 Well. Seventy (70) ditch cutting samples were subjected to foraminifera slide preparation technique and analysis was carried out with reflected light binocular microscope. Most of the species recorded are calcareous and arenaceous (agglutinated) benthic foraminifera species with planktic generally absent in the well. Four (4) foraminifera genera and twenty six (26) foraminifera species were recovered from the well. Two benthic foraminefera zones were identified: Lower N2- N4 and N4 – N5 Zones of Blow (1969, 1979). The age of the well from 9960ft – 11115ft indicates an Oligocene age based on the recovery of age diagnostic markers such as Spirosplectammina wrightii, Altistoma scalaris, Hopkinsinna bononiensis, Haplophragmoides narivaensis, Spirosigmoilina oligocaenica, Eponides eshira, Lenticulina grandis and Poritextularia panamensis, while the age from depth 6030 ft. - 9945ft. indicates Early Miocene age based on the recovery of age diagnostic markers such as Lenticulina grandis, Florilus costiferum, Lenticulina inornata, Eponides eshira and Poritextularia panamensis. Paleoenvironmental study based on the benthic foraminifera association revealed that the sedimentary sequences were deposited in range of environment from marginal marine environment (littoral Zone) to shallow marine environment (inner neritic zone). The alpha diversity index for Ash-3 Well based on the plot of the amount of benthonic foraminifera species against the number of individual foraminifera ranges from $\alpha 2 - \alpha 5$, this therefore indicates that the salinity during the deposition of the sediments of Ash-3 Well was within the hyposaline marshes – hyposaline shelf sea, which implies that the salinity of the water condition during this time was abnormally low salinity.

Keywords: calcareous, arenaceous, agglutinated, hyposaline marshes, hyposaline shelf sea.

INTRODUCTION

The Niger Delta is the largest hydrocarbon producing basin in Nigeria where profound petroleum exploration and exploitation activities have been in progress since the discovery of hydrocarbon in Oloibiri community, Bayelsa State in 1956 (Reijers et al., 1996). The basin is petroliferous in nature which has made the Nigeria economy to be depended on the oil and gas resources. It is situated at the zone where the rifting and separation of Africa and South America was initiated. The basin was formed by failed arm of a triple junction (aulacogen) after rifting ceased in the Mid-Cretaceous (Short and Stauble, 1967).

Foraminifera biostratigraphy as a tool in stratigraphy is used for age determination, correlation and paleoenvironmental analysis. The following workers that have documented their work on the Upper Cretaceous and Tertiary Foraminiferal on ages, paleoecological and paleoenvironmental interpretation in the Nigeria sedimentary basin (Adegoke et al., 1971; Ogbe, 1974; Ayayi and Okosun, 2006; Obaje and Okosun, 2013; Ajayi and Okosun, 2014; Fadiya et al., 2014 and Nwaejije et al., 2017), but there is scanty of information on the biostratigraphy of the Greater Ughelli depobelt. The area of study is located in the Greater Ughelli Depobelt. The well is geographically positioned on latitude 5°30'N and longitude 5°45'E (Figure 1).

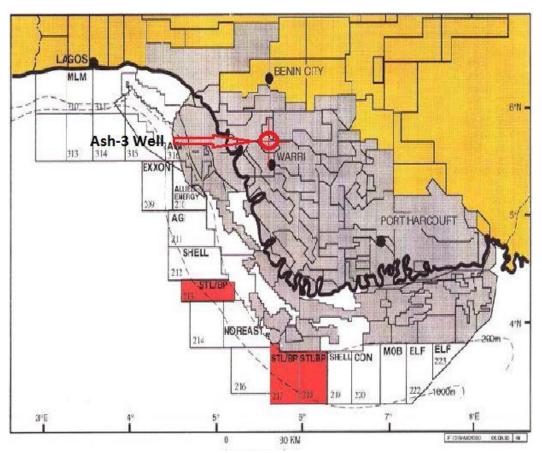


Figure 1: Location map of Study Area (Lucas et al., 2016)

MATERIALS AND METHOD

Seventy (70) ditch cutting samples from Ash-3 Well between the intervals of 6030 feet to 11430 feet were taken from the shaly and sandy shale intervals of interest for foraminifera slides preparation.

Materials:

Slides, microscope, digital camera, sieves, picking trays, needles, brushes and hot plates.

Procedures for Foraminifera Slide Preparation:

Labeling and Weighing: About 25g of each collected samples were weighed, packaged and labeled accordingly indicating the well name, sample type and depth.

Soaking: The samples were soaked with kerosene for about six (6) 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 270 mesh sieve with 53 micron (μ m) aperture under running tap water with a shower head. Washed samples were dried on hot plate at about 50°C for about 30 minutes.

Dry sieving and Bottling: A set of micro sieves (coarse, medium and fine) were stacked on each other and the dried residue for each sample was allowed to run through them and sieved manually. The respective fraction of each of the residue was collected and put inside a labeled bottle.

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 a reflected light binocular microscope. The forms were picked and placed in the cavity of appropriately labeled slide.

Splitting: This is the sorting and grouping of fossils according to their morphological similarity. Different species were grouped together with the help of a moistened fine brush and stocked in 10s, 20s, and 50s depending on the richness of the intervals. They were placed on the slide and glued with tragacanth gum. Analysis: Identification of foraminiferal was carried out using published references of Fayose (1970), Blow (1979) and Bolli and Saunders (1985) and foraminifera album considering the test composition, chamber arrangements, sutures, apertures, habits and ornamentation.

RESULTS AND DISCUSSION

Lithologic Description of Formations in Ash-3 Well

The depth of this well is from 15fts to 11430ft. This well consists of five lithofacies types namely: sandstone, clayey sandstone, shaly sandstone, sandy shale and shale. The grain sizes vary from shale to boulder. The well consists of two formations namely: the Agbada and Benin Formation (Figure 2).

Benin Formation

This formation occurs within the interval of 15ft to 6015ft. It consists mainly whitish to yellowish sandstones with clayey sandstone at the top (30ft to 225ft). The grain varies from very fine to boulder, angular to well-rounded and poorly sorted to very well sorted. Minerals found within this zone include iron oxide, mica, pyrite and carbonate. Coal is presence within the formation ranges from 5 to 80%. Thin laminae of shale are found occasional within this zone.

Agbada Formation

This formation occurs within the interval of 6030ft to11430ft. This zone consists of alternation of sand and shale with mainly shaly sandstone at the top and sandy shale at the base. The shale is mainly greyish in colour, fine grained and fissile, which is an

142

indicative of quiet and an anoxic condition and the sand varies from very fine to very coarse. The minerals found within this zone include iron oxide, mica, pyrite and clay. Wood fragments and rootlets also occur in this formation.

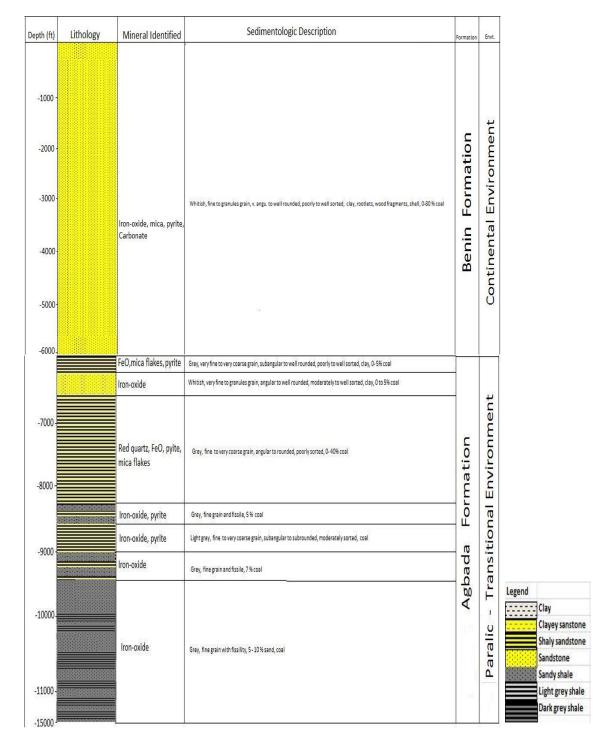


Figure 2: Lithologic log showing the Formations of Ash-3 Well

Quantitative Count

Foraminifera assemblages over these intervals are generally poor with some barren intervals. Most of the species recorded are calcareous and arenaceous (agglutinated) benthic foraminifera species with planktic foraminifera generally absent in the well. Seventeen (17) out of twenty six (26) foraminifera species recovered are calcareous benthics while arenaceous (agglutinated) benthics accounted for the remaining nine (9) species. This group of foraminifera has a calcareous wall that is either perforate or imperforate. They account close to seventy (70%) of the recovered foraminifera species.

The calcareous species recorded include: Heterolepa pseudoungeriana, Florilus Calcareous costiferum. indeterminate. Florilus atlanticus. Lenticulina inornata. Lenticulina grandis, Eponides esaira, Hanzawaia concentrica, Valvulineria sp., Nonion sp., Cristellaria sp., Altistonia scalaris. Altistonia sp., Hopkinsina bononiensis, Spirosigmoilina oligocaenica, Bolivina dertonensis and Nonionella turgidus.

The arenaceous (agglutinated) benthics for a minifera account for about (30%) of the total foraminifera species with low diversity. Their test is made up of foreign materials mainly sand grains, sponge spicules and mica flakes. The arenaceous (agglutinated) recorded are: Poritextularia panamensis, Eggerella scabra, Arenaceous indeterminate, *Reophax* sp., *Spiroplectammina* wrightii, Haplophragmoides sp., Bathysiphon sp., Alveolophragmium crassum and Haplophragmoides narivaensis.

Foraminifera Zonation and Age for Ash-3 Well

The foraminifera zonation for Ash-3 Well was guided by the work of Blow (1969, 1979), Bolli and Saunders (1985). The

benthic foraminifera species whose stratigraphic distribution has been well known in the Niger Delta and has been with planktic calibrated foraminifera species were used to assign age and biozonation. Important foraminifera bioevents considered include: First Downhole Occurrence (FDO) of chronostratigraphically significant planktic/benthic foraminifera marker species, the Last Downhole Occurrence (LDO) of chronostratigraphically significant planktic/benthic foraminifera marker species, foraminifera abundance and diversity peaks.

The result of the analysis indicates that the entire analyzed section (6030 - 11290ft) was deposited during the Early Oligocene to Early Miocene epoch which straddle within the Lower N2- N4 and N4 - N5 Zones of Blow (1969, 1979) (Table 1).

Stratigraphic Interval: 11115ft – 9960ft Zone: Lower: N2-N4 Age: Early to Late Oligocene

The upper boundary of this zone is defined by the FDO of Hanzawaia concentrica at 9960ft. The lower limit is placed at the LDO of *Spiroplectammina wrightii* at depth (11115ft). The interval is also characterized by the co-occurrences of the following species foraminifera viz: **Bolivina** dertonensis, Nonion sp., Altistoma scalaris, Hopkinsinna bononiensis, *Haplophragmoides* narivaensis, Spirosigmoilina oligocaenica, Eponides eshira, Lenticulina grandis and Poritextularia panamensis. The above foraminifera assemblage confirms the Early to late Oligocene age for this interval (11115ft - 9960ft).

Stratigraphic Interval: 9960ft – 9585ft Zone: N4 - N5 Age: Early Miocene

The lower limit of this zone is defined by the FDO of *Hanzawaia concentrica* at 9960ft, while the upper limit is placed at the FDO of Florilus costiferum. The First Downhole Occurrence of Hanzawaia concentrica at 9960ft which suggests Early Miocene at this depth. The co-occurrences of the following foraminifera assemblages viz Lenticulina grandis, Florilus costiferum, Lenticulina inornata, Eponides eshira, Poritextularia panamensis, Heterolepa pseudoungeriana and Florilus atlanticus in this zone are consistent with the Early Miocene age.

Stratigraphic Interval: 9585ft - 6030ft Zone: Indeterminate Age: Indeterminate

The lower limit of this zone is defined by the co-occurrence of *Heterolepa pseudoungeriana* and *florilus costiferum*, while the upper limit is placed at the top of analyzed interval (first sample analyzed). This interval is barren of foraminifera species.

3		1.0	Cal	careout	foram			Acchu	Foram			
	Rorilus costiferum (Nonion 6)	ticur	ira -	oncentrica		cnoniensis	rgidus	Spiroplectammina wrightii	Hoplophrogmoides narivoensis	162 /0961) ML		
wyeth (th.)	Rorlius costi	Renilus atlanticus	Eponides esaira	Hanzawaia concentrica	Nonion sp.	Hopkinsing bononiensis	Nonionella turgidus	Spiroplectam	Haplophragn	N/P ZONES BLOW (1964/ 79)	Foaraminifara events	AGE
6030	-	-		-				_				
6225	-	-		-								
7005	-		-			-	-					
71.60								-				
8100												
8,790	-		_						-			
8535	_					_	_					
8650	-	-	-				-					
8955		-				-	-					
9585	1	-	-			-+	-	-			FDO Florilus costiferum (Nonion 6)	
9660	1					-						10000
96.75												LL LL
9690										10		~ 7
9705												
9735	1	1	_			_			-	~		
9765	- 1		-					_				E O
9850	-	-							-	-		40
9825	- 4	-					-		-	N4 - N5		$\overline{m} \cong$
9900	-	-	1			-	-			~		
9915												EARLY MIOCENE
9930												10 - 10 - 10 - 10 - 10 - 10 - 10 - 10 -
9945	1							-				
9960	- 2		_	1		-	_	_	-		FDO Hanzawaia concentrica	
9975	-	-										
9990	1	1					-		-			
10005	-	-					-		-			
10035		-				-	-					
\$0050	1	1						1				
10065												
\$0095								-				
10125	1	1	_									
101-00			-	-		_	_					
80355	1		- 1	-	-	-	-	-				
10260	2	1	1		1		-		-			
\$0290	-	-1				-	-					
10.905		_					-					
80585										4		111
\$05.80										Z		
10545	_		_			-	_	-		-		<u> </u>
10540	-	-				-	-	-	-	2		щ
105.75		-								2		<u> </u>
105.00	-	-				-+	-		-	~		0
106.35												(7)
10665										-		-
10680										~		OLIGOCENE
10095	_	2	-		1	-				5		0
10755	1	7				-+	-			LOWER N2-N4		
\$0785		-				-	-		-	_		1
10800	-	2				-	-					
10815		1					_	1				
\$0860	1	2										
10875		2										
\$0990	-	-	-			_						
10905	1	_	_				-					
10920	-	-				-	-	-				
50950	-	1					-		-			
10965		1				-	-					
10980		1						1				
11050									-		in a second s	
\$3385	3.5	7				5			-		LDO Spiroplectammina wrightii	
11265	1	2					- 1		1			
11,280	2	2			1							

 Table 1: Foraminifera Biozonation and Age for #3 Well

Paleoenvironmental Study for Ash-3 Well

Foraminifera are marine organism; hence their presence in sedimentary rock is a direct indication of marine environment. Bandy (1960) stated that foraminifera have shown to be useful environmental indicator than any other microfossil group because of their occurrence in widespread geological environment.

The interval 11280ft - 10980ft consist of shale and sandy shale units. This depth recorded high amount of foraminifera abundance and diversity. The presence of paleobathymetric indicators such as Florilus costiferum, Haplophragmoides sp, Spirosigmoilina oligocaenica, Lenticulina grandis, Hopkinsina bononiensis, Bolivina dertonensis, Florilus atlanticus, Valvulina sp. and Spiroplectammina wrightii indicate inner to middle neritic zones (shallow to deep marine environments) (Murray, 1991, Brandy, 1967) (See Table 2). The presence of haplophragmoides species, which is infaunal and detritivore foram occur in muddy to sandy substrates suggest anoxic condition.

The interval 10980ft to 10815ft consist of shale and sandy shale units. The presence of paleobathymetric indicator such as Florilus costiferum, Florilus atlanticus. Haplophragmoides sp. and Aleoveophragmium crassum suggest littoral to inner neritic zones (marginal to shallow marine environments) (Murray, 1991, Bandy, 1967) (See Table 2). The dominance of arnaceous forms show anoxic condition for this part of the well (Gehhardt, 2006), this could be as a result of input of organic matter concentration.

The interval 10815ft to 10665ft consists of shale and sandy shale interval. There is a low recovery of foraminifera at the base of this interval and increase in calcareous and arenaceous forminifera close to the top. The presence of paleobathymetric indicators such as *Spiroplectammina wrightii*, *Florilus costiferum* and *Florilus atlanticus* suggest inner neritic zone (shallow marine environment) (Murray, 1991, Bandy, 1967) (See Table 2). The absence of foraminifera in this zone suggests highly stressed and high oxygen concentrated zone.

The interval 10665ft to 10275ft consists of shale and sandy shale intervals. The absence of foraminifera in this interval is an indication of littoral zone (marginal environment) (Murray, 1991, Bandy, 1967).

The interval 10275ft to 9735ft is a heterogeneous sequence. It consists of shale, sandy shale and shaly sandstone lithofacies. The amount of calcareous benthic and arenaceous benthic foraminifera is evenly distributed. The environment of deposition within the interval fluctuates between littoral and inner neritic zones (marginal to shallow marine environments), based on the recovery of paleobathymetric indicators such as *Eggerella* scabra, Florilus costiferum, Florilus atlanticus, Lenticulina inornata, Lenticulina grandis and Reophax sp (Adegoke et al., 1976, Murray, 1991) (See Table 2).

The interval 9735ft to 9285ft consists of sandy shale and shaly sandstone. The paucity of foraminifera and paleobathymetric indicators such as Florilus costiferum. Calcareous indeterminate and Florilus atlanticus (marginal suggest littoral zone environment). The low number of species in this zone suggest environmental highly stressed zone (Murray, 1994) (See Table 2). The absence of arenaceous forms shows oxic condition within this zone.

Some of the foraminifera that are diagnostic of certain environments are been shown in Plate 1.

Table 2	2: 1	For	an	nini										bio	ZOI	nat	io		-								ent of	Ash-3	Well	
					Ca	lca	reo	us	For	am	ini	fera	a					Α	ggl	utir	nate	ed f	ora	mir	ife	ra				
Depth (ft.)	Heterolepa pseudoungenana	Florilus costiferum (Nonion 6)	Calcareous indeterminate	Florilus atlanticus	Lenticulina inornata	Lenticulina grandis	Eponides esaira	Hanzawaia concentrica	Valvulineria sp.	Nonion sp. 4	Cristellaria sp.	Altistonia scalaris	Altistonia sp.	Hopkinsina bononiensis	Spirosigmoilina oligocaenica	Bolivina dertonensis	Nonionella turgidus	Poritextularia panamensis	Eggerella scabra	Arenaceous indeterminate	Reophax sp.	Spiroplectammina wrightii	Haplophragmoides sp.	Bathysiphon sp.	Alveolophragmium crassum	Haplophragmoides narivaensis	N/P Zones Blow (1969/1979)	Age	Paleobathymetry	Depositional Environment
6030																														
6225 6795								-					-																	
7005																											te			
7003																											Indeterminate			
8100																											E			
8280																											ŝte		Littoral zone	-
8535																											qe		z	Marginal
8610																											7		ral	are
8955																													tto	ŝ
9285																		1											C:	
9585	1	1																												
9660																														
9675																														
9690																														
9705																												e		
9735		1	1	1																-								Sen		
9765		1																4	1	2							NS	io		
9810		4																1		-							N4-N5	Σ		
9825		4			4	2												15		1	1						~	Early Miocene		
9885 9900						1	1											3										Еа	S	
9900						- 1	-									-		2											ů.	Ľ
9930													-			_													Littoral to inner neritic zones	Marginal to shallow marine
9945		1																1											tic	
9960		1						1					1					1											eri	ð
9975																				1									r n	lal
9990																													ne	s
10005		1		1																1									<u> </u>	с
10020																		7											to	la
10035																		2											a	gin g
10050		1		1														4				1	_						to	lar
10065																													Lit	2
10095													L																	
10125		1		1					2									1	1											
10140	1																	3	1	1										
10155		1				7							-					10		1										
10260		1		1			1			1			-					1		1		<u> </u>				<u> </u>				
10275		2		2									1					2		1						1 I.				

Table 2: Foraminifera distribution chart,	hiozonation ag	e and nalecenvironment (of Ash-3 Well
Table 2. For annihiler a distribution charty	, biozonación, ag	, c and pareoen in omnene	or right-5 with

1 1	9915																												IOZ	ï.
10005 1 <td></td> <td>U</td> <td>Ë</td>																													U	Ë
10005 1 <td></td> <td>riti</td> <td>≥</td>																													riti	≥
10005 1 <td></td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>ne</td> <td>≗</td>			1					1										1											ne	≗
10005 1 <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>J.</td> <td>ha</td>																				1									J.	ha
10005 1 <td></td> <td>Ĕ</td> <td>s</td>																													Ĕ	s
10005 1 <td></td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>.=</td> <td>¥</td>			1		1															1									.=	¥
10005 1 <td></td> <td>¥</td> <td>a</td>																													¥	a
10005 1 <td></td> <td>ral</td> <td></td>																													ral	
10005 1 <td></td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td>4</td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>tō</td> <td>lar</td>			1		1													4				1							tō	lar
10130 1 1 1 2 2 2 1 <td></td> <td>Ľ</td> <td>2</td>																													Ľ	2
10105 1																														
1 1 7 1 1 7 1 1 7 1			1		1				2																					
Market		1																	1											
00000 0	10155					7														1										
							1			1																				
10305 1			2		2													2		1										
10510 1																														
Matrix Matrix <td></td> <td>0</td> <td></td>																													0	
Matrix Matrix <td></td> <td>Ğ</td> <td>-</td>																													Ğ	-
Matrix Matrix <td></td> <td>ž</td> <td>Ľ.</td>																													ž	Ľ.
Matrix Matrix <td></td> <td>a</td> <td>are Bre</td>																													a	are Bre
Matrix Matrix <td></td> <td>to to</td> <td>Ξ</td>																													to to	Ξ
10695 1 2 1 1 1 3 1 <td></td> <td>ž</td> <td></td> <td>Ē</td> <td></td>																											ž		Ē	
10695 1 2 1 1 1 3 1 <td></td> <td>'n</td> <td>ů.</td> <td></td> <td></td>																											'n	ů.		
10695 1 2 1 1 1 3 1 <td>10620</td> <td></td> <td>Z</td> <td>ö</td> <td></td> <td></td>	10620																										Z	ö		
10695 1 2 1 1 1 3 1 <td></td> <td>Ē</td> <td>lige</td> <td></td> <td></td>																											Ē	lige		
10695 1 2 1 1 1 3 1 <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>8</td> <td>0</td> <td>ne</td> <td>e</td>																		1									8	0	ne	e
10000 1 2 0 <td></td> <td>2</td> <td></td> <td>zo</td> <td>i,</td>																											2		zo	i,
10000 1 2 0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>itic</td> <td>Ĕ</td>										1																			itic	Ĕ
10000 1 2 0 <td>10755</td> <td></td> <td></td> <td></td> <td>7</td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Jer</td> <td>≥</td>	10755				7													1		1									Jer	≥
10000 1 2 0 <td></td> <td></td> <td>17</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>er</td> <td>ĭ</td>			17																				1						er	ĭ
10000 1 2 0 <td></td> <td></td> <td></td> <td></td> <td>_</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td>ũ</td> <td>ų</td>					_																			1					ũ	ų
10860 1 2 0 0 1 1 0 1 0 0 1 0 0 1 0 0 0 1 0 <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td>																				1									-	
10860 1 2 0 0 0 1 0 <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td>ţi</td> <td>ne</td>																						1		1					ţi	ne
10875 2 2 1 <td>10860</td> <td></td> <td>1</td> <td></td> <td>eri</td> <td>nar</td>	10860		1																										eri	nar
10890 1 <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>5</td> <td>ž</td>																		1					-						5	ž
10905 1 - <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Jne</td> <td>allo</td>					1																		1						Jne	allo
10920 1 <td></td> <td></td> <td>1</td> <td></td> <td>o.</td> <td>, sh</td>			1																										o.	, sh
10935 1 <td></td> <td>alt</td> <td>멸</td>																													alt	멸
10950 1 <td></td> <td></td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td>ore</td> <td>gina</td>				1							1												1		1				ore	gina
10965 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 3 1 <td></td> <td>Lit</td> <td>larg</td>																													Lit	larg
10980 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 5 1 2 3 1 1 1 1 11115 11 7 2 1 1 1 3 2 1 1 1 11125 1 2 2 1 3 2 1 1 1 111280 2 2 3 1 1 1 1				<u> </u>			—								<u> </u>		-													2
11010 1 7 4 1 5 1 2 4 1 5 1 2 5 1					1			l				l	-	l	<u> </u>	I	I				l	1			_				dle	eep
11115 11 7 0 1 1 5 1 2 3 1 1 1 11265 1 2 0 0 0 1 3 0 1 1 11265 1 2 0 1 1 1 3 0 1 1 1 11280 2 2 0 1 1 1 1 1 1					<u> </u>	 <u> </u>	——	l				<u> </u>	L .	-	<u> </u>	<u> </u>	I				l								mic	tod
11200 1 2 1 1 1 1 11280 2 2 1 1 1 1 1	11115			—								1	1	5	1	2	-					1	_			-			r to	NO
										-			-	-	-	-	1					-	1			1			nne	hall
	11280		2		2	I	I	I		1	L		<u> </u>		I	2	L	1			I	1		1					-	s

Itiowe K. and Lucas F.A.: Foraminiferal Biostratigraphy and Paleoenvironmental Study of the Sediments Penetrated...

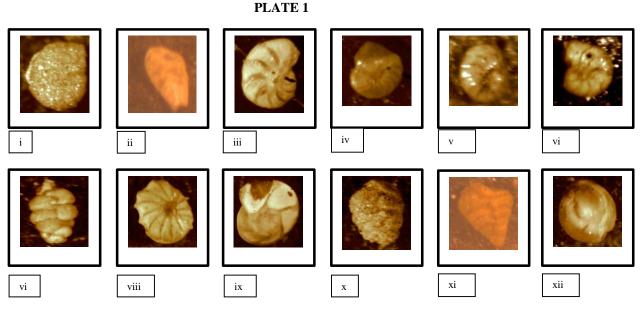


PLATE 1

(i) Alveolophragmium crissum, (ii) Bolivina dertonensis, (iii) Cibicorbis inflate (iv) Florilus atlanticus,
(v) Florilus costiferum, (vi) Hanzawaia concentrica, (vii) Hopkinsina bononiensis, (viii) Lenticulina grandis,
(ix) Lenticulina inornata, (x) Poritextularia panamensis, (xi) Spiroplectaminna wrightii,
(xii) Spirosigmoilina oligocaenica.

Salinity

The salinity for Ash-3 well was deduced from the alpha diversity index plot. This has to do with the amount of benthonic foraminifera species in standard-sized sample (Nwojiji, 2014). It has been established that lower the alpha index value, the shallower the marine condition, while the higher the alpha index value, the deeper the marine environment (Nwojiji, 2014). The number of individuals and number of species against depth for Ash-3 Well is shown in Table 3.The alpha diversity index for Ash-3 Well ranges from $\alpha 2 - \alpha 5$ (Figure 3). This therefore indicates that the salinity during the deposition of Ash-3 Well was within the hyposaline marshes – hyposaline shelf sea, which implies that the salinity of the water condition during this time was abnormally low salinity.

•••••••••••••••••••••••••••••		No. Of Individuals		_		
0 0 0 0 7203 0 0 0 0 8100 0 0 0 0 0 8233 0 0 0 0 0 0 0 8235 0	6030	0	0			
7240 0 0 7240 0 0 8280 0 0 9383 2 2 9383 2 2 9383 2 2 9383 2 2 9383 2 2 9383 2 2 9383 2 2 9383 2 2 9383 0 0 93930 2 3 93930 2 3 93930 2 2 93930 2 3 93930 2 2 93930 2 3 93930 2 3 93930 2 3 93930 2 3 93930 2 3 100020 7 4 100033 2 4 100033 2 4 100030 0 0 100330 0 0 100330 0 0 100330 0 0 100330 0 0 100330 0 0 100330 0 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td></t<>						
B300 0 0 B320 0 0 B320 0 0 B333 0 0 B333 0 0 B333 0 0 B320 1 1 P3283 2 2 P3283 2 1 100050 7 4 100050 7 4 100220 0						IRAPUR
B300 0 0 8380 0 0 0 0 0 8833 0 0 9285 1 1 9285 2 2 9285 0 0 9275 0 0 9275 0 0 9275 0 0 9275 0 0 9275 2 2 92800 5 3 92825 2 2 92825 2 2 92820 0 0 92825 2 2 92820 0 0 0 1 0 92825 2 2 92980 0 0 0 0 0 100020 7 1 1 1 100020 7 4 100020 7 4 100020 7 4 100020 7 4 100020 7 4 100020 1 1 100020 1 1 100020 1 1 100020						LEGEND
8280 0 0 0 8333 0 0 0 8833 0 0 0 9883 2 2 2 9860 0 0 0 9983 2 2 2 9960 0 0 0 99725 3 3 3 9775 3 4 1 9883 0 0 0 99930 0 0 0 99930 0 0 0 99930 0 0 0 99930 0 0 0 99930 0 0 0 99930 0 0 0 100000 3 3 3 100000 7 4 0 100000 7 4 0 100000 7 4 0 100000 0 0 0 100000 0 0 0 0 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
8833 0 0 0 8810 0 0 0 8955 0 0 0 9855 2 2 0 9866 0 0 0 9966 0 0 0 9970 0 0 0 9775 2 2 2 9780 0 0 0 9775 2 2 2 9865 0 0 0 9780 0 0 0 9781 1 1 0 9865 0 0 0 9980 0 0 0 9980 0 0 0 100005 3 3 1 100005 3 3 1 100005 7 4 1 100005 0 0 0 100005 0 0 0 100005 0 0 0 0 100205						
8830 0 0 0 9923 1 1 1 9923 2 2 0 9923 0 0 0 9923 0 0 0 9925 3 1 1 9925 3 1 1 9925 3 1 1 9925 3 1 1 9925 3 1 1 9926 2 2 1 9926 2 2 1 9926 2 2 1 9926 2 2 1 9926 2 2 1 100000 7 4 1 100000 7 4 1 100000 7 4 1 100000 7 4 1 100000 7 4 1 100000 7 4 1 100000 5 5 5 100000 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
8955 0 0 9285 1 1 9385 2 2 9660 0 0 9775 0 0 9775 0 0 9775 0 0 9775 0 0 9775 0 0 9775 0 0 9775 0 0 9875 2 1 9875 2 2 9935 0 0 9935 0 0 9935 0 0 9935 0 0 9935 0 0 9935 0 0 10020 2 1 10020 2 1 10125 2 5 10220 0 0 10220 0 0 10220 0 0 10303 0 0 10303 0 0 10305 0 <t< td=""><td></td><td></td><td></td><td></td><td></td><td>or two spaces in the</td></t<>						or two spaces in the
9285 1 1 9585 2 2 9660 0 0 9775 0 0 9775 3 3 9775 0 0 9775 0 0 9775 2 2 9980 0 0 9975 0 0 9975 0 0 9975 2 2 9980 0 0 9975 2 2 9980 0 0 100020 7 1 100025 3 3 100020 7 1 100025 0 0 100025 0 0 10140 6 4 10225 6 5 10325 0 0 10325 0 0 10325 0 0 10325 0 0 10325 0 0 103050 0 <td></td> <td></td> <td></td> <td></td> <td></td> <td>to - Ranin Format</td>						to - Ranin Format
9885 2 2 9660 0 0 9705 0 0 9705 0 0 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9705 8 4 9825 24 6 9930 0 0 9930 0 0 9930 0 0 9930 0 0 9930 0 0 10095 0 0 10095 0 0 101095 0 0 10225 6 5 10225 6 5 10225 0 0 10305 0 0 10305 0 0 10305 0 0 10305 0 0 103050 1 103050						of the second second second
9660 0 0 9675 0 0 9705 0 0 9725 3 3 9725 3 4 9810 1 1 9825 2 6 9842 0 0 9930 0 0 9930 2 2 9990 0 0 100005 3 3 100005 3 3 100005 7 4 100005 7 4 100005 7 4 100005 7 4 100005 7 4 100005 7 4 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0 100005 0 0						201 00000000000000000000000000000000000
36975 0 0 3705 0 0 37705 0 0 37705 0 0 37725 3 3 37725 2 2 38805 0 0 39305 5 3 39305 0 0 39305 2 2 39305 2 2 39305 2 2 39305 2 2 39305 2 2 39305 2 2 39305 3 3 100200 2 1 101025 20 5 10225 6 5 10225 7 4 10225 0 0 10225 0 0 10225 0 0 10305 0 0 10305 0 0 10305 0 0 103050 0 0 106665						
9600 0 0 9705 0 0 9725 3 3 9725 3 3 9725 3 3 9725 3 3 9725 3 3 9725 3 3 9725 2 0 9820 0 0 9825 0 0 99350 0 0 99353 2 2 99350 0 0 99350 0 0 100005 3 3 99350 0 0 100005 7 4 100055 0 0 101005 7 4 10020 0 0 101005 0 0 101005 0 0 101005 0 0 101005 0 0 101050 0 0 101050 0 0 101050						8 83
9705 0 0 97755 8 4 9825 24 6 9880 1 1 9825 24 6 9880 0 0 9930 5 3 9931 0 0 9932 0 0 99343 2 2 9950 3 3 100020 7 1 100035 2 1 100050 7 4 100055 0 0 10122 6 5 10205 7 4 10205 7 4 10205 7 4 10205 7 4 10205 0 0 10275 7 4 10220 0 0 10350 0 0 10355 0 0 10350 0 0 104665 1 1 10565 <t< td=""><td></td><td></td><td></td><td>100</td><td></td><td>- Achada Form</td></t<>				100		- Achada Form
9785 3 3 9785 3 4 9800 3 1 9825 0 0 9825 0 0 9825 0 0 9825 0 0 9930 0 0 9935 0 0 9935 0 0 9935 0 0 9935 0 0 9935 0 0 10005 3 3 9975 2 2 9936 0 0 10005 7 1 10005 7 4 10005 0 0 10100 6 4 10220 0 0 10330 0 0 10352 0 0 10352 0 0 10353 0 0 10356 0 0 10357 3 2 103665 0				20		- Aguada ronn
9765 8 4 9810 1 1 9825 24 6 9885 0 0 9885 0 0 9930 0 0 99343 2 2 9930 0 0 9930 0 0 10005 3 3 10020 7 1 10025 2 1 10025 7 4 10025 0 0 10125 6 5 10125 0 0 10220 0 0 10225 7 4 10220 0 0 103030 0 0 103050 0 0 103050 0 0 103050 0 0 103050 0 0 103050 0 0 1040665 1 1 10500 0 0 10665					n6	
9820 1 1 9825 24 6 9885 0 0 9900 5 3 9925 0 0 9925 2 2 9926 3 3 99275 2 2 9920 0 0 10005 3 3 10020 7 1 10025 2 1 10025 2 1 10025 0 0 10025 0 0 10025 0 0 10225 6 5 10220 7 4 10225 7 4 10225 0 0 10225 0 0 10225 0 0 10225 0 0 10225 0 0 10230 0 0 10230 0 0 10230 0 0 <td></td> <td></td> <td></td> <td></td> <td>ω</td> <td></td>					ω	
3820 1 1 9825 24 6 9826 0 0 9920 5 3 99215 0 0 99236 2 2 99245 2 2 99260 3 3 99275 2 2 99200 0 0 100005 3 3 100005 3 3 100055 2 1 100055 7 4 100055 0 0 101225 6 5 10125 6 5 10220 0 0 103035 0 0 10250 0 0 10305 0 0 10325 0 0 10326 0 0 10325 0 0 10326 0 0 10325 0 0 10326 0 0 10725				N		
9885 0 0 9900 5 3 99215 0 0 99235 2 2 9926 3 3 99275 2 2 99200 0 0 10005 3 3 99275 2 2 10005 3 3 10025 2 1 10025 2 1 10025 2 1 10025 2 1 10025 2 1 10025 2 1 10025 2 1 10025 0 0 10126 6 5 102275 7 4 10220 0 0 10323 0 0 10324 0 0 10305 0 0 103060 0 0 103060 0 0 10665 1 1 10785	9810		1	12		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $			6			
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	9885		0	U I		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				137)		
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				m	1 10,	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $				10	AN A P	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10330 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10665 1 1 10680 0 0 10055 1 5 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 109965 0 0 1010965					100 / 105	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	9960			h		
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	9975			* 15	Av I	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	9990	0	0			
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	10005	3	3	e	100 100	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	10020	7		50	1.00	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100		2	1	1		
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100		7	4			
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100				2	1.5	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10535 0 0 10530 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 101010 0 0 111115						
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	10125	6	5		(W), (V) (3	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	10140	6		2 - E	1 1 1 1 M	
10260 5 5 10275 7 4 10230 0 0 10305 0 0 10315 0 0 10535 0 0 10545 0 0 10550 0 0 10550 0 0 10550 0 0 10655 1 1 10665 1 1 10665 1 1 10680 0 0 10695 8 4 10775 11 5 10770 18 2 10800 2 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 109965 0 0 10100	10155	20	5	0		
10275 7 4 10290 0 0 10305 0 0 10535 0 0 10530 0 0 10531 0 0 10532 0 0 10533 0 0 10550 0 0 10550 0 0 10555 0 0 10665 1 1 10665 1 1 10665 1 1 10665 1 1 10775 18 2 10770 18 2 10800 3 2 10800 2 2 10800 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10100	10260	5	5			
10290 0 0 10305 0 0 10515 0 0 10530 0 0 10545 0 0 10560 0 0 10575 0 0 10560 0 0 10575 0 0 10665 1 1 10665 1 1 10665 1 1 10665 1 1 10705 11 5 10770 18 2 10770 18 2 10800 3 2 10800 3 2 10800 2 2 10800 2 2 10905 0 0 10920 0 0 10950 0 0 10980 2 2 10980 2 2 10980 2 2 11010 0 0 11115	10275	7	4	1 10		
10515 0 0 10530 0 0 10545 0 0 10545 0 0 10557 0 0 10550 0 0 10555 0 0 10665 1 1 10665 1 1 10665 1 1 10665 1 1 10665 1 1 10755 11 5 10770 18 2 10800 3 2 10800 3 2 10800 3 2 10800 3 2 10800 3 2 10800 2 2 10905 0 0 10920 0 0 10935 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11255	10290					
10545 0 0 10560 0 0 10575 0 0 10590 0 0 10620 0 0 10635 0 0 10665 1 1 10665 1 1 10665 1 1 10705 11 5 10770 18 2 10785 0 0 10815 5 4 10800 3 2 10800 3 2 10800 3 2 10800 4 3 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11265 9 8	10305	0	0	· · · · · ·		
10545 0 0 10560 0 0 10575 0 0 10590 0 0 10620 0 0 10635 0 0 10665 1 1 10665 1 1 10665 1 1 10705 11 5 10770 18 2 10785 0 0 10815 5 4 10800 3 2 10800 3 2 10800 3 2 10800 4 3 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11265 9 8	10515	0	0			
10545 0 0 10560 0 0 10575 0 0 10590 0 0 10620 0 0 10635 0 0 10665 1 1 10665 1 1 10665 1 1 10665 1 1 10705 11 5 10770 18 2 10785 0 0 10800 3 2 10800 3 2 10800 3 2 10800 2 2 10800 2 2 10800 2 2 10800 2 2 10905 0 0 10935 4 4 10950 0 0 10980 2 2 11010 0 0 11115 31 9 11255 9 8	10530	0	0			
10575 0 0 10590 0 0 10620 0 0 10635 0 0 10663 1 1 10680 0 0 10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10800 3 2 10875 3 2 10860 4 3 10875 3 2 10890 2 2 10995 0 0 10950 0 0 10965 0 0 10965 0 0 10965 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9		0				
10575 0 0 10590 0 0 10620 0 0 10635 0 0 10663 1 1 10660 0 0 10695 8 4 10755 11 5 10770 18 2 10800 3 2 10875 3 2 10875 3 2 10800 2 2 10800 2 2 10890 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10996 0 0 10980 2 2 11010 0 0 11115 31 9 11255 9 8	10560	0	0	S ず		
10590 0 0 10620 0 0 10635 0 0 10665 1 1 10665 1 1 10665 1 1 10765 11 5 10770 18 2 10785 0 0 10800 3 2 10800 3 2 10800 3 2 10800 3 2 10800 4 3 10875 3 2 10905 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11265 9 8		0				
10620 0 0 10635 0 0 10665 1 1 10680 0 0 10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10855 5 4 10860 4 3 10875 3 2 10890 2 2 10890 2 2 10995 0 0 10995 0 0 10995 0 0 10980 2 2 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11265 9 8				A 1/		
10635 0 0 10665 1 1 10680 0 0 10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10800 3 2 10875 3 2 10890 2 2 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10995 0 0 10996 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8				P 2		
10665 1 1 10680 0 0 10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10815 5 4 10820 2 2 10890 2 2 10990 0 0 10920 0 0 10950 0 0 10965 0 0 10965 0 0 10965 0 0 10100 0 0 11115 31 9 11255 9 8						
10680 0 0 10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10855 5 4 10860 4 3 10875 3 2 10890 2 2 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11265 9 8	10665	1	1	A 5		
10695 8 4 10755 11 5 10770 18 2 10785 0 0 10800 3 2 10815 5 4 10800 4 3 10875 3 2 10890 2 2 10995 0 0 10935 4 4 10950 0 0 10965 0 0 10965 0 0 10960 2 2 11010 0 0 11115 31 9 11255 9 8					8	
10770 18 2 10785 0 0 10800 3 2 10815 5 4 10860 4 3 10875 3 2 10905 0 0 10920 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11255 9 8				1. i	18	
10770 18 2 10785 0 0 10800 3 2 10815 5 4 10860 4 3 10875 3 2 10905 0 0 10920 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 10980 2 2 10980 2 2 11010 0 0 11115 31 9 11255 9 8				IC 📍		
10785 0 0 10800 3 2 10815 5 4 10860 4 3 10875 3 2 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10965 0 0 10965 0 0 10965 0 0 10106 0 0 11115 31 9 11265 9 8						
10800 3 2 10815 5 4 10860 4 3 10875 3 2 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8				1		
10815 5 4 10860 4 3 10875 3 2 10900 2 2 10920 0 0 10935 4 4 10950 0 0 10980 2 2 10980 2 2 11015 31 9 11265 9 8				11 🖬	XY	
10860 4 3 10875 3 2 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10965 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11255 9 8					N N	
10873 3 2 10890 2 2 10905 0 0 10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11255 9 8				6	0	
10890 2 2 10905 0 0 10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8				v T	8	
10905 0 0 10920 0 0 10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8						
10920 0 0 10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8				\$		
10935 4 4 10950 0 0 10965 0 0 10980 2 2 11010 0 0 11115 31 9 11265 9 8						
10980 Z Z 11010 0 0 11115 31 9 11265 9 8				10	100 500 1000	
10980 Z Z 11010 0 0 11115 31 9 11265 9 8				10	100	
10980 2 2 11010 0 0 11115 31 9 11265 9 8				1975	Number of individual	
11010 0 0 11115 31 9 11265 9 8				1		
11115 31 9 11265 9 8				1		
11265 9 8				1		
				1		

 Table 3: Number of individuals and number of species against depth for Ash-3 Well

Figure 3: Number of species against number of individuals forms for #3 Well

CONCLUSION

Foraminifera biostratigraphy and paleoenvironmental study of the sediments of Ash-3 Well shows that two foraminifera zones which are N4-N5 and lower N2-N4 Zones were identified and the age of the sediments ranges from Oligocene to Early Miocene. The paleoenvironmental study based on recovered benthic foraminiferal association revealed that the sedimentary sequences were deposited in environments ranging from marginal marine (littoral zone) to deep marine environments (middle neritic zone). The salinity during the deposition of the sediments of Ash-3 Well was within the hyposaline marshes – hyposaline shelf sea, which implies that the salinity of the water condition during this time was abnormally low salinity.

REFERENCES

- Adegoke, O. S., Dessauvaige, T. F. J. and Kogbe, C. A. (1971). Planktonic Foraminifera in Gulf of Guinea Sediments; Micropal., *Jour. Min. Geol.* 17(2): 197-213.
- Ajayi, E. O and Okosun E. A. (2014). Planktic Foraminiferal Biostratigraphy of A, B, C, D Wells, Offshore Niger Delta, Nigeria. American International Journal of Contemporary Research. 4(6): 108-120.
- Bandy, O. L (1967). Relationship of Neogene planktic foraminifera to paleoceanography and correlation. *Proc. 1st Intern. Conf. Planktic microfossils, Geneva*, 19671: 199-442.
- Blow, W. H. (1969). Late Miocene to Recent Planktonic Foraminifera Biostratigraphy. In Brönnimann, P. and Renz, H. H. (Eds.), Proceedings First Int. Conf. on Planktonic Microfossils, Geneva, 1:199-422.
- Blow, W. H. 1979. The Cenozoic Globigerinida, Leiden, E.J. Brill., 3 vol. 1413 p.
- Bolli, H.M. and Saunders, J.B. (1985).
 Oligocene to Holocene low latitude planktic foraminifera. In, H.M. Bolli, J.B. Saunders and K. Perch-Nielsen (Eds.), *Plankton Stratigraphy*. Cambridge University Press, pp. 155-262.
- Fadiya, S. L., Jaiyeola-Ganiyu, F. A. and Fajemila, O. T. (2014). Foraminifera Biostratigraphy and Paleoenvironment of Sediments from Well AM-2, Niger Delta. *Ife Journal of Science*. 16 (1): 61-72.

- Fayose, E. A. (1970). Stratigraphical paleontology of Afowo-1 well, southern Nigeria. *Journal of Mining and Geology Nigeria*, 5(1):1-97.
- Gebhardt, H. (2006). Resolving the Calibration Problem in Cretaceous Benthic Foraminifera Paleoecological Interpretation: Cenomanian to Coniacian Assemblages from the Benue Trough Analyzed by Conventional Methods and Correspondence Analysis. 52 (2): 151-176.
- Lucas F. A, Efiebuke E. O., Omodolor H E. and Benedict O.A. (2016). Chemostratigraphy: Major/Minor Elemental Ratio Trends in Goml-1 Well Benin Flank in the Northern Delta Depobelt Nigeria (A Case Study of Na:Zn And K:Mn.). International Journal of Sciences: Basic and Applied Research (IJSBAR), 28 (3): 204-216.
- Murray, J.W. (1974). Distribution and Ecology of Living Benthic Foraminiferids, Heinemann Educational Books, London, 274 p.
- Murray, J.W (1991). Ecology and paleoecology of benthic foraminifera, John Wiley & Sons Inc., New York, 397p.
- Nwaejije, E. C., Obiosio E. O. and Hamidu I. (2017). Foraminifera biostratigraphy and paleoenvironment of Well 5, OML 34, Niger Delta, Nigeria. *Palaeontologia Electronica*. 20.3.51A: p.1-17.
- Nwojiji, C.N., Osterloff, P., Okoro O., Ndulue G. (2014). Foraminiferal Stratigraphy and Paleoecological Interpretation of Sediments penetrated by Kolmani River-1 Well, Gongola Basin, Nigeria. *Journal of Geosciences and Geomatics*, 2014, 2(3):85-95.
- Obaje, S. O. and Okosun E. A. (2013). Planktic Foraminiferal Biozonation and Correlation of XY-1 Field,

Itiowe K. and Lucas F.A.: Foraminiferal Biostratigraphy and Paleoenvironmental Study of the Sediments Penetrated...

Offshore Western Niger Delta, Nigeria. *International Journal of Science and Technology*. 3(3): 160-166.

- Ogbe F. G. A. (1974). The stratigraphy and foraminifera of Lower Tertiary of Southern Nigeria. (Unpublished Dissert), Univ. Coll. London.
- Reijers, T. J. A., Petters S. W. and Nwajide C. S. (1996). The Niger Delta Basin, in: T.J.A. Reijers (ed.), Selected Chapters on Geology: SPDC corporate reprographic services, Warri, Nigeria, pp. 103-114New York, 397p.
- Short, K. C. and Stauble, A. J. (1967). Outline Geology of Niger Delta: *AAPG Bulletin*, 51:.761-779.