Early Cretaceous (Aptian–Albian) palynology of the Kabrit-1 borehole, onshore Northern Gulf of Suez, Egypt

Magdy S. Mahmoud1, Hassan A. Soliman1 and Amr S. Deaf2

1Assiut University, Faculty of Science, Geology Department, Assiut, 71516, Egypt.

2National Oceanography Centre, University of Southampton, Waterfront Campus, European Way, Southampton, SO14 3ZH, UK.

Abstract

Aptian and Albian palynofloras were extracted from a Lower Cretaceous succession penetrated by the Kabrit-1 borehole, northern Gulf of Suez. Representatives of Murospora and pollen such as Afropollis operculatus and A. zonatus are diagnostic of the Aptian palynoflora. Afropollis jardinus, Crybelosporites pannuceus spores and elaterate pollens such as Elaterosporites klaszii and E. verrucatus date the overlying succession as Albian and Upper Albian–Lower Cenomanian. Reyrea polymorphus and Cicatricosisporites sinuosus co-occur only in the Albian. The palynofloras are suggestive of shallow marine environment and warm humid palaeoclimate, as directly inferred from the nature and composition of the palynomorph content, which is dominated by pteridophytic spores, along with marine dinoflagellates. The occurrence of rich terrestrial influx of palynomorphs and palynodebris suggests proximity of the depositional sites to source vegetation. The vertical distribution of terrestrial versus marine palynomorphs cannot reflect contemporaneous regressive/ transgressive cycles during deposition of the different rock units. The Kabrit-1 palynoflora share general features of the Northern Gondwana province.

Keywords: Spores-pollen, Dinoflagellates, Biostratigraphy, Palaeoenvironment, Egypt
1. INTRODUCTION AND GEOLOGICAL SETTING

Much palynological work has been published on Cretaceous rocks of Egypt; most of the published articles described palynological assemblages from subsurface rocks at the Western Desert. This is in spite of very few palynological papers published on sections from the Eastern Desert in general and from the Gulf of Suez area in particular. In this work we present a palynological analysis of some Aptian-Albian subsurface rocks from the Kabrit-1 borehole, northern Gulf of Suez, aiming at better recognition of the characteristic Aptian-Albian palynofloral events in the local record.

In the studied borehole the following rock units were recognized by geologists of the original drilling company (Conoco, 1983):

1.1 Shaltut Formation (Ghorab et al., 1971)

This rock unit is given several synonymous names by different operators such as Alam El Bueib Formation, Matruh Group, Aptian clastics, Alamein shale, Dawabis, Umbarka, Mamura and some other operational units A, B, C, D1, D2, E, F1. The Shaltut Formation underlies the well-marked Alamein Formation. It is made up of shallow marine sandstone deposits, with continental influence toward the south, frequent shale interbeds in its lower part and occasional limestone beds in its upper part. The limestone beds become thicker and especially abundant in the northwest. The type locality is the interval 3927 to 4297 m of the Alam El Bueib-I well. This unit ranges in age from Barremian to Aptian, but in the investigated borehole it was given an Aptian age.

1.2 Alamein Formation (Ghorab et al., 1971)

This seemingly shallow marine unit, of low to moderate energy environment, is widespread and well-known all over North Africa and composed of light brown hard microcrystalline dolomite. Locally, few thin shale interbeds occur. The type section is the interval between 2489 to 2573 m of the Alamein-I well. Its thickness ranges from 20 to 80 m over most of the area except in the north where maximum thicknesses are reported in Kanayis-I (97 m) and Alamein E-I (92 m) boreholes. This unit ranges in age from Aptian to Albian in the type area. It is given an Aptian age by the drilling company.

Figure 1. Geographic map of northern Egypt showing location of the Kabrit-1 boreholes.
1.3 Kharita Formation (Ghorab et al., 1971)

The Kharita Formation is a marine unit composed of fine to coarse-grained sandstones with subordinate shale and carbonate interbeds. The type section is the interval between 2501 to 2890 m of the Kharita-I well. It ranges in age from Albian to Cenomanian. The Kharita Formation in the investigated borehole is given an Albian age.

1.4 Abu Roash Formation (Norton, 1967)

This predominantly carbonate succession, interbedded with shales and sandstones, is subdivided frequently into seven members, designated from bottom to top as: G, F, E, D, C, B and A. Although these operation names are famous none of them has been identified in the Kabrit-1 borehole. The type locality of this unit occurs in Abu Roash area to the north of Giza pyramids. The formation was believed to have been deposited in shallow (open) marine environment, except unit “G” that displays marginal (lagoonal) origin in the south. This unit reaches up to 1916 m in the WD-19-1 well in the Gindi basin. It ranges in age from Cenomanian to Turonian.

2. MATERIAL AND METHOD

18 cuttings samples were collected from the Kabrit 1-X well, which was drilled at Lat. 30° 12’ 17” N and Long. 32° 29’ 94’’ E, and penetrated the Lower Cretaceous succession at the Bitter Lake area (Fig. 1). Samples were prepared according to standard palynological techniques using HCl (47 %) and HF (58-62 %) to remove the carbonates and silicates, respectively. Samples were then sieved and the material greater than 10 lm was used in routine palynological analyses. Residues were not subjected to oxidation or through ultrasonic treatments. Palynomorphs were investigated using a Leica DM LB2 light microscope, equipped with a Leica DFC 280 digital camera. Samples and residues are stored in the Geological Museum, Geology Department, Assiut University.

3. TAXONOMIC REMARKS

For reference to taxa in this section see Jansonius and Hills (1976).

Genus Murospora Somers, 1952

Type species.- Murospora kosankei Somers 1952, p. 21, fig. 13 a.


1964. Asbeckiasporites Von Der Brelie, p. 141-142, pl. 8, figs. 7, 8; pl. 9, figs. 1-6.


Remarks.- Murospora spores are frequently misidentified in local records from Egypt as Matonisporites; the latter spores are not as large as Murospora. Murospora specimens in our material range in diameter between 70 to more than 120 microns and are patinate (mostly convex to slightly concave in outlines).

Murospora sp. 1
(Pl. 1, Figs. 1, 3, 5; Pl. 3, Figs. 1, 2, 3, 6, 9)

Remarks.- These grains are closely comparable with Murospora florida. They include varieties having triangular outlines with straight, slightly concave to slightly convex sides. El-Beialy (1995, pl. 84, fig. 13) identified Dictyophyllidites equiexinus, a specimen possessing relatively thick patinate? exine and seems to be very similar to Murospora sp. 1. He recorded Murospora sp., p. 665, fig. 2a, associating D. equiexinus at same horizons, at depths 7907 ft and 7892 ft, from the Aptian Alam El-Bueib Member, Razzak-1 borehole, but did not give photomicrographs.

Murospora sp. 2 (cf. Murospora florida)
(Pl. 2, Fig. 1; Pl. 3, Figs. 4–5, 7–8)
Plate 1. 1, 3. Murospora sp.1 (cf. M. florida), sample 4B, depth 5800 ft, 56.5/97.7, diameter 100 µm (1. proximal view, 3. distal view); 2, 4. Diagrammatic illustration of 1 and 3, showing details of spore. Shadowed areas indicate equatorial/distal patinate structure; white-dotted area shows spore exine; black-dotted area shows proximal margo; bold-black closed line shows outlines of envelope at the distal side of the spore; 5. Murospora sp.1 (= Dic-tyophyllidites equiexinus (Couper) Dettmann 1963 sensu El-Beialy 1995, p. 671, pl. 84, fig. 13), sample 1B, depth 6100 ft, 39/95, diameter 93 µm; 6. Diagrammatic illustration of 5, shadowed area shows spore exine. Distal outlines of the patinate structure can not be seen as in 2, 4 because patina covers the whole equatorial-distal area of the spore body.
Plate 2. 1. *Murospora* sp.; 2 (cf. *M. florida*), sample 4B, depth 5800 ft; 39/94; diameter 100 μm; 2. Diagrammatic illustration of 1. Shadowed area shows patinate structure. White dotted areas show the exine; 3, 5. *Murospora* sp.; 3. Sample 4B; depth 5800 ft; 14/105.4; diameter 98 μm; 5. Sample 4B; depth 5800 ft; 45/106; diameter 100 μm; 4. Diagrammatic illustration of 3. Shadowed area shows spore exine (interpretation of patinate structure as in plate 1, figs. 5, 6); 6. Diagrammatic illustration of 5. Note that the envelope (i.e. patinate structure) is not tightly connected with the exine. Patina does not cover the whole distal area, outline not clear.
Remarks.- Rounded triangular to semicircular contours and well-developed convex sides differentiate *Murospora* sp. 2 from *Murospora* sp. 1. They are also comparable with *Murospora florida* and with some species of *Patellaspores* Groot and Groot, 1962.

*Murospora* sp. 3  
(Pl. 2, Figs. 3, 5; Pl. 3, Figs. 11, 15–16)

Remarks.- These grains are different from *Murospora* sp. 1 and *Murospora* sp. 2 in having relatively thicker patinated structure and irregular outlines.

4. PALYNOCOGICAL AGE OF THE INVESTIGATED INTERVAL

Age assignment of the studied strata penetrated by the boreholes is based on diagnostic palynomorph taxa and their correlation with contemporaneous assemblages. Highest appearance data (HAD) of the index palynomorphs are integrated with lowest appearance data (LAD) of others to support interpretations. A summary of the biostratigraphic results is given in Figure 2 and Table 1.

Figure 2. Lithologic column and palynomorph ranges arranged by highest appearance of the Kabrit-1 borehole.
Table 1. Summary of important palynostratigraphic results in the Kabrit-1 borehole.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Depth (feet)</th>
<th>Important palynomorphs</th>
<th>Interpreted age</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 9</td>
<td>5550-5250</td>
<td><em>Afropollis jardinius</em> - <em>Elaterosporites klaszii</em> - <em>Retimonocolpites variiplicatus</em> - <em>Reyrea polymorphus</em></td>
<td>Albian</td>
</tr>
<tr>
<td>1 to 4</td>
<td>6100-5800</td>
<td><em>Afropollis perculatus</em> - <em>A. zonatus</em> - <em>Balmeisporites holodictyus</em> - <em>Reyrea polymorphus</em> - <em>Murospora</em> - <em>Palaeporidinium cretaceum</em></td>
<td>Albian</td>
</tr>
</tbody>
</table>

Figure 2. (continued) Lithologic column and palynomorph ranges arranged by highest appearance of the Kabrit-1 borehole.
4.1 Aptian (Shaltut Formation)

HAD of *Afropollis operculatus* and *A. zonatus* delineate the top of an interpreted Aptian interval in the borehole. *Murospora* and *Balmesporites holodictyus* spores, *Reyrea polymorphus* and *Palaeoperidinium cretaceum* dinoflagellate are significant Aptian/Albian elements in the regional palynofloras of Egypt (Omran et al., 1990; Mahmoud and Moawad, 1999, 2002).

4.2 Albian (Kharita Formation)

The base of this interval is drawn above the HAD of *Afropollis operculatus* and *A. zonatus*, which is consistent with the LAD of *Afropollis jardinus*. *Elaterosporites klaszii* is an important palynomorph, of possible gnetalean affinity (Dino et al., 1999), which enters the palynological records in Africa and South America during Albian (Herngreen and Dueñas-Jiménez, 1996). Other palynomorphs such as *Reyrea polymorphus* and *Cicatricosisporites sinuosus* terminate here and support an age not younger than Albian (Omran et al., 1990).

4.3 Upper Albian-lower Cenomanian? (Abu Roash Formation)

In middle to late Albian sections of West Africa such as Senegal, Ivory Coast and Gabon *Elaterosporites verrucatus* appears in a stratigraphic position above *Elaterosporites klaszii* (Jardiné, 1967; Herngreen and Dueñas-Jiménez, 1990). Schrank and Ibrahim (1995) defined their upper Albian-lower Cenomanian? interval on the basis of the lowest occurrence level of *E. verrucatus*. Few miospore species, which are known to range in the Cenomanian such as *Afropollis jardinus*, *Retimonocolpites variiplicatus* and *Microfoveolatosporits skottsbergii* occur in this interval. This biostratigraphic interpretation is supported by the presence of the dinoflagellates such as *Florentinia resex*, *Florentinia lacinia* and *Coronifera oceanica*, which are known to range from late Albian to early Cenomanian in North Africa (Below, 1984; Uwins and Batten, 1988; Schrank and Mahmoud, 1998).

5. PALAEOENVIRONMENT

5.1 Shaltut Formation (interval samples 1-4)

Dominating terrestrial organic matter of wood, tracheids and cuticles and abundant moderately diversified miospore association occur in samples 1 to 4 (Fig. 3). Dinoflagellates are found but in lower diversity. The miospore assemblage is dominated by pteridophytic spores such as *Deltoidospora* and *Triplanosporites* and other schizaeaceae like *Cicatricosisporites*, which probably reflect local pteridophytic vegetation, growing on wet biotopes (Schrank & Mahmoud, 1998) under warm subtropical conditions (Kedves, 1986). Few open marine skolochorate dinoflagellates (*Oligosphaeridium*, *Florentinia* and *Spiniferites*) occur in association with rare *Circulodinium*, *Subtilisphaera* and *Systematophora*, which are normally associated with marginal marine (brackish to coastal) conditions (Davey, 1970; Piasecki, 1984; Harding, 1986; Neo-Nygaard et al., 1987). The scarcity of microforaminiferal linings in this interval suggest shallow marine (inner shelf) conditions, as high concentrations of these chitinous inner linings are recorded in shallow waters (less than 7 meters deep), or waters of raised salinity (Stancliffe, 1989) or in deltaic deposits (Al-Ameri and Batten, 1997).

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Figure 3. Percentage frequency diagram of the palynomorph content of the Kabrit-1 borehole.

5.2 Kharita Formation (interval samples 5-9)

In the interval represented by samples 5 to 8, the occurrence of *Oligosphaeridium* with *Coronifera*, *Subtilisphaera*, *Circulodinium* and *Spini*eri*tes* along with microforaminiferal linings suggests deposition in coastal or shallow marine environment of stable (normal) salinity, which was sufficiently rich in nutrients to support a varied population of these dinocysts (Lister and Batten, 1988; Uwins and Batten, 1988). Because dinoflagellate cysts are diverse in shallow shelf deposits, their low relative abundances may be associated with either basinal or marginal marine settings, shallow marine environment may have prevailed. The occurrence of a large terrestrial influx of miospores and organic debris would suggest more inner-shelf setting and proximity to palaeoshoreline. The uppermost part of this unit, represented by sample 9, contains an acme of an *Oligosphaeridium*-dominated dinoflagellate association and other skolochorate cysts such as *Spini*eri*tes* and *Coronifera*, together with few *Subtilisphaera* and *Odontochitina*. This association is considered typical for open marine (middle shelf) environment (Dale, 1983). It is worthy noting that this unusual palynoflora of sample 9, with large numbers of few dinoflagellate species may also indicate near-shore, low salinity conditions. Occurrence of abundant fern spores, mainly of *Deltoidospora*, reflects existence of the previously inferred pteridophytic vegetation during deposition of the Kharita Formation. Influx of freshwater seems to be minimal, as could be inferred from scarcity of the freshwater algae like *Ovoidites* and *Chromotri*letes.

5.3 Abu Roash Formation (interval samples 10-11)

Samples 10 and 11 possess also rich wood and cuticle organic matter and poorly diversified dinoflagellate association, along with microforaminiferal linings. The low diversity assemblage of dinocysts may indicate brackish water conditions, since dinocyst species diversity is lower in stressed environment and water below normal marine salinity (Batten, 1983; Leckie and Singh, 1991). Occurrence of pollen and spores and rich terrestrial organic matter suggest normal marine environment but implies that the depositional sites were close to the land (e.g. Habib and Miller, 1989). The occurrence of *Oligosphaeridium*/*Coronifera*-dominated dinoflagellate association supports this interpretation.

6. CONCLUSIONS

Partly diverse and well preserved palynomorph association, mainly of spores, pollen and dinoflagellates are extracted from the Kabrit-1 borehole. The investigated sediments hosting these palynofloras are dated as Aptian/Albian to early Cenomanian and are interpreted to be deposited in a shallow marine environment under warm-humid palaeoclimate. *Murospora* representatives, *Afropollis* association and elaterospores are the key palynomorphs in the biostratigraphic analysis of the investigated interval of the Kabrit-1 borehole. So, *Murospora* and pollen such as *Afropollis operculatus* and *A. zonatus* are characteristic of the Aptian whereas *A. jardinus*, *Crybelosporites pannuceus* and elaterates such as *Elaterosporites klaszii* and *E. verrucatus* suggest an Albian and upper Albian-lower Cenomanian age. In the local records of Egypt *Murospora* seems to be restricted to sediments of Aptian age. The pteridophyte-dominated palynomorph association, occurrence of marine dinoflagellates and rich terrestrial influx suggest proximity.

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Plate 5. 1–2. *Micro*oveolatosporits *skottsbergii*: 1. Sample 5A, depth 5550 ft, 27.5/99.3, diameter 83 µm; 2. Sample 5A, depth 5550 ft, 52/105.2, diameter 85 µm; 3. *Cicatricosisporites* *brevia* *lae* *sus*, sample 2A, depth 6000 ft, 54.1/103, diameter 48 µm (smaller than holotype); 4. *Verrucosisporites* sp., sample 2A, depth 6000 ft, 45.5/97, diameter 35 µm; 5. *Cingulatipollenites* *ag* *i* *pti* *aca*, sample 4B, depth 5800 ft, 27.5/96, diameter 63 µm; 6. *Foraminisporis* sp., sample 5A, depth 5550 ft, 14.6/105.5, diameter 50 µm; 7. *Cicatricosisporites* *orb* *iculatus*, sample 4B, depth 5800 ft, 26.7/107.5, diameter 48 µm; 8, 12, 16. *Callialasporites* *infirmus*: 8. Sample 4B, depth 5800 ft, 44.5/107, diameter 50 µm; 12. Sample 7A, depth 5400 ft, 21/112, diameter 54 µm; 16. Sample 11B, depth 5000 ft, 61.2/99, diameter 48 µm; 9. *Clas* *sopollis* *torasus*, sample 2B, depth 6000 ft, 35/112, diameter 35 µm; 10. *In* *aperturopollenites* *undulatus*, sample 10B, depth 5200 ft, 36.5/105, diameter 63 µm; 11. cf. *Crybelosporites* sp., sample 4B, depth 5800 ft, 56.5/108.1, diameter 83 µm; 13. *Araucaria* *cites* sp., sample 8B, depth 5300 ft, 22/102, diameter 70 µm; 14. *Cicatricosisporites* *sinus* *sus*, sample 3B, depth 5850 ft, 27/102, diameter 45 µm; 15. *Crybelosporites* *pan* *nuceus*, sample 8B, depth 5300 ft, 29.8/105.7, diameter 77 µm; 17. *Eu* *cob*modites *t* *ro* *esd* *soni*, sample 11A, depth 5000 ft, 36.5/112, diameter 38 µm; 18. *Callialasporites* *micro* *va* *lu* *es*, sample 1B, depth 6100 ft, 33/106, diameter 60 µm; 19. *Elaterosporites* *verrucatus*, sample 10A, depth 5200 ft, 31.4/106.1, body diameter 52 µm; 20. *Elaterosporites* *klaszii*, sample 11B, depth 5000 ft, 15.7/99.8, diameter 35 µm.
Plate 5
of the depositional sites to palaeoshorelines. But, however, the vertical distribution of terrestrial versus marine palynomorphs does not reflect known regressive/transgressive cycles during deposition of the different rock units in the borehole investigated. On the basis of this palynological dating slight refinement to the original stratigraphy of the borehole is made. In spite of missing of the bisaccate pollen, the Kabrit-1 palynoflora is of Northern Gondwanan aspect.

7. ACKNOWLEDGEMENTS

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8. REFERENCES


Conoco 1983. *Final report and composite log of the Kabrit 1-X borehole (Oil Company)*.


APPENDIX 1: LIST OF SPECIES

**Spores**

- *Acanthotriletes* sp.
- *Aequitriradites spinulosus* (Cookson and Dettmann) Cookson and Dettmann, 1961, pl. 4, fig. 9.
- *Appendicisporites* sp.
- *Balmeisporites holodictyus* Cookson and Dettmann, 1958.
- *Cicatricosisporites brevilaesuratus* Couper emend. De Haan and Leereveld, 1987, pl. 5, fig. 3.
- *Cicatricosisporites sinuosus* Hunt, 1985, pl. 5, fig. 14.
- *Cicatricosisporites orbiculatus* Singh, 1964, pl. 5, fig. 7.
- *Cicatricosisporites* ssp.
- *Concavisporites* ssp., pl. 4, fig. 8.
- *Concavissimisporites punctatus* (Delcourt and Sprumont) Brenner, 1963, pl. 4, figs. 17, 18.
- *Crybelosporites pannuceus* (Brenner) Srivastava, 1977, pl. 5, fig. 15.
- cf. *Crybelosporites* sp. (Brenner) Srivastava, 1977, pl. 5, fig. 11.
- *Cyatheaceous spore*, pl. 4, fig. 13.
- *Deltoidospora* ssp., pl. 4, figs. 1-5, 7, 10, 20 (stratiographically insignificant smooth (sub)triangular spores preferably placed under the generic name *Deltoidospora* Miner, 1935 according to rules of priority.
- *Distriangularisporites* sp.
- cf. *Gleicheniidites* sp., pl. 4, figs. 11, 12.
- *Foraminisporis* sp., pl. 5, fig. 6.
- *Kyrtomisporis* ssp., pl. 3, fig. 13.
- *Leptolepidites* sp.
- *Matonisporites equiexinus* Couper, 1958, pl. 3, figs. 17, 18, 19, 20.
- *Matonisporites* ssp., pl. 4, fig. 6.
- *Microfoveolatosporis skottsbergii* (Selling) Srivastava, 1971, pl. 5, figs. 1, 2.
- *Microreticulatisporites* ssp., pl. 4, figs. 14, 15.
- *Murospora* ssp. 1 (cf. *M. florida* (Balme) Pocock, 1961), pl. 1, figs. 1, 3; pl. 3, figs. 1, 2, 3, 6, 9.
- *Murospora* ssp. 1 (= *Dictyophyllidites equiexinus* (Couper) Dettmann 1963 sensu El-Beialy 1995), pl. 1, fig. 5.
- *Murospora* ssp. 2 (cf. *M. florida* (Balme) Pocock, 1961), pl. 2, fig. 1; pl. 3, figs. 4, 5, 7, 8.
- *Murospora* ssp. 3, pl. 2, figs. 3, 5, pl. 3, figs. 11, 15, 16.
- *Osmundacidites wellmanii* Couper, 1953.
- *Pilosisporites* ssp.
- Trilobosporites laevigatus El-Beialy, 1994, pl. 4, figs. 16, 19.
- Verrucosisporites sp., pl. 5, fig. 4.
- Triplanosporites sp.

**Gymnosperm pollen**
- Araucariacites australis Cookson, 1947 ex Couper, 1953.
- Araucariaites sp., pl. 5, fig. 13.
- Balmeiopsis limbatus (Balme) Archangelsky, 1979, pl. 6, fig. 9.
- Bisaccate pollen
  - Callialasporites dampieri (Balme) Sukh Dev, 1961, pl. 6, fig. 13.
  - Callialasporites infirmus Mahmoud in Mahmoud and Schrank, 2003, pl. 5, figs. 8, 12, 16.
  - Callialasporites microvelatus Schulz, 1966, pl. 5, fig. 18.
- Cingulatipollenites aegyptiaca, Saad and Ghazaly, 1976, pl. 5, fig. 5.
- Classopollis classoides Pflug, 1953, pl. 6, fig. 15.
- Classopollis torosus (Reissinger) Balme, 1957, pl. 5, fig. 9.
- Cycadopites sp.
- Elaterosporites klaszii (Jardiné and Magloire) Jardiné, 1967, pl. 5, fig. 20.
- Ephedripites ovalis Muller, 1968 sensu Ibrahim, 2002, p. 129, pl. 8, fig. 4 (SEM), pl. 6, fig. 18.
- Elaterosporites verrucatus (Jardiné and Magloire) Jardiné, 1967, pl. 5, fig. 19.
- Ephedripites spp.
- Eucommiidites troedssonii Erdtman, 1948, pl. 5, fig. 17.
- Inaperturopollenites undulatus Weyland and Greifeld, 1953, pl. 5, fig. 10.
- Inaperturopollenites sp., pl. 6, fig. 4.
- Spheripollenites spp.
- Steevesipollenites sinuosus Azema and Boltenhagen, 1974

**Angiosperm pollen**
- Afropollis jardinus (Brenner) Doyle et al. 1982, pl. 6, figs. 5, 8.
- Afropollis operculatus Doyle et al. 1982, pl. 6, figs. 11, 17.
- Afropollis zonatus Doyle et al. 1982, pl. 6, figs. 3, 6.
- Afropollis sp.
- cf. Asteropollis asteroides Hedlund and Norris, 1968 sensu Burger, 1980, pl. 19, fig. 19; pl. 6, fig. 7.
- Clavatipollenites hughesi Couper, 1958.
- Monocolpopollenites sp., pl. 6, figs. 12, 19.
- Retimonicocolpites variplicatus Schrank and Mahmoud, 1998, pl. 6, fig. 10.
- Retimonicocolpites sp.
- Rousea cf. delicipollis Srivastava, 1977, pl. 6, fig. 2.
- Schrankipollis mawhoubensis (Schrank) Doyle, Hutton and Ward, 1990, pl. 6, fig. 14.
- cf. Schrankipollis mawhoubensis (Schrank) Doyle, Hutton and Ward, 1990, pl. 6, fig. 1.
- Stellatopollis barghoornii Doyle, 1975.
- Tricolpites spp. (sensu lato), pl. 6, fig. 16.

**Incertae Sedis**

**Dinoflagellate cysts**
- Coronifera oceanica Cookson and Eisenack, 1958.
- Coronifera tubulosa Cookson and Eisenack, 1974, pl. 7, figs. 5, 7.
- Coronifera sp.
- Circulodinium spp. (Deflandre and Cookson) Jansonius, 1986, pl. 7, figs. 15, 17.
- Cribroperidinium sp., pl. 7, fig. 12.
- Cribroperidinium orthoceras (Eisenack) Davey, 1969, pl. 7, fig. 16.
- Cyclonephelium brevispinatum (Millioud) Below, 1981.
- Cyclonephelium vannophorum Davey, 1969.
- Dinopterygium cladoides Deflandre, 1935, pl. 7, fig. 6.
- aff. Dinopterygium sp., pl. 7, fig. 13.
- Downiesphaeridium spinulastrum (Islam) Islam, 1993, pl. 7, fig. 18.
- Florentinia resex Davey and Verdier, 1976.
- Florentinia sp., Pl. 7, fig. 3.
- Odontochitina operculata (O. Wetzel) Deflandre and Cookson, 1955, pl. 7, fig. 9.
- Oligosphaeridium complex (White) Davey and Williams, 1966, pl. 7, fig. 1, 2.
- Oligosphaeridium pulcherrimum (Deflandre and Cookson) Davey and Williams, 1966.
- Palaeoperidinium cretaceum (Pocock) Lentin and Williams, 1976, pl. 7, fig. 10.
- Pseudoceratium securigerum (Davey and Verdier) Bint, 1986, pl. 7, fig. 19.
- Spiniferites multibrevis (Davey and Williams) Below, 1982.
- Spiniferites sp.
- Subtilisphaera sp., pl. 7, fig. 14.
- Systematophora penicillata (Ehrenberg) Sarjeant, 1980 pl. 7, fig. 8.
- aff. Systematophora sp., pl. 7, fig. 4