IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 8, Issue 1 Ser. I (Jan – Feb 2020), PP 01-19
www.iosrjournals.org

Palynological and Paleoenvironmental Study of the Tertiary Formations of the Audouin-Begretto Tertiary and the Bay of 'Milliardaires': South-West of The Lagoons Fault (Côte d'Ivoire)

BIÉ Goha René[1], N'ZI Jean Claude[2], GUÉDÉ Koré Elysée[3], YAO N'goran Jean-Paul[2] and DIGBÉHI Zéli Bruno[2]
[1] Jean Lorougnon Guédé University, UFR Environnement, Postal Box 150 Daloa, Côte d'Ivoire
[2] Félix Houphouët-Boigny University, UFR STRM, 22 Postal Box 582 Abidjan 22, Côte d'Ivoire
[3] Man University, UFR SGM, Postal Box 20 Man, Côte d'Ivoire
Corresponding Author: BIÉ Goha René

Abstract: *The palynological and paleoenvironmental study of tertiary age deposits are crossed by two hydraulic boreholes located at southwest of the "lagoon fault" on the coastal basin of Abidjan (Côte d'Ivoire) where fifty (50) pairs of thin palynological blades were examined. This study revealed an exceptional richness of these samples in spores and pollen grains associated with rare dinokysts that revealed an Association with Danea californica (Danien), an Association to Apectodinium quinquelatum and Apectodinium homomurphum (Selandian-Thanétian), an Association to Kallosphaeridium yorubaense, Adnatosphaeridium multispinosum, (Lutetian-Bartonian), an Association to Proxapertites operculatus (Priabonian) and an Association to Laevigatosporites ovatu (Aquitanian-Burdigalian). Paleoenvironmentally, sediments have evolved in an internal coastal nerine environment throughout the wells, depending on eustatic movements.*
Keywords*: Paleoenvironment, palynology, Audouin-Begretto,* ***,*** *Palynological Association, Côte d'Ivoire*

Date of Submission: 27-12-2019 Date of acceptance: 11-01-2020

I. Introduction

Since the 2000s, the Laboratory of Marine Geology and Sedimentology of the Training Unit and Research of Earth Sciences and Mining Resources (UFR-STRM) of the Felix Houphouet Boigny's University of Abidjan has initiated several works research on the Ivorian Sedimentary Basin with a view of better understanding this basin. These studies are carried out in collaboration with PETROCI and since 2017 with the Laboratory of Science and Environmental Techniques of the Training and Research Unit (UFR) Environment University Jean Lorougnon Guédé.

Palynologically, the recent work of [1] identified Oligocene in the Ivorian onshore basin north of the lagoon fault through a dinoflagellate assemblage dominated by the genus Lejeunecysta. That same part of the Ivorian sedimentary basin has been biostratigraphicaly study by [2], which was identified through spores and pollen grains of the Late Eocene and Miocene in sub-surface deposits regions of Bingerville and Assinie. Also, [3] proposed a local palynological scale of the upper Maastrichtian-Eocene interval of the Ivorian offshore sedimentary basin. Other even more recent works by [4] demonstrated Oligocene at Bingerville on the basis of palynomorphs such as Retitricolporites irregularis, Pachydermites diederixii, Crototricolporporites densus, Occulopollis magnoporus, Perfotricolporites digitatus, Polypodiaceoisporites simplex, Striatopollis bellus, Operculodinium centrocarpum, Spiniferites ramosus, Lejeunecysta lata, Lejeunecysta globosa, Selenopemphix nephroides and Selenopemphix quanta.

These previous studies generally relate to the palynostratigraphy and the reconstitution of the palaeoenvironments of the formations of different wells studied from the palynomorphs, encountered and the lithological characteristics of these formations. However, a better characterization of training repository environments requires new methodological approaches. Indeed, the analysis of the Dinocyst groups characteristic of the Inner Neritic (IN) and Outer Neritic (ON) environments is now an effective means for determining eustatic sea level sediment deposition and variation environments. This method coupled with the sedimentological data was considered necessary in this work to refine the depositing conditions of the Audouin-Begretto (AB) and the Bay of Milliadaires (BM) wells located at southwest of the lagoons fault (Côte d'Ivoire).

II. Presentation Of The Area And Location Of Wells

The study area is located at the southwest of the lagoon fault in the Ivorian onshore basin between the Ebrié lagoon and the Atlantic Ocean. Two (2) water wells named Audouin-Begretto (AB) and 'Bay of Milliadaires (BM) whose coordinates and depths are recorded in Table 1 are drilled in 2017. The two wells are twelve (12) kilometers apart (Figure 1).

Table 1: Geographical coordinates in UTM of the studied wells

Well	depth (m)	Longitude	Latitude
AB	109 m	373 699 W	584 821 N
BM	153 m	382 610 W	581 977 N

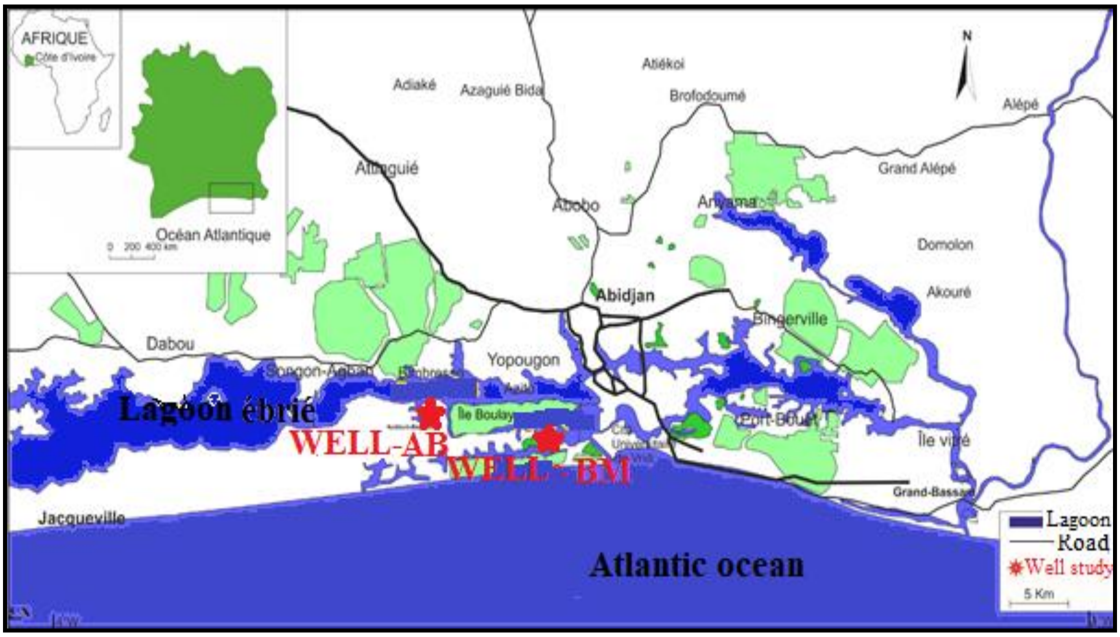


Figure 1: Presentation of the study area and location of the AB and BM wells.

III. Material And Methods

Fifty (50) cuttings samples from two hydraulic soundings AB (Audouin-Beugretto) and BM (Bay of Miliadaires) constitute the bulk of the material used for this study.

These excavations were the subject of a lithological analysis and a palynological preparation for a palynological analysis. The lithostratigraphic analysis consisted of a macroscopic description of the fresh samples and a description with a binocular magnifying glass of the washed samples on a column of four (4) sieves of respective mesh size 500µm, 250µm, 125µm and 63µm and then dried in at 90°C in the oven to determine the levels of sand, clay and sandstone. A detailed lithological log is thus established. This lithological study is coupled to a calcimetric study which aims to determine the calcium carbonate content in the samples. This study calcimetric that can better characterize levels clay, limestone levels and nature of sandstone cements.

The palynological approach consisted in attacking twenty (20) grams of each sample with strong acids (HCl and HF) in order to destroy the mineral matter and conserve the organic matter. After the attacks, each sample is washed on a mesh of 10 µm. The sporopollenic residue obtained is mounted between slides and coverslip and then observed under an optical microscope in order to count and identify the palynomorphs present on the slide.

The palaeoenvironmental determination is based on the relative proportions of dinocysts (marine organisms) relative to spores and pollen grains (continental organisms) in the palynological assemblage [5]. A succeeded, the Sporomorphes ratio (S)/dinocysts Acritarchs and (D) or S/D indicates the continental or marine influence on the deposition environment. It is also calculated with the formula of [6] according to which the ratio (S/D) can be written $S/D = nS/(nD + nS)$ with n=number. The environment deposition is also determined based on the relative proportions of certain intra-specific groups of dinocysts that have a distribution preference following a neritic to oceanic transect.

The ratio between the number of autotrophic dinocysts and that of the heterotrophic or ratio Peridinioides/Gonyaulacoides (P/G) (P/G=nP/ (nP + nG) according to Versteegh (1994) provides information on the productivity of the surface of the sea.

Also, the ratio between the number of dinocysts characterizing the internal neritic media (IN) and that of the dinocysts characterizing the external neritic media (ON) or IN / ON ratio is used to provide information on the paleo-depth and is calculated according to the formula: IN / ON = nIN / (nIN + nON) [6], [7], [8].

IV. Results and discussion

IV.1 Lithological Study

IV.1.1 Lithologic And Calcimetric Case Study Of The Well BM

Lithological analysis of cuttings from the BM well also revealed three units, B1, B2 and B3 (Figure 2). From the base to the summit, there are:

- Unit B1 consists of gray-dark clay sand (N2) rich in glauconite, pyrite and carbonaceous debris.
- Unit B2 of 104 consists of clay of various colors (black, dark green, light green, gray to dark, yellow-brown) with levels more or less rich in limestone, carbonaceous debris, pyrite, in shell debris and in glaucony.
- Unit B3 consisting of clay sand and sandy clay and some white sandbanks. This unit is poor in limestone, carbonaceous debris, pyrite and glauconite.

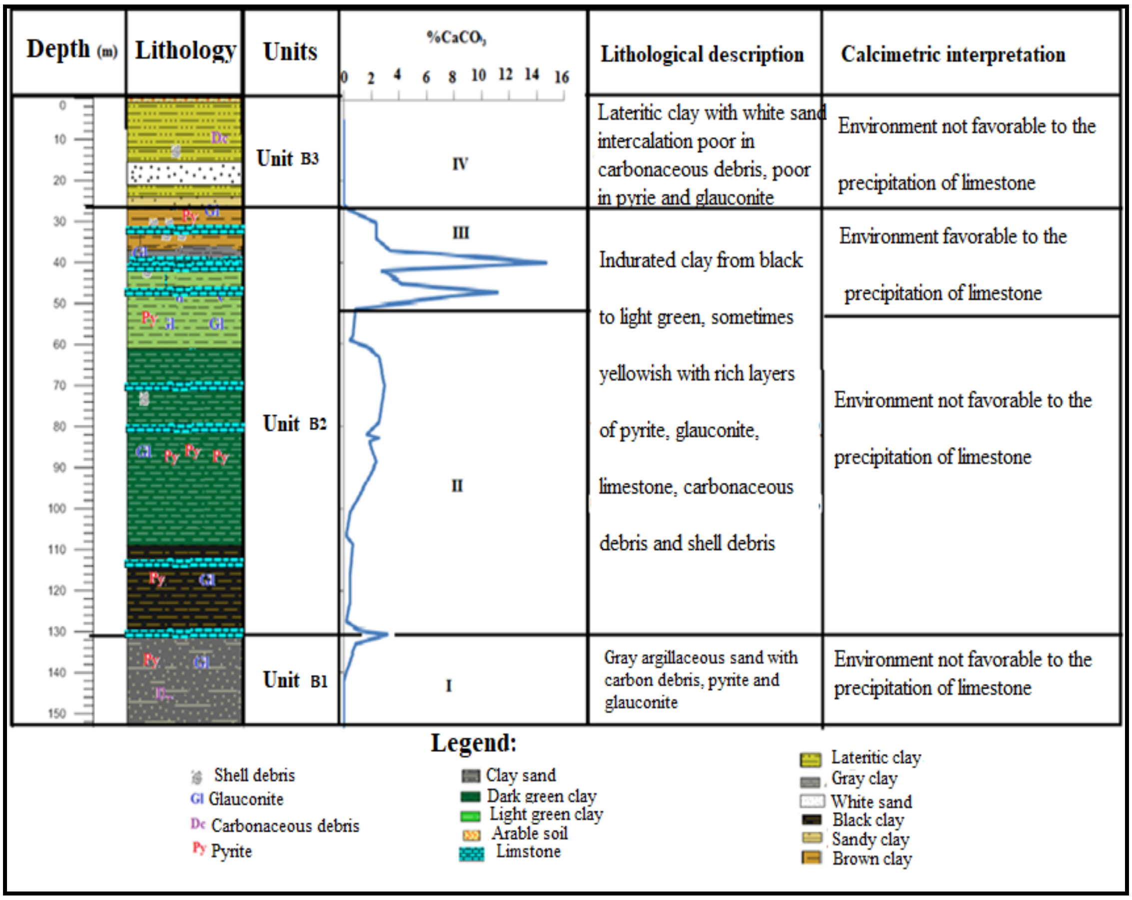


Figure 2: Lithological and calcimetrical log curve of the BM well

IV.1.2 Study the lithologic and calcimetric wells AB

The lithological analysis of this well revealed three units (A1, A2 and A3) characterized by four lithological facies (Figure 3) including mixed sediments (sandy clays and clay sands), sandy levels, lateritic clays and the bar ground according to the direction of sedimentation. Mixed sediments have a $CaCO_{33}$ content of between 2 and 7%. The others are devoid of calcium carbonates (Figure 3).

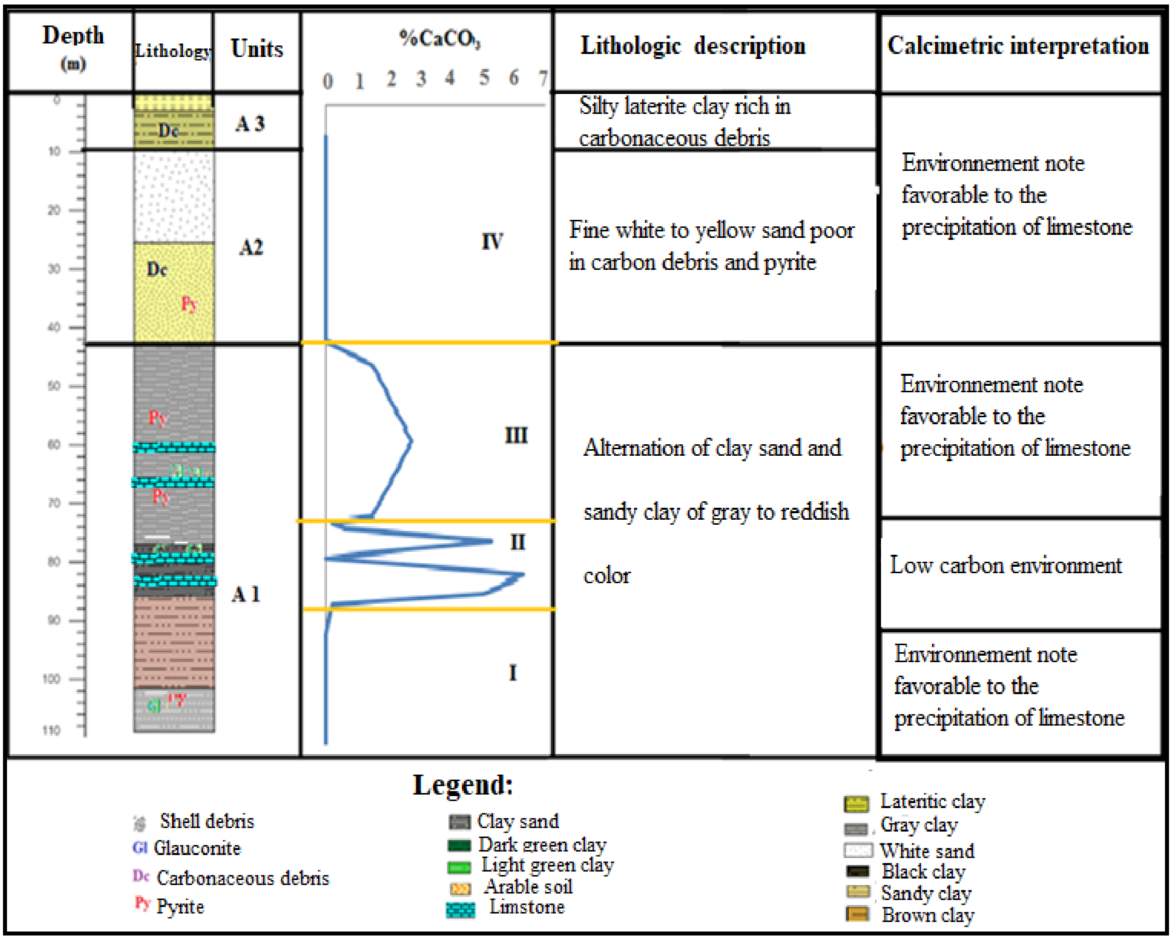


Figure 3: Lithological and calcimetrical log curve of the AB well

IV.2 Palynological study

Palynological analysis of drill cuttings from the AB and BM study intervals revealed a diverse palynoflora as a whole. Some are of stratigraphic interest and have made it possible to characterize different stages. The others were used to determine palaeoenvironmental conditions.

Quantitative analysis of palynomorphs involving thirty-five (35) pairs of palynological blades of the BM well and fifteen (15) pairs of palynological slides of the AB well made it possible to count 2122 spores and pollen grains, 1484 dinoflagellate cysts and 40 foraminiferal basals whose distribution by well and by type of palynomorphs is given in Table **2**. Tables 3 to 5 give details of these accounts of palynomorphs per well and sampled ratings.

Table 2: Inventory of palynomorphs obtained by wells

Well	Dinokystes	Spores and pollen grains	foraminiferal basals	Acritarches
AB	200	668	00	3
BM	1284	1454	40	5
Total	1484	2122	40	8

Table 3: Quantitative Distribution of Dinocysts in the BM Well

STAGES	DEPTH (m)	DINOCYSTS																															
		Cerodinium diebelii	*Danea californica*	*Phelodinium magnificum*	*Palaeocystodinium australinum*	*Senegalinium bicavatum*	*Palaeocystodinium golzowense*	*Aeroligera senonensis*	*Apectodinium spp.*	*Cordosphaeridium inodes*	*Homotryblium tenuispinosum*	*Apectodinium quinquelatum*	*Homotryblium abbreviatum*	*Cleistosphaeridium diversispinosum*	*Apectodinium quinquelatum*	*Kallosphaeridium yorubaense*	*Fibrocysta axialis*	*Cometodinium obscurum*	*Cordosphaeridium fibrospinosum*	*Lejeunecysta lata*	*Lejeunecsta pulchra*	*Apectodinium homomurphum*	*Adnatosphaeridium multispinosum*	*Muratodinium fimbriatum*	*Cordosphaeridium gracile*	*Hafniasphaera septata*	*Operculodinium centrocarpum*	*Spiniferites ramosus*	*Cribroperidinium exilicristatum*	*Batiacasphaera sp.*	*Polysphaeridium sp.*	*Polysphaeridium subtile*	*Microforaminifère*
Aquitanien-Burdigalien	29																										18		2	10			4
	37																										22	2		4			2
	41																										12	4	2	6			4
Priabonien	54																									8	20	2	4	6			2
Lutétien-Bartonien	61																12	10	12	6	8	24	46	12	26	8	22	18	12	30	8	8	6
Yprésien	85											2	2	2	2	64	2	2	8			10	2	2	2	4	8	10	2	6	2		
	96									4	4	2		4	2	58		2	8	2		10	4		2	6	4	12	2	10		4	
Sélandinien-Thanétien	103								2		2	4			4	28	2	4	6	2	4	4	2	4		8	4	4		12		4	4
	109							2	2	2			2	2		20	8		4	4		6				6	6		4	2	2		2
	114						2	2	2	4	4	4	2		4	6	2		4			2	6	2		6	8		8	4		2	
	125						2		2	2		12	2		12	2	2	2			4			2		4	4		10	10			2
Danien	131	2	2	4	4	2	4	2	6			2		10	2	28	2		10	14	2	4		4		14	10			2	10		6
	141									2	2	2			2	18			6	2	2	4		2		6	2			6	4		4
	153	4	2					2				4	2		4		4	12	6			8		8		14	18	2		20			4
TOTAL		6	4	4	4	2	8	8	14	14	12	32	10	18	32	224	34	32	64	30	20	72	60	36	6	84	##	54	46	128	26	18	40

Table 4: Quantitative distribution of spores and pollen grains in the BM well

STAGES	DEPTH (m)	SPORES AND POLLEN GRAINS																																				
		Camarozonocolpites ambigens	*Foveotriletes margaritae*	*Longapertites marginatus*	*Periretisyncolpites giganteus*	*Longapertites inornatus*	*Monosulcites sp.*	*Margocolporites rauvolfii*	*Spinizonocolpites echinatus*	*Tricolpites americana*	*Bombacaccidites bombax*	*Proxapertites operculatus*	*Proxapertites cursus*	*Mauritiidites crassibaculatus*	*Psilatricolpites crassus*	*Momipites sp.*	*Crassaroretitriletes vanraadshooveni*	*Pachydermites diederixi*	*Striattopollis catatumbus*	*Cupressacites hiapitites*	*Deltoidospora delicata*	*Retitricolporites irregularis*	*Polyadopollenites microreticulatus*	*Polypodiaceoisporites regularis*	*Baculatisporites sp.*	*Laevigatosporites ovatus*	*Psilatricolporites laevigatus*	*Deltoidospora minor*	*Monocolpites marginatus*	*Verrucatosporites usmensis*	*Leiotriletes ardriensis*	*Monocolpopolenites sp.*	*Polygalacidites sp.*	*Retitricolporites sp.*	*Triorites festatus*	*Spirosyncolpites spiralis*	*Echitricolporites trianguliformis*	*Retitriporites sp.*
Aquitanien-Burdigalien	29															2	4	4		4	4	4		4		6	4			10	6	4		8	2			
	37															2	2	6	4	2	10		2		6	14	2	14		4	2	4	2	2			2	2
	41														2	2		2	4	4	8	2	2		2	10	2	2	2	2	4	4		2	2			2
Priabonien	54									6	2	14	6	6	2	2	2	4	2	2	4	2	2		2	8		2	4	2		4	2		2		2	2
Lutétien-Bartonien	61						12	10	6	2	2	12	22	2	2				6	2	2	4	2	8	2	24	2	24	6	4			2	6	2	4	4	12
Yprésien	85						8	6	2	6		10	6												2			2	2									
	96						6	2	2	2	2	8	6												2			2	2			2						
Sélandinien-Thanétien	103	2		16		2		2				2	2			2												2	2				2	2				
	109	8		8	2	2		6				2		2												8						2		6		6	6	2
	114	12	20	20	10			2				6	38	10		2								2		10	2	2	4	4	2	2	2	6			2	2
	125	4	2	12				2	6			6	10			2										2		4	2				2	4				
Danien	131	12	22	26	12	2	4					24	38	10										2		12		18	4	4	2	2	2	4				
	141	4	8	8		6						14	20	10										10		28		6	10	10	2	6	2	6		8	8	6
	153	8	16	14	6	4	40					6	14	26													2	12	12	14	2	12	6	10				4
TOTAL		50	68	104	30	16	70	30	16	16	6	104	162	66	6	14	8	16	16	14	28	12	8	26	16	122	14	90	50	54	20	48	18	56	8	18	24	32

Table 5: Quantitative evolution of dinocysts, spores and pollen grains in the well AB

STAGES	DEPHT (m)	DINOCYSTS							SPORES AND POLLEN GRAINS																							
		Batiacasphaera sp.	*Cleistosphaeridium sp.*	*Operculodinium centrocarpum*	*Fibrocysta axialis*	*Cordosphaeridium fibrospinosum*	*Polysphaeridium sp.*		*Verrucatosporites usmensis*	*Laevigatosporites ovatus*	*Leiotriletes ardriensis*	*Pachydermites diederixi*	*Polyadopollenites microreticulatus*	*Monocolpollenites sp.*	*Psilatricolporites sp.*	*Inaperturopollenites sp.*	*Monocolpites marginatus*	*Proxapertites operculatus*	*Crassoretitriletes vanraadshooveni*	*Retitricolporites sp.*	*Spirosyncolpites spiralis*	*Baculatisporites sp.*	*Retitriporites sp.*	*Proxapertites cursus*	*Psilastephanocolporites sp.*	*Striattopollis catatumbus*	*Mauritiidites crassibaculatus*	*Cingulatisporites sp.*	*Camarozonocolpites ambigens*	*Deltoidospora minor*	*Magnastriatites howardi*	*Margocolporites rauvolfii*
Aquitanien-Burdigalie	44	28		10			28		24	20			18	16		6	2		4	8	2		2		2	14		12		4		4
	52	10	8	18					8	56	2			20			12		4	2						2		4	16	18	2	2
Priabonien	65	4	2	14			2		8	8	2	2		14	4		2	8	2	2	12	2	8	10	6	6		8	6	10	2	
	68			8					6	12	4	2		6	4			8		4			2		4	2			8	12		
Lutétien-Bartonien	80	4		6	6	4	2			4	6	4	2	12		2	4	14		16		8		12		2	4	2	6	16		
	85	12		2	2		16		4	2	4		2	4			4	6		2				6			4				2	
	102	4		2	8					6	4			2						2				16		2						
TOTAL		62	10	60	16	4	48		50	108	22	8	22	74	8	8	24	36	10	36	14	10	12	44	12	28	8	26	36	60	6	6

IV.3 Palynostratigraphy

Palynoflora palynostratigraphic study revealed six (6) palynological associations covering the Danian-Aquitanian interval, based on the presence of reference palynomorphs.

- **Danea californica Association**

This association is only found in the BM well, between 153 m to 131 m. It is marked by the presence of dinocysts as Danea californica, Cerodinium diebelii, Phelodinium magnificum, Palaeocystodinium australinum, Palaeocystodinium golzowense and Senegalinium bicavatum.

The continental influence in this group is manifested by the presence of Foveotriletes margaritae, Longapertites marginatus, Monocolpites marginatus, Mauritiidites crassibaculatus and Ambiguous Camarozonocolpites.

This head Association dated Danian (lower Paleocene) on the basis of the last apparition of species Cerodinium diebelii, Palaeocystodinium australinum, Danea californica and Senegalinium bicavatum. In fact, the species Cerodinium diebelii and Senegalinium bicavatum are, according to reference of author [9], good markers of Maastrichtian and Lower Paleocene (Danian). In Maastrichtian, it is associated with Andalusiella and Cerodinium granulostriata. The absence of these in the meantime indicates a lower Paleocene age. In addition, the last occurrence of Cerodinum diebelii marks the end of the Danian to reference of authors [10 - 11]. This has been confirmed in recent work in Côte d'Ivoire, by Awad and to references of authors [8, 12] and [13] in the Fresco region, and then by reference of author [14] in the Eboinda region.

The species Danea californica, is a characteristic species of Danian in most basins of the world to reference of author [9]. The first appearance of this species is a good marker of the base of the Danian and the K-Pg boundary in the Northern Hemisphere to reference of authors [15 - 20]. In Côte d'Ivoire, the works of reference of authors [8, 13, 14] have highlighted the Danian with the presence of the species Danea californica.

- **Apectodinium. Association**

This palynological association characterized by the abundance of the genus Apectodinium spp. Especially Apectodinium homomurphum and Apectodinium quinquelatum. It is also specific to the BM well where it is encountered in the range 131 m to 96 m. It is marked by the appearance of dinocysts such as Homotryblium tenuispinosum, Cribroperidinium exillicristatum and Adnatosphaeridium multispinosum. Some species, present in the preceding interval, persist and develop. This is, Hafniasphaera Septata, Kallosphaeridium yorubaense, Muratodinium fimbriatum, Paleocystodinium golzowense, and Fibrocysta axialis.

The continental influence in this group is manifested by the presence of spores and pollen grains such as Foveotriletes margaritae, Longapertites marginatus, Monocolpites marginatus, Mauritiidites crassibaculatus, Camarozonocolpites ambigens, Proxapertites operculatus, Proxapertites cursus and Margocolporites rauvolfii.
This set is dated Upper Paleocene (Sélandien-Thanétien) on the basis of the disappearance of species characteristic of the lower Paleocene.

The dissociation between the Selandian and the Thanetian could not be done, for lack of characteristic species. However, the recent occurrences of Cerodinium diebelii and Danea californica mark the Danian-Selandian limit, thus the beginning of the Selandian as evidenced by the works of reference of author [8, 13 and 21]. Regarding the Paleocene-Eocene limit, it is characterized by the assemblage of dinocysts dominated by the genus Apectodinium in Argentina and Chile [22]. The FAD of Apectodinium spp. Is a well-known global bio-event, recorded between Sélandien and Thanétien of reference of authors [8 and 13].

- **Kallosphaeridium yorubaense Association**

This Association is characterized by the abundance of the genus Kallosphaeridium yorubaense. It is specific to the BM well and covers the range 96 m to 61 m.

In this Association, some species already present in the first set persist such as Apectodinium homomurphum, Adnatosphaeridium multispinosum, Hafniasphaera septate and Muratodinium fimbriatum.

A few rare spores and pollen grains of the genus Bombaccacidites bombax, Tricolpites Americana and Baculatisporites sp., make their first appearance.

This set is dated from Ypresian on the basis of the latest occurrences of the species Apectodinium quinquelatum, Apectodinium paniculatum and Kallosphaeridium yorubaense.

In fact, the species Kallosphaeridium yorubaense is characteristic of the Danian-Ypresian stages in many works. Its abundance is related to the Ypresian and last occurrence brand Ypresian-Eocene boundary means to reference of authors [18, 23 and 24] and [1, 8, 12, 18, 21, 23 and 24]. Also, this last occurrence coincides with that of the species Apectodinium quinquelatum which is related to the Ypresian in the works of references of authors [23, 25, 26, and 27].

- **Adnatosphaeridium multispinosum Association**

This set is characterized by both the abundance of the species Adnatosphaeridium multispinosum and the disappearance of almost all dinocysts with the exception of Batiacasphaera sp, Hafniasphaera septata, Spiniferites rasmosus and Operculodinium centrocarpum.

The continental influence in this group is characterized by the appearance of the following spores and pollen grains: Retitricolporites irregularis, Momipites sp., Laevigatosporites ovatus, Deltoidospora delicata, Psilatricolporites sp., Psilatricolpites crassus, Pachydermites diederixii, Cupressacites hiapitites and Striatopollis catatumbus.

This set is dated from the Lutetian-Bartonian (Middle Eocene) and its top is fixed at 54 m in the BM well, and at 80 m in that of AB, on the basis of the last appearances of the dinocysts such as Cometodinium obscurum, Kallosphaeridium yorubaense, Muratodinium fimbriatum, Hafniasphaera septata, Cordosphaeridium gracile, Apectodinium homomurphum, Adnatosphaeridium multispinosum and Fibrocysta axialis.

The disappearance of most of the lower Eocene dinocysts, namely Apectodinium quinquelatum, to reference of author [27], and Kallosphaeridium yorubaense to reference of authors [9] at the top of the lower Eocene, confirms the basis of the Middle Eocene. In addition, the last occurrence of the species Apectodinium homomurphum, Muratodinium fimbriatum and Adnatosphaeridium multispinosum is related to the upper Eocene-Eocene limit according to reference of author [28].

The abundant Adnatosphaeridium multispinosum species at the base of this interval is, according to Lentin and William (2004), a palynomorph of the Eocene. The reference of author [21] showed that the last appearance of this species in Côte d'Ivoire is in the lower Eocene. This result was also significant in reference of [13] recent work.

- **Proxapertites operculatus Association**

This association, which extends from the 54 m to 41 m interval in the BM well and 80 m to 65 m in the AB well, is marked by the presence of species such as Proxapertites operculatus, proxapertites cursus, Pachydermites diederixi, Verrucatosporites usmensis, Psilatricolporites crassus, Retitricolporites irregularis, Deltoidospora minor, Deltoidospora delicata, Baculatisporites sp. characterizing the continental influence in these intervals. The marine influence is marked by the species Operculodinium centrocarpum, Batiacasphaera sp., Cribroperidinium excilicristatum and foraminiferal test linings.

This Association is dated from the Priabonian (Upper Eocene) on the basis of the disappearance of characteristic Lutetian-Bartonian species in this interval.

Most of the species present in these two wells are cosmopolitan Eocene and Miocene. However, species such as Verrucatosporites umensis, Pachydermites diederixii and Psilatricolporites crassus were used in Cameroon by reference of authors [29, 30], in Côte d'Ivoire, to reference of authors [2] and [21] to characterize the Upper Eocene. In addition, the species Proxapertites cursus and proxapertites operculatus are used by reference of author [30] in Ghana to characterize the upper Eocene to confirm this stage.

- Laevigatosporites ovatus Association

This association is characterized by an abundance of Laevigatosporites ovatus and the presence of the following spores and pollen grains: Polyadopollenites microreticulatus, Psilatricolporites laevigatus, Striatopollis catatumbus, Retitricolporites irregularis, Verrucatosporites usmensis, Retitriporites sp., Monocolpopollenites sp. and Crassoretitriletes vanraadshooveni.

To these spores and grains of pollen are associated marine palynomorphs consisting of Batiacasphaera sp. and Cribroperidinium exilicristatum. This set is dated lower Miocene.

Species such as Polyadopollenites microreticulatus and Psilatricolporites laevigatus were used in Cameroon by reference of author [32] and in Côte d'Ivoire by reference of author [2] to characterize the lower Miocene.

In addition, species such as Striatopollis catatumbus and Retitricolporites irregularis were used in Côte d'Ivoire by reference of authors [33] and [2] to characterize the lower Miocene. These results were approved in the recent work of reference of author [14].

From this palynological study, a local palynostratigraphic scale of the Danian - (Aquitanian-Burdigalian) interval was established (Tables 6 and 7)

Table 6: Distribution of spores and pollen grains and local palynostratigraphic scale of the Danian - Aquitanian-Burdigalian interval of the studied wells

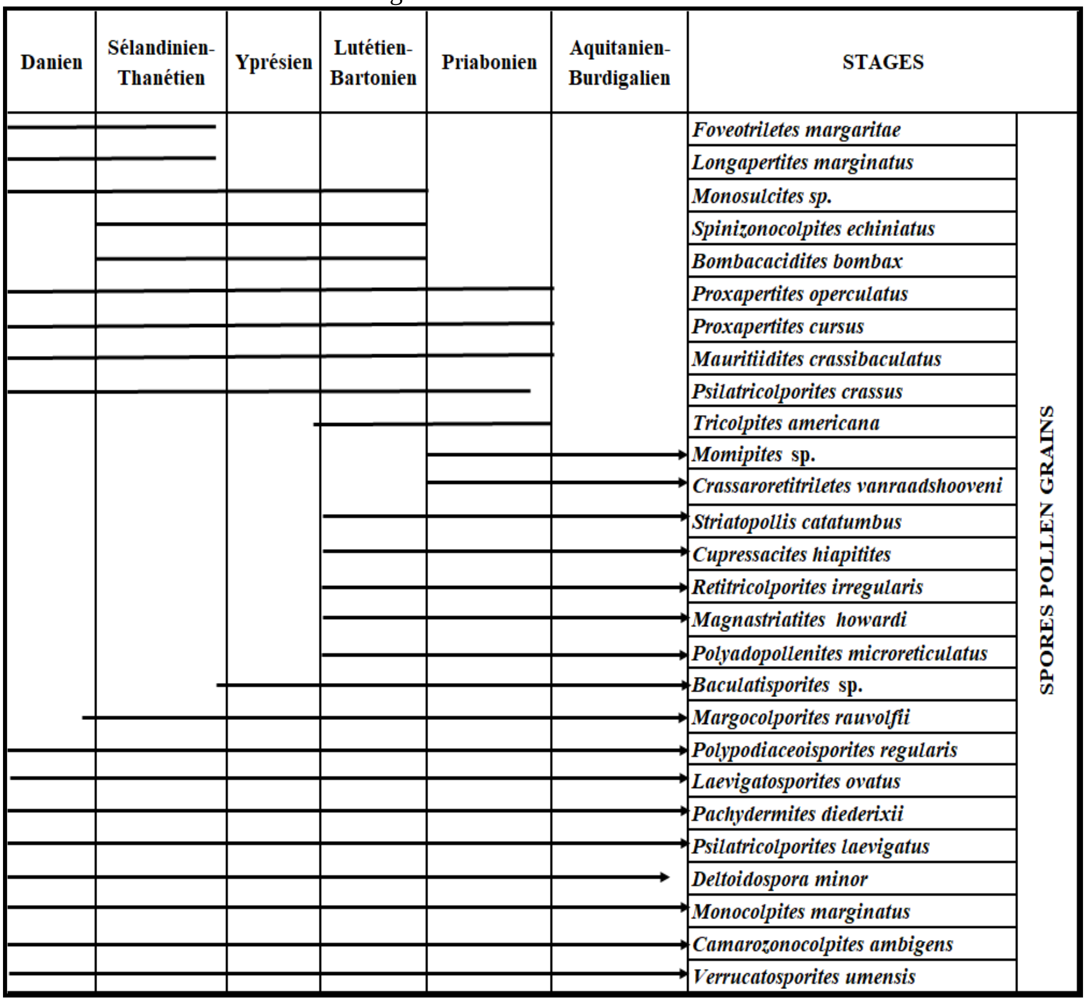


Table 7: Dinocyst distribution and local palynostratigraphic scale of the lower Danian-Miocene interval of the studied wells

Danien	Sélandinien-Thanétien	Yprésien	Lutétien-Bartonien	Priabonien	Aquitanien-Burdigalien	STAGES	
—						*Cerodinium diebelii*	DINOFLAGELLATE CYSTES
—						*Danea californica*	
—						*Phelodinium magnificum*	
—						*Paleocystodinium australinium*	
—						*Senegalinium bicavatum*	
—	—					*Paleocystodinium golzowense*	
—	—					*Apectodinium* spp.	
—	—					*Areoligera senonensis*	
—	—	—				*Cordosphaeridium inodes*	
—	—	—				*Homotryblium abbreviatum*	
—	—	—				*Homotryblium tenuispinosum*	
—	—	—				*Kallosphaeridium yorubaense.*	
—	—	—				*Apectodinium quinquelatum*	
—	—	—				*Cleistosphaeridium diversispinosum*	
—	—	—	—			*Muratodinium fimbriatum*	
—	—	—	—			*Lejeunecysta lata*	
—	—	—	—			*Lejeunecysta pulchra*	
—	—	—	—			*Cometodinium obscurum*	
—	—	—	—			*Apectodinium homomorphum*	
—	—	—	—			*Cordosphaeridium fibrospinosum*	
	—	—	—			*Adnatosphaeridium multispinosum*	
—	—	—	—			*Fibrocysta axialis*	
—	—	—	—			*Hafniasphaera septata*	
—	—	—	—	—	→	*Operculodinium centrocarpum*	
	—	—	—	—	→	*Cribroperidinium excilicristatum*	
—	—	—	—	—	→	*Spiniferites ramosus*	
—	—	—	—	—	→	*Polysphaeridium* sp.	
—	—	—	—	—	→	*Batiacasphaera* sp.	
—	—	—	—	—	→	*Microforaminifères*	Other

IV.4 Palynological correlation of AB and BM wells

Palynological data from the wells revealed three (3) storeys in the AB well (Lutetian-Bartonian to Aquitanian-Burdigalian) and six storeys in the BM (Danian to Aquitanian-Burdigalian).

Danian, Sélandinien-Thanétien and Yprésien were not found in well AB (Figure 4). Also, Oligocene was not found in both wells. This stage is completely eroded in this zone as indicated by references of authors [33] and [1] which show that the Oligocene is much eroded in the Ivorian sedimentary basin and appears only in shreds in places.

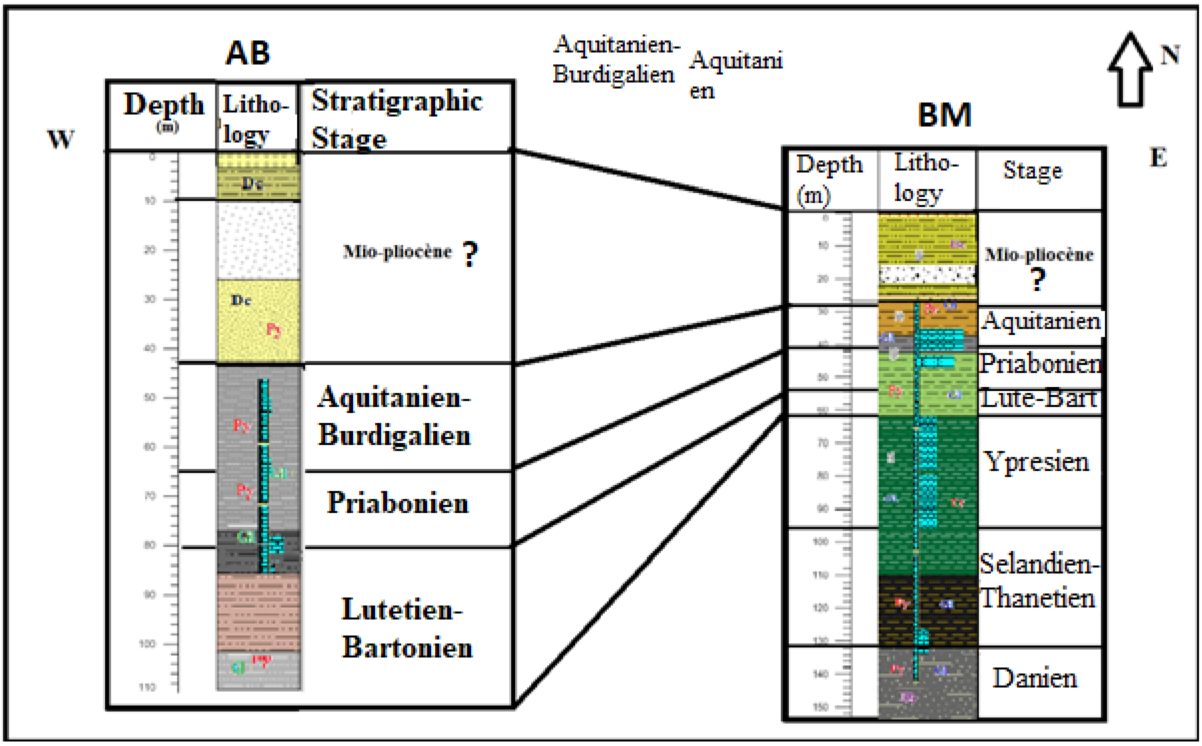


Figure 4: West-East Palynostratigraphic Correlation of AB and BM Wells

IV.5 Paleoenvironment

IV.5.1 Paleoenvironment of the BM well

IV.5.1.1 Evolution of Paleoenvironment in Danian (Lower Paleocene) and Sélandinian-Thanétian (Late Paleocene)

In these two stages, the organic matter is dominated by spores and pollen grains with a S/D ratio that varies from 0.57 to 0.65 (Figure 5) which reflects a mean continental influence on the depositional environment. The marine influence is characterized by the predominance of Gonyaulacoid group dinokists with a low Peridinioid/Gonyaulacoid (P/G) ratio ranging from 0.03 to 0.17 indicating low paleo-productivity of the sea surface in a small area deep. This shallow depth is indicated by a very high IN/ON ratio of between 0.94 and 0.97 (Figure 5). The most representative groups of dinocysts are the Fibrocysta groups (10% to 20%), the Aeroligera group (0 to 5%), the Lejeunecysta group (0 to 5%) and the Senegalinium group (0 to 5%).

The Fibrocysta Group (dominant group) typically characterizes an inner neritic depositional environment of references of authors [34, 35, 36, 37 and 38] and reference of author [7].

Also, the Areoligera Group that accompanies this group of Fibrocysta characterizes the inner and coastal neritic depositional environments reference of authors [7, 18, 34, 39, and 40].

The Lejeunecysta Group characterizes areas of high productivity references of authors [7] and [41 - 44] that of Senegalinium marking an environment of neritic deposit at oceanic. This group is associated with nutrients and high productivity levels [39, 40, 45, and 46].

Considering the high proportion of the Fibrocysta group associated with small proportions of the Areoligera, Senegalinium and Lejeunecysta groups, the depositional environment is inner neritic with low productivity.

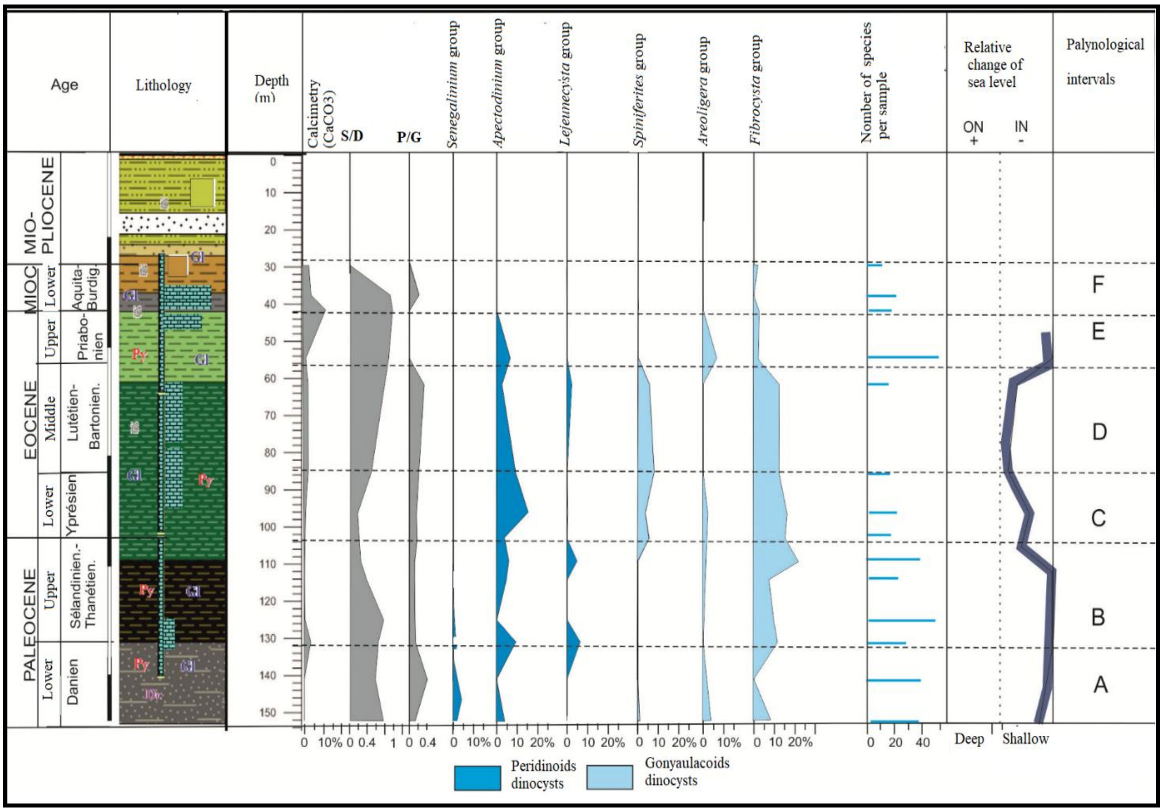


Figure 5: curve of calcimetry; curve of the Sporomorphs report on Dinoflagellates; Peridinoid to Gonyaulacoid curve (productivity), relative abundances of morphologically and ecologically related dinoflagellate cysts; species diversity by sample; relative sea level change (IN / ON) curve and palynological intervals

IV.5.1.2 Palaeoenvironment evolution in Ypresian (lower Eocene) and Lutetian-Bartonian (middle Eocene)

In Ypresian and Lutetian-Bartonian, organic matter is still dominated by dinocysts with a S/D ratio of 0.24 to 0.6, indicating a low to medium continental influence. The marine influence is characterized by the presence of dinocysts with a very low Peridinioids/Gonyaulacoids (P/G) ratio between 0.2 and 0.3 (Fig. 5) indicating a low paleo-productivity of the surface of a shallow sea, with a higher sea level than the previous one (IN/ON = 0.69 mean).

The group Fibrocysta (15% to 17%), Spiniferites (5% to 7%) and Apectodinium (8% to 15%) are the most abundant on that of Aeroligera (Fig. 5) suggesting an inner neritic Paleoenvironment deeper than the previous and warmer, favorable to the proliferation of the genus Apectodinium.

In fact, the group of Spiniferites present in this environment characterizes an outer neritic environment reference of authors [7, 18, 40, 41, 47, 48, 49 and 50]. However, its low proportion reduces the environment to an inner neritic environment.

IV.5.1.3 Evolution of Paleoenvironment at Priabonian (Upper Eocene) and Aquitanian-Burdigalian (Early Miocene)

This environment is poor in organic matter and is marked by a strong continental influence with a high S/D ratio of up to 1 or more (Fig.5). Spores and pollen grains are abundant.

The ratio of Peridinioids / Gonyaulacoids (P/G) is very low, less than 0.2%, thus indicating almost non-existent paleo-productivity in a shallow sea with an IN / ON ratio greater than 1. Fibrocysta group and Areoligera group are the groups of dinocysts most representative of this environment although that their rates are very low suggesting an inner neritic to coastal environment.

IV.5.2 Paleoenvironment of the AB Well

The palaeoenvironments of the different stages (Lutetian, Bartonian and Aquitanian-Burdigalian) of this well are characterized by a strong continental influence with a S/D ratio between 0.8% and 1.1% (Fig. 6). Palynomorphs remain dominated by spores and pollen grains more than 70% against less than 30% of dinocysts. We also note that dinocysts of the group of Peridinoids are rare compared to Gonyaulacoids with a P/G ratio between 0 and 0.2%. This very weak report shows that the paleo-productivity of the sea surface is very weak or non-existent.

Noticing that, the ratio IN / ON is greater or equal to 1 and characterizes a shallow sea. The presence in these environments of Fibrocysta group (5%) and a few rare representatives of Areoligera group and that of Lejeunecysta group (Fig.6) shows that the sediments of these stages were set up in an inner neritic to coastal environment.

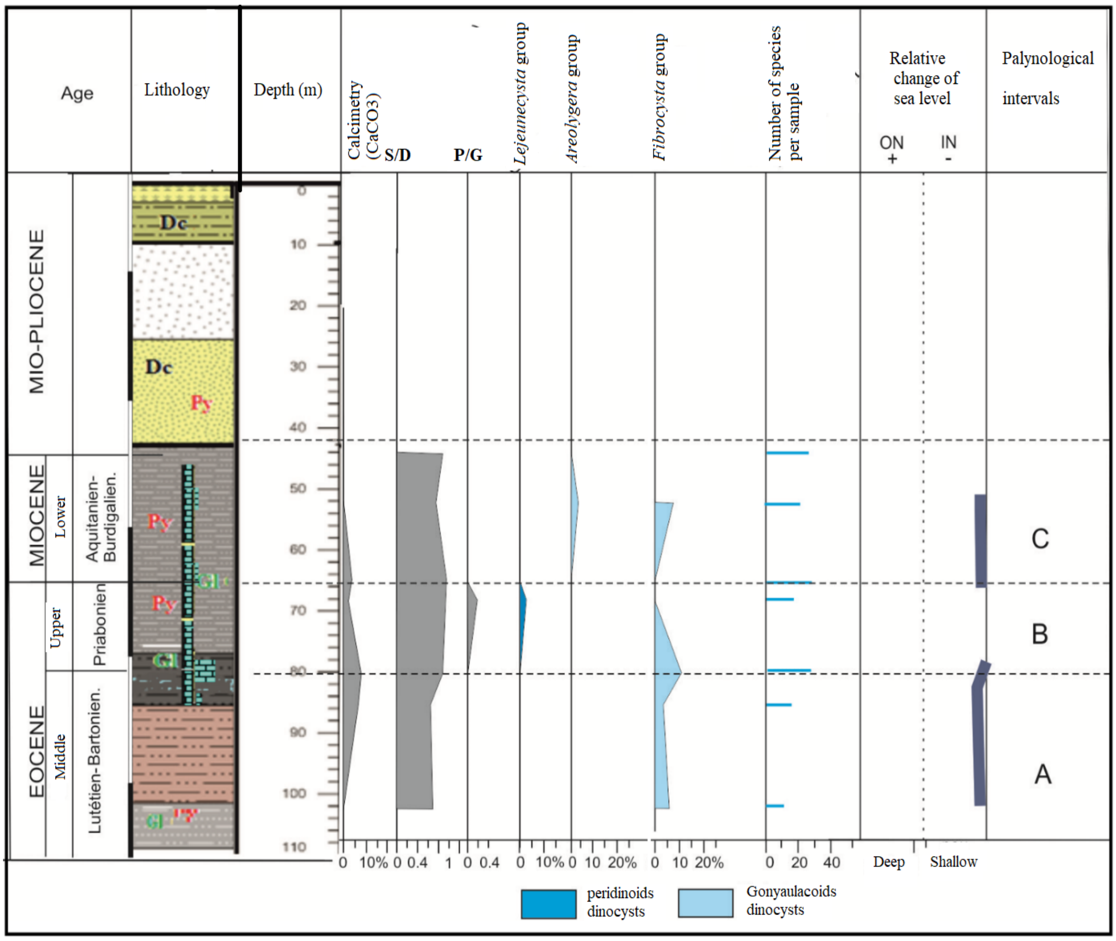


Figure 6: Calcimetry curve; curve of the Sporomorphs report on Dinoflagellates; Peridinoid to Gonyaulacoid curve (productivity), relative abundances of morphologically and ecologically related dinoflagellate cysts; species diversity by sample; relative sea level change (IN/ON) curve and palynological intervals along the AB well**.**

V. Conclusion

This study has highlighted six stages including Danian, Sélandian-Thanétian, Yprésian, Lutétian-Bartonian, Priabonian and Aquitanian-Burdigalian in the BM well through specific palynological associations. In the AB well only the last three stages of the BM well are highlighted.

The palynostratigraphic correlation established between the two wells shows that the Danian, Selandian-Thanetian and Ypresian stages are not reached by AB drilling because of high sedimentation in this area. This correlation also demonstrated the absence of Oligocene in the two wells as it was completely eroded in this study area. Also, the study of palaeoenvironments of BM and AB well deposits shows that these palaeoenvironments have known little variation over geological time. In fact, sediment deposition environments have evolved in an inner neritic to coastal environment in all wells, depending on eustatic movements.

References

[1]. Digbéhi B. Z., D. Mamery, J. Téa, K. R. Yao, J. P. N. Yao, K. David et T. Ignace. Palynostratigraphy and palaeoenvironmental characterization and evidence of Oligocene in the terrestrial sedimentary basin, Bingerville area, Southern Côte d'Ivoire, Northern Gulf of Guinea. African Journal of Environmental Science and Technology. 2012, 6: 28-42.

[2]. Gbangbot. J.M. Caractérisation stratigraphique des aquifères des formations de subsurface de la région des lagunes de côte d'ivoire : essai de modélisation des environnements de dépôts du tertiaire (Côte d'Ivoire). Thèse de doctorat, Univ. F.H.B. Cocody, 2012.

[3]. Bié G. R., Digbéhi Z. B., Yao K. R., Téa Y. J., Kangah K. D. & Tahi I., Stratigraphie Palynologique du Maastrichtien Supérieur-Éocène Supérieur du Bassin Sédimentaire Offshore de Côte d'ivoire, Afrique de l'Ouest. International Journal of African Studies. 2012, 6: 40-57.

[4]. Bié G. R., Yao N. J.P., Gbangbot J. M., Fofana F., Doukoure M. et Digbéhi Z.B. Caractérisation paléoenvironnementale des formations de l'Oligocène de Bingerville, Côte d'Ivoire, à partir de l'analyse des palynofaciès. Rev. Ivoir. Sci. Technol. 2015, 26: 254 - 278

[5]. Chateauneuf J. J. et Reyre Y. Eléments de palynologie. Applications géologiques. Cours de 3ème cycle en Science de la Terre. 1974.

[6]. Versteegh G.J.M. Recognition of cyclic and non-cyclic environmental changes in the Mediterranean Pliocene: a palynological approach. Marine Micropaleontology. 1994, 23: 147-183.

[7]. Guasti E.T., Kouwenhoven T.J., Brinkhuis H., Speijer R.P. Paleocene sea-level and productivity changes at the southern Tethyan margin (El Kef, Tunisia). Marine Micropaleontology. 2005, 55: 1-17.

[8]. Guédé K. E. Etude comparée de la palynoflore (kystes de dinoflagellé s) au passage Crétacé-Paléogène (K-Pg) et Paléocène-Eocène (P-E) du Nord-Ouest du Maroc et au Sud-Ouest de la Côte d'Ivoire: Systématique, Biostratigraphie, Paléoenvironnement et Paléogéographie. Thèse de doctorat, Univ Rabat, Maroc, 2016.

[9]. Lentin J. K. & Williams G. L. Fossil Dinoflagellates. Index to Genera and species. Bedford Ins. Oceanogr. Report, B2Y4A2, Canada, 2004.

[10]. Fensome R.A., Macrae R.A., Williams G.L. DINOFLAJ2, Version 1. American Association of Stratigraphic Palynologists, Data Series. 2008, 1.

[11]. Fensome, R.A., Williams, G.L. & Macrae, R.A. Late Cretaceous and Cenozoic fossil dinoflagellates and other palynomorphs from the Scotian Margin, offshore eastern Canada. Journal of Systematic Palaeontology. 2009, 7 (1): 1-79.

[12]. Awad, W.K., Oboh-Ikuenobe, F.E., Early Paleogene dinoflagellate cysts from ODP Hole 959D, Côte d'Ivoire-Ghana transform margin, west Africa: new species, biostratigraphy and paleoenvironmental implications. Journal. Afr. Earth Sci. 2016, 123: 123–144.

[13]. Guédé, K.E., Slimani, H., Jean-Paul Yao, N., Chekar, M., Jean-Claude Koffi, N., M'Hamdi, A., Mouah, R., Digbehi, B.Z. Late Cretaceous to Early Eocene dinoflagellate cysts from the "12 frères" borehole, Fresco, southwestern Côte d'Ivoire: Biostratigraphy and paleobiogeographic implication. Journal of African Earth Sciences. 2019, 150:744-756.

[14]. Toé Bi. K. K. K. Evolution et caractérisation des sediments de subsurface et de la microflore dans la région d'Eboïnda (zone sud de la faille des lagunes): sédimentologie, géochimie, biostratigraphie, paleoenvironnement et paléobiogéographie. Thèse de doctorat, de l'Université Felix Houphouet Boigny de Cocody en sciences de la terre, Option Océanologie, 2016.

[15]. Slimani H. Les kystes de dinoflagellés du Campanien au Danien dans la région de Maastricht (Belgique et Pays-Bas) et de Turnhout (Belgique): biozonation et corrélation avec d'autres régions en Europe occidentale. Geologica et Palaeontologica, 2001, 35 : 161-201.

[16]. Williams, G.L., Brinkhuis, H., Pearce, M.A., Fensome, R.A., Weegink, J.W. Southern Ocean and global dinoflagellate cyst events compared: index events forthe late Cretaceous–Neogene. In: Exon, N.F., Kennett, J.P., Malone, M.J. (Eds.), Proceedings of the Ocean Drilling Program, Scientific Results. 2004, 189: 1–98.

[17]. Habib D., Saeedi F. The Manumiella seelandica global spike: cooling duringregression at the close of the Maastrichtian. Palaeogeography, Palaeoclimatology, Palaeoecology. 2007, 255: 87–97.

[18]. Slimani H., Louwye S., Toufiq A. Dinoflagellate cysts from the Cretaceous–Paleogene boundary at Ouled Haddou, southeastern Rif, Morocco: biostratigraphy, paleoenvironments and paleobiogeography. Palynology. 2010, 34: 90-124.

[19]. Slimani H., Louwye S., Dusar M., Lagrou D. Connecting the Chalk Group of the Campine Basin to the dinoflagellate cyst biostratigraphy of the Campanian to Danian in borehole Meer (northern Belgium). Netherlands Journal of Geosciences. 2011, 90 : 129–164.

[20]. Guédé K.E., Slimani H., Louwye S., Asebriy L., Toufiq A., Ahmamou M.F., El Amrani El Hassani I.E., Digbéhi Z.B. Organic-walled dinoflagellate cysts from the Upper Cretaceous–lower Paleocene succession in the western External Rif, Morocco: New species and new biostratigraphic results. Geobios. 2014, 47: 291-304.

[21]. Bié G.R., Evolution des microflores du bassin sédimentaire de côte d'Ivoire (marge d'Abidjan) au cours du Cénozoïque, palynostratigraphie, paléobotanique, évolution des environnements de dépôt et maturation de la matière organique. (Côte d'Ivoire). Thèse de doctorat, Univ. F.H.B. Cocody, 2012.

[22]. Quattrocchio M. E. Paleogene dinoflagellate cysts from Punta Prat, Southern Chile. Palynology. 2009, 33: 141–156.

[23]. Jan Du Chêne R.E., Adediran S.A. Late Paleocene to Early Eocene dinoflagellates from Nigeria. Cahiers de Micropaléontologie. 1985, 3: 1-38.

[24]. Masure E., Rauscher R., Dejax J., Schuler M. & Ferre B. Cretaceous–Paleocene Palynology from the Côte d'Ivoire–Ghana transform margin, sites 959, 960, 961 and 962. Proceedings of the Ocean Drilling Program, Scientific Results. 1998, 159: 253-276.

[25]. Oloto I. N. Maastrichtian dinoflagellate cyst assemblage from the Npkoro shale on the Benin Flank of the Niger Delta. Review of Paleobotany and Palynology. 1989, 57: 173-186.

[26]. Bankole S. I., Schrank E. & Erdtmann B. D., Palynology of the Paleogene Oshosun Formation in the Dahomey Basin, southwestern Nigeria. Revista Española de Micropaleontología, 2007, 39 (1-2) : 29-44.

[27]. Mbesse C.O. La limite Paléocène–Eocène dans le Bassin de Douala (Cameroun). Biostratigraphie et essai de reconstitution des paléoenvironnements. Thèse de doctorat, Univ. Liège; PhD, Univ. Yaoundé 1, 2014.

[28]. Williams, G.L., Stover, L.E., Kidson, E.J. Morphology and stratigraphic ranges of selected Mesozoic–Cenozoic dinoflagellate taxa in the Northern Hemisphere. Geological Survey of Canada Paper. 1993, 92 (10).

[29]. Salard-Cheboldaeff M. Palynologie Maestrichtienne et Tertiaire du Cameroun. Resultats botaniques. Review of Palaeobotany and Palynology. 1981, 32 : 401-439.

[30]. Salard–Cheboldaeff M. Intertropical African palynostratigraphy from Cretaceous to late Quaternary times. Journ. of African Earth sciences. 1990, 11(12): 1-24.

[31]. Atta D-Peters & Salami M.B. Late Cretaceous to Early Tertiary pollen grains from offshore Tano basin, Southwestern Ghana. Revista Española de Micropaleontología. 2004; 36 (3): 451-465.

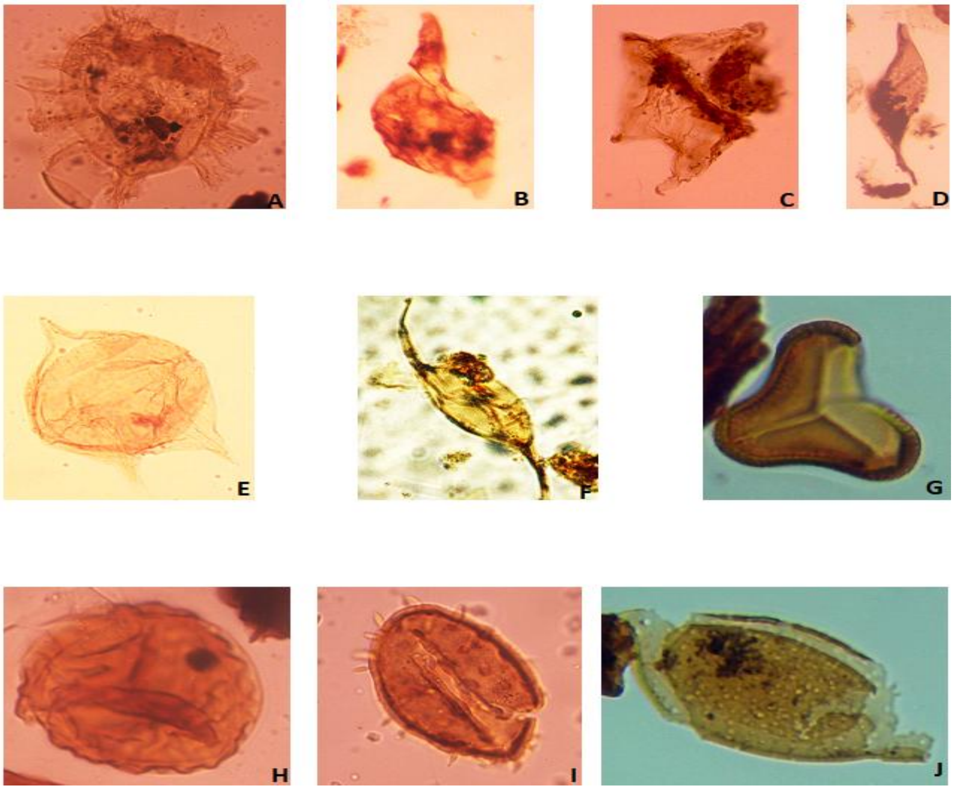
[32]. Salard-Cheboldaeff M. Paléontologie du bassin sédimentaire littoral du Cameroun dans ses rapports avec la stratigraphie et la paléoécologie. Thèse de Doctorat d'Etat, Université Pierre et Marie Curie, Paris VI, 1977

[33]. Simon P., Caratini C., Charpy N., Tissot C. Sédimentologie et palynologie du Crétacé terminal et du Tertiaire de la région de BONOUA (Côte d'Ivoire). Géologie Méditerranéenne. 1984, 11(1): 77-80.

[34]. Brinkhuis H. Late Eocene to Early Oligocene dinoflagellate cysts from the Priabonian type-area (Northeast Italy): biostratigraphy and paleoenvironmental interpretation. Palaeogeography, Palaeoclimatology, Palaeoecology. 1994, 107(1): 121-163.

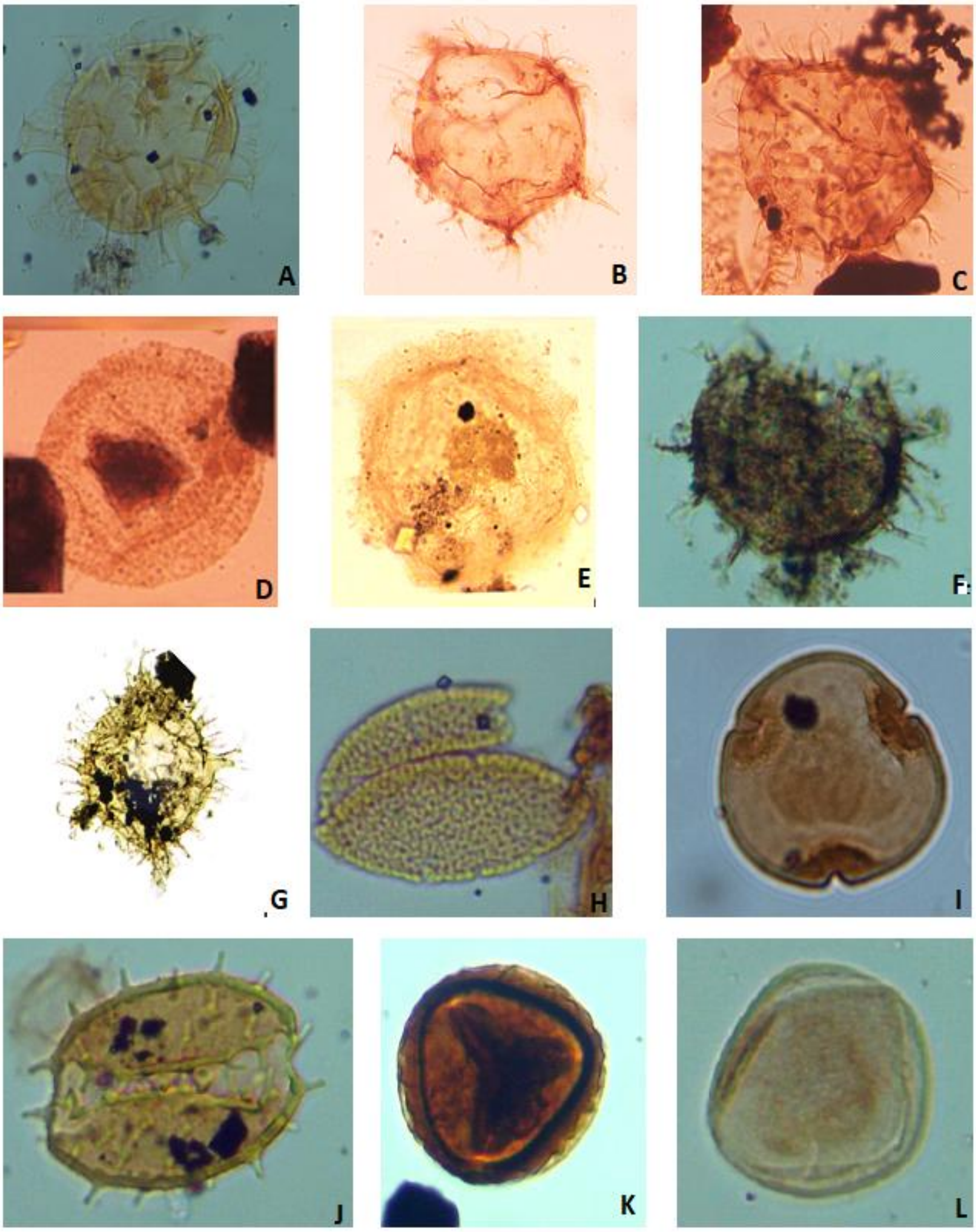
[35]. Brinkhuis H., Romein A.J.T., Smit J., Zachariasse W.J. Danian–Selandian dinoflagellate cysts from lower latitudes with special reference to El Kef section, NW Tunisia. GFF. 1994, 116 (1): 46-48.
[36]. Powell A.J., Brinkhuis H., Bujak J.P. Upper Paleocene–lower Eocene dinoflagellate cyst sequence biostratigraphy of southeast England. Geological Society Special Publication. 1996, 101: 145-183.
[37]. Sluijs A., Brinkhuis H., Stickley C.E., Warnaar J., Williams G.L., Fuller M. Dinoflagellate cysts from Eocene–Oligocene transition in the Southern Ocean: results from ODP Leg 189. Proceedings of the Ocean Drilling Program. Scientific Results. 2003, 189: 1-42.
[38]. Pross J., Brinkhuis H. Organic-walled dinoflagellate cysts as paleoenvironmental indicators in the Paleogene; a synopsis of concepts. Paläontologische Zeitschrift. 2005, 79: 53-59.
[39]. Brinkhuis H., Zachariasse W.J. Dinoflagellate cysts, sea level changes and planktonic foraminifers across the Cretaceous–Tertiary boundary at El Haria, northwest Tunisia. Marine Micropaleontology.1988, 13: 153-191
[40]. Eshet Y., Moshkovitz S., Habib D., Benjamini C., Margaretz M. Calcareous nannofossil and dinoflagellate stratigraphy across the Cretaceous/Tertiary boundary at Hor Hahar, Israel. Marine Micropaleontology. 1992, 18: 199-228.
[41]. Brinkhuis H., Bujak J.P., Smit J., Versteegh G.J.M., Visscher H. Dinoflagellate-based sea surface temperature reconstructions across the Cretaceous–Tertiary boundary. Palaeogeography, Palaeoclimatology, Palaeoecology. 1998, 141: 67-83.
[42]. Pross J., Schmiedl G. Early Oligocene dinoflagellate cysts from the Upper RhineGraben (SW Germany): paleoenvironmental and paleoclimatic implications. Marine Micropaleontology. 2002, 45: 1-24.
[43]. Sangiorgi F., Capotondi L., Brinkhuis H. A centennial scale organic-walled dinoflagellate cyst record of the last deglaciation in the South Adriatic Sea (Central Mediterranean). Palaeogeography, Palaeoclimatology, Palaeoecology. 2002, 186: 199-216.
[44]. Roncaglia L. Palynofacies analysis and organic-walled dinoflagellate cysts asindicators of paleo-hydrographic changes: an example from Holocene sediments inSkálafjord, Faroe Islands. Marine Micropaleontology. 2004, 50: 21-42.
[45]. Firth J.V. Dinoflagellate assemblages and sea level fluctuations in the Maastrichtian of southwest Georgia. Review of Palaeobotany and Palynology. 1993, 79: 179-204.
[46]. Nøhr-Hansen H., Dam G. Palynology and sedimentology across a new marine Cretaceous/Tertiary boundary coupe on Nuussuaq, West Greenland. Geology. 1997, 25: 851–854.
[47]. Schrank E. Organic-geochemical and palynological studies of a Dakhla Shale profile (Late Cretaceous) in southeast Egypt. Part A: succession of microfloras and depositional environment. Berliner Geowissenschaftliche Abhandlungen (A). 1984, 50: 189-207.
[48]. Brinkhuis H., Schiøler P. Palynology of the Geulhemmerberg Cretaceous–Tertiary boundary section (Limburg, SE Netherlands). In: Brinkhuis, H., Smit, J. (Eds.), The Geulhemmerberg Cretaceous–Tertiary Boundary Section (Maastrichtian Type Area, SE Netherlands). Geologie en Mijnbouw. 1996, 75: 193-213.
[49]. Sluijs A., Pross J., Brinkhuis H. From greenhouse to icehouse; organic-walled dinoflagellate cysts as paleoenvironmental indicators in the Paleogene. Earth-Science Reviews. 2005, 68: 281-315.
[50]. Peyrot D., Fernando Barroso-Barcenilla F., Barrón E., María José Comas-Rengifo M. J. Palaeoenvironmental analysis of Cenomaniane–Turonian dinocyst assemblages from the Castilian Platform (Northern-Central Spain). Cretaceous Research. 2011, 32: 504-526.

PLATE 1: Some Palynomorphs of Danea californica Association



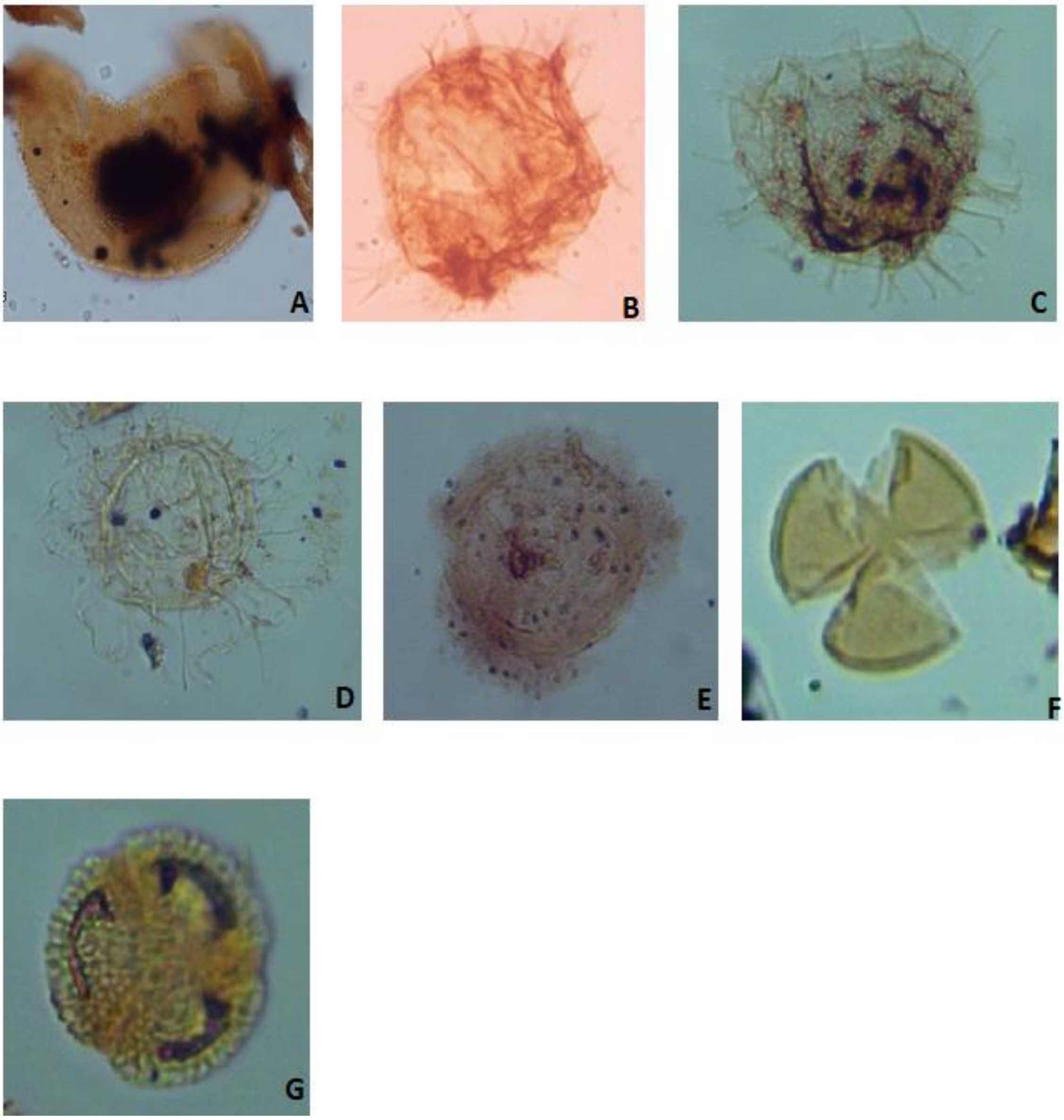
A- Danea californica (Drugg, 1967) Fensome et al., 1993; BM, 131 m; B- Cerodinium? diebelii Alberti 1959; BM, 131 m, P 52; C- Phelodinium magnificum (Stanley 1965) Stover et Evitt 1978; BM, 153 m; D- Palaeocystodinim australinum (Cookson, 1965) Lentin et Williams, 1976; BM, 153 m, B 37; E- Senegalinium bicavatum Jain et Millepied, 1973; BM, 153 m, V 37/3; F- Palaeocystodinium golzowense Alberti, 1961; BM, 125 m, U 22/1; G- Foveotriletes margaritae, (Van der Hammen 1954) Germeraad & Muller, 1968, BM, 141 m ; H-Camarozonosporites ambigens Playford, 1971, BM, 131 m, C 35; I- Mauritiidites crassibaculatus Van Hoeken-Klinkenberg, 1964, BM, 131 m, L 40/4; J- Longapertites marginatus Van Hoeken-Klinkenberg, 1964, BM, 141 m, N 49/4.

PLATE 2: Some Palynomorphs of Apectodinium Danea Association



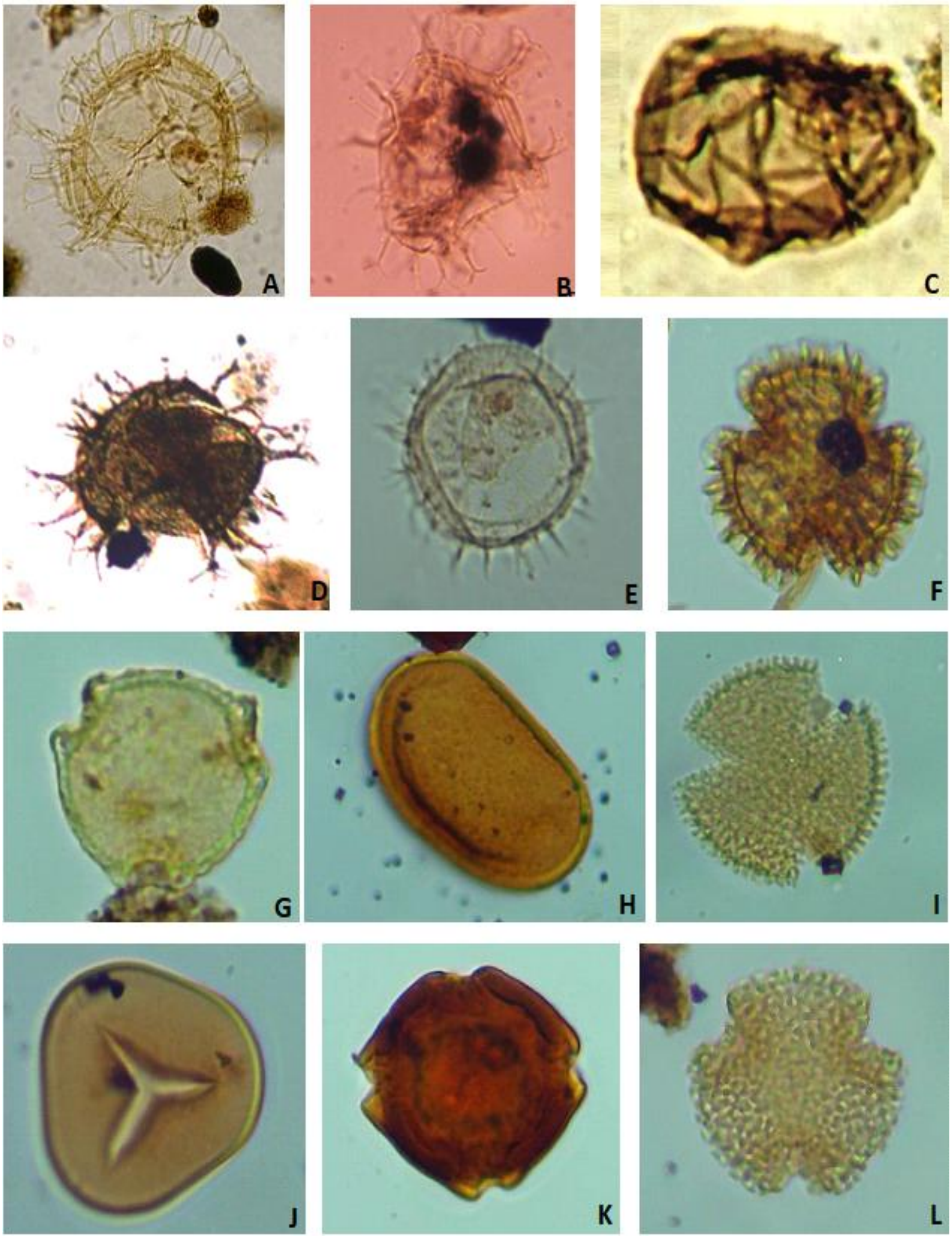
A-Homotryblium tenuispinosum, Davey et Williams 1966; BM, 114 m, O 43/3; B- Apectodinium homomorphum (Deflandre et Cookson, 1955) Lentin et Williams, 1977; BM, 114 m, E 40; C- Apectodinium quinquelatum (Williams et Downie1966) Costa et Downie 1979, BM, 114 m, T 33/4; D- Kallosphaeridium yorubaense Jan Du Chêne et Adediran, 1985; BM, 109 m, U 46/3; E- Muratodinium fimbriatum. (Cookson et Eisenack, 1967) Drugg, 1970; BM, 109 m; U20/1; F- Hafniasphaera septata (Cookson et Eisenack, 1967) Hansen, 1977; BM, 109 m, L 48/4 ; G- Fibrocysta axialis (Eisenack, 1965) Stover & Evitt, 1978, BM, 109 m, Q 32/3; H- Longapertites marginatus Van Hoeken-Klinkenberg, 1964, BM, O40/2, 109m ; I- Margocolporites rauvolfii Salard, 1978, BM, 109 m, P52/1 ; J- Mauritiidites crassibaculatus Van Hoeken-Klinkenberg, 1964, BM, 114 m, T32/2 ; K- Camarozonocolpites ambigens Playford, 1971, BM, 114m, U36/3 ; L- Proxapertites operculatus (Van Der Hammen, 1954) Germeraad & Muller, 1968, BM, 109, P40/1

PLATE 3: Some Palynomorphs of Kallosphaeridium yorubaense Association



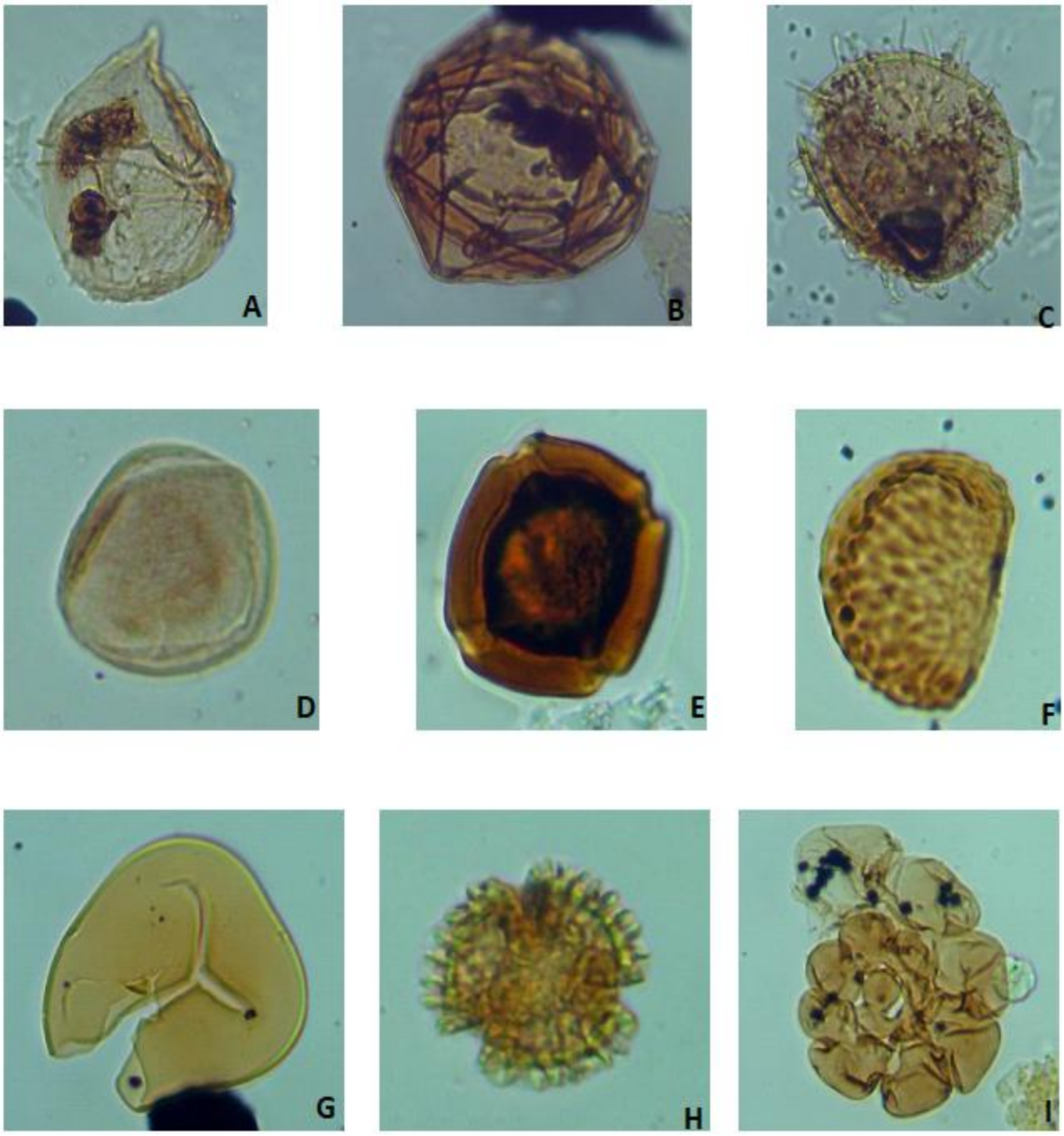
A- Kallosphaeridium yorubaense Jan Du Chêne et Adediran, 1985; BM, 96 m, F 16/3; B- Apectodinium homomorphum (Deflandre et Cookson, 1955) Lentin et Williams, 1977; BM, 96 m, P 41/3; C- Hafniasphaera septata (Cookson et Eisenack, 1967) Hansen, 1977; BM, 96 m, G 48/4 ; D- Spiniferites ramosus (Ehrenberb,1938) Loeblich 1966, BM, 96, F 22 ; E- Muratodinium fimbriatum. (Cookson et Eisenack, 1967) Drugg, 1970; BM, 66 m; T 20; F-Tricolpites Americana, BM; 66 m, R42; G- Bombaccacidites bombax, BM, 66 m, Q52/3.

PLATE 4: Some Palynomorphs of Adnatosphaeridium multispinosum Association



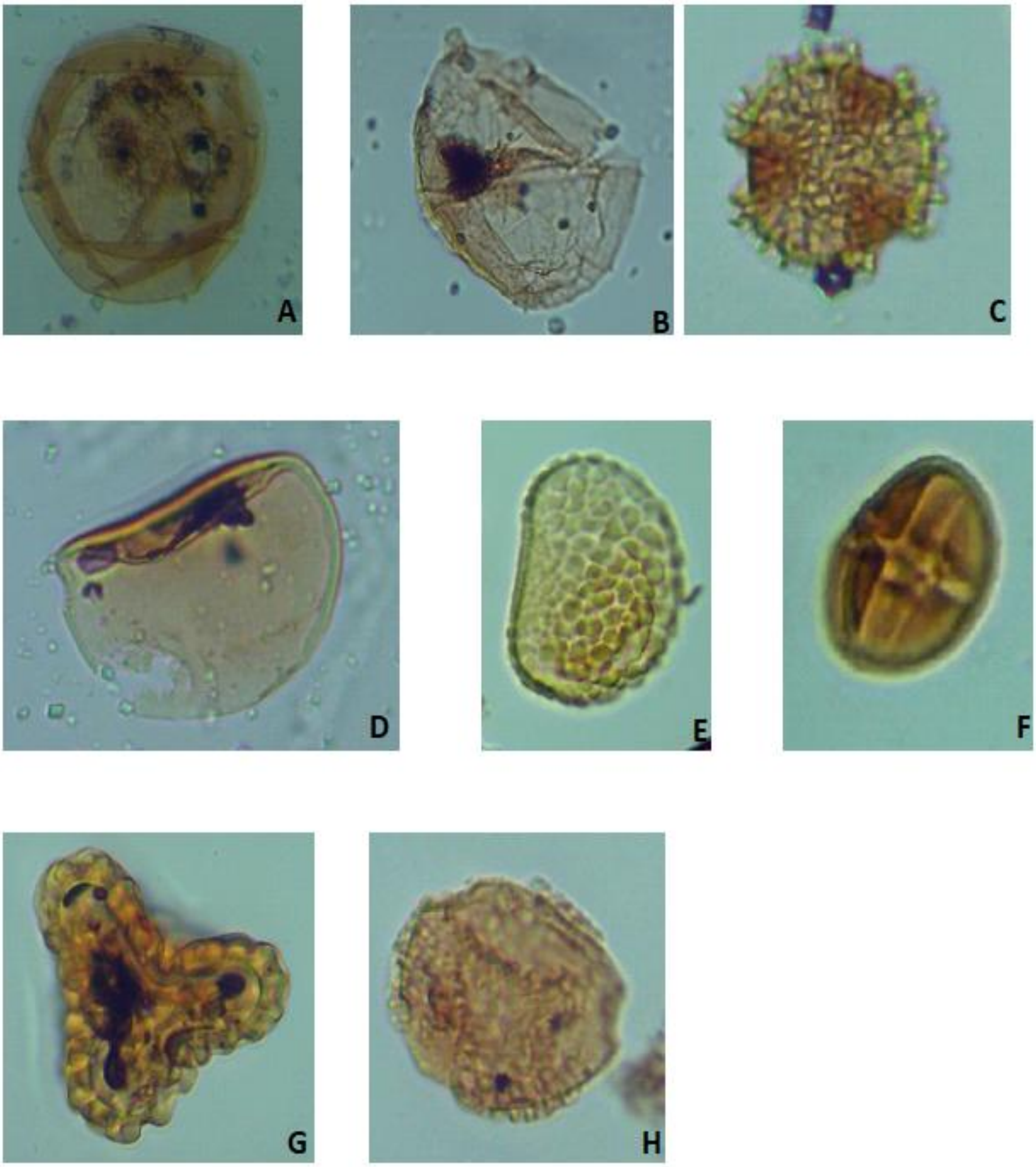
A- Adnatosphaeridium multispinosum Williams et Downie, 1966; BM, 61 m, D 48; B- Spiniferites ramosus (Ehrenberb,1938) Loeblich 1966, BM, 61m, F 48/2 ; C- Batiacasphaera sp., BM, 61 m, K43/1, G 42/1 ; D- Hafniasphaera septata (Cookson et Eisenack, 1967) Hansen, 1977; BM, 61 m, F35/1 ; E- Operculodinium centrocarpum (Deflandre & Cookson, 1955) Wall, 1967, BM, 61 m, J26/3 ; F- Retitricolporites irregularis Van der Hammen & Wijmstra, 1964, BM, 61 m, D32/4 ; G- Momipites sp., AB, 85 m, J32/4 ; H-Laevigatosporites ovatus, Wilson & Webster, 1946 , AB, 85 m, O42/1 ; I- Psilatricolpites crassus Van der Hammen &Wijmstra, 1964 , AB, 85 m, J32 ; J- Deltoidospora minor (Couper, 1953) Pocock, 1970, AB 85 m, K45/1, K- Pachydermites diederixii Germeraad & Muller, 1968, AB, 85 m, J26/2 ; L- Psilatricolporites sp., AB, 85 m, K25/3.

PLATE 5: Some Palynomorphs of Proxapertites Operculatus Association



A- Cribroperidinium excilicristatum (Davey, 1969) Stover & Evitt, 1978, AB, 65 m, K30/1 ; B- Batiacasphaera sp., AB, 65 m,, Q30/1 ; C- Operculodinium centrocarpum (Deflandre & Cookson, 1955) Wall, 1967, AB, 65 m, Q26/1 ; D- Proxapertites operculatus (Van Der Hammen, 1954) Germeraad & Muller, 1968, BM, 51 m, J22 ; E- Pachydermites diederixii Germeraad & Muller, 1968, AB, 65m, O50/1 ; F- Verrucatosporites usmensis (Van der Hammen, 1956) Germeraad & Muller, 1968, AB, 65m, Q24/1, G- Deltoidospora minor (Couper, 1953) Pocock, 1970, AB, 65 m, N 22 ; H- Retitricolporites irregularis Van der Hammen & Wijmstra, 1964, AB, 65 m, J52/4 ; I- Basale de Microforaminifère.

PLATE 6: Some Palynomorphs of Laevigatosporites ovatus Association



A- Batiacasphaera sp., AB, 52 m,, J36/1; B- Cribroperidinium excilicristatum (Davey, 1969) Stover & Evitt, 1978, AB, 52 m, O32/1 ; C- Retitricolporites irregularis Van der Hammen & Wijmstra, 1964, AB, 52 m, Q26/4; D- Laevigatosporites ovatus, Wilson & Webster, 1946 , AB, 52 m, J32/2 ; E- Verrucatosporites usmensis (Van der Hammen, 1956) Germeraad & Muller, 1968, AB, 52 m, I34/1 ; F- Psilatricolporites laevigatus, AB, 52 m, Q28/1 ; G- Baculatisporites sp., AB, 52 m, J22/3 ; Retitriporites sp. AB, 52m, H32/1.

BIÉ Goha René.et.al. "Palynological and paleoenvironmental study of the tertiary formations of the audouin-begretto tertiary and the bay of 'milliardaires': south-west of the lagoons fault (Côte d'Ivoire)". *IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG),* 8(1), (2020): pp. 01-19.