PALYNOLOGICAL INVESTIGATION OF THE LATE JURASSIC TO LATE CRETACEOUS STRATA IN THE VENTURE B-13 WELL SCOTIAN BASIN, OFFSHORE EASTERN CANADA

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Introduction

This report discusses the palynological analysis and appraisal of the Late Jurassic to Late Cretaceous interval (15-5360m) in the Mobil et al Venture B-13 well. This well is located on the Scotian Shelf in the Sable Subbasin at 44° 02 minutes 11.6 sec north; 59° 32 minutes 03.5 sec West.

A total of 286 samples was analyzed for this study comprising 126 cuttings samples, 159 SWC and 1 core sample. The samples were processed in the Eastern Petroleum Geology. Both the coarse fraction (+20 microns) and the fine fraction (-20 microns) were analyzed for the SWC preservations. The fine fractions for these preparations had good to excellent recovery due to the recent upgrading procedures developed in the EPG laboratory. The coarse fractions for the cuttings samples were analyzed while the fine fractions were only checked briefly. The fine fractions of these cuttings samples, which were processed before these new procedures were implemented, contain predominantly densely mounted finely dispersed matter which mask and diluted the assemblages. Subsequently the fine fractions of 33 cuttings samples between the intervals of 1535-2510m were upgraded utilizing the new procedures at EPG laboratories and were then analyzed in detail. These upgraded samples had generally good to excellent recovery.

In general, good to excellent recovery was found throughout the well except for the lower portions of the well below 4820m. Between 4820-5070m recovery was generally poor with a number of barren samples and the odd sample with good recovery. Below 5070m the samples were generally barren or almost barren except for a cuttings sample at 5210m which most likely is caved from higher strata in the well.

Caved material is generally present minimally throughout the well and is partically distinguished from the in situ populations by differences in thermal alteration colours and staining properties. In the lower portions of the well, below 5000m, palynomorphs from lignitic mud additives are present in both the cuttings and the sidewall cores. This material is easily identified by its bright red staining.

The palynological subdivision of the well mainly utilizes the highest (latest) occurrences of index species of dinoflagellates, spores and pollen. The additional use of lowest (earliest) occurrences is generally precluded because the samples available for analysis are mostly cuttings and therefore potentially contain caved fossils. The lowest occurrences are however, utilized in intervals where the ranges are supported by occurrences within sidewall cores. Specimens of interesting or biostratigraphically useful taxa were ringed with indelible ink.

The index species and palynological zonations used for the initial subdivision and age assignment of the well follows that of Williams (1975), Bujak & Williams (1978, 1977) and Barss et al. (1979) for the Jurassic and Cretaceous of offshore eastern Canada (Figure 1). This has generally an accuracy to within a stage.

To further subdivide the zones, several palynological publications and reports were utilized. The ranges of spores and pollen from the Hibernia area (Davies & McAlpine, in press) and the miospore zonation for the Oxfordian-Turonian of North America and Western Europe which is primarily based on offshore eastern Canadian material (BDG Report 87-0142) were very useful especially in defining the ages of the Kimmeridgian to Aptian strata. In this interval the traditional dinoflagellate marker species were absent or rarely present. The dinoflagellate assemblages of the middle Cretaceous are similar to those described by Below (1981) from the Hauterivian to Cenomanian of Morocco. The spores and pollen of the middle Cretaceous, especially

the angiosperms, were similar to those described by Brenner (1963) from Maryland and Doyle & Robyns (1977) from the Atlantic Coastal Plain.

A palynological zonation (Figures 2-10) is thus proposed to subdivide the Venture B-13 well which is intended for the local use in the Venture area.

A palynofacies model is proposed for the Barremian to Cenomanian strata based on the cyclic nature of the palynomorph assemblages.

FORMAT

The format of the report includes a section on the conclusions of the investigation. A second section is devoted to the zonal discription. A third section describes the paleoecological model. Two appendices are included. Appendix A is a complete list of palynomorphs in the the well. Appendix B lists the samples and their sample type, i.e. cuttings, sidewall core, or conventional core. Appendix C lists the important species occurrences which comprise the bases for the subdivision of the well.

A palynological analysis chart is included with this report as Table 1. Listed on the chart are the palynological zones and their inferred ages, the important sample depth, the significant palynological events, the sample levels where a solid line equals sidewall core and a partial line equals a cuttings sample and a C equals a conventional core and the dinoflagellate and miospore diversity plots. Original computer drafted colour copies of the palynological analysis chart are available from the Bujak Davies Group.

Two palynological range charts are included to document the occurrences of the dinoflagellate species and the miospore species within each sample.

Species "files" on each taxon is also supplied. Each file consists of a 5 X 8 file card with at least one illustration of the species and a record of its well location, horizontal depth, name, photomicrographic film and frame number and magnification.

Appendix D contains brief descriptions of new and/or informal taxa. Appendix E contains a key to the ringed specimens for each slide with identifications. These have already been submitted to Eastern Petroleum Geology.

PROPOSED ZONATION

The zonation which has traditionally been applied to the Scotian Shelf (Figure 1) was devised for broad regional correlations. The local variations were not taken into consideration. In wells such as Venture B-13 many of the traditional marker species such as Kiokansium polypes, Chichaouadinium cf. vestitum, Pseudoceratium pelliferum, Ctenidodinium elegantutum, Phoberocysta neocomica, and Ctenidodinium panneum are rare, have more restricted ranges or may be absent. This results in a necessity to rely frequently on other fossils which are often more consistently present. In general the larger part of the palynoflora, terrigenous spores and pollen, were not utilized in the zonation which is primarily based on marine dinoflagellates. This leaves a wealth of potential marker species left to be utilized for further subdivision and interfacies correlations.

The zonation proposed herein utilizes the zonal subdivisions of the traditional zonation in order to provide continuity in zonal assignments. These zones may require re-definition and insertion of new zones if the type sections of the tradional zones are found to be more stratigraphically restricted.

The zones are subdivided into subzones. Species named for these subzones have been selected on two criteria: firstly, repetitive occurrences throughout the subzone in the Venture B-13 well and widespread occurrence in other wells on the Scotian Shelf based on personal experience.

The subzones are further subdivided through the use of successive biohorizons. These are the highest occurrences of selected species which have a strong potential to be utilized for detailed resevoir

correlations within the Venture area. A few peaks in species occurrences are also included.

The strict definition of the biostratigraphic units can not be made at this time since further testing on their laterial continuity is required. Each zone is illustrated as a separate figure with subzones and important biohorizons indicated in Figures 2 to 10. Due to the large diversity of dinoflagellates and miospores present within the Chichaouadinium vestitum cf. Zone, separate figures are given for the different fossil groups.

BIOSTRATIGRAPHIC SUMMARY

1510-1510m:	H. trunciqerum to O. operculata Zones (Santonian to Campanian)
1535-1535m:	Oligosphaeridium pulcherrimum Zone (Coniacian)
1565-1567m:	Surculosphaeridium longifurcatum Peak Zone (Turonian)
1595-1595m:	Kiokansium polypes Zone (Cenomanian)
1625-1685m:	Chichaouadinium vestitum cf. Zone: O. totum totum Subzone (late Albian)
1702-1835m:	Chichaouadinium vestitum cf. Zone: S. microreticulata Peak Subzone (middle Albian)
1857-1925m:	Chichaouadinium vestitum cf. Zone: C. vestitum cf. Subzone (middle Albian)
1955-2200m:	Chichaouadinium vestitum cf. Zone: S. pirnaensis (Kalyptra) Subzone (early Albian)
2230-2260m:	Chichaouadinium vestitum cf. Zone: O. perforatum perforatum Subzone (early Albian)
2281-2470m:	Chichaouadinium vestitum cf. Zone: O. asterigerum Subzone (early Albian)
2500-2500m:	Subtilisphaera perlucida Zone: Stiphrosphaeridium #EA Subzone (late Aptian)

2505-2530m: Subtilisphaera perlucida Zone: P. trichopapillosus Subzone (mid-Aptian)

2560-2613m: Subtilisphaera perlucida Zone: C. attadalicum Subzone (early Aptian)

2620-2770m: Subtilisphaera perlucida Zone: S. terrula Subzone (early Aptian)

2800-2900m: Aptea anaphrissa Zone: P. gochtii Subzone (late Barremian)

2925-2968m: Aptea anaphrissa Zone: C. boreas Subzone (early Barremian)

2985-3089m: Ctenidodinium elegantulum Zone: M. staurota Subzone (late Hauterivian)

3105-3218m: Ctenidodinium elegantulum Zone: Kleithriasphaerium #EA Subzone (early Hauterivian)

3225-3350m: Phoberocysta neocomica Zone: O. diluculum Subzone (late Valanginian)

3370-3576m: Phoberocysta neocomica Zone: Occisucysta #EX Subzone (early Valanginian)

3585-3696m: Phoberocysta neocomica Zone: Muderongia sp. A Subzone (late Berriasian)

3705-3795m: Phoberocysta neocomica Zone: A. metaelliptica Subzone (early Berriasian)

3825-3835m:	Phoberocysta neocomica Zone: C. granuligerum Subzone (late Tithonian to early Berriasian)
3855-4369m:	Ctenidodinium panneum Zone: C. culmulum Subzone (late Portlandian)
4395-4624m:	Ctenidodinium panneum Zone: C. speciosum Subzone (early Portlandian)
4635-4677m:	Ctenidodinium panneum Zone: G. dimorphum Subzone (early Portlandian)
4683-5060m:	Hystrichoonyaulax cladophora Zone: Subzone not differentiated (Kimmeridgian)
5072-5190m:	Indeterminate (Late Jurassic)
5210-5210m:	Indeterminate (possible Oxfordian)
5210-5360m:	Indeterminate (Indeterminate)

PALEOECOLOGY

Palynological facies model has not yet been described in the published literature which allows the detailed description of the paleoenvironments of Cretaceous rocks. The status of paleoecological papers with respect to dinoflagellates was reviewed by Davies, Bujak & Williams (1982). Recent works by Davies & Bujak (1987) on the Plio-Pliestocene of northern Gulf of Mexico demonstrated cyclcity in the dinoflagellate and the miospore assemblages responding to the glacial-interglacial climatic cycles of North America. This approach has been demonstrated in the Neogene sediments of the Beaufort Sea (in-house studies of the Bujak Davies Group). The appraisal of Barremian to Albian cyclcity in response to transgressive and regressive events of the Ellerslie and Ostracode Zone of western Canada has been described by Banerjee & Davies (in press). Similar cyclcity is also evident within the Aptian to Cenomanian sediments of the Venture B-13 well. The following facies model is based on the varying diversities and abundances of dinoflagellate cysts and secondarily by the miospores and by the imperical recognization of reoccurring palynomorph assemblage successions.

Initially for the assemblages of all the samples, several indices were calculated and illustrated in a histogram-log format: marine dinoflagellate index, terrigenous pollen index, freshwater - brackishwater algae index and the fern spore index. These were calculated by counting the diversity weighted by abundances for the various groups. For example, if in one sample there were five species of dinoflagellates with abundances of present (1), rare (2) common (3) abundant (4) dominant (5) the sum would be fifteen and the index would be divided by four to give a rounded integer between 0 and 15. The divisor 4 is an arbitrary number based on the maximum sum of 60 found within this well. The miospore sums were divided by 2, the freshwater/

brackish water algal sums were divided by 1 and the fern spore sums were divided by 2.5. Each cycle was then examined to resolve this succession in the type of palynomorph assemblage. The cycles were composited into an idealized cycle and then subdivided into typical assemblages and grouped into four phases.

The succession marine to freshwater algal communities and of the terrestrial floral communities through an idealized transgression-regression cycle can be expressed by a palynological succession which is divided into four phases and ten assemblages (Figures 11-13). The four main driving forces for this cyclity are: 1) sediment influx; 2) freshwater influx; 3) water temperature (air and sea); 4) static sea level changes. It is difficult however to discern the independent response to these forces without collaboration with parallel sedimentological and a foraminiferal studies. For simplicity it is assumed that the cycles expressed by the palynological assemblages represent eustatic sealevel changes associated with transgressive and regressive events. In the northern Gulf of Mexico these cycles correspond to climatic interglacial cycles which parellel transgressive and regressive events. Cycles usually terminate at sequence boundaries.

Similarities in the morphotypes of dinoflagellates found between the same phases in Plio-Pleistocene cycles and the middle Cretaceous cycles is clear. Subtilisphaera replaces Niadinium; Chichaouadinium replaces Geiselodinium; Oligosphaeridium replaces Polysphaeridium; Oodnatia replaces Tuberculodinium; Florentina/Silicisphaera replace Hystricholopoloma. This suggests that climate is at least partly responsible for the cyclical nature of the palynomorph assemblage successions. The following cycles can be recognized within the Floral Development Chart (Figure 14):

Depth	Cycle
1702-1567m	X
1830-1782m	IX
1923-1830m	VIII
2029-1923m	VII
2170-2029m	VI
2470-2170m	V
2605-2470m	IV
2702-2605m	III
2850-2702m	II
3035-2850m	I

In the lower portions of the well a different model must be devised. Due to the thermomaturation in the deepest portions of the well, this type of paleoecological analysis would prove to be ineffective due to the low recovery of palynomorphs.

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APPENDIX A

Alphabetical Listing of Species Shown on Occurrence Chart: Marine Dinoflagellates

Taxa location index
Index numbers are the columns in which the taxon appears

Index number	Taxon names
214	Achomosphaera neptunii : p
1	Achomosphaera ramulifera
123	Achomosphaera sp. indet.
46	Alcesiodinium 'antocularum' : p
24	Alterbia balmei : p
36	Alterbia sp. indet. : p
235	Amphorula #EA
256	Amphorula #EE
215	Amphorula metaelliptica : p
257	Amphorula sp. indet. : p
166	Aptea annaphrissa
64	Aptea polymorpha : p
159	Apteodinium grande : p
101	Apteodinium granulatum
237	Apteodinium nuciforme
169	Apteodinium sp. indet. : p
2	Areoligera senonensis : p
3	Areoligera tauloma : p
91	Astrocysta #EA : p
65	Astrocysta cretacea : p
170	Astrocysta #Eechinata : p
254	Atopodinium prostratum : p
124	Balmula tripenta : p
225	Breedoxiella #EB : p
47	Caddasphaera halosa : p
48	Callaiosphaeridium asymmetrica
66	Canningia minor : p
49	Canningia ringnesiorum : p
161	Canningia sp. indet. : p
160	Canningia sp. indet. : p
253	Cantulodinium #EA : p
247	Cantulodinium speciosum : p
201	Cassiculosphaeridia #Eimperfecta : p
182	Cassiculosphaeridia magna, Duxbury : p
4	Ceratiopsis speciosa : p
6	Chatangiella victoriensis : p
85	Chichaouadinium #EA : p
110	Chichaouadinium #Eglobosum : p
126	Chichaouadinium #EX : p
135	Chichaouadinium boydii : p
144	Chichaouadinium sp. indet. : p
102	Chichaouadinium vestitum cf. : p
50	Chlamydophorella nyei
81	Chlamydophorella nyei, Singh 1971 : p
259	Chlamydophorella sp. A, Davies '83 : p
25	Chlamydophorella sp. indet. : p
37	Cleistosphaeridium aciculare : p
51	Cleistosphaeridium huguoniotii : p
67	Cometodinium whitei : p
270	Compositosphaeridium polonicum
7	Cordosphaeridium fibrospinosum
8	Cordosphaeridium gracile
38	Coronifera oceanica : p
178	Corrudinium #EA
190	Corrudinium #EB
117	Cribroperidinium #EX : p
171	Cribroperidinium boreas : p
68	Cribroperidinium edwardsii : p
232	Cribroperidinium ehrenbergii
96	Cribroperidinium episomum : p
205	Cribroperidinium globatum : p
226	Cribroperidinium granuligerum : p
218	Cribroperidinium muderongense
172	Cribroperidinium sepimentum : p
267	Cribroperidinium sp. F : p
127	Cribroperidinium sp. indet. : p
9	Cribroperidinium wetzelii : p
115	Ctenidodinium #ES : p
269	Ctenidodinium chondrum : p
207	Ctenidodinium culmulum : p
208	Ctenidodinium elegantulum : p
233	Ctenidodinium panneum : p
227	Ctenidodinium rugulatum : p
238	Ctenidodinium schizoblatum : p
69	Ctenidodinium sp. indet. : p
133	Cyclonephelium attadalicum : p
87	Cyclonephelium attadalicum cf. : p
26	Cyclonephelium brevispinatum : p
10	Cyclonephelium distinctum : p
209	Cyclonephelium distinctum #Dgiganteum
90	Cyclonephelium eisenackii : p
111	Cyclonephelium sp. indet. : p
52	Cyclonephelium vannophorum : p
186	Cymososphaeridium sp. I : p
198	Cymososphaeridium validum : p
129	Dapsilidinium #EA : p
132	Dapsilidinium #Ecaminatum : p
53	Deflandrea limpida cf.
27	Deflandrei cooksonii of Benson 1976
194	Dingodinium cerviculum : p
251	Dingodinium jurassicum : p
264	dinoflagellate indeterminate : p
11	Diphyes colligerum
245	Egmontodinium ovatum : p
82	Ellipsoidictyum reticulatum : p
199	Endoscrinium pharo
70	Epelidosphaeridia spinosa : p
249	Escharisphaeridia pocockii : p
244	Escharisphaeridia sp. indet. : p
28	Exochosphaeridium bifidum : p

APPENDIX A (Cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Marine Dinoflagellates

Taxa location index
Index numbers are the columns in which the taxon appears

130 Exochosphaeridium striolatum : p
29 Florentina cooksoniae : p
112 Florentinia laciniata : p
39 Florentinia radiculata : p
100 Florentinia resex : p
134 Florentinia sp. indet. : p
105 Fromea amphorula : p
54 Fromea atlantica : p
138 Fromea fragilis : p
140 Gardodinium eisenackii : p
193 Gardodinium trabeculosum : p
106 Ginginodinium sp. indet. : p
260 Glossodinium dimorphum : p
210 Gonyaulacysta diutina : p
83 Gonyaulacysta sp. indet. : p
12 Hafniasphaera cryptovesiculata : p
204 Heslertonia heslertonensis : p
211 Hystrichodinium lanceatum : p
153 Hystrichodinium pulchrum : p
250 Hystrichodinium sp. indet. : p
261 Hystrichogonyaulax cladophora
30 Hystrichosphaeridium difficule
165 Hystrichosphaerina schindewolfi : p
265 Imbatodinium attenuatum : p
125 Imbatodinium micropodum : p
228 Imbatodinium pomum : p
266 Imbatodinium sp. indet. : p
40 Isabelidinium belfastense : p
5 Isabelidinium cf. belfastense, B&W '78 : p
13 Isabelidinium cooksoniae
55 Isabelidinium magnum : p
107 Kiokansium #EA : P
75 Kiokansium polypes : p
56 Kiokansium williamsii : p
183 Kleithriasphaeridium #EA : p
219 Kleithriasphaeridium corrugatum : p
145 Kleithriasphaeridium eoinodes : p
57 Kleithriasphaeridium loffrense : p
181 Lanterna bulgarica : p
180 Lanterna sp. indet. : p
220 Lanterna sportula : p
14 Lejeunecysta hyalina : p
15 Lejeunecysta spinulosa
262 Leptodinium aceras : p
146 Luxadinium #EA : p
189 Luxadinium #EVG : p
103 Luxadinium primulum
76 Luxadinium propatulum : p
58 Luxadinium sp. indet. : p
16 Manumiella cretacea : p

234 Meiourogonyaulax deflandrei
229 Meiourogonyaulax sp. indet. : p
203 Meiourogonyaulax stoveri : p
239 Muderongia #EA : p
142 Muderongia asymmetrica : p
191 Muderongia californica : p
167 Muderongia imparilis : p
240 Muderongia mcWhaei : p
175 Muderongia simplex microperforata : p
176 Muderongia simplex simplex : p
206 Muderongia sp. A, Davey 1978 : p
179 Muderongia staurota 'perforata' : p
88 Nummus #EO : p
108 Nummus monoculatus
59 Nummus sp. indet.
77 Nyktericysta arachnion : p
200 Occisucysta #EX : p
187 Occisucysta distincta : p
158 Occisucysta sp. A, Bujak & Williams
230 Occisucysta sp. indet.
241 Occisucysta tentoria : p
41 Odontochitina costata : p
31 Odontochitina operculata : p
32 Oligosphaeridium anthophorum, Brid'71 : p
141 Oligosphaeridium asterigerum : p
17 Oligosphaeridium complex
185 Oligosphaeridium complex cf., Will.'75 : p
188 Oligosphaeridium diluculum : p
177 Oligosphaeridium dividuum
143 Oligosphaeridium fenestratum : p
197 Oligosphaeridium heilongjiangense : p
155 Oligosphaeridium macrotubulum : p
118 Oligosphaeridium perforatum colum : p
136 Oligosphaeridium perforatum perforatum : p
173 Oligosphaeridium poculum : p
44 Oligosphaeridium pulcherrimum : p
259 Oligosphaeridium pulcherrimum cf. : p
97 Oligosphaeridium reniforme : p
121 Oligosphaeridium reniforme 'minor' : p
92 Oligosphaeridium sp. indet. : p
113 Oligosphaeridium tenuiprocessum : p
137 Oligosphaeridium totum 'porus' : p
60 Oligosphaeridium totum minor : p
71 Oligosphaeridium totum totum : p
131 Oligosphaeridium vasiforme
147 Oligosphaeridium verrucosum : p
114 Oligosphaeridium 'recurvatum' : p
61 Oodnadattia tuberculata : p
139 Ovoidinium scabrosum : p
104 Ovoidinium verrucosum : p

APPENDIX A (Cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Marine Dinoflagellates

Taxa location index
Index numbers are the columns in which the taxon appears

18 Palaeocystodinium australinum : p
84 Palaeohystrichophora #EA : p
62 Palaeohystrichophora infusorioides : p
19 Palaeoperidinium basilum
20 Palaeoperidinium pyrophorum
168 Palaeostomocysta fragilis : p
21 Palambages sp. indet. : p
216 Pareodinia ceratophora : p
231 Perisseiasphaeridium #EA : p
243 Perisseiasphaeridium sp. indet. : p
248 Perisseiasphaeridium sp. of Davey : p
213 Phoberocysta neocomica convexa : p
212 Phoberocysta neocomica neocomica : p
223 Phoberocysta sp. indet.
195 Polystephanophorus sp. indet. : p
119 Prolixosphaeridium sp. indet. : p
163 Pseudoceratium gochtii : p
156 Pseudoceratium pelliferum
98 Pterodinium aliferum : p
196 Pterospermella helios : p
22 Senegalinium laevigatum : p
263 Senoniasphaera jurassica : p
78 Senoniasphaera microreticulata : p
42 Senoniasphaera reticulata : p
33 Senoniasphaera rotundata
184 Senoniasphaera sp. indet.
236 Sentusidinium cuculliforme : p
221 Sentusidinium filiatum : p
255 Sentusidinium rioultii : p
242 Sentusidinium sp. indet.
45 Silicisphaera ferox : p
162 Silicisphaera sp. indet.
72 Silicisphaera tenera : p
93 Silicisphaera torulosa : p
109 Spiniferites #Easpinosum : p
149 Spiniferites dentatus : p
79 Spiniferites membranaceus : p
34 Spiniferites ramosus ramosus : p
94 Spiniferites sp. indet. : p
09 Spongodinium #EA
120 Spongodinium #Ecerebrus : p
128 Spongodinium sp. indet. : p
73 Stephodinium coronatum : p
154 Stiphrosphaeridium #EA : p
80 Stiphrosphaeridium anthophorum : p
174 Stiphrosphaeridium arbustum : p
217 Stiphrosphaeridium dictyophorum : p
148 Stiphrosphaeridium sp. indet. : p
164 Subtilisphaera #EA : p
63 Subtilisphaera foliacea : p
99 Subtilisphaera perlucida : p
116 Subtilisphaera pirnaensis (kalyptra) : p
86 Subtilisphaera senegalensis : p
150 Subtilisphaera sp. indet. : p
157 Subtilisphaera terrula : p
43 Surculosphaeridium longifurcatum : p
95 Surculosphaeridium longifurcatum cf. : p
202 Surculosphaeridium sp. III : p
252 Surculosphaeridium sp. indet.
224 Systematophora areolata cf., Davey 82 : p
246 Systematophora sp. indet. : p
222 Systematophora turonica
151 Taeniophora #EA : p
192 Tanyosphaeridium isoclamus : p
23 Trithyrodinium sp. indet.
260 Tubotuberella egemenii : p
152 Vesperopsis mayi : p
74 Xenascus #EA : p
35 Xenascus ceratioides : p
122 Xiphophoridium alatum : p

APPENDIX A (cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Pollen and Spores

Taxa location index
Index numbers are the columns in which the taxon appears

Index number	Taxon names
2	Abiespollenites microreticulatus : p
115	Acanthotriletes varispinosus : p
107	Acritosporites excavatus : p
143	Aequitriradites #Eprocibaculatus : p
332	Aequitriradites baculatus
198	Aequitriradites conisimilis : p
184	Aequitriradites cooksonae : p
250	Aequitriradites sp. indet. : p
194	Aequitriradites spinulosus : p
289	Aequitriradites subverrucosus : p
240	Aequitriradites verrucosus
98	Afropollis jardinus : p
191	Afropollis zonalis : p
192	Ajatipollis sp. A : p
193	Alatipollis #EA : p
310	Alisporites #EG
21	Alisporites bilateralis : p
3	Alisporites grandis : p
290	Alisporites thomasii : p
33	Aratrisporites monosacatus : p
22	Aratrisporites ocellatus : p
1	Araucariacites australis : p
260	Araucariacites punctatus : p
78	Asteropollis #Econate : p
79	Asteropollis asteroides : p
99	Asteropollis trichotomosulcatus : p
199	Baculatisporites comaumensis : p
124	Balmeisporites holodictyus
181	Balmeisporites trictyus : p
61	Biretisporites potoniae : p
349	Callialasporites #EFG : p
195	Callialasporites dampieri : p
238	Callialasporites infrapunctatus : p
206	Callialasporites monoalasporus : p
15	Callialasporites segmentatus : p
261	Callialasporites trilobatus : p
218	Callialasporites turbatus : p
302	Callialasporites turbatus cf. : p
127	Camarozonosporites dakotaensis : p
23	Camarozonosporites insignis : p
148	Campenia #EA : p
306	Cardiangulina #EA : p
239	Cedripites #EA : p
34	Cedripites canadensis : p
300	Ceratispora sp. indet. : p
337	Cerebropollenites #EB
125	Cerebropollenites #EC : p
241	Cerebropollenites #Eminutus : p
219	Cerebropollenites macroverrucosus : p
73	Cerebropollenites mesozoicus : p
242	Chasmatosporites major : p
341	Chasmatosporites spp. : p
62	Cicatricosisporites #EAA : p
224	Cicatricosisporites #EAE : p
91	Cicatricosisporites #EAI : p
248	Cicatricosisporites #EAK : p
217	Cicatricosisporites #EAL : p
208	Cicatricosisporites #EAL cf. : p
100	Cicatricosisporites #EF : p
317	Cicatricosisporites #EM : p
336	Cicatricosisporites #EO : p
335	Cicatricosisporites #EW : p
333	Cicatricosisporites abacus
283	Cicatricosisporites angicanalis
101	Cicatricosisporites annulatus : p
63	Cicatricosisporites apiteretus : p
102	Cicatricosisporites augustus : p
202	Cicatricosisporites australiensis : p
4	Cicatricosisporites coconoiensis : p
35	Cicatricosisporites crassiterminatus
64	Cicatricosisporites delicatus : p
235	Cicatricosisporites exilioides Dorh '71 : p
269	Cicatricosisporites globosus : p
186	Cicatricosisporites gondiodontus : p
327	Cicatricosisporites grabowensis : p
220	Cicatricosisporites hannoverana aff.
65	Cicatricosisporites hughesii : p
295	Cicatricosisporites magnus : p
168	Cicatricosisporites mohrioides : p
229	Cicatricosisporites nankingensis : p
88	Cicatricosisporites potomacensis : p
297	Cicatricosisporites purbeckensis
247	Cicatricosisporites purbeckensis cf.
258	Cicatricosisporites reticicatricosus : p
5	Cicatricosisporites sp. indet. : p
273	Cicatricosisporites sternum
244	Cicatricosisporites striatus : p
116	Cicatricosisporites subrotundus : p
308	Cicatricosisporites undatus : p
80	Cicatricosisporites venustus : p
243	Clavatipollenites #Edensus : p
51	Clavatipollenites hughesi : p
89	Clavatipollenites minutus
140	Clavatipollenites rotundus
52	Clavitipollenites #Edensus : p
174	Concavissimisporites cotidianum : p
263	Concavissimisporites informis : p
225	Concavissimisporites longiverrucatus
190	Concavissimisporites minor : p
303	Concavissimisporites multituberculatus : p

APPENDIX A (cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Pollen and Spores

Taxa location index
Index numbers are the columns in which the taxon appears

128 Concavissimisporites punctatus : p
321 Concavissimisporites robustus
92 Concavissimisporites sp. indet. : p
325 Concavissimisporites variverrucatus : p
296 Concavissimisporites verrucatus : p
169 Concavissimisporites verrucatus cf. : p
311 Contignisporites cooksoniae : p
304 Contignisporites dorsostriatus : p
212 Contignisporites glebulentus : p
347 Contignisporites notabilis
81 Converrucosisporites platyverrucosus : p
108 Coptospora williamsii
144 Corniculatisporites auritus cf. : p
165 Corniculatisporites sp. indet.
350 Corollina chateaunovii : p
277 Corollina itunensis : p
36 Corollina torosa : p
270 Corollina vignollensis : p
309 Coronatispora valdensis : p
230 Costatoperforosporites #EB
226 Costatoperforosporites #ECH : p
278 Costatoperforosporites #EG : p
126 Costatoperforosporites fistulosus
162 Costatoperforosporites foveolatus : p
282 Costatoperforosporites sp. indet. : p
253 Couperisporites complexus : p
301 Couperisporites major
37 Crybelosporites pannuceus : p
152 Cupuliferopollenites minutus : p
16 Cupuliferopollenites parvus : p
38 Cupuliferopollenites parvus
53 Cyathidites minor : p
342 Cycadopites carpentieri : p
135 Cycadopites nitidus : p
163 Decussosporites microreticulatus : p
6 Deltoidospora hallii : p
274 Densoisporites #EA : p
187 Densoisporites microrugulatus : p
188 Densoisporites sp. indet. : p
318 Densoisporites triradiatus : p
259 Densoisporites triradiatus cf. : p
96 Dichastopollenites dunveganensis : p
103 Dictyophyllidites sp. Brenner 1968 : p
93 Distaltriangulisporites costatus : p
130 Distaltriangulisporites irregularis : p
39 Distaltriangulisporites sp. indet. : p
154 Distaltriangulisporites triangularis
40 Ephedripites proceras : p
264 Ephedripites sp. 5, Kotova 1968 : p
185 Ephedripites sp. indet. : p
74 Ephedripites sulcatus : p
24 Ephedripites virginiaensis : p
54 Eucommiidites minor : p
151 Eucommiidites sp. indet. : p
117 Exesipollenites scabratus : p
118 Exesipollenites tumulus : p
66 Flagellispora sp. indet.
170 Foraminisporis asymmetrica : p
82 Foraminisporis dailyi : p
83 Foraminisporis wonthaggiensis : p
207 Foveosporites canalis : p
94 Foveotriletes subtriangularis : p?
131 Gleicheniidites distalgranulatus : p
271 Gleicheniidites minor : p
7 Gleicheniidites senonicus : p
215 Impardecispora #EB : p
221 Impardecispora apigranulosa
326 Impardecispora apiverrucata : p
216 Impardecispora macrotuberculata : p
265 Impardecispora mirabile : p
267 Impardecispora pseudogibberula : p
330 Impardecispora sp. A, Dorhofer 1977 : p
211 Impardecispora sp. indet. : p
251 Impardecispora splendida : p
141 Impardecispora texensis
284 Inaperturopollenites #EA : p
338 Inaperturopollenites #EVL : p
136 Inaperturopollenites crisopolensis : p
345 Inaperturopollenites granulatus : p
249 Interlobites #Everrucatus : p
139 Interlobites triangularis
129 Ischyosporites amoholkus : p
67 Ischyosporites disjunctus : p
346 Ischyosporites jurassicus : p
275 Ischyosporites tuberosus : p
97 Januasporites spiniferus
252 Januasporites tumulosus
175 Klukisporites areolatus : p
84 Klukisporites foveolatus
119 Klukisporites pseudoreticulatus : p
145 Klukisporites sp. indet.
315 Klukisporites variegatus : p
155 Kraeuselisporites linearis
256 Kuyliporites lunaris : p
164 Kuylisporites waterbolkii : p
8 Laevigatosporites ovatus : p
90 Leiotriletes mecklenburgensis : p
285 Leiotriletes sp. indet.
292 Leptolepidites major : p
352 Leptolepidites spp. : p

APPENDIX A (cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Pollen and Spores

Taxa location index
Index numbers are the columns in which the taxon appears

279 Leptolepidites verrucatus
41 Liliacidites dividuus : p
178 Liliacidites inequalis
104 Liliacidites peroreticulatus : p
105 Liliacidites sp. E, Doyle & Robbins '73 : p
25 Lycopodiumsporites austroclavitidites : p
176 Lycopodiumsporites marginatus : p
286 Matonisporites equiexinus
109 Microreticulatisporites diatretus : p
280 Microreticulatisporites sp. indet. : p
180 Microreticulatisporites uniformis : p
156 Minerisporites sp. : p
112 Monosulcites #Egrandis : p
42 Monosulcites scabratus : p
149 Multiporopollenites sp. Jardine & Mag. : p
161 Neoraistrickia truncata : p
152 Nodosisporites #EG : p
120 Nodosisporites babsae : p
113 Nodosisporites costatus
68 Nodosisporites genuina : p
234 Nodosisporites sp. indet.
196 Nodosisporites spinosus : p
55 Nyssapollenites albertensis : p
132 Ornamentifera baculata : p
85 Ornamentifera echinata : p
231 Osmundacidites major
287 Osmundacidites sp. indet.
9 Osmundacidites wellmanii
232 Parvisaccites #EA : p
254 Parvisaccites #EB
133 Parvisaccites amplus : p
142 Parvisaccites amplus cf. : p
26 Parvisaccites granisaccus : p
43 Parvisaccites hortenensis : p
44 Parvisaccites radiatus : p
45 Parvisaccites rugosus : p
27 Penetetrapites #EA : p
114 Penetetrapites #Esubequatorialis : p
56 Penetetrapites mollis : p
17 Perinopollenites elatoides : p
203 Perotriletes striatus : p
28 Phyllocladidites inchoatus : p
75 Phyllocladidites microreticulatus : p
343 Phyllocladidites spp.
210 Pilosisporites crassangularis : p
245 Pilosisporites ericus : p
312 Pilosisporites sp. A
222 Pilosisporites trichopapillosus : p
236 Pilosisporites verus : p
10 Pinuspollenites sp. indet.
255 Pityosporites #EA : p
288 Pityosporites #ER
305 Pityosporites dividuus : p
344 Platysaccus megasaccus : p
268 Plicatella #EAD : p
110 Plicatella #EK : p
266 Plicatella #EP
276 Plicatella #ES : p
137 Plicatella #ET : P
46 Plicatella baconensis : p
197 Plicatella bifurcata : p
76 Plicatella bilateralis : p
157 Plicatella cristata : p
69 Plicatella erdtmannii : p
158 Plicatella jansonius
166 Plicatella macrorhyza : p
106 Plicatella matesovae : p
246 Plicatella parviangulata : p
121 Plicatella potomacensis : p
204 Plicatella problematica cf. : p
201 Plicatella pseudomacrorhyza : p
29 Plicatella sp. indet. : p
30 Plicatella tricornitata : p
307 Podocarpidites #ED : p
123 Podocarpidites canadensis : p
47 Podocarpidites epistriatus : p
11 Podocarpidites granulosus : p
227 Podocarpidites herbtsii : p
12 Podocarpidites potomacensis : p
354 Podocarpidites sp. indet.
171 Podocarpidites tricocca : p
138 Polycingulatisporites segmentatus : p
146 Psilatriletes circumundulatus : p
257 Reticulatisporites sp. indet. : p
70 Retitricolpites georgensis : p
57 Retitricolpites geranoides : p
134 Retitricolpites magnificus
159 Retitricolpites vermimurus : p
122 Retitricolpites vulgaris : p
294 Rotverrusporites #ED : p
328 Rotverrusporites ambiguum : p
281 Rotverrusporites obscurilaesuratus : p
329 Rotverrusporites tenuis : p
189 Rouseisporites #Espinulosus : p
58 Rouseisporites euskirchensoides : p
31 Rouseisporites radiatus : p
71 Rouseisporites simplex : p
86 Rouseisporites singularis : p
233 Rugubivesiculites #EA : p
77 Rugubivesiculites minimus : p

APPENDIX A (cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Pollen and Spores

Taxa location index
Index numbers are the columns in which the taxon appears

13 Rugubivesiculites reductus : pp
48 Rugubivesiculites rugosus : p
340 Saxosporis variabilis : p
18 Schizosporis #EL : p
313 Scortea #Emicrolumena
214 Scortea tecta : p
177 Sequoiapollenites sp. indet. : p
353 spore indet.
111 Stellatopollis #ED : p
49 Stellatopollis largissimus : p
19 Stereisporites antiquasporites : p
172 Stereisporites clavus : p
213 Stereisporites sp. indet. : p
87 Striamonoletes auritus : p
298 Striatella #EA : p
316 Striatella #EC : p
291 Striatella #EE : p
299 Striatella #EF : p
324 Striatella #EJ : p
348 Striatella #ET
322 Striatella sp. indet. : p
59 Striatricolporites #EA : p
167 Taurocusporites reduncus : p
14 Taxodiaceaepollenites hiatus : p
182 Tigrisporites scurrundus : p
147 Todisporites major : p
150 Todisporites minor
223 Triangulopsis discoidalis : p
50 Tricolpites sp. indet. : p
72 Tricolpopollenites crassimurus : p
160 Tricolpopollenites micromunus
272 Trilobosporites #EB
293 Trilobosporites aequiverrucatus
319 Trilobosporites aornatus
173 Trilobosporites crassus : p
95 Trilobosporites humilis : p
237 Trilobosporites sp. indet.
320 Trilobosporites weylandii
179 Triretilobata marylandensis : p
209 Triretilobata sp. indet. : p
205 Triretilobata tribotrys : p
183 Triretilobata trioreticulosa : p
323 Tuberositriletes grossetuberculatus : p
314 Tuberositriletes major : p
351 Tuberositriletes minutus : p
228 Tuberositriletes montuosus : p
262 Tuberositriletes sp. indet. : p
60 Uvaesporites glomeratus
331 Varirugosisporites #EK : p
339 Varirugosisporites sp. indet.
32 Verrucatosporites pseudoreticulatus : p
200 Verrucatosporites sp. indet. : p
334 Vitreisporites minor : p
20 Vitreisporites pallidus : p

APPENDIX A (cont'd)

Alphabetical Listing of Species Shown on Occurrence Chart: Algae, Fungal and Miscellaneous

Taxa location index
Index numbers are the columns in which the taxon appears

Index number	Taxon names
7	Baltisphaeridium sp. indet. : p
12	Concentricystes minor : p
10	Cymososphaeridium sp.
16	extruded hydrocarbons
1	foraminiferal liners : p
15	fungal material : p
3	Micrhystridium fragile
9	Micrhystridium stellatum : p
13	Pterospermella sp. indet.
5	Schizocystia #EL : p
11	Schizocystia #Espinate : p
4	Schizocystia laevigata : p
6	Schizosporis parvus : p
2	Schizosporis reticulatus : p
8	Solisphaeridium sp. indet.
14	Veryhachium sp. indet.

APPENDIX B

Examined Samples: Venture B-13 Well

1505.00 : cuttings
1535.00 : cuttings
1565.00 : cuttings
1567.00 : swc
1595.00 : cuttings
1625.00 : cuttings
1649.80 : swc
1655.00 : cuttings
1683.00 : swc
1685.00 : cuttings
1702.00 : swc
1715.00 : cuttings
1743.00 : swc
1745.00 : cuttings
1775.00 : cuttings
1791.56 : swc
1805.00 : cuttings
1810.00 : swc
1830.00 : swc
1835.00 : cuttings
1857.00 : swc
1865.00 : cuttings
1895.00 : cuttings
1896.00 : swc
1923.00 : swc
1925.00 : cuttings
1955.00 : cuttings
1990.00 : cuttings
2015.00 : cuttings
2029.00 : swc
2045.00 : cuttings
2075.00 : cuttings
2105.00 : cuttings
2140.00 : cuttings
2142.00 : swc
2160.00 : swc
2170.00 : cuttings
2192.00 : swc
2200.00 : cuttings
2230.00 : cuttings
2260.00 : cuttings
2281.00 : swc
2290.00 : cuttings
2320.00 : cuttings
2350.00 : cuttings
2377.00 : swc
2380.00 : cuttings
2410.00 : cuttings
2440.00 : cuttings
2470.00 : cuttings
2500.00 : cuttings
2505.00 : swc
2530.00 : cuttings
2560.00 : cuttings
2584.00 : swc
2590.00 : cuttings
2605.00 : swc
2613.00 : swc
2620.00 : cuttings
2650.00 : cuttings
2680.00 : cuttings
2702.00 : swc
2710.00 : cuttings
2740.00 : cuttings
2770.00 : cuttings
2800.00 : cuttings
2810.00 : swc
2825.00 : swc
2830.00 : cuttings
2850.00 : swc
2865.00 : cuttings
2870.00 : swc
2895.00 : cuttings
2900.00 : swc
2925.00 : cuttings
2955.00 : cuttings
2960.00 : swc
2968.50 : swc
2985.00 : cuttings
3015.00 : cuttings
3036.00 : swc
3045.00 : cuttings
3075.00 : cuttings
3089.00 : swc
3105.00 : cuttings
3135.00 : cuttings
3135.00 : swc
3146.00 : swc
3150.50 : swc
3165.00 : cuttings
3170.00 : swc
3195.00 : cuttings
3202.50 : swc
3218.00 : swc
3225.00 : cuttings
3251.00 : swc
3255.00 : cuttings
3259.50 : swc
3273.50 : swc
3276.12 : swc
3280.00 : swc
3285.00 : cuttings
3285.00 : swc
3300.00 : swc
3308.50 : swc
3312.50 : swc
3315.00 : cuttings
3315.00 : swc
3328.50 : swc
3335.00 : swc
3340.00 : swc
3345.00 : cuttings
3350.00 : swc
3370.00 : swc
3375.00 : cuttings
3385.00 : swc
3386.00 : swc
3392.00 : swc
3396.00 : swc
3400.00 : swc
3405.00 : cuttings
3410.00 : swc
3420.00 : swc
3435.00 : cuttings
3445.00 : swc
3465.00 : cuttings
3495.00 : cuttings
3525.00 : cuttings
3555.00 : cuttings
3576.50 : swc
3585.00 : cuttings
3595.00 : swc
3615.00 : cuttings
3616.50 : swc
3632.00 : swc
3645.00 : cuttings
3652.50 : swc
3675.00 : cuttings
3676.00 : swc
3695.50 : swc
3705.00 : cuttings
3705.00 : swc
3715.00 : swc
3735.00 : cuttings
3759.50 : swc
3765.00 : cuttings
3765.00 : swc
3775.00 : swc
3795.00 : cuttings
3825.00 : cuttings
3835.00 : swc
3855.00 : cuttings
3885.00 : cuttings
3898.00 : swc
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3975.00 : cuttings
3977.00 : swc
4005.00 : cuttings
4005.00 : swc
4035.00 : cuttings
4055.00 : swc
4065.00 : cuttings
4095.00 : cuttings
4103.50 : swc
4106.00 : swc
4112.00 : swc
4116.00 : swc
4120.50 : swc
4125.00 : cuttings
4125.50 : swc
4135.50 : swc
4155.00 : cuttings
4160.00 : swc
4165.00 : swc
4175.00 : swc
4185.00 : cuttings
4185.00 : swc
4203.00 : swc
4215.00 : cuttings
4245.00 : cuttings
4275.00 : cuttings
4299.00 : swc
4305.00 : cuttings
4327.50 : swc
4335.00 : cuttings
4350.00 : swc
4365.00 : cuttings
4369.00 : swc
4395.00 : cuttings
4403.50 : swc
4412.00 : swc
4425.00 : cuttings
4442.50 : swc
4445.00 : swc
4455.00 : cuttings
4456.00 : swc
4460.50 : swc
4476.50 : swc
4481.50 : swc
4483.50 : swc
4485.00 : cuttings
4491.00 : swc
4515.00 : cuttings
4545.00 : cuttings
4548.50 : swc
4560.00 : swc
4568.00 : swc
4571.00 : swc
4575.00 : cuttings
4575.00 : swc
4579.00 : swc
4585.00 : swc
4595.00 : swc
4600.00 : swc
4605.00 : cuttings
4613.00 : swc
4624.50 : swc
4635.00 : cuttings
4665.00 : cuttings
4668.00 : swc
4672.00 : swc
4677.00 : swc
4683.00 : swc
4694.29 : core
4695.00 : cuttings
4730.00 : cuttings
4733.00 : swc
4752.00 : swc
4760.00 : cuttings
4780.00 : swc
4790.00 : cuttings
4802.00 : swc
4820.00 : cuttings
4820.00 : swc
4840.00 : swc
4850.00 : cuttings
4868.00 : swc
4875.00 : swc
4880.00 : cuttings
4893.00 : swc
4910.00 : cuttings
4922.00 : swc
4926.00 : swc
4935.00 : swc
4940.00 : cuttings
4970.00 : cuttings
5000.00 : cuttings
5005.00 : swc
5019.00 : swc
5024.00 : swc
5030.00 : cuttings
5032.00 : swc
5044.00 : swc
5060.00 : cuttings
5072.00 : swc
5078.00 : swc
5090.00 : cuttings
5104.00 : swc
5110.00 : swc
5119.00 : swc
5120.00 : cuttings
5136.00 : swc
5143.00 : swc
5148.00 : swc
5150.00 : cuttings
5155.00 : swc
5158.00 : swc
5161.00 : swc
5166.00 : swc
5172.00 : swc
5180.00 : cuttings
5183.00 : swc
5190.00 : swc
5210.00 : cuttings
5210.00 : swc
5211.00 : swc
5215.00 : swc
5222.00 : swc
5220.00 : swc
5230.00 : swc
5240.00 : cuttings
5270.00 : cuttings
5290.00 : cuttings
5360.00 : cuttings

APPENDIX C

List of Selected Palynomorphs

SELECTED PALYNOMORPHS

Listings show highest occurrences unless otherwise specified.

(+) indicates marker species.

1510-1510m: H.truncigerum to O.operculata Zones (Santonian to Campanian)

Comment: The sample density is too low for futher subdivision of the Senonian.

1505m

Areoligera senonensis (Common)
Ceratiopsis speciosa speciosa (Common)
Chatangiella victoriensis
Cribroperidinium wetzelii
Cyclonephelium distinctum (+)
Isabelidinium belfastense cf. (+)
Isabelidinium cooksoniae (+)
Manumiella cretacea (+)
Oligosphaeridium complex
Palaeoperidinium basilum (Common)
Senegalinium laevigatum (+) (Common)

1535-1535m: Oligosphaeridium pulcherrimum Zone (Coniacian)

1535m

Abiespollenites microreticulatus
Alterbia balmei
Cicatricosisporites cocononiensis
(Questionably present)
Deflandrei cooksonii of Benson 1976
Exochosphaeridium bifidum
Florentina cooksoniae (+)
Hystrichosphaeridium difficule

Odontochitina operculata
Oligosphaeridium anthophorum, Brid'71 (+)
Podocarpidites granulosus
Podocarpidites potomacensis
(Questionably present)
Rugubivesiculites reductus
Senoniasphaera rotundata (+)
Xenascus ceratioides

1565-1567m: Surculosphaeridium longifurcatum Peak Zone (Turonian)

1565m
Callialasporites segmentatus
Cleistosphaeridium aciculare
Coronifera oceanica
Cupuliferopollenites parvus
Isabelidinium belfastense
Odontochitina costata
Senoniasphaera reticulata
Surculosphaeridium longifurcatum (+) (Common)

1567m
Abiespollenites microreticulatus (Common)
Oligosphaeridium pulcherrimum
Silicisphaera ferox (+)
Vitreisporites pallidus (+)

1595-1595m: Kiokansium polypes Zone (Cenomanian)

1595m
Alcesiodinium 'antocularum'
Alisporites bilateralis (Common)
Aratrisporites ocellatus
Callaiosphaeridium asymmetrica
Canningia ringnesiorum (Common)
Chlamydophorella nyei

Cicatricosisporites cocononiensis (+)
Cleistosphaeridium huquoniotii (+) (Common)
Cyclonephelium vannopharum (+)
Deflandrea limpida cf.
Ephedripites virginiaensis
Fromea atlantica
Isabelidinium magnum (Common)
Kiokansium williamsii (+)
Kleithriasphaeridium loffrense
Nummus sp. indet.
Oligosphaeridium totum minor (+)
Oodnadattia tuberculata
Penetetrapites #EA
Phyllocladidites inchoatus
Plicatella tricornitata
Rouseisporites radiatus
Subtilisphaera foliacea
Surculosphaeridium longifurcatum (Abundant)
Xenascus ceratioides (Common)

1625-1685m: Chichaouadinium vestitum cf. Zone: O.totum totum Subzone (late Albian)

1625m

Aptea polymorpha (+)
Aratrisporites monosacatus
Astrocysta cretacea
Canningia minor
Cedripites canadensis (+)
Cicatricosisporites crassiterminatus (+)
Corollina torosa (+)
Cribroperidinium edwardsii (Common)
Crybelosporites pannuceus (+)
Cupuliferopollenites parvus
Cyclonephelium brevispinatum (Common)
Epelidosphaeridia spinosa (+)
Ephedripites proceras
Kiokansium williamsii (Abundant)
Liliacidites dividuus

Monosulcites scabratus
Oligosphaeridium totum totum (+)
Parvisaccites hortenensis (+)
Parvisaccites radiatus
Parvisaccites rugosus (+)
Plicatella baconensis
Podocarpidites epistriatus
Podocarpidites potomacensis
Rugubivesiculites rugosus
Silicisphaera tenera
Stellatopollis largissimus (+)
Stephodinium coronatum (+)
Xenascus #EA

1649.8m

Clavatipollenites hughesi
Eucommiidites minor (+)
Kiokansium polypes (Common)
Luxadinium propatulum
Nyktericysta arachnion (+)
Nyssapollenites albertensis
Penetetrapites mollis (+)
Retitricolpites geranoides (+)
Rouseisporites euskirchensoides (+)
Senoniasphaera microreticulata (+)
Stiphrosphaeridium anthophorum
Striatricolporites #EA
Uvaesporites glomeratus

1655m

Biretisporites potoniae
Chlamydophorella nyei, Singh 1971
Cicatricosisporites #EAA (Common)
Cicatricosisporites apiteretus
Cicatricosisporites delicatus
Ellipsoidictyum reticulatum
Epelidosphaeridia spinosa (Common)
Ischyosporites disjunctus (+)
Kiokansium williamsii (Common)
Nodosisporites genuinus (+)

Palaeohystrichophora #EA
Plicatella erdtmannii (+)
Retitricolpites georgensis (+)
Rouseisporites simplex (+)
Tricolpopollenites crassimurus (+)

1683m
Cerebropollenites mesozoicus (+)
Ephedripites sulcatus
Phyllocladidites microreticulatus
Plicatella bilateralis
Rugubivesiculites minimus (Common)

1685m
Aptea polymorpha (Common)
Asteropollis #Econate
Asteropollis asteroides (+)
Astrocysta cretacea (Common)
Chichaouadinium #EA (+)
Cicatricosisporites hughesii
Cicatricosisporites venustus
Converrucosisporites platyverrucosus
Cribroperidinium edwardsii (Common)
Foraminisporis dailyi
Foraminisporis wonthaggiensis
Klukisporites foveolatus
Ornamentifera echinata (+)
Rouseisporites singularis
Striamonoletes auritus
Subtilisphaera senegalensis
Surculosphaeridium longifurcatum (Common)

1702-1835m: Chichaouadinium vestitum cf. Zone: S. microreticulata Peak Subzone (middle Albian)

1702m
Camarozonosporites insignis (Common)
Cicatricosisporites potomacensis
Clavatipollenites minutus

Cyclonephelium attadalicum cf. (+) (Common)
Nummus #EO (+) (Common)
Spongodinium #EA

1715m

Astrocysta cretacea (Common)
Cedripites canadensis (Common)
Cicatricosisporites #EAI (+)
Cyclonephelium eisenackii (+)
Distaltriangulisporites costatus (+)
Foveotriletes subtriangularis
Kiokansium williamsii (Common)
Senoniasphaera microreticulata (+) (Common)
Trilobosporites humilis (+)

1743m

Dichastopollenites dunveganensis
Januasporites spiniferus
Schizocystia #EL
Schizosporis parvus
Stellatopollis largissimus (Common)

1745m

Afropollis jardinus (+)
Asteropollis trichotomosulcatus (+)
Cicatricosisporites #EF (+)
Cicatricosisporites annulatus (+)
Cicatricosisporites augustus (+)
Dictyophyllidites sp. Brenner 1968
Kiokansium williamsii (Common)
Liliacidites peroreticulatus (+)
Liliacidites sp.E, Dolye & Robbins 77 (+)
Oligosphaeridium totum totum (Common)
Plicatella matesovae
Senoniasphaera microreticulata (Common)

1775m

Acritosporites excavatus
Astrocysta #EA (+)
Coptospora williamsii

Kiokansium polypes (Common)
Microreticulatisporites diatretus
Oligosphaeridium totum totum (Common)
Plicatella #EK
Senoniasphaera microreticulata (Common)
Silicisphaera torulosa
Stellatopollis #ED (+)
Surculosphaeridium longifurcatum cf.

1791.56m
Monosulcites #Egrandis
Nodosisporites costatus (+)
Penetetrapites #Esubequatorialis

1805m
Acanthotriletes varispinosus
Cicatricosisporites subrotundus
Cribroperidinium episomum (+)
Exesipollenites tumulus
Kiokansium williamsii (Common)
Nodosisporites babsae (+)
Oligosphaeridium reniforme (+) (Common)
Plicatella potomacensis
Pterodinium aliferum
Retitricolpites vulgaris (+)
Senoniasphaera microreticulata (Common)

1810m
Podocarpidites canadensis
Subtilisphaera perlucida
(Questionably present)

1830m
Balmeisporites holodictyus
Cerebropollenites #EC
Costatoperforosporites fistulosus (+)
Rugubivesiculites rugosus (Common)
Surculosphaeridium longifurcatum (Common)

1835m

Biretisporites potoniae (Common)
Camarozonosporites dakotaensis
Cyclonephelium brevispinatum (Common)
Florentinia resex
Ischyosporites amoholkus (+)
Kiokansium polypes (Common)
Oligosphaeridium totum totum (Common)

1857-1925m: Chichaouadinium vestitum cf. Zone: C.vestitum cf. Subzone (middle Albian)

1857m

Chichaouadinium vestitum cf. (+)
Luxadinium primulum (Questionably present)
Ovoidinium verrucosum (+)

1865m

Astrocysta #EA (+) (Common)
Distaltriangulisporites irregularis (+)
Fromea amphorula
Gleicheniidites distalgranulatus
Kiokansium #EA
Nummus monoculatus
Ornamentifera baculata (+)
Parvisaccites amplus (Questionably present)
Retitricolpites magnificus
Spiniferites #Easpinosum (+)

1895m

Cedripites canadensis (Common)
Cycadopites nitidus
Inaperturopollenites crisopolis (+)
Plicatella #ET
Polycingulatisporites segmentatus

1896m

Interlobites triangularis

1923m
Abiespollenites microreticulatus (Common)
Chichaouadinium #Eglobosum (+)
Chichaouadinium vestitum cf. (Common)
Clavatipollenites rotundus (+)
Impardecispora texensis
Palaeohystrichophora #EA (Common)
Parvisaccites amplus cf. (+)
Rugubivesiculites rugosus (Abundant)
Surculosphaeridium longifurcatum (Common)

1925m
Aequitriradites #Eprocibaculatus
Astrocysta #EA (Common)
Cedripites canadensis (Common)
Corniculatisporites auritus cf.
Florentinia laciniata
Oligosphaeridium tenuiprocessum (+)
Psilatriletes circumundulatus

1955-2200m: Chichaouadinium vestitum cf. Zone: S.pirnaensis (kalyptra) Subzone (early Albian)

1955m
Astrocysta #EA (Common)
Campenia #EA
Cedripites canadensis (Common)
Chichaouadinium vestitum cf. (Common)
Ctenidodinium #ES (+)
Cyclonephelium brevispinatum (Common)
Cyclonephelium eisenackii (Common)
Kiokansium williamsii (Common)
Odontochitina operculata (Common)
Oligosphaeridium totum totum (Common)
Subtilisphaera pirnaensis (kalyptra)
Surculosphaeridium longifurcatum (Common)
Todisporites minor

1990m
Cedripites canadensis (Common)

Cribroperidinium #EX (+)
Nodosisporites #EG (+)
Oligosphaeridium perforatum colum
Oligosphaeridium reniforme (Common)
Spongodinium #Ecerebrus

2015m
Cupuliferopollinites minutus
Distaltrianqulisporites triangularis
Kiokansium polypes (Common)
Kraeuselisporites linearis
Oligosphaeridium reniforme 'minor' (+)
Plicatella cristata
Plicatella jansonius (Questionably present)
Retitricolpites vermimurus

2029m
Neoraistrickia truncata
Surculosphaeridium longifurcatum (Common)

2045m
Cedripites canadensis (Common)
Costatoperforosporites foveolatus
Decussosporites microreticulatus
(Questionably present)
Kuylisporites waterbolkii
Xiphophoridium alatum

2075m
Balmella tripenta (Present)
Cedripites canadensis (Common)
Cerebropollenites #EC (Common)
Cyclonephelium eisenackii (Common)
Imbatodinium micropodum (+)
Plicatella macrorhyza
Surculosphaeridium longifurcatum cf. (Common)
Taurocusporites reduncus

2105m
Cedripites canadensis (Common)

Cicatricosisporites mohrioides (+)
Concavissimisporites verrucatus cf.
Foraminisporis asymmetrica (+)
Podocarpidites tricocca
Trilobosporites crassus (Questionably present)

2140m
Cedripites canadensis (Abundant)
Chichaouadinium #EX
Concavissimisporites cotidianum
Klukisporites areolatus
Lycopodiumsporites marginatus
Plicatella jansonius

2142m
Dapsilidinium #EA (+)
Exochosphaeridium striolatum
Liliacidites inequalis (+)
Oligosphaeridium vasiforme
Triretilobata marylandensis (+)

2160m
Dapsilidinium #Ecaminatum
Microreticulatisporites uniformis
Podocarpidites potomacensis (Abundant)

2170m
Cicatricosisporites #EAI (Common)
Cyclonephelium attadalicum cf. (+) (Common)
Tigrisporites scurrundus (+)

2192m
Parvisaccites amplus (+)

2200m
Astrocysta #EA (Common)
Cedripites canadensis (Abundant)
Chichaouadinium boydii
Oligosphaeridium reniforme (Common)
Podocarpidites epistriatus (Common)

Triretilobata trioreticulosa (+)

2230-2260m: Chichaouadinium vestitum cf. Zone: O. perforatum perforatum Subzone (early Albian)

2230m

Aequitriradites cooksonae
Astrocysta #EA (Common)
Cedripites canadensis (Abundant)
Muderongia asymmetrica
Oligosphaeridium perforatum perforatum (+)
Oligosphaeridium pulcherrimum (Common)
Oligosphaeridium totum 'porus' (+) (Common)
Surculosphaeridium longifurcatum (Common)

2260m

Chichaouadinium vestitum cf. (Common)
Cicatricosisporites gondiodontus
Densoisporites microrugulatus
Fromea fragilis (+)
Oligosphaeridium reniforme (Common)
Rouseisporites #Espinulosus
Surculosphaeridium longifurcatum (Abundant)

2281-2470m: Chichaouadinuim vestitum cf. Zone: O. asterigerum Subzone (early Albian)

2281m

Astrocysta cretacea (Abundant)
Chichaouadinium #Eglobosum (Common)
Chichaouadinium vestitum cf. (Abundant)
Cyclonephelium eisenackii (Common)
Gardodinium eisenackii (+)
Oligosphaeridium asterigerum (+)
Oligosphaeridium perforatum colum (Common)
Senoniasphaera microreticulata (Common)

2290m

Afropollis zonalis (+)
Alatipollis #EA
Astrocysta #EA (Common)
Chichaouadinium vestitum cf. (Common)
Luxadinium primulum
Oligosphaeridium fenestratum (+)

2320m

Aequitriradites spinulosus
Alisporites grandis (Common)
Astrocysta #EA (Abundant)
Callialasporites dampieri (+)
Chichaouadinium #Eglobosum (Common)
Chichaouadinium vestitum cf. (Abundant)
Cyclonephelium eisenackii (Common)
Kiokansium polypes (Common)
Kleithriasphaeridium eoinodes (+)
Nodosisporites spinosus (+)
Plicatella bifurcata

2350m

Aequitriradites conisimilis
Astrocysta #EA (Common)
Baculatisporites comaumensis
Luxadinium #EA (+)
Oligosphaeridium verrucosum
Ovoidinium scabrosum
Surculosphaeridium longifurcatum (Common)

2377m

Astrocysta #EA (Abundant)
Oligosphaeridium perforatum colum (Common)
Oligosphaeridium totum minor (Common)
Plicatella pseudomacrorhyza
Subtilisphaera pirnaensis (kalyptra) (Common)

2380m

Astrocysta #EA (Abundant)
Chichaouadinium #Eglobosum (Common)
Cicatricosisporites australiensis

Perotriletes striatus
Plicatella problematica cf.
Spiniferites dentatus
Triretilobata tribotrys

2410m Callialasporites monoalasporus (Questionably present)

2440m Astrocysta #EA (Common)
Chichaouadinium vestitum cf. (Common)
Cyclonephelium eisenackii (Common)
Taeniophora #EA
Vesperopsis mayi

2470m Astrocysta #EA (Abundant)

2500-2500m: Subtilisphaera perlucida Zone: Stiphrosphaeridium #EA Subzone (late Aptian)

2500m Astrocysta #EA (Common)
Cicatricosisporites #EAL cf. (+)
Gleicheniidites senonicus (Abundant)
Hystrichodinium pulchrum
Stiphrosphaeridium #EA (+)
Subtilisphaera perlucida (+)

2505-2530m: Subtilisphaera perlucida Zone: P. trichopapillosus Subzone (mid-Aptian)

2505m Pilosisporites crassangularis (+)
Subtilisphaera perlucida (Common)

2530 Astrocysta #EA (Abundant)

2560-2613m: Subtilisphaera perlucida Zone: Cyclonephelium attadalicum Subzone (early Aptian)

2560m Astrocysta #EA (Common)
Cyclonephelium attadalicum (+)
Kiokansium williamsii (Common)
Parvisaccites amplus (Common)

2584m Oligosphaeridium macrotubulum (+)

2590m Cribroperidinium #EX (Present)
Cyclonephelium attadalicum (Common)

2605m Contignisporites glebulentus
Parvisaccites amplus (Common)
Parvisaccites radiatus (Common)

2620-2770m: Subtilisphaera perlucida Zone: S.terrula Subzone (early Aptian)

2620m Cedripites canadensis (Abundant)
Pseudoceratium pelliferum (Questionably present)
Scortea tecta (+)
Subtilisphaera terrula (+)

2650m Cedripites canadensis (Abundant)
Impardecispora #EB (+)
Parvisaccites amplus (Common)

2680m
Impardecispora macrotuberculata
Occisucysta sp. A, Bujak & Williams (Questionably present)
Parvisaccites amplus (Common)

2710m
Apteodinium grande
Callialasporites monoalasporus (+)
Cedripites canadensis (Abundant)

2740m
Astrocysta #EA (Common)
Cicatricosisporites #EAL (+)
Podocarpidites potomacensis (Common)

2770m
Podocarpidites potomacensis (Common)

2800-2900m: Aptea anaphrissa Zone: Pseudoceratium gochtii Subzone (late Barremian)

2800m
Pseudoceratium gochtii (+)
Subtilisphaera #EA (Present)
Vesperopsis mayi (Common)

2825m
Callialasporites turbatus (+)
Cyclonephelium attadalicum (Common)
Parvisaccites amplus (Common)

2830m
Cerebropollenites macroverrucosus (Questionably present)
Hystrichosphaerina schindewolfii (+)

2865m
Astrocysta #EA (Common)
Cicatricosisporites hannoverana aff.

Muderongia imparilis (+)

2870m
Callialasporites monoalasporus (Common)
Cyclonephelium attadalicum (Abundant)

2895m
Astrocysta #EA (Common)
Callialasporites monoalasporus (Common)
Cyclonephelium attadalicum (Common)
Impardecispora apigranulosa
Pseudoceratium pelliferum

2900m
Cyclonephelium attadalicum (Common)
Cyclonephelium brevispinatum (Common)
Pilosisporites trichopapillosus
Subtilisphaera terrula (Common)
Triangulopsis discoidalis (+)

2925-2968m: Aptea anaphrissa Zone: C. boreas Subzone (early Barremian)

2925m
Astroscysta #Eechinata
Cicatricosisporites #EAE (+)
Concavissimisporites longiverrucatus
Costatoperforosporites #ECH
Cribroperidinium borealis (+)
Cribroperidinium sepimentum (+)
Cyclonephelium attadalicum (Common)
Podocarpidites herbtsii

2955m
Cicatricosisporites nankingensis
Costatoperforosporites #EB
Cyclonephelium attadalicum (Common)
Oligosphaeridium poculum
Parvisaccites #EA

Rugubivesiculites #EA (+)
Stiphrosphaeridium arbustum (Questionably present)
Taeniophora #EA (Common)

2960m
Muderongia simplex simplex (+) (Common)
Parvisaccites radiatus (Common)
Taeniophora #EA (Common)

2968.5m
Oligosphaeridium dividuum (+)
Stiphrosphaeridium #EA (Common)

2985-3089m: Ctenidodinium elegantulum Zone:Muderongia staurota Subzone (late Hauterivian)

2985m
Cicatricosisporites exilioides Dorh '71
Corrudinium #EA (+)
Muderongia staurota 'perforata' (+)
Pilosisporites verus
Taeniophora #EA (Common)

3015m
Callialasporites infrapunctatus (+)
Cedripites #EA (+)
Cyclonephelium attadalicum (Common)
Muderongia simplex simplex (Common)

3036m
Aequitriradites verrucosus
Callialasporites monoalasporus (Common)
Cerebropollenites #Eminutus (Rare)
Chasmatosporites major (+)
Clavatipollenites #Edensus

3045m
Caddasphaera halosa (Abundant)

Callialasporites monoalasporus (Common)
Cicatricosisporites striatus
Muderongia simplex microperforata (+) (Common)
Pilosisporites ericus (+)
Plicatella parviangulata

3075m
Cicatricosisporites purbeckensis cf.
Muderongia simplex microperforata (Common)

3089m
Cassiculosphaeridia magna, Duxbury (+)
Cicatricosisporites #EAA (Common)
Cicatricosisporites #EAK
Interlobites #Everrucatus
Parvisaccites amplus

3105-3218m: Ctenidodinium elegantulum Zone: Kleithriasphaerium #EA Subzone (early Hauterivian)

3105m
Impardecispora splendida
Januasporites tumulosus (Questionably present)
Kleithriasphaeridium #EA
Muderongia simplex microperforata (Common)

3135m
Cedripites canadensis (Abundant)
Couperisporites complexus
Muderongia simplex microperforata (Abundant)
Oligosphaeridium complex cf., Will.'75 (+)
Parvisaccites #EB
Pityosporites #EA

3135m
Kuylisporites lunaris
Perinopollenites elatoides (Dominant)

3150.5m Phyllocladidites microreticulatus (Common)

3165m Muderongia simplex simplex (Common)
Subtilisphaera terrula (Common)

3170m Chasmatosporites major (Common)

3195m Cymososphaeridium sp. I (+)
Muderongia simplex microperforata (Common)
Podocarpidites canadensis (Common)

3202.5m Subtilisphaera perlucida (Common)
Subtilisphaera terrula (Common)

3218m Cicatricosisporites reticicatricosus
(Questionably present)

3225-3350m: Phoberocysta neocomica Zone: Oligosphaeridium diluculum Subzone (late Valanginian)

3225m Occisucysta distincta (+)
Oligosphaeridium diluculum (+) (Common)

3251m Densoisporites triradiatus cf. (+)
Luxadinium #EVG (+)

3255m Araucariacites punctatus
Callialasporites moncalasporus (Common)
Cedripites canadensis (Abundant)
Corrudinium #EB (+)
Muderongia californica (+)

Muderongia simplex microperforata (Common)
Subtilisphaera perlucida (Common)
Tanyosphaeridium isoclamus

3259.5m Taxodiaceaepollenites hiatus (Dominant)

3276.12m Callialasporites trilobatus
Gardodinium trabeculosum (+) (Present)

3280m Concavissimisporites informis
(Questionably present)
Dingodinium cerviculum (+)
Subtilisphaera #EA (Common)

3285m Impardecispora mirabile (Present)
Plicatella #EP

3308.5m Impardecispora pseudogibberula
Plicatella #EAD

3312.5m Aratrisporites ocellatus (Common)
Cyclonephelium brevispinatum (Common)

3315m Cicatricosisporites globosus (+)

3315m Pterospermella helios

3328.5m Corollina vignollensis (+)

3340m Cerebropollenites mesozoicus (Common)

Subtilisphaera perlucida (Common)

3345m Oligosphaeridium heilongjiangense (+)

3350m Concavissimisporites informis
Cyclonephelium brevispinatum (Abundant)
Cymososphaeridium validum (+)

3370-3576m: Phoberocysta neocomica Zone: Occisucysta #EX Sub-zone (early Valanginian)

3370m Cyclonephelium brevispinatum (Common)
Endoscrinium pharo (+)
Occisucysta #EX (+)
Occisucysta distincta (Common)
Schizocystia #Espinate
Trilobosporites #EB

3375m Cassiculosphaeridium #Eimperfecta
Cedripites canadensis (Abundant)
Densoisporites #EA
Ischyosporites tuberosus (+)
Plicatella #ES
Podocarpidites herbtsii (Common)

3386m Araucariacites punctatus
Cassiculosphaeridia #Eimperfecta (Abundant)
Cyclonephelium brevispinatum (Common)
Cyclonephelium distinctum (Abundant)
Occisucysta distincta (Common)
Surculosphaeridium sp. III

3396m Pityosporites #EA (Common)

3400m
Corollina itunensis
Perinopollenites elatoides (Abundant)

3405m
Cassiculosphaeridium #Eimperfecta (Common)
Costatoperforosporites #EG (+) (Present)
Meiourogonyaulax stoveri (+)
Rotverrusporites obscurilaesuratus
(Questionably present)
Surculosphaeridium sp. III (Dominant)

3445m
Cerebropollenites macroverrucosus (+)
Heslertonia heslertonensis
Parvisaccites amplus (Common)
Subtilisphaera perlucida (Common)

3495m
Cicatricosisporites angicanalis (+)
Inaperturopollenites #EA
Pityosporites #EA (Common)

3525m
Matonisporites equiexinus (Present)

3555m
Cribroperidinium globatum

3576.5m
Pityosporites #ER

3585-3696m: Phoberocysta neocomica Zone: Muderongia sp. A Sub-zone (late Berriasian)

3585m
Aequitriradites subverrucosus
(Questionably present)

Alisporites thomasii (+)
Muderongia sp. A, Davey 1978 (+)
Striatella #EE

3595m
Pityosporites dividuus (+) (Common)
Subtilisphaera terrula (Common)
Trilobosporites aequiverrucatus
Tuberositriletes montuosus

3615m
Pityosporites #EA (Common)

3616.5m
Ctenidodinium culmulum (Questionably present)
Ctenidodinium elegantulum
Cyclonephelium distinctum #Dgiganteum
Gonyaulacysta diutina
Hystrichodinium lanceatum (+)
Phoberocysta neocomica neocomica (+)
Pityosporites #EA (Common)
Rotverrusporites #ED

3632m
Phoberocysta neocomica convexa
(Questionably present)

3645m
Rotverrusporites obscurilaesuratus

3652.5m
Cerebropollenites macroverrucosus (Common)

3675m
Achomosphaera neptunii (+)
Caddasphaera halosa (Common)
Cicatricosisporites magnus (+)
Concavissimisporites verrucatus
Oligosphaeridium heilongjiangense (Common)

3676m Cicatricosisporites purbeckensis (Questionably present)
Pityosporites #EA (Common)

3705-3795m: Phoberocysta neocomica Zone: A. metaelliptica Sub-zone (early Berriasian)

3705m Aequitriradites subverrucosus
Alisporites thomasii (Common)
Amphorula metaelliptica (+)
Cyclonephelium brevispinatum (Common)
Paraadinia ceratophora
Stiphrosphaeridium arbustum
Stiphrosphaeridium dictyophorum (+) (Rare)
Striatella #EA (+)
Striatella #EF

3705m Cerebropollenites mesozoicus (Common)
Perinopollenites elatoides (Abundant)
Pityosporites #EA (Common)
Vitreisporites pallidus (Common)

3715m Cribroperidinium muderongense
Pityosporites #EA (Common)

3735m Cedripites #EA (Common)
Kleithriasphaeridium corrugatum (+)
Lanterna bulgarica (+)
Lanterna spartula (+)
Sentusidinium filiatum (+)
Systematophora turonica

3765m Systematophora areolata cf., Davey 82 (+)

3795m Couperisporites major
Pityosporites #EA (Common)

3825-3835m: Phoberocysta neocomica Zone: Cribroperidinium granuligerum Subzone (late Tithonian to early Berriasian)

3825m Breedoxiella #EB (+)
Callialasporites turbatus cf.
Cedripites canadensis (Abundant)
Concavissimisporites multituberculatus
Contignisporites dorsostriatus
Cribroperidinium granuligerum (+)
Ctenidodinium rugulatum
Imbatodinium pomum (+)
Pityosporites dividuus (+) (Common)

3835m Alisporites thomasii (Common)
Cardiangulina #EA
Muderongia sp. A, Davey 1978 (Common)
Perisseiasphaeridium #EA (Rare)
Pityosporites #EA (Common)
Podocarpidites #ED
Vitreisporites pallidus (Common)

3855-4369m: Ctenidodinium pannneum Zone:Ctenidodinium culmulum Subzone (late Portlandian)

3855m Cicatricosisporites undatus
(Questionably present)
Cribroperidinium ehrenbergii (+)
Ctenidodinium culmulum (+)
Ctenidodinium rugulatum (Common)

3885m Ctenidodinium panneum (+)

Meiouroqonyaulax deflandrei (+)
(Questionably present)

3898m
Amphorula #EA (Questionably present)
Callialasporites monoalasporus (Common)
Lanterna bulgarica (Common)
Perinopollenites elatoides (Abundant)

3915m
Alisporites #EG (+)
Contignisporites cooksoniae
Pilosisporites sp. A (Questionably present)
Scortea #Emicrolumena
Sentusidinium cuculliforme
(Questionably present)
Tuberositriletes major

3945m
Apteodinium nuciforme (Questionably present)
Cicatricosisporites purbeckensis
Ctenidodinium schizoblatum
(Questionably present)
Muderongia #EA (+)

3952m
Perinopollenites elatoides (Abundant)

3975m
Muderongia sp. A, Davey 1978 (Common)
Pityosporites dividuus (Common)

3977m
Pityosporites #EA (Common)

4005m
Muderongia mcWhaei

4035m
Klukisporites variegatus

4065m	Pilosisporites sp. A (+) (Present) Striatella #EC
4095m	Cicatricosisporites #EM (Present) Cicatricosisporites undatus (Common) Densoisporites triradiatus Trilobosporites aornatus Trilobosporites weylandii
4125m	Concavissimisporites robustus (+) Pityosporites dividuus (Common) Tuberositriletes grossetuberculatus
4155m	Alisporites thomasii (Common)
4160m	Exesipollenites scabratus (Common) Perinopollenites elatoides (Abundant) Pityosporites #EA (Common)
4165m	Perinopollenites elatoides (Abundant)
4175m	Pityosporites dividuus (Abundant)
4185m	Striatella #EJ (+)
4185m	Corollina vignollensis (Common) Pityosporites dividuus (Abundant)
4215m	Pityosporites #EA

Sentusidinium cuculliforme

4245m Cicatricosisporites grabowensis
Rotverrusporites ambiguum
Rotverrusporites tenuis

4275m Egmontodinium ovatum (Questionably present)
Varirugosisporites #EK

4305m Aequitriradites baculatus
Pseudoceratium gochtii (Common)

4335m Cicatricosisporites abacus

4369m Pityosporites dividuus (Abundant)

4395-4624m: Ctenidodinium panneum Zone:Cantulodinium speciosum Subzone (early Portlandian)

4395m Cantulodinium speciosum (+)

4425m Corollina vignollensis (Abundant)

4445m Cyclonephelium brevispinatum (Common)
Escharisphaeridia pocockii (+)
Vitreisporites minor

4455m Cicatricosisporites #EW

4460.5m — Ctenidodinium rugulatum (Common)
Dingodinium jurassicum (+) (Common)

4476.5m — Amphorula #EA (+) (Common)
Cantulodinium #EA (+)
Polystephanophorus sp. indet. (Abundant)
Sentusidinium rioultii

4485m — Cicatricosisporites #EO

4491m — Amphorula #EE (Questionably present)

4560m — Cerebropollenites #EB (+)
Lanterna sportula (Common)
Pityosporites dividuus (Common)
Polystephanophorus sp. indet. (Common)

4613m — Inaperturopollenites #EVL
Oligosphaeridium pulcherrimum cf. (+)

4624.5m — Chlamydophorella sp. A, Davies '83 (+)

4635-4677m: Ctenidodinium panneum Zone: Glossodinium dimorphum Subzone (early Portlandian)

4635m — Glossodinium dimorphum (+)
Hystrichogonyaulax cladophora (Questionably present)
Muderongia sp. A, Davey 1978 (Common)

4668m — Lanterna bulgarica (Common)

Leptodinium aceras (+)

4683-5060m: Hystrichogonyaulax cladophora Zone: Subzones not differentiated (Kimmeridgian)

4683m	Saxosporis variabilis (+) Senoniasphaera jurassica (Questionably present)
4733m	Cycadopites carpentieri Imbatodinium attenuatum (Questionably present)
4780m	Inaperturopollenites granulatus Ischyosporites jurassicus (+)
4790m	Apteodinium nuciforme (+) Hystrichogonyaulax cladophora (+)
4802m	Contignisporites notabilis (+) Cribroperidinium sp. F (+) Senoniasphaera jurassica (+)
4820m	Striatella #ET (Questionably present)
4840m	Callialasporites #EFG
4910m	Lanterna bulgarica (Common) Lanterna sportula (Common) Tubotuberella egemenii (+)

4922m Corollina chateaunovii (+)
(Questionably present)
Ctenidodinium chondrum (+)
(Questionably present)
Tuberositriletes minutus
(Questionably present)

4940m Pityosporites dividuus (Common)

5032m Ischyosporites jurassicus

5060m Lanterna bulgarica (Common)
Senoniasphaera jurassica (Rare)

5072-5190m: Indeterminate (Late Jurassic)

Comment: Samples are generally barren or in some poor.

5158m Senoniasphaera jurassica
(Questionably present)

5210-5210m: Indeterminate (possible Oxfordian)

5210m Compositosphaeridium polonicum (+)
(Questionably present)
Corollina vignollensis
Muderongia sp. A, Davey 1978

5210-5360m: Indeterminate (Indeterminate)

Comment: Samples are barren or have mud additive contaminates in cuttings and SWC's.

Palynological Zonation
Venture B-13

ZONES	SUBZONES
Dinogymnium euclaensis	
Odontochitina operculata	
Pervosphaeridium truncigerum	
Oligosphaeridium pulcherrimum	
Surculosphaeridium longifurcatum	
Kiokansium polypes	
Chichaouadinium vestitum cf.	*Oligosphaeridium totum totum*
	Senoniasphaera microreticulata
	Chichaouadinium vestitum cf.
	Subtilisphaera pirnaensis (kalptra)
	Oligosphaeridium perf.perforatum
	Oligosphaeridium asterigerum
Subtilisphaera perlucida	*Subtilisphaera perlucida*
	Pliosisporites trichopapillosus
	Cyclonephelium attadalicum
	Subtilisphaera terrula
Aptea anaphrissa	*Pseudoceratium gochtii*
	Cribroperidinium boreas
Ctenidodinium elegantulum	*Muderongia staurota*
	Kleithriasphaeridium #EA
Phoberocysta neocomica	*Oligosphaeridium diluculum*
	Occisucysta #EX
	Muderongia sp.A
	Amphorula metaelliptica
	Cribroperidinium granuligerum
Ctenidodinium panneum	*Ctenidodinium culmulum*
	Cantulodinium speciosum
	Glossodinium dimorphum
Hystrichogonyaulax cladophora	

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Figure 1

Chichaouadinium vestitum cf. Zone
Subzones - Dinoflagellates - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	ALBIAN	*O.totum totum*	F	*A.polymorpha*	1625	X
				L.propatulum	1649	
MIDDLE		*S.microreticulata* Peak	E	*C.attadalicum cf.*	1702	IX
				C.elsenackii	1715	
				S.senegalensis	1743	
				Astrocysta #EA	1775	
				O.reniforme reniforme	1805	
		C.vestitum cf.	D	*Ov.verrucosum*	1857	VIII
				Spiniferites #Easpinosus	1865	
				Chichaouadinium #Eglobosum	1923	VII
				O.tenuiprocessum	1925	
EARLY		*S.pirnaensis* (kalyptra)	C	*Ctenidodinium #ESmooth*	1955	
				Cribroperidinium #EX	1990	
				O.reniforme 'minor'	2015	
				I.micropodum	2075	VI
				Dapsilidinium #EA	2142	
		O.perforatum	B	*O.totum 'porus'*	2230	V
				F.fragile	2260	
		O.asterigerum	A	*O.asterigerum*	2281	
				O.fenestratum	2290	
				K.eolnides	2320	
				Luxadinium #EA	2350	
				V.mayi	2440	

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Figure 2

Chichaouadinium vestitum cf. Zone
Subzones - Miospores - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	ALBIAN	*O.totum totum*	F	*P.rugosus*	1625	X
				E.minor	1649	
				A.asteroides	1685	
MIDDLE		*S.microreticulata* Peak	E	*T.humilis*	1715	IX
				A.jardinus	1745	
				Stellatopollis #ED	1775	
				N.babsae	1805	
		C.vestitum cf.	D	*I.amoholkus*	1835	VIII
				O.baculata	1865	
				I.crisopolis	1895	
				I.triangularis	1896	
EARLY		*S.pirnaensis* (kalyptra)	C	*C.rotundus*	1923	VII
				Nodosisporites #EG	1990	
				P.cristata	2015	
				P.macrorhyza	2075	VI
				C.mohrioides	2105	
				T.marylandensis	2142	
				Cicatricosisporites #EAI	2170	V
				T.trioreticulata	2200	
		O.perforatum	B	*D.microrugulatus*	2260	
				A.zonalis	2290	
		O.asterigerum	A	*C.dampieri*	2320	
				P.pseudomacrorhysa	2377	

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Figure 3

Subtilisphaera perlucida Zone
Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	APTIAN	*S.perlucida*	D	*Stiphrosphaeridium #EA*	2500	IV

MIDDLE		*P.trichopapillosus*	C	*P.crasslangularis*	2505	

EARLY		*C.attadallcum*	B	*C.attadallcum*	2560	
				O.macrotubulum	2584	
				C.attadallcum peak	2570	
				C.glebulentus	2605	III
		S.terrula	A	*Scortea tecta*	2620	
				Imperdeclspora #EB	2650	
				I.macroverrucosus	2680	
				C.monoalasporus	2710	
				Cicatricosisporites #EAL	2740	

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Figure 4

Aptea anaphrissa Zone

Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	BARREMIAN	*P.gochtii*	B	*Subtilisphaera #EA*	2800	II
				C.turbatus	2825	
				H.schindewolfii	2830	
				C.attadalicum Peak	2870	I
				P.pelliferum	2895	
				T.discoidalis	2900	
				S.terrula Peak	2900	
EARLY		*C.boreas*	A	*C.septmentum*	2925	
				Rugubivesiculites #EA	2955	
				O.poculum	2955	
				M.simplex simplex	2960	
				O.dividuum	2968	

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Figure 5

Ctenidodinium elegantulum Zone
Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	HAUT	*M.staurota*	B	*Corrundinium #EA*	2985	
				C.Infrapunctatus	3015	
				M.simplex microperforata	3045	
				C. magna sensu Duxbury,81	3089	
EARLY		*Kleithriasphaeridium #EA*	A	*M.simp. microperforata Peak*	3105	
				O.complex cf.,Williams,75	3135	
				Cymososphaeridium sp.1	3195	

Phoberocysta neocomica Zone
Upper Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	VALANGINIAN	*O.diluculum*	D	*O.distinctum*	3225	
				Luxadinium #EVG	3251	
				Corrundinium #EB	3255	
				G.trabeculosum	3276	
				D.cerviculum	3280	
				Pilcatella #EP	3285	
				C.globosus	3315	
				C.vignolliensis	3328	
				O.hellongjiangense	3345	
				C.validum	3350	
EARLY		*Occisucysta #EX*	C	*E.pharo*	3370	
				Cassiculosph.#Elmperfecta	3375	
				Surculosphaeridium sp.III	3386	
				C.ltunensis	3400	
				M.stoverii	3405	
				H.heslertonensis	3445	
				C.anglicanalis	3495	
				C.globosum	3555	

Phoberocysta neocomica Zone
Lower Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	BERR	*Muderongia sp.A*	C	*A.thomasii*	3585	
				H.lanceatum	3616	
				A.neptunii	3675	
EARLY		*A.metaelliptica*	B	*S.dictyophorum*	3705	
				L.eportula	3735	
				S. areolata cf,Davey,82	3765	
PORT/BERR		*C.granuligerum*	A	*I.pomum*	3825	
				Perisselasphaeridium #EA	3835	

Ctenidodinium panneum Zone
Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
LATE	PORTLANDIAN	*C.culmulum*	C	*C.ehrenbergii*	3855	
				C.panneum	3885	
				Muderongia #EA	3945	
				T.grossetuberculatus	4125	
				E.scabratus Peak	4160	
				Striatella #EJ	4185	
				S.cucullilforme	4215	
				Varirugosisporites #EK	4275	
EARLY		*C.speciosum*	B	*C.speciosum*	4395	
				E.pocockii	4445	
				D.jurassicum Peak	4460	
				Cantulodinium #EA	4476	
				Amphorula #EE ?	4491	
				Cerebropollenites #EB	4560	
				O.pulcherrimum cf.	4613	
				Chlamydophorella sp.A	4624	
		G.dimorphum	A	*G.dimorphum*	4635	
				L.aceras	4668	

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Figure 9

Hystrichogonyaulax cladophora Zone

Subzones - Venture B-13

AGE	#	SUBZONE	##	BIOHORIZON	DEPTH	CYC
NOT DIVIDED	KIMMER	NOT ASSIGNED		*S.variabilis*	4683	
				I.attenuatum?	4733	
				I.jurassica	4780	
				H.cladophora	4790	
				C.notabilis	4802	
				Cribroperidinium sp.F	4802	
				Callialasporites #EFG	4840	
				T.egemenii	4910	
				C.chondrum ?	4922	
				C.chateaunovii	4922	

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Figure 10

PALYNOFACIES MODEL, APTIAN TO CENOMANIAN
IDEALIZED CYCLE

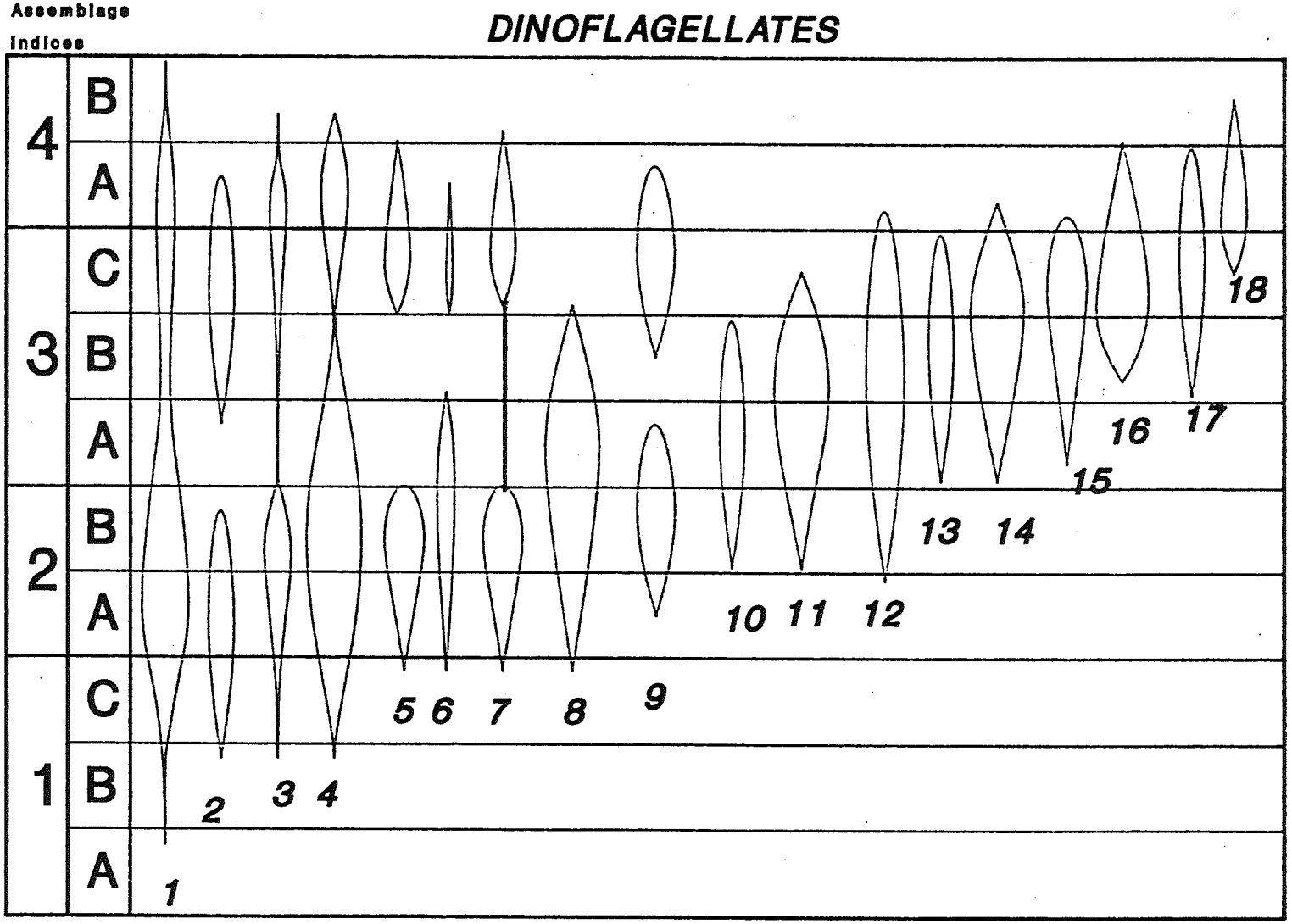

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Figure 11

PALYNOFACIES MODEL, APTIAN TO CENOMANIAN
IDEALIZED CYCLE

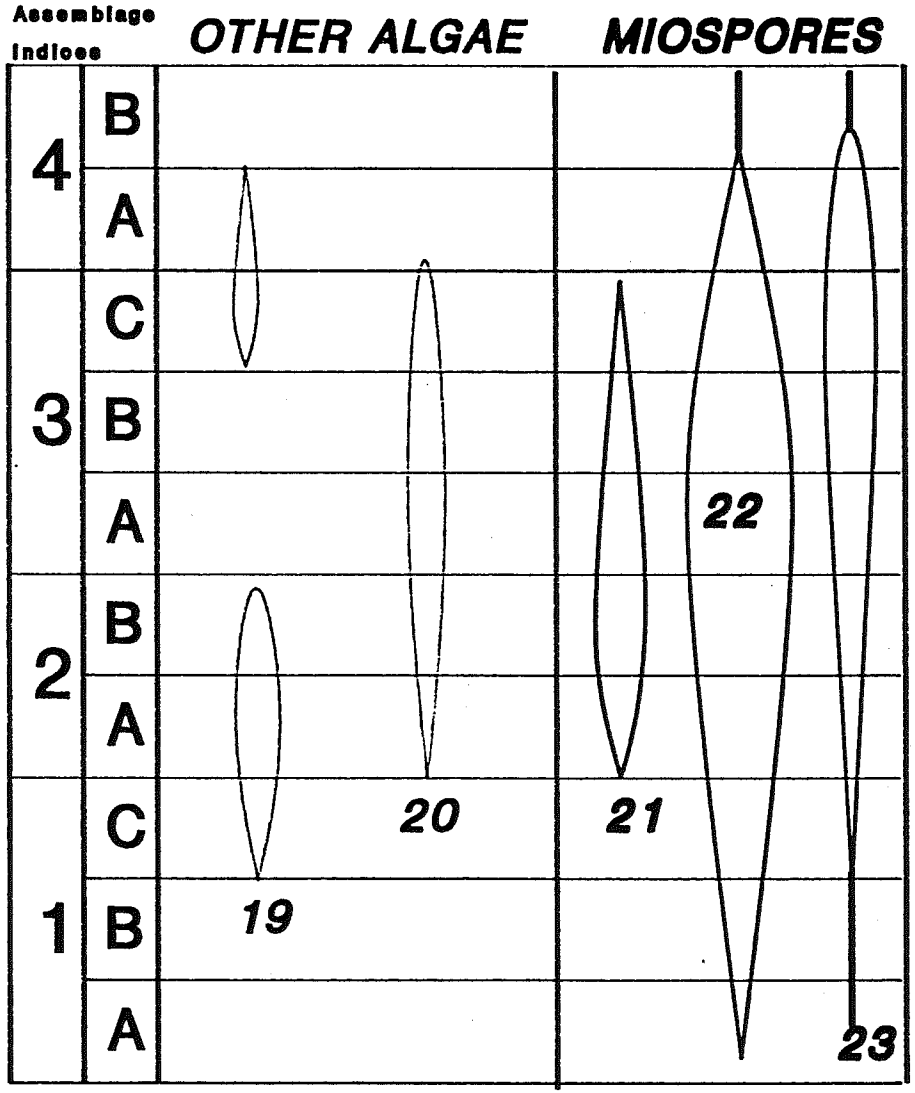

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Figure 12

KEY TO PALYNOMORPH GROUPS
PALYNOFACIES MODEL

1. **Astrocysta spp.**
2. **Nyktericysta/Balmula spp.**
3. **Spiniferites spp./Achomosphaera spp.**
4. **Cyclonephelium spp. and closely related genera**
5. **Luxadinium spp.**
6. **Subtilisphaera spp./Caddosphaera spp.**
7. **Cleistosphaeridium spp./Chlamodophorella spp.**
8. **Senoniasphaera including C.vannophorum**
9. **Chichaouadinium spp.**
10. **Odontochitina spp.**
11. **Oligosphaeridium spp. and related genera**
12. **Kiokansium spp.**
13. **Aptea spp. including C.eisenackii**
14. **Cribroperidinium spp.**
15. **Xenascus spp.**
16. **Epelidosphaeridia spp.**
17. **Nummus spp.**
18. **Florentinia/Silicisphaera spp.**
19. **Schizosporis and related algae**
20. **Micrhystridium/Baltisphaeridium spp.**
21. **Angiospermous pollen**
22. **Gymnospermous pollen**
23. **Fern and moss spores**

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Figure 13