



**DINOFLAGELLATE CYST  
BIOZONATION FOR LATE CRETACEOUS –  
TERTIARY SUCCESSION OF GBEKEBO-1 WELL,  
BENIN FLANK, ANAMBRA BASIN, NIGERIA.**

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**LUCAS, F.A AND ISHIEKWENE, E**  
*Department of Geology, University of Benin,  
Benin- City, Nigeria*

**ABSTRACT:** A detailed palynological study of 50 ditch cuttings recovered from Gbekebo-1 well yielded biostratigraphically significant dinoflagellate cysts. Interpretation of the first and last occurrences of the recovered dinoflagellate cyst assemblages allowed the delineation of the stage boundaries and erection of fourteen informal dinoflagellate cyst assemblage biozones. The biozones from bottom to top are as follows: *Paleocystodinium australinum* biozone-A, *Svalberdella* sp. biozone-B, *Senegalinium microgranulatum* biozone-C, *Alterbidinium* minor biozone-D, *Diphysis colligerum* biozone-E, *Damassadinium californica* biozone-F, *Apectodinium homomorphum* biozone-G, *Fibrocysta lappacea* biozone-H, *Adnatosphaeridium vittatum* biozone-I, *Achomosphaera ramulifera* biozone-J, *Apectodinium quinquelata* biozone-K, *Spiniferites ramosus* biozone-L, *Polysphaeridium congregatum* biozone-M and *Spinidinium margaritae* biozone-N respectively. The biozonation has potentials for the recognition of Maastrichtian / Danian / Selandian / Thanetian /Ypresian / Lutetian stage boundaries respectively. The Cretaceous/Tertiary boundary is at depth intervals 904-905m based on the first stratigraphic occurrence of *Damassadinium californica*

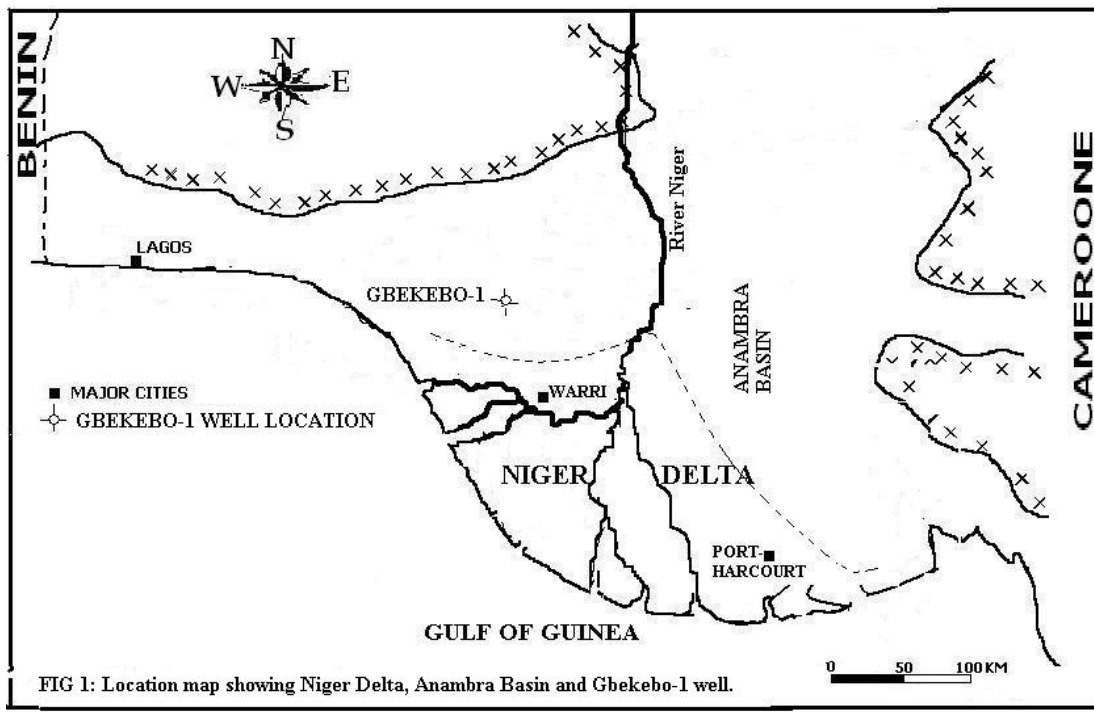
### **INTRODUCTION**

The erection of the biozones of the well (Gbekebo-1) is based essentially on the diagnostic dinoflagellate cyst assemblages observed within the various sections of the studied interval. Gbekebo-1 well is an exploratory well, which was drilled by Shell-BP Petroleum Development Company of Nigeria. It is located within the Benin Flank of the Anambra basin in Southern Nigeria (Fig. 1). On the basis of the stratigraphic distribution of the recovered dinoflagellate cysts in the well, a palynological range chart suitable for erection of the fourteen biozones was generated, (Fig. 2) The Cretaceous section was characterized into four biozones (A, B, C, D and E), the Paleocene section- six biozones (F, G, H, I, J and K) and the Eocene section- three biozones (L, M and N) respectively. Hitherto, the Nigerian Paleocene is poorly characterized contrary to the agreement reached in the 1984 meeting of International Sub-commission on Paleogene Stratigraphy (ISPS) as well as in accordance with the outcome of the 1993 symposium on the stratigraphy of the Paleocene (Schmitz, 1994). This work is therefore an effort to also characterize the Nigerian Paleocene Epoch into three globally acceptable stages- Danian, Selandian and Thanetian respectively.

### **MATERIALS AND METHODS**

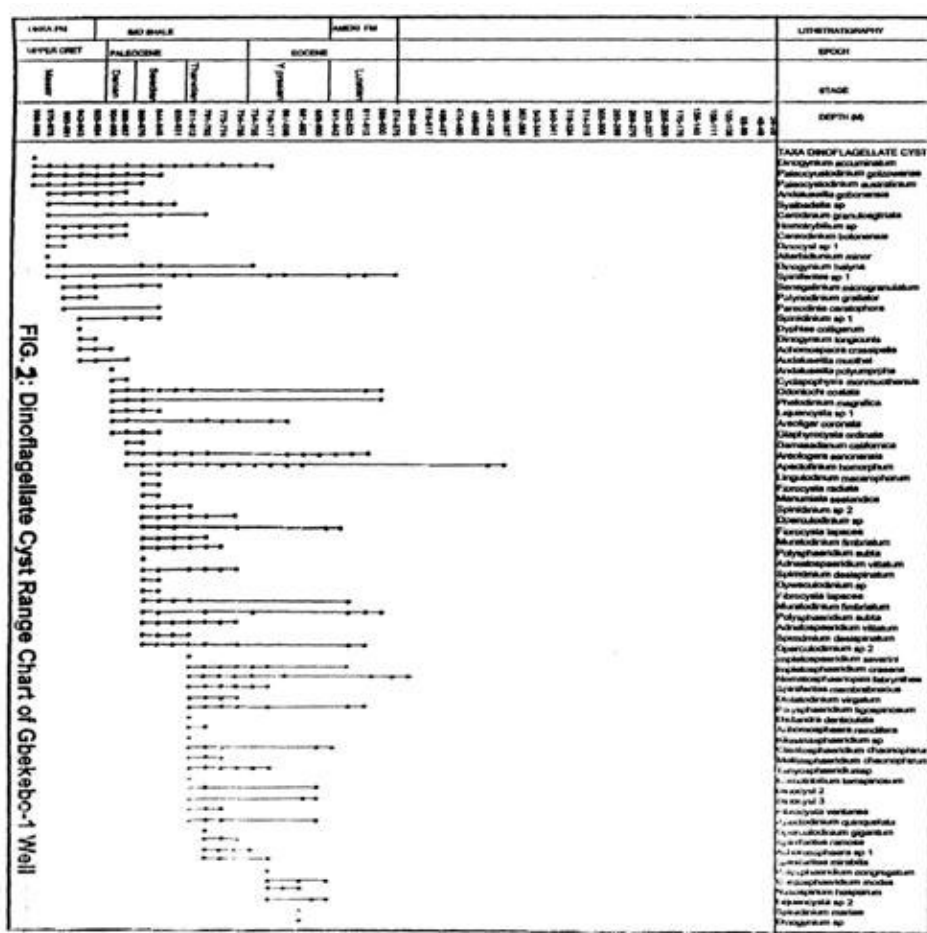
A total of fifty ditch cuttings from the different depth intervals of Gbekebo-1 well were identified collected and sampled (Fig. 2) The sampling covered 3.35 to 998.999 metres depth. From each depth-interval, about 10gms was weighed, thoroughly washed/cleaned. The pre-treatment of the samples with various Acid combinations include removal of unwanted carbonate material by washing with 10ml diluted hydrochloric acid as well as further treating the residue with 60% hydrofluoric acid and boiling hydrochloric to dissolve/ remove all

silicates and silicofluoride gel respectively. The ultrasonic centrifuge machine further separated out the dissolved material (i.e. dirt, clay, mud etc) from the organic matter residue for 2 minutes. Subsequently, three drops of safranin allow for proper mixing and then pipette into a cover slip glass slide on top of the hot plate until dryness and was ready for palynological microscopic evaluation.



### Geological Setting

The Anambra Basin is a Cretaceous/Tertiary basin, which is the structural link between the Cretaceous Benue Trough and the Tertiary Niger Delta basin. Spatially, it is the sedimentary wedge bordered by the Abakaliki anticlinorium to the East, the Basement rock and the Benue hinge line to the north and northwest respectively. The Basin originated as a fault-controlled depression within the Basement complex of the African shield. Maximum sedimentation in the depression occurred in the Benue Trough and its enclon equivalent, the Abakaliki trough. However, there was a structural inversion of the Abakaliki Trough through the structural movement of the Coniacian - Santonian times (Benkheilil, 1989). The movement led to the formation of depression on its two flanks. The small Afikpo syncline on the southeast and much wide Anambra basin on the Northeast. (Cratchley and Jones, 1965; Reymont, 1965, Grant, 1971; Murat, 1972) Anambra basin derives its sediments from the erosion of the Abakaliki anticlinorium, which had become the major site of deposition in the late Cretaceous-Eocene time. The Southern position of the Anambra basin in downwarped and overlapped by thick Tertiary deposits of the Niger Delta.



## RESULTS AND DISCUSSIONS

### PALYNOSTRATIGRAPHY

Stratigraphic distribution of significant dinoflagellate cysts are displayed in Fig. 2. Interpretation of this distribution from bottom to top has yielded fourteen informal biozones ranging in age from Maastrichtian to mid Eocene (Table 1). The biozones are defined based on the use of the first and last occurrences of at least one species. The biozones are compared with those proposed by Oloto (1984) and Hansen (1977).

### DINOFLAGELLATE CYST ZONES

#### *Paleocystodinium australinum* biozone-A

Reference section: 998-999m.

**Definition:** Species appearing within this zone include *Paleocystodinium golzowense*, *P. australinum*, *Dinogymium acuminatum* and *andalusiella gabonensis*

This zone represents the base of the well. As a result, species having their first appearances are difficult to differentiate. However, top of the zone is defined by the first appearance of *Svalberdella* sp.

TABLE 1: DINOFLAGELLATE CYST BIOZONATION OF GBEKEBO-1 WELL.

LITHOSTRATIGRAPHY	AGE		DEPTH (M)	ZONE CODES	DINOFLAGELLATE CYST ZONES	
	EPOCH	STAGE				
NSUKKA FM	UPPER CRET	MAAST	34-35			
			46-49			
			85-88			
			105-108			
			108-111			
			138-140			
			170-176			
			205-208			
			233-237			
			268-270			
			293-299			
			305-308			
			314-318			
			319-324			
			332-334			
			340-341			
			343-344			
			367-368			
			386-387			
			437-438			
459-462						
474-480						
496-497						
516-517						
538-535						
554-555						
574-575						
599-560						
AMEKI FM	Eocene	Lutetian	611-612	N	<i>Spondinium mariae</i>	
			622-623			
			641-642			
			659-660	M	<i>Polysphaeridium congeratum</i>	
			683-682			
		Ypresian	697-698			
			716-717	L	<i>Spongerites ramosus</i>	
			735-736			
			754-755	K	<i>Apectodinium spinosaccharitum</i>	
			773-774	J	<i>Deflandra denticulata</i>	
IND SHALE	PALEOCENE	Thanetian	811-812			
			830-831	I	<i>Adiantosphaeridium rittorum</i>	
			844-845	H	<i>Fibrococconeis lapocera</i>	
		Selandian	869-870	G	<i>Apectodinium homomorphum</i>	
			886-887	F	<i>Exaniosodinium californica</i>	
	Danian	904-903				
		923-924	E	<i>Diphyxis colligerum</i>		
		942-943	D	<i>Polymedusium gratiosum</i>		
	NSUKKA FM	UPPER CRET	MAAST	960-961	C	<i>Senegalinium microgranulatum</i>
				979-980	B	<i>Svalberdella sp</i>
994-990				A	<i>Paleocystodinium australium</i>	

**Svalberdella sp.** Biozone-B

Reference section: 979-982m.

**Definition:** The base of this zone marks the top of biozone-A. It is characterized by the first appearance of *Svalberdella sp.* *Cerodinium granulostrata*, *Homotribylium sp.*, *Cerodinium boloniensis*. Common species include *Paleocystodinium golzowense*, *P. australinum* and *Andalusiella granulostrata*.

**Senegalinium microgranulatum** biozone-C

Reference section: 960-961m

**Definition:** The base is the same as the top of biozone-B. It is marked by first appearance of *Senegalinium microgranulatum*, *Alterbidinium minor*, *Dinogymnium hyaline*; *Spiniferites sp.* Common species include *Cerodinium boloniensis*, *dinocyst sp.1* and *Svalberdella sp.*

**Alterbidinium minor** biozone -D

Reference section: 942-943m

**Definition:** The base of the zone is the same as the top of biozone-C. Common species include *Senegalinium microgranulatum* and *Alterbidinium minor*.

**Diphyxis colligerum** biozone-E.

Reference section: 923-924m.

**Definition:** The base is the top of biozone-D. It is marked by the first appearances of *Andalusiella mouthei*, *Andalusiella polymorpha*, *Dinogymnium longiscunis* and *Diphyxis colligerum*. The extinction of *Dinogymnium longiscunis* is in this biozone.

Zones A-E above are within the P-100 of Evamy *et al* (1978) Niger delta biozonation scheme.

***Damassadinium californica*** biozone-F

Reference section: 886-887m.

**Definition:** The base is the same as the top of biozone –E. It is marked by first appearances of *Damassadinium californica*, *Cyclapophysis monmouthensis*, *Odontochitininian costata*, *Lejeunecysta* sp. and *Glaphyrocysta* sp. commonly occurring species within the biozone include *Achomosphaera crassipelis* and *Senegalinium microgranulatum*. The extinction of *Cyclapophysis monmoutensis* is in this biozone.

***Apectodinium homomorphum*** biozone-G

Reference section: 869-870m

**Definition:** The base is the same as the top of biozone –F. It is marked by the first appearance of *Apectodinium homomorphum*. Other species commonly occurring in the biozone include *Aeoligera coronata*, *Damassadinium californica* and *Phelodinium* sp.

***Fibrocysta lappacea*** biozone-H

Reference section: 844-845m

**Definition:** The base is the same as the top of biozone-G. It is characterized by the first appearances of *Fibrolcysta lappacea*, *Spinidinium* sp.2 and *Op* macrophorum erculodinium sp.2. Common species include *Lingulodinium* and *Damassadinium californica*.

***Adnatosphaeridium vittatum*** biozone-I

Reference section: 830-831m

**Definition:** The base is the same as the top of biozone-H.It is characterized by the first appearances of *Adnatosphaeridium vittatum*, *impletosphaeridium severinii* and *Diphyses colligerum*.

***Achomosphaera ramulifera*** biozone-J

Reference section: 773-774m

**Definition:** The base is the same as the top of biozone-I. It is characterized by the first appearance of *Achomosphaera ramulifera*.

***Apectodinium quinquelatum*** biozone-K

Reference section: 754-755m

**Definition:** The base is the same as the top of biozone –J. It is marked by the first appearance of *Apectodinium quinquelatum*. Common species include *Paleocystodinium golzowense* *Nematosphaeropsis labyrinthea* and *Spiniferites membranaceous*. The extinction of *Achomosphaera ramulifera* is in this biozone.

Zones F-K above are within the P-200 of Evamy *et al* (1978) Niger delta biozonation scheme.

***Spiniferites ramosus*** biozone-L

Reference section: 735-736m

**Definition:** The base is the same as the top of biozone-K. It is characterized by the first appearance of *Spiniferites ramosus* and *Spiniferites mirabilis*. Common species include *Apectodinium quinquelatum* and *Melitasphaeridium chaonophorum*.

***Polysphaeridium conregatum*** biozone-M

Reference section: 659-660m.

**Definition:** The base is the same as the top of biozone-M. It is characterized by the first appearance of *Polysphaeridium congregatum* and *Cordosphaeridium inodes*. The extinction of *Achomosphaera* sp.2 is in this zone.

### ***Spinidinium mariae*** biozone-N

Reference section: 622-623m.

**Definition:** The base is the same as the top of biozone-M. This was marked by the first appearance of *Spinidinium mariae*. The extinction of *Apectodinium homomorphum* is in this biozone.

Zones L-M above are within the P-330 to P-420 of Evamy *et al* (1978) Niger delta biozonation scheme.

### **Age of Biozones**

Palynological analyses of ditch cutting samples of exploratory Gbekebo- 1 well has allowed the erection of fourteen dinoflagellate cyst biozones. Maastrichtian age was assigned to biozones A to E on the basis of recognized diagnostic dinocyst assemblages within the section 998-999m and 904-905m. Dinoflagellate cysts recovered in this section of the well include species of *Andalusiella*, *Cerodinium*, *Paleocystodinium* and *Dinogymnium*. The foregoing species were used to delineate Maastrichtian sections in different parts of the world by Jain *et al* 1975, Drugg (1967), Jain and Millipied, (1973). The Paleocene age was assigned to biozones F to G on the basis of recognised Paleocene diagnostic species recovered between intervals 904-905m to 754-755m. These are *Damassadinium californica*, *Apectodinium homomorphum*, *Cerodinium granulostriata*, *Delandrea denticulata*, *Homotryblidium tenuispinosus* and *Spinidinium densispinatum*. The Paleocene was subdivided into three stages- Danian, Selandian and Thanetian respectively. The Cretaceous/Tertiary boundary was placed at depth 904-905m based on the first stratigraphic occurrence of *Damassadinium californica* which is global event for the delineation of Cretaceous/Tertiary boundary. The Danian/Selandian was recognized at 869-870m based on the first stratigraphic occurrence of *Apectodinium homo morphum* which is global event for the delineation of Danian/Selandian boundary. The Selandian/Thanetian boundary was recognized at 830-831m based on the first stratigraphic occurrence of *Deflandrea denticulata* while the Thanetian/Ypresian boundary was recognized at 754-755m based on the first stratigraphic occurrence of *Spiniferites ramosus*, Fig.2.

Eocene age was assigned to biozones L to M. on the basis of Eocene diagnostic dinoflagellate cyst assemblage from intervals 735-736m to 622-623m. These are *Fibrocyta lappacea*, *Trivalvadinium* species, *Impletosphaeridium Ligospinosum* and *Operculodinium bellum*. Drugg (1970) recorded *Fibrocyta lappacea* from Eocene of Gulf Coast. Islam (1983) also described *Trivalvadinium* sp., *Impletosphaeridium Ligospinosum* and *Operculodinium bellum* from southeast England and assigned Eocene age to the section studied. Therefore, the occurrence of these dinoflagellate cysts in the study intervals 735-736 to 622-623m agrees with the findings of Drugg (1970) and Islam (1983), thus an Eocene age was assigned to this interval.

### **CONCLUSION**

Appraisal and evaluation of dinoflagellate cyst recovered from Gbekebo-1 well, allowed the erection of fourteen informal biozones ranging in age from Maastrichtian to Lutetian. Maastrichtian age was assigned to biozone A to E on the basis of recognized diagnostic dinoflagellate cyst assemblages within the section. Also biozones F to K was dated Paleocene and biozones L to N dated Eocene on the basis of various dinoflagellate cysts recovered in the various sections studied. The Paleocene Epoch was characterized into three- Danian, Selandian and Thanetian in line with standard global stratigraphic scale. This study has therefore streamlined the various disparities inherent in the characterization of the Paleocene Epoch of the Nigerian sedimentary basins.

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