

**PALYNOLOGICAL ANALYSIS OF  
CARBONIFEROUS OUTCROP AND  
COREHOLE SAMPLES FROM THE  
NATMAP PROGRAM,  
1993 FIELD SEASON**

By

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ENCLOSURES



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## SECTION 2

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**SAMPLE:** K03PSG-93-1  
**Age:** Mid-Westphalian C to D

**Remarks**

This is an extremely rich and diverse assemblage typical of mid-Westphalian C and younger strata. The age is based on the presence of *Vestispora fenestrata*, *V. cf. irregularis*, *V. foveata*, abundant *Punctatosporites granifer* and modest numbers of *Torispora* spp. *V. foveata* is an essentially C-D species but occurs in the basal Stephanian of the Sydney Basin. The remainder of the assemblage comprises a "background assemblage" from the mid-C to Early Stephanian. No specifically D or Stephanian markers were recorded.

**SAMPLE:** K03PSG-93-2  
**Age:** Westphalian D to ?Early Stephanian

**Remarks**

Most of the spores and pollen from this rich sample characterise the mid-Westphalian C to Early Stephanian of Nova Scotia. The presence of *Mooreisporites inusitatus* is used to define the age. This species is part of a group which is usually found in the Westphalian D and Stephanian. Peppers (1985) considers this group to appear in the very latest C but Smith & Butterworth (1967) and Smith (1987) maintain that it is a Westphalian D event.

No Stephanian markers were found in this assemblage but they are present in one of two samples from this area submitted by Dr. Gibling.



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**SAMPLES:** K03PSG-93-3, 4A, 4B, 5  
**Age:** Latest Tournaisian  
**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

These assemblages are rich and resemble those in the 93FF-016, 021, 022 and 046 samples. They contain Tournaisian markers such as *Vallatisporites vallatus* and *Spelaeotriletes pretiosus* var. *pretiosus* along with an unusual *Vallatisporites* spp. complex. Also present are abundant *Auroraspora macra*, *Crassispora trychera* and *Retusotriletes incohatus*. The typically Windsor species *Densosporites columbaris* is present in 93-3, 4A and 5 suggesting that these assemblages are transitional between the Wilkie Brook and Windsor.

**SAMPLE:** K03PSG-93-08  
**Age:** ?Early Stephanian

**Remarks**

This is a rich sample but of limited composition dominated by extremely abundant *Lycospora* spp. There are several specimens of striate pollen present including *Illinites unicus*, *Striatopodocarpites* sp. and *Protohaploxylinus* spp. These numbers are unusually large for such a restricted, coal-swamp assemblage, especially since *Florinites* spp. are rare.

A similarly restricted assemblage from the same area collected by Dr. Gibling contained a striate pollen specimen which I consider to be Stephanian in age.

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**SAMPLES:** K04PSG-93-1, 2, 3, 4

**Age:** Namurian C to early Westphalian A

**Zone:** *S. arenaceus* - *Florinites* spp, Dolby (in prep).

**Remarks**

These four assemblages appear to cover the transition from the Late Namurian to the early Westphalian A. They all contain large numbers of *Potonieisporites* spp. and specimens of *Florinites visendus*. Samples 1, 3 and 4 also contain *Crassispora kosankei* and samples 2 and 3 contain *Spelaeotriletes arenaceus*. The first three indicate that the section is no older than Namurian and the latter no younger than early Westphalian A. Sample 4 yielded questionable specimens of *F. florinii* an essentially Westphalian species.

*F. florinii* appears approximately 360m above the base of the Boss Point Formation (sample J8) in the type section. The assemblages below that point are not dissimilar to samples 1-3 except that *Florinites visendus* are often smaller, approaching the range of *F. pumicosus*.

Neves & Belt (1971) did not record *Florinites* spp. nor *C. kosankei* from the Hastings-Pomquet sections of Namurian A-B age. In addition, their assemblages were dominated by the Windsor-Canso spore association.

It would appear that these samples are equivalent in age to the Claremont and lowermost Boss Point formations.

**SAMPLE:** F13PSG-93-1

**Age:** Early Westphalian A

**Zone:** *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

The preservation of this assemblage is similar to K04PSG-93-4. *Lycospora orbicula*, a Westphalian species is abundant and specimens of *Secarisporites* spp., *S. lobatus* and *Knoxisporites dissideus* indicate an age no younger than early Westphalian A.

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**SAMPLE:** F13PSG-93-2  
**Age:** Westphalian A, possibly late  
**Zone:** *C. mehtae* - *R. fulva micra*, Dolby (in prep.)

**Remarks**

This assemblage is rich but of limited composition and dominated by *Lycospora* spp. The presence of Spore type A indicates an age no younger than Westphalian A and a specimen of *Cannanoropollis* cf. *mehtae* indicates that it may be of late Westphalian A age.

**SAMPLE:** H93-13  
**Age:** Tournaisian  
**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

This sample contains Tournaisian species such as *Spelaetriletes pretiosus* var. *pretiosus* and *Vallatisporites vallatus*. *Crassispora trychera* is abundant indicating a Wilkie Brook equivalent age.

**SAMPLE:** H93-23  
**Age:** Tournaisian  
**Zone:** upper *S. cabotii*, Utting et al. (1989); 3B, Dolby (1991, 1993)

**Remarks**

The presence of *Vallatisporites ciliaris* indicates an age no older than mid-3B and *Schopfites augustus* indicates an age no younger than earliest Zone 4 (Cheverie equivalent). The abundance of the *V. verrucosus*-*V. vallatus* association favors a 3B age, equivalent to the uppermost Horton Bluff.

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**SAMPLE:** H93-85

**Age:** Latest Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

This sample contains a rich assemblage similar to those in K03PSG93-3, 4A, 4B, 5 and 93FF-016, 021, 022 and 046 and appears to be transitional between the Wilkie Brook and Windsor.

**SAMPLES:** H93-70, 123

**Age:** Tournaisian

**Zone:** *S. pretiosus*, Utting et al. (1989); 4, Dolby (1991, 1993)

**Remarks**

The age is based on the presence of small numbers of *Spelaeotriletes cabotii* and numerous *S. pretiosus* var. *pretiosus* and *Crassispora trychera* suggesting a Cheverie equivalent age.

**SAMPLES:** H93-133, 136

**Age:** Latest Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

Sample 133 yielded a restricted assemblage dominated by simple spores whereas 136 contained a more diverse assemblage. Both contain abundant *Crassispora trychera* and small numbers of *Spelaeotriletes pretiosus* var. *pretiosus*, *Vallatisporites vallatus* and *V. verrucosus* indicating a latest Tournaisian age. Sample 133 also yielded specimens of the *Vallatisporites* complex and sample 136 yielded specimens of *Densosporites columbaris* and *S. tuberosus* which suggest that the samples are of transitional Wilkie Brook-Windsor age similar to H93-85.

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**SAMPLE:** H93-151

**Age:** Tournaisian

**Zone:** Basal *S. cabotii*, Utting et al. (1989); 3A, Dolby (1991, 1993)

**Remarks**

*Spelaetriletes cabotii* is abundant which is typical of Horton Bluff assemblages. Rare specimens of *Verrucosisporites congestus*, *Crassispora* cf. *trychera* and *Vallatisporites galearis* indicate a transitional 2B-3A age. The specimens of *C.* cf. *trychera* favor a basal 3A age.

**SAMPLE:** H93-154

**Age:** Tournaisian

**Zone:** Upper *S. cabotii*, Utting et al. (1989); 3B, Dolby (1991, 1993)

**Remarks**

The *Vallatisporites vallatus*-*V. verrucosus* association is prominent and the presence of *V. ciliaris* and *Schopfites claviger* indicates a mid to upper 3B age.

**SAMPLE:** H93-162

**Age:** Latest Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

This assemblage is identical to those in K03PSG93-3, 4A, 4B, 5, 93FF016, 021, 022, 046 and H93-85 and appears to be transitional between the Wilkie Brook and Windsor.



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**SAMPLE:** H93-179

**Age:** Tournaisian

**Zone:** Upper *S. cabotii*, Utting et al. (1989); 3B, Dolby (1991, 1993)

**Remarks**

This sample is rich in the *Vallatisporites vallatus*-*V. verrucosus* association, typical of the Horton Bluff. The presence of *V. ciliaris*, *Schopfites claviger* and *Anapiculatisporites hystricosus* indicates a mid to upper 3B age.

**SAMPLE:** H10-002-93

**Age:** uncertain

**Remarks**

The presence of *Spelaeotriletes echinatus* indicates an age no younger than the AT Zone of the Windsor Group for the assemblage. The sample comes from the Shepody Formation which, in the Boss Point area, has yielded Namurian assemblages. No saccate fragments are present here and it is possible that the entire assemblage was reworked from the Windsor.

**SAMPLES:** H10-004-93B

**Age:** Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp, Dolby (in prep.)

**Remarks**

This assemblage closely resembles those from K04PSG93-1, 2 and 3 and are equivalent in age to the Claremont and lowermost Boss Point Formations.

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**SAMPLES:** H15-003-93E, F, B, C

**Age:** Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

These four samples are from the Noranda Demoiselle 93-5 corehole. Saccate pollen, especially *Florinites visendus*, form a significant proportion of the assemblages which indicates a strong Westphalian influence. However, no specifically Westphalian species were recorded. The samples are equivalent in age to the Claremont and lowermost Boss Point formations at Boss Point. They resemble samples K04PSG93-1, 2 and 3.

**SAMPLES:** H15-004-93A, B

**Age:** Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

These Boss Point samples from 300m and 100m above the formation base respectively, yielded poor assemblages of similar composition to the H15-003 samples (above). A questionable specimen of *Lycospora orbicula* in 93B suggests the possibility that the section may be of Westphalian A age at this point.

**SAMPLES:** H15-004-93D, E

**Age:** Namurian

**Remarks**

These samples come from near the top and from 20m above the base of the Shepody Formation respectively. The upper sample contains fragments of monosaccate pollen and the lower has specimens of *Crassispora kosankei* and *Spelaeotriletes* cf. *arenaceus* indicating an age no older than Namurian. Both contain numerous to abundant *Auroraspora macra*, *Crassispora trychera*, *Rugospora minuta*, *Retusotriletes incohatus* and *Schopfipollenites ellipsoides*, an association typical of the Canso Group. Reworked Tournaisian spores are also present.

Grossly similar assemblages were recovered from the Shepody Formation at Boss Point.

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**SAMPLES:** H15-006-93B, C2

**Age:** Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

These poor assemblages come from 40m and 65m above the base of the Boss Point Formation respectively and they are of similar composition to other Boss Point samples in this study. The presence of *Lycospora* cf. *orbicula* in the lower sample suggests the possibility that the section is of Westphalian rather than Namurian age, but this is extremely tentative.

**SAMPLE:** H16-002-93B

**Age:** probably Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp, Dolby (in prep.)

**Remarks**

This sample was taken at a position 6m above the base of the Boss Point Formation. Rare fragments of saccate pollen are present indicating an age no older than Namurian but, as in other basal Boss Point samples, including those from the type section, most of the assemblage consists of spores reworked from the Lower Carboniferous.



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## SECTION 3

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**SAMPLES:** UWR93-1, 3

**Age:** Namurian C - early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

These samples supposedly come from the Windsor but the assemblages in no way resemble those from rocks of that age in the Maritimes. Sample 93-1 consists almost entirely of *Lycospora pusilla* and *L. pellucida* with rare saccate fragments and *Potonieisporites* spp. Sample 93-3 is also dominated by *Lycospora* spp. but also contains *Crassispora kosankei*, *Florinites visendus*, *Potonieisporites* spp. and abundant *Schopfipollenites ellipsoides*.

These assemblages resemble those described from the basal Boss Point in this study.

The Scotch Village Formation in the Riverside Corner RC85-1 corehole was dated as mid-Westphalian C (Dolby, 1987, Report 86/10, 12). The slides and data were re-examined and the age down to 351m confirmed. The 410m sample is too poor to assign a precise age as only 24 palynomorphs were recorded.

**SAMPLE:** UWR93-2

**Age:** Viséan

**Zone:** NS-AT, Utting (1987)

**Remarks**

This assemblage is dominated by extremely abundant *Crassispora trychera*. Other typically Windsor species are present in small numbers. The presence of *Spelaeotriletes* cf. *tuberosus* suggests a correlation with the NS-AT zones. A more precise age cannot be assigned due to the lack of marker species.

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**SAMPLE:** BRK.RK93-5

**Age:** Viséan

**Remarks**

Spores are relatively rare in this sample. The assemblage consists of numerous *Rugospora minuta*, *Retusotriletes incohatus* with rare *Auroraspora macra* and *Crassispora trychera*. A Windsor age is indicated but there are insufficient data to assign the sample to a zone.

**SAMPLE:** COG R 93-1

**Age:** Namurian C to early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

This sample contains numerous specimens of *Lycospora pusilla* and *L. pellucida* with rare specimens of *Potonieisporites* sp., *Florinites visendus*, *Crassispora kosankei* and *Schopfipollenites ellipsoides*. Although not so rich, the assemblage resembles UWR93-3.

**COREHOLE:** STANLEY 93-1

**Interval:** 260.5'-565'

**Age:** Early Westphalian A

**Zone:** *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

Six of the eight samples submitted were productive and the assemblages resemble many of those from the Boss Point submitted for this study.

The presence of *Lycospora orbicula* in all the samples indicate an age no older than Westphalian. The numbers of large monosaccate pollen, including *Florinites visendus* s.s., and the lack of smaller species over the 289'-565' interval suggests a correlation with the lower part of the Boss Point Formation, i.e., the lower 360m in the type section. *F. florinii* is present at 260.5' and this appears approximately 360m above the base of the Boss Point at Joggins (sample J8). Also present at 260.5' is a specimen of *Spelaetriletes arenaceus* which confirms an age no younger than early Westphalian A.

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**COREHOLE: STANLEY 93-3**

**Interval:** 252'-309', Viséan, ?AT Zone, Utting (1987)

**Interval:** 423'-476.5', Viséan, NS Zone, Utting (1987)

**Remarks**

Of the 8 sample processed, 3 proved to be barren. The maturation level is quite high and in the 309' sample, the corrosion and pyrite damage to the spores is severe.

The age of the upper interval is based on the presence of a questionable specimen of *Knoxisporites triradiatus* at 309'. This assignment must remain tentative since, in the same sample, several poorly preserved specimens of the *Vallatisporites vallatus-verrucosus* complex suggest a correlation with the lower Windsor NS Zone. The 423' sample yielded few spores but the 476.5' assemblage is both rich and well preserved, if of limited composition. The presence of undoubted specimens of *V. verrucosus* in the lower sample indicates correlation with the NS Zone.

**SAMPLES: WSL93-1, 306.5', 399.4'**

**Age:** No older than Westphalian A

**Zone:** ?lower *S. arenaceus* - *Florinites* spp.

**Remarks**

Spores are relatively rare in the upper sample and the lower assemblage is extremely rich but of limited composition. The species lists are essentially similar.

*Lycospora* spp. are the predominant taxon and the presence of *L. orbicula* indicates an age no older than Westphalian for the samples. Saccate pollen are rare and belong to *Potonieisporites* spp. and *Florinites visendus* s.s.. These, with the lack of smaller species of *Florinites*, suggests a correlation with the lower 360m of the Boss Point Formation in the type section. However, this must remain tentative because of the limited composition of the assemblages.

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**SAMPLE:** C6210

**Age:** Probably Westphalian

**Remarks**

Spores are rare in this fusinite dominated sample. The presence of *Lycospora orbicula* indicates an age no older than Westphalian. There are no other spores or pollen present to assign a precise age.

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## SECTION 4

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**SAMPLES:** T2-09A, T7-2A, T3-9A, 1-001

**Age:** Indeterminable

**Remarks**

These samples yielded numerous spores which could not be indentified due to the high thermal maturity.

**SAMPLES:** T17-4B, T17-07, T-S

**Age:** Indeterminable

**Remarks**

Spores are rare in these samples and indeterminable due to the high degree of maturation.

**SAMPLE:** 4-005B

**Age:** Tournaisian

**Zone:** ?lower *D. distinctus*, Utting et al. (1989); 2A, Dolby (1991, 1993)

**Remarks**

Although spores are rare in this sample, specimens of *Vallatisporites vallatus* and *V. verrucosus* predominate. A specimen of *Cymbosporites* aff. *acutus* suggests a Zone 1 influence on an otherwise Horton Bluff assemblage.

**SAMPLES:** 5-10, 6-12, 7-7

**Age:** Indeterminable

**Remarks**

Barren samples.



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**SAMPLE:** 7-11 (810P)  
**Age:** probably Tournaisian

**Remarks**

Spores are extremely rare. A specimen of *Vallatisporites verrucosus* suggests that this is a Horton Group sample although the spore does range into the lower Windsor.

**SAMPLES:** 12-3A, 3B  
**Age:** Tournaisian  
**Zone:** ?lower *D. distinctus*, Utting et al. (1989); 2A, Dolby (1991, 1993)

**Remarks**

The thermal maturation level for both samples is quite high. *Vallatisporites verrucosus* is abundant in 3A with smaller numbers of *V. vallatus* and *Verrucosisporites nitidus*. A lower Horton Bluff age is tentatively assigned as for 4-005B. Sample 3B is less rich but is essentially similar.

**SAMPLES:** 18-35, 19-12, 22-2, 25-8A  
**Age:** Indeterminable

**Remarks**

These samples yielded inertinitic debris but no sporomorphs.

**SAMPLE:** 25-8B  
**Age:** Tournaisian  
**Zone:** ?1, Dolby (1991, 1993)

**Remarks**

Inertinitic debris predominates and spores are extremely rare. The presence of several specimens of *Spelaeotriletes crenulatus* suggests a possibly pre-Horton Bluff age equivalent (?Zone 1). This spore ranges to the top of the Tournaisian but tends to be more abundant in Zone 1.

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**SAMPLE:** 93HB-122

**Age:** Tournaisian

**Zone:** upper *S. cabotii*, Utting et al. (1989); 3B (mid-upper), Dolby (1991, 1993)

**Remarks**

This is a rich and diverse Horton Bluff assemblage characterised by abundant *Vallatisporites vallatus* and *V. verrucosus*. The presence of *V. ciliaris* and *Crassispora trychera* indicate an upper *S. cabotii* age.

**SAMPLE:** 93HB-188

**Age:** Tournaisian

**Zone:** *S. pretiosus*, Utting et al. (1989); 4, Dolby (1991, 1993)

**Remarks**

*Spelaeotriletes pretiosus* is numerous in this sample which is more typical of Cheverie equivalent assemblages. Rare specimens of *Vallatisporites ciliaris*, *Crassispora trychera* and questionable *Schopfites claviger* confirm that it is no older than the upper *S. cabotii* Zone, uppermost Horton Bluff equivalent.

**SAMPLE:** 93HB-191

**Age:** Tournaisian

**Zone:** *S. cabotii*, Utting et al. (1989); 3, Dolby (1991, 1993)

**Remarks**

*Vallatisporites vallatus* and *V. verrucosus* are the most numerous spores in this poor assemblage which also includes rare *Spelaeotriletes pretiosus* and *Crassispora trychera*. Although a *S. pretiosus* Zone age (4) cannot be ruled out, a *S. cabotii* age is more likely.

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**SAMPLES:** 93HB-219, 230

**Age:** Indeterminable

**Remarks**

Barren samples.

**SAMPLE:** 93HB-231

**Age:** Indeterminable

**Remarks**

Small, fusinitic residue only.

**SAMPLE:** 93HB-247

**Age:** Tournaisian

**Zone:** *V. vallatus*, Utting et al. (1989); 2-3, Dolby (1991, 1993)

**Remarks**

The thermal maturation level is high. *Vallatisporites verrucosus* and *V. vallatus* are the most numerous of the identifiable spores present, indicating a probable Horton Bluff equivalent age. The assemblage is too poor to be more precise.

**SAMPLE:** 93HB-363

**Age:** Tournaisian

**Zone:** upper *S. cabotii*, Utting et al. (1989); 3B (mid-upper), Dolby (1991, 1993)

**Remarks**

This is a rich and diverse assemblage in which *Vallatisporites vallatus* and *V. verrucosus* predominate. The presence of *V. ciliaris* and *Schopfites claviger* indicate an age no older than the upper *S. cabotii* Zone. Specimens of *S. augustus* and *Leiozonotriletes insignitus*



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indicate an age no younger than the lowermost *S. pretiosus* Zone. However, a specimen of *Anapiculatisporites* cf. *hystricosus* and the abundance of the *V. vallatus-verrucosus* group restrict the age to the upper *S. cabotii* Zone.

**SAMPLE:** 93HB-383

**Age:** Tournaisian

**Zone:** upper *S. cabotii*, Utting et al. (1989); 3B (mid-upper), Dolby (1991, 1993)

**Remarks**

This sample is rich in simple spores which is typical for the Horton Group. The presence of numerous *Spelaeotriletes cabotii*, *S. pretiosus*, *Vallatisporites vallatus* and *V. verrucosus* with *V. ciliaris* and *Anapiculatisporites hystricosus* indicates an upper *S. cabotii* Zone age, similar to 93HB-363.

**SAMPLE:** 93HB-625

**Age:** Indeterminable

**Remarks**

The residue consists of fusinitic debris with rare, unidentifiable sporomorphs.

**SAMPLES:** 93HB-748, 750

**Age:** Viséan

**Zone:** AT, Utting (1987)

**Remarks**

Both samples yielded rich, typically Windsor Group assemblages. The presence of *Schopfipollenites arcadiensis* in both samples indicates an age no older than the AT Zone. *Discernisporites barssii* and *Densosporites columbaris* in 748 and *Knoxisporites literatus* in 750 confine the age to the AT Zone.

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**SAMPLES:** 93LY-147, 151

**Age:** Indeterminable

**Remarks**

Residues consist of fusinitic debris and extremely rare, unidentifiable sporomorphs.

**SAMPLE:** 93LY-247A

**Age:** Tournaisian

**Zone:** *E. rotatus* - *H. explanatus* to *D. distinctus*, Utting et al. (1989); 1B-2, Dolby (1991, 1993)

**Remarks**

The yield from this sample was extremely low. A fragment of the aptly named *Dibolisporites distinctus* and a specimen of *Auroraspora macra* define the age.

**SAMPLE:** 93LY-247B

**Age:** Indeterminable

**Remarks**

A barren sample.

**SAMPLE:** 93LY-247C

**Age:** Tournaisian

**Zone:** upper *D. distinctus*, Utting et al. (1989); 2B, Dolby (1991, 1993)

**Remarks**

The abundance of *Spelaeotriletes cabotii* and the presence of *Dibolisporites distinctus* is typical of the *D. distinctus* Zone. Numerous specimens of *Retusotriletes avonensis* suggest that the sample comes from the upper part of the zone since this species is rare below 2B.

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**SAMPLE:** 93LY-292

**Age:** Indeterminable

**Remarks**

A barren sample.

**SAMPLE:** 93LY-316

**Age:** Namurian

**Remarks**

Palynomorphs are rare in this inertinitic residue. A fragment of a monosaccate pollen grain indicates an age no older than Namurian. The remainder of the assemblage is typical of the Windsor-Canso and acritarchs are quite numerous.

Given the poor quality, the entire assemblage may have been reworked. There is certainly evidence for reworking in the richer 93LY-531 sample.

**SAMPLE:** 93LY-531

**Age:** Namurian

**Remarks**

This is an extremely rich assemblage but the preservation is quite poor and pyrite damage is common.

Windsor-Canso spores are abundant but the presence of fragments of monosaccate pollen grains indicates an age no older than Namurian. There is evidence of reworking of Horton and possibly lower Windsor rocks. The sample is probably from the upper part of the Windsor-Canso Boundary Beds or from the Canso.

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**SAMPLE:** 93LY-540

**Age:** Namurian

**Remarks**

This sample yielded a rich and diverse assemblage of spores and pollen typical of the Windsor-Canso Boundary Beds and the Canso Group. The presence of a fragment of a saccate pollen grain and a spore specimen with strong affinities to *Ahrensia* favors a Namurian age similar to 93LY-531.

**SAMPLES:** 93FF-016, 021, 022, 046

**Age:** Latest Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

**Remarks**

These samples yielded rich spore assemblages which appear to be transitional in character between the Wilkie Brook and Lower Windsor. They contain numerous Tournaisian markers such as *Vallatisporites vallatus* and *Spelaeotriletes pretiosus* var. *pretiosus* as well as spores which have not been found below the Windsor such as *S. pretiosus* var. *windsorensis*, *Densosporites columbaris* and *Discernisporites barsii*. The 046 sample also contains a specimen of *Lycospora pusilla*. This usually characterises Viséan to Upper Carboniferous assemblages but, according to Clayton et al. (1977) it first appears in the latest Courcayan, latest Tn3.

The most noticeable feature of the assemblages is the presence of a complex of spores belonging to the genus *Vallatisporites*. Some approach *V. ciliaris* and others resemble *V. vallatus* but all have a cingulum which differs from those species.

The background assemblage is typical of the Wilkie Brook and Windsor Group. There is some evidence for reworking of the Horton Bluff rocks in the 046 sample.



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**SAMPLE:** 93FF-135

**Age:** Visean

**Remarks**

This is an unusual and distinctive assemblage with evidence of bacterial degradation. Of the identifiable spores, the *Auroraspora macra-Colatisporites decorus* complex is the most abundant. Also present are several specimens of *Lycospora pusilla* and rare specimens of *Spelaeotriletes* aff. *windsorensis*, *Rugospora minuta*, *R. polyptycha* and *Retusotriletes incohatus*. Although the spores indicate that the sample comes from the Windsor Group, there are insufficient data to assign it to one of the zones of Utting (1987).

Acritarchs are extremely abundant and belong to a single species of *Gorgonisphaeridium*.

The restricted spore assemblage with the monospecific acritarch assemblage indicate a restricted marine environment.

**SAMPLES:** 93FF-173, 182, 197

**Age:** Indeterminable

**Remarks**

Barren samples.

**SAMPLES:** 93FF-251, 279

**Age:** Visean

**Remarks**

Both samples are organic-rich but pyritization is severe. They contain abundant, simple acritarchs belonging to *Leiosphaeridia* sp. which indicate restricted marine conditions.

Sample 251 contains abundant *Crassispora trychera* and *Auroraspora macra* but no spores with more restricted ranges. Spores are extremely rare in 279 but the assemblage is similar to 251. The overall composition of the assemblages indicates that the samples are probably from the Windsor Group.

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**SAMPLE:** 93FF-279A  
**Age:** Late Visean  
**Zone:** SM, Utting (1987)

**Remarks**

This sample contains a typical Windsor-Canso spore assemblage and the presence of *Schulzospora plicata* indicates that it comes from the SM Zone. Utting (1987) recorded such assemblages from the lower part of the Windsor-Canso Boundary Beds of Late Visean Age.

*Lycospora pusilla* is unusually abundant in this sample.

**SAMPLES:** 93FF-279B, 331  
**Age:** Indeterminable

**Remarks**

Both samples yielded extremely small organic residues with few sporomorphs.

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## SECTION 5

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**COREHOLE:** SALT SPRINGS #1

**SAMPLES:** 1958.5', 1978'

**Age:** Viséan

**Zone:** NS, Utting (1987)

### Remarks

Only 2 of 14 samples from this corehole yielded spores. The assemblages are dominated by abundant *Crassispora trychera* with smaller numbers of *Retusotriletes incohatus*, *Rugospora minuta*, *Schopfites claviger* and *Auroraspora macra*. The assemblages are typical of the Windsor Group. A specimen of *Spelaeotriletes tuberosus* at 1978' indicates an age no younger than the AT Zone of Utting (1987) but the lack of AT Zone and younger markers and the presence of *Vallatisporites cf. vallatus* means that correlation with the lower zone is more appropriate.

**COREHOLE:** INTERNATIONAL MINERAL AND CHEMICAL CORP. #21

**SAMPLE:** 2563'

**Age:** Viséan

**Zone:** ?NS, Utting (1987)

### Remarks

This highly thermally mature assemblage is typical of the Windsor Group. *Crassispora trychera* and *Retusotriletes incohatus* are extremely abundant and other species such as *Rugospora minuta*, *Schopfites claviger* and *Auroraspora macra* are rare. There is no evidence of an age younger than the NS Zone but the assemblage composition is extremely restricted.

**COREHOLE:** URNEY 72-1

Eleven cuttings samples from the 1'-4450' interval were processed but the 7 from the section down to 2500' were barren.

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**SAMPLE:** 3070'

**Age:** Tournaisian

**Zone:** *Dibolisporites distinctus*, Utting et al. (1989); 2, Dolby (1991, 1993)

**Remarks**

The spores are highly corroded and heavily damaged by pyrite crystals. A specimen of *Dibolisporites distinctus* with abundant *Spelaeotriletes cabotii* define the age.

**SAMPLE:** 3590'

**Age:** Tournaisian

**Zone:** ?1C-D, Dolby (1991, 1993)

**Remarks**

Spores are rare in this sample. Species present include *Retusotriletes incohatus*, *Verrucosisporites* spp., *V. papulosus* and *Knoxisporites literatus*. The lack of Zone 2 markers suggests a Zone 1 age but the assemblage is very poor.

**SAMPLES:** 4080', 4450'

**Age:** Early Tournaisian, Tn1b

**Zone:** 1A, Dolby (1991, 1993)

**Remarks**

The spores in these assemblages are poorly preserved due to a high maturation level and severe pyrite damage. However, there are sufficient, identifiable spores to assign an age.

The presence of *Hystricosporites* sp. at 4080' and *Indotriradites (Hymenozonotriletes) explanatus* at 4450' indicate a lower Zone 1 age. The latter species suggests correlation with the *rotatus-explanatus* Zone of Utting but the presence of *Hystricosporites* indicates an age slightly older than this i.e., Zone 1A, equivalent to Tn1b.



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**SAMPLE:** GSC6858 (32564-03)

**Age:** ?Late Namurian to early Westphalian A

**Zone:** lower *S. arenaceous* - *Florinites* spp., Dolby (in prep.)

**Remarks**

This assemblage is dominated by extremely abundant Windsor-Canso spores. The presence of *Crassispora kosankei*, *Potonieisporites* spp. and *Florinites visendus* s.s. indicates a Namurian or younger age. However, there are no specifically Namurian species present and similar assemblages have been encountered, in this study, from the lower parts of the Boss Point Formation at several localities. At Joggins, similar spore-pollen associations are present in the lowermost 360m of the Boss Point.

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## SECTION 6

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### WELL: POLLETT RIVER #1

Twenty-three samples over the 300'-6750' interval were processed. Most were cuttings but 2 were core samples and of the total, 8 proved to be barren. The results are plotted on Enclosure \_\_. Three distinct assemblages are present from the Westphalian, Visean and Givetian respectively.

#### Succession

Interval	Age	Zone
300'-880'	Westphalian C, prob. mid to late	
1390'-2440'	Early Westphalian A to ?Late Namurian	
4880'-4960'	Visean	AT
6445'-6750'	Late Givetian	<i>optivus-triangulatus</i>

**INTERVAL:** 300'-880'

**Age:** Westphalian C, probably mid to late

#### Remarks

The assemblages from this interval are poor. The age is based on the presence of *Anapiculatisporites cf. minor*, *Punctatosporites granifer*, *P. minutus*, and questionable specimens of *Illinites unicus* and striate bisaccate pollen fragments. The assemblages are too poor to be more precise. Reworked Silurian acritarchs are present at 370' and 630'.

**INTERVAL:** 1390'-2440'

**Age:** Early Westphalian A to ?Late Namurian

#### Remarks

The 1390' and 1650' samples yielded poor assemblages of relatively long-ranging taxa. *Florinites visendus* s.s. dominates both assemblages and smaller species of this genus are

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absent. This suggests a correlation with the lower part of the Boss Point Formation. Extremely rare specimens of *Lycospora orbicula*, if *in situ*, indicate that the section is no older than Westphalian. The 2440' sample is extremely poor but contains *F. visendus*.

The lower part of the section is probably no older than Late Namurian but it must be emphasised that the recovery is poor and the palynomorphs may have come from cavings.

**INTERVAL:** 4880'-4960'  
**Age:** Viséan  
**Zone:** ?AT Zone, Utting (1987)

**Remarks**

*Crassispora trychera* is extremely abundant in these two samples. Other *in situ* spores are rare and Westphalian cavings contamination is prominent, especially at 4960'. The presence of what appear to be *in situ* specimens of *Knoxisporites triradiatus* and *Schopfipollenites* sp. at 4880' indicates that the section is no older than the AT Zone of the Windsor Group. The lower sample also contains a specimen of *Lycospora pusilla* which appears to be *in situ*.

**INTERVAL:** 6445'-6750'  
**Age:** Middle Devonian, late Givetian  
**Zone:** lower *optivus-triangulatus*, Richardson & McGregor (1986)

**Remarks**

The spores from this interval, although numerous, are poorly preserved due to the high maturation level. The age is based on the presence of Givetian markers such as *Grandispora naumovii* and significant numbers of *Rhabdosporites langii*, with late Givetian-Frasnian species such as *Cristatisporites triangulatus* and multifurcate forms of *Ancyrospora* spp. and *Hystricosporites* spp. *Grandispora* spp. and anchor-ornamented species of *Ancyrospora* and *Hystricosporites* are abundant.

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## SECTION 7

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### WELL: LITTLE RIVER #1

Ten slides prepared from cuttings samples over the 760m-1380m were examined and the results are plotted on Enclosure \_\_. The spore assemblages are typical of the Early to Middle Tournaisian and similar to those recovered from an unnamed, pre-Horton Bluff Formation by Utting et al. (1989). and from the lower part of the Albert Formation by Dolby (1991, 1993).

### Succession

Interval	Age	Zone
760m-1215m	Middle Tournaisian	<i>E. rotatus-l. explanatus</i> , 1B
1215m-1380m	Middle to Early Tournaisian	1A

**INTERVAL:** 760m-1215m

**Age:** Middle Tournaisian

**Zone:** *E. rotatus - l. explanatus*, Utting et al. (1989); 1B, Dolby (1991, 1993)

### Remarks

The age of this interval is based on the presence of numerous specimens of *Hymenozonotriletes explanatus* at and below 760m. Although the range of this species extends into Zone 4 equivalent strata in Ireland (Higgs et al., 1988) its range is restricted to Zone 1A-B in New Brunswick. A Zone 1C influence in the upper two samples is suggested by the presence of rare specimens of *Spelaeotriletes cabotii* and *S. balteatus* but these may have caved. Similarly, the abundance of *Cristatisporites mathewsii* may in part be due to caving. *Verrucosisporites nitidus* is numerous to abundant which is typical for Zone 1. The abundance of *S. crenulatus* is also typical of Zone 1A-B in the Albert Formation (Dolby, 1993).

The preservation deteriorates towards the base of the section, due to increasing thermal maturity, and cavings contaminants are often evident.



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**INTERVAL:** 1215m-1380m  
**Age:** Middle to Early Tournaisian  
**Zone:** 1A, Dolby (1991, 1993)

**Remarks**

The preservation continues to deteriorate due to increasing thermal maturity and many spore specimens are corroded. The upper limit of the interval coincides with re-appearance in small but significant numbers of *Corystisporites* spp. An isolated specimen is also present at 765m. This group may go into Zone 1B in the Albert Formation but is essentially a Zone 1A marker. In Ireland, the range of these forms extends up to lower Zone 4 (Higgs et al., 1988). *Spelaeotriletes* cf. *echinatus*, a coarsely ornamented variety, increases markedly in the lower two samples. This is also a feature of Zone 1A in the Albert Formation. *Retusotriletes incohatus* are somewhat more abundant than usual which, with numerous to abundant *Verrucosisporites nitidus* is a feature of the VI Zone of Higgs et al. which is equivalent, at least in part to Zone 1A.

The lowermost sample contains a moderate number of specimens of *Vallatisporites* spp. Their preservation prevents a precise identification but they are generally coarsely ornamented forms, tending towards *V. pusillites*, a Strunian marker. However, there is no other evidence for the Strunian and the age of the lowermost sample is considered to be Carboniferous early Tn1b.

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## SECTION 8

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### WELL: HILLSBOROUGH #1

Although 45 samples from this well were prepared, 22 proved to be barren. The results are plotted on Enclosure \_\_. The spore assemblages recovered between 1235m and 2575m are more typical of the Late Tournaisian but the well may just penetrate the Middle Tournaisian towards 2575m. The degree of organic metamorphism is quite high especially at and below 1700m. The productive section is younger than that studied in Little River #1.

### Succession

Interval	Age	Zone
1235m-1320m	Late Tournaisian	
1320m-1385m	Late Tournaisian	<i>S. cabotii</i> , 3
1385m-1910m	Late Tournaisian	<i>D. distinctus</i> , 2
1910m-2575m	Late to ?late Middle Tournaisian	1D-?1C

**INTERVAL:** 1235m-1320m

**Age:** Late Tournaisian

**Zone:** Indeterminable

### Remarks

The one sample from this interval (1235m-1240m) yielded a poorly preserved assemblage of thermally altered and corroded spores. Specimens of *Crassispora trychera* and *Spelaeotriletes plicatus* indicate a Late Tournaisian age but a zone cannot be assigned.

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**INTERVAL:** 1320m-1385m

**Age:** Late Tournaisian

**Zone:** *S. cabotii*, Utting et al. (1989); 3, Dolby, (1991, 1993)

The age of this interval is based on the following criterion:

- The presence of numerous specimens of *Spelaeotriletes cabotii* at and below 1320m.

**Remarks**

The 1320m sample is rich and contains numerous specimens of *S. cabotii* as well as other forms of *Spelaeotriletes* spp. typical of the Late Tournaisian. *S. cabotii* is found in small numbers in Zone 4 but is most abundant in Zones 2 and 3 in the Albert Formation (Dolby 1991, 1993) and the equivalent Horton Bluff Formation (Utting et al. 1989). A small number of specimens of *Schopfites claviger* at 1320m indicate a 3B age and their state of preservation suggests that they may be *in situ*. However, the abundance of *Crassispora trychera* also indicates that cavings contamination may be present since this taxon is usually relatively rare below Zone 5. Other species present include:

*Retusotriletes incohatus* (A)  
*Plicatispora quasilabrata*  
*S. plicatus* (A)  
*Auroraspora macra*  
*Cristatisporites mathewsii* (R)  
*Vallatisporites vallatus*  
*Verrucosisporites nitidus*

*Crassispora trychera* (A)  
*Spelaeotriletes* spp.  
*Apiculiretusispora fracticosa*  
*Colatisporites decorus*  
*Rugospora minuta* (R)  
*V. verrucosus*  
*V. papulosus*

**INTERVAL:** 1385m-1910m

**Age:** Late Tournaisian

**Zone:** *D. distinctus*, Utting et al. (1989); 2, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Umbonatisporites distinctus* at and below 1385m.
- The presence of *Umbonatisporites* cf. *variabilis* at 1425m.
- The presence of *Umbonatisporites abstrusus* at and below 1565m.
- The continued abundance of *Spelaeotriletes cabotii*.

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### Remarks

These species of *Umbonatisporites* range up to perhaps as high as Zone 5 equivalent strata in Ireland (Higgs et al., 1988) but are used as Zone 2 indices in the Albert Formation and Horton Group (Dolby, 1991, 1993; Utting et al., 1989). New species to appear, typical of Zones 3, 2 and older strata include:

*Baculatisporites fusticulus*  
*Spelaeotriletes pretiosus bellii*  
*S. pretiosus*  
*Raistrickia cf. corynoges*  
*Rugospora polyptycha*

*Leiozonotriletes insignitus*  
*S. cf. tuberosus*  
*Spinozonotriletes uncatus*  
*R. ponderosa*

Cavings contamination is often significant and probably accounts for the specimens of *Schopfites claviger*, *Crassispora trychera* and *Vallatisporites ciliaris*.

At and below 1700m, there is a marked deterioration in spore preservation due to thermal maturity and the effects of pyrite. The drop in cavings contamination (casing?) emphasises this change. Spore numbers decrease below this point and many species are difficult to identify.

**INTERVAL:** 1910m-2575m  
**Age:** Late to ?late Middle Tournaisian  
**Zones:** 1D-?1C, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Spelaeotriletes obtusus* at and below 1910m.
- The absence of *S. cabotii* below 1910m.

### Remarks

Identifiable spores are rare in this interval due to the extremely poor preservation. However, *Spelaeotriletes* spp. are present, often as broken specimens, but can sometimes be identified if the sculpture is preserved. *S. obtusus*, which appears at 1910m ranges up to the BP Zone in Ireland, i.e., equivalent to Zones 1C and possibly D.

The numbers of *S. cabotii* drop markedly below Zone 2 in the Albert and Horton Bluff formations. Usually in these formations there is an abundance of *Verrucosiporites nitidus*



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and *Cristatisporites mathewsii*. In this interval however, *V. nitidus* is rare and *C. mathewsii* is absent. The preservation obviously affects numbers but the former species is still identifiable at high levels of maturity. It is abundant in much of Little River #1 a section of 1A-1B age.

Based on the foregoing, the age of this interval is considered to be upper Zone 1, i.e., 1D to possibly 1C, and the section appears to be younger than that encountered in Little River #1.

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## SECTION 9

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### WELL: EAST STONEY CREEK #1

Of the 26 samples prepared from this well over the 180m-1435m interval, 4 proved to be barren. The results are plotted on the species occurrence chart (Enclosure \_\_). Most of the section is of Late Tournaisian age with Middle Tournaisian strata at and below 1015m. In many of the samples, large numbers of spores are unidentifiable due to pyritization. This is not unusual in the Albert Formation. Inertinitic debris is abundant at 1305m and the level of organic maturity increases markedly in the lower productive samples (1340m-1400m).

### Succession

Interval	Age	Zone
215m-1015m	Late Tournaisian	<i>D. distinctus</i> , 2-?1D
1015m-1400m	Middle Tournaisian	1C

**INTERVAL:** 215m-1015m

**Age:** Late Tournaisian

**Zone:** *D. distinctus*, Utting et al. (1989); 2-?1D, Dolby (1991, 1993)

### Remarks

The age of this interval is based on the presence of *Verrucosiporites congestus* and abundant *Spelaeotriletes cabotii* at and below 215m and *Umbonatisporites* spp. at and below 610m. Cavings from Zone 3 are indicated by the presence of *Schopfites claviger* at 215m and by rare and sporadic occurrences of *Crassispora trychera*. Pyrite damage to the spore exines is severe at and below 610m.

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**INTERVAL:** 1015m-1400m  
**Age:** Middle Tournaisian  
**Zone:** 1C, Dolby (1991, 1993)

**Remarks**

There is a marked drop in the numbers of *S. cabotii*, *Vallatisporites vallatus* and *V. verrucosus* at the top of this interval and *S. obtusus* appears. The latter species characterises Zone 1C and possibly D equivalent and older rocks in Ireland and the abundance drop of the first three species is characteristic of Zone 1C-D. *S. cabotii* is still present at 1340m and it appears to be in situ indicating that at this level, the section is no older than Zone 1C.

The level of organic maturation increases markedly in the two lowermost samples suggest the presence of faulting. Spores resembling the Strunian marker *Vallatisporites pusillites* are present at 1400m but these may have been reworked since no other Strunian species were recorded. Similar forms were also seen in Little River #1 at 1380m in strata assigned to Zone 1A.

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## SECTION 10

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### THE MABOU MINES AREA

#### Coal Mine Point

Twenty samples of clastics from this section were processed and of these, four were barren. Samples from the coal seams were analysed in a previous study (Dolby, 1988, Report 87/18). The data are plotted on Enclosure \_\_.

For this report, the data and the slides from the earlier study were re-assessed and combined with the new samples. In addition, coarse fractions of the palynological residues from the coals were analysed.

Bell (1944) correlated the section with his *Linopteris obliqua* Zone of mid to late Westphalian C age. Barss & Hacquebard (1967) and Hacquebard (1972) assigned the section to the equivalent *Torispora* Zone. Zодrow in Zодrow & Vasey (1986) stated that the section is of late C to early D age and equivalent to much of the South Bar Formation in the Sydney Basin. Vasey, in Zодrow & Vasey (1986) felt that the fauna is of Westphalian C age. The spore-pollen data from this study suggest that the sequence is significantly younger.

**INTERVAL:** 6m-29.6m

**Age:** Mid to late Westphalian C

#### Remarks

The 3 samples from this interval yielded rich assemblages typical of the mid-C and D of Nova Scotia. Important species include *Torispora securis*, abundant *Punctatosporites granifer*, *P. minutus*, *Triquitrites sculptilis* and *Vestispora foveata* with smaller numbers of *Triquitrites additus*, *T. spinosus*, *T. tribullatus*, *V. fenestrata* and *Striatosporites* spp.

The presence of several specimens of *V. cf. tortuosa* in CMP-1 at 11.5m indicates that the section is unlikely to be younger than Westphalian C although this species does range elsewhere into the very earliest D.



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**INTERVAL:** 29.6m-249m  
**Age:** Westphalian D

**Remarks**

This interval encompasses the 1' Seam up to and including the 7' Seam. The spore-pollen assemblages are grossly similar to those from the underlying interval and most of the species appearing in this interval are also typical of the Westphalian C.

*Cadispora magna* is present in a significant number of samples including the 1', 4'6", 5', 8' and 7' seams and in CMP-16 where it is numerous. Peppers (1985) considers this species to appear in the very latest Westphalian C along with a group of species, all of which Smith & Butterworth (1967) and Smith (1987) consider to appear at the base of D.

*Mooreisporites inusitatus* is present in the 4'6" seam, and also just above the 15' seam at Finlay Point and *Raistrickia aculeata* is present in the 7' seam. Both of these species are part of the D association mentioned above. However, another important component, the *Thymospora* group was not recorded. This may be a function of sampling.

A specimen of *Cingulizonates cf. loricatus* is present in CMP6, 51m above the base of the section. Undoubted specimens of this species are usually found in Westphalian C and older strata but it does range into the earliest D in Belgium (Peppers, 1985).

**INTERVAL:** 249m-276.3m  
**Age:** Stephanian

**Remarks**

The clastic samples from this interval, especially CMP17 and 18, are rich in striate pollen including *Illinites unicus*, *I. boehneri*, *I. annosus*, *Protohaploxylinus* spp., *Striatoabieites* spp., *Striatopodocarpites* spp. and *Striomonosaccites* spp. The sacs in *Striatoabieites* 93-17 are sometimes indiscernible so that the pollen grain resembles *Vittatina nova* (= *Aumancisporites striatus*) a taxon recorded from the Late Stephanian of France (Alpern, 1958; Liabeuf & Alpern, 1969, 1970) and of Germany (Helby, 1966). *Vittatina* spp. first appear in the early Stephanian of Europe (Clayton et al., 1977).



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In Nova Scotia, striate pollen are to be found sporadically and in small numbers in rocks as old as late Westphalian B. However, numbers such as these are more characteristic of the Stephanian and Barss & Hacquebard (1967) referred such assemblages to their *Potonieisporites* Zone.

*Lundbladispora gigantea* occurs in samples CMP17, 18 and 19. This species first appears in the Westphalian C of Europe but is rarely found below the Stephanian.

A specimen of *Vestispora fenestrata* in CMP20 indicates that the section is no younger than Stephanian A.

If this major change in assemblage type was a response to a change in the environment (?climate), it may also explain the absence or reduction in numbers in this interval of such species as *Vestispora foveata*, *Triquitrites* spp. and *Torispora securis*.

### **Finlay Point**

Four samples (FP26-29) were processed and all yielded assemblages. They were taken from just below and above the 15' Seam and, are therefore approximately equivalent to the CMP11, 13 samples at Coal Mine Point.

All four yielded the mid-Westphalian C to D "background assemblage." A poor specimen of *Mooreisporites inusitatus* in FP29 confirms a D age but there are no other markers. Also present in FP29 are specimens of *Densosporites sphaerotriangulus*. This is a long-ranging species but the only occurrences at Coal Mine Point are in the stratigraphically equivalent CMP13, and also in the CMP14 sample.

### **MacKinnons Brook**

Three samples (MKB31-33) were processed and MKB32 proved to be barren. The lower productive sample MKB33 yielded a very rich assemblage of limited composition but of the mid-C to D "background assemblage" type.

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Sample 31 is inertinite dominated with few palynomorphs. A specimen of the fungal body *Centonites symmetricus* suggests a possible Stephanian age for this sample. The species appears to be a Missourian-Virgilian marker in the U.S.A. (Peppers, 1964) and is also present in the Middle and Upper Stephanian in the type section (Liabeuf & Alpern, 1969). This implies that the coal at this locality may be equivalent to the 7' or 11' seams at the top of the Coal Mine Point section.

#### **Port Ban/Broad Cove**

Of the 3 samples collected, only one (PB/BC-41) yielded spores and pollen. The assemblage is rich and contains a specimen of *Striatoabieites* 93-17 which characterises the Stephanian zone at Coal Mine Point. It further helps confirm the correlation of the coal seam here and at MacKinnons Brook with the uppermost Coal Mine Point section.

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## SECTION 11

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**COREHOLE: DDH P58**

Twenty samples were processed for this project of which 7 were barren or yielded very few palynomorphs. This corehole was also studied in an earlier project (Dolby, 1988, Project 87/18). Those data and slides were re-examined and have been included here and plotted on Enclosure \_\_. The quality of the assemblages varies considerably with those from the upper part of the corehole being particularly poor.

**Succession**

Sample/Interval	Age
3m	?Westphalian D
33.86m-133.6m	Westphalian D-C (undiff.)
133.6m-454m	Mid to late Westphalian C
655.85m-710.17m	Early Westphalian A
710.17m-834.7m	Early Westphalian A - ?Late Namurian

**SAMPLE: 3m**

**Age:** ?Westphalian D

**Remarks**

This assemblage is comprised of relatively long ranging spores and pollen and mid-C and younger species. The age is based on the presence of *Anapiculatisporites spinosus* which Smith & Butterworth (1967) described from the Westphalian D of England. No other D species were recorded.

**INTERVAL: 33.86m-133.6m**

**Age:** Westphalian C-D (undiff.)

**Remarks**

The 33.86m, 62.72m and 85.5m samples yielded long-ranging taxa. No specifically D or C markers are present.

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**INTERVAL:** 133.6m-454m

**Age:** Mid to late Westphalian C

**Remarks**

Many of the samples below and including 133.6m contained rich and diverse assemblages typical of the Westphalian C with no sign of D influence. The essentially C and older taxon *Vestispora* cf. *pseudoreticulata* is present at 194.79m and *V. pseudoreticulata* is numerous at 222m. *Anapiculatisporites* cf. *minor* which probably does not range above the C is present at and below 194.79m.

Most of the samples down to and including 451.14m contain species such as *Punctatosporites granifer*, *P. minutus*, small forms of *Triquitrites tribullatus*, *T. additus*, *T. spinosus* and a variety of striate, bisaccate pollen which together indicate an age no older than mid-Westphalian C. *Torispora securis* is surprisingly rare.

The 454m sample yielded very few palynomorphs but the character of the assemblage, such as it is, is closer to the overlying section than to the assemblages at and below 655.85m.

**INTERVAL:** 655.85m-710.17m

**Age:** Early Westphalian A

**Zone:** lower *S. arenaceus* - *Florinites* spp, Dolby (in prep.)

**Remarks**

No samples were submitted from the 454m-655.85m interval.

The assemblages at and below 655.85m contain numerous spores reworked from the Windsor-Canso strata, as well as long ranging Upper Carboniferous species.

The presence of abundant *Florinites visendus* s.s. without smaller species of this genus is significant. This species is sporadically present in the Namurian of the British Isles but was not recorded in the Namurian A-B Hastings-Pomquet sequence by Neves & Belt (1970). Smaller forms such as *F. florinii* do not become significant until the mid-Westphalian A. The presence of *Lycospora orbicula* at 710.17m indicates that this section is no older than Westphalian.

Similar assemblages are present in the lower 360m of the Boss Point Formation.



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**INTERVAL:** 710.17m-834.7m  
**Age:** Early Westphalian A - ?Late Namurian  
**Zone:** lower *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

**Remarks**

These assemblages are characterised by *Florinites visendus*, often in abundance, *Potonieisporites* spp., *Lycospora* spp. and *Schopfipollenites ellipsoides* with large numbers of Windsor-Canso species. The presence of *Ibrahimisporites* spp. indicates that the Windsor-Canso component is no younger than mid-Namurian B. Although *F. visendus* is found sporadically in the Namurian of the British Isles, the numbers here suggest that the section is unlikely to be older than late Namurian or, more probably, Westphalian in age. The older portion of the assemblage is therefore considered to have been reworked.

Similar assemblages are present in the lower parts of the Boss Point Formation at Joggins and in New Brunswick.

Late Namurian assemblages have not as yet been recorded from onshore sections in the Maritime Provinces. A probable Namurian C section is present in the Bradelle L-49 well, offshore and also in the Wellington #1 well, P.E.I.

### 93C Series (Outcrop samples)

Of the 20 samples processed, 4 were barren of spores and pollen or the yield was too low to assign an age.

**SAMPLES:** 11, 25A, 35B, 52B  
**Age:** Indeterminable

**Remarks**

Sample 25A was barren of organic matter, 11 was barren of palynomorphs and the other two were too poor to date with confidence.



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**SAMPLE:** 51A  
**Age:** earliest Westphalian D

**Remarks**

Specimens of *Cadiospora magna* and *Vestispora pseudoreticulata* indicate a transitional C-D age. Peppers (1985) states that *C. magna* ranges down into the latest C but some associated spores on his charts do not range below the D according to Smith (1987). The latter species ranges up to the very earliest Westphalian D.

The sample is rich in *Lycospora* spp. and *Botryococcus* is moderately abundant indicating a lacustrine swamp environment.

**SAMPLE:** 51B  
**Age:** Mid to late Westphalian C

**Remarks**

Specimens of *Punctatosporites granifer* and *Torispora securis* indicate the sample is no older than mid-Westphalian C. A specimen of *V. cf. pseudoreticulata* indicates that the sample is no younger than earliest D but there are no specifically D markers present.

**SAMPLE:** 68B  
**Age:** Westphalian, ?A

**Remarks**

This assemblage is dominated by reworked palynomorphs from Windsor, Devonian and Ordovician sources. The Ordovician acritarchs are from the Arenig-Llanvirn and are quite well preserved.

*Florinites visendus* s.s. is abundant but a small number of *F. florinii* indicates a Westphalian age. Similar associations have been recorded from Boss Point samples in this study but it must be emphasised that the *in situ* assemblage is very small.

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**SAMPLE:** 76

**Age:** Westphalian

**Remarks**

Palynomorphs are rare and comprise long ranging taxa. The presence of *Florinites* cf. *mediapudens* indicates an age no older than Late Namurian but the species has an essentially Westphalian range.

**SAMPLE:** 93B

**Age:** Probably mid-late Westphalian C

**Remarks**

Spores such as *Torispora securis*, *Punctatosporites granifer*, *Triquitrites additus* and *T. tribullatus* indicate an age no older than mid-Westphalian C and no D markers are present. The state of preservation suggests a moderately high energy environment of deposition.

**SAMPLE:** 128B

**Age:** Probably mid-late Westphalian C

**Remarks**

Spores are rare and the kerogen is well sorted indicating a high energy environment. Specimens of *Illinites unicus* and *Punctatosporites granifer* indicate an age no older than mid-C. No D markers are present.

**SAMPLE:** 128C

**Age:** Westphalian D

**Remarks**

The age is based on the presence of *Cadiospora magna* (see Sample 51A). Westphalian species are relatively rare and the assemblage is dominated by extremely abundant reworked Namurian palynomorphs.

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**SAMPLE:** 131

**Age:** No older than mid-Westphalian C

**Remarks**

The residue consists almost entirely of well sorted inertinitic debris. Spores are extremely rare but specimens of *Torispora securis* and *Punctatosporites granifer* indicate an age no older than mid-C. A high energy, channel or splay environment is indicated.

**SAMPLE:** 139

**Age:** No older than mid-Westphalian C

**Remarks**

An extremely low organic yield. The age is based on the presence of *Punctatosporites granifer*, *P. minutus* and *Torispora securis*.

**SAMPLES:** 142, 154H, 154I, 154J

**Age:** ?Late Namurian - early Westphalian A

**Remarks**

The assemblages consist almost entirely of Windsor-Canso spores. Several specimens of *Florinites visendus* s.s. and the lack of smaller species of this genus suggests a correlation with the lower part of the Boss Point Formation.

**SAMPLE:** 238

**Age:** Namurian B

**Remarks**

This extremely rich assemblage is dominated by Windsor-Canso species. The presence of *Secarisporites lobatus*, *Spelaeotriletes arenaceus*, *Ibrahimisporites magnificus* and *Reticulatisporites cf. reticulatus* indicate a Namurian, possibly late B age.

The assemblage resembles those recorded from the Pomquet Formation by Neves & Belt (1970) but no saccate pollen are present here.

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**SAMPLE:** 276C

**Age:** Viséan - Namurian

**Remarks**

Palynomorphs are extremely rare and consist of Windsor-Canso species. There are too few palynomorphs to assign a precise age.

**SAMPLE:** 357

**Age:** Tournaisian

**Remarks**

This is an extremely small assemblage of thermally altered palynomorphs. The presence of *Vallatisporites vallatus* indicates a Tournaisian age and the other, largely unidentifiable spores, have a Horton rather than Windsor character.

### 93Q Series (Outcrop samples)

Sixteen samples comprise this series but only 5 contained reasonable assemblages.

**SAMPLE:** 13A

**Age:** Stephanian

**Remarks**

This is an upland assemblage in which pollen are abundant and swamp species, such as *Lycospora* spp., are absent.

The age is based on the presence of abundant striate bisaccate pollen such as *Illinites unicus*, *Striatoabieites* spp., *Protohaploxylinus* spp. and *Hamiapollenites* sp. and several specimens of *Lundbladispora gigantea*.

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**SAMPLE:** 13B  
**Age:** ?Late Westphalian

**Remarks**

Only 11 palynomorphs are present in this small residue. Questionable striate pollen grains suggest a Late Westphalian or even Stephanian age.

**SAMPLES:** 33A, 39B, 57A, 75, 88  
**Age:** Indeterminable

**Remarks**

Small residues of inertinitic debris only.

**SAMPLE:** 115  
**Age:** Late Viséan  
**Zone:** AT, Utting (1987)

**Remarks**

This is a typical Windsor assemblage. The presence of *Secarisporites remotus*, *Knoxisporites triradiatus* and *Schopfpollenites arcadiensis* correlates the sample with the AT Zone.

**SAMPLES:** 115B, 131, 142A, 152, 152B, 195A  
**Age:** Indeterminable

**Remarks**

Low yields of inertinitic debris.



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**SAMPLES:** 213, 214

**Age:** ?Late Namurian - early Westphalian A

**Remarks**

Spores and pollen are relatively rare and the assemblages are dominated by Windsor-Canso species. Small numbers of *Florinites visendus* s.s. suggest a correlation with the Boss Point Formation.

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## SECTION 12

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**SAMPLE:** SHUB-1  
**Age:** Westphalian, ?mid to late C

**Remarks**

The yield from this sample was poor and the assemblage is of limited composition. Two specimens of *Punctatosporites* cf. *granifer* and three of *P. minutus* and rare specimens of *Lophotriletes* cf. *gibbosus* suggest a possible mid to late Westphalian C age. However, this is extremely tentative.

**SAMPLES:** MAL-1, MAL-2  
**Age:** probably late Westphalian C

**Remarks**

The MAL-2 sample from the lowest coal in the Malagash Formation type section yielded an assemblage of relatively limited composition dominated by *Lycospora* spp.. *Punctatosporites granifer* is quite numerous indicating an age no older than mid-Westphalian C. The presence of several specimens of *P. oculus* further limits this to the late C.

The MAL-1 sample, from immediately above this coal, yielded a sparse spore-pollen assemblage dominated by pollen grains (hinterland assemblage). Striate pollen species are present in small numbers which is not unusual in rocks of this age. Specimens of *Anapiculatisporites* cf. *minor* indicate that the age is most probably no younger than Westphalian C.

**SAMPLE:** MAL-3  
**Age:** Probably earliest Westphalian D

**Remarks**

Several specimens of *Cadiospora magna* are present in this rich sample. This species supposedly appears in the latest C with spores such as *Thymospora* spp. However, Smith

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(1987) considers this association to be of D age. Poor specimens of *Vestispora* aff. *psuedoreticulata* suggest a strong C influence and an earliest Westphalian D age is assigned.

In a previous study (Dolby, 1986, RRC/85/2311) a coal sample from this section was studied, i.e., sample 11E/14-54 (?=503) and a tentative Westphalian D age assigned. A re-examination of the slide and the data has not changed this.

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## SECTION 13

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**SAMPLE:** D2718, 18-93-1  
**Age:** Visean  
**Zone:** Basal AT Zone, Utting (1987)

**Remarks**

The sample yielded extremely abundant spores typical of the Windsor Group. However, many are corroded due to the high level of thermal maturity and pyrite damage is prevalent.

*Rugospora minuta* and *Crassispora trychera* are abundant and *Vallatisporites* spp. are quite numerous. Good specimens of *Knoxisporites triradiatus* indicate that the sample is no older than the AT Zone but a specimen of *V. verrucosus* which does not range above the underlying NS Zone is also present. A basal AT age is therefore assigned.

Other species present include *Densosporites columbaris*, *Spelaeotriletes pretiosus windsorensis*, *V. ciliaris*, *V. galearis* and *K. literatus*.

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## SECTION 14

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### **COREHOLES & EXPLORATION WELLS**

In sequences of cuttings samples spaced at approximately 30m, stratigraphic boundaries are drawn at the base of the cuttings composite interval where an event occurs. The boundaries may therefore be slightly low. Where samples are widely spaced, there may be significant gaps between the biozones.



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## SECTION 14

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### WELLINGTON #1

Twenty-two cuttings and 9 core samples were processed from this well over the 1930'-9274' interval. Of these, 4 of the cuttings and two of the cores failed to yield palynomorphs. The species present are recorded on Enclosure \_\_.

#### Succession

Interval	Age	Zone
1930'-3140'	Westphalian D	
4460'-5000'	?Namurian C	
6973'-9080'	Late Tournaisian	<i>C. decorus</i> - <i>S. claviger</i> , 5
9274' (core sample)	Late Tournaisian	<i>S. pretiosus</i> , 4

**INTERVAL:** 1930'-3140'

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Cadiospora magna* in most samples.
- The presence of *Thymospora pseudothiessenii* and *Vestispora* cf. *witneyensis* at 2600'.
- The presence of *Raistrickia aculeata* and *Thymospora* sp. at 3140'.

#### Remarks

Most of the samples in this interval yielded rich assemblages of spores and pollen which characterise much of the mid-Westphalian C to Stephanian sequence. No specifically Stephanian markers are present and the presence of the above-named species indicate an age essentially no older than Westphalian D.

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**INTERVAL:** 4460'-5000'

**Age:** ?Namurian C

The age of this interval is based on the following criteria:

- The presence of *Pteroretis* sp. at 4460'.
- The presence of *Kraeuselisporites* spp. at 5000'.

**Remarks**

Only 2 of the 4 samples from this interval were productive. Apart from some minor cavings contamination at 4460', the Westphalian D association is absent from this interval.

New species to appear include *Vestispora tortuosa*, *V. pseudoreticulata* and *Reticulatisporites polygonalis* an assemblage which characterise the early Westphalian C and late Westphalian B in the Sydney and Cumberland Basins. However, the presence of *Pteroretis* sp. and *Kraeuselisporites* spp. is significant. The former is an essentially Namurian C taxon and the latter group is more typical of the Namurian. They could have been recycled into late Westphalian B-early C strata but the *Pteroretis* specimens are well-preserved. The Westphalian species are therefore interpreted as being possible cavings contaminants.

The total assemblage resembles those from Bradelle L-49 in the section between 6730' and the top of the Windsor Group.

**INTERVAL:** 6973.5'-9080'

**Age:** Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of generally abundant *Crassispora trychera* at and below 6973.5'.
- The presence of abundant, simple spores at and below 6973.5'.
- The presence of *Retusotriletes avonensis* at and below 6973.5'.
- The presence of *Spelaeotritetes crenulatus* at and below 7420'.
- The presence of *Vallatisporites vallatus* at and below 7590'.

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### Remarks

Lower Windsor and upper Horton (Wilkie Brook) assemblages are essentially similar and difficult to distinguish if stratigraphically restricted species are absent. Species such as *Crassispora trychera*, *Retusotriletes incohatus*, *Schopfites claviger*, *Auroraspora macra*, *Rugospora minuta* and *Colatisporites decorus*, especially the first two, can be abundant in both the Wilkie Brook and the Windsor. Horton assemblages are usually characterised by abundant, simple spores broadly referable to *Punctatisporites*. This group is much less obvious in the Windsor.

The assemblages at and below 6973.5' (core sample) are comprised of the upper Horton-lower Windsor "background assemblage" listed above as well as abundant simple spores. In addition, *Retusotriletes avonensis* is present at and below 6973.5', *Spelaeotriletes crenulatus* is present at and below 7420' and *Vallatisporites vallatus* occurs at and below 7590'.

The upper range of *R. avonensis* is uncertain but it appears to be a Horton species. *S. crenulatus* is a Tournaisian taxon as is *V. vallatus*.

Some of the *V. cf. ciliaris* specimens resemble those from outcrop samples in this study which were assigned to the same zone (Wilkie Brook equivalent).

**SAMPLE:** 9274' (core)  
**Age:** Late Tournaisian  
**Zone:** *S. pretiosus*, Utting et al. (1989); 4, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Spelaeotriletes cabotii*.
- The continued abundance of *Crassispora trychera*.

### Remarks

*S. cabotii* does not range above the Cheverie. The continued abundance of *C. trychera* suggests that this sample comes from uppermost Cheverie equivalent strata. *Vallatisporites* spp. also increase in numbers but the remainder of this assemblage is not dissimilar to those from the overlying interval.

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## SECTION 15

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### MACDOUGALL #1

Fifty cuttings and 4 core samples were processed from the 2380'-9070' interval and of these, 4 were barren of organic residue. The species present are recorded on Enclosure \_\_.

#### Succession

Interval	Age	Zone
2380'-2920'	Westphalian D	
3990'-4360'	Late Tournaisian	<i>D. distinctus</i> , 2B
4360'-5960'	Late Tournaisian	<i>D. distinctus</i> , 2A
5960'-7030'	Late to Middle Tournaisian	1C-D
7030'-9070'	Middle Tournaisian	<i>E. rotatus</i> - <i>I. explanatus</i> , 1B

**INTERVAL:** 2380'-2920'

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The absence of Stephanian markers.
- The presence of *Cadiospora magna* at and below 2560'.
- The presence of *Vestispora witneyensis* at 2740'.

#### Remarks

These samples yielded the typical mid-C to Stephanian background assemblage of spores and pollen which includes *Punctosporites granifer*, *P. minutus*, *Triquitrites tribullatus*, *T. additus* and sporadic striate bisaccate pollen. *Cadiospora magna* is present in significant numbers in three of the four samples from this interval and although this species may range into the very latest C (Peppers, 1985), it is an essentially D-Stephanian species (Smith, 1987). *V. witneyensis* is present at 2740'. This species is known only from D strata. There is no obvious Stephanian influence on the assemblages although one striate pollen specimen at 2560' does in some ways resemble *Striatoabieites* 93-17, a possible Stephanian form.



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**INTERVAL:** 3990'-4360'

**Age:** Late Tournaisian

**Zone:** *D. distinctus*, Utting et al. (1989); 2B, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Rugospora minuta* down to 4360'.
- The presence of *Dibolisporites distinctus* and *Spelaeotriletes cabotii* at and below 4180'.

#### Remarks

The assemblages at and below 3990' are typical of the Horton Group. Undifferentiated, simple spores and *Retusotriletes incohatius* are often abundant and species of *Spelaeotriletes*, *Vallatisporites* and *Verrucosisporites* occur frequently.

The uppermost sample at 3990' is dominated by the long-ranging simple forms but, given the close proximity of marker species at 4180', it is included in this zone. The usually elusive species *Dibolisporites distinctus* is present at and below 4180' and *D. abstrusus* is also present at 4180'. *S. cabotii* is also numerous at and below this depth and the assemblages indicate the presence of Zone 2 strata. The presence of *Rugospora minuta* at 4180' and 4360' confines the age to the upper part of the zone.

**INTERVAL:** 4360'-5960'

**Age:** Late Tournaisian

**Zone:** *D. distinctus*, Utting et al. (1989); 2A, Dolby (1991, 1993)

The age of this interval is based on the following criterion:

- The presence in most samples of *S. cabotii*.

#### Remarks

Yields vary considerably in this interval but *S. cabotii* is usually present. The acme of this species is in the Horton Bluff (*D. distinctus* and *S. cabotii* zones) and is absent in the *E. rotatus* - *I. explanatus* Zone (1B). It is sporadically present below Horton Bluff equivalent assemblages but absent in 1B assemblages in New Brunswick (Dolby, 1991, 1993), and Nova Scotia, Utting et al. (1989).



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At 4940', there is an abundance of an unidentified palynomorph, referred to on the chart as *incertae sedis*. It occurs sporadically down to 8560' and may be an unusual acritarch.

The level of thermal maturity increases significantly at and below 5600'. Black, indeterminate spores are abundant in most samples below this level.

**INTERVAL:** 5960'-7030'

**Age:** Late to Middle Tournaisian  
**Zone:** 1D-1C, Dolby (1991, 1993)

The age of this interval is based on the following criterion:

- The absence of *S. cabotii*.

**Remarks**

Although the yields vary considerably the assemblages are dominated by simple, indeterminate spores, *Retusotriletes incohatus* and carbonised, unidentifiable species (usually simple forms). *Spelaeotriletes* spp. such as *S. echinatus* and *S. crenulatus* are frequently present but *S. cabotii* is absent.

The interval is therefore correlated with zones 1D and 1C (Dolby 1991, 1993).

**INTERVAL:** 7030'-9070'

**Age:** Middle Tournaisian  
**Zone:** *E. rotatus* - *I. explanatus*, Utting et al. (1989); 1B, Dolby (1991, 1993)

The age of this interval is based on the following criterion:

- The presence of *Indotriradites explanatus* at 7030' and 7430'.

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### Remarks

Although *I. explanatus* ranges into younger Tournaisian rocks in Ireland (Higgs et al., 1988) it has not been found above the early Middle Tournaisian in the Maritime Provinces.

The assemblages down to 9070' consist predominantly of simple spores, many of them carbonised. New species of note include *Neoraistrickia loganii* at 8290' and *Spelaeotriletes obtusus* at 8650'. The former ranges into the Late Tournaisian in Ireland (Higgs et al., 1988) but the latter does not range significantly above the 1C Zone. *S. cabotii* is present in some of the samples towards the top of the interval but judging from the preservation, these specimens almost certainly caved.

There is no evidence of Strunian in this interval nor of 1A species. The level of maturity is high but would not have obscured the more complex forms from Tn1b or older strata.

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## SECTION 16

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### MABOU #1

Seventy-three slides from the 320'-4032' interval were analysed and the data are plotted on Enclosure \_\_. Most of the samples were cuttings but six sidewall core slides were included. The average sample spacing was approximately 51'.

### Succession

Interval	Age
320'-1050'	Stephanian A
1050'-3050'	Westphalian D
3050'-4032'	Late to mid-Westphalian C

**INTERVAL:** 320'-1050'  
**Age:** Stephanian A

The age of this interval is based on the following criteria:

- The presence of relatively numerous striate bisaccate pollen at and above 440'.
- The presence of *Angulisporites splendidus* and *Schopfites dimorphus* at and below 970'.
- The presence of *Vestispora fenestrata* at 320'.
- The presence of *Granisporites medius* at and below 440'.

### Remarks

The presence of *Angulisporites splendidus* indicates that there are Stephanian rocks in the corehole and since *Vestispora fenestrata* occurs in the topmost sample, the interval is no younger than Stephanian A. *Cirratriadites saturni*, at and below 440', indicates an age no younger than mid-Stephanian A.

Striate bisaccate pollen are relatively numerous in the upper part of the interval which is normal for sediments of this age although they are not as abundant as in the equivalent section onshore.

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*Granisporites medius* occurs at and below 440'. This essentially Westphalian species ranges into the basal Stephanian of Iowa. It is also present in the lower part of the Stephanian section onshore. In the absence of other indicators, this species is used to define the Westphalian top in other sections in this study.

*Schopfites dimorphus* is a Westphalian D species according to Peppers (1985). However, in the Sydney Basin, it ranges up to the level of the Lloyd Cove Seam of basal Stephanian (Cantabrian) age where it occurs with *A. splendidus*.

The remainder of the total assemblage for this interval consists of the typical mid-Westphalian C - early Stephanian background assemblages which includes *Punctatosporites* spp. and *Triquitrites* spp. Also present are Westphalian D - Stephanian species such as *Cadiospora magna*, *Mooreisporites inusitatus* and *Raistrickia aculeata*.

**INTERVAL:** 1050'-3050'  
**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Vestispora* cf. *witneyensis* at and below 1050'.
- The presence of *V. colchesterensis* and *V. wanlessii* at and below 1370' and of *V. laevigata* at and below 1390'.
- The presence of abundant to numerous *Thymospora pseudothiessenii* at and below 1390'.
- The presence of *Thymospora obscura* at and below 1740' and in abundance at 1850'-60'.

#### Remarks

The downhole appearance of *Vestispora* species resembling *V. witneyensis* followed shortly by *V. colchesterensis*, *V. wanlessii* and *V. laevigata* indicate that Westphalian D strata have been penetrated.

*Thymospora pseudothiessenii* appears at 1390' and *T. obscura* at 1740'. Both species range into the Stephanian but their epibole is in the mid to late Westphalian D.

*Torispora securis* is extremely rare (a single specimen at 1470') otherwise the assemblages are grossly similar to those in the overlying interval.



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**INTERVAL:** 3050'-4032'

**Age:** Late to mid-Westphalian C

The age of this interval is based on the following criteria:

- The presence of *Vestispora tortuosa* at and below 3050'.
- The presence of *V. magna* at and below 3370'.
- The presence of *V. cf. pseudoreticulata* at 3390'.
- The presence of *V. fenestrata*, *V. laevigata*, *Illinites unicus*, *Punctatosporites granifer*, *P. minutus* and *Triquitrites tribullatus* in a SWC at 3766'.
- The presence of a mid-C assemblage at 4032' (T.D.)

#### Remarks

The appearance of *Vestispora tortuosa* at 3050' is used to define the top of the Westphalian C. This species may occur occasionally in earlies D assemblages but it is essentially a B-C species. *V. magna* and *V. cf. pseudoreticulata* appearing at 3370' and 3390' respectively, confirm the presence of C strata.

The assemblages to 4032' (T.D.) are usually rich and diverse. The SWC at 3766' contains specimens of *V. fenestrata*, *V. laevigata*, *Illinites unicus*, *Punctatosporites granifer*, *P. minutus* and small forms of *Triquitrites tribullatus*. This assemblage is characteristic of mid-C to Stephanian rocks in the Maritimes.

A questionable specimen of *Raistrickia fulva* at 3950' suggests some early C influence but at T.D., the assemblage is essentially similar to that in the 3766' SWC.

*Torispora securis* has a limited range here but is usually rare. The *Vestispora* rich assemblages which predate the mid-C association is not present here.



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## SECTION 17

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### MABOU #2

Only seven samples (4 cuttings and 3 cores) were processed from the 1450'-3298' interval in this well. The data are plotted on Enclosure \_\_.

#### Succession

Sample/Interval	Age
1450'	?Stephanian
1775'-3298'	Westphalian D

**SAMPLE:** 1450'

**Age:** ?Stephanian

The age of this interval is based on the following criterion:

- The presence of *Angulisporites splendidus*.

#### Remarks

If *Angulisporites splendidus* is *in situ*, the sample is of Stephanian age. However, the specimen may have caved as it has at 2120' and at similar depths in Mabou #1. The assemblage lacks other Stephanian character and the abundance of *Granisporites medius* suggests that a Westphalian D age may be more appropriate.

**INTERVAL:** 1775'-3298'

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Cirratriradites maculatus* at and below 1775'.
- The presence of *Thymospora* spp. in the core samples at 3291' and 3298'.

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### Remarks

The presence of *Cirratiradites maculatus* at 1775' indicates that the section is no younger than Westphalian D at this level. The remaining assemblages are typical of the Westphalian D with such species as *Thymospora pseudothiessenii*, *T. obscura*, *Raistrickia aculeata*, *Schopfites dimorphus*, *Cadiospora magna*, *Vestispora foveata*, *V. cf. colchesterensis* and *Anapiculatisporites spinosus*.

Specimens of *Thymospora* spp. including *T. obscura* and *T. pseudothiessenii* are present in the lowermost core samples at 3291' and 3298'. Peppers (1985) states that this group first appears in the very latest Westphalian C but Smith & Butterworth (1967) and Smith (1987) argue that it appears at the base of the D. No Westphalian C markers are present.

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## SECTION 18

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### PORT HILL #1

Twelve samples (10 cuttings, 2 cores) were processed from the 1770'-4267.5' interval. The core samples were barren. The data are plotted on Enclosure \_\_.

#### Succession

Sample/Interval	Age
1770'-2410'	Stephanian
2900'-4220'	Westphalian D

**INTERVAL:** 1770'-2410'

**Age:** Stephanian

The age of this interval is based on the following criteria:

- The presence of *Vittatina* sp. in the 1770'-90' sample.
- The presence of relatively numerous striate bisaccate pollen.

#### Remarks

Although the organic yield in the 1770'-90' sample was low, palynomorphs are numerous. Striate bisaccate pollen such as *Illinites unicus*, *I. annosus*, *Protohaploxylinus* spp. and *Striatoabieites* spp. are relatively abundant in this sample and this feature along with a specimen of *Vittatina* sp. indicates a Stephanian age. The other samples contained still smaller residues with limited spore-pollen assemblages in which striate pollen are prominent. It is possible that these lower assemblages are cavings contaminants given the low yields.

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**INTERVAL:** 2900'-4220'

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Vestispora foveata* and the lower numbers of striate pollen at and below 2900'.
- The presence *V. witneyensis* at 3050'.
- The presence of *Cadiospora magna* throughout the section.

**Remarks**

*V. foveata* is an essentially Westphalian D-C species although rare specimens are present in the basal Stephanian of the Sydney Basin. However, Stephanian markers are absent here and there is also a marked drop in the number of striate bisaccate pollen. *V. witneyensis* is confined to Westphalian D strata in the U.K.

*Cadiospora magna* is present in all samples and abundant in two of them. It is present in the lowest sample studied, at 4220', which indicates that, if these specimens are *in situ*, the section at this point is Westphalian D in age.

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## SECTION 19

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### BEATON POINT F-70

Thirty-two slides prepared from cuttings samples covering the 710m-1720m interval were analysed and the results are plotted on Enclosure \_\_.

According to the well history reports, 27 sidewall cores were shot. The breakdown would probably be improved by a palynological study of these samples since there is evidence of significant cavings contamination.

#### Succession

Interval	Age
720m-?980m	Westphalian D
?980m-1430m	Mid to late Westphalian C
1430m-1720m	Early Westphalian C

**INTERVAL:** 720m-980m  
**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Cadisporea magna* and *Raistrickia aculeata* and *Thymospora* spp. at and below 720m.
- The presence of *Schopfites dimorphus* at 740m.
- The presence of *Knoxisporites stephanephorus* at and below 830m.

#### Remarks

These assemblages are dominated by long-ranging spores typical of the late Westphalian including *Lycospora* spp., *Endosporites globiformis*, *Crassispora kosankei* and *Punctatospirites* spp. with smaller numbers of *Vestispora fenestrata*, *Triquitrites* spp. and rare *Torisporea securis*.

The age is based on the presence of *Cadisporea magna*, *Raistrickia aculeata*, *Thymospora* spp. and *Schopfites dimorphus* which are presumed to be *in situ*. It should



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be pointed out that there are some 200m of uncased hole above the studied section and, given the prevalence of cavings in the lower parts of the well, these species may have caved. Peppers (1985) states that this assemblage appears in the latest Westphalian C but Smith & Butterworth (1967) and Smith (1987) maintain that the event occurs at the base of the D.

If the specimens of *Knoxisporites stephanephorus* are *in situ* and not recycled, the section at 830m is no younger than mid-Westphalian D.

**INTERVAL:** ?980m-1430m

**Age:** Mid to late Westphalian C

The age of this interval is based on the following criterion:

- The appearance of *Vestispora cf. psuedoreticulata* at 980m.

**Remarks**

The top of the Westphalian C is difficult to determine. The assemblages from this interval are essentially similar to those in the overlying interval, indeed, Westphalian D markers continue to occur, sometimes in significant numbers as at 1185m and 1245m.

*Vestispora pseudoreticulata sensu stricto* is an essentially C and B species but it does occur sporadically in earliest D sediments. The specimen here is broken and the identification may be somewhat tentative.

Since Westphalian D markers are present as undoubted cavings in the underlying interval, their occurrences here are interpreted as cavings and the D-C boundary tentatively placed at 980m.

**INTERVAL:** 1430m-1720m

**Age:** Early Westphalian C

The age of this interval is based on the following criteria:

- The presence of *Raistrickia fulva* at and below 1430m.
- The presence of *Vestispora tortuosa* and *V. psuedoreticulata* s.s. at and below 1430m.

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- The presence of *Dictyotriletes muricatus* at 1480m.
  - The presence of *Knoxisporites triradiatus* at 1680m.
  - The presence of *Triquitrites tribullatus* at and above 1650m.
  - The presence of *Vestispora fenestrata* and *V. laevigata* at and above 1720m.
  - The presence of *Microreticulatisporites sulcatus* at and above 1750m.
  - The absence of *Torispora securis* and the great reduction in numbers of *Punctatosporites* spp. below 1450m.

#### Remarks

A major palynological change is apparent over the 1430m-1450m interval. Mid-Westphalian C and younger associations give way to early Westphalian C assemblages.

*Raistrickia fulva*, *Dictyotriletes muricatus* and *Knoxisporites triradiatus* do not range above the early Westphalian C. Their extinction is approximately concomitant with the appearance, in abundance, of the *Torispora* spp. - *Punctatosporites granifer/minus* association. The latter are essentially absent below 1450m and isolated specimens are probably cavings contaminants.

The interval is also characterised by an increase in numbers and diversity of *Vestispora* spp. *V. tortuosa* and *V. pseudoreticulata* s.s., while they range into younger strata, are more numerous in the early C and late B in Nova Scotia.

Small forms of *Triquitrites tribullatus* persist down to 1650m. This taxon first appears in the early C prior to the *Torispora* - *Punctatosporites* epibole mentioned above.

*Vestispora fenestrata* and *V. laevigata* are present at 1720m. If these specimens are *in situ*, the age of the section at this point is no older than early Westphalian C. The latter species is rare in the well and these specimens could possibly be *in situ*. *V. fenestrata* is present in most samples in the well and cavings contamination is not out of the question, especially when D markers occur at 1620m. *Microreticulatisporites sulcatus* is also present in small numbers down to 1700m. This species does not range below the C.

The Westphalian B-C transition in both the Cumberland and Sydney Basins is characterised by abundant *Vestispora* spp., especially *V. tortuosa*, *V. magna* and *V. pseudoreticulata*. This feature, present in Bradelle L-49, is not seen here and there are no other strong indications of B influence. The age of the section is therefore considered to be early Westphalian C.

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## SECTION 20

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### EAST POINT E-47

Eighteen slides prepared from cuttings samples covering the 350m-2660m interval were examined. The uppermost slide was barren and the effective interval analysed was 1020m-2660m. The species present are recorded on Enclosure \_\_.

The biostratigraphic breakdown is based on samples taken at an average spacing of 152m over the 1010m-2380m interval. The remainder of the well was usually sampled at a more practical 30m spacing. Lithologies may have governed the wider spacing. According to the well history reports, 43 sidewall cores were shot. The breakdown would probably be improved by a palynological study of these samples.

### Succession

Interval	Age
1020m-2120m	Late Stephanian D to B
2120m-2440m	Early Stephanian B to late Westphalian D
2440m-2660m	Westphalian D

**INTERVAL:** 1010m-2120m

**Age:** Late Stephanian D to B

**Zone:** *P. novicus* - *bhardwaji* - *C. major*, Clayton et al. (1977)

The age of this interval is based on the following criteria:

- The abundance of *Potonieisporites* spp. throughout the interval.
- The relative abundance of striate bisaccate pollen grains.
- The presence of *Vittatina* sp. at 1020m.
- The presence of *Lundbladispora gigantea* at 1560m.

### Remarks

Although *Potonieisporites* spp. first appear in the Namurian and are often present in Westphalian samples, they do not become abundant until the Stephanian. Barss & Hacquebard (1967) use this feature as one of the criteria for defining the Stephanian. In Europe, the increase in *Potonieisporites* spp. occurs in the late Stephanian B (Clayton et al., 1977) and is probably associated with widespread increases in aridity.



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Striate pollen are relatively numerous given the generally low yields from this interval and a specimen of *Vittatina* sp. is present at 1020m and *Lundbladispora gigantea* at 1560m. Assemblages such as this can be found in the Early Permian however, *Vittatina* spp. would be far more numerous and *Florinites* spp. less abundant.

**INTERVAL:** 2120m-2440m

**Age:** Early Stephanian B to late Westphalian D

The age of this interval is based on the following criteria:

- The significant drop in numbers of *Potonieisporites* spp.
- The presence of *Angulisporites splendidus* at 2120m.

#### Remarks

The presence of *Angulisporites splendidus* at the top of this interval indicates that the section at this point is still Stephanian in age. There is a pronounced change in the quality of the assemblages at and below 2310m. This presumably reflects a change to wetter conditions since species such as *Lycospora pusilla*, *L. orbicula*, *Endosporites globiformis* and *Punctatosporites minutus* appear in abundance. The Stephanian A and older species *Vestispora fenestrata* appears at 2380m. The same horizon also marks the highest occurrence of *Granisporites medius*. This species does not range above the Westphalian D equivalent in Illinois (Peppers, 1985) but is present in the earliest Stephanian A of Iowa (Ravn, 1986).

The Westphalian-Stephanian (Cantabrian) boundary in the Sydney Basin is poorly defined using the palynoflora. In Europe, Clayton et al. (1977) show a microfloral change within the Stephanian A. This interval is therefore assigned a transitional Stephanian-Westphalian age.

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**INTERVAL:** 2440m-2660m

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Vestispora foveata* at 2440m.
- The presence of *Cadiospora magna* down to 2660m.
- The presence of *Raistrickia aculeata* at 2560m.

**Remarks**

The assemblages from this interval are generally poor and the palynomorphs are highly corroded. *Vestispora foveata* is an essentially Westphalian D-C species although it occurs, but rarely, in the earliest Stephanian of the Sydney Basin. The presence of several specimens at 2440m almost certainly signifies the presence of Westphalian D strata.

*Raistrickia aculeata* is present at 2560m and *Cadiospora magna* is present down to 2660m. The preservation of the specimens indicates that they are probably *in situ*. These species are considered by Peppers (1985) to range into the latest Westphalian C but Smith & Butterworth (1967) and Smith (1987) state that they do not range below the D.



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## SECTION 21

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### BRADALLE L-49

One hundred and eighteen slides from the 1100'-14500' interval were analysed and the results are plotted on Enclosures \_\_ and \_\_.

A sample from core #1 at 3173' proved to be barren but a sample from core #2 at 7368' was productive. No slides from core #3 (9648'-9675') were available. The study is based essentially on cuttings samples with all the inherent problems of cavings contamination. Sidewall cores were shot and preparations from these might improve the breakdown, particularly around the Westphalian C-D and Stephanian boundaries.

The section below 7130' comprises the Windsor and Horton groups. Very little identifiable *in situ* material is present below core #2 and the residues are dominated by cavings contaminants. However, the cavings provided useful information which helped resolve the age of the section immediately above the Windsor.

### Succession

Interval	Age	Zone
1100'-3420'	Stephanian A - early B	
3420'-4830'	Westphalian D	
4830'-5430'	Mid to late Westphalian C	
5430'-5930'	early Westphalian C	
5930'-?6730'	Probably Westphalian B	
?6730'-7030'	Namurian C	
7030'-?9030'	Visean	NS-AT
?9030'-14500'	Indeterminable	

**INTERVAL:** 1100'-3420'

**Age:** Stephanian A - early B

The age of this interval is based on the following criteria:

- The presence of *Angulisporites splendidus* at 3060'.
- The presence of *Vittatina* sp. as cavings contaminants at and below 4630'.
- The presence of relatively numerous bisaccate and striate bisaccate pollen, especially in the upper part of the interval.
- The lack of abundant *Potonieisporites* spp.
- The presence of *Microreticulatisporites sulcatus* at and below 2780'.
- The presence of *Cadiospora magna*, *Endosporites globiformis* and *Raistrickia aculeata* at and below 2540'.

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**Remarks**

Only ten samples at an average spacing of 232' were prepared from this interval, presumably because of red-beds. The upper 3 samples (1100'-1820') are very poor but contain relatively high numbers of bisaccate and striate bisaccate pollen. This feature is typical of Stephanian to Permian rocks in the area but the lack of *Potonieisporites* spp. in abundance suggests a pre-late Stephanian B age. Specimens of *Cadiospora magna*, *Raistrickia aculeata* and *Endosporites globiformis* at 2540' also indicate that the section is no younger than Stephanian at this depth.

*Angulisporites splendidus*, which first appears in the mid-Stephanian A is present at 3060'. The presence of post-Westphalian strata is also confirmed by caved specimens of *Vittatina* spp. at and below 4630' and of *Centonites symmetricus* at and below 4730'.

*Microreticulatisporites sulcatus* is numerous at 2780'. Isolated specimens of this taxon have been found in the latest Virgilian of Illinois but it is an essentially earliest Stephanian B and older species.

*Mooreisporites inusitatus* occurs at and below 3060'. According to Peppers (1985) this species does not range above the Westphalian D but it is certainly present in the early Stephanian of the Sydney Basin.

**INTERVAL:** 3420'-4830'

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The presence of *Granisporites medius* at and below 3420'.
- The presence of *Vestispora laevigata* at and below 4030'.
- The presence of *Vestispora burfordensis* at 4430'.

**Remarks**

The highest occurrence of *Granisporites medius* is used here, as in other wells in this study, to help define the top of the Westphalian D. Peppers (1985) shows that it does not range above D equivalent strata in Illinois but Ravn (1986) extended the range into the

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earliest Missourian. Data from the Sydney Basin tend to confirm it as an essentially D and older species.

Apart from *Vestispora laevigata* at and below 4030' and *V. burfordensis* at 4430', species which do not range above the Westphalian, the assemblages are comprised largely of the mid-Westphalian C to early Stephanian "background" association. This association is comprised of abundant *Endosporites* spp. and *Punctatosporites* spp. and numerous *Vestispora fenestrata* and *Triquitrites* spp. with fairly persistent striate bisaccate pollen. *Torispora securis* was not recorded, which is unusual.

Westphalian D - Stephanian species such as *Cadiospora magna*, *Thymospora* spp., *Raistrickia aculeata*, *Mooreisporites inusitatus* and *Schopfites dimorphus* also occur.

**INTERVAL:** 4830'-5430'

**Age:** Mid to late Westphalian C

The age of this interval is based on the following criteria:

- The presence of *Vestispora tortuosa* at and below 4830'.
- The presence of *V. pseudoreticulata* at and below 5330'.

#### Remarks

*Vestispora tortuosa* ranges into the very earliest Westphalian D but for all practical purposes is a B-C species. The assemblages are little different from the overlying interval. Westphalian D and younger species are often present as cavings contaminants. The boundary may be low and a study of SWC slides might prove worthwhile.

The lowest sample contains *V. pseudoreticulata* which has a similar range to *V. tortuosa* but is rare above the mid-C. This sample also contains a single specimen of *Torispora securis* which is surprisingly rare in this well.



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**INTERVAL:** 5430'-5930'

**Age:** early Westphalian C

The age of this interval is based on the following criteria:

- The appearance of *Dictyotriletes muricatus* at 5430.
- The increase in abundance of *Vestispora pseudoreticulata* at and below 5430'.
- The increase in abundance of *V. tortuosa* at and below 5730'.
- The appearance of *Knoxisporites triradiatus*, *Raistrickia fulva* and *V. magna* at 5730'.
- The significant reduction in the number of specimens of *Punctatosporites* spp., *Triquitrites* spp. and *Illinites unicus*.

#### Remarks

The top of this zone marks the changeover from the mid-Westphalian C - Stephanian "background association" to early C assemblages. This change is also apparent in Beaton Point F-70.

Several early C and older species make their first downhole appearance such as *Dictyotriletes muricatus*, *Knoxisporites triradiatus* and *Raistrickia fulva*. *Vestispora* spp. are also more prominent which is typical of the early C - late B of Nova Scotia.

The downhole disappearance of the mid-C to Stephanian "background association" has been almost certainly extended by caving since Westphalian D markers still occur. A study of SWC material would certainly add some precision to the definition of the boundary.

**INTERVAL:** 5930'-?6730'

**Age:** probably Westphalian B

The age of this interval is based on the following criteria:

- The marked increase in abundance of densospores at and below 5930'.
- The presence of *Dictyotriletes bireticulatus* at and below 5930'.
- The presence of *Apiculatisporis variocorneus* at and below 6330'.

#### Remarks

Although *Dictyotriletes bireticulatus* ranges to the top of the Westphalian C, it is more prominent in the Westphalian B. *Ahrensia sporites guerickei* and *Grumosia sporites varioreticulatus*, which die out in the early C are also prominent here. Peppers (1985)

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extends the range of *Apiculatisporis variocorneus* to the mid-C in Illinois, but it does not range above the B in Britain and it tends to be more persistent in the B of Nova Scotia.

These assemblages are highly distinctive in that densospores are persistently present in moderate to large numbers. This group is more abundant below the Westphalian C which Smith (1962, 1964) attributed to a more humid climate. Such assemblages are not present in equivalent strata in the Western Cumberland Basin nor in the Sydney Basin. This implies that this part of the Maritimes Basin had a more humid climate in the Westphalian B than other areas.

**INTERVAL:** ?6730'-7030'

**Age:** Namurian C

The age of this interval is based on the following criteria:

- The presence of *Crassispora maculosa* and *Kraeuselisporites* sp. at 6730'.
- The presence of *Pteroretis* sp. at and below 6830'.
- The presence of significant numbers of these species and *Reticulatisporites carnosus* and *Knoxisporites dissideus* as cavings contaminants in the Windsor-Horton section.

#### Remarks

The assemblages here are little different from the overlying interval and cavings contamination virtually obliterates the *in situ* assemblage. The Namurian species listed above could easily be interpreted as reworked into the Westphalian B. However, specimens of *Pteroretis* sp. are sporadically present throughout the underlying Windsor-Horton section but particularly below 12500' where *Crassispora maculosa*, *Reticulatisporites carnosus*, *Knoxisporites dissideus* and *Kraeuselisporites* spp. are also found as cavings contaminants.

The range of *Pteroretis* sp. is uncertain but it appears to be confined to the Namurian C (Yeadonian) of Britain. *C. maculosa* ranges into the Namurian C, *K. dissideus* is an essentially Namurian species and *R. carnosus* dies out in the early Westphalian A.

Since most of the evidence for this unit is present as cavings, the top is only tentatively placed at 6730'.



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Rocks of this age may also be present in Wellington #1 (4460'-5000') although the data there are poor. An isolated specimen of *Pteroretis* sp. is also present in Beaton Point #1 at 1430m at the top of the early Westphalian C.

**INTERVAL:** 7030'-?9030'  
**Age:** Viséan  
**Zone:** NS-AT, Utting (1987)

The age of this interval is based on the following criteria:

- The presence of *Retusotriletes incohatus* at and below 7030'.
- The presence of *Auroraspora macra* at and below 7130'.
- The presence of *Densosporites columbaris* at 7230'.
- The presence of *Crassispora trychera* at and below 7368'.
- The presence of *Knoxisporites stephanephorus* and *Spelaeotriletes tuberosus* at 7368'.
- The presence of *Rugospora minuta* at and below 8230'.

#### Remarks

The core at 7368' yielded a rich assemblage typical of the Windsor Group. The level of thermal maturity is quite high and the spores are much darker than in the overlying interval. The boundary is drawn at the first appearance of dark, Windsor Group spores at 7030' but it may be slightly higher since the 6930' sample contains abundant fusinitic debris.

The assemblage is typical of the NS-AT zones of Utting (1987). The presence of a questionable specimen of *Knoxisporites triradiatus* in the core and what appear to be *in situ* specimens at 7030' and 8030' indicate that the upper part of the interval is of AT Zone age. A specimen of *Spelaeotriletes tuberosus* in the core indicates that the section at this depth is no younger than the AT Zone.

The preservation of the spores deteriorates rapidly below the core and 9030' appears to be the lower limit for *in situ* spores.

Cavings from the Westphalian are extremely heavy and dominate the samples.

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**INTERVAL:** ?9030'-14500'

**Age:** Indeterminable

**Remarks**

The assemblages consist of abundant Westphalian cavings with occasional Namurian species. Smaller numbers of highly carbonised, indeterminate spores also occur.

There are no identifiable, *in situ* species to assign an age.

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## SECTION 22

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### CABLEHEAD #1

Forty-two slides prepared from cuttings samples over the 1970m-3235m interval were analysed and the data are plotted on Enclosure \_\_\_.

The recoveries were frequently low and the assemblages of poor quality. The section includes Westphalian D to early but not earliest Westphalian C strata but the C-D boundary is impossible to place with any degree of accuracy.

### Succession

Interval	Age
1970m-?2900m	Westphalian D
?2900m-3200m	Late to mid-Westphalian C
3200m-3235m	Early Westphalian C

**INTERVAL:** 1970m-?2900m

**Age:** Westphalian D

The age of this interval is based on the following criteria:

- The lack of any obvious Stephanian influences.
- The presence of *Granisporites medius* at 1970m and in abundance at and below 2060m.
- The presence of *Cirratriradites maculatus* at 2120m and 2150m.
- The presence of *Vestispora foveata* and *V. laevigata* at and below 2330m.
- The presence of *V. colchesterensis* at and below 2570m.

### Remarks

The assemblages from this interval are typical of the Westphalian D except that they are often of poor quality, in contrast to other sections in this study. There is no sign of any Stephanian influence in the uppermost samples.

*Granisporites medius* ranges into the earliest Stephanian but is essentially a Westphalian species particularly when consistently numerous to abundant. *Cirratriradites maculatus*,

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*Vestispora foveata* and *V. laevigata* do not range above the Westphalian D and *V. colchesterensis* is confined to D strata.

The remainder of the total assemblage consists of the mid-C to Stephanian "background association" of *Punctatosporites* spp., *Triquitrites* spp., *Illinites unicus* and *Torispora securis* with D and younger species such as *Cadiospora magna* and *Raistrickia aculeata*.

There is evidence of Arenig-Llanvirn reworking at 2780m.

**INTERVAL:** ?2900m-3200m

**Age:** Late to mid-Westphalian C

The age of this interval is based on the following criteria:

- The lowest occurrence of Westphalian D marker species at 2900m.
- The presence of *Anapiculatisporites minor* at 2960m.

#### Remarks

The upper boundary of this interval is placed on the lowest occurrence of *Cadiospora magna* at 2900m. Since the samples were prepared from cuttings, the lower range may have been extended by cavings as in other wells in this study. The boundary may therefore be low. The only other indication of the well penetrating C strata is the presence of *Anapiculatisporites minor* at 2960m.

The remainder of the total assemblage consists of mid-Westphalian to Stephanian species such as *Punctatosporites* spp., *Triquitrites* spp., *Illinites unicus* and *Torispora securis* with C-D species such as *Vestispora foveata*, *V. cf. foveata* and *V. laevigata*. *V. tortuosa* is present at 3170m, the lowest sample in the interval.

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**INTERVAL:** 3200m-3235m  
**Age:** early Westphalian C

The age of this interval is based on the following criteria:

- The presence of *Knoxisporites triradiatus* at and below 3200m.
- The presence of *Vestispora* spp. at and below 3200m.

**Remarks**

Towards the base of the overlying interval, the presence of palynomorphs which make up the mid-Westphalian C to Stephanian "background association" becomes sporadic. This feature is present in other sections in this study and is typical of the mid to early C transition.

The appearance of *Knoxisporites triradiatus* indicates the presence of the early Westphalian C. Also present in these poor assemblages are fragments and operculae of *Vestispora* spp., probably belonging to *V. pseudoreticulata/magna*. This group is often abundant in the early C in the Maritimes.



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## SECTION 23

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### PORT HOOD #1

Twenty-seven cuttings samples from the 440'-9770' interval were processed. The spacing varied from 80' to 740'. The species present are recorded on Enclosure \_\_.

#### Succession

Interval	Age	Zone
440'-3750'	Late Namurian to ?early Westphalian A	
4540'-4680'	Namurian B	KV
5160'-5610'	Namurian A	SO, TK, NC (pars)
5610'-8730'	Visean	SM-AT
9140'-9770'	Visean	?NS

**INTERVAL:** 440'-3750'

**Age:** Late Namurian to ?early Westphalian A

The age of this interval is based on the following criteria:

- The presence of numerous to abundant *Potonieisporites* spp. and *Florinites visendus*.

#### Remarks

These assemblages closely resemble those from the lower part of the Boss Point Formation, both in the type section and in various localities collected for this study. They are most likely of Late Namurian age but an earliest Westphalian age cannot be ruled out despite the lack of Westphalian species.

The typical Windsor-Canso spore assemblage comprising *Retusotriletes incohatus*, *Rugospora minuta*, *Crassispora trychera* and *Auroraspora macra* is prominent and may have been reworked. The presence of *Spelaeotriletes echinatus* certainly indicates recycling of Windsor or Horton sediments. Reworked acritarchs are present in most samples. They are usually long-ranging forms but some have Ordovician affinities.

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**INTERVAL:** 4540'-4680'  
**Age:** Namurian B  
**Stages:** lower Marsdenian to Kinderscoutian  
**Zone:** KV, Clayton et al. (1977)

The age of this interval is based on the following criteria:

- The presence of *Rugospora corporata* and *R. corporata verrucosa* at and below 4540'.

#### Remarks

There is a 790' gap between the lowest sample of the overlying interval and the top of this interval.

Assemblages from this and the underlying interval are similar to those described by Neves & Belt (1970) from the Antigonish and the Port Hood-S.W. Mabou basins. In the latter area, they examined the upper part of the Hastings, the Grant Point and the Emery Brook formations in outcrop.

The assemblages they described differed in one important respect: they did not record *Florinites visendus* in any of their samples. A small number of specimens is present at 4540' and a single specimen is present at 5290' which may have caved.

Apart from the presence of *Rugospora corporata* and *R. corporata verrucosa*, a species which does not range above the KV Zone or lower Marsdenian, there are other changes in the assemblages. There is a marked increase in the numbers of *Crassispora trychera*, *Retusotriletes incohatus* and *Rugospora minuta* which Neves & Belt also found to be abundant in their Cansoan samples. *Potonieisporites* spp. and monosaccate pollen fragments are less numerous and somewhat more sporadic in occurrence.

Reworked acritarchs are present at 4540' and one specimen has an Ordovician affinity. The degree of thermal maturation is increasing and indeterminate, corroded spores are not uncommon.

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**INTERVAL:** 5160'-5610'  
**Age:** Namurian A  
**Stages:** Alportian to Pendelian  
**Zone:** SO, TK, NC (pars), Clayton et al. (1977)

The age of this interval is based on the following criteria:

- The presence of *Grandispora spinosa* at and below 5160'.
- The presence of *Schulzospora elongata* at and below 5370'.
- The continued presence of *Potonieisporites* spp. and monosaccate pollen fragments.

#### Remarks

There is a 480' gap between the base of the overlying interval and the top of this section.

The downhole appearance of *Grandispora spinosa* indicates that Namurian A strata have been penetrated. The presence of *Schulzospora elongata* confirms this. *S. bilunata* is also present but the upper range of this species has yet to be determined. Judging by their states of preservation, the specimens of *Potonieisporites* spp. and monosaccate pollen fragments are *in situ* and these do not range below the Namurian.

The most noticeable feature of this sample is the presence of "*Norandacysta*." This informally named taxon is highly distinctive and is known only from the Namurian of Nova Scotia. Neves & Belt (1970) illustrate it as *Incertae sedis* (plate 3, fig. 19) but quote only one locality for it in the upper Hastings Formation in the S.W. Mabou area. The present author has recorded it in rocks of similar age to the east of Port Hawkesbury.

**INTERVAL:** 5610'-8730'  
**Age:** Viséan  
**Zones:** SM-AT, Utting (1987)

The age of this interval is based on the following criteria:

- The presence of *Vallatisporites galearis* at 5610'.
- The presence of *Schopfipollenites arcadiensis* at and above 8730'.

#### Remarks

The level of thermal maturation has increased to such an extent that indeterminate, blackened spores are numerous to abundant. Cavings contaminants are also more obvious.

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*Vallatisporites galearis* was first described from the Visean of Britain (Sullivan, 1964) and as far as the author is aware, it does not range into the Namurian. Poor specimens of *Schopfipollenites arcadiensis* at 8730' appear to be close to *in situ*, judging by their preservation, indicating that the section at this point is unlikely to be older than the AT Zone of Utting (1987).

The *in situ* background microflora is typical of the Windsor Group.

**INTERVAL:** 9140'-9770'  
**Age:** Visean  
**Zone:** ?NS, Utting (1989)

The age of this interval is based on the following criterion:

- The presence of a typical Windsor assemblage.

**Remarks**

Only two samples were submitted below 8730', i.e., 9140' and 9770'. Both yielded small residues dominated by abundant indeterminate, black spores of sizes and shapes typical of the Windsor. Identifiable species include *Auroraspora macra*, *Rugospora minuta*, *Crassispora trychera* and *Retusotriletes incohatus*, the latter two in abundance.

Due to the lack of *in situ* AT Zone marker species, the interval is tentatively assigned to the NS Zone.

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## SECTION 24

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### MULL RIVER #1

Twenty-seven cuttings samples from the 35m'-1502m' interval were processed. Down to 570m the sample spacing is approximately 31m but below this it varies from 30m to 145m with an average of 85m. The species present are recorded on Enclosure \_\_\_.

#### Succession

Interval	Age	Zone
35m-145m	Late Tournaisian	<i>C. decorus</i> - <i>S. claviger</i> , 5
145m-410m	Late Tournaisian	<i>S. pretiosus</i> , 4
410m-1502m	Late Tournaisian	upper <i>S. cabotii</i> , 3B

**INTERVAL:** 35m-145m

**Age:** Late Tournaisian

**Zone:** *C. decorus* - *S. claviger*, Utting et al. (1989); 5, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Spelaeotriletes pretiosus* and *Vallatisporites vallatus* at and below 35m.
- The presence of numerous *Vallatisporites* cf. *ciliaris*, *Crassispora trychera* and *Schopfites claviger*.
- The presence of *Densosporites columbaris* at and below 115m.

#### Remarks

The presence of numerous *Spelaeotriletes pretiosus* and *Vallatisporites vallatus* indicates that the well spudded in Tournaisian rocks. The presence of numerous specimens of a distinctive variety of *V. ciliaris* as well as numerous *Crassispora trychera*, *Schopfites claviger* and, at the base of the interval, *Densosporites columbaris* is typical of Wilkie Brook equivalent assemblages described elsewhere in this report.

Reworked acritarchs can be significant components of the assemblages. Most are long-ranging forms but some are of Ordovician origin.



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**INTERVAL:** 145m-410m

**Age:** Late Tournaisian

**Zone:** *S. pretiosus*, Utting et al. (1989); 4, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The increase in abundance of *Spelaeotriletes pretiosus* at and below 145m.
- The presence of rare *S. cabotii* at and below 205m.

**Remarks**

The presence of abundant *Spelaeotriletes pretiosus* with rare and sporadic *S. cabotii* defines the *S. pretiosus* Zone of Utting et al. (1989). Assemblages of this type are typical of the Cheverie Formation.

Reworked acritarchs, including Ordovician and Silurian forms, are usually present.

**INTERVAL:** 410m-1502m

**Age:** Late Tournaisian

**Zone:** upper *S. cabotii*, Utting et al. (1989); 3B, Dolby (1991, 1993)

The age of this interval is based on the following criteria:

- The presence of *Anapiculatisporites hystricosus* at and below 410m.
- The increase in abundance of *Vallatisporites vallatus* at and below 515m.
- The decrease in numbers of *Spelaeotriletes pretiosus* at and below 515m.
- The slight increase in *S. cabotii* at and below 1015m.
- The presence of *Schopfites claviger* at and above 1420m.
- The presence of *Vallatisporites ciliaris* at and above 1450m.
- The presence of significant numbers of *Crassispora trychera* at 1502m.

**Remarks**

Utting et al. (1989) do not record *Anapiculatisporites hystricosus* above the *S. cabotii* Zone and the downhole appearance of this species is used to define the top of the interval. Just below this at 515m, *Vallatisporites vallatus* increases in abundance concomitant with a marked decrease in numbers of *S. pretiosus*. This feature is also typical of uppermost Horton Bluff assemblages.

*S. cabotii* remains a minor component but shows a slight increase towards the base of the well.

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The percentage data based on counts of 200 specimens (400 for PT0005) are presented in the following pages. Those species which were not recorded in the count are included as traces. The computer program can plot numerical data only and the number ".0001" is used as a trace symbol.

The species are grouped botanically as follows:

- Arborescent lycopods
- Herbaceous lycopods
- Marattiaceous ferns
- Other ferns
- Sphenopsids
- Pollen
- Spores of unknown affinity