

1 **Palynological characteristic of dark gray clays in the southern part of the**  
2 **city of Bingerville (Ivorian onshore basin)**

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7 **ABSTRACT**

8 Samples from two wells implanted at the level of the dark gray clay outcrop of Bingerville  
9 were the subject of this palynological study. The main objective of this work is to establish  
10 the age of these levels in order to understand the geographical distribution of tertiary  
11 formations north of the lagoon fault. The samples were processed according to the classical  
12 procedure of extraction and concentration of palynomorphs.

13 The high populations of dinocysts of the genus *Lejeunecysta lata*, *Opreculodinium*  
14 *centrocarpum* and *Selenopemphix quanta* as well as those of spores and pollens of the genre  
15 *Magnastriatites howardii*, *Perfotricolpites digitatus*, *Pachydermites diderixi*,  
16 *Bombacacidites bombax*, *Retitricolporites irregularis*, *Retitriporites sp. Verrucatosporites*  
17 *usmensis* are tributary to Oligocene.

18 At the palaeobotanical and palaeoecological level, the highlighted palynoflora made it  
19 possible to characterize three environments, including mangroves, coastal plain, and  
20 rainforests.

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23 **Keywords :** Dinocyst, spore, pollen, Oligocene

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25 **1. INTRODUCTION**

26 Long remained unknown in the ivorian sedimentary basin, the Oligocene age formations were  
27 described for the first time by [1] southeast of the city of Bingerville. These results indicated  
28 lithologically that this stage is mainly composed of gray clays interspersed with thin joints of  
29 stratifications (hardground). The palynology data highlight the presence of characteristic  
30 dinocysts such as *Lejeunecysta communis*, *Lejeunecysta lata*, *Lejeunecysta pulchra*,  
31 *Lejeunecysta sp.*, *Lejeunecysta granosa*, *Lejeunecysta globosa*, *Lejeunecysta beninensis*,  
32 *Pheolodinium magnificum*, *Pheolodinium africanum*, *Selenopemphix nephroides* et  
33 *Cordosphaeridium inodes*. These dinocysts are associated with spores and pollen grains as  
34 *Magnastriatites howardii*, *Spirosyncolpites spiralis*, *Perfotricolpites digitatus*,  
35 *Retitricolporites irregularis*, *Retimonocolpites irregularis*, *Pachydermites diderixii*,  
36 *Psilatricolporites operculatus* et *Punctodiporites harrisii*.

37 Beside these studies, no results exist on the mapping of Oligocene age formations in the  
38 ivorian sedimentary basin and in particular in the northern part of the lagoon fault.

39 Recently, as a result of the aménagement work, gray but darker clays located beneath the  
40 variegated clays of known Mio-Pliocene age have been exposed at the southwestern entrance  
41 to Bingerville. This study was undertaken to date these levels in order to contribute to the  
42 paleogeographic reconstruction of tertiary deposits.

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46 **2. MATERIAL AND METHODS**

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48 **2.1. Presentation of the study area**

50 Bingerville area is located east of the city of Abidjan. This region is part of the onshore  
51 sedimentary basin of Côte d'Ivoire. There are generally clay formation unconformity on  
52 Meso-Cenozoic schist and granites.

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54 This very narrow onshore basin is crossed from west to east by a fault "Lagoon Fault" of a  
55 rejection of several thousand meters separating two distinct zones [2] in [3] :

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57 - South of this fault, a deep basin in which the base sinks at 4000 or 5000 m on the vertical of  
58 the coast;

59 - north of this fault is the shallower basin where the sedimentary cover rarely reaches 300 m  
60 thick. This onshore basin belongs to the lagoons region and covers an area of approximately  
61 664 km<sup>2</sup>.

62 This is the northern part of the Bingerville area. Sedimentation is dominated by clays and  
63 sands or ferruginous sandstones. Two wells P1 and P2 of depth 5,5 m and 18,5 m respectively  
64 were made in this study.

65 From a physical geography, the Bingerville area has relatively rugged terrain. It has numerous  
66 lagoon water plans (the Ebrié South Lagoon and the Potou Lagoon in the North) around  
67 which a mangrove forest has developed.

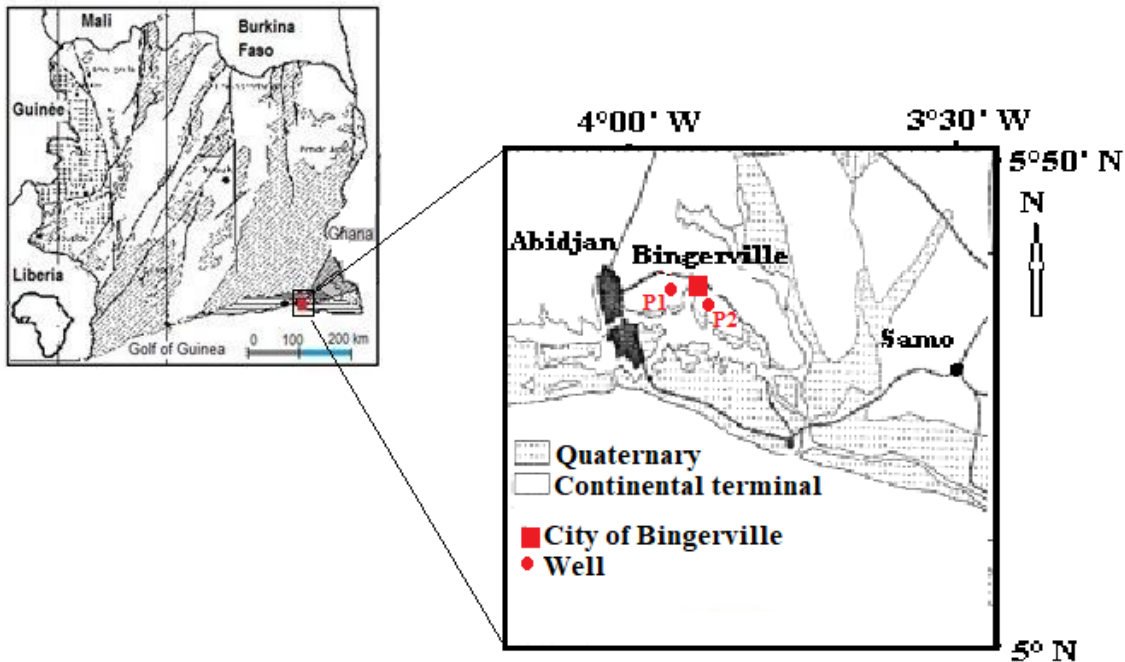
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77 **Figure 1: Location of the study area**

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80 **2.2. Methods**

81 The material used consists of ten (10) cuttings samples (Table I) from two wells made in the  
82 Bingerville area east of Abidjan (Côte d'Ivoire).

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85 **Table I: Number of Samples and Well Depth**

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Well	Number of sample	Well depth (m)
Well P1	4	5,5
Well P2	6	18,5

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89 Each sample of cuttings collected underwent a palynological preparation. This preparation  
90 consists in destroying all the mineral phases of the sediment by the strong acids (HCl 30%  
91 and HF 70%) in order to preserve only the organic phase generally consisting of sporopollinic  
92 or palynomorphic materials. After this attack with strong acids, each sample is washed on a  
93 10 micron canvas and the sporopollenic residue obtained is mounted between the blade and  
94 the lamella using a special resin to glue the coverslip. For each sample, a pair of slides is  
95 made and observed under a biological microscope. This observation aims to identify the  
96 palynomorphs present in the samples, to make a palynostratigraphy and to determine the  
97 depositional environment.

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### 100 **3. RESULTS**

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#### 102 **3.1. Lithological analysis of the wells**

##### 103 **3.1.1. Lithology of well P1**

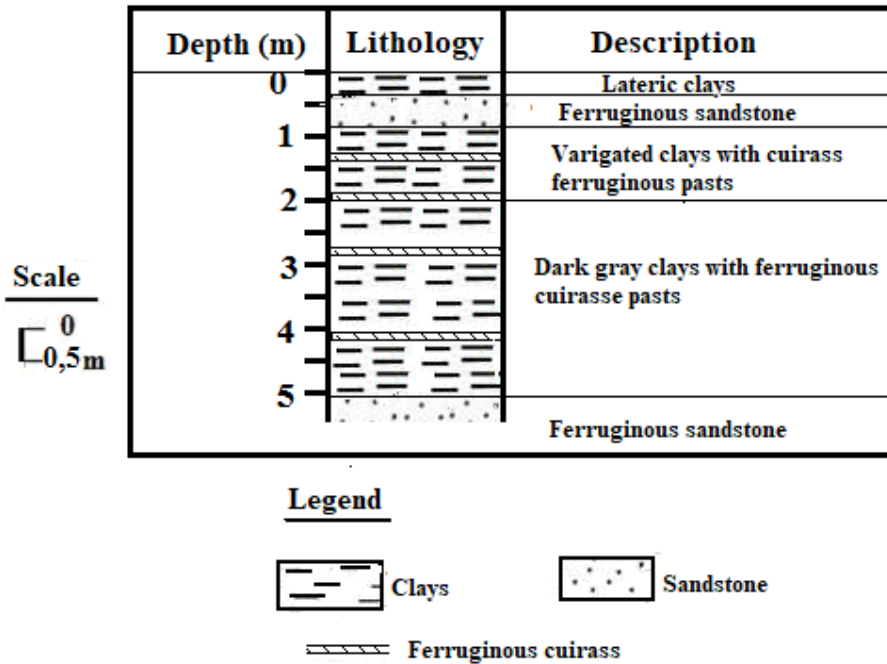
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105 The lithology indicates in the sense of sedimentation the presence of ferruginous sandstones  
106 surmounted by dark gray clays interspersed with past ferruginous cuirasses. These clay  
107 formations have an average thickness of 3 m. They are surmounted by variegated clays with  
108 pasts of ferruginous cuirasses on 1 m thick (Figure 2). At the top, sandstone (0,7 m) and  
109 lateritic clays (0,3 m) meet.

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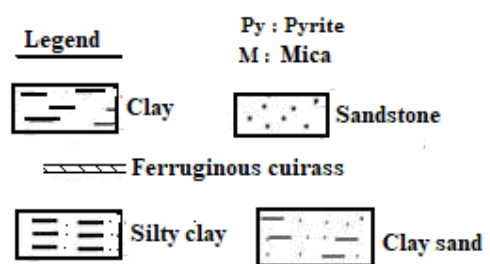
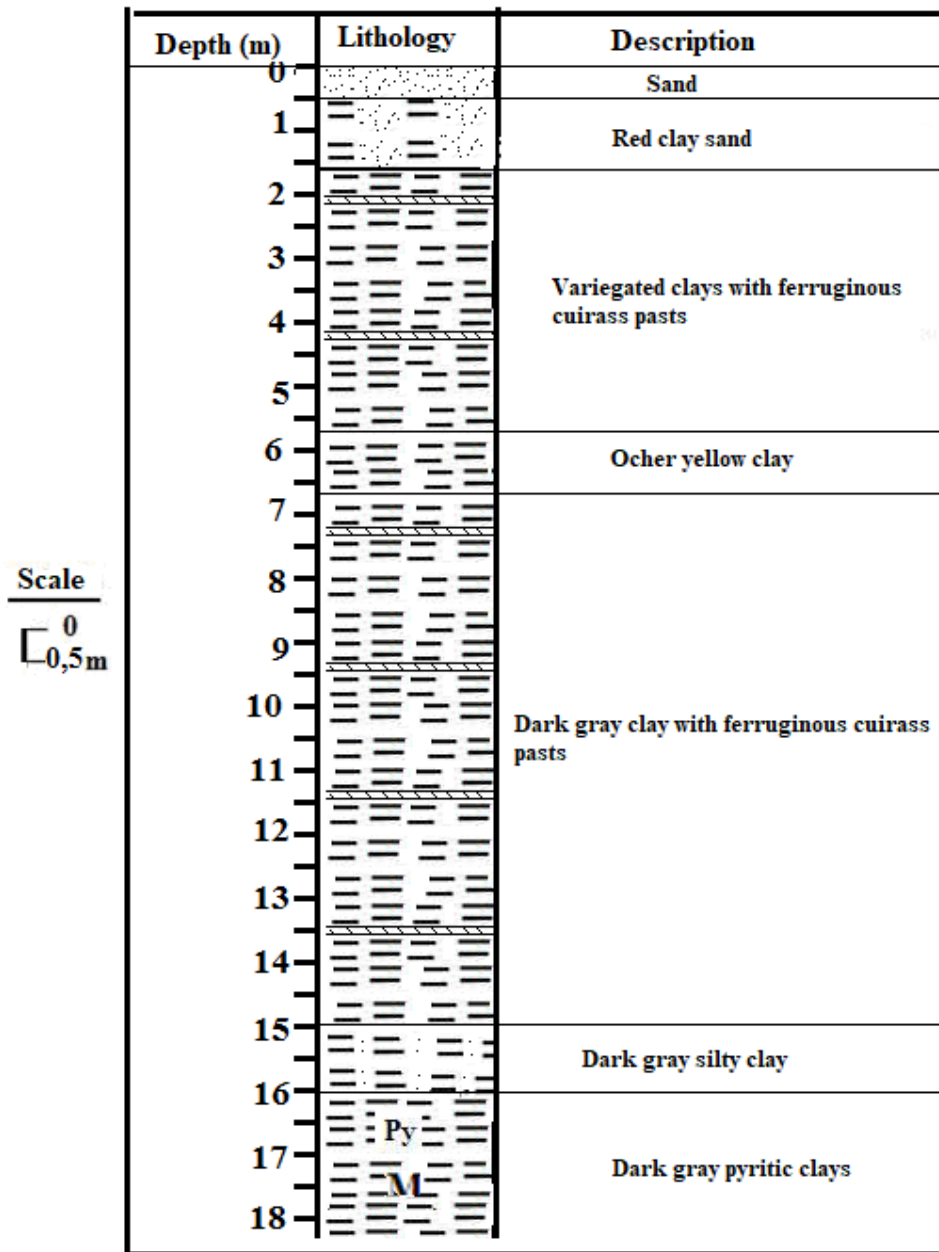
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**Figure 2: Lithological synthesis of the well P1**

**3.1.2. Lithology of the P2 well**

This well P2 is distant from the well P1 of 5 Km. It reached a depth of 18,5 m. Sedimentation shows from the bottom to the top dark pyritic and micromicassed gray clays capped by silty dark gray clays (1m). Above this set are dark gray clays interspersed with ferruginous cuirasses on 9,5 m of power (Figure 3).

Above, ocher yellow clays (1 m) are in contact with variegated clays interspersed with past ferruginous cuirasses over 4 m. At the summit clay sands (1 m) and sands (0,3 m) meet.



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Figure 3: Lithological synthesis of the well P2

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### 3.2. Qualitative and quantitative palynological analysis of the studied wells

Quantitative analysis of these wells resulted in a total of 629 spores and pollen grains, 292 dinocysts and 43 foraminifera basals. The details of this quantitative study are given in Table II below.

**Table II: Number of palynomorphs per well**

Well	Dinocysts	Spores and pollen grains	Foraminifera basals
Well P1	54	153	4
Well P2	238	476	39
Totals	292	629	43

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Qualitative analysis of the palynomorphs of these two wells revealed a low variety of dinocysts and many spores and pollen grains. The details of these palynomorphs are presented in tables III and IV below.

The analysis of these tables III and IV shows a poverty of samples in dinocysts and an exceptional richness in spores and pollen grains. These spores and pollen grains are numerous and varied.

### 3.3. Palynostratigraphy

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The palynostratigraphic study of this well shows that the palynomorphs encountered extend over a single stage which is Oligocene. The different characteristic palynomorphs of this stage are illustrated on plates I, II and III.

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Oligocene is characterized by the following dinocysts: *Operculodinium centrocarpum*, *Cordosphaeridium inodes*, *Spiniferites ramosus*, *Batiacasphaera sp.*, *Lejeunecysta globosa* and *Lejeunecysta lata*.

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These dinocysts are associated with the following spores and pollen grains: *Verucatosporites usmensis*, *Laevigatosporites ovatus*, *Perforicolporites digitatus*, *Monocolpites sp.*, *Deltoidospora minor*, *pachydermites diderixii*, *Leiotriletes adriensis*, *polypodiaceoisporites simplex*, *Monocolpopollenites sp.*, *Psilatricolporites laevigatus*, *Monocolpites irregularis*, *Triorites sp.*, *Momipites sp.*, *Striatopollis bellus*, *Crototricolites densus*, *Retitricolpites americana*, *Retitricolporites irregularis* and *Occulopollis magnoporus*.



175 Table IV: Palynomorphs count sheet in well P2

STAGE	DEPTH (m)	DINOCYSTS												SPORE AND POLLEN GRAINS																										
		TOTALS SPORE AND POLLEN GRAINS																																						
OLIGOCENE	TOTALS DINOCYSTS	TOTALS SPORE AND POLLEN GRAINS																																						
	Lejeunecysta sp.	Operculodinium centrocarpum	Spiniferites ramosus	Lejeunecysta lata	Batiacasphaera sp.	Lejeunecysta globosa	Selenopemphix nephroides	Basales de foraminiferes	Retiriporites sp.	Deltoispora minor	Verrucatosporites usmensis	Psilatricolporites crassus	Retiricopporites irregularis	Laevigatosporites ovatus	Tetracolporites sp.	Momipites sp.	Psilastephanocolporites perforatus	Triorites sp.	Monocolpopollenites sp	Margocolporites vanwijhei	Monocolpites marginatus	Oculopolis magnoporus	Psilatriporites sp.	Periporopollenites sp.	Polypodiacoisporites regularis	Striatopollis bellus	Psilatricolporites operculatus	Margocolporites rauvolfii	Crotocolporites densus	Polypodiadopollenites van campoi	Racemonocolpites hians	Leiotritretes adriensis	Monocolpites sp.	Psilatricolporites laevigatus	Retiricopporites verrucatus	Laevigatosporites Hardii	Pachydermites diderixi	Heterocolpites verrucatus	Tricolpites americana	
	11	40	136	40	12	13	3	2	4	1	3	28	4	3	1	1	4	1	10	3	1	4			1	2		5	1	13	1	1	1	21	1	20	3		2	
	11.5	57	88	1	37	1	2	9	3	4		1	3			1	2		3	1	2	3	1		2		1	4	1	10	1		2	9	3	9	1	21	1	
	12.0	30	42	10	8		8		1	3	1	1	1	3	1	2		2	1	3			1	1	1	4		3				1	2	3	2	2	2	2	2	
	13.5	26	54		14		2		10	1	4	1	6	4	2	1	1	3	4			1	5		1	1	1	1	1						8	1	5	1		
	15	55	69	1	20	3	2	14	1	2	12	3	1	4	3	10	4	5	1	3		1	5	2	1	1		3				1	5	10			5	1		
18	35	87	2	14	4	3	2	1	3	6	5	3	11	13	2	5	1	2	1	4	3	1	4	2	2		2					1	8	2	5	6	4			
TOTALS		14	133	20	7	48	8	8	39	13	12	49	28	25	13	5	13	9	20	15	3	8	19	6	3	6	7	2	18	3	23	2	3	11	59	9	41	13	32	6

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177 **4. DISCUSSION**

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179 **4.1. Palynostratigraphy**

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181 Oligocene has long been considered absent throughout the ivorian sedimentary basin because  
182 it is strongly eroded. This erosion is highlighted in the Port-Bouet 1 sounding where the  
183 Miocene rests unconformably on the upper Cretaceous.

184 However, the recent palynological work of [4, 5] highlighted Oligocene in Bingerville east of  
185 Abidjan. This study continued by [6], has actually revealed a palynological association in the  
186 gray clays that overcome the variegated clays (Continental terminal). This palynological  
187 association consists of pollens *Spirosyncolpites spiralis*, *Perfotricolpites digitatus*.

188 The work of [7] in the same area, allowed to define two associations of palynomorphs:  
189 *Crassoretitriletes vanraadshooveni*, *Verrucatosporites usmensis* encountered in gray clays  
190 and *Verrutricolporites laevigatus* encountered in peats are characteristic associations of the  
191 lower Miocene

192 This work has highlighted most of the species cited by these authors. These are spore species  
193 and pollen grains such as *Perfotricolpites digitatus*, *Verucatosporites usmensis*,  
194 *Laevigatosporites ovatus*, *Pachydermites diederixii*, *Polypodiaceoisporites simplex*,  
195 *Psilatricolporites laevigatus*, *Monocolpites irregularis*, *Tripurites sp.*, *Momipites sp.*,  
196 *Striatopollis bellus*, *Striatopollis catatumbus*, *Spinizonocolpites echinatus* and *Occulopollis*  
197 *magnoporus*.

198 These species are associated with dinocysts such as *Lejeunecysta pulchra*, *Lejeunecysta lata*,  
199 *Lejeunecysta globosa* and *Selenopemphix nephroides* characteristic of the Oligocene in most  
200 West African countries.

201 [8] have shown that the association of dinocysts consisting of *Lejeunecysta pulchra*,  
202 *Lejeunecysta lata*, *Lejeunecysta globosa*, *lejeunecysta sp.* *Selenopemphix nephroids*,  
203 *Operculodinium centrocarpum*, *Selenopemphix quanta* and *Cordosphaeridium inodes*  
204 characterizes the Oligocene in Nigeria.

205 [9] showed in Gabon that the association of spores and pollen grains such as *Perfotricolpites*  
206 *digitatus*, *Magnastriatites howardii*, *Praedapollis africanus*, *Psilatricolporites operculatus*,  
207 *Pachydermites diederixii*, *Verrucatosporites usmensis*, *Striatopollis bellus*, *Retitricolporites*  
208 *irregularis* and *Occulopollis magnoporus* characterizes the Oligocene.

209 [10] indicate that the species *Bombacidites bombax*, *Psilastephanocolporites perforatus*.  
210 *Psilatricolporites operculatus*, *Magnastriatites howardii*, *Pachydermites diederixii*,  
211 *Perfotricolpites digitatus*, *Praedapollis africanus*, *Retitripurites sp.* and *Verrucatosporites*  
212 *usmensis* characterize the upper Oligocene-lower Miocene passage in most African  
213 sedimentary basins.

214 Most of these palynomorphs cited by these authors have been highlighted in work. The  
215 Oligocene age was retained and confirmed in view of the presence of *Lejeunecysta lata* and  
216 *Lejeunecysta globosa* in the studied wells.

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## 4.2. Paleobotany and paleoecology

The paleobotanical study of the wells shows the presence of the pollen grains of the Arecaceae (*Retitricolporites irregularis*, *Monocolpopollenites sp.*), Nypa (*Monocolpites marginatus*, *Racemonocolpites hians*), Meliaceae (*Psilastephanocolporites punctatus*), Moraceae (*Momipites sp.*), Polygalaceae (*Psilastephanocolporites perforatus*), Caesalpiniaceae (*Striatopollis bellus*), Alchorneas (*Psitricolporites operculatus*), Apocynaceae (*Margocolporites rauwolfii*, *Psilatricolporites crassus*) and Fabaceae (*Crototricolporites densus*). These pollen grains are associated with spores of Polypodiaceae (*Laevigatosporites ovatus*, *verrucatosporites usmensis*) and Cyatheaceae (*Deltoidospora minor*).

These different botanical groups can be divided into three paleoecological groups that are all mangroves group, rainforest group and Coastal plain group (including Swamp Species).

### 4.2.1. Mangrove group

The main mangrove elements identified in this study are *Psilatricolporites crassus* (Apocynaceae), *Psilatricolporites laevigatus*, *Cyathidites minor* and *polypodiaceiosporites regularis*.

*Psilatricolporites crassus* and *Psilatricolporites laevigatus* are important elements of mangrove widespread throughout tropical Africa and South America [11, 12, 13, 14].

The *Psilatricolporites crassus* pollen is believed to be derived from the mangrove plant *Pelliceria* [13, 15].

Ferns of the genus *Cyathidites minor* and *polypodiaceiosporites regularis* present in this group are typical of the dense forests of the coastal plains and are also found in mangrove areas [14,16, 17].

### 4.2.2. Coastal Plain Group (including Swamp Species)

This groupe is represented by an assemblage consisting of *Pachydermites diderixi*, *Retitricolporites irregularis*, *Verrucatosporites usmensis*, *Laevigatosporites ovatus*, *Monocolpopollenites sp.*, *Polypodiaceoisporites regularis*, *Momipites sp.* and *Cyathidites minor*.

The genus *Pachydermites diderixi* shows a constant occurrence in both wells studied and associated with the pteridophyte of the genus *Polypodiaceoisporites regularis*. This fern spore inhabits coastal wetlands and wetlands [18].

The species *Pachydermites diderixi*, which belongs to the family *Symphonia globulifera*, is known to be a dominant species in the coastal marshes of Africa [11]. The species *Retitricolporites irregularis* has been identified as a taxon present in coastal swamp environments [11].

[19] attribute this same pollen to freshwater swamp forests. Tree ferns such as *cyathidites minor* (cyatheacea) and *Polypodiaceoisporites regularis* (Pteridaceae) inhabit thick tropical forests [16, 20].

The association of *Pachydermites diderixi*, *Verrucatosporites usmensis* and *Laevigatosporites ovatus* indicate a freshwater or brackish swamp environments [21]. This could probably happen in the freshwater marsh behind the mangrove.

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#### 4.2.3. Rainforest group

This group consists of *Psilastephanocolporites punctatus*, *Striatopollis bellus*, *Psilatricolporites operculatus*, *Margocolporites rauwolfii*, *Racemonocolpites hians*, and *Psilatricolporites laevigatus*. [14] have shown that *Psilastephanocolporites punctatus*, *Racemonocolpites hians*, and *Psilatricolporites laevigatus* are indicative of dense moist forest. [22] attribute the species *Striatopollis bellus* and *Racemonocolpites hians* to rainforest. [23] confirms that *Striatopollis bellus* is a characteristic species of rainforest. [13] also indicates that the species *Psilatricolporites laevigatus* is a characteristic species of rainforest.

#### CONCLUSION

The biostratigraphic analysis of Tertiary deposits in the Bingerville region through two wells P1 and P2 allowed to carry out the lithostratigraphic description of the formations present and their contents in palynomorphs.

Sedimentologically, the sediments are mainly composed of lateritic clays, variegated, dark gray with parts of ferruginous cuirasses. There are also ferruginous sandstones, sands and reddish clay sands.

Palynologically, the study of palynoflor showed Oligocene, characterized by the following dinocysts: *Lejeunecysta pulchra*, *Lejeunecysta lata*, *Lejeunecysta globosa*, *Selenopemphix nephroids*, *Selenopemphix quanta*, *Operculodinium centrocarpum* and *Cordosphaeridium inodes*.

These dinocysts are associated with the following spores and pollen grains: *Magnastriatites howardii*, *Perfotricolpites digitatus*, *Pachydermites diderixi*, *Bombacacidites bombax*, *Retitricolporites irregularis*, *Retitriporites sp.* *Verrucatosporites usmensis* etc.

At the palaeobotanical and palaeoecological level, the highlighted palynoflora made it possible to characterize three environments, including mangroves, coastal plain, and rainforests.

319 **Plate 1: Oligocene Dinocysts of Bingerville**

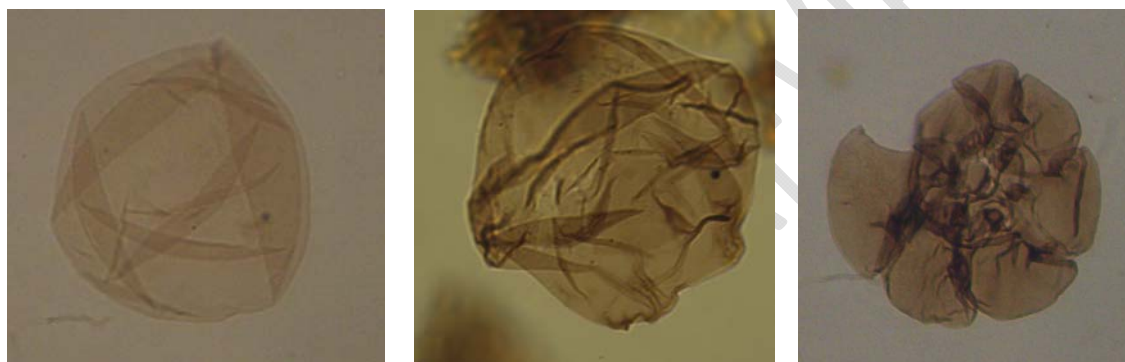


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326 *1- Operculodinium centrocarpum* ; 2- *Spiniferites ramosus* ; 3- *Lejeunecysta lata* ; 4-  
327 *Batiacasphaera* sp. ; 5- *Lejeunecysta globosa* ; 6- foraminifera basal.

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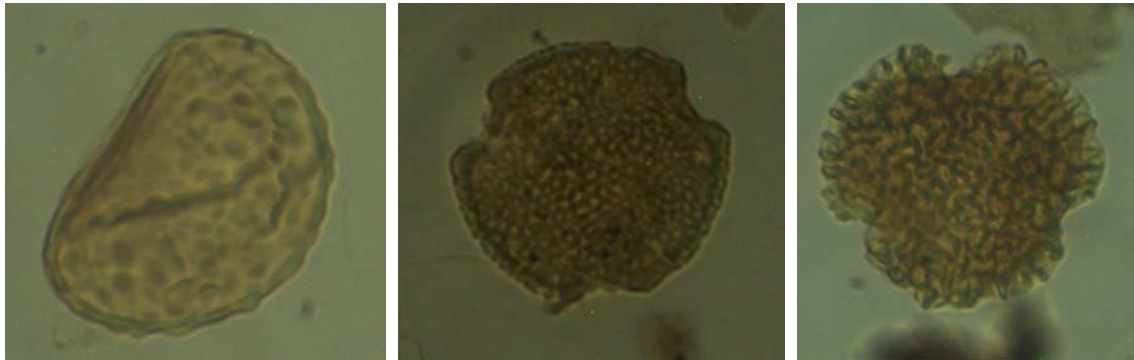
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339 Plate 2: Oligocene spore and pollen grains of Bingerville



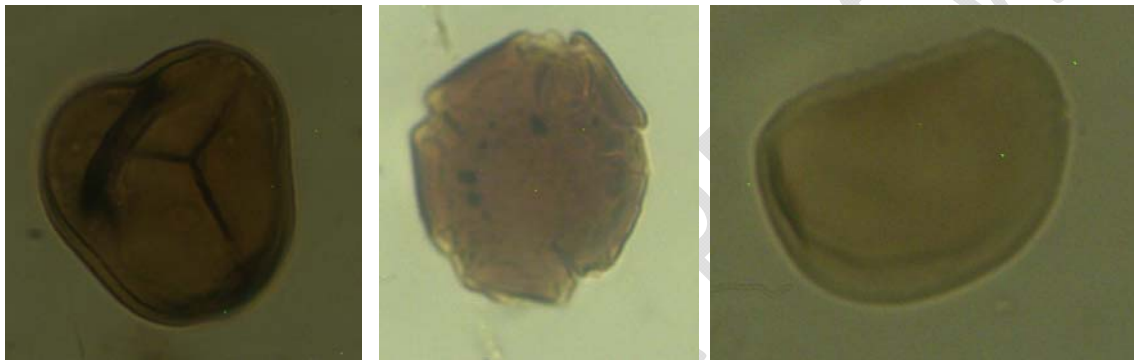
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346 1-*Verrucatosporites usmensis*; 2-*Retitriporites* sp.; 3- *Retitricolporites irregularis*; 4-  
347 *Cyathidites minor*; 5- *Pachydermites diderixii*; 6- *Laevigatosporites ovatus*; 7-  
348 *Occulopollis magnoporus*; 8- *Psilastephanocolporites laevigatus*; 9- *Momipites* sp.

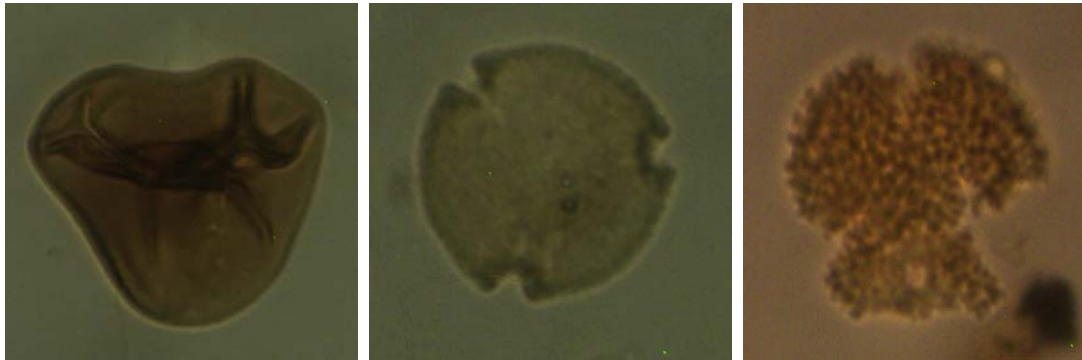
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353 **Plate 3 : Oligocene spore and pollen grains of Bingerville**



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360 *1- Leiotriletes adriensis* ; 2- *Tripurites sp.* ; 3- *Crototricolporites densus* ; 4- *Tricolpites sp.* ;  
361 *5-Tricolpites americana* ; 6 -*Striatopolis bellus*; 7- *Margocolporites rauwolfii* ; 8 -  
362 *Psilatricolporites crassus* ; 9 - *Psilatricolporites operculatus*

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367 **Plate 4 : Oligocene spore and pollen grains of Bingerville**



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373 *1- Polypodiaceosporites simplex* ; 2 - *Psilastephanocolporites punctatus* ; 3 -  
374 *Margocolporites rauvolfii* ; 4 - *Monocolpites marginatus* ; 5 - *Retitricolporites verrucatus*

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379 **APPENDIX**

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381 **Dinoflagellate cysts**

382 *Cordosphaeridium inodes* (Klumpp) Eisenack, 1963b

383 *Lejeunecysta globose* Biffi and Grignani, 1983

384 *Lejeunecysta lata* Biffi and Grignani, 1983

385 *Operculodinium centrocarpum* (O. Wetzel, 1933a) Deflandre and Cookson, 1955

386 *Spiniferites ramosus* (Ehrenberg, 1838) Mantell, 1854

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388 **Pteridophyte and bryophyte spores**

389 *Laevigatosporites ovatus* Wilson & Webster, 1947

390 *Leiotriletes andriensis* Krutzsch, 1959

391 *Polypodiaceoisporites simplex* Sah, 1967

392 *Verrucatosporites usmensis* (Van der Hammen, 1956) Germeraad et al., 1968

393 *Deltoidospora minor* (Couper, 1953) Pocock, 1970

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