Palynological analysis of core (342.9' to 1037') from the U. S. Navy Umiat Test Well No. 11.

Received 29 October 1990

Total of 20 pages in report

Alaska Geologic Materials Center Data Report No. 177
Palynological analysis of core from the U. S. Navy Umiat Test well No. 11

GMC Data Report No. 177

Sample Code | Depth  
--- | ---  
U.A. | 342.9'  
U.B. | 345.5'  
U.C. | 392.3'  
U.D. | 462.5'  
U.E. | 546.2'  
U.F. | 547'  
U.G. | 561.2'  
U.H. | 709.6'  
U.I. | 716.4'  
U.J. | 723'  
U.K. | 762.5'  
U.L. | 778.5'  
U.M. | 1032'  
U.N. | 1037'
PALYNOLOGICAL ANALYSIS OF 14 OUTCROP SAMPLES
FROM THE CRETACEOUS OF ALASKA

Actually samples were from one of the U.S. Navy
UMIAT TEST WELL No. 11 SR

Report No. 90-0012
April 1990

Bujak Davies Group
Calgary, Alberta
PALYNOLOGICAL ANALYSIS OF 14 OUTCROP SAMPLES
FROM THE CRETACEOUS OF ALASKA

INTRODUCTION

This report discusses the results of palynological analyses of 14 outcrop samples from the Cretaceous of Alaska which were submitted to the Bujak Davies Group by James Talbot of ARCO Oil and Gas Co.

All of the samples were all processed at the Bujak Davies laboratories in Calgary. During palynological analysis, a kerogen slide, coarse fraction palynological slide (greater than 20 microns), and a fine fraction palynological slide (less than 20 microns) were examined to determine the relative abundances of the total reworked and in situ palynological assemblages in each sample.

Palynological zonal and age determinations of the samples mainly utilized index species of marine dinoflagellates plus the spores and pollen of terrestrial plants. Rare fungal palynomorphs observed in some samples represent taxa with long stratigraphic ranges, so that these specimens provided little information on the age of the samples.

The integrated Cenozoic-Mesozoic palynological zonation used for the biostratigraphic subdivision and age determinations of the 14 samples has not been published but is shown in Figure 1. This zonation has been developed in-house by the Bujak Davies Group and is generally consistent with that used by the Geological Survey of Canada and various petroleum exploration groups drilling in the Canadian Beaufort Sea and Alaskan North slope.

The zonation has been published in part by Norris (1986) for the Oligocene to Pleistocene based on his analysis of the Nuktak C-22 well, Canadian Beaufort Sea, but additionally utilizes the occurrences of marine Miocene dinoflagellates recognized through the use of fluorescence microscopy. The Cenozoic zonation is also partially based on earlier published work by Doerenkamp et al. (1976), Rouse (1977) and Staplin (1976) for the Paleogene section.

The Mesozoic palynological zonation used in the present study is primarily based on unpublished data from North Slope Alaskan surface and subsurface sections due to the scarcity of published Alaskan information, plus published and unpublished data from the adjacent Mackenzie Delta and other relevant Arctic regions.

Published data on the Jurassic are rare and include Brideaux (1977), Brideaux & Fisher (1976), and Davies (1979, 1983), plus the Northern Hemisphere Oxfordian and younger Miospore Atlas of the Bujak Davies Group (1986) which also discusses the Berriasian to Turonian section.

FORMAT

In the following report, the examined samples are listed in alphabetic order, with a discussion of the zonal/age justification, and the interpreted paleoenvironment based on palynology. Within each sample, all of the observed taxa are listed and are grouped into the following categories reflecting their affinities and habitats:

- marine dinoflagellates
- other algae
- terrestrial pollen and spores
- fungi

The following categories of relative abundances are denoted, with undenoted abundances representing a single observed specimen:

- Present: one specimen
- Rare: two to four specimens
- Few: five to 19 specimens
- Common: 20 to 49 specimens
- Abundant: more than 50 specimens
Figure 1. Bujak Davies Group Late Triassic to Pleistocene palynological zonation, Canadian Beaufort and Alaskan North Slope.
### BIOSTRATIGRAPHIC SUMMARY

<table>
<thead>
<tr>
<th>Sample</th>
<th>Age and Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.A. 347.9</td>
<td>Late Coniacian to early Santonian <em>Chatangiella verrucosa</em> Zone</td>
</tr>
<tr>
<td>U.B. 345.5</td>
<td>Late Turonian to early Coniacian <em>Eurydinium glomeratum</em> Zone</td>
</tr>
<tr>
<td>U.C. 392.3</td>
<td>Probable early to ?middle Albian <em>Vesperopsis mayi</em> Zone</td>
</tr>
<tr>
<td>U.D. 462.5</td>
<td>Aptian to early - ?middle Albian <em>Pseudoceratium regium</em> to <em>Vesperopsis mayi</em> Zone</td>
</tr>
<tr>
<td>U.E. 646.2</td>
<td>Middle Albian <em>Chlchaouadinium vestitum</em> Zone</td>
</tr>
<tr>
<td>U.F. 547.9</td>
<td>Probable early to ?middle Albian <em>Vesperopsis mayi</em> Zone</td>
</tr>
<tr>
<td>U.G. 561.2</td>
<td>Late Santonian <em>Chatangiella ditissima</em> Zone</td>
</tr>
<tr>
<td>U.H. 701.4</td>
<td>Late Turonian to early Coniacian <em>Eurydinium glomeratum</em> Zone</td>
</tr>
<tr>
<td>U.I. 714.4</td>
<td>Early Turonian <em>Isabelidinium magnum</em> Zone</td>
</tr>
<tr>
<td>U.J. 723</td>
<td>Early Turonian <em>Isabelidinium magnum</em> Zone with Cenomanian to Albian reworking</td>
</tr>
<tr>
<td>U.K. 767.6</td>
<td>Late Aptian or older <em>Oligosphaeridium asterigerum</em> Zone, or possibly as old as early Aptian</td>
</tr>
<tr>
<td>U.L. 778.5</td>
<td>Early to ?middle Albian <em>Vesperopsis mayi</em> Zone</td>
</tr>
<tr>
<td>U.M. 1032</td>
<td>Probable middle to late Albian <em>Chlchaouadinium vestitterum</em> to <em>Chlchaouadinium davidil</em> Zones</td>
</tr>
<tr>
<td>U.N. 1037</td>
<td>Either (1) early to ?middle Albian <em>Vesperopsis mayi</em> Zone or (2) Turonian <em>Eurydinium glomeratum</em> Zone with Albian reworking.</td>
</tr>
</tbody>
</table>
**PALYNOLOGICAL ASSEMBLAGE DESCRIPTIONS**

Unless otherwise noted, single specimens were observed.

(+ ) indicates a marker species.

### 1: Sample designation: U.B. outcrop

**Age & Zone**
late Coniacian to early Santonian Chatangiella verrucosa Zone

**Dinoflagellates**
- *Astrocystra cretacea* (Abundant)
- *Canningia collervæ* (Common)
- *Chatangiella scheri* (+) (Rare)
- *Chatangiella sp. 1, Bujak 1985* (+) (Common)
- *Chatangiella sp. 2, Bujak 1985* (+) (Common)
- *Chatangiella verrucosa* (+) (Rare)
- *Ginginodinium omatum* (+) (Common)
- *Isabelidinium magnun* (Common)
- *Laciniodinium biconiculatum* (+) (Rare)
- *Pseudoceratoides sp. 1, Bujak 1985* (+)
- *Spinilidinium sverdriplanum* (+) (Common)
- *Trithyrodinium suspectum* (+) (Common)

**Other Algae**
- No taxa observed.

**Pollen**
- *Allsporites spp.* (Abundant)
- *Taxodiaceae pollenites hiatus* (Abundant)

**Fern and Moss Spores**
- *Camarozonosporites insignis*
- *Cicatricostporites mohloides*
- *Cycadioidites australis* (Abundant)
- *Cycadioidites minor* (Common)
- *Gleicheniidites minor*
- *Gleicheniidites senonicus* (Rare)
- *Laevigatosporites ovatus* (Common)
- *Lycopodiumsporites australisclavatidites*
- *Lycopodiumsporites marginatus*

**Fungal Spores**
- No taxa observed.

**Reworked Palynomorphs**
- *Densosporites spp.*

**Paleoenvironment**
- Neritic marine

**Comments**
Dinoflagellates are abundant in this sample, including several species whose association indicated assignment to the *Chatangiella verrucosa* Zone.

Miospores are also abundant, with all of the observed taxa being fairly long-ranging stratigraphically. Their association with abundant marine dinoflagellates reflects a neritic marine environment with the common input of terrestrial material to the depositional site.

### 2: Sample designation: U.B. outcrop

**Age & Zone**
late Turonian to early Coniacian Euryalium glomeratum Zone

**Dinoflagellates**
- *Astrocystra cretacea*
- Gen. et sp. Indet. 1, Bujak 1985 (+) (Common)
- *Nelsonilella aceras sensu* McIntyre 1974 (+)

**Other Algae**
- No taxa observed.
### Pollen

- *Allsporites spp.* (Common)
- *Taxodiaceae pollenites hiatus* (Rare)

### Fern and Moss Spores

- *Cyathidites australis* (Abundant)
- *Cyathidites minor* (Abundant)
- *Gleicheniidites minor*
- *Laevigatosporites ovatus* (Rare)
- *Cernuacladites weillmannii* (Rare)
- *Stereisporites antiquasporites* (Rare)
- *Stereisporites minor*

### Fungal Spores

- *Pluricellaeasporites spp.* (Rare)

### Reworked Palynomorphs

- No taxa observed.

### Paleoenviromnet

Stressed marine

### Comments

Dinoflagellates are rare in this sample and have low diversity, but the taxa that occur indicate assignment to the *E. glomeratum* Zone and a stressed marine depositional environment. Miospores are more common, with rare fungal spores also being observed.

### Sample designation: U.C. outcrop

**Age & Zone**

Probable early to middle Albian, *Vesperopsis mayii* Zone

**Dinoflagellates**

- *Ctenidodinium #ES, Banerjee & Davies '88 (+)

**Other Algae**

- *Schizocysta parvus* (Common)

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### Pollen

- *Allsporites spp.* (Rare)
- *Araucariacites austails*
- *Cycadopites spp.*
- *Ephedrites costiferus (+)*
- *Parvicosigites amplius (+)*
- *Phyllocladites inchoatus (+) (Rare)*
- *Taxodiaceae pollenites hiatus* (Abundant)
- *Vitreisporites paludis*

### Fern and Moss Spores

- *Cicatricosisporites #EF (+)*
- *Cicatricosisporites cocononlensis (+) (Rare)*
- *Cyathidites minor* (Rare)
- *Gleicheniidites senonicus*
- *Laevigatosporites ovatus*
- *Lycopodiumsporites austroclavioidites*
- *Cernuacladites weillmannii* (Dominant)
- *Stereisporites antiquasporites* (Rare)

### Fungal Spores

- *Pluricellaeasporites spp.*

### Paleoenvironment:

Paralic to marginally marine with euryhaline conditions.

### Comments

Dinoflagellates are rare consisting of opportunistic species. Euryhaline algal cysts are common. The miospores are abundant with high-domiance in gymnospermous pollen and generalized fern spores.

The sample lacks the primary zonal marker species of the *Vesperopsis mayii* Zone but it contains several species that can be related to the terrigenous miospore zonation (Subzones 11A-8) of equivalent age proposed by the Bujak Davies Group (1986) for the North America and Europe. *Ctenidodinium sp. S* of Banerjee and Davies (1986) is known from the Barremian to Albian Mannville Formation of Western Canada.
### 4: Sample designation: U.D. outcrop

**Age & Zone**

Aptian to early - middle Albian Pseudoceratium reglum to Vesperopsis may Zone

**Dinoflagellates**

- *Ctenidodinium* sp. Banerjee & Davies '88 (+)
- *Luxadinium* sp. indet.

**Other Algae**

- Concentricystis minor
- Schizocystis parvus (Rare)

**Pollen**

- *Alisporites* spp. (Rare)
- *Cedrerpites canadensis*
- Larchoidites magnus (Rare)
- *Parvisaccites* amplus (+) (Fragments)
- *Perinopoleites* elatoloides
- Taxodiaceae pollenites hiatus (Common)

**Fern and Moss Spores**

- *Cystidiolites australis* (Common)
- *Cystidiolites minor* (Common)
- Densosporites microreticulatus
- *Gleicheniidites senonicus*
- *Laevigatosporites ovatus* (Rare)
- *Lycopodiumsporites auctocavitidites*
- *Osmundacidites wellmannii* (Abundant)
- Stereisporites antiquasporites (Rare)

**Fungal Spores**

- Multiellipseaerisporites spp.

**Paleoenvironment:**

Paralic to marginally marine with euryhaline conditions.

**Comments**

Dinoflagellates are rare consisting of opportunistic species. Euryhaline algal cysts are common. The spores are abundant with high-dominance in gymnospermous pollen and generalized fern spores.

The sample lacks the primary zonal marker species Alaskan North Slope - Beaufort palynological zonation but it contains a few species that can be related to the teregetious miospore zonation (Zones 10-11) of Aptian to Albian age proposed by the Buikak Davies Group (1986) for the North America and Europe. *Ctenidodinium* sp. S of Banerjee and Davies (1988) is known from the Barremian to Albian Mannville Formation of Western Canada.

### 5: Sample designation: U.E. outcrop

**Age & Zone**

middle Albian *Chlchaouadinium vestitum* Zone

**Dinoflagellates**

- Astrocystra cretacea (Common)
- *Chlchaouadinium* #EA (+)
- *Chlchaouadinium vestitum* (+)
- *Cleistosphaeridium huginoluti* (+)
- *Ctenidodinium* ES, Banerjee & Davies '88
- *Cyclonephelium distinctum*
- *Luxadinium propagatum* (+) (Rare)
- *Maghrebina cingularata* (+) (Rare)
- *Odontochitina operculata* (Rare)
- *Spiniferites ramosus*
- *Stilphrosphaeridium anthophorum* (+)

**Other Algae**

- Concentricystis sp. A
- Schizocystis parvus

**Pollen**

- *Alisporites* spp. (Rare)
- *Cedrerpites canadensis* (Rare)
- *Parvisaccites* amplus (+) (Rare)
- *Perinopoleites* elatoloides
- *Podocarpidites potomacensis* (Rare)
- *Taxodiaceae pollenites hiatus* (Abundant)
- *Vitreisporites pallidus* (Rare)

**Fern and Moss Spores**

- *Chytridiophytae rupeserrorum* (Common)
- *Cicatricosisporites delicatus* (Common)
- *Cicatricosisporites mohrioides*
- *Cicatricosisporites problematicus*
- *Cicatricosisporites subafricosus* (Rare)
- *Densosporites microrugulatus*
Gleicheniidites senonicus
Laeivagatosporites ovatus
Leiotriletes mecklenburgensis
Leptolepidites verrucosus
Osmundacitites wellmannii (Common)
Rouselsporites simplex (Rare)
Stereisporites antiquasporites (Abundant)

Paleoenvironment:
Marginally marine

Comments:
Dinoflagellates are common consisting of high tolerance marine species. Euryhaline algal cysts are rare. The miospores are abundant with high-dominance in gymnosperous pollen and generalized fern spores.

The presence of C.vestitum, L.propatatum, C.huguolettii, M.cingulata, C.delicatus and C.subrotundus is indicative of the middle Albian C.vestitum Zone.

6: Sample designation: U.F. outcrop

Age & Zone
probable early to ? middle Albian Vesperops mayi Zone

Dinoflagellates
Astrocystra cretacea

Other Algae
No taxa present

Pollen
Allisporites spp. (Common)
Araucariaceae austals
Cedrites canadensis
Cerebropollenites mesozolcus (Rare)
Parvisaccites rugatus (+)
Parvisaccites amplius (+) (Common)
Phyllocladites inchoatus (+)
Taxodiaceae pollenites hirtus (Abundant)
Vitreisporites pallicus (Rare)

Fern and Moss Spores
Acanthotriletes variispinosum (+)
Cicatricosporites JEF (+) (Rare)
Cicatricosporites annulatus (+) (Rare)
Cyathidites australis
Gleicheniidites senonicus (Rare)
Intertubis triangularis (+) (Rare)
Laeivagatosporites ovatus (Common)
Lycopodiumsporites austrocavitidites (Rare)
Lycopodiumsporites marginatus
Osmandacitites wellmannii (Common)
Rouselsporites simplex (+)
Stereisporites antiquasporites (Common)

Fungal Spores
Pluricelaeasporites spp.

Paleoenvironment:
paralic

Comments:
Dinoflagellates are very rare consisting of a single opportunistic species. The miospores are abundant with high-dominance in gymnosperous pollen and generalized fern spores.

The sample lacks the primary zonal marker species of the Vesperops mayi Zone but it contains a several species that can be related to the terrigenous miospore zonation (Subzones 11A-8 and possibly older) of equivalent age proposed by the Bujak Davies Group (1986) for the North America and Europe. Cheniiodinium sp. S of Banerjee and Davies (1988) is known from the Barremian to Albian Mannville Formation of Western Canada.

7: Sample designation: U.G. outcrop

Age & Zone
late Santonian Chatangella dittissa Zone

Dinoflagellates
Astrocystra cretacea
Callalosphaeridium asymmetricum (+)
Chatangella sp. 1, Bujak 1985 (+) (Common)
Reworked Palynomorphs

Densosporites spp.

Paleoenvironment

neritic marine

Comments

Dinoflagellates are abundant and diverse in this sample, with most taxa indicating assignment to the C. dlflissima Zone. One exception is a tentatively identified specimen of Isabelidinium amphiatum which, if correctly identified, would indicate an age no older than the early Campanian Chatangellia coronata Zone. However, the poorly preserved specimen may represent Isabelidinium amphiatum which occurs in the C. dlflissima Zone.

Miospores are also common to abundant in this sample and include common water-transported fern spores.

Age \\nlate Turonian to early Coniacian Eurydinum glomeratum Zone

Dinoflagellates

Chlamydophorella navel
Cleistosphaeridium acicular (Rare)
Cribroperidinium sp., McIntyre 1974 (Common)
Cyclonephelium distinctum (Common)
Dorocysta latitax (Rare)
Exochosphaeridium bitidum (Common)
Florentinla cooksoniae
Florentinla mantelli
Ginginodinium ornatum (+) (Rare)
Hystrichodinium pulchrum (Rare)
Hystrichosphaeridium difficile (+) (Abundant)
Hystrichosphaeropsis sp., McIntyre '74 (Common)
Isabelidinium amphiatum (Questionably present)
Isabelidinium magnum (Common)
Lacinaadinium biconiculatum (+)
Lacinaadinium orbiculatum (+) (Rare)
Odontochilina costata (Rare)
Odontochilina operculata (Common)
Oligosphaeridium complex (Common)
Oligosphaeridium pulcherrimum (+)
Pseudocecotrium sp., McIntyre 1974 (Rare)
Pteradinium sp., 1 McIntyre 1974
Spiniferites cingulatus (Rare)
Spiniferites ramosus sensu lato
Tethyrodinium suspectum (+) (Common)
Xenascus ceratoides

Other Algae

Micrhystridium fragile (Common)

Pollen

Alisporites spp. (Abundant)
Taxodiceapollenites hiatus (Abundant)

Fern and Moss Spores

Cicatricosisporites delicatus
Converrucosporites exquisitus
Cyathidites australis (Common)
Cyathidites minor (Common)
Laevgatosporites ovatus (Common)
Lycoptpusporites australiavidites
Osmundacladites wellmannii (Common)
Sterisporites antiquasporites (Rare)
Sterisporites minor (Rare)

Fungal Spores

Pluricellalesporites spp.

Chlamydophorella navel
Cleistosphaeridium acicular (Rare)
Cribroperidinium sp., McIntyre 1974 (Common)
Cyclonephelium distinctum (Common)
Dorocysta latitax (Rare)
Exochosphaeridium bitidum (Common)
Florentinla cooksoniae
Florentinla mantelli
Ginginodinium ornatum (+) (Rare)
Hystrichodinium pulchrum (Rare)
Hystrichosphaeridium difficile (+) (Abundant)
Hystrichosphaeropsis sp., McIntyre '74 (Common)
Isabelidinium amphiatum (Questionably present)
Isabelidinium magnum (Common)
Lacinaadinium biconiculatum (+)
Lacinaadinium orbiculatum (+) (Rare)
Odontochilina costata (Rare)
Odontochilina operculata (Common)
Oligosphaeridium complex (Common)
Oligosphaeridium pulcherrimum (+)
Pseudocecotrium sp., McIntyre 1974 (Rare)
Pteradinium sp., 1 McIntyre 1974
Spiniferites cingulatus (Rare)
Spiniferites ramosus sensu lato
Tethyrodinium suspectum (+) (Common)
Xenascus ceratoides

Other Algae

Micrhystridium fragile (Common)

Pollen

Alisporites spp. (Abundant)
Taxodiceapollenites hiatus (Abundant)
### Fem and Moss Spores

<table>
<thead>
<tr>
<th>Spore Type</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthotritites varispinosus</td>
<td>Rare</td>
</tr>
<tr>
<td>Camarozonosporites insignis</td>
<td>Rare</td>
</tr>
<tr>
<td>Cyathidites australis (Common)</td>
<td>Common</td>
</tr>
<tr>
<td>Cyathidites minor (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Giselchenidites minor</td>
<td>Rare</td>
</tr>
<tr>
<td>Laevigatosporites ovatus (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Lycopodiumsporites austroclavifidites</td>
<td>Common</td>
</tr>
<tr>
<td>Osmundacidites wellmannii (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Stereisporites antiquosporites (Common)</td>
<td>Common</td>
</tr>
<tr>
<td>Stereisporites minor</td>
<td>Rare</td>
</tr>
</tbody>
</table>

### Fungal Spores

<table>
<thead>
<tr>
<th>Fungal Spore</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pluricellalesporites spp.</td>
<td>Rare</td>
</tr>
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</table>

### Reworked Palynomorphs

<table>
<thead>
<tr>
<th>Palynomorph</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muderongla asymmetica</td>
<td>Rare</td>
</tr>
</tbody>
</table>

### Paleoenvironment

- Stressed marine

### Comments

Dinoflagellates are rare in this sample, but the population that occurs is a high-dominance assemblage indicating a stressed marine environment. Miospores including water-transported fem spores are more common, reflecting some input of terrigenous material to the depositional site, and this is supported by the presence of rare fungal spores.

The rare marine dinoflagellates that occur indicate assignment to the late Turolian to early Coniacian Eurydinium glomeraatum Zone.

### Age & Zone

- Early Turolian Isabellidinium magnun Zone

### Dinoflagellates

<table>
<thead>
<tr>
<th>Spore Type</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrocysta cretacea (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Cleistosphaeridium acicularae (Common)</td>
<td>Common</td>
</tr>
<tr>
<td>Cyclonephelium distintum (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Dorocysta lithotes (+)</td>
<td>Rare</td>
</tr>
<tr>
<td>Exochnophydatides bifidum</td>
<td>Rare</td>
</tr>
<tr>
<td>Gen. et sp. indet. 1, Bujak 1985 (+) (Rare)</td>
<td>Rare</td>
</tr>
</tbody>
</table>

### Other Algae

<table>
<thead>
<tr>
<th>Algae</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micrhystridium fragile</td>
<td>Rare</td>
</tr>
<tr>
<td>Palamagges spp. (Rare)</td>
<td>Rare</td>
</tr>
</tbody>
</table>

### Pollen

<table>
<thead>
<tr>
<th>Pollen</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alisporites spp. (Abundant)</td>
<td>Abundant</td>
</tr>
<tr>
<td>Taxodiaceae-pollenites hiatus (Abundant)</td>
<td>Abundant</td>
</tr>
</tbody>
</table>

### Fem and Moss Spores

<table>
<thead>
<tr>
<th>Spore Type</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthotritites varispinosus</td>
<td>Rare</td>
</tr>
<tr>
<td>Cleistosphaeridium acicularae</td>
<td>Rare</td>
</tr>
<tr>
<td>Cyathidites australis</td>
<td>Rare</td>
</tr>
<tr>
<td>Cyathidites minor</td>
<td>Rare</td>
</tr>
<tr>
<td>Foveostracites triangularis</td>
<td>Rare</td>
</tr>
<tr>
<td>Laevigatosporites ovatus (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Lycopodiumsporites austroclavifidites</td>
<td>Rare</td>
</tr>
<tr>
<td>Lycopodiumsporites marginatus</td>
<td>Rare</td>
</tr>
<tr>
<td>Osmundacidites wellmannii (Rare)</td>
<td>Rare</td>
</tr>
<tr>
<td>Stereisporites antiquosporites (Common)</td>
<td>Common</td>
</tr>
<tr>
<td>Stereisporites minor (Common)</td>
<td>Common</td>
</tr>
</tbody>
</table>

### Fungal Spores

- Pluricellalesporites spp.

### Reworked Palynomorphs

- No taxa observed.

### Paleoenvironment

- Nearshore marine
Comments

Dinoflagellates and water-transported fern spores are abundant in this sample, indicating a nearshore marine environment with the common input of terrigenous material to the depositional site. Fungal spores and euryhaline algae are also rare.

10: Sample designation: U. J. outcrop

Age & Zone

early Turonian Isabellidinium magnum Zone with Cenomanian to Albian reworking

Dinoflagellates

- *Astrocysta cretacea* (Rare)
- *Chatanglella* sp. 1, Bujak 1985 (+) (Rare)
- *Chlamydophorella nyel* (Rare)
- *Cleistosphaeridium aculare* (Rare)
- *Cyclonephelium distinctum* (Rare)
- *Gen. et sp. Indet. 1, Bujak 1985* (+) (Rare)
- *Hystrichosphaeridium difficile*
- *Isabellidinium magnum* (+) (Rare)
- *Laciniodinium biconiculatum* (Rare)
- *Odontochitina operculata* (Rare)
- *Oligosphaeridium macrotubulum* (Rare)
- *Spinifertites ramosus sensu lato* (Rare)
- *Tritthyrodinium suspectum* (+)

Other Algae

No taxa observed.

Pollen

- *Allsporites* spp. (Abundant)
- *Paraanipollenites confusus* (Questionably present)
- *Taxodiaceae* pollenites hifatus (Abundant)

Fern and Moss Spores

- *Acanthotriletes varispinosus* (Rare)
- *Aequitriradites* sp. (Questionably present)
- *Cladocerosporites hailei* (Rare)
- *Cladocerosporites moehlides* (Rare)
- *Cyathidites australis* (Common)
- *Cyathidites minor* (Rare)
- *Gleicheniidites minor* (Rare)
- *Gleicheniidites senonicus* (Rare)
- *Laevigatosporites ovatus* (Common)

Lycopodiumsporites austroclaviformites
Lycopodiumsporites marginatus
Osmundaccladites weilmannii (Abundant)
Sterelisporites antiquasporites (Common)
Sterelisporites minor (Abundant)
Sterelisporites regium (Rare)

Fungal Spores

No taxa observed.

Reworked Palynomorphs

- *Aequitriradites spinulosus*
- *Luxadinium propatum*
- *Oligosphaeridium asterigerum*
- *Parvisaccites amplius*

Palaeoenvironment

nearshore marine

Comments

Dinoflagellates: rare to common
Miospores: common to abundant
Paleoenvironment: nearshore marine
Sample designation: U. J.
Zone: Isabellidinium magnum

Paleoenvironment:

nearshore marine

Comments

Dinoflagellates are rare to common and comprise marginal to open marine species, with water-transported fern spores being abundant. Euryhaline algal cysts are absent...

Most of the taxa that occur in this sample indicate assignment to the *Isabellidinium magnum* Zone, but Albian to Cenomanian dinoflagellates and gymnosperm pollen were also observed and are interpreted to be reworked, particularly due to the occurrence of the genus *Chatanglella*. A questionably identified poorly preserved specimen of the pollen *Paraanipollenites confusus* would indicate assignment to strata no older than Maastrichtian, providing the specimen were correctly identified. However, this interpretation would indicate that almost all of...
the other palynomorphs in the sample are reworked, and the preferred interpretation is that the sample should be assigned to the Isabellinum magnum Zone.

11: Sample designation: U.K. outcrop

Age & Zone

Late Aptian or older. Oligosphaeridium asterigerum Zone or possibly as old as Early Aptian.

Dinoflagellates

- Eryea nebuloosa (Rare)
- Porepentina cooksoniae (+)
- Luxadinum primatum (+) (Questionably present)
- Oligosphaeridium asterigerum (+) (Rare)
- Odontochitina operculata (corroded)
- Subtilisphaera sp. Indet. (Rare)
- Vesperopsis mayii (+)

Other Algae

No taxa observed.

Pollen

- Allspores spp. (Rare)
- Araucarites austals (Common)
- Cedrpidites canadensis (Abundant)
- Parvisaccites amplus (+) (Common)
- Phytochitites inchoatus (+)
- Plicatella tinctomata (+)
- Podocarpidites polomacensis
- Podocarpidites epistitius
- Taxodiaceaepollenites hiatus (Abundant)
- Vitrinopores palliatus

Fern and Moss Spores

- Acanthopites variispinosum (+)
- Calectosiospores delicatus (+)
- Calectosiospores polomacensis (+)
- Cyathidites australis
- Gleichenidites senoncus
- Interobites triangularis (+)
- Kukispores foecolatus
- Lycopodiumspores astocriovitidites
- Comunaxialites wellmannii (Rare)

Fungal Spores

No taxa observed.

Paleoenvironment:

Paralic to marginally marine

Comments

Dinoflagellates are rare consisting of primarily opportunistic species and the occasional marine species. Euryhaline algal cysts are absent. The miospores are abundant with high-dominance in gymnospermous pollen and generalized fern spores. Black coaly material is abundant.

The association of O. asterigerum, V. mayi, and L. primatum suggest assignment to the late Aptian Oligosphaeridium asterigerum Zone although most species range down further into the Aptian. The miospores are long-ranging indicating a Barremian to early Albian Age.

12: Sample designation: U.K. outcrop

Age & Zone

Early - ? middle Albian. Vesperopsis mayi Zone

Dinoflagellates

- Astrocytha cretacea (+) (Common)
- Cribroperidinium edwardsii (+)
- Ctenidodinium #ES. Banerjee & Davies '88 (+) (Rare)
- Stiphrosphaeridium anthophorum (+) (Questionably present)
- Subtilisphaera sp. Indet.
- Vesperopsis mayi (+) (questionably present)

Other Algae

- Schizocysta parva

Pollen

- Allspores spp. (Common)
- Araucarites austals (Common)
- Cedrpidites canadensis (Common)
- Parvisaccites amplus (+)
- Phytochitites inchoatus (+)
- Podocarpidites epistitius
- Ratitirochitites vulgare (+)
- Taxodiaceaepollenites hiatus (Abundant)
Fern and Moss Spores

Actinosporites excavatus (+)
Aequitrinitades spinulosus
Cicatricosisporites #EF (+)
Cyathidites australis (Common)
Gleicheniidites minor
Gleicheniidites senonicus (Rare)
Granulatisporites sp. A
Kukuiisporites foveolatus
Lycopodiumsporites austroclavatidites
Osmundacclidites wellmannii
Plicatella problematicus (+)
Podocarplaites epistriatus

Fungal Spores

No taxa observed.

Paleoenvironment:
Paralic to marginally marine

Comments
Dinoflagellates are rare consisting of primarily opportunistic species. Euryhaline algal cysts are rare. The miospores are abundant with high-dominance in gymnospermous pollen and generalized fern spores.

The association of 7V. mayii, Claniodinum sp. S. edwardsii, Cicatricosisporites #EF, P. amplus, P. problematicus and R. vulgaris suggests an assignment to the early to middle Albian Vesperopsis mayii Zone.

13: Sample designation: U.M. outcrop

Age & Zone
probable middle to late Albian, Chichaouadlnium vestitum to Chichaouadlnium davidi Zones

Dinoflagellates

Achnomophaera sp. indet.
Astrocystra cretacea
Calliosphaeridium asymmetricum (+)
Canningia colliveri
Chichaouadlnium sp. indet. (+)

Eyreopsis nebulosa
Eurydinium glomeratum (+) (Rare)
Fritea complicata (+)

Hystrichodinum pulchrum (+) (Rare)
Hystrichospheraidium difficile (Questionably present)
Imbatodinium jaegeri (+)
Luxadinium primulum (+) (Questionably present)
Luxadinium propatum (+) (Questionably present)
Maghribina cingulata (+)
Odontochitina operculata
Oligosphaeridium complex
Paleohystrichophora fusiformoides
Spiniferites sp. indet.

Other Algae
Schizocysta parvus

Pollen
Allisporites spp. (Common)
Parvisaccites amplus (+)
Taxodiaceae pollenites hiatus (Abundant)
Vitreisporites pallidus

Fern and Moss Spores

Acantholithites variispinus
Camaronozonosporites insignis
Cicatricosisporites annulatus (+)
Crybelisporites pannaceus (+)
Cyathidites australis (Common)
Distaltriangulisporites costatus (+) (Rare)
Leiofilites mecklenburgensis
Lycopodiumsporites austroclavatidites
Lycopodiumsporites marginatus
Osmundacclidites wellmannii (Rare)
Pilosporites crassangularis
Rousselisporites reticulatus
Steresporites antiquasporsites
Striamonoletes auritus (+)

Fungal Spores

No taxa observed.

Reworked Palynomorphs

Hymenozonosporites leptoplepidyphytes (Devonian)

Paleoenvironment:
Restricted marine with high freshwater influx.
Dinoflagellates are common consisting of primarily opportunistic euryhaline species along with a few rare open marine species. Euryhaline algal cysts are rare. The miospores are abundant with high-dominance in gymnospermous pollen and generalized fern spores.

The association of the dinoflagellates Chlcaouachinia sp., Eglomeratum, F.complicata, I.jaegeri, L.prilmum, L.propatulum, and M.cingulata along with the miospores C.annulatus, C.pannaceus, D.costatus and S.outitus indicates assignment to the middle to late Albian C.vestitum to C.davidii Zones.

14: Sample designation: U.N. outcrop

Age & Zone

either

(1) early to middle Albian Vesperopsis may Zone, or
(2) Turonian Euryaldinium glomeratum Zone with Cenomanian reworking

Dinoflagellates

Astrocystra cretacea
Cydonpohellum distinctum (Rare)
Gen. et sp. Indet. 1, Bujak 1985 (+) (Common)
Luxadinium primulm (?reworked)
Nelsonia acers sensu McIntyre 1974 (+) (Questionably present)
Spiniferites cingulatus
Spiniferites ramosus sensu lato (Rare)

Other Algae

No taxa observed.

Pollen

Allsporrites spp. (Common)
Parvisaccites amplus (Common)
Taxodiaceae pollenites liatus (Abundant)
Ulmipollenites undulosus (?contaminant)

Fern and Moss Spores

Acanthosetites varispinosus

Comments

No taxa observed.

Fungal Spores

No taxa observed.

Reworked Palynomorphs

Densosporites spp.

Paleoenvironment

stressed marine

Comments

Dinoflagellates are extremely rare in this sample and include species indicating assignment to the Euryaldinium glomeratum Zone. A single specimen of the dinoflagellate Luxadinium primulm would indicate the penetration of Cenomanian strata, providing the observed specimen were in place.

A specimen of the angiosperm pollen Ulmpollenites undulosus is interpreted to be a modern contaminant.
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