

CREOLE PETROLEUM CORPORATION

Geological Office

Exploration Section

MAZACAIBO - VENEZUELA

JERSEY PRODUCTION RESEARCH COMPANY

Report of Service Work

1961 41

STUDIES ON CRETACEOUS ACID-INSOLUBLE MICROFOSSILS

IN WESTERN VENEZUELA

By

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GEOLOGICAL DIVISION

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For

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BARINAS BASIN

Assb. A	7-12	Rio Curito
Assb. B	13-14	"
Assb. C	15	"
Assb. A	16-17	Burgua-3
Assb. B	18-22	"
Assb. B	23	Sinco-2
Assb. C	24-25	Rosalia-1
Assb. C	26-27	Capitanejo-1
Paleoc? - U. Cret?	28	Masparro-1

MARACAIBO BASIN

Alb	29-34	2. Sta. Rosa
Apt	35	Cañada la Ge
Alb	36	P-114
Apt	37-42	P-114
Alb	43-45	SVSX-1

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Section B-B'.
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Maracaibo Basin.

P A R T I

Text

INTRODUCTION

The purpose of this study has been to evaluate acid-insoluble microfossils as dating and correlation tools in the Cretaceous of western Venezuela and to set up criteria for their use in this area. It has been done in response to Creole Petroleum Corporation's letter DM-357 of April 17, 1959. Because of the basic nature of some of this work, part of it has been done on a research basis and charged accordingly. Specifically, the basic studies have centered around fossil dinoflagellates. They are the most important single group of organisms in these Cretaceous samples. Although they show tremendous promise as markers, very little study has been devoted to fossil dinoflagellates, and we are just in the initial stages of evaluating them. ✓

The service part of this work has been charged to Job No. 5216.

Upper Cretaceous

Acid-insoluble control for the Upper Cretaceous* has largely been pieced together from well and surface samples from the Barinas Basin (Masparro-1, Silvestre-17, Sinco-2, Rosalia-1, Apure-2, and Capitanejo-1 wells and Rio Curito measured surface section, shown in Figs. 1 and 2). The reason these samples had to be used, rather than the Upper Cretaceous control provided or suggested by Creole (Quebrada Mito Juan, Rio Lobaterita, and Rio Blanco sections, and Rama-1 and Raban-14 wells) is that, with the exception of the Mito Juan section, all of these samples were barren.** For this reason, precise age assignments have not been possible. Rather, we have tried to get a general picture of the Upper Cretaceous of western Venezuela as exemplified by microfossils and to superimpose this on the regional picture as portrayed through electric logs, stratigraphic sections, and other available information. The two pictures show a fair degree of coincidence. Even, so, that of the microfossils remains somewhat sketchy owing to a lack of adequate samples. Also some dilemmas have arisen over some seemingly misplaced assemblages.

The microfossil assemblages arrayed in their entirety and superimposed on other geologic information has given us a much better picture of the situation than we had when we first reported on the Barinas

* Upper Cretaceous, as used in this report, embraces the Cenomanian through Maestrichtian stages.

** Barren, as used in this report, refers to acid-insoluble microfossils.

samples. It has forced us, among other things, to revise our opinions on the ranges of several key dinoflagellates. For example, we now believe Gymnodinium heterocostatum to range from the Upper Albian to the Maestrichtian; formerly we had thought it confined to the Senonian.

Therefore some of our previous reports on microfossils from the Barinas must be revised, and the results contained in this report are to supersede any previous ones.

Lower Cretaceous

Lower Cretaceous acid-insoluble microfossil control for western Venezuela was obtained from two wells and two surface sections in the Maracaibo Basin (SVSX-1 and P-114 wells and the Cañada La Ge and Quebrada Santa Rosa sections, shown in Fig. 3). These provided Aptian and Albian assemblages. Also certain assemblages from the Barinas Basin are thought to be Albian; these are referred to as "Assemblage C".

THE FOSSIL ASSEMBLAGES

Barinas Basin

Figs. 1 and 2 show assemblages of selected fossils from the Barinas Basin plotted on electric logs or stratigraphic sections. These are distinctive fossils that appear more than once in the samples studied and are believed to be the most promising potential markers. They are illustrated in Plates 1-4 (examples of complete assemblages are illustrated in Plates 7-28). The top of the Fortuna limestone, or its interpreted position, has been used as the datum in the above figures.

It can be noted that three general fossil assemblages are present. Although the evidence is inconclusive because of insufficient samples, these assemblages seem to more or less coincide with the Colon, La Luna, and Aquardiente formations or their equivalents.

Assemblage A - The upper assemblage, Assemblage A, is best characterized by several species of brown-pigmented dinoflagellates: Palaeoperidinium "gigas"*, P. "cyanos", P. "brownium", and P. "spindulosum". We believe these to be closely related to similar species we have seen from the Maestrichtian and Campanian from other parts of the world. Deflandrea "laevigata", D. "psilata", Hystriosphera A, and H. "nemathia" are dinoflagellates that also show promise of being reliable markers. To a lesser extent, "Laciniadinium" sp. appears to be a marker for this assemblage, though it occasionally is found in the top of Assemblage B. These forms are illustrated in Plate 1.

Assemblage B - The middle assemblage, Assemblage B, is characterized by the fairly consistent occurrence of the dinoflagellate Gymnodinium heterocostatum. This species occurs both above and below this assemblage, but so far such occurrences have been spotty. Other typical dinoflagellates are: Gymnodinium cretaceum**, Palaeohystriosphera isodiametrica***, P. infusorioides****, Deflandrea 1, and D. 2. The latter two reach a peak of abundance within narrow vertical limits in several of the wells and may serve as a correlation horizon. More evidence

* Names in quotes are manuscript names or nomena imaginata.

** Described by Deflandre (1935) from the Senonian of the Paris Basin.

*** Described by Cookson and Eisenack (1957) from the Campanian-Maestrichtian of Australia. Seen by us in the Senonian of Pakistan.

**** Described by Deflandre (1935) from the Senonian of the Paris Basin. Reported by Cookson and Eisenack (1957) from the Cenomanian to Lower Turonian of Australia. Seen by us in the Cenomanian-Turonian and Senonian of Pakistan and the Coniacian-Santonian of Colorado.

is needed to show whether or not this is an environmental effect. The above fossils are illustrated in Plate 2.

Assemblage C - Because of the lack of diagnostic fossil-bearing samples between the second (Assemblage B) and third (Assemblage C) assemblages, it is not possible to determine how, or if, they grade into one another. Assemblage C is characterized by the dinoflagellates Gonyaulax 1, Odontochitina sp., Palaeoperidinium "heterostatum", "Fimbriasphaera fimbria", Hystrichosphaera B, and Hystrichosphaeridium "gordum"; and by the pollen and spores Lycopodiacidites 2, Cicatricosisporites, Porocolpopollenites "striatus", P. PuVer, and Tetradites "spinosus". (Cicatricosisporites is used here and in the Lower Cretaceous of the Maracaibo Basin at the generic, not the specific, level.) In this assemblage Gonyaulax 1 would indicate an Albian age. We have also seen the same species of Odontochitina from the Mowry (Upper Albian) of Utah.

Certain of these fossils (Odontochitina sp., Gonyaulax 1, Palaeoperidinium "heterostatum", and Cicatricosisporites) are also found in Albian sediments from the Maracaibo Basin and may prove of value in correlating between these basins. Key Assemblage C fossils are illustrated in Plate 3.

Maracaibo Basin - Lower Cretaceous

From what we have seen of Lower Cretaceous assemblages elsewhere, those from the Albian and Aptian of the Maracaibo Basin are fairly typical. As stated above, certain forms found in the Albian here are also found in samples believed to be Albian (Assemblage C) from the Barinas Basin. The overall assemblages are somewhat different between the two basins, however.

The number of productive samples here - as in the Barinas Basin - is less than would be desired for a comprehensive study. They do provide a basis for generalizing on the microfossil make-up of the Aptian-Albian, but generalizations on separating the Aptian from the Albian are more tenuous. Additional study should be conducted to see if the separation suggested by these samples can be verified. Possible markers are illustrated in Plates 5-6, whereas complete assemblages are shown in Plates 29-46.

Fig. 3 shows assemblages of these possible Aptian and Albian markers plotted on electric logs or stratigraphic sections. The fossil groups that best characterize the Aptian-Albian here are the spore genera Zonalasporites and Cicatricosisporites, the pollen Classopollis, and the dinoflagellate genus Gonyaulax. In addition there are two species that may prove of value: Liliacidites sp. and Hystrichosphaeridium "tubiferum" "cortum". Cicatricosisporites is a genus common in both the Upper and Lower Cretaceous of the North Temperate Zone, but so far it has not been

seen in any Upper Cretaceous from northern South America. Classopollis is a genus common in the Lower Cretaceous and Jurassic of many parts of the world. The particular types of Gonyaulax in these samples are typical of many Aptian-Albian sediments.

The Albian - Fossils that may turn out to be Albian markers in this area are illustrated on Plate 5. These are the spore Concavisporites sp., the pollen Classopollis 1, and the dinoflagellates Odontochitina sp., Gonyaulax 1, Palaeoperidinium "ellipticum", P. "heterostatum", and P. "cilium".

The Aptian - Possible Aptian markers are shown on Plate 6. These are the pollen Classopollis 2, and the dinoflagellates Gonyaulax 3, Palaeoperidinium "caudatum", and P. "spinulosum".

Mito Juan Section

Six samples collected from the Mito Juan formation, Quebrada Mito Juan, Barco Concession, Columbia, contained good assemblages of acid-insoluble microfossils, and these assemblages are illustrated in Plates 46-53. This formation has been dated as Upper Maestrichtian. The assemblages are predominantly of terrestrial origin, but occasional dinoflagellates and hystrichosphaerids suggest a brackish depositional environment. Regrettably the latter organisms are both poorly preserved and of generalized morphology. Thus two specimens of Gymnodinium heterocostatum are the only forms that can be determined.

The spore-pollen assemblages are quite distinctive, but are unlike any encountered in the Upper Cretaceous of the Barinas Basin. Some of the forms have been found in Maestrichtian-Danian sediments from other parts of Colombia. Also several pollen species seem identical to forms found in the Maestrichtian of Wyoming and Colorado. This came as quite a surprise to us, but we believe that, even if the forms are botanically the same, their occurring at the same time in the two areas is mere coincidence.

PROBLEMATIC ASSEMBLAGES

Rio Curito Section - Sample No. 80352 (Fig. 1) contains a predominance of Gonyaulax 2, a dinoflagellate most similar to forms that we know elsewhere from Aptian-Albian sediments. Both by lithologic and fossil correlations, this stratigraphic position could not be this old.

Rosalia-1 - The 9283-foot sample (Fig. 1) (from a core) contains dinoflagellates of Assemblage A. On the basis of the electric log, however, this sample would fall in the Eocene, between thirty and forty feet above the Cretaceous-Eocene unconformity. The presence in the sample of a single bombacaceous pollen of likely Eocene age leads us to believe that the Cretaceous fossils are reworked.

Apure-2 - The 6550-6570-foot sample (Fig. 2) (core) is placed by electric log correlations in the Eocene. The dinoflagellate assemblage from it would appear to be Assemblage B; also certain plant fossils have been seen so far only from the Cretaceous. However, a few pollen agree fairly well with Eocene forms from the Maracaibo Basin. On the basis of this evidence we believe the Cretaceous fossils to be reworked.

Masparro-1 - The log of the Masparro-1 well places the Cretaceous-Eocene unconformity at 6756 feet. In Fig. 1 we have treated the assemblages between 6611 feet and 6756 feet as Cretaceous, but there is definitely something peculiar about them. The pollen agree in general with forms recorded from the Maestrichtian-Danian of Colombia. The dinoflagellates, however, are most typical of Assemblage B. We suspect the dinoflagellates are reworked, but believe the pollen to be in place. The possibility of reworked fossils is further suggested by a sample from Core-No. 7 (6872-6920 feet). This sample contains reworked shale fragments, which Dr. C. V. Campbell thinks are La Luna. The possibility is suggested that the interval covered by Cores 1-7 (6611-6920 feet) is Danian. We definitely do not think any of this interval is Eocene.

Burgua-3 - The Burgua-3 well (Fig. 1) presents a very paradoxical situation so far as the sequence of fossil assemblages is concerned. Assemblage A is found in the interval (3691-5108 feet) called Colon on the log, as would be expected. It is followed by Assemblage B. But in the 6447-6453-foot core Assemblage A is repeated. The next two cores (6817-6823 feet and 6893-6903 feet) below this contain pollen and spores only noted from Assemblage C. The picture is further clouded by a ditch sample from further down the hole (8300-8350 feet) that contains an assemblage we would suppose to be high Assemblage C or low B. (Since this is a ditch sample, the explanation could be cavings.) At any rate we feel there must be considerable faulting in this well to produce this scrambling of assemblages.

CONCLUSION

Undoubtedly there remain problems in the application of acid-insoluble microfossils to the Cretaceous of western Venezuela, but we believe that they show considerable promise in this area. We hope that the study presented in this report may serve as a guide in their application and a basis upon which to conduct further investigations.

APURE-2

ROSALIA-1

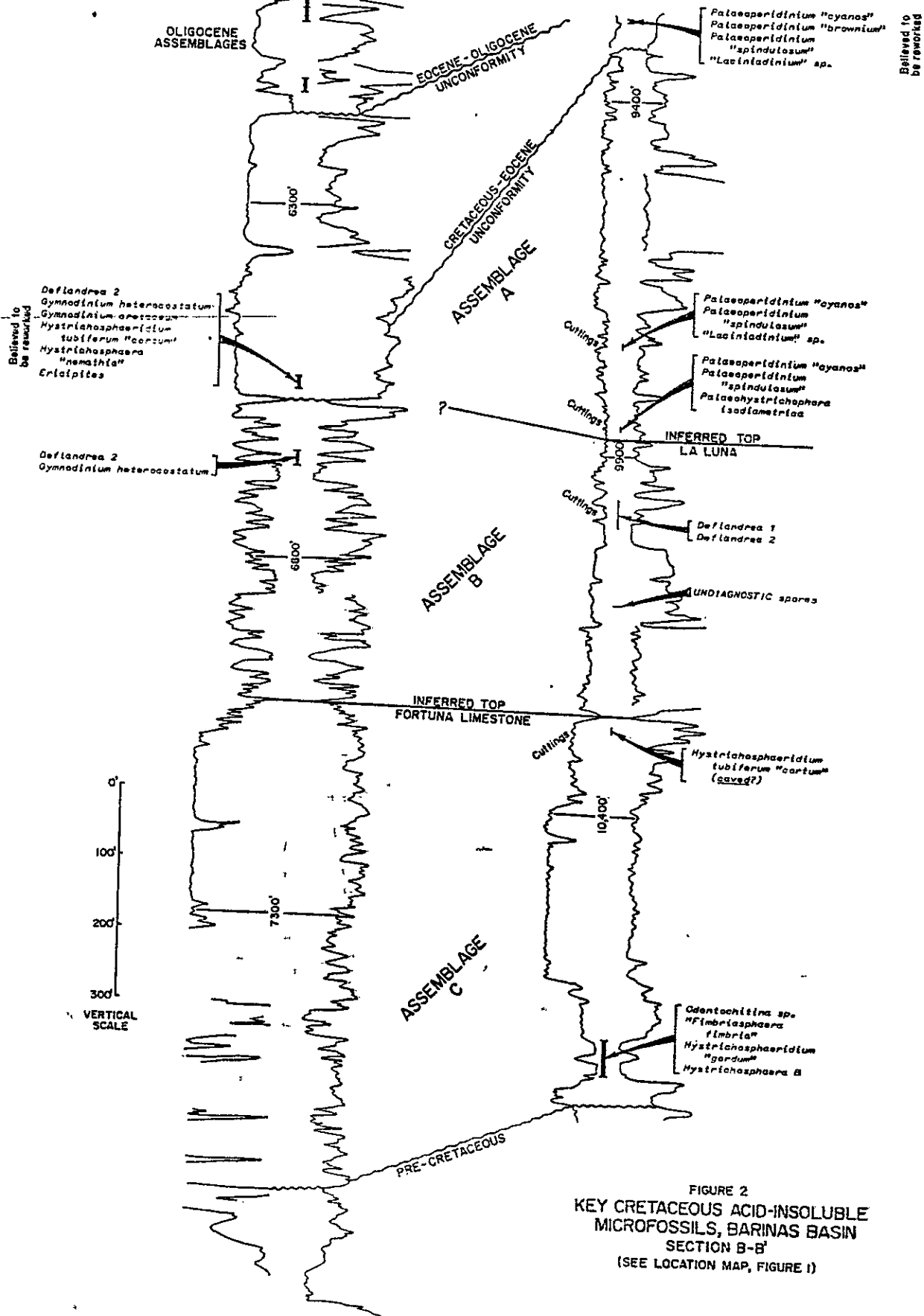


FIGURE 2
 KEY CRETACEOUS ACID-INSOLUBLE
 MICROFOSSILS, BARINAS BASIN
 SECTION B-B'
 (SEE LOCATION MAP, FIGURE 1)

Plate 1.

Key Microfossils - Assemblage A

Barinas Basin

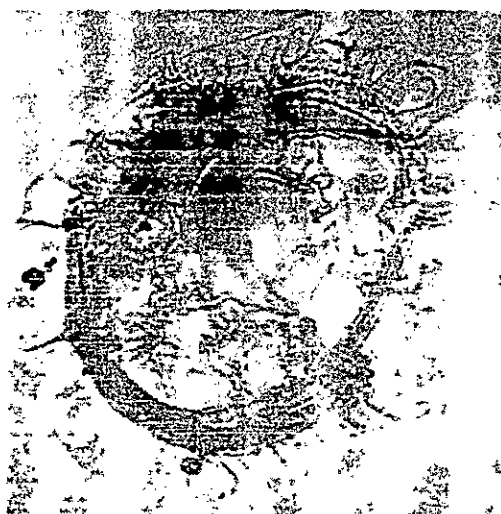
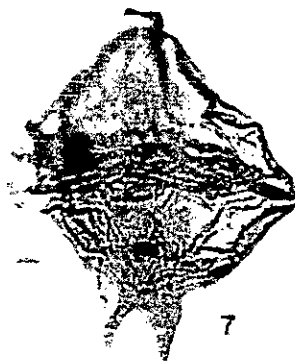
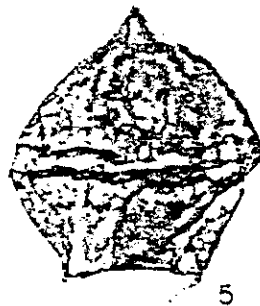
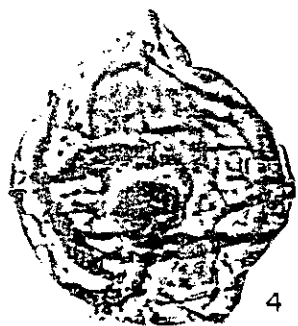
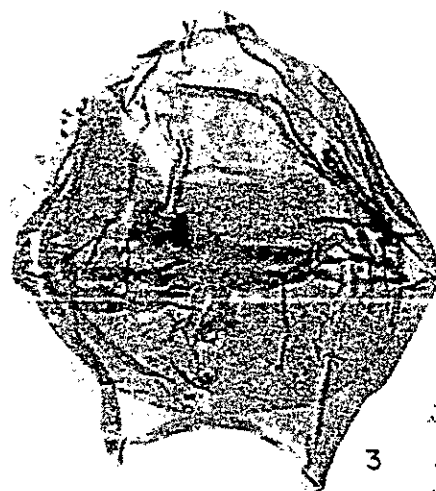
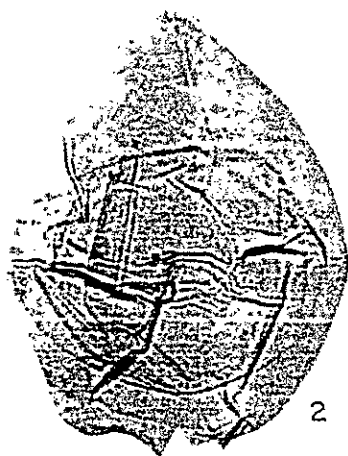
- Fig. 1. Palaeoperidinium "gigas". 750x. (Rio Curito Measured Section : 80329. Ser. 54685-1-2.)
- Fig. 2. Deflandrea "laevigata". 750x. (Burgua-3 : 5108-5118 feet. Ser. 33455-1B : 29 x 120.)
- Fig. 3. Deflandrea "psilata". 750x. (Burgua-3 : 5108-5118 feet. Ser. 33442-3B : 21.5 x 113.)
- Fig. 4-5. Palaeoperidinium "brownium". 750x. (Rio Curito Measured Section : 80329. Ser. 54704-1-22, 54690-1-7.)
- Fig. 6-7. Palaeoperidinium "cyanos". 750x. (Burgua-3 : 3937-3947 feet. Ser. 33698-1 : 19.5 x 117.5, 33694-1 : 27 x 113.5.)
- Fig. 8. Palaeoperidinium "spindulosum". 750x. (Burgua-3 : 5108-5118 feet. Ser. 33457-3A : 38 x 120.)
- Fig. 9-10. Hystriosphera A. 750x. (Burgua-3 : 3937-3947 feet. Ser. 33697-1 : 13.5 x 116.5, 33691-1 : 12.5 x 112.5).
- Fig. 11. "Laciniadinium" sp. 750x. (Burgua-3 : 5475-5484 feet. Ser. 33473-1 : 15 x 113.5.)
- Fig. 12. Hystriosphera "nemathia". 750x. (Burgua-3 : 5108-5118 feet. Ser. 33451-3B : 11.5 x 116.)

PART II

Plates

KEY CRETACEOUS ACID-INSOLUBLE MICROFOSSILS

Plates 1-6



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MARACAIBO - VENEZUELA

Plate 2

Key Microfossils - Assemblage B

Barinas Basin

- Fig. 1-3. Deflandrea 2. 750x. (Fig. 1 - Burgua-3 : 5902-5906 feet. Ser. 33540-1 : 17 x 122.5. Fig. 2 - Masparro-1 : 7035-7084 feet. Ser. 33686-1 : 41.5 x 121. Fig. 3 - Burgua-3 : 5902-5906 feet. Ser. 33541-1 : 24.5 x 127.5.)
- Fig. 4-5. Deflandrea 1. 750x. (Fig. 4 - Masparro-1 : 7035-7084 feet. Ser. 33688-1 : 31 x 120.5. Fig. 5 - Burgua-3 : 5902-5906 feet. Ser. 33534-1 : 19 x 117.)
- Fig. 6. Deflandrea "javalina". 750 x. (Burgua-3 : 5475-5484 feet. Ser. 33494-2 : 35 x 114.)
- Fig. 7. Palaeohystrichophora isodiametrica. 750x. (Sinco-2 : 8723-8774 feet. Ser. 54890-1-8.)
- Fig. 8. Palaeohystrichophora infusorioides. 750x. (Sinco-2 : 8774-8812 feet. Ser. 54206-1-4.)
- Fig. 9. Gymnodinium cretaceum. 750x. (Burgua-3 : 6317-6322 feet. Ser. 33560-1 : 28.5 x 115.5.)
- Fig. 10-13. Gymnodinium heterocostatum. 750x. (Fig. 10 - Rio Curito Measured Section : 80329. Ser. 54686-1-3. Fig. 11 - Burgua-3 : 5475-5484 feet. Ser. 33486-1 : 27.5 x 117. Fig. 12 - Sinco-2 : 8723-8774 feet. Ser. 54893-1-11. Fig. 13 - Burgua-3 : 5725-5735 feet. Ser. 33514-1 : 29.5 x 112.)

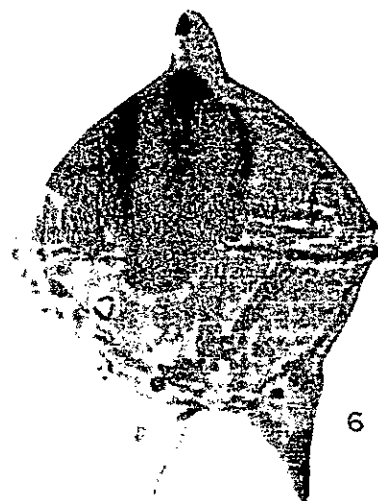
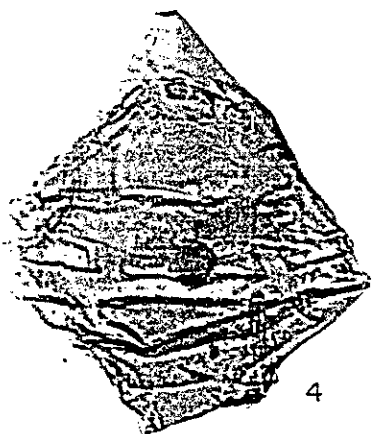
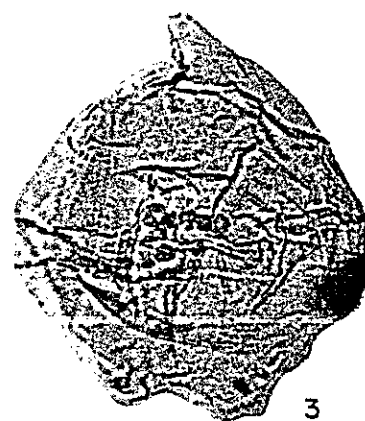
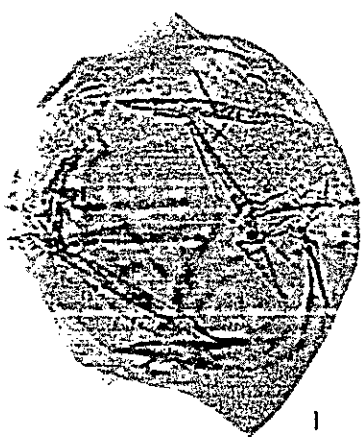


Plate 3

Key Microfossils - Assemblage C

Barinas Basin

- Fig. 1. Lycopodiacidites 2. 1000x. (Capitanejo-1 : 15,006 feet.
Ser. 54353-1-13.) Camarozonosporites
- Fig. 2. Porocolpopollenites "striatus". 1000x. (Burgua-3 :
6817-6823 feet. Ser. 33600-1 : 27 x 117.5.)
- Fig. 3. Tetradites "spinosus". 1000x. (Silvestre-17 : 9708
feet. Ser. 54870-3-1.)
- Fig. 4. Porocolpopollenites PuVer. 1000x. (Capitanejo-1 :
15,006 feet. Ser. 54644-1-3.)
- Fig. 5. Cicatricosisporites. 1000x. (Burgua-3 : 6817-6823 feet.
Ser. 33620-1 : 43 x 126.5.)
- Fig. 6. Palaeoperidinium "heterostatum". 750x. (Capitanejo-1 :
14,994 feet. Ser. 54632-1-6.)
- Fig. 7. Gonyaulax 1. 750x. (Rio Curito Measured Section :
80360. Ser. 54876-2-1.)
- Fig. 8. Odontochitina sp. 750x. (Rosalia-1 : 10,718-10,768 feet.
Ser. 54611-1-5.)
- Fig. 9. Hystrichosphaeridium "gordum". 750x. (Rosalia-1 :
10,718-10,768 feet. Ser. 54619-2-4.)
- Fig. 10. "Fimbriasphaera fimbria". 750x. (Rosalia-1 : 10,718-
10,768 feet. Ser. 54617-2-2.)
- Fig. 11-12. Hystrichosphaera B. 750x. (Fig. 11 - Rosalia-1 :
10,718-10,768 feet. Ser. 54623-2-8. Fig. 12 - Capitanejo-1 :
14,994 feet. Ser. 54631-1-5.)



1



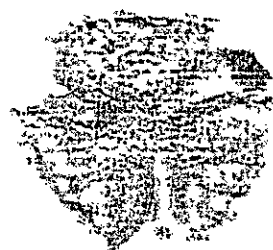
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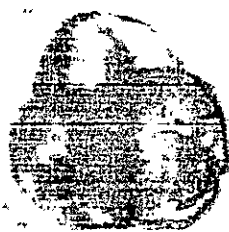
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Plate 4

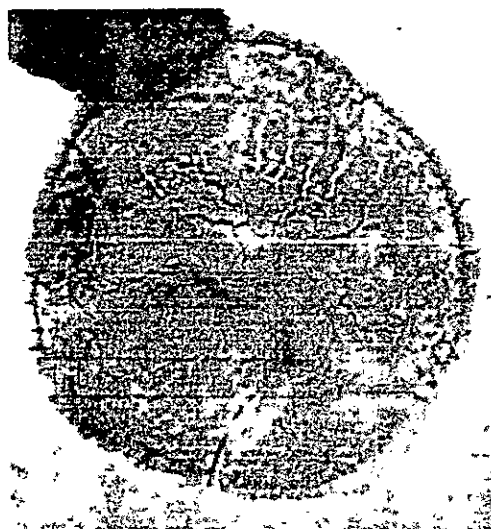
Possible Key Microfossils - Miscellaneous

Barinas Basin

- Fig. 1. Ericipites. 1000x. (Burgua-3 : 5725-5735 feet.
Ser. 33515-1 : 25.5 x 112.)
- Fig. 2. Reticuræ. 1000x. (Burgua-3 : 6817-6823 feet.
Ser. 33619-1 : 41 x 118.)
- Fig. 3. Lycopodiacidites 1. 1000x. (Burgua-3 : 5725-5735
feet. Ser. 33533-1 : 23 x 118.3.)
- Fig. 4-5. Foveotrilites sp. 1000x. (Rio Curito Measured Section :
80387. Ser. 54049-2-15, 54065-2-31.)
- Fig. 6. Triporopollenites "granulosus". 1000x. (Burgua-3 :
5475-5484 feet. Ser. 33496-2 : 25 x 115.)
- Fig. 7. Gonyaulax 2. 750x. (Rio Curito Measured Section :
80342. Ser. 54757-4-1.)
- Fig. 8. Hystriosphæridium tubiferum "cortum". 750x. (Rio
Curito Measured Section : 80357. Ser. 54761-8-3.)



1



2



3



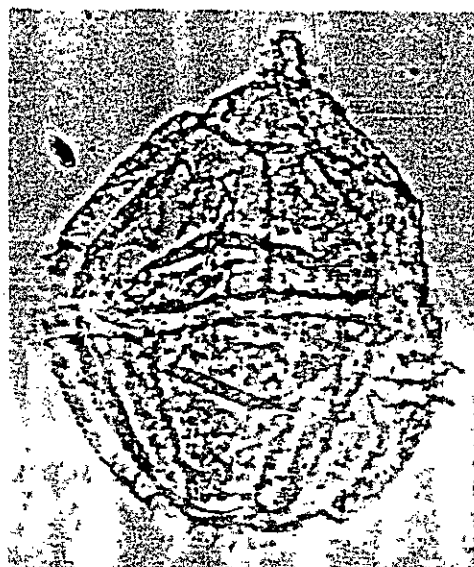
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5



6



7



8

Plate 5

Key Microfossils - Albian

Maracaibo Basin

- Fig. 1-2. Concavisporites sp. 1000x. (Qda. Sta. Rosa : 160191.
Ser. 54398-3-4, 54409-3-17.)
- Fig. 3. Classopollis l. 1000x. (Qda. Sta. Rosa : 160191.
Ser. 54404-3-12.)
- Fig. 4. Odontochitina sp. 750x. (SVSX-1 : 13,538-13,541 feet.
Ser. 54792-1-18.)
- Fig. 5-6. Gonyaulax l. 750x. (SVSX-1 : 13,538-13,541 feet.
Ser. 54784-1-10, 54786-1-12.)
- Fig. 7. Palaeoperidinium "ellipticum". 750x. (Qda. Sta. Rosa :
160191. Ser. 54433-3-8.)
- Fig. 8. Palaeoperidinium "heterostatum". 750x. (P-114 :
9351.5-9353 feet. Ser. 54483-3-5.)
- Fig. 9. Palaeoperidinium "cilium". 750x. (SVSX-1 : 13,597-
13,600 feet. Ser. 54810-1-6.)



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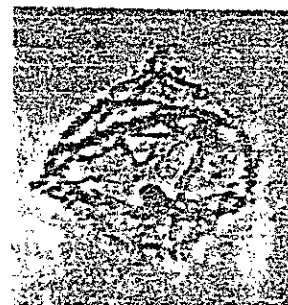
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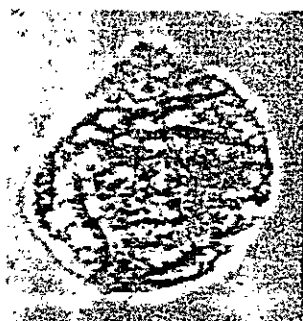


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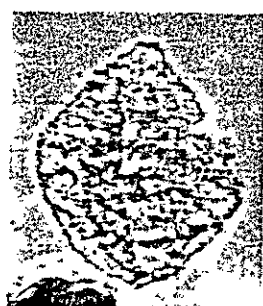


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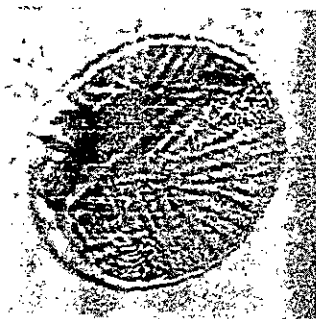
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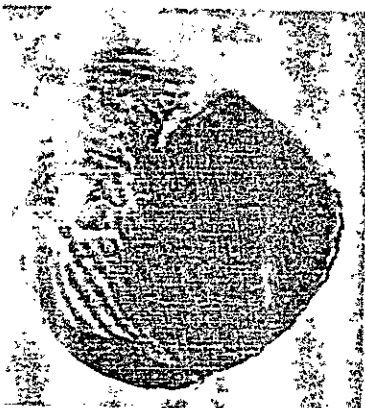
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Plate 6

Key Microfossils - Aptian

Maracaibo Basin

- Fig. 1. Palaeoperidinium "caudatum". 750x. (P-114 : 10,269-10,271.5 feet. Ser. 54511-5-2.)
- Fig. 2. Gonyaulax 3. 750x. (P-114 : 10,284.5-10,287 feet. Ser. 54675-1-14. Fig. 2a, bright field; 2b, phase contrast.)
- Fig. 3-4. Palaeoperidinium "spinulosum". 750x. (Canada La Ge : 160364. Ser. 54493-1-4, 54497-1-7b.)
- Fig. 5. Classopollis 2. 1000x. (P-114 : 10,269-10,271.5 feet. Ser. 54514-5-4.)

Key Microfossils - Aptian-Albian

Maracaibo Basin

- Fig. 6-9. Cicatricosisporites. 1000x. (Fig. 6-7 - P-114 : 10,269-10,271.5 feet. Ser. 54515-5-5, 54540-5-28. Fig. 8 - Qda. Sta. Rosa : 160190. Ser. 54421-3-29. Fig. 9 - P-114 : 10,276.5-10,279 feet. Ser. 54651-1-10.)
- Fig. 10. ?Liliacidites sp. 1000x. (Qda. Sta. Rosa : 160195. Ser. 54470-3-24.)
- Fig. 11. Zonalasporites sp. 100x. (Qda. Sta. Rosa : 160191. Ser. 54440-3-14.)
- Fig. 12. Hystriosphæridium tubiferum "longum". 750x. (P-114 : 10,284.5-10,287 feet. Ser. 54662-1-3.)

BARINAS BASIN CRETACEOUS ASSEMBLAGES

Plates 7-28

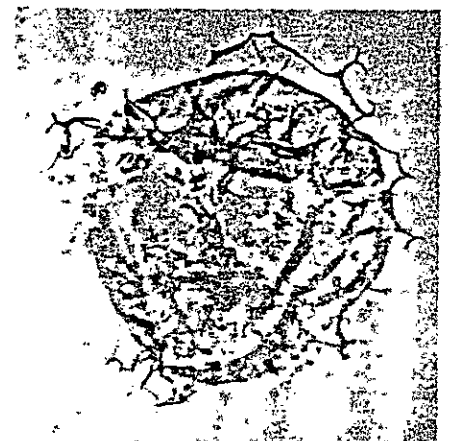


Plate 7

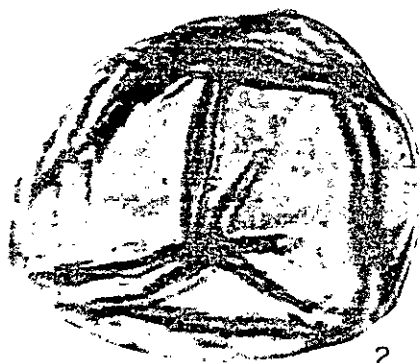
Rio Curito Measured Section
80329

(Assemblage A Level)

- Fig. 1-2. Palaeoperidinium "gigas". 750x. (Ser. 54685-1-2,
54694-1-13.)
- Fig. 3-4. Palaeoperidinium "brownium". 750x. (Ser. 54702-1-20,
54690-1-7.)
- Fig. 5-6. Dinoflagellate. 750x. (Ser. 54697-1-15a, 54695-1-14a.)
- Fig. 7-8. Gymnodinium heterocostatum. 750x. (Ser. 54686-1-3,
54693-1-11.)
- Fig. 9. Hystrichokibotium. 750x. (Ser. 54705-1-23.)
- Fig. 10. Hystrichokibotium. 750x. (Ser. 54689-1-6.)
- Fig. 11. Hystrichokibotium. 750x. (Ser. 54692-1-10.)



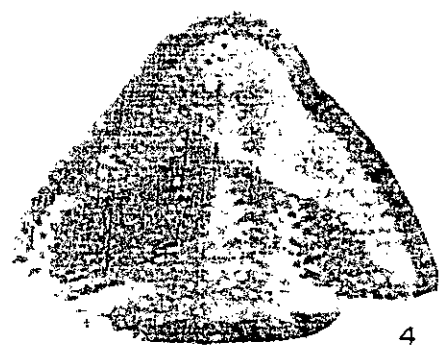
1



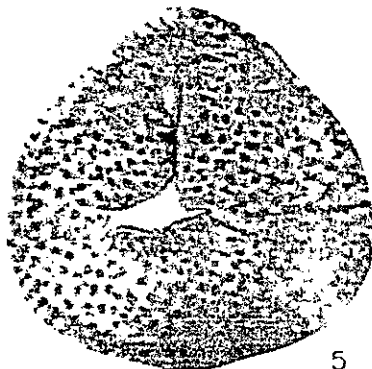
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Plate 8

Rio Curito Measured Section
80347

(Assemblage A Level)

- Fig. 1. Punctatisporites. 1000x. (Ser. 54066-2-32.)
Fig. 2. Punctatisporites. 1000x. (Ser. 54045-2-11.)
Fig. 3. Reticulatisporites. 1000x. (Ser. 54057-2-23.)
Fig. 4-5. Foveotrilletes. 1000x. (Ser. 54049-2-15, 54065-2-31.)
Fig. 6. Planisporites. 1000x. (Ser. 54051-2-17.)
Fig. 7. Verrucosisporites. 1000x. (Ser. 54067-2-33.)
Fig. 8. Apiculatisporis. 1000x. (Ser. 54052-2-18.)
Fig. 9. Apiculatisporis. 1000x. (Ser. 54050-2-16.)
Fig. 10. Ephedrapites. 1000x. (Ser. 54056-2-22.)
Fig. 11. ?Spore. 1000x. (Ser. 54053-2-19.)

(Continued on Plate 9.)

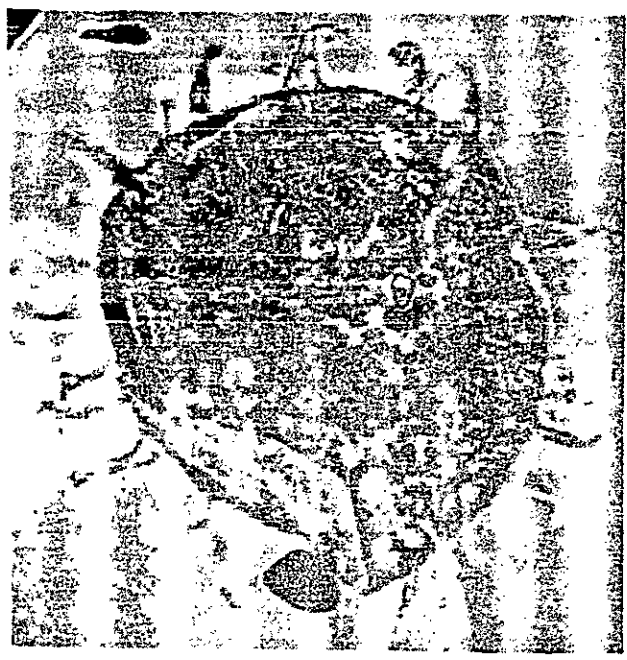
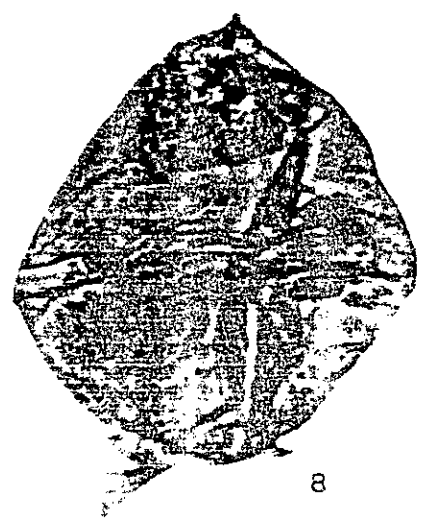
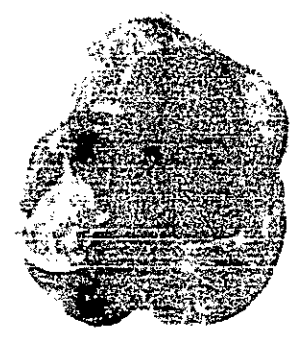
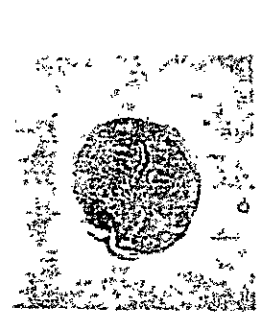
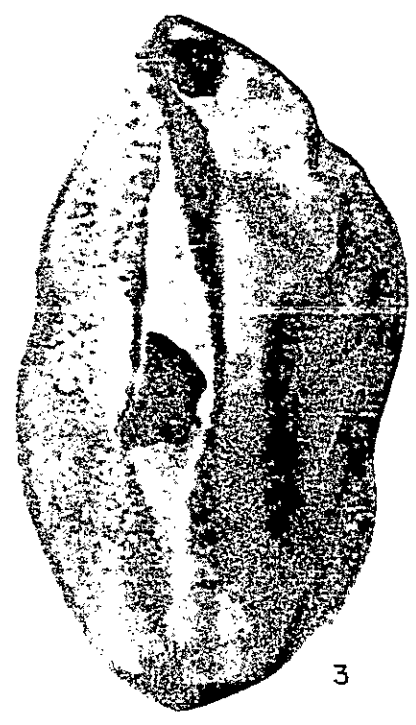
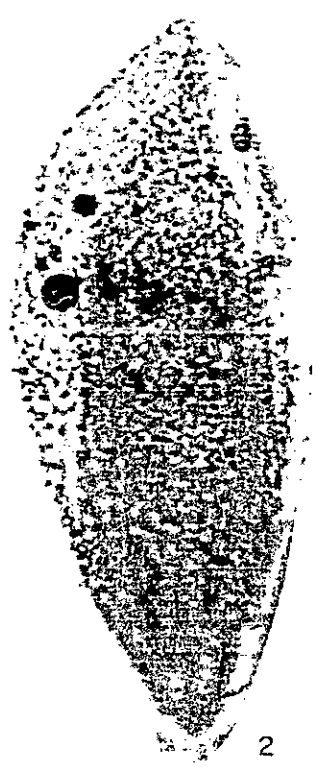


Plate 9.

Rio Curito Measured Section

80347

(Assemblage A Level)

(Continued from Plate 8.)

- Fig. 1. Cycadopites. 1000x. (Ser. 54042-2-7.)
- Fig. 2. Sabalpollenites. 1000x. (Ser. 54038-2-3.)
- Fig. 3. Sabalpollenites. 1000x. (Ser. 54054-2-20.)
- Fig. 4. Porocolpopollenites. 1000x. (Ser. 54064-2-29.)
- Fig. 5. Porocolpopollenites. 1000x. (Ser. 54040-2-5.)
- Fig. 6. Tricolpites. 1000x. (Ser. 54041-2-6.)
- Fig. 7. Tetrad. 1000x. (Ser. 54061-2-27.)
- Fig. 8. Dinoflagellate. 1000x. (Ser. 54037-2-2.)
- Fig. 9. Baltisphaeridium. 1000x. (Ser. 54068-2-29.)

Plate 10

Rio Curito Measured Section

80348

(Assemblage A Level)

- Fig. 1. Punctatisporites. 500x. (Ser. 54711-1-7.)
- Fig. 2. Deltoidospora. 1000x. (Ser. 54722-1-19.)
- Fig. 3. Granulatisporites. 1000x. (Ser. 54709-1-5.)
- Fig. 4. Cyclogranisporites. 1000x. (Ser. 54720-1-17.)
- Fig. 5. Convolutiliae. 1000x. (Ser. 54723-1-20.)
- Fig. 6. Convolutiliae. 1000x. (Ser. 54707-1-3.)
- Fig. 7. Reticulatisporites. 1000x. (Ser. 54725-1-22.)
- Fig. 8. Tetrad. 600x. (Ser. 54724-1-21.)
- Fig. 9-10. Reticuræ. 600x. (Ser. 54716-1-12; 54718-1-15.)
- Fig. 11-12. Inaperturopollenites. 1000x. (Ser. 54715-1-11;
54719-1-16.)
- Fig. 13. Cycadopites. 600x. (Ser. 54710-1-6.)

(Continued on Plate 11.)

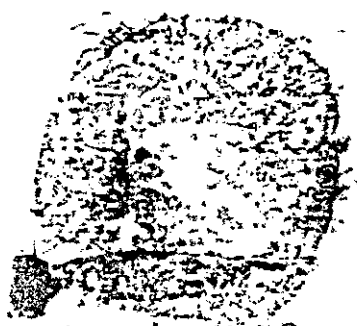
PLATE 10



PLATE II



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Plate 11

Rio Curito Measured Section
80348

(Assemblage A Level)

(Continued from Plate 10.)

- Fig. 1. Cannosphaeropsis. 600x. (Ser. 54714-1-10.)
- Fig. 2. Baltisphaeridium. 750x. (Ser. 54727-1-24.)
- Fig. 3. Baltisphaeridium. 750x. (Ser. 54721-1-18.)
- Fig. 4-5. Baltisphaeridium. 600x. (Ser. 54706-1-1, 54712-1-8.)
- Fig. 6-8. Hystriospheridium. 750x. (Ser. 54713-1-9,
54726-1-23, 54708-1-4.)

Plate 12

Rio Curito Measured Section

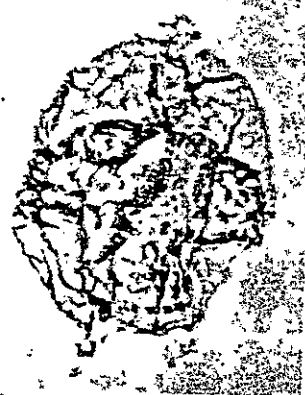
80349

(Assemblage A Level)

- Fig. 1-3. Palaeoperidinium "brownium". 750x. (Ser. 54743-1-15,
54740-1-12b, 54733-1-6.)
- Fig. 4. Dinoflagellate. 600x. (Ser. 54738-1-11.)
- Fig. 5. Gymnodinium heterocostatum. 750x. (Ser. 54745-1-17.)
- Fig. 6. ?Dinoflagellate. 750x. (Ser. 54735-1-8.)
- Fig. 7. Cyst. 750x. (Ser. 54730-1-4a.)
- Fig. 8. Nematosphaeropsis. 600x. (Ser. 54742-1-14.)
- Fig. 9. Cannosphaeropsis. 400x. (Ser. 54728-1-1.)
- Fig. 10. Baltisphaeridium. 600x. (Ser. 54731-1-4b.)
- Fig. 11. Baltisphaeridium. 750x. (Ser. 54741-1-13.)
- Fig. 12. "Bilateralia". 1000x. (Ser. 54729-1-3.)
- Fig. 13. Triporopollenites. 1000x. (Ser. 54739-1-12a.)
- Fig. 14. Tricolporites. 1000x. (Ser. 54736-1-9.)



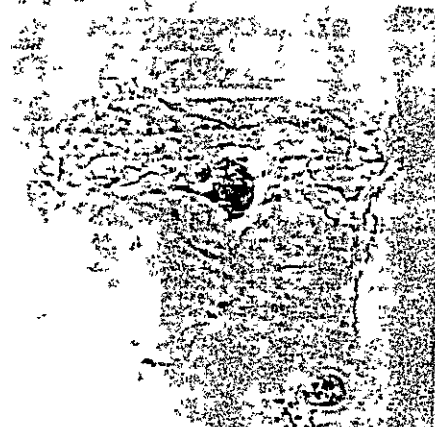
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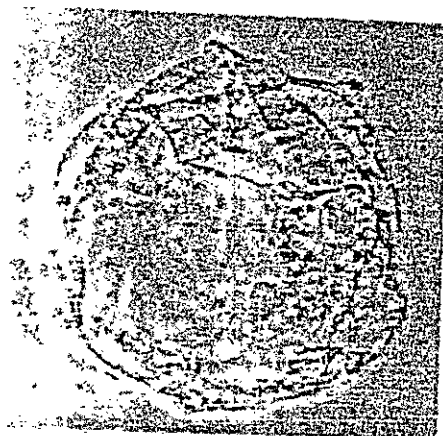
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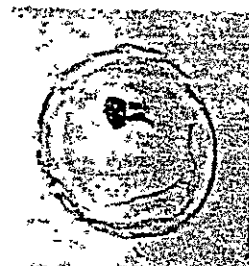
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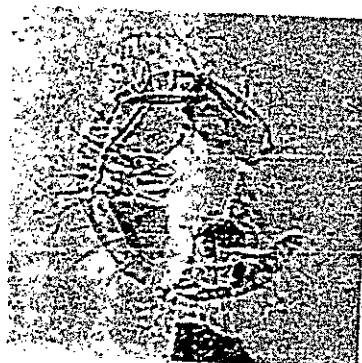
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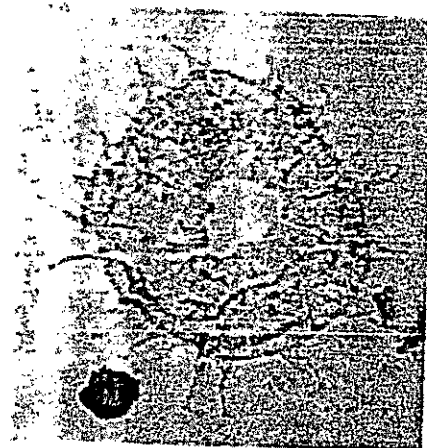
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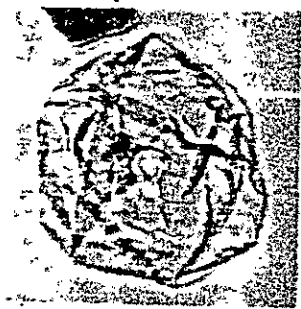
PLATE 13



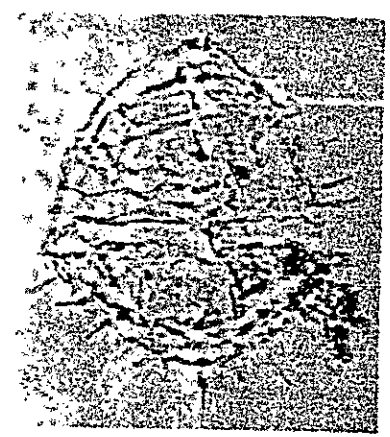
1



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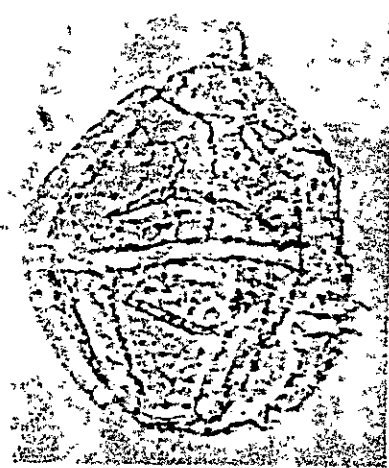
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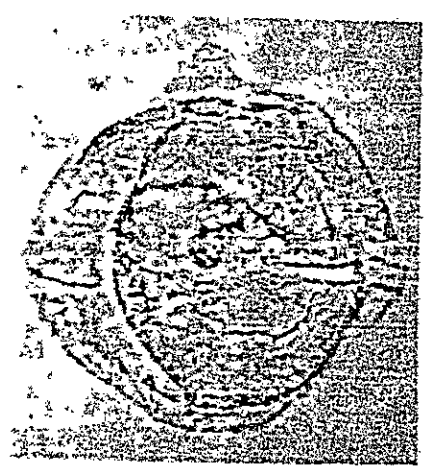
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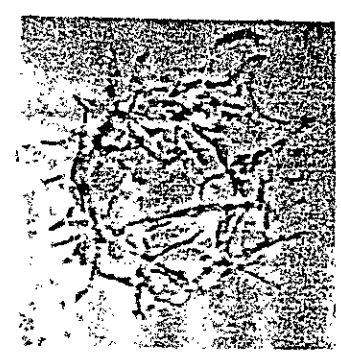
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Plâte 13.

Rio Curito Measured Section
80352

(Assemblage B Level)

- Fig. 1. Punctatisporites. 1000x. (Ser. 54749-1-3.)
- Fig. 2. Dinoflagellate. 400x. (Ser. 54750-1-4.)
- Fig. 3. Cyst. 750x. (Ser. 54746-1-1a.)
- Fig. 4. Palaeohystrichophora isodiametrica. 750x. (Ser. 54758-4-2.)
- Fig. 5-7. Gonyaulax 2. 600x. (Ser. 54752-1-6, 54757-4-1, 54748-1-2.)
- Fig. 8. Baltisphaeridium. 750x. (Ser. 54754-1-8a.)
- Fig. 9-10. Hystriochobotium. 750x. (Ser. 54753-1-7, 54755-1-8b,
54756-1-9.)

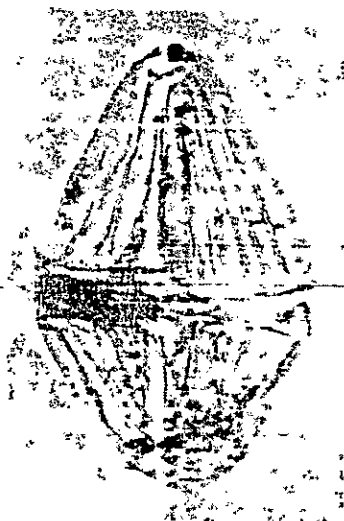
Plate 14

Rio Curito Measured Section
80357

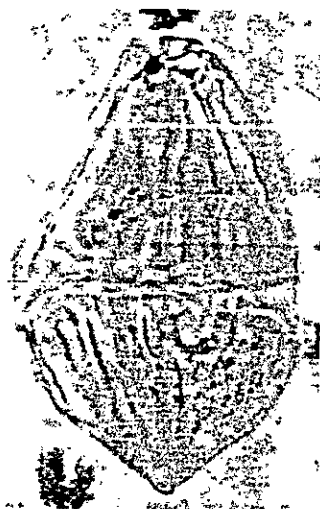
(Assemblage B Level)

- Fig. 1-2. Gymnodinium heterocostatum. 750x. (Ser. 54773-8-12,
54767-8-7.)
- Fig. 3. Dinoflagellate. 750x. (Ser. 54775-8-14.)
- Fig. 4. Dinoflagellate. 750x. (Ser. 54766-8-6.)
- Fig. 5. Hystrichosphaera. 600x. (Ser. 54759-8-1.)
- Fig. 6-7. Hystrichokibotium. 750x. (Ser. 54771-8-10, 54770-8-10.)
- Fig. 8. Baltisphaeridium. 750x. (Ser. 54760-8-2.)
- Fig. 9. Hystrichosphaeridium tubiferum "cortum". 600x.
(Ser. 54761-8-3.)
- Fig. 10. Nematosphaeropsis. 600x. (Ser. 54762-8-4.)

PLATE 14



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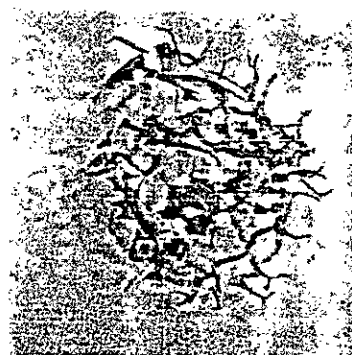
4



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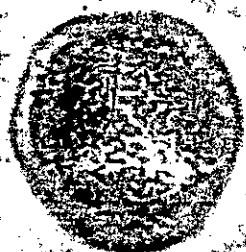
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Plate 15

Rio Curito Measured Section
80360

(Assemblage C Level)

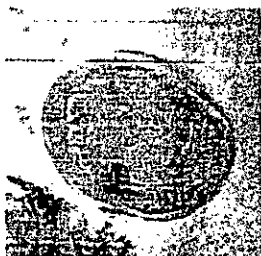
- Fig. 1. Lycopodiacidites 1. 1000x. (Ser. 54879-3-3,
54880-3-3.)
- Fig. 2. Classopollis. 1000x. (Ser. 54872-1-1b.)
- Fig. 3. Tricolpites. 1000x. (Ser. 54878-3-2.)
- Fig. 4. Porocolpopollenites. 1000x. (Ser. 54877-3-1.)
- Fig. 5. Dinoflagellate. 750x. (Ser. 54881-3-4.)
- Fig. 6. Hystrihosphaera B. 750x. (Ser. 54871-1-1a.)
- Fig. 7. "Fimbriasphaera fimbria". 750x. (Ser. 54875-1-4.)
- Fig. 8-10. Gonyaulax 1. 400x. (Ser. 54873-1-2, 54874-1-3,
54876-2-1.)



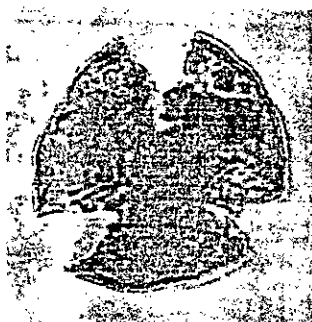
1a



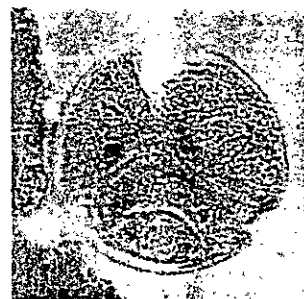
1b



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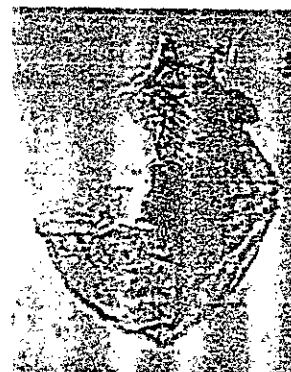
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Plate 16

Burgua-3 Well
3937-3947 ft.

(Assemblage A Level)

- Fig. 1-2. Palaeoperidinium "cyanos". 750x. 750x. (Ser. 33698-1 : 19.5 x 117.5, 33694-1 : 27 x 113.5.)
- Fig. 3. Dinoflagellate. 750x. (Ser. 33695-1 : 34 x 113.5.)
- Fig. 4. Dinoflagellate. 750x. (Ser. 33683-4 : 20 x 122.)
- Fig. 5. Palaeoperidinium "brownium". 750x. (Ser. 33690-1 : 24 x 112.)
- Fig. 6-7. Palaeoperidinium. 750x. (Ser. 33693-1 : 17 x 113, 33696-1 : 21 x 115.5.)
- Fig. 8. Palaeoperidinium "gigas". 750x. (Ser. 33684-4 : 26.5 x 122.)
- Fig. 9. Hystriosphera. 750x. (Ser. 33692-1 : 10 x 113.5.)
- Fig. 10-11. Hystriosphera A. 750x. (Ser. 33697-1 : 13.5 x 116.5, 33691-1 : 12.5 x 112.5.)



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Plate 17

Burgua-3 Well
5108-5118 ft.

(Assemblage A Level)

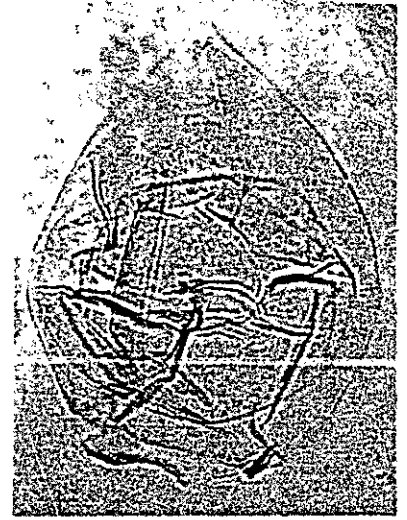
- Fig. 1-2. Deflandrea "psilata". 750x. (Ser. 33442-3B :
21.5 x 113, 33453-3B : 26 x 117.)
- Fig. 3. Deflandrea "laevigata". 750x. (Ser. 33455-1B :
29 x 120.)
- Fig. 4-5. Hystriosphera "nemathia". 750x. (Ser. 33451-3B :
11.5 x 116, 33458-3A : 41 x 120.)
- Fig. 6. Palaeoperidinium "spindulosum". 750x. (Ser. 33448-3B :
29 x 114.)
- Fig. 7. Dinoflagellate. 750x. (Ser. 33454-1B : 23.5 x 120.)
- Fig. 8-9. Hystriosphera. 750x. (Ser. 33443-3B : 9.5 x 113,
33450-3B : 41 x 115.5)
- Fig. 10. Cyst. 750x. (Ser. 33452-3B : 16.5 x 117.)



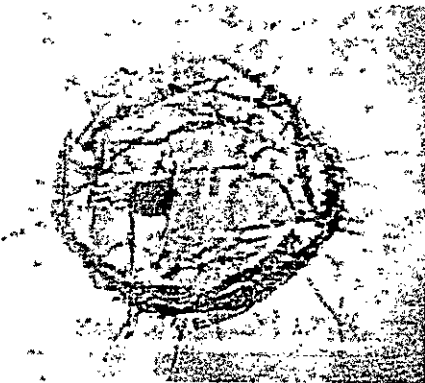
1



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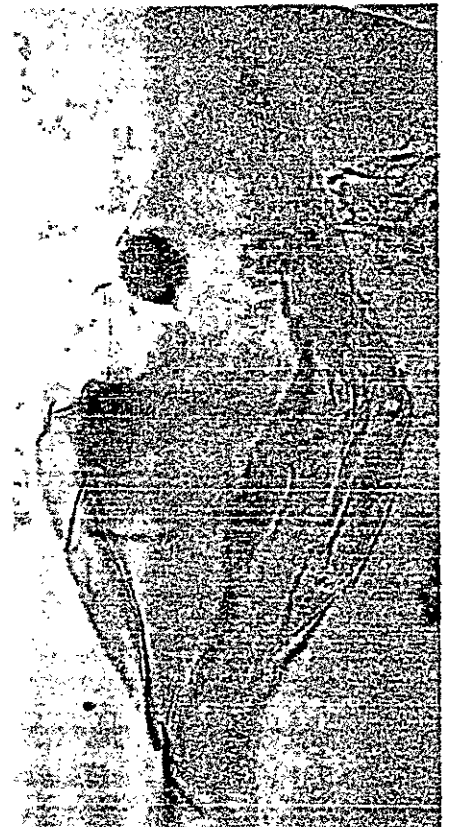
3



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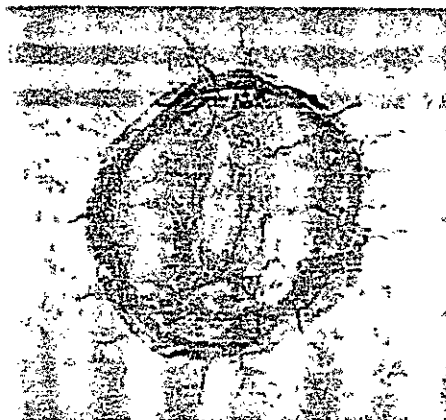
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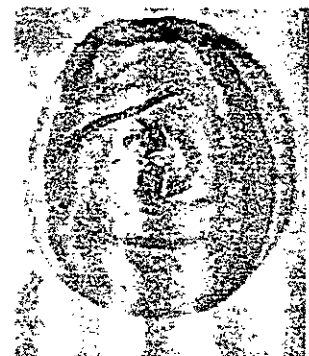
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Plate 18

Burgua-3 Well
5475-5484 ft.

(Assemblage B Level)

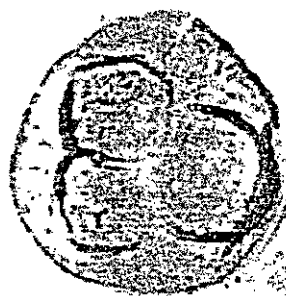
- Fig. 1. Punctatisporites. 1000x. (Ser. 33489-1 : 27.7 x 115.8.)
- Fig. 2. Rugulatisporites. 750x. (Ser. 33475-1 : 14 x 113.)
- Fig. 3. Rugulatisporites. 750x. (Ser. 33465-1 : 9 x 111.5.)
- Fig. 4. Cirratriradites. 750x. (Ser. 33493-2 : 31.5 x 120.)
- Fig. 5. Rugulatisporites. 750x. (Ser. 33499-2 : 32 x 125.)
- Fig. 6-7. Reticuræ. 750x. (Ser. 33467-1 : 23 x 112.5, 33485-1 : 30 x 117.)
- Fig. 8. Apiculatisporites. 750x. (Ser. 33490-1 : 27 x 116.)
- Fig. 9. Monosulcites. 1000x. (Ser. 33489-1 : 27.7 x 115.8.)
- Fig. 10. Tricolpites. 1000x. (Ser. 33472-1 : 23 x 113.5.)
- Fig. 11. Tricolpites. 1000x. (Ser. 33477-1 : 8 x 114.)
- Fig. 12. Porocolpopollenites. 1000x. (Ser. 33478-1 : 9 x 114.)
- Fig. 13. Tricolporites. 1000x. (Ser. 33497-2 : 33 x 117.)
- Fig. 14. Liliacidites. 100x. (Ser. 33491-1 : 24 x 116.)
- (Continued on Plate 19.)



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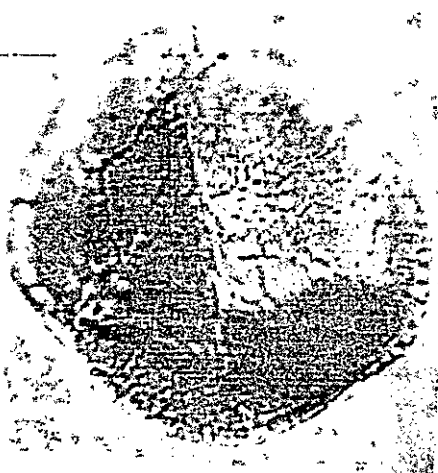
3



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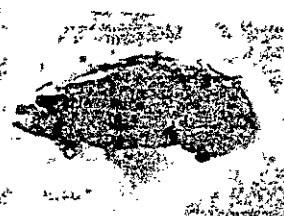
5



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Plate 19

Burgua-3 Well
5475-5484 ft.

(Assemblage B Level)

(Continued from Plate 18.)

- Fig. 1-2. Gymnodinium heterocostatum. 750x. (Ser. 33486-1 :
27.5 x 117, 33481-1 : 10 x 116.5.)
- Fig. 3. "Laciniadinium" sp. 750x. (Ser 33473-1 : 15 x 113.5.)
- Fig. 4. Deflandrea "javalina". 750x. (Ser 33494-2 : 35 x 114.)
- Fig. 5. Dinoflagellate. 750x. (Ser. 33492-2 : 36 x 116.5.)
- Fig. 6. ?Inaperturate pollen. 750x. (Ser. 33468-1 : 28 x 112.5.)
- Fig. 7. Hystrichosphaerid. 750x. (Ser. 33463-1 : 23 x 111.)
- Fig. 8. Hystrichosphaeridium. 750x. (Ser. 33484-1 : 34 x 116.)
- Fig. 9. Pterospermopsis. 750x. (Ser. 33495-2 : 23 x 119.5.)
- Fig. 10. Cyst. 750x. (Ser. 33476-1 : 11 x 113.)



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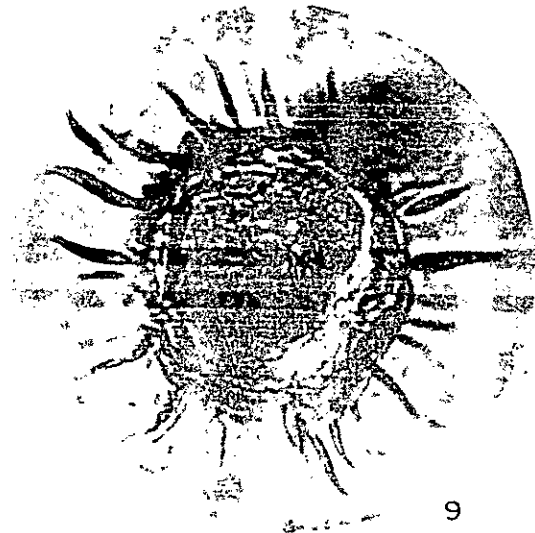
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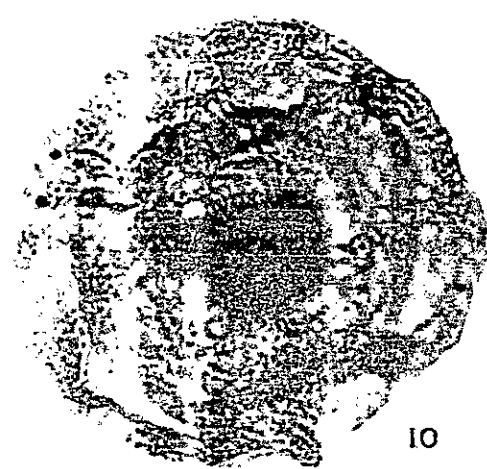
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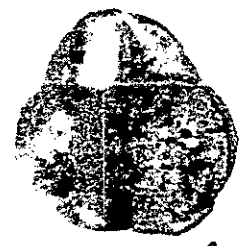
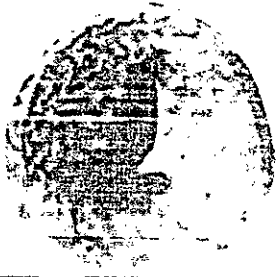
Plate 20

Burgua-3 Well
5725-5735 ft.

(Assemblage B Level)

- Fig. 1. Lycopodiacidites 1. 1000x. (Ser. 33533-1 : 23 x 118.3.)
- Fig. 2. Spore. 750x. (Ser. 33525-1 : 23 x 117.)
- Fig. 3. Tricolpites. 1000x. (Ser. 33520-1 : 31 x 112.)
- Fig. 4. Eriopites. 1000x. (Ser. 33515-1 : 25.5 x 112.)
- Fig. 5-7. Gymnodinium heterocostatum. 750x. (Ser. 33514-1 : 29.5 x 112, 33527-1 : 21 x 118, 33522-1 : 31 x 114.)
- Fig. 8. Dinoflagellate. 750x. (Ser. 33529-1 : 28 x 121.)
- Fig. 9. Dinoflagellate. 750x. (Ser. 33528-1 : 22 x 118.)

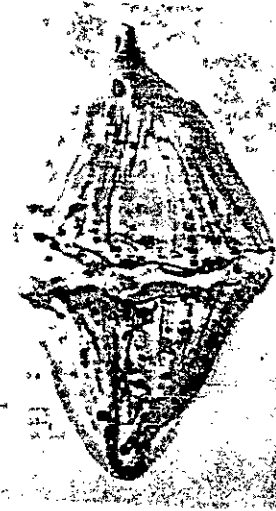
(Continued on Plate 21.)



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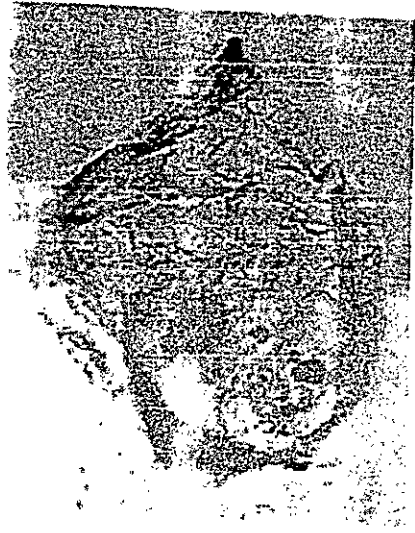
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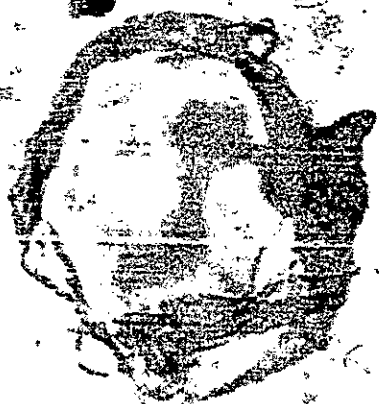
Plate 21

Burgua-3 Well
5725-5735 ft.

(Assemblage B Level)

(Continued from Plate 20.)

- Fig. 1. Hystrichosphaeridium tubiferum "cortum". 750x.
(Ser. 33531-1 : 28.5 x 123.)
- Fig. 2. Hystrichosphaerid. 750x. (Ser. 33530-1 : 27 x 120.5.)
- Fig. 3. Baltisphaeridium. 750x. (Ser. 33524-1 : 39 x 116.)
- Fig. 4. Hystrichosphaerid. 750x. (Ser. 33526-1 : 14 x 116.5.)
- Fig. 5. Hystrichokibotium. 750x. (Ser. 33521-1 : 39.5 x 112.5.)
- Fig. 6. Baltisphaeridium. 750x. (Ser. 33517-1 : 29 x 112.5.)
- Fig. 7. Hystrichokibotium. 750x. (Ser. 33523-1 : 39 x 115.)
- Fig. 8. Cyst. 750x. (Ser. 33518-1 : 29 x 112.5.)



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Plate 22

Burgua-3 Well
5902-5906 ft.

(Assemblage B Level)

- Fig. 1. Deflandrea 1. 750x. (Ser. 33534-1 : 19 x 117.)
- Fig. 2-5. Deflandrea 2. 750x. (Ser. 33541-1 : 24.5 x 127.5,
33540-1 : 17 x 122.5, 33536-1 : 21 x 119, 33539-1 :
27 x 123.)
- Fig. 6. Cyst. 750x. (Ser. 33538-1 : 42.5 x 122.5.)
- Fig. 7-8. Baltisphaeridium. 750x. (Ser. 33537-1 : 30.5 x 121,
33535-1 : 30 x 119.)



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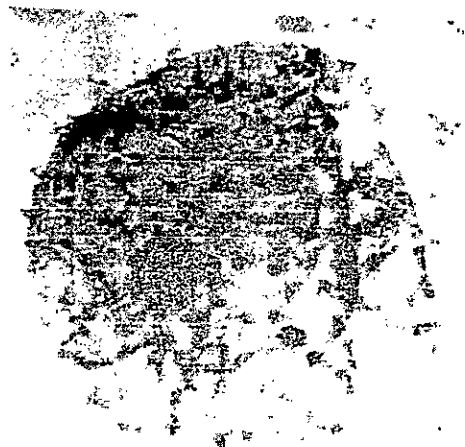
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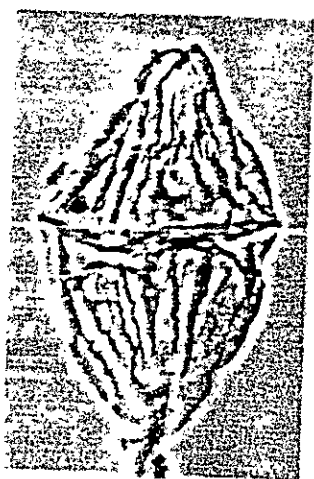
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Plate 23

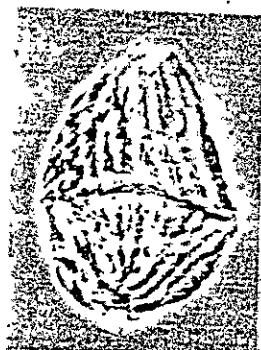
Sinco-2 Well
8723-8774 ft.

(Assemblage B Level)

- Fig. 1-3. Gymnodinium heterocostatum. 750x. (Ser. 54893-1-11,
54887-1-5, 54888-1-6.)
- Fig. 4-5. Palaeohystrichophora isodiametrica. 750x. (Ser. 54890-1-8,
54895-1-12.)
- Fig. 6. Baltisphaeridium. 750x. (Ser. 54883-1-1.)
- Fig. 7-8. Cannosphaeropsis. 750x. (Ser. 54892-1-10, 54889-1-7.)
- Fig. 9. Cyst. 750x. (Ser. 54885-1-3.)



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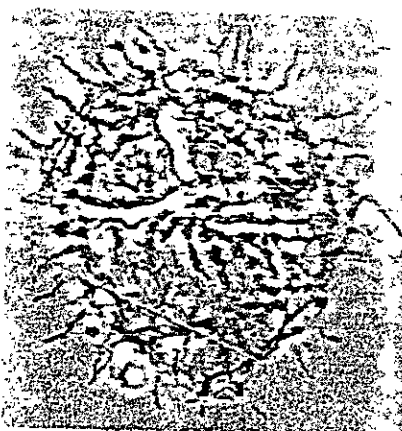
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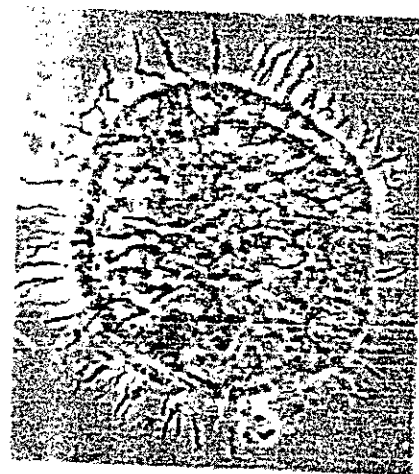
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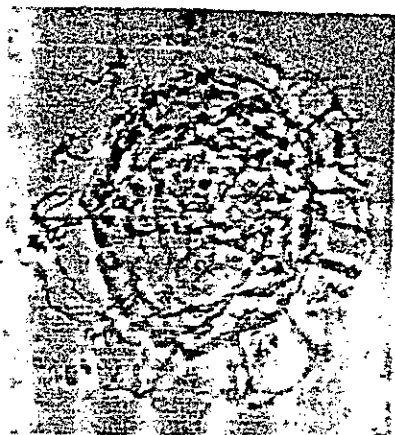
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Plate 24 .

Rosalia-1 Well
10,718-10,768 ft.

(Assemblage C Level)

- Fig. 1. Deltoidospora. 750x. (Ser. 54608-1-2.)
- Fig. 2. Ephedrapites. 1000x. (Ser. 54625-2-9b.)
- Fig. 3. Tricolpites. 1000x. (Ser. 54614-1-7.)
- Fig. 4. ?Inaperturate spore. 750x. (Ser. 54609-1-3.)
- Fig. 5-8. Dinoflagellate. 750x. (Ser. 54607-1-1, 54615-1-8, 54620-2-5, 54626-2-10.)
- Fig. 9. Odontochitina sp. 750x. (Ser. 54611-1-5.)
- Fig. 10. "Fimbriasphaera fimbria". 750x. (Ser. 54617-2-2.)
- Fig. 11. Hystrichosphaera B. 750x. (Ser. 54623-2-8.)

(Continued on Plate 25.)



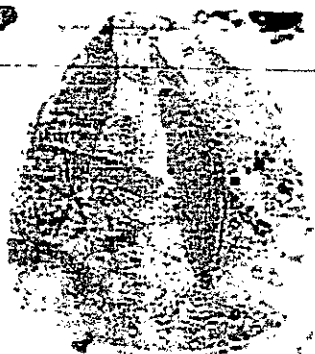
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Plate 25

Rosalia-1 Well
10,718-10,768 ft.

(Assemblage C Level)

--- (Continued from Plate 24.)

- Fig. 1. Hystrichosphaerid. 750x. (Ser. 54621-2-6.)
- Fig. 2-3. Baltisphaeridium. 750x. (Ser. 54610-1-4, 54612-1-6.)
- Fig. 4-5. Hystrichosphaeridium "gordum". 750x. (Ser. 54622-2-7, 54619-2-4.)
- Fig. 6-8. Hystrichokibotium. 750x. (Ser. 54616-2-1, 54624-2-9a, 54618-2-3.)



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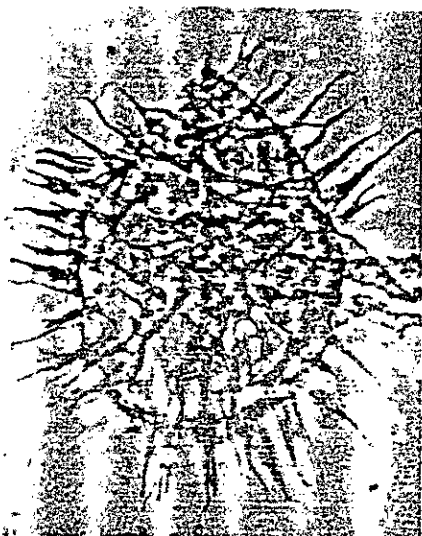
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Plate 26

Capitanejo-1 Well
14,994 ft.

(Assemblage C Level)

- Fig. 1. Lycopodiacidites 2. 1000x. (Ser. 54636-1-12.)
- Fig. 2. Granulatisporites. 750x. (Ser. 54627-1-1.)
- Fig. 3. Ephedrapites. 1000x. (Ser. 54635-1-10.)
- Fig. 4-5. Gymnodinium heterocostatum. 750x. (Ser. 54634-1-8,
54630-1-4.)
- Fig. 6. Dinoflagellate. 750x. (Ser. 54628-1-2.)
- Fig. 7. Palaeoperidinium heterostatum. 750x. (Ser. 54632-1-6.)
- Fig. 8. Odontochitina sp. 750x. (Ser. 54633-1-7.)
- Fig. 9. Palaeoperidinium ellipticum. 750x. (Ser. 54638-1-14.)
- Fig. 10-11. Hystriosphera B. 750x. (Ser. 54629-1-3, 54631-1-5.)



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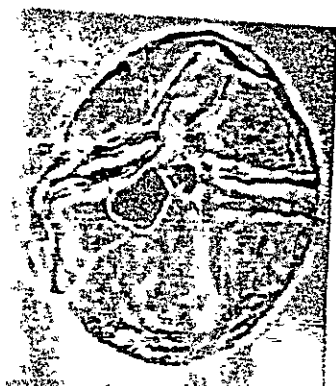
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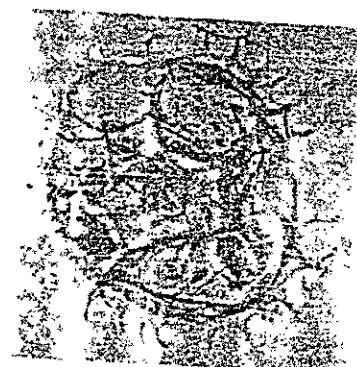
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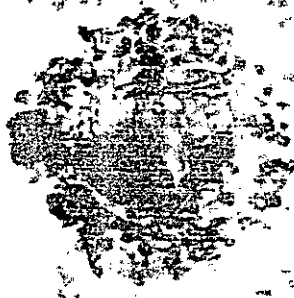
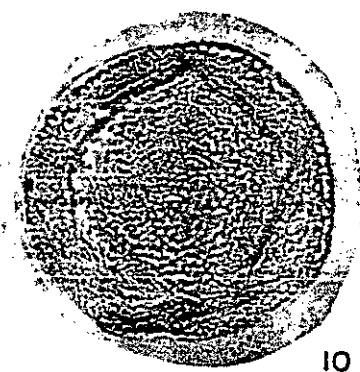
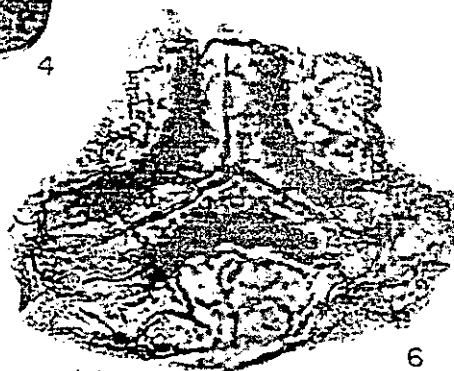
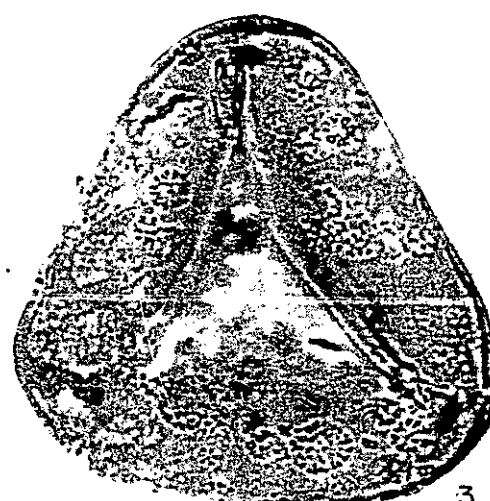
11

Plate 27

Capitanejo-1 Well.
15,006 ft.

(Assemblage C Level)

- Fig. 1. Deltoidospora. 1000x. (Ser. 54641-1-2a.)
- Fig. 2-3. Deltoidospora. 1000x. (Ser. 54645-1-4, 54646-1-5.)
- Fig. 4. Gleichenioidites. 1000x. (Ser. 54349-1-8.)
- Fig. 5-6. Concavispores sp. 1000x. (Ser. 54351-1-10a, 54639-1-1.)
- Fig. 7. Hymenophyllumsporites. 1000x. (Ser. 54643-1-2c.)
- Fig. 8. Granulatisporites. 1000x. (Ser. 54347-1-6.)
- Fig. 9. Lycopodioidites 2. 1000x. (Ser. 54353-1-13.)
- Fig. 10. Araucariacites. 1000x. (Ser. 54352-1-10b.)
- Fig. 11. Apiculatisporis. 1000x. (Ser. 54642-1-2b.)
- Fig. 12. Porocolpopollenites. 1000x. (Ser. 54350-1-9.)
- Fig. 13. Porocolpopollenites PuVer. 1000x. (Ser. 54644-1-3.)



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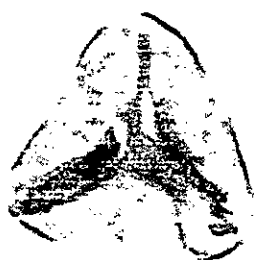
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Plate 28

Masparro-1 Well
6611-6661 ft.

(Paleocene? Upper Cretaceous? Assemblage)

- Fig. 1. Deltoidospora. 1000x. (Ser. 33714-3fi : 38.7 x 119.5.)
- Fig. 2. Punctatisporites. 1000x. (Ser. 33716-3fi : 34 x 121.)
- Fig. 3. Foveolatisporites. 1000x. (Ser. 33715-3fi : 29 x 121.)
- Fig. 4-6. ?Monosulcites. 1000x. (Ser. 33713-3fi : 35.2 x 119.5,
33707-3fi : 20.5 x 114.8, 33705-3fi : 18.8 x 114.)
- Fig. 7. Liliacidites. 1000x. (Ser. 33704-3fi : 11.6 x 115.7.)
- Fig. 8. Tricolpites. 1000x. (Ser. 33712-3fi : 17 x 119.7.)
- Fig. 9-10. Triporopollenites "granulosus". 1000x. (Ser. 33709-3fi :
12.5 x 117.8, 33703-3fi : 37.8 x 114.)
- Fig. 11. Tricolpites. 1000x. (Ser. 33711-3fi : 10.9 x 119.5.)
- Fig. 12. Tricolpites. 1000x. (Ser. 33701-3fi : 41.8 x 113.5.)
- Fig. 13. Ericipites. 1000x. (Ser. 33708-3fi : 14.5 x 117.5.)



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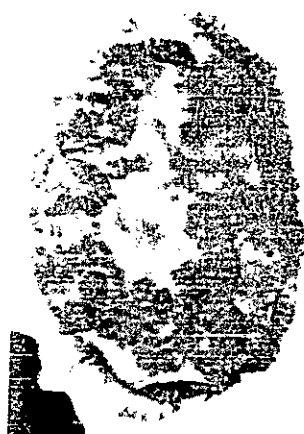
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12a



12b



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