19. LATE CRETACEOUS PALYNOFLORAS (SPOROMORPHS AND DINOCYSTS) FROM THE KERGUELEN PLATEAU, SOUTHERN INDIAN OCEAN (SITES 748 AND 750)

Barbara A.R. Mohr and Carole T. Gee

ABSTRACT

Pollen, spore, and dinoflagellate cyst floras of Late Cretaceous age were found at Sites 748 (120-748C-62R through -79R) and 750 (120-750B-11W) of Ocean Drilling Program Leg 120 to the Kerguelen Plateau area in the Southern Indian Ocean. The ranges of dinocyst and sporomorph species indicate ages between the Cenomanian and Coniacian (to possibly the early Santonian). The ratio of marine/terrestrial flora elements is extremely variable, showing a trend from highly terrestrial (up to ~70%) in the late Cenomanian to highly marine (up to 90%) in the Coniacian/early Santonian. Low sedimentation rates of about 3–5 cm/1000 yr were calculated for the glauconitic sediments of Turonian and Coniacian age at Site 748 (lithologic Subunit IIIIB).

INTRODUCTION

The objective of the drilling operations of Leg 120 of the Ocean Drilling Program was to recover expanded Paleogene and Cretaceous sections to document the early sedimentation and tectonic history of the Southern Kerguelen Plateau. This southern part lies at a depth of 1000–3000 m. The depth of the seafloor surrounding the Kerguelen Plateau is generally 4000–4500 m, except on the feature’s northeastern and southern flanks, where depths range from 3000 to 4000 m toward the Southeast Indian Ridge and the Antarctic continental margin, respectively (Coffin et al., 1990).

Before the drilling campaigns of Legs 119 and 120, only scattered samples derived from piston cores and dredging were available from the Kerguelen Plateau area (Houtz et al., 1977). Seismic profiles that first surveyed the sedimentary filling of such basins as the Raggatt Basin were published as results of French and Australian cruises (Colwell et al., 1988). To succeed in the primary goal of calibrating the seismic stratigraphy, precise dating of the section was necessary. Palynology proved to be a major tool that could provide a stratigraphic framework in the lower part of the deposits overlaying the basaltic basement, as other microfossil groups are missing from the lower part of Sites 748 and 750. These sites contain expanded Cretaceous sections from the early Alban (120-750B-12R through -14R; Mohr and Gee, this volume) to the Maestrichtian (120-748C-27R; Maa and Mohr, this volume).

Until recently, few palynofloras were known from the early Late Cretaceous of the southern high latitudes. The papers published thus far are concerned mostly with the Australian area and include the classic studies of Deflandre and Cookson (1955) and Cookson and Eisenack (1958, 1960, 1962, 1970, 1974) and, more recently, the studies of Norvick and Burger (1976), Harris (1976), Helby et al. (1987), and McMinn (1988). Papers by Dettmann and Thomson (1987) and Olivero and Palamarzuk (1987) report on early Late Cretaceous palynomorph floras from the Antarctic Peninsula area.


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was cored (Unit II). Figure 3 shows the lower part of Hole weathering of volcanic complexes on land and/or submarine. Holes 750A and 750B were drilled at this site. In these drill ooze, chalk, and chert of middle Eocene to Maestrichtian age components Fe and kaolinite, whereas Subunit IIIA shows the dominant features of the Late Cretaceous sequence (lithologic Subunit IIIB) is an enrichment in glauconite pellets, which comprise 10% to 90% of the sediment. Lithologic Subunit IIIB exhibits cross bedding and slight to intense bioturbation, but less bioproductivity than in lithologic Subunit IIIA. According to these authors, the concentration of Cr (bulk sediment) is very high in lithologic Subunit IIIB and is derived from the weathering of volcanic complexes on land and/or submarine. In addition, this subunit is rich in the two land derived components Fe and kaolinite, whereas Subunit IIIA shows the highest input of biogenic carbonate and phosphatic debris.

Site 750 (approximately 57°36'S, 81°15'E, water depth to 2030.5 m) is located in the eastern part of the Raggatt Basin. Holes 750A and 750B were drilled at this site. In these drill holes, below a 40-cm-thick layer of Pleistocene to early Pliocene diatom ooze (Unit I), 360 m of white nannofossil ooze, chalk, and chert of middle Eocene to Maestrichtian age was cored (Unit II). Figure 3 shows the lower part of Hole 750B with the lower part of sedimentary Units III and IV and the cores drilled into the basaltic basement. Unit III consists of pale green to green gray chalk and chalk. Limestones with dark bands, traces of molluscs, inorganic elements and wood were recovered in the lower part at depths of 595–623 m below sea level (mbsl) (Subunit IIIIC). The entire Unit III is dated as late Maestrichtian to late Turonian by foraminifers and nannoplankton, and, in part, by the dinoflagellate cysts that are described in this paper (Core 120-750B-11W).

From 623.5 to 675.5 mbsl (Unit IV), a red brown silty claystone with coal and minor conglomerates was recovered (Fig. 2). An early to early middle Albian age for this section was determined by sporomorphs (Mohr and Gee, this volume). Below 675.5 mbsl, approximately 35 m basalt was drilled.

MATERIAL AND METHODS

Late Cretaceous sediments in Cores 120-748C-62R through -79R and 120-750B-11W are composed of a broad range of glauconitic sandstones, silt, and claystones with some sandy or conglomeratic intervals. The shipboard results (Schlich, Wise, et al., 1989) determined that there were abundant carbonized wood fragments in the basal part of Hole 748C, which are recognized by Francis and Coffin (this volume) as being of gymnospermous origin. Coarse authigenic siderite and pyrite grains and accretions were also observed. Analysis of the reddish brown, silty clay indicates that it consists primarily of kaolinite, but up to 25% siderite, 6% pyrite, and 20% altered grains can be derived from the altered basalt.

We processed 43 samples from Hole 748C and 1 sample from Hole 750B using standard centrifuge preparation techniques for palynomorphs, in addition to straining with a 15 µm mesh sieve. Smear slides using glycerine jelly were made to examine the kerogen and palynomorph content. For taxonomic determination and photographic documentation, additional single grain slides were made. ODP localities and slide numbers of the figured specimens are given in the plate captions. Coordinates are noted for sporomorphs found in smear slides, and refer to the Nikon “Microphot FX” Microscope, no. 1020-1219. The slides are deposited at the Geological Institute of the ETH (Swiss Federal Institute of Technology) in Zurich.

RESULTS

Kerogen Analysis

After using the standard processing method mentioned above, but before sieving and oxidization, the kerogen content of the samples was checked. In samples from the lower part of the investigated interval of Site 748, the content of palynomorphs (mostly dinocysts and sporomorphs) is moderately high. The palynodebris is mostly composed of large, well-preserved cuticle, wood, and fusinite particles, as well as bacterially degraded phytoleasts of unknown origin. Globular amorphanous material and finely shredded amorphous palynodebris make up only about 10% to 20%. In samples 120-748C-79R-1, 55–58 cm, and -73R-6, 57–60 cm, the amount of finely shredded amorphous material appears to be even lower. The palynofacies in these samples can be classified as the “tracheal facies” defined by Habib (1979).

In the upper part of the examined interval of Site 748, the amount of finely shredded and amorphous material increases (up to 30%–50%), so that the facies can be assigned to the xenomorphic palynofacies of Habib (1979). The thermal alteration index (TAI) of the kerogen is about -2, according to the color chart in Traverse (1988). The organic matter is thus still immature.
Figure 2. Detailed lithologic summary of the lower part of Site 748, western Raggatt Basin. Palynological samples, analyzed in this paper, come exclusively from lithologic Subunit IIIIB.
Figure 3. Lithologic summary of Site 750. The palynological sample comes from lithologic Subunit IIIc.
After sieving and oxidation, quantitative analysis of palynomorphs from Site 748 was conducted on those samples in which the content was high enough. On the average, 150 palynomorphs per sample were counted. Terrestrial (spores and pollen) vs. marine (dinocysts, acritarchs, and foraminifera) ratios show high variability (Table 1 and Fig. 4). Low (30%) marine percentages, however, are seen in the lower part of the section (late Cenomanian to early Turonian age; see “Biostratigraphy” section, this chapter). The marine percentages reach maxima of about 90% (Samples 120-748C-72R-1, 70-73 cm, and -63R-1, 82-84 cm). It is apparent from Figure 4 that there is a tendency toward increasing marine conditions from the bottom to the top of the section. This impression is verified by a regression line (Fig. 4). In the bottom of the hole, the regression estimates are between 40% and 50% marine, and at the top of the sequence between 70% and 80% marine. In addition to the terrestrial/marine ratio, the diversity of marine dinocyst taxa was also plotted. The highest diversity (24–25 species) is seen at the bottom of the hole (Sample 120-748C-79R-2, 138-141 cm). Other maxima are reached in the interval from Cores 120-748C-70R through -65R. A diagram (Fig. 5) in which species diversity is plotted vs. marine percentages shows highest diversity where the ratios of terrestrial input vs. marine organic matter are about balanced or are slightly shifted toward the marine side. Nutrient-rich influx from land (minerals bearing P, Fe, Al, K, and Si) may be the reason for the high dinocyst diversity in those samples.

Table 1. Percentage of marine kerogen (dinocysts, acritarchs and foraminifera) and dinocyst species diversity (number of dinocyst taxa) from selected samples of lithologic Subunit IIIB (Site 748).

<table>
<thead>
<tr>
<th>Core, section, interval (cm)</th>
<th>Depth (mbsf)</th>
<th>Marine (%)</th>
<th>Diversity (species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120-748C-2R-4, 115-117</td>
<td>738.18</td>
<td>81</td>
<td>11</td>
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<tr>
<td>62R-6, 52-55</td>
<td>740.62</td>
<td>61</td>
<td>6</td>
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<tr>
<td>62R-CC</td>
<td>742.00</td>
<td>76</td>
<td>5</td>
</tr>
<tr>
<td>63R-1, 82-84</td>
<td>742.82</td>
<td>91</td>
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<td>63R-CC</td>
<td>751.50</td>
<td>62</td>
<td>5</td>
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<tr>
<td>64R-1, 63-65</td>
<td>752.13</td>
<td>81</td>
<td>6</td>
</tr>
<tr>
<td>64R-3, 78-81</td>
<td>755.28</td>
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<tr>
<td>65R-1, 46-50</td>
<td>761.46</td>
<td>70</td>
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<tr>
<td>66R-1, 48-51</td>
<td>770.98</td>
<td>79</td>
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<tr>
<td>67R-1, 69-73</td>
<td>780.69</td>
<td>50</td>
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<tr>
<td>68R-1, 30-33</td>
<td>789.80</td>
<td>71</td>
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<tr>
<td>69R-1, 56-59</td>
<td>798.03</td>
<td>62</td>
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<td>70R-4, 54-57</td>
<td>807.54</td>
<td>63</td>
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<tr>
<td>70R-CC</td>
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<td>42</td>
<td>6</td>
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<tr>
<td>71R-CC</td>
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<td>72R-1, 70-73</td>
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<td>9</td>
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<td>72R-CC</td>
<td>835.50</td>
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<td>892.50</td>
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<td>15</td>
</tr>
<tr>
<td>79R-1, 55-58</td>
<td>893.05</td>
<td>30</td>
<td>4</td>
</tr>
<tr>
<td>79R-2, 60-63</td>
<td>894.60</td>
<td>65</td>
<td>18</td>
</tr>
<tr>
<td>79R-2, 136-141</td>
<td>895.38</td>
<td>54</td>
<td>24</td>
</tr>
</tbody>
</table>

The organic matter of Section 120-750-11W-CC has about the same level of maturity as the kerogen of Site 748. The composition of the palynomorphs is >90% marine (dinocysts, acritarchs) and <10% terrestrial (sporomorphs). Most of the organic debris is finely shredded or amorphous, which is typical for “xenomorphic palynofacies” (Habib, 1978).
THE PALYNOFLORA

The palynoflora in Section 120-748C-62R-CC through Sample 120-748C-79R-2, 138–141 cm, as well as that in Core 120-750B-11W, consists of spores, pollen, and fungal remains of terrestrial origin and marine phytoplankton, such as dinoflagellate cysts, acritarchs, and other algal cysts. Among all these palynomorphs, the dinocysts proved to be the most valuable group for stratigraphic purposes in the sedimentary sections mentioned above.

Dinoflagellate Cysts

Most of the dinocysts found in the Kerguelen Plateau material were previously described in the classic papers on Australian Mesozoic dinocysts by Deflandre and Cookson (1955) and by Cookson and Eisenack (1958, 1960, 1962, 1970, 1974). The Kerguelen Plateau dinocyst flora shares the greatest number of species with those from early Late Cretaceous age described by Norvick and Burger (1976) and Olivero and Palamarczuk (1987).

The dinocyst taxonomy used here generally follows the index of Lentin and Williams (1989). This index contains the full citations to the original papers used in the present paper; thus, these citations will not be repeated here in the references. A complete list of all taxa encountered in our material is given in Appendix A.

TAXONOMIC REMARKS

Tehamadinium Jan du Chêne et al., in Jan du Chêne et al., 1986

(Plate 6, Figs. 1A–B, 3, 4A–B, and 5)

These cysts contain the very prominent archeopyle of the genus Tehamadinium, consisting of two paraplates (Type 2P, 2", and 3"; see specimens on Plate 6, Figs. 1A–B and 4A). When compared with other species of Tehamadinium, the ornamentation is very rough, consisting of thick, hallow spines that are closely arranged at the parasites or are even fused to one another at the base. These spines are long and mostly pointed apically but are sometimes also formed conically. One apical spine is usually more prominent than others. Tehamadinium sp. A is most similar to T. tenisceram (Eisenack, 1958) Jan du Chêne et al., 1986 (an Aiptian form) that has spines about half of the size of Tehamadinium sp. A.

Sample size. About 12 specimens.

Measurements (6 specimens). Length about 60–70 µm; width about 60–70 µm; length of the spines 3–8 µm; apical spine 10–12 µm.

Occurrence. Tehamadinium sp. A is found exclusively in sediments of supposedly Coniacian age (Sections 120-748C-62R-6 to -63R-1; 740.62–742.82 mbsf).

Crasedodinium Cookson and Eisenack, 1974

Crasedodinium cf. indistinctum Cookson and Eisenack, 1974

The specimens encountered in our material are similar in shape, outline, and archeopyle structure to the specimen figured by Cookson and Eisenack (1974, plate 25, fig. 7). In both cases, the archeopyle seems to be apical. The specimens in our material are, however, far smaller (length: about 40 µm, width: about 35 µm) than those described by Cookson and Eisenack (1974; type specimen: 103 × 96 µm). The age of the sediments from which the type specimen is described is thought to be Aptian-Albian.

Trithyrodinium Druge, 1969 Lentin and Williams, 1976

Trithyrodinium cf. sabulum Mao and Norris, 1988

(Plate 8, Figs. 2, 4, 7, and 9)

Cyst similar in appearance to Trithyrodinium sabulum Mao and Norris (1988); however, it is more pear-shaped than the specimens described by these authors (see Plate 8, Figs. 2 and 9, this paper). The apical horn is commonly less obvious than in the original description. The antapical horns are slightly more prominent and are often seen as two short protrusions, bulging out from the antapical part of the cyst.

T. sabulum occurs in the Tarim Basin (China) in the Kukebat to Yigeziya formations, which are correlated with the Conenomian to the post-Conenomian (Maestrichtian).

Terrestrial Palynomorphs from Hole 74GC

The terrestrial palynomorphs consist of fungal remains, moss and fern spores, one megaspore, and conifer and angiosperm pollen. Of these, fern spores are the most common. The most frequently encountered spore is, by far, Cyathidites minor, which is present in almost all samples in the section, even in those that are highly marine in composition. Another fairly common spore is Laevigatosporites ovoides. The other, more distinctive moss and fern spores play only a minor role in the flora. The few fungal remains found are shield-shaped fruticoid bodies lacking central stalks and ostioles.

Bisaccate and trisaccate pollen grains are scarce in these microfloras, which is in direct contrast to their numbers in the microflora recovered from slightly older early Alban sediments in the region (Mohr and Gee, this volume). The few grains encountered are also usually so badly preserved that it is difficult to assign them to species. Their poor preservation may be caused in part by the use of strong oxidizing agents in the preparation of the samples. The air bladders of sacate pollen, which are often found to contain balls of pyrite at nearby localities, may be more susceptible to damage than other pollen if the oxidation process that destroys the pyrite balls also affects the delicate bladders that house them.

Angiosperm pollen is more frequently found in the higher parts of the sequence. The most common pollen is the monocolate Clavatipollenites hughesii, although the pollen of several other tricolpate and tricolporate genera also occur.


Biostatigraphy

Dinocysts, Hole 74GC

The ranges of the dinoflagellate cysts in this material are mostly compiled from the work of Williams and Buja (1988), Helby et al. (1987), and McMinn (1988). These three papers form the basis for Figure 6. In comparison to other Cenomanian/Turonian palynomorphs from the Australian area (Norvick and Burger, 1976), the floras in our material contain 0–25 species (average: 8) and are generally low in diversity (Fig. 4). This makes age determination more difficult.

The most common dinocyst in Cores 120-748C-79R and -78R is Cribroropenidium edwardsi, which, according to Helby et al. (1987), has an acme in the late Diconodinium multipinum Interval Zone and early Palaeohystrichophora infusoriodi Zone Interval Zone. Other common cysts are Diconodinium multipinum, the name-giving cyst of the overlying P. infusoroides Zone. These zones range, respectively, from the early Cenomanian to the late Cenomanian and from the latest Cenomanian to the mid to late Turonian. The base of the P. infusoroides Zone is defined by the last occurrence of Pseudoceratium ludbrookiae.

Thus, in regard to the occurrence of the three most common dinocyst species, the deepest cores of Hole 74GC (120-748C-79R and -78R) can be placed in the time interval between the upper part of the D. multipinum Zone and the lower part of the P. infusoroides Zone of Helby et al. (1987). This defines the age of the sediment as late Cenomanian to early Turonian. Unfortunately, the marker form P. ludbrookiae, which would give evidence of a Cenomanian age, is absent. There are, however, dinocyst taxa, found in the lower
Figure 6. Stratigraphic ranges of selected dinoflagellate cysts found in lithologic Subunits IIIB (Site 748) and IIIC (Site 750), according to the literature. Time scale according to Helby et al. (1987).
part of the section, which are confined only to the Cenomanian, according to the existing literature. *Litosphaeridium siphoniphorum glabrum* is considered by Lucas-Clark (1984) to be a subspecies restricted to the Cenomanian, although *Litosphaeridium siphoniphorum siphoniphorum* also occurs in the Turonian. In our material, *L. siphoniphorum glabrum* was encountered only in samples of Cores 120-748C-79R and -76R.

The occurrence of *Ascodinium acrophorum* was previously reported by Cookson and Eickenscheid (1960) from the Albian and Cenomanian of the Freemenite area (Australia). At Hole 748C *A. acrophorum* is restricted to Core 120-748C-79R. The last appearance of *Kleithriasphaeridium granulatum* was previously reported at the end of the Cenomanian (Fig. 6). In our material, this species is found at the base of the section (120-748C-79R-2 through -79R-1, see Table 2). *Valensiella grijphus*, described by Norrick and Burger (1976) from Cenomanian sediments, was also encountered exclusively in Core 120-748C-79R.

In the material described here, the first (poorly preserved) specimen of the genus *Chatangiella* (*C. victoriensis*) was observed in Section 120-748C-76R-1. From Sample 120-748C-70R-1, 63–67 cm, upward, this cyst starts to be more common (see Table 2). According to the literature (McMinn, 1988), *C. victoriensis* appears for the first time in the mid-Isabelidinium acuminatum Zone, which is about equivalent to the upper Palaeohystrichophora infusorioides Zone of Helby et al. (1987). The mid-Isabelidinium acuminatum Zone and the upper Palaeohystrichophora infusorioides Zone are thought to correspond to the mid-Turonian.

Beginning with Sample 120-748C-65R-1, 46–50 cm, and continuing through Sample 120-748C-62R-4, 115–117 cm, *Kleithriasphaeridium tubulosum* was regularly observed. According to Helby et al. (1987), *K. tubulosum* was found exclusively in the Conospheridium strictoconus Zone, which is of Cenomanian age. *C. strictoconus* itself was only observed in Samples 120-748C-64R-1, 63–65 cm, and -62R-4, 115–117 cm.

*Isabelidinium sp.* was found in Sample 120-748C-66R-1, 48–51 cm, through Section 120-748C-61R-CC. In this interval, *Xenusac* cf. *ceratoideae*, a more or less nonspiny form of this genus, also appears. *Xenusac* was found by Mao and Mohr (this volume) consistently until Core 120-748C-32R, which is equivalent in time to the early Maestrichtian. According to Yun (1981), nonspiny specimens of the genus *Xenusac* seem to occur mostly from the “Senonian” on (Coniacian through Maestrichtian). He describes similar unornamented forms under the name *X. esbeckiana*.

The change from a Coniacian to a probable Santonian flora occurs between Samples 120-748C-62R-4, 115–117 cm, and 62R-1, 52–59 cm, where the compositional differences between the two floras can be observed (last appearance of *C. strictoconus* and *K. tubulosum* and the frequent occurrence of *X. cf. ceratoideae*). A detailed description and interpretation of the Santonian to Maestrichtian dinocyst floras in Sample 120-748C-62R-2 through Section 120-748C-27R-2 are the subject of the paper by Mao and Mohr (this volume).

Summarizing the marine plankton results, the ranges of the dinocysts suggest ages between the late Cenomanian through Coniacian/early Santonian. The age of the lower part of the section (Samples 120-748C-79R-2, 138–141 cm through -79R-1, 55–58 cm), and possibly also Core 120-748C-78R (see sporomorph evidence below), is most likely late Cenomanian. Core 120-748C-77R through Section 120-748C-73R-CC seem to be of early Turonian age. The mid-Turonian was reached in Sample 120-748C-73R-5, 57–60 cm. A Coniacian age is probable for the section from Samples 120-748C-66R-1, 48–51 cm, through 120-748C-62R-4, 115–117 cm. Probable Santonian sediments are preserved between Sample 120-748C-62R-1, 52–59 cm, and Section 120-748C-61R-CC.

Turning to the sporomorph evidence, most of the spores and pollen species found throughout the section (Table 3) have fairly long ranges in the Late Jurassic and Cretaceous. There are, however, a few sporomorphs that have restricted ranges in the southern Gondwana area. Although taxon characteristic of major spor-pollen zones (e.g., those listed by Helby et al., 1987) do not occur in the material, a few biostratigraphically indicative sporomorphs were found. These species, listed with their stratigraphic ranges in Figure 7, contribute to the dating of the core sediments. Figure 7, as well as the species ranges discussed in the following analysis, unless otherwise cited, is based exclusively on the spore-pollen zonation established by Helby et al. (1987), one of the few that cover the Cenomanian through Santonian interval in southern Gondwana.

In southern Gondwana, *Dictyotosporites complex* makes its last, if irregular, appearance at the end of the Cenomanian. Its only occurrence in the section in Sample 120-748C-78R-1, 59–62 cm, indicates an age no younger than the Cenomanian for the lowermost part of the section. *Nyssapollenites lanosus* also occurs once in the section in Section 120-748C-76R-CC. In late Albian to Turonian sequences from southern Australia, this pollen species ranges from the mid-Cenomanian to the Turonian (Dettmann, 1973) and thus indicates that this part of the section can be no younger than the mid-Cenomanian. Another biostratigraphically significant spore, *Interolobites intraverrucatus*, was also found in the lower part of the section, from Sections 120-748C-79R-2 through 120-748C-76R-5. This species has a restricted range in the Late Cretaceous, ranging from the latest Albian to the Coniacian, and supports an early late Cretaceous age for the lower part of the section.

Contignisporites fornicatus occurs sporadically throughout the section. Its late appearance in the literature in the early Santonian limits the upper part of the section to an age no younger than the early Santonian. A slightly younger Coniacian age is indicated for the upper part of the section by *Clavatipollenites hughesi*, which occurs frequently until the late Cenomanian and only irregularly until its last appearance in the early Santonian. Thus, the occurrence of *C. hughesi* in the uppermost part of the section limits the upper age boundary to the basal Santonian, although its frequency in the uppermost samples most likely indicates an age older than the Santonian.

In summary, the ranges of selected pollen and spores found in Hole 748C support the dinocyst evidence for an early Late Cretaceous age, bracketing this age to an interval between the mid-Cenomanian to the Coniacian or possibly early Santonian.

**Dinocysts, Hole 750B**

Only one sample (Section 120-750B-11W-CC) was examined. The range overlap of certain taxa found in this sample, such as *Palaeohystrichophora infusorioides* (first appearance datum [FAD] = Vraconian), *Dispachyra macroplyla* (FAD = Vraconian; last appearance datum [LAD] = Coniacian), and *Canninginopsis colliveri* (LAD = mid-Cenomanian) make an early to middle Cenomanian age for this sample most likely.

Members of the genus *Isabelidinium* were also encountered. Because the species greatly differ in shape and size, it is difficult to assign this form to a particular species. Some of the specimens could be assigned to *L. glabrum*, which is regularly found during the Cenomanian. Other specimens may
Table 2. Stratigraphic occurrences of the dinoflagellate cysts in lithologic Subunit IIIB (Site 748).

<table>
<thead>
<tr>
<th>Age</th>
<th>Depth (mbsf)</th>
<th>Core, section, interval (cm)</th>
<th>Age</th>
<th>Depth (mbsf)</th>
<th>Core, section, interval (cm)</th>
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<tr>
<td>Santonian</td>
<td>732.50</td>
<td>61R-CC</td>
<td>Coniacian</td>
<td>780.69</td>
<td>67R-1, 69-73</td>
</tr>
<tr>
<td></td>
<td>733.02</td>
<td>62R-1, 52-59</td>
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<td>789.80</td>
<td>68R-1, 30-33</td>
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<tr>
<td></td>
<td>738.15</td>
<td>62R-4, 115-117</td>
<td></td>
<td>798.03</td>
<td>69R-1, 56-59</td>
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<td>740.62</td>
<td>62R-6, 52-55</td>
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<td>807.63</td>
<td>70R-1, 63-67</td>
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<tr>
<td></td>
<td>742.00</td>
<td>62R-CC</td>
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<td>807.54</td>
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<td>742.82</td>
<td>63-1, 82-84</td>
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<td>816.50</td>
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<td>865.24</td>
<td>76R-1, 60-63</td>
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<td>72R-CC</td>
<td></td>
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<td>76R-5, 120-123</td>
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<td>74R-CC</td>
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<td>76R-1, 60-63</td>
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<td>895.38</td>
<td>79R-2, 138-141</td>
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</tbody>
</table>

belong to *I. belfastense* or even to the genus *Chatangia*.
This would imply that sediments of younger age (Turonian to Coniacian) higher up in the core were washed down as a result of the special coring technique mentioned by Mohr and Gee (this volume). If so, this dinocyst assemblage can then be interpreted as a mixture of floras from the early Cenomanian and the Turonian/Coniacian.

**PALEOCEANOGRAPHIC IMPLICATIONS**

During the (early to mid) Albian, after the formation of the volcanic basement (Whitechurch et al., this volume), large parts of the Kerguelen Plateau must have still been terrestrial, as there is no evidence of marine fossils in sediments of this age (Mohr and Gee, this volume).
Major flooding of the Kerguelen Plateau area must have occurred between the early to mid-Albian and between the early to mid-Cenomanian, which may be preserved at Site 750. Even if the early to mid-Cenomanian is not found at Site 750 (see “Biostratigraphy” section, this chapter), there is evidence from Eltanin Core ES4-7 (55°52.78'S, 81°07.09'E) that marine sediments were accumulated during the (late) Cenomanian (Quilty, 1973). The fossil record seems to be discontinuous and resumes with late Cenomanian deposits at the base of Hole 748C. There, the kerogen is more terrestrial influenced than in the middle Cenomanian. If we consider the overall kerogen trends in the investigated interval of Site 748 (Fig. 4), the abundance of terrestrial material decreases from the upper Coniacian through the Coniacian deposits, with maxima in the lower Turonian.
During the late Cenomanian (Cores 120-74C-79R and 78R), the terrestrial kerogen source must have been still fairly close to the sedimentary basin, because the terrestrial particles (wood, cuticles) are coarse in comparison with the organic matter in the younger part of this section. In the late Cenomanian interval, the number of dinoflagellate species (species diversity) is the highest (24-25 species).

The late Cenomanian is considered by many authors (Ens et al., 1983; Haq et al., 1987; Hinchliffe, 1989) to be a time of worldwide regression (in comparison with the mid-Cenomanian and early Turonian). Increased terrestrial input in the sediments of presumed late Cenomanian age reflects a more continental climate. The high species diversity in these layers can be explained by a more continental climate with increased terrestrial input.
B. A. R. MOHR, C. T. GEE

Age
- 90 - 100
- 110

Celar
Φ
CL
ceo

Stage
Santonian
Coniacian
Turonian
Cenomanian
late
Albian
middle
early

Hoegl/ispore Superzone

Sporomorphs

Tricolporites apoxyexinus
Phyllocladidites mawsonii
Appendicisporites distocarinatus
Phimopollenites pannosus
Coptospora paradoxa
Crybelosporites striatus

Figure 7. Stratigraphic ranges of selected pollen and spores found in lithologic Subunit IIIB (Site 748). Time scale, zonation scheme, and species ranges after Helby et al. (1987).

explained by the increased nutrients entering the inner to outer shelf areas where the largest numbers of cyst producing species generally occur. This pattern is strongly overprinted by surface currents (Harland, 1983), where large dinocyst concentrations are associated with areas of convergence and/or divergence.

From the Turonian time on, terrestrial input generally decreased. However, in the early Turonian deposits, maxima of terrestrial input were noted and may correlate to short regressive intervals. During late Turonian and Coniacian/early Santonian times, conditions became increasingly more open-marine, a tendency found during the Campanian and Maastrichtian (Mao and Mohr, this volume).

Sedimentation rates calculated using the ages of the different sections of lithologic Subunit IIIB (Fig. 2) of Site 748 seem to be low for a shelf environment. If we take a Turonian age for the sediment between 780.69 and 883.59 mbsf, during this time interval, 102.90 m of sediment would have accumulated. If we assume a total length of about 2.5 m.y. for the Turonian, sediment accumulated at a rate of 41.2 m/m.y. For the Coniacian (duration ca. 1 m.y.), sediments for which seem to be more or less completely preserved (39.83 m), a sedimentation rate of about 39.8 m/m.y. was calculated. These low sedimentation rates of 3-5 cm/1000 yr seem to fit with observations of extensive bioturbation in the glauconitic siltstones of lithologic Subunit IIIB at Site 748 (Schlich, Wise, et al., 1989). Low sedimentation rates are characteristic of glauconites deposited in normal saline waters from 20 to 730 m in depth (Pettijohn, 1975).

CONCLUSIONS

Based on dinocyst and sporomorph evidence, the sediments investigated are (late) Cenomanian to Coniacian/Santonian in age. Kerogen analysis, especially ratios of terrestrial vs. marine organic matter, indicate a high terrestrial input in the late Cenomanian. During the Turonian and Coniacian/early Santonian, the sequence became increasingly more marine. Low sedimentation rates of about 3-5 cm/1000 yr were calculated for lithologic Subunit IIIB of Site 748.

ACKNOWLEDGMENTS

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Yun, H.-S., 1981. Dinoflagellaten aus der Oberkreide (Santon) von Ms 120B-196.

Date of initial receipt: 8 May 1990

Date of acceptance: 24 November 1990

Ms 120B-196

APPENDIX A

List of Dinoflagellate Cysts and Acritarchs

Dinoflagellate Cysts from Hole 748C

Achomosphaera triangularis (Gerlach, 1961) Davey and Williams, 1969; Plate 1, Fig. 1

Ascodium acrophorum (Cookson and Eisenack, 1969a) Helenees, 1983; Plate 1, Fig. 5

Batiacasphaera sp.; Plate 8, Fig. 5

Cassidulosa sp. reticulata Davey, 1969a; Plate 1, Figs. 6A-B
Chantangiella tripurita (Cookson and Eisenack, 1969) Lent and Williams, 1976; Plate 1, Figs. 2–4
Chantangiella victorina (Cookson and Manum, 1964) Lent and Williams, 1976; Plate 1, Figs. 7A–B
Chantangiella sp.
Chlamydomorpha neyi Cookson and Eisenack, 1958; Plate 1, Fig. 9
Circuloidinium distinctum (Deflandre and Cookson, 1955) Jansonius, 1968; Plate 2, Figs. 7A–B
Cleistosphaeridium ancoriferum (Cookson and Eisenack, 1960) Davey et al., 1966, emend. Cookson and Eisenack, 1968; Plate 1, Fig. 8
Cleistosphaeridium sp.
Conosphaeridium striatocostatum (Deflandre and Cookson, 1955) Cookson and Eisenack, 1969; Plate 1, Figs. 10A–B
Coronofera oceanica (Cookson and Eisenack, 1958) Mao and Norris, 1988; Plate 2, Fig. 6
Craspedodinium cf. indistinctum Cookson and Eisenack, 1974; Plate 3, Figs. 1A–B
Crirhaeridium cooksoniae Novick, 1976; Plate 3, Figs. 4 and 6
Crirhaeridium edwardsii (Cookson and Eisenack, 1958) Davey, 1969; Plate 2, Fig. 4
Crirhaeridium nudagenense (Cookson and Eisenack, 1958) Davey, 1969; Plate 2, Figs. 1A–B
Cyclonephelium hughesi Clarke and Verdier, 1967
Cyclonephelium sp.; Plate 3, Fig. 2
Diconodinium multispinum (Deflandre and Cookson, 1955) Morgan, 1977; Plate 2, Fig. 5
Diconodinium pseudatum Morgan, 1977; Plate 8, Fig. 1
Diconodinium sp.
Disphaeria macroplana (Cookson and Eisenack, 1960a) Novick, 1973
Exochosphaeridium muelleri Yun, 1981; Plate 3, Figs. 7A–B
Eycra nubilosa Cookson and Eisenack, 1958; Plate 2, Fig. 2
Florentinia farq (Deflandre, 1973b) Duxbury, 1980; Plate 3, Figs. 3A–B
Florentinia mantelli (Davey and Williams, 1966) Davey and Verdier, 1973; P. 3, Fig. 5
Florentinia cooksoniae (Ch. Singh, 1971) Duxbury, 1980
Heterosphaeridium heterocanthum (Deflandre and Cookson, 1955) Eisenack and Kjellström, 1971a
Hystrichodinium pulchrum Deflandre, 1935; Plate 4, Fig. 5
Kallasphaeridium granulatum (Novick, 1976) Sover and Evitt, 1978; Plate 5, Fig. 1
Isabelidinium belfastense (Cookson and Eisenack, 1961a) Lent and Williams, 1977a; Plate 4, Fig. 3
Kioansium polyxos (Cookson and Eisenack, 1962) Below, 1982; Plate 4, Fig. 2
Kleithriasphaeridium tubulosum (Cookson and Eisenack, 1969) Sover and Evitt, 1978; Plate 4, Figs. 8A–B
Kleithriasphaeridium sp.; Plate 8, Fig. 8
Litosphaeridium siphonophorum (Cookson and Eisenack, 1958) Davey and Williams, 1966, subsp. glabrum Lucas-Clark, 1984
Litosphaeridium sp.; Plate 4, Figs. 1 and 7
Microdinium ornatum Cookson and Eisenack, 1960; Plate 5, Fig. 8
Microdinium setosum Sargeant, 1966b; Plate 4, Fig. 6
Odontochitina costata Alberti, 1961
Odontochitina operculata (O. Wetzel, 1933) Deflandre and Cookson, 1955; Plate 7, Fig. 2
Oligosphaeridium astigerum (Gocht, 1959) Davey and Williams, 1969; Plate 5, Fig. 3
Oligosphaeridium complex (White, 1842) Davey and Williams, 1966
Ovoidinium diversum Davey, 1979b; Plate 5, Figs. 6A–B
Palseoacritosphaera infusorioides Deflandre, 1953; Plate 6, Figs. 2A–B
Palseoacritosphaera cretaevarum (Pocock, 1962) Davey, 1970
Pervosphaeridium pseudohystrichodinium (Deflandre, 1937) Yun, 1981; Plate 5, Figs. 2A–B
Pteridosporeidium conulatum Davey, 1969a; Plate 5, Fig. 5
Sentsidinium sp.; Plate 8, Fig. 6
Spiniferites furcatus (Ehrenberg, 1838) Loeblich and Loeblich, 1966
Spiniferites wesseli (Deflandre, 1937b) Sargeant, 1970; Plate 5, Figs. 6A–B
Surculosphaeridium sp.
Taleisphaera hydra Duxbury, 1979a; Plate 5, Fig. 7

Tehanimadinium sp. A; Plate 6, Figs. 1A–B, 3, 4A–B, and 5
Trichodiwnium castanea (Deflandre, 1935) Clarke and Verdier, 1967
Trityrhodinum cf. sabulon Mao and Norris, 1988; Plate 8, Figs. 2, 4, 7, and 9
Valensiella griphus Novick, 1976; Plate 6, Fig. 6
Xenus cf. ceraticoides (Deflandre, 1937b) Lentin and Williams, 1973; Plate 8, Fig. 3

Acritarchs from Hole 748C
Mikrophytum spp.
Pterospemrella australiensis
Veryhachium reducunt
Veryhachium singular

Dinoflagellate Cysts from Hole 750B
Baticasphaera sp.; Plate 7, Fig. 5
Canningsnopsis collivi (Cookson and Eisenack, 1960b) Backhouse, 1988; Plate 7, Fig. 1
Cleistosphaeridium sp.; Plate 7, Fig. 8
Cometodinium comatum Srivastava, 1984; Plate 7, Fig. 7
Disphaeria macroplana Cookson and Eisenack, 1960a) Novick, 1976; Plate 7, Fig. 3
Litosphaeridium siphonophorum (Cookson and Eisenack, 1958) Davey and Williams, 1966; subsp. glabrum Lucas-Clark, 1984; Plate 7, Fig. 9
Hystrochidium pulchrum Deflandre, 1935
Impagidinium sp.
Isabelidinium sp.
Microdinium ornatum Cookson and Eisenack, 1960; Plate 5, Fig. 8
Odontochitina costata Alberti, 1961
Odontochitina operculata (O. Wetzel, 1933) Deflandre and Cookson, 1955; Plate 7, Fig. 2
Oligosphaeridium complex (White, 1842) Davey and Williams, 1966
Pulseoacritosphaera infusorioides Deflandre, 1935
Psaligonyaulax deflandrei (Sargeant, 1966b) Sargeant, 1982b; Plate 7, Fig. 4
Pterodinium cingulatum granulatum (Clarke and Verdier, 1967) Lent and Williams, 1981; Plate 7, Fig. 6
Spiniferites sp.
Tanyosphaeridium salpinx Novick, 1976; Plate 7, Fig. 10

APPENDIX B
Terrestrial Palynomorphs from Hole 748C
Fungal and Nondinoflagellate Algal Remains
Scutate fungal fruit-body (ascocorma) lacking ostiole (several types)
Schizospora reticulata Cookson and Dettmann, 1959 emend. Pierce, 1961

Cryptogamic Spores
Appendicisporites sp., cf. A. jansonii Pocock, 1962; Plate 9, Fig. 1
Baccellatisporites cuneatus (Cookson, 1953) Potonié, 1956; Plate 9, Fig. 2
Calamospora sp.; Plate 9, Fig. 3
Ceratosporites distalgranulatus Couper, 1958) Kemp, 1970; Plate 9, Fig. 4
Cicatricosisporites australiensis (Cookson, 1947 ex Potonié, 1956) Dettmann, 1963; Plate 9, Fig. 8
Cicatricosisporites heugesi Dettmann 1963; Plate 9, Fig. 6
Cryptosporites distalgranulatus (Bolchovitina, 1953) Bolchovitina, 1966; Plate 9, Fig. 7
Cryptosporites pseudotripartitus (Bolchovitina, 1961) Dettmann, 1963
Clavulifera triplex (Bolchovitina, 1953) Bolchovitina, 1966; Plate 9, Fig. 6
Contigisporites scoticus Dettmann, 1963; Plate 9, Fig. 8
Cycatheacites annulatus Cookson, 1947 ex Potonié, 1956; Plate 9, Fig. 9
Cycatheacites botuliformis Dettmann, 1980b; Plate 9, Fig. 10
Cycatheacites sp. A; Plate 9, Fig. 11
Cycatheacites sp. B
Cyathidites australis Couper, 1953; Plate 9, Fig. 12
Cyathidites minor Couper, 1953; Plate 9, Fig. 13
Dicytopyllidites equites (Couper, 1958) Dettmann, 1963; Plate 10, Fig. 1
Dictyotosporites complex Cookson and Dettmann, 1958; Plate 10, Fig. 2
Distaltriangulisporites sp.; Plate 10, Fig. 3
Foveogleicheniidites confossus (Hedlund, 1966) Burger, 1975; Plate 10, Fig. 4
Interulobites intraverrucatus (Brenner, 1963) Phillips and Felix, 1972; Plate 10, Fig. 5
Laevigatosporites ovatus Wilson and Webster, 1946; Plate 10, Fig. 6
Leptolepidites major Couper 1958; Plate 10, Fig. 7
Leptolepidites verrucatus Couper 1953; Plate 10, Fig. 8
Microfoveolatosporis canaliculatus Dettmann, 1963; Plate 10, Fig. 9
Neoraistrickia equalis (Cookson and Dettmann, 1958) Backhouse, 1988; Plate 10, Fig. 10
Neoraistrickia truncata (Cookson, 1953) Potonié, 1956; Plate 10, Fig. 11
Nevesisporites dailyi (Cookson and Dettmann, 1958) Burger, 1987
Perotrilites majus (Cookson and Dettmann, 1958) Evans, 1970; Plate 10, Fig. 12
Polycingulatisporites clavus (Balme, 1957) Burger, 1980; Plate 10, Figs. 13 and 14
Reticulatisporites (sensu Uwin and Batten, 1988, pl. 67, figs. 1 and 2) sp.
A; Plate 10, Fig. 15
Reticulatisporites (sensu Uwin and Batten, 1988, pl. 67, figs. 1 and 2) sp.
B; Plate 10, Fig. 16
Retitriletes australocavatidites (Cookson, 1953) Döring et al. in Krutzsch, 1963; Plate 10, Fig. 17
Stoverisporites antiquasporites (Wilson and Webster, 1946) Dettmann, 1963
Stoverisporites pocockii Burger 1980; Plate 11, Fig. 1
Stoverisporites lunaris (Cookson and Dettmann, 1958) Burger, 1975
Stoverisporites microverrucatus Burger, 1975; Plate 11, Fig. 2
Triletes tuberculiformis Cookson, 1947; Plate 11, Fig. 3
Tuberculatisporites sp.; Plate 11, Fig. 4
Megaspor; Plate 11, Fig. 5
Gymnospermous Pollen
Alisporites similis (Balme, 1957) Dettmann, 1963; Plate 11, Fig. 6
Corollina (Classopolis) sp.; Plate 11, Fig. 7
Cupressaetes sp.; Plate 11, Fig. 8
Ephedrinites sp.; Plate 11, Fig. 9
Microcachryidites parvus Couper, 1960; Plate 11, Figs. 10 and 11
Microcachryidites sp. (bisaccate and trisaccate forms); Plate 11, Fig. 12
Podocarpidites sp. A; Plate 11, Fig. 13
Podocarpidites sp. B; Plate 11, Fig. 14
Podocarpidites sp. C
Vitreisporites pallidus (Reissinger, 1950) Nilsson, 1958; Plate 11, Fig. 15
Angiospermous Pollen
Clavatipollenites hughesii Couper, 1958; Plate 11, Fig. 16
Clavatipollenites sp. 8 (sensu Dettmann, 1973, pl. 2, Figs 8-10); Plate 11, Fig. 17
Liliacidites sp.; Plate 11, Figs. 18 and 19
Nyssapollenites lanosus Dettmann, 1973; Plate 11, Fig. 20
Retimonocolpites peroreticulatus (Brenner, 1963) Doyle, 1975; Plate 11, Fig. 21
Tricolporopollenites sp. A; Plate 11, Fig. 22
Tricolporopollenites sp. B; Plate 11, Fig. 23
Plate 2. All magnifications at ×1000, unless otherwise noted. 1. Cribroperidinium muderongense. Sample 120-748C-79R-2, 60–63 cm; sl. S1, 40.3/93.2. 2. Eyrea nebula. Sample 120-748C-79R-2, 138–141 cm; sl. S2, 46.2/98.5. 3. Cleistosphaeridium sp. Sample 120-748C-63R-CC, 13–16 cm; sl. S2, 42.2/87.8. 4. Cribroperidinium edwardsii. Sample 120-748C-79R-2, 138–141 cm; sl. S4, ×500. 5. Diconodinium multispinum. Sample 120-748C-79R-2, 138–141 cm; sl. S4, 51.2/91.2. 6. Coronifera oceanica. Sample 120-748C-68R-1, 30–33 cm; sl. S3, 40.5/94.2. 7. Circulodinium distinctum. Sample 120-748C-71R-1, 65–68 cm; sl. S1, 46.2/88.
Plate 3. All magnifications at ×1000, unless otherwise noted. 1. Craspedodinium sp. Sample 120-748C-79R-2, 60–63 cm; sl. S1, 30.95.8. 2. Cyclonephelium sp. Sample 120-748C-62R-4, 115–117 cm; sl. S3, 39.597. 3. Florentinia radiculata. Sample 120-748C-76R-CC; sl. S3, 42.5/100. 4. Criboperidinium cooksoniae. Sample 120-748C-68R-1, 30–33 cm; sl. S3, 44.5/107; ×500. 5. Florentinia mantelli. Sample 120-748C-62R-4, 115–117 cm; sl. S3, 38.789.1. 6. Criboperidinium cooksoniae. Sample 120-748C-79R-2, 138–141 cm; sl. S4, 36.2/93; ×500. 7. Exochosphaeridium muelleri. Sample 120-748C-78R-CC, sl. S4, 35.5/89.5.
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Plate 4. All magnifications at ×1000, unless otherwise noted. 1. *Magrebinia membraniphora*. Sample 120-748C-79R-2, 138–141 cm; sl. S4; ×500. 2. *Kokansium polypo*. Sample 120-748C-78R-CC; sl. S1, 41.9/91.5. 3. *Isabelidinium belfastense*. Sample 120-748C-62R-6, 52–55 cm; sl. S1, 45.2/88.7. 4. *Maduradinium* sp. Sample 120-748C-64R-3, 78–81 cm; sl. S1, 39.9/1.5. 5. *Hystrixochidinium pulchrum*. Sample 120-748C-79R-2, 60–63 cm; sl. S1, 34.1/90. 6. *Microdinium setosum*. Sample 120-748C-79R-2, 138–141 cm; sl. S2, 32.5/92.5. 7. *Magrebinia membraniphora*. Sample 120-748C-73R-1, 57–60 cm; sl. S3, 39/96. 8. *Kleithriasphaeridium tubulosum*. Sample 120-748C-64R-1, 63–65 cm; sl. S2, 41.9/2.2; ×500.
Plate 6. All magnifications at ×1000, unless otherwise specified. 1. Tehamadinium sp. A Sample 120-748C-62R-6, 52–55 cm; sl. S3, 41.2/95.
2. Palaeohystrichophora infusorioides. Sample 120-748C-79R-2, 138–141 cm; sl. S3, 35.7/97.2. 3. Tehamadinium sp. A. Sample 120-748C-62R-6, 52–55 cm; sl. S2, 37.7/93. 4. Tehamadinium sp. A. Sample 120-748C-62R-6, 52–55 cm; sl. S1, 40/91.5. 5. Tehamadinium sp. A. Sample 120-748C-62R-6, 52–55 cm; sl. S2; 42/89.2. 6. Valensiella griphus. Sample 120-748C-79R-2, 138–141 cm; sl. 11; ×500.
Plate 11. All magnifications at ×1000.


3. Triletes tuberculiformis. Sample 120-748C-62R-6, 52–55 cm; sl. S1, 40/87.1.

4. Tuberculatosporites sp. Sample 120-748C-78R-CC; sl. S1, 42.5/99.2.

5. Megaspore. Sample 120-748C-78R-CC; sl. S1, 39/92.2.


7. Corollina sp. Sample 120-748C-62R-4, 115–117 cm; sl. S3, 45.5/93.5.

8. Cryptosporites sp. Sample 120-748C-77R-CC; sl. S1, 34/90.5.


10. Microchaeyridites parvus, the trisaccate form. Sample 120-748C-62R-4, 115–117 cm; sl. S3, 42.2/102.

11. Microchaeyridites parvus, the bisaccate form. Sample 120-748C-62R-6, 52–55 cm; sl. S1, 39/91.6.

12. Microchaeyridites sp., the bisaccate form (trisaccate form not shown). Sample 120-748C-62R-6, 52–55 cm; sl. S1, 39/91.6.

13. Podocarpidites sp. A. Sample 120-748C-75R-1, 58–61 cm; sl. S1, 43/88.9.


15. Vireisporites pallidus. Sample 120-748C-70R-1, 63–67 cm; sl. S3, 43/89.3.


17. Clavatipollenites sp. 8 (sensu Dettmann, 1973). Sample 120-748C-77R-CC; sl. S1, 42.5/90.5.

18. Liliacidites sp., mid-focus showing the pollen wall. Sample 120-748C-62R-4, 115–117 cm; sl. S1, 43/91.

19. Liliacidites sp., proximal focus showing the sulcus. Sample 120-748C-62R-4, 115–117 cm; sl. S1, 43/91.

20. Nyssapollenites lanosus. Sample 120-748C-76R-CC; sl. S1, 36.5/92.


22. Tricolporopollenites sp. A. Sample 120-748C-76R-CC; sl. S1, 40/99.

23. Tricolporopollenites sp. B. Sample 120-748C-79R-1, 55–58 cm; sl. S1, 38.2/98.5.