PALYNOLOGICAL ANALYSES OF CARBONIFEROUS OUTCROP & CORE SAMPLES FOM THE NATMAP PROGRAM, 1994 FIELD SEASON

by
G. Dolby

Project 94.07
March 1995

Prepared for:
Geological Survey of Canada
Atlantic Geoscience Centre
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, N.S. B2Y 4A2

Prepared by:
G. Dolby, P. Geol.
6719 Leaside Drive S.W.
Calgary, Alberta
T3E 6H6

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This report summarises the palynological analyses carried out on samples collected in 1994 as part of the Natmap program. The scientific authority was Dr. R. Fensome of the Geological Survey of Canada, Atlantic Geoscience Centre. 370 slides processed by the G.S.C. and by Global Geolab Ltd. were examined. The data from continuous sections or wells are plotted on Enclosures 1-12 using the GeoSci plotting program. Full species lists from other samples are not given in the text but are available on a diskette using the GeoSci program.

The report is arranged so that each section describes the results for the samples submitted by an individual worker. Occasionally, an age is assigned on the basis of the affinities of that assemblage rather than on the presence of specific markers. Field relationships may indicate that some of the assignments are possibly erroneous and further work may result in revisions. Any papers which use any of the palynological data should be submitted to the author for checking prior to submission for publication.

Tournaisian

The zonation for the Tournaisian (Text-figure 1) is that of Utting (1987b) and Utting et al. (1989) but uses numbers in place of spore names for the zones. Additional subzones have been tentatively erected below and above the *H. explanatus* - *E. rotatus* Zone of Utting et al. (1989) based on material from New Brunswick (Dolby, 1993).

During the course of the 1993 and 1994 Natmap programs, samples from the upper part of the Horton Group were studied which contained spores not previously seen in the Tournaisian of the Maritimes. These included *Densosporites columbaris*, a species found in the Visean, Windsor Group (Utting, 1987a) and a new and distinctive species of *Vallatisporites*. These were found together initially and a very late Tournaisian, Zone 5 age, equivalent to the Wilkie Brook Formation was assigned. The reasoning was that they represent a Visean influence or a transitional Tournaisian-Visean palynoflora not seen previously in the Wilkie Brook, a formation which generally consists of lithologies unsuitable for the preservation of spores. When the distinctive *Vallatisporites* species was encountered by itself a similar age was assigned. This may prove to be erroneous. Some of these dates may have to be revised when field relationships have been determined.

Visean - Namurian

The zonation used here is that of Utting (1987a) but the base of the Namurian is difficult to define. The palynological zonation of the European stratotypes is based on sections deposited under humid conditions whereas the co-eval climate in the Maritimes was arid to semi-arid. The different ecologies resulted in different spore-pollen sequences.

Monosaccate gymnosperm pollen first appear at the base of the Namurian and the presence of specimens of this group in Windsor type spore-pollen assemblages is typical of the Mabou Group. However, their presence is sporadic and a boundary thus defined may be high. In addition, isolated outcrop samples could erroneously be assigned a Visean age if these markers happen to be absent at that locality.

Late Namurian - early Westphalian (Yeadonian - Langsettian)

The base of the Westphalian is difficult to define palynologically which is due in part to the different climatic regimes in Europe and the Maritimes respectively. In addition to this factor, most of the samples studied have come from the Boss Point Formation where suitable lithologies are rare.

A model of the spore-pollen succession has been developed for correlation within the Maritimes and, tentatively, with Europe. It is based in large part on the development of the *Florinites* group of monosaccate gymnosperm pollen. *Florinites visendus*, a very large species, is found sporadically to the base of the Namurian in Europe. New species such as *F. mediapudens* appear at the base of the Westphalian A. *Florinites* spp. become abundant in the early mid-Westphalian A in both Europe and the U.S.A. when assemblages become diverse and include such species as *F. pumicosus* and *F. florinii*. It is probable that these latter two species appeared earlier.

In the proposed model, the Late Namurian is characterised by large monosaccates, *F. visendus* and *Potonieisporites elegans*. *F. pumicosus* may occur sporadically towards the Namurian - Westphalian Boundary. The appearance of the small forms *F. florinii* and *F. mediapudens* is used to mark the base of the Westphalian. In coaly sequences, the appearance of *Lycospora orbicula* may also be used. *Cingulizonates loricatus* is also a good marker but is usually rare. *Granulatisporites microgranifer* appears to be confined to the Westphalian but species such as this are not usually considered to be reliable indices.

Westphalian - Cantabrian - Stephanian

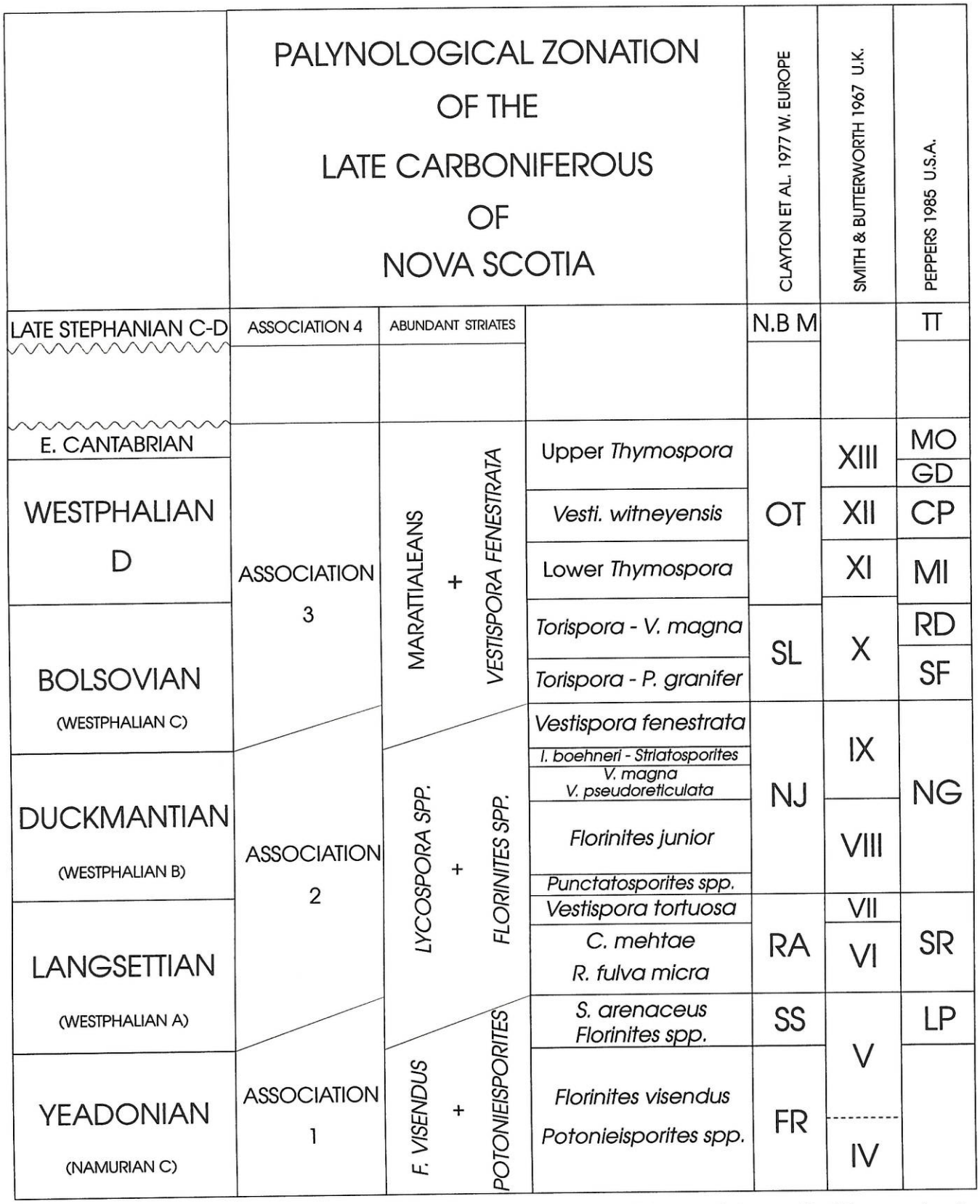
The zonation for the Westphalian to Stephanian is shown in Text-figure 2 and is based on work carried out in the Cumberland and Sydney Basins. The Westphalian B-C portion (Duckmantian - Bolsovian) is enlarged in Text-figure 3 to show the relative durations of the zones.

In some areas in this and previous studies, a late B age has been assigned to sections previously dated as early C by Barss. These assemblages contain abundant *Vestispora* spp. which Barss & Hacquebard (1967) gave an early C age. However, this group becomes prominent in the latest B, a feature noted by Smith & Butterworth (1967) in the U.K., and may be subdivided on the appearance of *V. fenestrata*, a C marker.

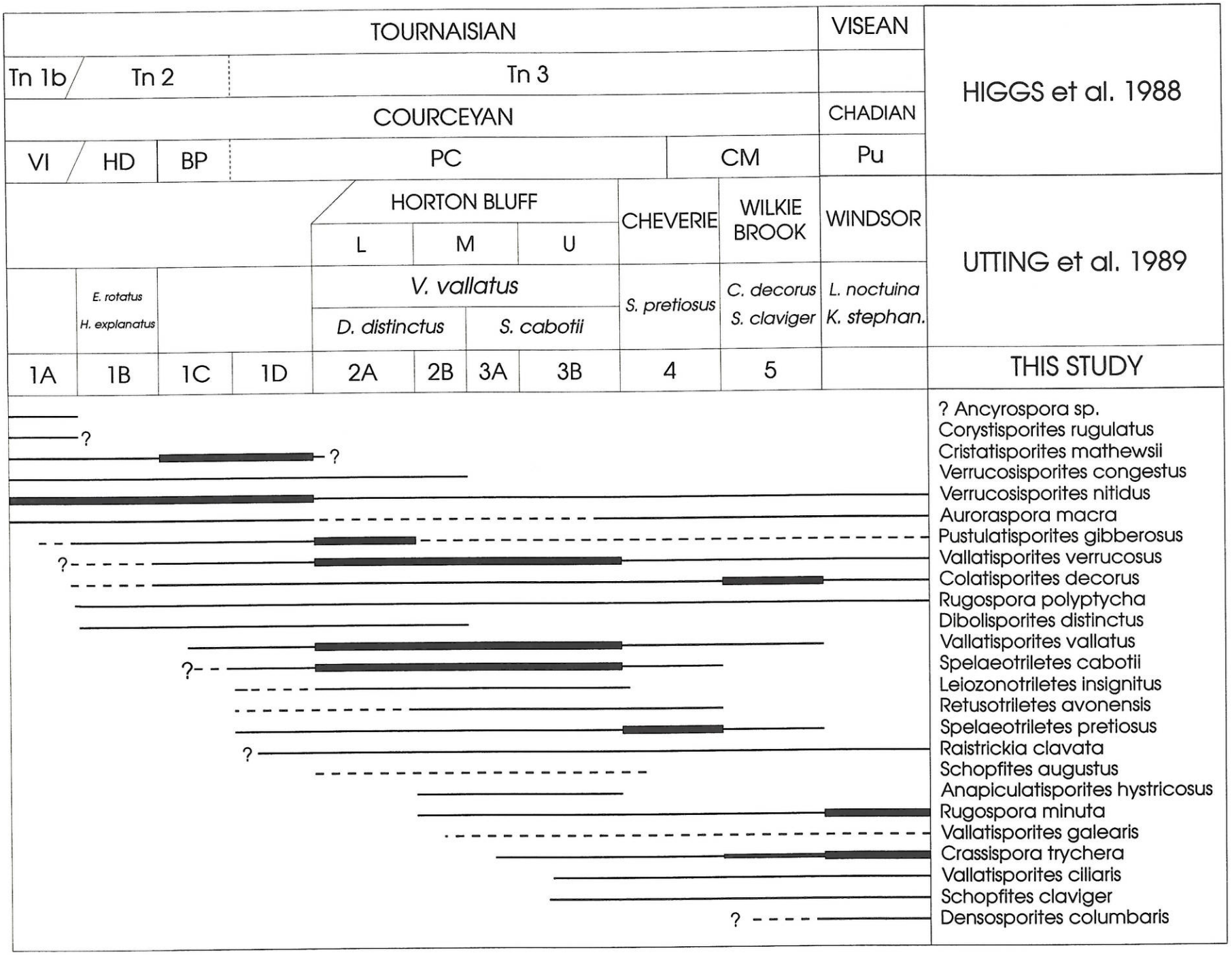
The base of the Cantabrian is difficult to define palynologically. Early Cantabrian assemblages are usually of Westphalian D character with the addition of rare and sporadic Stephanian species. Occasionally, samples rich in striate bisaccate pollen are encountered which are difficult to fit into the sequence as there is a strong Permian influence in these assemblages. At the Bell Symposium (1995) Wagner & Lyons stated that part of the Cantabrian and most of the Stephanian is missing throughout the Appalachians. This hypothesis explains the lack of good Stephanian palynofloras and the striate-rich samples are probably of late Stephanian age.

More work needs to be done to resolve this issue and an informal, international working group was established at the symposium to develop palaeobotanical and palynological criteria for recognising the Westphalian-Cantabrian Boundary.

TEXT FIGURE 2

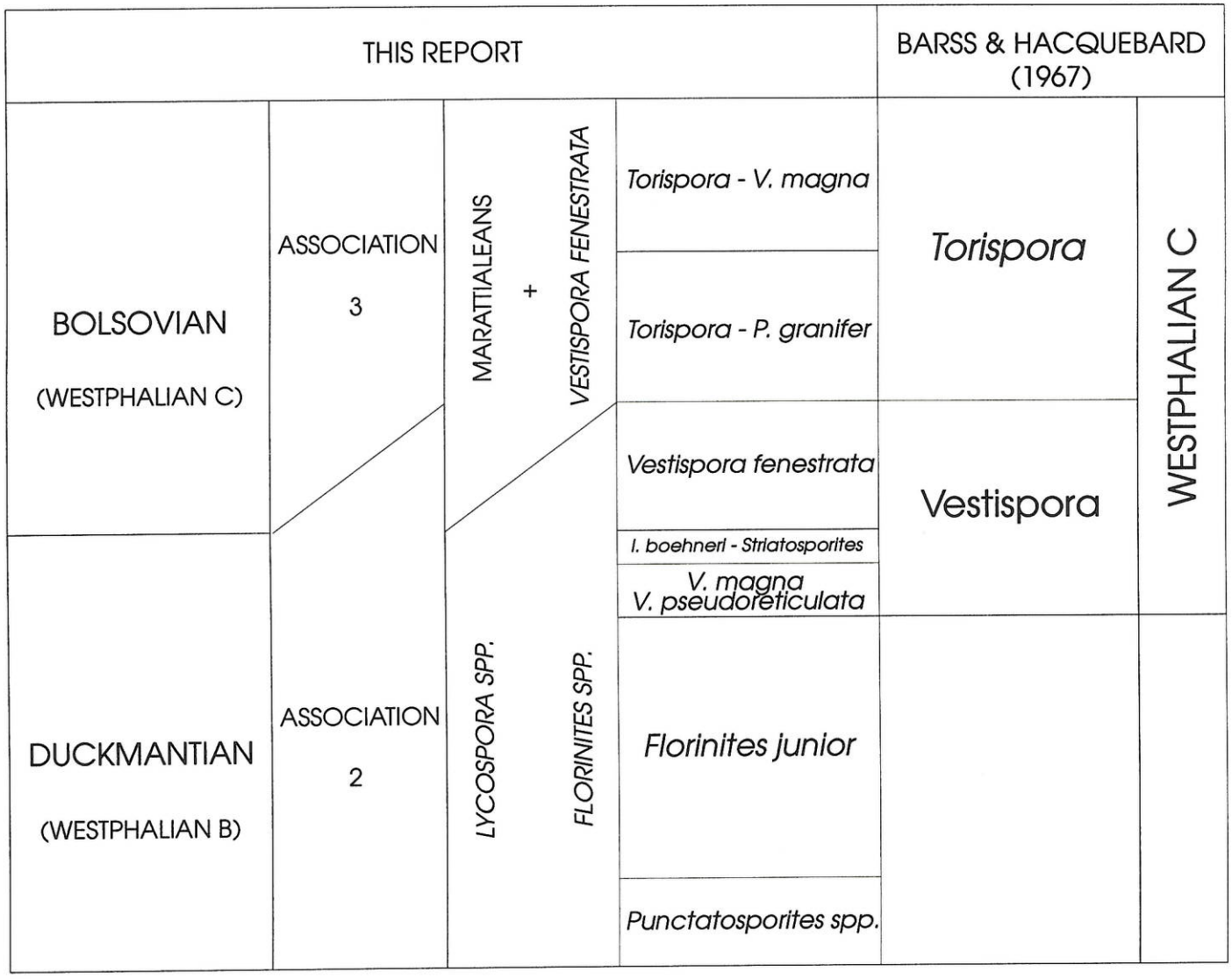


Late Cantabrian - late Stephanian C break as proposed by Wagner & Lyons (Bell Symposium)



TEXT FIGURE 1 **Spore zonation modified from Utting et al. 1989**

TEXT FIGURE 3 **Palynological zonation of the Westphalian B-C of Nova Scotia**



SUMMARY OF RESULTS

CK SERIES

Sample	Age	Zone/Assemblage
15	Westphalian A	2
19A	Early Westphalian	2
23	Indeterminable	
36	Early Westphalian	2
44	Westphalian C	3
48	mid to late Westphalian C	3
97A	Uncertain	
116	Indeterminable	
124	Indeterminable	
130	Indeterminable	
132	Indeterminable	

CL SERIES

143	Early Namurian	
152	Uncertain	
154	Early Namurian	
157	Early Namurian	
167	Westphalian C	3
169	Visean	AT
170	Indeterminable	
172	Indeterminable	
173A	Indeterminable	
173B	Indeterminable	
174A	Early Namurian	
174B	NYT basal Namurian A (Pendleian)	

CM SERIES

3A	Westphalian C	3
3B	?mid to late Westphalian C	3
6	Indeterminable	
8	Indeterminable	
9	Early Namurian	
13	Late Namurian	1
14	Late Namurian	1
18	Late Namurian	1

CM SERIES (continued)

Sample	Age	Zone/Assemblage
19	Early Westphalian A	2
20	Late Namurian - ?early Westphalian A	1
23	Indeterminable	
26	?Visean	
32A	early middle Westphalian C	3
32B	?late Westphalian C	3
33	probably mid to late Westphalian C	3
105B	Indeterminable	

CQ SERIES

76A	Indeterminable	
78B	early middle Westphalian C	3
83A	Indeterminable	
95A	Uncertain	
99A	Late Visean	AT
105	?mid Westphalian A	?2
107B	Visean	AT

CR SERIES

23	Indeterminable	
25	?Early Westphalian	2
26A	basal Late Westphalian A	C.m.-R.f.m./2
30A	Late Westphalian A	C.m.-R.f.m./2
61	Late Westphalian A	C.m.-R.f.m./2
63A	Late Westphalian A	C.m.-R.f.m./2
63B	Westphalian A	2
66	Westphalian A	2
67A	Early Westphalian A	F.-S.a/2
67B	basal Westphalian A	C.m.-R.f.m./2
68	Late Westphalian A	C.m.-R.f.m./2
68B	Late Westphalian A	C.m.-R.f.m./2
70	Late Westphalian A	C.m.-R.f.m./2
82A	Late Westphalian A	C.m.-R.f.m./2
83B	Westphalian A	2
129A	probably Westphalian C	3
131	probably Westphalian C	3
137	Indeterminable	
146A	latest Westphalian B - early Westphalian C	2-3
167	latest Westphalian B - early Westphalian C	2-3
173A	Late Westphalian A	C.m.-R.f.m./2
175	Early Westphalian A	F.-S.a/2

CS SERIES

Sample	Age	Zone/Assemblage
4A	Indeterminable	
8A	Indeterminable	
15	early mid Westphalian C	3
26A	?Westphalian A	?2
I1	?Stephanian	3

SAMPLE: CK015
Age: Westphalian A

Remarks

This poor assemblage is dominated by the larger species of Florinites such as *F. visendus* and *F. pumicosus* which are more numerous in the lower parts of the Cumberland Group. Specimens of *F. florinii* and *F. mediapudens* indicate that the sample is no older than Westphalian A in age.

Significant species

Florinites visendus (A)
F. florinii
Sinuspores sinuatus
F. pumicosus (A)
F. mediapudens
Auroraspora solisorta (A)

SAMPLES: CK019A, 036
Age: Early Westphalian

Remarks

These are extremely poor samples with much modern contamination in 019A. Of the few spores present, *Knoxisporites triradiatus* is numerous in 019A and specimens of *Sinuspores sinuatus* and *Plicatipollenites* sp. indicate a lower Cumberland Group rather than Stellarton Group age.

SAMPLES: CK023, 116, 124, 130, 132
Age: Indeterminable

Remarks

These samples yielded small residues of predominantly inertinitic kerogen with rare, long-ranging spores.

SAMPLE: CK044
Age: Westphalian C, undifferentiated

Remarks

This assemblage is dominated by species of *Lycospora*. The remainder of the assemblage is typical of Westphalian C and younger sediments (Assemblage 3) but there are no markers present with which to refine the age.

Significant species

Endosporites zonalis
Vestispora fenestrata
E. globiformis
Illinites boehneri

SAMPLE: CK048
Age: mid to late Westphalian C

Remarks

This is an unusual assemblage for the Stellarton Group. Striate bisaccate pollen are abundant and if this assemblage had been recovered from a sample outside the basin a younger age could easily be assigned. The pollen abundance and relative rarity of swamp species suggests a drier ?upland provenance for the organic residue.

Significant species

Illinites unicus (A)
I. boehneri
Striatopodocarpites sp.
Torispora securis (ER)
I. cf. *annosus*
Striatoabieites sp.
Protohaploxypinus sp.
Lycospora spp.

SAMPLE: CK097A
Age: Uncertain

Remarks

Although the sample comes from the Stellarton Formation there is no strong evidence for this in the assemblage. *Florinites visendus* is abundant which is more typical of the lower parts of the Boss Point. Recycled acritarchs and Windsor-Canso species are also abundant. A questionable striate pollen fragment and a specimen of *Endosporites globiformis* are the only forms more typical of the Stellarton Group and even the latter ranges to the base of the Westphalian B. This may be an example of massive reworking of Boss Point and Windsor/Mabou into the Stellarton Group.

Significant species

Florinites visendus (A)
?Striate bisaccate

Schopfipollenites ellipsoides (A)
Endosporites globiformis

Reworked
Acritarchs (A)
Crassispora trychera

Rugospora minuta (A)
Auroraspora macra

SAMPLES: CL143, 154, 157, 174A
Age: Early Namurian

Remarks

These samples yielded assemblages typical of the early Namurian in Nova Scotia. They consist of numerous to abundant spores typical of the Windsor Group and rare monosaccate gymnosperm pollen fragments or entire specimens of *Florinites visendus*. *Schopfipollenites arcadensis* and *S. ellipsoides* are also numerous.

Significant species

Florinites visendus
Auroraspora macra
A. solisorta
Crassispora trychera
Schopfites claviger

Schopfipollenites ellipsoides
S. arcadensis
Rugospora minuta
Spelaeotriletes tuberosus
Retusotriletes incohatus

SAMPLE: CL152
Age: Uncertain

Remarks

This assemblage is markedly different to the Cansoan samples described above. *Florinites visendus* and *Potonieisporites* spp. are abundant and "Windsor" elements are rare, correlating it with Assemblage 1. The presence of a specimen of *Endosporites* aff. *globiformis* suggests some Westphalian influence. *Sensu stricto* forms of this species do not appear until the late Westphalian A and then only very rarely. It is more typical of Late B and younger strata. The assemblage lacks the array of *Florinites* spp. typical of the early to middle Westphalian A. It is possible that this is another case of massive reworking into the Stellarton Group.

Significant species

Florinites visendus (A)
Potonieisporites spp. (A)
Kraeuselisporites ornatus
Auroraspora solisorta
F. cf. *mediapudens*
Plicatipollenites sp.
Endosporites aff. *globiformis*
Schopfipollenites ellipsoides

SAMPLE: CL167
Age: Westphalian C

Remarks

This assemblage contains a single specimen of *Torispora securis* which first appears in the early, but not earliest Westphalian C. A specimen of *Lundbladispora* aff. *gigantea* suggests a mid C or younger age but there is nothing else present to support this.

Significant species

Torispora securis
Lundbladispora aff. *gigantea*

SAMPLE: CL169
Age: Visean; AT Zone, Utting (1987)

Remarks

This is a rich assemblage typical of the Windsor Group. The presence of a specimen of *Schopfipollenites arcadensis* and *Densosporites* cf. *columbaris* indicates an AT Zone age. The level of thermal maturity is moderately high.

Significant species

Retusotriletes incohatus (A)
Schopfites claviger
Rugospora minuta
Lycospora cf. *noctuina*
Crassispora trychera (A)
Auroraspora macra
Schopfipollenites arcadensis
Densosporites cf. *columbaris*

SAMPLES: CL170, 172, 173A, 173B
Age: Indeterminable

Remarks

Essentially barren samples.

SAMPLE: CL174B
Age: No younger than basal Namurian A (Pendleian)

Remarks

This assemblage resembles those from the other Canso samples in this group (143, 154, 157, 174A) but lacks even fragments of monosaccate gymnosperm pollen. *Schopfipollenites ellipsoides* is quite numerous suggesting that a Namurian age is more likely but this species ranges into the latest Visean. A specimen of *Raistrickia nigra* indicates that the sample is no younger than the NC Zone of Clayton et al. (1977), i.e., basal Namurian A (Pendleian).

SAMPLE: CM003A
Age: Westphalian C undifferentiated

Remarks

This sample is dominated by amorphous material typical of a Thorburn Member oil shale. Palynomorphs are rare and specimens of *Striatosporites ovalis*, striate bisaccate pollen and *Punctatosporites* sp. together suggest a Westphalian C age although all range down into the latest B.

Significant species

Striatosporites ovalis
Striate bisaccate

Punctatosporites sp.

SAMPLE: CM003B
Age: ?mid to late Westphalian C

Remarks

This is a rich spore-pollen assemblage and it contains abundant *Botryococcus*. The presence of numerous *Illinites unicus* indicates an age no older than mid-C in this area and a specimen of *Raistrickia* cf. *superba* (*sensu* S & B, 1967) suggests that the upper age limit is late but not latest C. However, there are specimens of *Cadiospora magna* and *C.* cf. *magna* present. This species is usually considered to be a D to Stephanian marker although some extend its range into the latest C. In the current Natmap study, it has been appearing in what are generally considered to be C strata and results based on it must therefore be treated with caution at the moment.

Significant species

Illinites unicus
Microreticulatisporites sulcatus
Endosporites globiformis
Cadiospora magna

Raistrickia cf. *superba*
Triquitrites tribullatus
E. zonalis
C. cf. *magna*

SAMPLES: CM006, 008
Age: Indeterminable

Remarks

Virtually barren samples.

SAMPLE: CM009
Age: Early Namurian

Remarks

This coaly sand from the Canso Group yielded a very small assemblage with specimens of *Florinites visendus* and *Potonieisporites* spp. indicating an age no older than Namurian. The Windsor influence is represented by *Rugospora minuta*.

Significant species

Florinites visendus
Rugospora minuta
Schopfipollenites ellipsoides
Potonieisporites spp.
Colatisporites decorus
Knoxisporites triradiatus

SAMPLES: CM013, 014, 018, 020
Age: Late Namurian

Remarks

These samples yielded assemblages typical of the lower part of the Cumberland Group. *Florinites visendus* and *Potonieisporites* spp. are numerous to abundant and the lack of smaller species of *Florinites* is used to assign a pre-Westphalian A age. No specifically Westphalian A markers are present and the samples may be assigned to Assemblage 1.

Significant species

Florinites visendus (A)
Rugospora calderi (A)
Kraeuselisporites spp.
Ibrahimisporites spp.
Potonieisporites spp. (A)
R. gracilirugosa
K. ornatus
Knoxisporites dissidius

SAMPLE: CM019
Age: early Westphalian A

Remarks

This assemblage is similar to those in CM013, 014, 018 and 020 but the presence of *Cingulizonates loricatus* and *Radiizonates striatus* indicate a Westphalian A age.

Significant species

Cingulizonates loricatus
Radiizonates striatus
Cannanoropollenites cf. *mehtae*
Raistrickia fulva
R. cf. *aligerens*
Kraeuselisporites spp. (A)

SAMPLE: CM023
Age: Indeterminable

Remarks

A virtually barren sample.

SAMPLE: CM026
Age: ?Visean

Remarks

This sample yielded abundant inertinitic debris and only 12 palynomorphs and some modern contaminants. The spores are typical of the Windsor but, given the recovery, the possibility that the entire assemblage was reworked cannot be ruled out.

Significant species

Retusotriletes incohatus
Spelaeotriletes echinatus
Crassispora trychera
Schopfites claviger

SAMPLE: CM032A
Age: early middle Westphalian C

Remarks

The spores and pollen are poorly preserved due to bacterial/fungal activity. The combination of *Torispora securis*, *Punctatosporites granifer* and *Densosporites anulatus* indicates an early middle Westphalian C age.

Significant species

Torispora securis
Densosporites anulatus
Punctatosporites granifer
Vestispora fenestrata

SAMPLE: CM032B
Age: ?late Westphalian C

Remarks

The presence of *Punctatosporites granifer* indicates an age no older than early middle Westphalian C. However, a specimen of *Cadiospora* cf. *magna* suggests a significantly younger age. See discussion of CM003B.

Significant species

Punctatosporites granifer
Cadiospora cf. *magna*

SAMPLE: CM033
Age: Westphalian C, probably mid to late

Remarks

Spores are rare in this amorphous kerogen-rich sample. Several specimens of *Torispora securis* and a specimen of *Vestispora laevigata* in such a poor sample suggest a mid to late Westphalian C age.

Significant species

Torispora securis
Triquitrites sculptilis
Vestispora laevigata
Punctatosporites sp.

SAMPLE: CM105B
Age: Indeterminable

Remarks

A virtually barren sample.

SAMPLE: CQ076A
Age: Indeterminable

Remarks

A barren sample.

SAMPLE: CQ078B
Age: early middle Westphalian C

Remarks

The assemblage contains numerous specimens of *Vestispora tortuosa* and *V. pseudoreticulata*, a feature typical of the B-C transition although both species range into the late C. Numerous specimens of *Illinites unicus* are indicative of early middle C and younger strata in the area.

Significant species

Vestispora tortuosa
Illinites unicus
V. pseudoreticulata
Endosporites globiformis

SAMPLE: CQ083A
Age: Indeterminable

Remarks

The residue consists of inertinitic debris and rare, long-ranging spores.

SAMPLE: CQ095A
Age: Uncertain

Remarks

Most of the spores and pollen in this poor sample belong to background Assemblage 2 which characterises much of the Westphalian A and B. Specimens of *Ibrahimisporites brevispinosus* would restrict the age to mid A. However, two specimens of *Illinites unicus* are present. This species does not range below the mid C in Nova Scotia although it has been found in Namurian C and Westphalian A sections in Spain and Britain respectively. It is possible that most of the assemblage was reworked into Westphalian C sediments. The age assigned must therefore remain tentative. This is almost certainly a case of massive reworking of the Boss Point into the Stellarton.

Significant species

Florinites florinii
F. mediapudens
Knoxisporites triradiatus
Ibrahimisporites brevispinosus
F. visendus
F. pumicosus
K. stephanephorus
Illinites unicus

SAMPLE: CQ099A
Age: Late Visean; AT Zone, Utting (1987)

Remarks

This Windsor assemblage is less rich than usual. The presence of *Schopfipollenites arcadensis* indicates that the sample is no older than the AT Zone. Acritarchs are abundant and at least some of them have been reworked from Early Palaeozoic rocks.

Significant species

Rugospora minuta
Crassispora trychera
Schopfipollenites arcadensis
Auroraspora macra
Retusotriletes incohatus
Knoxisporites stephanephorus

Micrhystridium spp. (A)
Cymatiosphaera spp.
Veryhachium spp.
Diexallophasis spp.

SAMPLE: CQ105
Age: ?mid Westphalian A

Remarks

Spores are sparse and often broken in this sample and many cannot be identified suggesting that this may be a reworked assemblage. A specimen of *Wilsonites vesicatus* and of *Plicatipollenites minutus* indicate that the sample is unlikely to be older than mid Westphalian A and the lack of *Florinites* spp. other than *F. visendus* is more typical of Namurian and older rocks. *Knoxisporites dissidius* dies out in the Westphalian A. However, as in CQ095A, a striate pollen grain is present, in this case *Protohaploxypinus* sp., which has not been recorded below the latest Westphalian B. There are no other markers present to substantiate this and it may be a contaminant.

Significant species

Wilsonites vesicatus
Plicatipollenites minutus
Protohaploxypinus sp.
Cyclogranisporites cf. *aureus*
Florinites visendus
Knoxisporites dissidius
K. triradiatus
K. stephanephorus

SAMPLE: CQ107B
Age: Visean; AT Zone, Utting (1987)

Remarks

A typical Windsor assemblage. The age is based on *Schopfipollenites arcadensis* and the lack of younger species.

Significant species

Rugospora minuta (A)
Crassispora trychera
Schopfipollenites arcadensis
Retusotriletes incohatus (A)
Auroraspora macra
Schopfites claviger

SAMPLE: CR023
Age: Indeterminable

Remarks

An essentially barren sample.

SAMPLE: CR025
Age: ?Early Westphalian

Remarks

This is an extremely poor sample with few spores. Eleven specimens of *Knoxisporites triradiatus* and a questionable specimen of *Reticulatisporites reticulatus* suggest an early Westphalian age.

SAMPLE: CR026A
Age: basal Late Westphalian A; *C. mehtae - R. fulva micra* Zone
Dolby (in press)

Remarks

This is a very rich and interesting assemblage. It contains elements of both the SS and RA Zones of Clayton et al. (1977). Spore type A (a complex of spores which show a complete morphological intergradation between the genera *Triquitrites* and *Ahrensisporites*) are abundant which is a character of the SS Zone. *Reticulatisporites reticulatus* and *R. polygonalis* are numerous which, along with specimens of *Raistrickia fulva* cf. var *micra*, *Cannanoropollenites* cf. *mehtae* and *Endosporites* cf. *globiformis* are more typical of RA Zone rocks. The sample may be equated with the middle part of the Coal Mine Point Member of the Joggin Formation at Joggins although the assemblages there are not so rich.

Significant species

Spore type A (A)
Reticulatisporites reticulatus
Endosporites cf. *globiformis*
Raistrickia fulva
Knoxisporites dissidius (C)
K. triradiatus
Alatisporites pustulatus
R. polygonalis
Cannanoropollis cf. *mehtae*
R. fulva cf. var *micra*
K. stephanephorus (C)
Florinites spp. (A)

SAMPLE: CR030A
Age: Late Westphalian A; *C. mehtae - R. fulva micra* Zone
Dolby (in press)

Remarks

The assemblage is not quite so rich and varied as CR26A but has many species in common. *Sensu stricto* specimens of *Cannanoropollis mehtae* confirm that the sample is no older than Late Westphalian A.

Significant species

Cannanoropollis mehtae
Knoxisporites triradiatus (A)
K. stephanephorus
Ibrahimisporites brevispinosus
Spore type A
C. cf. *mehtae*
K. dissidius
Rugospora calderi (A)
Secarisporites remotus
Florinites spp. (A)

SAMPLES: CR061, 063A
Age: Late Westphalian A; *C. mehtae - R. fulva micra* Zone
Dolby (in press)

Remarks

Both assemblages are rich and dominated by monosaccate pollen and they resemble many others from the Westphalian A in this study. The presence of *Punctatosporites* sp. and *Cannanoropollis mehtae* indicates a mid to late Westphalian A age.

Significant species

Potonieisporites spp. (A)
Florinites spp. (C)
Schopfipollenites ellipsoides (A)
Punctatosporites sp.
Secarisporites remotus
Knoxisporites spp.
Lycospora spp. (A)
Guthoerlisporites spp. (A)
Auroraspora solisorta (A)
Cannanoropollis mehtae
Anapiculatisporites cf. *vergrandis*
Ibrahimisporites brevispinosus
K. dissidius
L. orbicula (A)

SAMPLES: CR063B, 066
Age: Westphalian A

Remarks

These samples are poorer than those above but share many elements in common. The presence of an array of *Florinites* species indicates an age no older than Westphalian A and there are no markers present to suggest anything younger.

Significant species

Florinites spp.
Auroraspora solisorta (A)
Lycospora spp.(A)
Potonieisporites spp. (A)
Anapiculatisporites cf. *vergrandis* (C-A)
L. orbicula

SAMPLE: CR067A
Age: Early Westphalian A; *Florinites* spp. - *S. arenaceus* Zone
Dolby (in press)

Remarks

The preservation is very poor in this sample. The assemblage is virtually identical to those from CR063B and 066 but a specimen of *Spelaeotriletes arenaceus* indicates an Early Westphalian A age.

Significant species

Spelaeotriletes arenaceus

SAMPLE: CR067B
Age: basal Late Westphalian A; *C. mehtae* - *R. fulva micra* Zone
Dolby (in press)

Remarks

This rich assemblage is similar to those from CR061 to 067A. Several specimens of *Cannanoropollis mehtae* and a specimen of *Spelaeotriletes arenaceus* indicate an early Late Westphalian A age.

Significant species

Cannanoropollis mehtae *Spelaeotriletes arenaceus*

SAMPLES: CR068, 68B, 70, 82A
Age: Late Westphalian A; *C. mehtae* - *R. fulva micra* Zone
Dolby (in press)

Remarks

These assemblages resemble those from CR061 to 067B. The presence of specimens of *Cannanoropollis mehtae* and *Raistrickia fulva* var. *micra* indicate a Late Westphalian A age.

Significant species

Cannanoropollis mehtae *Raistrickia fulva* var. *micra*

SAMPLE: CR083B
Age: Westphalian A

Remarks

This poor assemblage contains an array of *Florinites* species indicating an age no older than Westphalian A. Spores such as *Kraeuselisporites ornatus* and *Ibrahimisporites brevispinosus* are more typical of the Early Westphalian A and Late Namurian.

Significant species

Florinites spp. (A) *Kraeuselisporites ornatus*
Ibrahimisporites brevispinosus

SAMPLES: CR129A, 131
Age: probably Westphalian C

Remarks

Both samples yielded little organic debris and few spores. The presence of *Torispora securis* in both samples indicates an age no older than Early (but not earliest) Westphalian C. *Illinites unicus* in 129A appears in the early mid C in Nova Scotia.

SAMPLE: CR137
Age: Indeterminable

Remarks

A barren sample.

SAMPLES: CR146A, 167
Age: latest Westphalian B - early Westphalian C

Remarks

Both samples were extremely poor and yielded very few spores. The presence of several specimens of *Endosporites globiformis* in both samples, *Vestispora tortuosa* in 146A and *V. pseudoreticulata* in 167 suggests a transitional B-C age. These species have much longer ranges but tend to be abundant together in the B-C transition.

SAMPLE: CR173A
Age: Late Westphalian A; *C. mehtae* - *R. fulva micra* Zone
Dolby (in press)

Remarks

This is a poorly preserved but moderately rich assemblage similar in composition to those in CR061 to 82A. The presence of *Cannanoropollis mehtae* indicates a Late Westphalian A age.

SAMPLE: CR175
Age: Early Westphalian A; *Florinites* spp. - *S. arenaceus* Zone
Dolby (in press)

Remarks

This is an extremely impoverished assemblage with elements common to the mid Westphalian A assemblages above. A specimen of *Spelaeo-triletes arenaceus* indicates an Early Westphalian A age.

SAMPLES: CS004A, 008
Age: Indeterminable

Remarks

Essentially barren samples.

SAMPLE: CS015
Age: early mid Westphalian C

Remarks

This sample yielded a poor association of background Assemblage 3 spores. Numerous *Torispora securis* and specimens of *Illinites unicus* and *Triquitrites tribullatus* indicate an age no older than mid Westphalian C. The presence of *Knoxisporites triradiatus* confines the age to the early mid C.

Significant species

Torispora securis
Knoxisporites triradiatus
Rugospora calderi
Illinites unicus
Triquitrites tribullatus
T. sculptilis

SAMPLE: CS026A
Age: ?Westphalian A

Remarks

This is a rich but poorly preserved assemblage seriously affected by biodegradation and pyritization. Poor specimens of cf. *Ibrahimisporites* sp. with abundant *Florinites* spp. suggest a mid Westphalian A age but given the preservation, a tentative Westphalian A age is assigned.

Significant species

Florinites spp.
cf. *Ibrahimisporites* sp.
Lycospora pellucida (A)
Knoxisporites triradiatus

SAMPLE: I-1
Age: ?Stephanian

Remarks

This is a very poor assemblage assignable to Assemblage 3. Two specimens of *Centonites symmetricus* are present. The only reliable records of this fungal palynomorph are from the Stephanian. A poor specimen of *Spinososporites* sp. lends some support to this result.

Significant species

Centonites symmetricus
Raistrickia cf. *aculeata*
Endosporites globiformis
cf. *Spinososporites* sp.
Vestispora fenestrata
Crassispora kosankei

Twenty-one samples were prepared from this section and most yielded rich assemblages typical of the Late Namurian to Westphalian A. Three zones are recognised and described below. The data are plotted on Enclosure 1.

Interval	Age	Zone
100m - 205m	Late Westphalian A	*C. mehtae - R. fulva micra*
42m - 100m	Early Westphalian A	*S. arenaceus - Florinites* spp.
14m - 42m	Probably Late Namurian, Yeadonian	*S. arenaceus - Florinites* spp.

INTERVAL: 14m - 42m
Age: Probably Late Namurian, Yeadonian
Zone: *S. arenaceus - Florinites* spp., Dolby (in press)

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

- The presence of *Florinites visendus* in abundance.
- The presence of *Spelaeotriletes arenaceus*.

Remarks

F. visendus occurs sporadically throughout most of the Namurian in Europe. In those lowland floodplain swamp environments it does not become abundant until the middle of the Westphalian A. In Nova Scotia, by contrast, in the drier intermontaine basins, monosaccate pollen are often abundant in the Namurian-Westphalian transition. The relatively large species of *F. pumicosus* appears at 35m but it seems that smaller forms of *Florinites* such as *F. florinii* do not appear until the Westphalian becoming numerous by the middle A. *Spelaeotriletes arenaceus* ranges into the latest Visean in Europe but has not been recorded below the Late Namurian in Nova Scotia.

The remainder of the assemblage is typical of the Namurian-Westphalian transition in the Cumberland Basin. Reworked acritarchs are usually present in significant numbers. At least some originated in Ordovician and Silurian rocks.

INTERVAL: 42m - 100m
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

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

- The presence of *Florinites florinii* at and above 42m.
- The presence of *Cingulizonates loricatus* at 46m.
- The presence of *Spelaeotriletes arenaceus*.

Remarks

The appearance of *F. florinii* is used to define the base of the Westphalian in this section. *F. pumicosus*, the form intermediate in size between *F. visendus* and *F. florinii* also becomes abundant. *Cingulizonates loricatus* does not range below the Westphalian A. A single specimen of *Raistrickia fulva* var. *micra* is present at 51m. *Cannanoropollis* cf. *mehtae* appears near the top of the zone as it does at Joggins.

This interval also correlates with the SS Zone of Clayton et al. (1977).

INTERVAL: 100m - 205m
Age: Late (but not latest) Westphalian A
Zone: *C. mehtae - R. fulva micra*, Dolby (in press)

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

- The presence of *Cannanoropollis mehtae* at and above 100m.
- The presence of cf. *Punctatosporites* sp. at and above 100m.
- The presence of *Raistrickia fulva* var *micra* at and above 123m.

Remarks

The appearance of *Cannanoropollis mehtae* and persistent occurrence of *Raistrickia fulva* var. *micra* define this zone. The isolated specimen of *Spelaeotriletes arenaceus* at 155m is not unusual although this species effectively dies out at the base of this zone.

The appearance of cf. *Punctatosporites* sp. is also noteworthy. In Europe this group is rare below the mid Westphalian A but is more or less persistent above the SS Zone of Clayton et al. (1977).

Species such as *Schultzospora* cf. *elongata* and *Knoxisporites dissideus* and the lack of *Vestispora tortuosa* indicates that the top of the section is no younger than Late *but not latest* Westphalian A. The European equivalent would be the lower to middle RA Zone of Clayton et al. (1977).

Ten samples were prepared from this section and most yielded good or rich assemblages but #71 at 8m was poor and #75 at 64m was barren. The section is of mid-Westphalian D to possibly earliest Stephanian age. Three zones are tentatively recognised and described below. The data are plotted on Enclosure 2.

Interval	Age	Zone
18m - 8m	?Stephanian	Upper *Thymospora* spp.
95m - 18m	Westphalian D	Upper *Thymospora* spp.
115m - 95m	Westphalian D	*Vestispora witneyensis*

INTERVAL: 115m - 95m
Age: Westphalian D
Zone: *Vestispora witneyensis*, Dolby (in prep.)

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

- The presence of *Vestispora witneyensis*, *V.* cf. *witneyensis*, *V. colchesterensis* and *V.* cf. *colchesterensis*.

Remarks

These assemblages are rich in species typical of the late Westphalian C and younger strata (Assemblage 3). Good specimens of *Vestispora witneyensis* and *V. colchesterensis* along with specimens closely resembling these species are typical of the mid Westphalian D in both England (Smith, 1987) and Illinois (Peppers, 1970). The equivalent section in the Sydney Basin extends from approximately 25m above the Phalen Seam to the Hub Seam.

INTERVAL: 95m - 18m
Age: Westphalian D
Zone: Upper *Thymospora* spp., Dolby (in prep.)

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

- The lack of *V. witneyensis*.

Remarks

This zone yielded generally poor samples with species such as *Cadiospora magna* and *Thymospora obscura* which are Westphalian D - Stephanian species. The lack of *Vestispora witneyensis* and data from the overlying zone suggests that this interval is of latest Westphalian D. age.

INTERVAL: 18m - 8m
Age: ?Stephanian
Zone: Upper *Thymospora* spp., Dolby (in prep.)

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

- The abundance of striate bisaccate pollen.
- The presence of cf. *Vittatina* sp..

Remarks

Striate bisaccate pollen appear in the latest Westphalian B in Nova Scotia and are occasionally numerous to abundant in Westphalian C and D strata. However, they are thought to be more consistently numerous in Stephanian and younger sediments. Three specimens in the 18m sample resemble *Vittatina* a predominantly Permian genus which can occur sporadically in the Stephanian.

On this somewhat tenuous evidence, the section is tentatively correlated with the Stephanian.

Nine samples were prepared from this corehole but only the two lowermost (3.1m and 8.3m from base) yielded reasonable assemblages. The 22.5m and 27.6m contained a few long-ranging spores but the remainder proved to be barren. The productive section is of Westphalian D age. The data are plotted on Enclosure 3.

Interval	Age	Zone
31.6m - 58.5m	Indeterminable	
8.3m - 31.6m	Westphalian D - ?Stephanian (undiff.)	
3.1m - 8.3m	Westphalian D	*Vestispora witneyensis*

INTERVAL: 3.1m - 8.3m
Age: Westphalian D
Zone: *Vestispora witneyensis*, Dolby (in prep.)

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

- The presence of *Vestispora* cf. *witneyensis* at 3.1m and *V. witneyensis* at 8.3m.
- The presence of *Cadiospora magna* in both samples.
- The presence of *Raistrickia* cf. *aculeata* at 8.3m.

Remarks

Both samples yielded rich assemblages of spores from Assemblage 3 which may be found in Westphalian C to Stephanian strata. Specimens of *Cadiospora magna* and *Raistrickia* cf. *aculeata* indicate an age no older than Westphalian D and *Vestispora witneyensis* and *V.* cf. *witneyensis* confine this to the *V. witneyensis* Zone (see Inverness Shore, 115m-95m).

INTERVAL: 8.3m - 31.6m
Age: Westphalian D - ?Stephanian (undiff.)

Remarks

These samples contained a few long-ranging Carboniferous palynomorphs i.e., *Lycospora pellucida* and *Schopfipollenites ellipsoides* and a precise age cannot be assigned. The presence of Spore type A at 22.5m indicates reworking of Westphalian A sediments.

INTERVAL: 31.6m - 58.5m
Age: Indeterminable

Remarks

Barren samples.

Eight samples were prepared from this section and all yielded good assemblages and some of the higher ones are extremely rich. Two zones are recognised and these are described below. The data are plotted on Enclosure 4.

Interval	Age	Zone/Assemblage
29.5m - 36m	Westphalian D	?Lower *Thymospora*, 3
4m - 29.5m	?late Westphalian C	3

INTERVAL: 4m - 29.5m
Age: ?late Westphalian C
Zone: Assemblage 3

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

- The presence of Assemblage 3 palynomorphs.
- The presence of *Triquitriletes additus* at 4m.

Remarks

The assemblages from this interval are typical of Assemblage 3 which characterises the Westphalian C to the Stephanian. The presence of *Triquitrites additus* at 4m indicates that the base of the section is no older than late Westphalian C. There are no species present to confirm either a Westphalian C or a Westphalian D age and although a late Westphalian C age is tentatively assigned, an early Westphalian D age cannot be ruled out.

INTERVAL: 29.5m - 36mm
Age: Westphalian D
Zone: Assemblage 3, ?Lower *Thymospora* Zone, Dolby (in prep.)

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

- The presence of *Mooreisporites inusitatus* at and above 29.5m.
- The presence of *Raistrickia aculeata* at 36m.

Remarks

The assemblages here are rich and belong to Assemblage 3. The presence of *Mooreisporites inusitatus* and *Raistrickia aculeata* indicates that they are of Westphalian D age. The lack of other markers suggests that the interval could be correlatable with the early Westphalian D, Lower *Thymospora* Zone, but this is tentative.

Three samples were prepared from this section and are described below. All contain abundant reworked palynomorphs.

Sample	Age	Zone/Assemblage
601	mid Westphalian C - ?earliest D	3
602	mid Westphalian C - ?earliest D	3
603	mid Westphalian C - ?earliest D	3

SAMPLES: 601, 602, 603
Age: Eearly middle Westphalian C - ?earliest D
Zone: Assemblage 3

Remarks

These are relatively poor assemblages with evidence of reworking of Visean-early Namurian rocks. The *in situ* assemblage contains elements of Assemblage 3 with specimens of *Torispora securis*, *Punctatosporites granifer*, *P. oculus*, *Triquitrites tribullatus* and striate pollen including *Illinites unicus* which together indicate an age no older than early middle Westphalian C. Specimens of *Vestispora pseudoreticulata* in 601 indicate that this sample is no younger than earliest Westphalian D although this species tends to be rare above the middle C.

Significant species

Torispora securis
Punctatosporites granifer
Vestispora pseudoreticulata
V. foveata
Murospora kosankei
Triquitrites tribullatus
P. oculus
V. fenestrata
Illinites unicus
Protohaploxypinus sp.

Ten samples from this corehole were prepared and all yielded rich assemblages typical of the late Westphalian. The results are described below and the data are plotted on Enclosure 5.

Samples	Age	Zone
PB1-10	Westphalian D - ?Stephanian	?Upper *Thymospora*

SAMPLES: PB1-10
Age: Westphalian D - ?Stephanian
Zone: ?Upper *Thymospora*, Dolby (in prep.)

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

- The presence of *Thymospora* spp. and *Cadiospora magna* throughout the section.
- The presence of *Mooreisporites inusitatus* in PB4.
- The presence of questionable specimens of *Spinososporites* sp. in PB5 and of cf. *Vittatina* sp. in PB2.

Remarks

These are rich assemblages in which Assemblage 3 (Westphalian C - Stephanian) species are abundant. The age is based on the presence of *Thymospora* spp., including *T. obscura* and *T. pseudothiessenii*, *Cadiospora magna* and *Mooreisporites inusitatus*.

The *Thymospora* numbers, although not large, suggest that the section is not of early D age. The lack of *Vestispora witneyensis* and *V. colchesterensis* also suggests a middle to early late D age is not appropriate although *Vestispora* spp. are rare in this section. The abundances of *Torispora* spp. and *Punctatosporites* spp. is noteworthy. The former species usually peaks in the late C to earliest D. However, in the Sydney Basin, there is a second set of peak abundances for both species in the high D to Stephanian.

In this corehole, the questionable specimens of *Spinososporites* sp. and cf. *Vittatina* sp. suggest that the section may extend into the Stephanian. The section is therefore tentatively correlated with the Upper *Thymospora* Zone.

Nineteen samples were prepared from this structurally complex section. Most yielded good assemblages but one was extremely poor and three proved to be barren. Since the relative stratigraphic positions of the samples is not known, they are described in the order in which they were collected.

Sample	Age	Zone/Assemblage
FP50	late Westphalian C	*Torispora* - *V. magna*, 3A
FP51	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP52	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP53	Indeterminable	
FP54	Indeterminable	
FP55	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP-fp-1	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP56	basal Westphalian A	*S. arenaceus* - *Florinites* spp., 1
FP-fp-2	Indeterminable	
FP-fp-3	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP-fp-4	Late Namurian, Yeadonian	*S. arenaceus* - *Florinites* spp., 1
FP57	basal Westphalian A	*S. arenaceus* - *Florinites* spp., 1
FP-fp-5	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP58	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP59	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP60	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP61	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP62	late Westphalian C - early D	*Torispora* spp. - *V. magna* to Lower *Thymospora*
FP63	Indeterminable	

SAMPLE: FP50
Age: late Westphalian C
Zone: *Torispora* spp. - *Vestispora magna*, Dolby (in prep.)

Remarks

This sample contains abundant *Torispora securis* which, with a small number of specimens of *Punctatosporites granifer*, indicate an age no older than late Westphalian C. Most of the species present have long stratigraphic ranges and there are no signs of Westphalian D influence. *Botryococcus* colonies are very abundant.

Significant species

Torispora securis (A)
Endosporites globiformis
Cirratriradites saturni
Murospora kosankei
Punctatosporites granifer
Triquitrites sculptilis
Apiculatisporites abditus
Botryococcus sp. (A)

SAMPLES: FP51, 52
Age: Late Namurian, Yeadonian
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

Remarks

These two samples yielded rich assemblages typical of the Late Namurian, Yeadonian, similar in nature to those from the lower part of the Port Hood sequence (Section 3A). However, *Botryococcus* colonies are numerous in 51 and rare in 52 and there are specimens of *Punctatosporites granifer* and *Triquitrites sculptilis* in 51 and *P. minutus* in 52. These are interpreted as contaminants from FP50 but the possibility exists that these assemblages are the result of massive reworking of Yeadonian rocks into the Westphalian C.

Significant species

Florinites visendus
Crassispora kosankei
Schopfipollenites ellipsoides
Knoxisporites triradiatus
Auroraspora solisorta (A)
Sinuspores sinuatus
S. arcadensis
Cannanoropollis sp.

Secarisporites remotus
Anapiculatisporites variocorneus

Botryococcus sp.
Punctatosporites granifer

Kraeuselisporites spp.
Anapiculatisporites spinulistratus

Triquitrites sculptilis
P. minutus

SAMPLES: FP53, 54
Age: Indeterminable

Remarks

Barren samples.

SAMPLES: FP55, FP-fp-1
Age: Late Namurian, Yeadonian
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in prep.)

Remarks

These are typical assemblages from the Namurian - Westphalian transition but the lack of small *Florinites* spp. and other Westphalian markers confines the age to the Late Namurian.

Significant species

Florinites visendus(A)
Potonieisporites spp. (A)
Auroraspora solisorta (A)
Stenozonotriletes sp.

F. pumicosus (R)
Spelaeotriletes arenaceus
Crassispora kosankei
Ahrensisporites guerickei

SAMPLE: FP56
Age: basal Westphalian A
Zone: *S. arenaceus* - *Florinites* spp.

Remarks

This rich assemblage resembles others from this zone. The presence of *Lycospora orbicula* and *Granulatisporites microgranifer* suggests that a basal Westphalian A age is more appropriate than Namurian.

SAMPLE: FP-fp-2
Age: Indeterminable

Remarks

A barren sample.

SAMPLES: FP-fp-3, fp-4
Age: Late Namurian, Yeadonian
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

Sample fp-3 yielded a rich assemblage similar to the other Yeadonian samples described above and in the Port Hood sequence (Section 3A). Sample fp-4 is poor but contains specimens of *Spelaeotriletes arenaceus* and *Florinites visendus* with no Westphalian A species.

SAMPLE: FP57
Age: basal Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

This is a rich assemblage similar to those above but with *Florinites florinii* and a significant number of *F. pumicosus*.

SAMPLES: FP-fp-5, 58, 59, 60, 61, 62
Age: late Westphalian C - early D
Zone: *Torispora* spp. - *V. magna* to Lower *Thymospora*, Dolby (in prep.)

Remarks

These are rich assemblages typical of the late Westphalian C and younger rocks. *Torispora securis* is generally numerous to abundant along with *Punctatosporites* spp. Samples FP58 and 62 also contain good specimens of *Cadiospora magna*. This is universally recognised as a Westphalian D - Stephanian species but variants have been seen in Westphalian C samples in the current NATMAP study.

Sample FP59 is rich in striate bisaccates including a form which is abundant in the uppermost part of the Coal Mine Point section. It was assigned a Stephanian age in the 93-94 NATMAP project. Recent studies have thrown some doubt on this.

The samples are therefore assigned an undifferentiated late C to early D age.

Reworked Namurian to early Westphalian A species are numerous.

Significant species

Torispora securis
Triquitrites tribullatus
T. additus
Endosporites globiformis
Microreticulatisporites nobilis
Illinites unicus
I. annosus
Punctatosporites granifer
T. sculptilis
Vestispora fenestrata
Cadiospora magna
M. sulcatus
Protohaploxypinus spp.
Striatoabieites spp.

SAMPLE: FP63
Age: Indeterminable

Remarks

An essentially barren sample.

Of the twelve outcrop samples submitted for analysis, five yielded small residues, which allowed only a tentative age assignment, and a sixth contained inertinitic particles but few spores. The results are summarised and described in detail below.

Sample	Age	Zone
94C Series		
6A	Late Visean	AT - ?SM
6B	Early Namurian	
37A	No older than Westphalian C	
39A	Westphalian D	
39B	No older than Westphalian C	
62	Visean	AT
165	Visean	SM
330B	Indeterminable	
332	?Windsor	
334A	No older than Late Namurian	
359A	Late Namurian - earliest Westphalian A	
359B	No older than Namurian	

SAMPLE: 94C-6A
Age: Late Visean
Zone: Upper AT - ?lower SM, Utting (1987)

Remarks

This is a rich assemblage typical of the Windsor Group. Numerous *Schopfipollenites arcadensis* indicate an AT Zone younger age. Specimens of *Knoxisporites literatus* and *Spelaeotriletes tuberosus* favor an AT age but a specimen of ?*Schultzospora* sp. suggest that a lower SM might be more appropriate, i.e., equivalent to the lower part of the Windsor-Canso Boundary Beds (see Utting, 1987. Table 6). There is no evidence for a younger age but Namurian markers are often rare in the lower part of the Canso Group.

Significant species

Schopfipollenites arcadensis
Crassispora trychera (C)
Auroraspora macra (A)
Retusotriletes incohatus
Colatisporites decorus
K. stephanephorus
Spelaeotriletes tuberosus
S. cf. *ellipsoides* (C)
Rugospora minuta (A)
A. solisorta (C)
?*Schultzospora* sp.
Knoxisporites triradiatus
K. literatus
S. pretiosus windsorensis

SAMPLE: 94C-6B
Age: Early Namurian

Remarks

This is an assemblage typical of the Canso Group in that it contains a Windsor palynoflora but with the addition of monosaccate gymnosperm pollen, which first appeared in the Namurian.

Significant species

Auroraspora macra
Rugospora minuta
Retusotriletes incohatus
Knoxisporites triradiatus
Schopfipollenites arcadensis
Crassispora trychera
A. solisorta
Colatisporites decorus
Secarisporites lobatus
K. stephanephorus
S. ellipsoides
Schopfites claviger
Monosaccate gymnosperm pollen fragments

SAMPLE: 94C-37-A
Age: No older than early mid Westphalian C

Remarks

This sample yielded very few spores and pollen and some modern contaminants. A specimen of *Illinites unicus* indicates that the age is no older than early mid C. However, this species has been recorded in the Westphalian A of England and the Namurian C of Spain, although in Nova Scotia it appears to be confined to much younger strata.

Significant species

Illinites unicus
Triquitrites sp.
Endosporites globiformis
E. zonalis

SAMPLE: 94C-39A
Age: Westphalian D

Remarks

This is a rich assemblage of mostly long-ranging species. Specimens of *Triquitrites spinosus*, *Mooreisporites inusitatus* and *Cadiospora magna* indicate a Westphalian D age. There is evidence of reworking of early Westphalian and older Carboniferous sediments.

Significant species

Triquitrites spinosus
Cadiospora magna
T. additus
Mooreisporites inusitatus

SAMPLE: 94C-39B
Age: No older than late Westphalian C

Remarks

Spores and pollen are relatively sparse in this fusinite-dominated assemblage. A specimen of *Triquitrites additus* indicates that the sample is no older than late Westphalian C in age.

Significant species

Triquitrites additus
Punctatosporites granifer
T. tribullatus
P. minutus

SAMPLE: 94C-62B
Age: Visean, AT Zone; Utting (1987)

Remarks

This is an essentially upper Windsor assemblage similar to 94C-6A but less rich. There is nothing present to suggest a younger age.

SAMPLE: 94C-165
Age: Visean, SM Zone; Utting (1987)

Remarks

This contains a rich Windsor assemblage similar to 94C-6A but with fewer specimens of *Schopfipollenites* spp. A specimen of *Schultzospora bilunata* indicates a Windsor-Canso Boundary Beds age.

SAMPLE: 94C-330B
Age: Indeterminable

Remarks

The residue is rich in inertinitic debris with a few, highly altered spores. No age can be assigned.

SAMPLE: 94C-332
Age: ?Windsor

Remarks

Only 18, poorly preserved spores typical of the Windsor Group are present in this inertinite-dominated sample. The sample is too poor to date with confidence.

SAMPLE: 94C-359A
Age: Late Namurian - earliest Westphalian A

Remarks

This is another poor sample with rare, poorly-preserved spores and pollen. Specimens of *Florinites visendus* are the most common and in proportions such as this suggest a transitional Namurian - Westphalian age. However, the species is found sporadically to the base of the Namurian in Europe. A few Windsor spores are also present as well as some reworked Early Palaeozoic acritarchs.

SAMPLE: 94C-359B
Age: No older than Namurian

Remarks

The yield from this sample was extremely small and modern contaminants are present. A few fragments of saccate gymnosperm pollen indicate that the sample is no older than Namurian but it is too poor to be more precise.

Four samples were prepared from this corehole and all yielded rich Westphalian A assemblages. The results are summarised and described in detail below and the data are plotted on Enclosure 6.

Sample Depth	Age	Zone
12.37m	Latest Westphalian A	*V. tortuosa*
49.8m	Late Westphalian A	*C. mehtae* - *R. fulva micra*
101.5m	Late Westphalian A	*C. mehtae* - *R. fulva micra*
219.7m	late Early Westphalian A	*S. arenaceus* - *Florinites* spp.

SAMPLE DEPTH: 12.37m
Age: Latest Westphalian A
Zone: *Vestispora tortuosa*, Dolby (in press)

Remarks

This is a rich assemblage typical of the lower part of the Cumberland Group. The presence of *Vestispora tortuosa* and Spore type A (Dolby, in press) indicate a latest Westphalian A age.

SAMPLE DEPTHS: 49.8m, 101.5m
Age: Late Westphalian A
Zone: *Cannanoropollis mehtae* - *Raistrickia fulva micra*, Dolby (in press)

Remarks

These are rich assemblages dominated by monosaccate pollen. Specimens of *Cannanoropollis mehtae*, *Raistrickia fulva micra* and *Punctatosporites* sp. indicate an age no older than Late Westphalian A.

SAMPLE DEPTH: 219.7m
Age: late Early Westphalian A
Zone: *Spelaeotriletes arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

A specimen of *Spelaeotriletes arenaceus* is used to date this assemblage. A specimen of *Cannanoropollis* aff. *mehtae* suggests that the sample could come from high in the *S. arenaceus* - *Florinites* spp. Zone. Silurian and Ordovician acritarchs are numerous.

Seven samples were prepared from this well but the lower three yielded few palynomorphs. The upper four indicate a Westphalian - Stephanian age for the section down to 507m. The results are summarised and described in detail below and the species occurrences plotted on Enclosure 7.

Sample Depth	Age
21.6m	Stephanian
80m	Westphalian D - Stephanian
152.65m	Westphalian D
507m	Westphalian D
701.8m	Westphalian, undifferentiated
718.2m	Westphalian, undifferentiated
727m	Westphalian, undifferentiated

SAMPLE DEPTH: 21.6m
Age: Stephanian

Remarks

The age is based on the presence of very large numbers of striate bisaccate pollen such as *Illinites* spp., *Striatoabieites* spp., *Hamiapollenites tractiferinus*, and *Protohaploxypinus* spp. Monosaccate pollen are also abundant and include some specimens of *Nuskoisporites* sp. A specimen of *Angulisporites* aff. *splendidus* also tends to confirm the age.

Assemblages such as this were assigned to the Stephanian by Barss and Hacquebard (1967) although striate pollen appear in the latest Westphalian B. Thus there is always the potential for rich striate assemblages earlier than the Stephanian.

SAMPLE DEPTH: 80m
Age: Westphalian D - Stephanian undifferentiated

Remarks

Although rich, this assemblage is of limited composition. The species present all have long stratigraphic ranges.

SAMPLE DEPTHS: 152.65m, 507m
Age: Westphalian D

Remarks

Striate pollen are quite numerous in the upper sample but there is also a specimen of *Triquitrites sculptilis* present which does not range above the Westphalian D according to Peppers (1985). The lower sample has this species in abundance as well as a specimen of *Thymospora obscura* which indicates an age no older than Westphalian D. Among the species of *Vestispora* present are specimens of *V.* cf. *witneyensis* and *V.* cf. *colchesterensis*. *Sensu stricto* forms of these characterise the mid D.

SAMPLE DEPTHS: 701.8m, 718.2m, 727m
Age: Westphalian undifferentiated

Remarks

The upper and lower sample yielded abundant inertinitic debris but few spores and pollen. The presence of *Florinites florinii* at 718.2m and 727m indicates a Westphalian age if the specimens are *in situ*. Given the poor quality of the assemblages, the potential for contamination is relatively high.

The 718.2m sample yielded a small quantity of amorphous kerogen reminiscent of Stellarton oil shale residues.

Five samples were prepared from this corehole but only the four lower ones produced spores and pollen. The palynomorphs are severely thermally altered but are all typical of the Windsor Group.

Sample Depth	Age	Zone
21.5m, Box 37	Indeterminable	
27m, Box 46	Visean	AT
27.5m, Box 85	Visean	AT
6.3m, Box 90	Visean	?AT
98.25, Box 102	Visean	?AT

SAMPLE: 21.5m, Box 37
Age: Indeterminable

Remarks

The residue consists of inertinite only.

SAMPLES: 27m, Box 46 and 27.5m, Box 85
Age: Visean
Zone: AT, Utting (1987)

Remarks

These are typical Windsor assemblages. The presence of *Schopfipollenites arcadensis* in both samples indicates an age no older than the AT Zone. A questionable specimen of *Densosporites columbaris* in the upper sample suggests an age no younger than the AT Zone.

Significant species

Retusotriletes incohatus (A)
Rugospora minuta (A)
Spelaeotriletes echinatus
Schopfipollenites arcadensis
Crassispora trychera
Auroraspora macra
S. pretiosus bellii
Densosporites cf. *columbaris*

SAMPLES: 6.3m, Box 90 and 98.25m, Box 102
Age: Visean
Zone: ?AT, Utting (1987)

Remarks

Indeterminate blackened spores are extremely abundant in both samples. Identifiable species form a Windsor assemblage similar to the overlying samples. There are some black, ellipsoidal palynomorphs in the lower sample which could be *Schopfipollenites arcadensis* indicating a possible AT age.

Two further core samples were processed from this corehole which was described in Section 11 of the 1994 report (Dolby, 1994, #93-05). Both samples contain rich assemblages and the species occurrence chart has been modified to include the new data, Enclosure 8.

Although the upper sample at 451m is rich, most of the species have long ranges. The 452m assemblage is rich and diverse. The combination of *Torispora securis*, *Illinites unicus*, *Striatoabieites* sp. and *Raistrickia fulva* var. *fulva* indicates an early middle Westphalian C age. *R. fulva fulva* is considered to be an early C and older species, dying out at approximately the same time as *Torispora* spp. appear. In the Sydney Basin it is found mostly below *Torispora* spp. occurrences but there are two isolated occurrences slightly higher than this. If all the ranges are valid, the section at 452m can be assigned to the *Torispora* spp. - *Punctatosporites granifer* Zone (Dolby, in prep.). This is roughly equivalent to a position midway between the Buchanan and Mullins seams in the Sydney Basin.

This corehole intersects both Cretaceous and Carboniferous strata. Samples from the former were examined briefly to determine the top of the Carboniferous section.

Nine samples from the 207'6" - 255' interval contain poorly preserved spores typical of the Windsor Group. The results are described below and the species occurrences plotted on Enclosure 9.

Interval	Age	Zone
207'6" - 239'6"	Visean	NS
240'4" - 255'	?Visean	

INTERVAL: 207'6" - 239'6"
Age: Visean
Zone: NS, Utting (1987)

Remarks

Most of the spores have been severely altered by pyrite and many are therefore unidentifiable. The assemblages are typical of the Windsor with abundant *Crassispora trychera*, *Retusotriletes incohatus* and *Rugospora minuta*. The presence of *Vallatisporites verrucosus* and the lack of AT Zone markers indicates that the section belongs to the NS Zone. A specimen of *Lycospora* cf. *pusilla* at 239.6" indicates that the section at this point is no older than Visean.

INTERVAL: 240'4" - 255'
Age: Visean

Remarks

The three samples from this interval yielded few identifiable spores. Those which are identifiable are typical of the Windsor but do range into the Horton Group, however, there is no sign of Horton influence. These extremely poor assemblages are tentatively assigned to the Visean Windsor Group.

Ten slides from miscellaneous outcrop samples were analysed. Of these, four were barren of palynomorphs. The results summarised and described below.

Sample	Age	Zone
6699	??Tournaisian	
6662	Indeterminable	
6664	Indeterminable	
6693	Indeterminable	
6573	Indeterminable	
SMB94-91	Tournaisian	upper 3B
SMB94-8A	Tournaisian	4
SMB94-8B	Indeterminable	
Shub-2	Early Westphalian	
Shub-3	Basal Westphalian B	*Punctatosporites* spp.

SAMPLE: 6699
Age: ??Tournaisian

Remarks

This sample is difficult to date. Spores are sparse, poorly preserved and usually broken and they are difficult to identify with confidence. Some fragments of *Spelaeotriletes* resemble *S. cabotii* , a Horton species, but these identifications are tentative.

SAMPLES: 6662, 6664, 6693, 6573
Age: Indeterminable

Remarks

The residues consist of inertinitic debris only.

SAMPLE: SMB94-91
Age: Tournaisian
Zone: upper 3B; upper *S. cabotii*, Utting et al. (1989)

Remarks

The assemblage is dominated by simple spores typical of the Horton with few species of limited range. Rare specimens of *Schopfites claviger* and *Crassispora* cf. *trychera* indicate an upper 3B Zone age or younger. The most numerous species are, however, *Vallatisporites vallatus* and *V. verrucosus* which suggest that the sample is unlikely to be significantly younger than Zone 3.

The zonation of the upper part of the Horton is currently being reviewed.

Significant species

Vallatisporites spp. (F)
V. vallatus
Schopfites claviger
Spelaeotriletes pretiosus
Knoxisporites literatus
V. verrucosus
V. cf. *ciliaris*
Crassispora cf. *trychera*
S. echinatus
Auroraspora macra

SAMPLE: SMB94-8A
Age: Tournaisian
Zone: 4; *S. pretiosus*, Utting et al. (1989)

Remarks

This sample contains numerous specimens of *Spelaeotriletes pretiosus* and several *Crassispora trychera* which indicate a Zone 4, Cheverie equivalent age.

Significant species

Spelaeotriletes pretiosus (F)
Crassispora trychera
Vallatisporites vallatus (R)
S. echinatus
Schopfites claviger
V. verrucosus (R)

SAMPLE: SMB94-8B
Age: Indeterminable

Remarks

This sample contained extremely rare, indeterminate spores and acritarchs. No age can be assigned.

SAMPLE: SHUB-2
Age: Westphalian, early

Remarks

Although the organic yield was high, spores and pollen are rare and most are long-ranging species. The overall character is typical of the Westphalian A-B.

Significant species

Lycospora spp. (A)
Florinites florinii
Raistrickia fulva
Rugospora calderi
Granulatispories spp.
F. pumicosus
Crassispora kosankei
Cirratriradites cf. *saturni*

SAMPLE: SHUB-3
Age: Early Westphalian B
Zone: *Punctatosporites* spp., Dolby (in press)

Remarks

This assemblage is much richer than that from SHUB-2 but is of similar composition. Specimens of *Punctatosporites* spp. and *Raistrickia fulva* cf. var *micra* indicate a basal Westphalian B age.

Significant species

Raistrickia fulva cf. var *micra*
Punctatosporites spp.

Three samples were prepared from this corehole but the lowermost is virtually barren. The results are summarised and described below.

Depth	Age	Zone
254.2m	probably late Westphalian C	*Torispora* spp. - *V. magna*
291.6m	?No older than early middle Westphalian C	?*Torispora* spp. - *P. granifer*
331.9m	Indeterminable	

SAMPLE DEPTH: 254.2m
Age: probably late Westphalian C
Zone: *Torispora* spp. - *V. magna*

Remarks

Most of the species in this rich assemblage range through the Westphalian C, D and Stephanian. A specimen of *Triquitrites* cf. *spinosus* suggests that the age may be as young as Westphalian D but there are no other markers present. A late C age is therefore tentatively assigned.

Significant species

Triquitrites cf. *spinosus*
T. additus
Microreticulatisporites nobilis
Punctatosporites granifer (R)
Vestispora fenestrata
T. sculptilis
T. tribullatus (C)
M. sulcatus
Endosporites globiformis
Apiculatisporis abditus

SAMPLE DEPTH: 291.6m
Age: ?No older than early middle Westphalian C
Zone: ?No older than *Torispora* spp. - *P. granifer*, Dolby (in prep.)

Remarks

This very small assemblage consists mostly of long-ranging spores and pollen. A single specimen of *Triquitrites tribullatus*, if *in situ*, indicates an age no older than early middle Westphalian C. However, sample contamination cannot be ruled out.

Significant species

Lycospora spp. (F)
Crassispora kosankei
Florinites spp. (R)
Triquitrites tribullatus

SAMPLE DEPTH: 331.9m
Age: Indeterminable

Remarks

Six, long-ranging Carboniferous spores were present in this sample. They are considered to be contaminants.

Two samples were prepared and each yielded sparse spore/pollen assemblages of Westphalian A aspect. The results are described below.

Depth	Age
97.9m	Late Westphalian A
112.9m	Late Westphalian A

SAMPLE DEPTHS: 97.9m, 112.9m
Age: Late Westphalian A

Remarks

Palynomorphs are sparse in this sample and most are long-ranging species. At 97.9m specimens of Spore type A indicate a Westphalian A age and *Raistrickia fulva* cf. var. *micra* suggests that it is late A. The 112.9m sample is rich in organic and fungal debris but there are few spores and pollen. Specimens of *Cyclogranisporites aureus* indicate an age no older than late Westphalian A.

Significant species

Lycospora spp. (A)
F. mediapudens (R)
Raistrickia fulva
Spore type A
Florinites visendus (R)
F. florinii
R. fulva cf. var *micra*
Cyclogranisporites aureus

Ten samples were analyzed in this series and one of them was effectively barren. The results are summarised and described below.

Sample	Age	Zone
G940 Series		
200	Late Visean	SM
211	Late Visean	SM
384	Tournaisian	4-5
386	Indeterminable	
392	Late Visean	SM
399	Late Visean	SM
425	Basal Namurian	
695	Late Visean	SM
947a	No older than Namurian	
947b	No older than Namurian	

SAMPLE: G940-200
Age: Late Visean
Zone: SM, Utting (1987)

Remarks

This is a rich assemblage containing *Ibrahimisporites magnificus*, *Schulzospora bilunata* and *Grandispora* cf. *spinosa* which are indicative of a Windsor-Canso Boundary Beds or SM Zone age.

Significant species

Colatisporites decorus
Auroraspora macra
Schopfites claviger
Schopfipollenites arcadensis
Spelaeotriletes echinatus
Cribrosporites cribellatus
Grandispora cf. *spinosa*
Lycospora pellucida
Rugospora minuta
A. solisorta
Schulzospora bilunata
S. ellipsoides
S. sp. A Neves & Belt 1970
Ibrahimisporites magnificus
Densosporites cf. *spinifer*
L. noctuina

SAMPLE: G940-211
Age: Late Visean
Zone: SM, Utting (1987)

Remarks

This is a rich assemblage similar to G940-200. It also contains *Spelaeotriletes arenaceus*, a prominent Namurian spore which does range down into the Late Visean.

Significant species

Spelaeotriletes arenaceus
Rugospora corporata verrucosa
Schulzospora plicata
Scutulum trisupplementum

SAMPLE: G940-384
Age: Late Tournaisian
Zone: 4-5, Dolby 1993

Remarks

This is a poor assemblage which has been thermally altered. There is a large proportion of simple, indeterminate spores and the overall appearance is that of a Horton Group assemblage. The presence of numerous *Crassispora trychera* with several *Spelaeotriletes pretiosus* and *Vallatisporites* spp. suggests a possible Zone 4-5, Cheverie-Wilkie Brook transition age.

Significant species

Crassispora trychera
Vallatisporites spp.
Spelaeotriletes pretiosus
Schopfites claviger
V. verrucosus
S. pretiosus bellii

SAMPLE: G940-386
Age: Indeterminable

Remarks

An essentially barren sample.

SAMPLES: G940-392, G940-399
Age: Late Visean
Zone: SM, Utting (1987)

Remarks

These assemblages are virtually identical in composition to G940-211. A specimen of *Knoxisporites* cf. *dissidius* in each of the samples suggests a very late Visean age. There are no specifically Namurian markers present.

SAMPLE: G940-425
Age: Basal Visean

Remarks

This sample yielded a typical Windsor-Canso Boundary Beds assemblage but rare fragments of monosaccate gymnosperm pollen indicate a Namurian age.

Significant species

Crassispora trychera (A)
Schopfites claviger
Schulzospora bilunata
Rugospora minuta (A)
Schopfipollenites arcadensis
Saccate fragments (R)

SAMPLE: G940-695
Age: Late Visean
Zone: SM, Utting (1987)

Remarks

This is a rich Windsor-Canso Boundary Beds assemblage. No saccate pollen are present.

Significant species

Crassispora trychera (A)
Schopfites claviger (C)
Schulzospora bilunata (A)
Rugospora minuta (A)
Schopfipollenites arcadensis (A)
Densosporites cf. *spinifer*

SAMPLES: G940-947a, b
Age: No older than Namurian

Remarks

Both assemblages are poor and the kerogens have been winnowed in a relatively high-energy environment. They contain Windsor-Canso species and monosaccate gymnosperm pollen which indicates an age no older than Namurian. Silurian acritarchs are present in both and it is probable that the both assemblages have been entirely reworked.

Significant species

Schopfipollenites arcadensis
Rugospora minuta
Potonieisporites spp.

S. ellipsoides
Crassispora trychera
Saccate fragments

Veryhachium carminae
Diexallophasis sp.

Dateriocradus sp.
Multiplicisphaeridium sp.

Three samples were examined from this series and all contained good assemblages. The results are summarised and described below.

Sample	Age	Zone
G95 Series		
0001	Early Westphalian A	*S. arenaceus* - *Florinites* spp.
0003	Early Westphalian A	*S. arenaceus* - *Florinites* spp.
0711	Latest Westphalian B - ?C	

SAMPLES: G95-001, 003
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

Both assemblages are typical of the Namurian-Westphalian transition and resemble other samples of similar age in this study. The presence of rare *Florinites florinii* with larger numbers of *F. visendus* and *F. pumicosus* signifies the early stages of diversification in this group which often dominate assemblages from the early mid Westphalian A onwards. *Spelaeotriletes arenaceus* is present in 0003. This species does not range above the early A. *Lycospora orbicula*, a Westphalian-Stephanian species, occurs in both samples. Ordovician acritarchs are present in both samples.

Significant species

Florinites florinii (R)
F. pumicosus
Anapiculatisporites cf. *vergrandis* (A)
Potonieisporites spp.
Granulatisporites granulatus
Auroraspora solisorta (F)
L. orbicula
Veryhachium spp.
F. visendus
Spelaeotriletes arenaceus
Spore type A
Kraeuselisporites ornatus
G. microgranifer
Lycospora spp. (C-A)
L. cf. *orbicula*
Leiofusa sp.

SAMPLE: G95-0711
Age: latest Westphalian B - ?C

Remarks

Although this sample is rich, it is difficult to assign an age with confidence. There are several specimens of bisaccate pollen with vaguely developed taeniae. These are more prominent from the early middle Westphalian C but can range down to the latest B. There are also several specimens of *Illinites* sp. vaguely resembling *I. boehneri* which appears in the B - C transition. A poorly preserved specimen of *Vestispora* resembling *V. foveata* suggests a C or younger age. However, there are no species present which are usually found in C and younger strata. The assemblage is overwhelmingly dominated by long-ranging taxa. Recycled Early Palaeozoic acritarchs are present.

Significant species

Florinites florinii (A)
F. visendus (A)
Wilsonites delicatus (C)
Potonieisporites spp.
Cannanoropollis janakii (F)
Illinites spp.
Lycospora spp. (R)
Veryhachium spp.
Baltisphaeridium spp.
F. pumicosus (A)
F. mediapudens (A)
W. vesicatus (F)
Guthoerlisporites spp.
Protohaploxypinus sp.
I. cf. *boehneri*
Schopfipollenites ellipsoides (A)
Micrhystridium spp.
Diexallophasis spp.

Thirteen samples were analysed in this series of which four were too poor to assign an age. The results are summarised and described below. Some samples have the same number but come from different localities.

Sample	Age	Zone
H940 Series		
238	Late Namurian - early Westphalian A	
432	Tournaisian	
466	Tournaisian	3-4
481	Early Namurian	
518/D2828	Indeterminable	
518/D2925	Tournaisian	
519	Indeterminable	
595	Indeterminable	
776	Indeterminable	
816	Late Visean - Early Namurian	
818	Tournaisian	?4
877	Tournaisian	No older than upper 3A
911/D2834	Tournaisian	5
911/D2927	Tournaisian	4
934/D2835	Tournaisian	No older than upper 3B
934/D2928	Tournaisian	upper 3A - 3B

SAMPLE: H940-238
Age: Late Namurian - early Westphalian A

Remarks

This is a very poor sample with a few palynomorphs which range through the Namurian and Westphalian. The lack of Windsor-Canso spores and the presence of *Florinites visendus* suggests a Late Namurian - early Westphalian A age.

Significant species

Lycospora pusilla (C)
Florinites visendus
L. pellucida (A)
Crassispora kosankei

SAMPLE: H940-432
Age: Tournaisian

Remarks

A very poor assemblage. *Vallatisporites verrucosus*, *V. vallatus* and *Verrucosisporites papillosus* are the only identifiable species. The first two are more abundant in the Horton Bluff but there are insufficient data here to be precise.

SAMPLE: H940-466
Age: Tournaisian
Zone: probably 3-4, Dolby (1993)

Remarks

This is obviously a Horton Group assemblage but, although spores are abundant, they are severely thermally altered. *Vallatisporites verrucosus* is quite numerous and there are several specimens of *Spelaeotriletes pretiosus* and *Crassispora trychera* which together suggest a probable Zone 3-4 transition age. A few acritarchs are also present.

Significant species

Vallatisporites verrucosus
Spelaeotriletes pretiosus
Crassispora trychera
Auroraspora macra
Schopfites claviger
Grandispora uncata

SAMPLE: H940-481
Age: Early Namurian

Remarks

Although rich, most of the palynomorphs are unidentifiable due to severe pyritization. Saccate pollen fragments are present in a Windsor-Canso spore assemblage indicating an Early Namurian age.

Significant species

Rugospora minuta
Schopfites claviger
Lycospora pellucida
Knoxisporites stephanephorus
R. polyptycha
Crassispora trychera
Saccate fragments
K. triradiatus

SAMPLES: H940-518 (D2828), 519, 595, 776
Age: Indeterminable

Remarks

The residues consist of inertinitic debris with extremely rare, carbonised and unidentifiable spores.

SAMPLE: H940-518 (D2925)
Age: Tournaisian

Remarks

Spores are rare and mostly unidentifiable due to the level of thermal maturity and pyritization. Specimens of *Vallatisporites vallatus* and *V. verrucosus* together suggest a Tournaisian age.

SAMPLE: H940-816
Age: Late Visean - Early Namurian

Remarks

The yield was extremely low. The few species present are typical of the Windsor-Canso and the presence of *Schopfipollenites ellipsoides* suggests an age no older than the latest Visean.

Significant species

Retusotriletes incohatus
Rugospora minuta
Auroraspora macra
Schopfipollenites ellipsoides
Crassispora trychera
Micrhystridium spp.

SAMPLE: H940-818
Age: Tournaisian
Zone: ?4, Dolby (1993)

Remarks

Most of the spores are unidentifiable due to heavy pyritization. Of the identifiable spores, *Spelaeotriletes pretiosus* and *Vallatisporites verrucosus* are the most numerous suggesting a possible Cheverie equivalent age.

Significant species

Spelaeotriletes pretiosus
Vallatisporites verrucosus
Schopfites claviger
Veryhachium spp.
Grandispora uncata
V. ?ciliaris
Knoxisporites literatus
Micrhystridium spp.

SAMPLE: H940-877
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

Most of the spores are unidentifiable due to carbonisation and pyritization. The presence of *Crassispora trychera* inicates an age no older than uppermost Horton Bluff equivalent.

Significant species

Crassispora trychera
Vallatisporites vallatus
Converrucosisporites parvinodosus
V. verrucosus

SAMPLE: H940-911 (D2834)
Age: Late Tournaisian
Zone: 5, Dolby (1993)

Remarks

Although the overall appearance of the assemblage is referable to the Horton, the Windsor influence is very strong. *Crassispora trychera* is abundant and there are specimens of *Densosporites columbaris* and *Vallatisporites* spp. which are present in other Wilkie Brook equivalent sections. Acritarchs are numerous and at least some are derived from Ordovician or Silurian rocks.

Significant species

Rugospora minuta (A)
Retusotriletes incohatus (A)
Vallatisporites ?ciliaris
V. verrucosus (C)
Schopfites claviger
Veryhachium spp.
Crassispora trychera (A)
Auroraspora macra (A)
V. vallatus (F)
Densosporites columbaris
Simple indet. spores (A)
Micrhystridium spp.

SAMPLE: H940-911 (D2927)
Age: Tournaisian
Zone: 4, Dolby (1993)

Remarks

This is a rich assemblage somewhat different in composition to the 911 (D2834) sample. *Spelaeotriletes pretiosus* is abundant indicating a Zone 4, Cheverie equivalent age.

Significant species

Spelaeotriletes pretiosus (A)
S. echinatus
Schopfites claviger (F)
Vallatisporites verrucosus (C)
V. cf. *ciliaris*
Veryhachium spp.
S. cabotii
Crassispora trychera (F)
Grandispora uncata
V. vallatus (F)
Rugospora polyptycha
Micrhystridium spp.

SAMPLE: H940-934 (D2835)
Age: Tournaisian
Zone: No older than upper 3B, Dolby (1993)

Remarks

The spores are very poorly preserved and most are unidentifiable. The presence of *Schopfites claviger* indicates an age no older than upper 3B but there are insufficient data to be more precise.

Significant species

Schopfites claviger
Retusotriletes incohatus (C)
Vallatisporites vallatus
Crassispora trychera
Auroraspora macra
V. verrucosus

SAMPLE: H940-934 (D2928)
Age: Tournaisian
Zone: upper 3A - 3B, Dolby (1993)

Remarks

The abundance of *Vallatisporites vallatus* and *V. verrucosus* with a small number of *Crassispora trychera* indicates an upper 3A to 3B age equivalent to the upper part of the Horton Bluff. A small number of acritarchs is present but they appear to be reworked Early Palaeozoic species.

Significant species

Vallatisporites vallatus (A)
Crassispora trychera
Veryhachium spp.
V. verrucosus (A)
Rugospora polyptycha
Micrhystridium spp.

Only two samples were submitted in this series and both yielded good assemblages of Horton and Westphalian ages respectively.

Sample	Age	Zone
94PSG0083	Tournaisian	3B - 4
94PSG0163	Early Westphalian A	*S. arenaceus* - *Florinites* spp.

SAMPLE: 94PSG0083
Age: Tournaisian
Zone: 3B - 4 transition, Dolby 1993

Remarks

This rich assemblage contains features typical of Zone 3B with elements of Zone 4 affinity. The abundances of *Vallatisporites vallatus* and *V. verrucosus* are more typical of Zone 3 and *Schopfites claviger* appears in 3B. *Spelaeotriletes pretiosus* is numerous and *S. cabotii* is rare which is more typical of Zone 4. A 3B - 4 transition age is therefore assigned. (See T940899)

Significant species

Vallatisporites vallatus (A)
V. cf. *ciliaris*
Spelaeotriletes pretiosus (C)
S. echinatus
Tricidarisporites sp.
V. verrucosus (A)
Schopfites claviger
S. cabotii (R)
Crassispora trychera (F)
Auroraspora macra

SAMPLE: 94PSG0163
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby 1993

Remarks

The presence of *Lycospora orbicula* indicates a Westphalian age and the abundance of larger forms of *Florinites* but rarity of *F. florinii*

suggest an early A age. However, there is a specimen of a *Vestispora* species present. It more closely resembles *V. lucida*, an early Namurian form which Ravn (1986) also recorded in a Late Namurian coal in Iowa. This species in many ways resembles *V. tortuosa* which does not appear until the late A, but the overall character of the assemblage appears to be older.

Significant species

Vestispora cf. *lucida*
L. pusilla (A)
Florinites visendus (A)
F. florinii (R)
Lycospora pellucida (A)
L. orbicula (C)
F. pumicosus (C)
Kraeuselisporites ornatus

Ten samples from the Strathlorne-Ainslie formations were analysed. Eight yielded rich assemblages of spores but two were dominated by amorphous kerogen.

Sample	Age	Zone
94TLA Series		
0162	Tournaisian	4
0165	Tournaisian	3-4
0216	Tournaisian	3-4
0311	Tournaisian	No older than upper 3A
0321	Tournaisian	3-4
0399	Tournaisian	3-4
0403	Tournaisian	3-4
0416	Tournaisian	upper 3B
0418	Tournaisian	upper 3B
0421	Tournaisian	?2B-3

SAMPLE: 94TLA0162
Age: Tournaisian
Zone: 4, Dolby (1993)

Remarks

This is a rich assemblage in which *Spelaeotriletes pretiosus* is abundant and *Crassispora trychera* and *Schopfites claviger* are numerous. A Zone 4, Cheverie equivalent age is indicated. Reworked Ordovician acritarchs are present.

Significant species

Spelaeotriletes pretiosus (A)
Schopfites claviger (C)
Vallatisporites vallatus (R)
Crassispora trychera (C)
Auroraspora macra
V. verrucosus (R)

SAMPLES: 94TLA0165, 0216
Age: Tournaisian
Zone: 3-4 transition, Dolby (1993)

Remarks

Both samples closely resemble 94PSG0083.

Significant species

Vallatisporites vallatus (A)
V. ciliaris
Spelaeotriletes pretiosus (C-A)
S. echinatus
V. verrucosus (A)
Schopfites claviger
S. cabotii (R)
Crassispora trychera (F)

SAMPLE: 94TLA0311
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

This sample is dominated by amorphous kerogen and the spores are relatively rare. *Vallatisporites* spp. are the most numerous and two specimens of *Crassispora trychera* indicate that the age is no older than upper 3A.

Significant species

Vallatisporites vallatus (F)
Crassispora trychera (R)
V. verrucosus (F)
Spelaeotriletes pretiosus (R)

SAMPLES: 94TLA0321, 0399, 0403
Age: Tournaisian
Zone: 3-4 transition, Dolby (1993)

Remarks

These are rich assemblages which closely resemble 94PSG0083 and 94TLA0165 and 0216. Samples 0399 and 0403 contain specimens of *Anapiculatisporites hystrichosus* which is more of a 2B-3 species.

SAMPLES: 94TLA0416, 0418
Age: Tournaisian
Zone: Upper 3B, Dolby (1993)

Remarks

Both samples are similar in composition to 0321-0403 (see above), but the Zone 4 influence (abundances of *Spelaeotriletes pretiosus*, *Crassispora trychera* and *Schopfites claviger*) is much weaker. Recycled Early Palaeozoic acritarchs are present.

SAMPLE: 94TLA0421
Age: Tournaisian
Zone: ?2B-3, Dolby (1993)

Remarks

Spores are extremely rare in this sample which is overwhelmingly dominated by amorphous kerogen. The presence of *Anapiculatisporites hystrichosus* in such a poor assemblage suggests than a 2B3 age is most likely.

Significant species

Vallatisporites verrucosus (R)
Anapiculatisporites hystrichosus (R)
Auroraspora macra (R)
Rugospora polyptycha (R)

Seventeen samples were analysed in this series of which seven could not be assigned a precise age. The results are summarised and described below.

Sample	Age	Zone
T940 Series		
596	Late Visean	CM
617	?Early Namurian	
632	?Early Namurian	
654	Tournaisian	
659	Indeterminable	
695	Tournaisian	No older than 3B
697	Tournaisian	No older than 3B
725	Tournaisian	
729	Tournaisian	
741	Tournaisian	?4
750	Tournaisian	
769	Indeterminable	
899	Early Westphalian A	*S. arenaceus* - *Florinites* spp.
930	Tournaisian	2B-3
960	Indeterminable	
972	Late Visean	SM
986	?Late Westphalian B	?*V. magna* - *V. pseudoreticulata*

SAMPLE: T940596
Age: Late Visean
Zone: CM, Utting (1987)

Remarks

This assemblage is typical of the Windsor-Canso but lacks even fragments of saccate, gymnosperm pollen. A Late Visean age is therefore assigned.

Significant species

Rugospora minuta (A)
Crassispora trychera (C)
Schopfites claviger (A)
Lycospora pellucida (A)
Auroraspora macra (A)
Schopfipollenites spp. (A)
Grandispora spinosa
L. noctuina (A)

SAMPLES: T940617, 632
Age: ?Early Namurian

Remarks

Sample 617 is rich but 632 is relatively poor. Both contain assemblages similar to 596 (above) and lack saccate pollen. The presence of *Dictyotriletes* cf. *castanaeformis* suggests that an Early Namurian age is more appropriate.

SAMPLE: T940654
Age: Tournaisian

Remarks

This is an extremely poor assemblage of simple spores and *Retusotriletes incohatus*. An undifferentiated Horton age is assigned.

SAMPLES: T94659, 769, 906
Age: Indeterminable

Remarks

Essentially barren samples.

SAMPLE: T940695
Age: Tournaisian
Zone: No older than upper 3B

Remarks

This is an extremely poor assemblage which has been thermally altered. *Crassispora trychera* and *Schopfites claviger* are numerous indicating an age no older than upper 3B. Fragments of a distinctive *Vallatisporites* species first seen in the Wilkie Brook are present however, the range of this taxon may range down further than was previous thought.

Significant species

Crassispora trychera (C)
Vallatisporites sp.
Schopfites claviger (F)
V. verrucosus

SAMPLE: T940697
Age: Tournaisian
Zone: No older than upper 3B

Remarks

Indeterminate spores are abundant but heavily pyritized. The presence of *Vallatisporites ciliaris* indicates an age no older than upper 3B. The preservation prevents a more precise assignment.

Significant species

Vallatisporites ciliaris (R)
V. verrucosus (R)
Spelaeotriletes cf. *cabotii*
V. vallatus (R)
Crassispora trychera (R)
S. cf. *pretiosus*

SAMPLES: T940725, 729
Age: Tournaisian

Remarks

Spores are rare and corroded but typical of the Horton Group. The only significant species present is a single specimen of *Vallatisporites verrucosus* in 725.

SAMPLE: T940741
Age: Tournaisian
Zone: ?4, Dolby (1993)

Remarks

This is a poor, thermally altered assemblage. Rare *Vallatisporites ciliaris* and *Schopfites claviger* indicate an age no older than upper 3B. Three specimens of *Spelaeotriletes pretiosus*, a relatively high number for the sample, suggest a Zone 4 age might be suitable.

Significant species

Vallatisporites ciliaris (R)
Schopfites claviger (R)
Spelaeotriletes pretiosus (R)
V. verrucosus (R)
Crassispora trychera (R)
Verrucosisporites nitidus

SAMPLE: T940750
Age: Tournaisian

Remarks

An extremely poor assemblage of mostly simple spores typical of the Horton. The only distinctive species are rare *Retusotriletes incohatus*, *Rugospora minuta* and *Auroraspora macra*.

SAMPLE: T940899
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

This sample resembles 94PSG0163 but is much richer and more diverse. Only the larger species of *Florinites* are present but the presence of *Lycospora orbicula*, *Cingulizonates loricatus* and *Raistrickia polygonalis* indicate a Westphalian A age. Other typically Early A species include *Spelaeotriletes arenaceus* and Spore type A.

Significant species

Lycospora orbicula
Reticulatisporites polygonalis
Spelaeotriletes arenaceus
Florinites visendus
Cingulizonates loricatus
Spore type A
Secarisporites remotus
F. pumicosus

SAMPLE: T940930
Age: Tournaisian
Zone: 2B-3, Dolby (1993)

Remarks

Spores are rare but are mostly simple forms typical of the Horton. The only diagnostic species are a specimen of *Anapiculatisporites hystrichosus* and fragments of *Vallatisporites verrucosus* indicating a 2B-3 age.

SAMPLE: T940972
Age: Late Visean
Zone: SM, Utting (1987)

Remarks

This is a very rich assemblage similar in composition to other SM Zone samples in this study. No undoubted specimens of saccate pollen or even fragments are present and the assemblage is therefore

assigned to the Visean. Specimens of *Triquitrites marginatus* and *T. comptus* are present. The former does not range above the mid-Arnsbergian of the Namurian A.

Significant species

Lycospora pellucida (A)
Rugospora minuta
Schopfipollenites arcadensis
Schulzospora plicata
Crassispora trychera
Triquitrites marginatus
L. noctuina
Auroraspora macra
Densosporites cf. *spinifer*
S. bilunata
Schopfites claviger
T. comptus

SAMPLE: T940986
Age: ?Late Westphalian B
Zone: *V. magna - V. pseudoreticulata*, Dolby (in prep.)

Remarks

This assemblage comes from a shale in an abandoned channel which may account for the high proportion of reworked material. The character of the assemblage resembles those from the Westphalian A but the presence of *Vestispora* cf. *pseudoreticulata* and *Endosporites globiformis* indicates a B age at the oldest. The former of these two species ranges to the base of the D in Europe but is more typical of the late B to C of Nova Scotia. There is no sign of undoubted C influence. A late B age is tentatively assigned.

Significant species

Florinites visendus (A)
F. florinii (A)
Plicatipollenites malabarensis
Wilsonites spp.
Knoxisporites dissidius (RW)
K. triradiatus
Vestispora cf. *pseudoreticulata*
F. mediapudens (A)
Potonieisporites spp. (A)
Cannanoropollis janakii
C. cf. *mehtae*
K. stephanephorus
Apiculatisporites abditus
Endosporites globiformis (F)

SAMPLE: T94-1055
Age: Tournaisian
Zone: No older than upper 3B, Dolby (1993)

Remarks

The spores in this sample, although numerous, have been thermally altered as well as corroded by pyrite and few are identifiable. A single specimen of *Schopfites claviger* indicates that the age is no older than upper 3B.

Significant species

Schopfites claviger (R)
Vallatisporites vallatus (R)
Rugospora minuta (R)
V. verrucosus

SAMPLE: SWM-1
Age: possibly basal Namurian

Remarks

This is a rich Windsor-Canso Boundary Beds assemblage with extremely rare and questionable saccate pollen fragments. Good, undoubted specimens of the latter would indicate a Namurian age. Silurian acritarchs are present.

Significant species

Rugospora minuta (R)
L. pusilla
Crassispora trychera (A)
Grandispora spinosa
magnificus
Lycospora pellucida (A)
L. noctuina
Schopfites claviger (R)
Ibrahimisporites

SAMPLE: C7255
Age: Indeterminable

Remarks

The residue consists of highly thermally altered kerogen with extremely rare spores which are interpreted as contaminants.

Twenty samples were analysed in this group and most yielded good assemblages. The results are summarised and described below.

Sample	Age	Zone
CS94 Series		
011	?Tournaisian	
012	Tournaisian	4-5
016	Tournaisian	4-5
030	Tournaisian	?5
039	Tournaisian	4-5
068	Tournaisian	No older than upper 3A
070d	Tournaisian	4-5
076	Tournaisian	4-5
106d	No older than mid Westphalian C	
110	Tournaisian	?5
112	Tournaisian	?No older than upper 3A
117	Tournaisian	?1D-2
126B	Tournaisian	4-5
138	Tournaisian	5
149	Tournaisian	upper 3B
174	Tournaisian	5
188	Tournaisian	4-5
203	Indeterminable	
250	Late Westphalian B	*V. magna - V. psuedoreticulata*
253	Indeterminable	

SAMPLE: CS94-011
Age: ?Tournaisian

Remarks

Most of the assemblage consists of contaminants. Rare *Retusotriletes incohatus* and *Crassispora trychera* are present but there are insufficient data to assign an age.

SAMPLES: CS94-012, 016
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

Crassispora trychera is very abundant in both samples suggesting a high Horton age possibly as young as Zone 5. Rare *Spelaeotriletes cabotii* are more typical of Zone 4 and older rocks, furthermore, *Anapiculatisporites hystrichosus* is more typical of Zones 2B-3.

A 4-5 transition age is tentatively assigned.

Significant species

Crassispora trychera (A)
Anapiculatisporites hystrichosus (R)
Schopfites claviger (R)
Spelaeotriletes cabotii (R)
Auroraspora macra (A)
Vallatisporites (R)

SAMPLE: CS94-030
Age: Tournaisian
Zone: ?5, Dolby (1993)

Remarks

This assemblage is of more limited composition than 012 or 016 and lacks any sign of Zone 4 influence. However, *Colatisporites decorus* is absent when, according to Utting et al. (1989) it should be abundant.

Significant species

Crassispora trychera (A)
Verrucosisporites nitidus (A)
Retusotriletes incohatus (A)
Rugospora polyptycha

SAMPLE: CS94-039
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

This sample closely resembles 012 and 016.

SAMPLE: CS94-068
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

This is a poor assemblage. A few specimens of *Crassispora trychera* indicate an age no older than upper 3A.

Significant species

Crassispora trychera (R)
Rugospora polyptycha (R)
Knoxisporites literatus(R)
Auroraspora macra (R)

SAMPLES: CS94-070d, 076
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

These assemblages are essentially identical to 012, 016 and 039. *Crassispora trychera* is very abundant.

SAMPLE: CS94-106d
Age: No older than mid Westphalian C

Remarks

The spore-pollen assemblage is small and the kerogen is dominated by fusinite (bogen debris). Specimens of *Punctatosporites granifer* indicate an age no older than mid Westphalian C.

Significant species

Punctatosporites granifer
Triquitrites cf. *tribullatus*
Vestispora fenestrata
T. cf. *sculptilis*

SAMPLE: CS94-101
Age: Tournaisian
Zone: ?5

Remarks

This sample closely resembles 030 except that it also contains a few *Collatisporites decorus* and abundant *Spelaeotriletes crenulatus* specimens.

SAMPLE: CS94-112
Age: Tournaisian
Zone: ?No older than upper 3A, Dolby (1993)

Remarks

Spores are rare in this small residue. A specimen of *Crassispora trychera*, if *in situ* indicates an age no older than upper 3A. There is nothing else present to assign a more precise age and, given the richness of the previous samples, the specimens here could be contaminants.

SAMPLE: CS94-117
Age: Tournaisian
Zone: ?1D-2 undifferentiated, Dolby (1993)

Remarks

Although rich, pyrite has damaged most specimens beyond recognition. A specimen of *Cristatisporites mathewsii* and of *Leiozonotriletes* cf. *insignitus* suggests a possible 1D-2 age.

SAMPLE: CS94-126B
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

Crassispora trychera is extremely abundant as is a small variety of *Spelaeotriletes* cf. *cabotii*. A Zone 4 or 4-5 transition age seems appropriate.

Significant species

Crassispora trychera (A)
S. crenulatus (A)
Schopfites claviger (A)
Spelaeotriletes echinatus (A)
S. cf. *cabotii* (A)
Verrucosisporites nitidus (R)

SAMPLE: CS94-138
Age: Tournaisian
Zone: 5, Dolby (1993)

Remarks

Both *Crassispora trychera* and *Colatisporites decorus* are abundant, a feature of Zone 5 according to Utting et al. (1989). Otherwise the assemblage resembles other high Horton samples in this group.

SAMPLE: CS94-149
Age: Tournaisian
Zone: upper 3B

Remarks

Despite a stratigraphic position above 138, the assemblage is completely different and more typical of Zone 3. *Vallatisporites verrucosus* and *V. vallatus* are extremely abundant a feature of Zone 3 and a specimen of *V.* cf. *ciliaris* limits this to no older than upper 3B. *Crassispora trychera* is numerous but much less abundant than the 4-5 and 5 assemblages described above.

Is it possible that the samples have been mixed up?

Significant species

Vallatisporites vallatus (A)
V. cf. *ciliaris*
V. verrucosus (A)
Crassispora trychera (C)

SAMPLE: CS94-174
Age: Tournaisian
Zone: 5

Remarks

Crassispora trychera, *Auroraspora macra* and *Spelaeotriletes crenulatus* are all abundant and there is no sign of a Zone 4 influence. The preservation is poor due to pyrite corrosion.

SAMPLE: CS94-188
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

This sample resembles others in this group assigned a 4-5 transition age. *Crassispora trychera* is abundant and there are a few specimens of *Spelaeotriletes* cf. *cabotii* indicating a Zone 4 influence.

SAMPLE: CS94-203
Age: Indeterminable

Remarks

Spores are rare and there is a mixture of preservational colors which suggests contamination.

SAMPLE: CS94-250
Age: Late Westphalian B
Zone: *V. magna - V. psuedoreticulata*, Dolby (in press)

Remarks

Lycospora spp. dominate this Cumberland Group sample. Specimens of *Vestispora pseudoreticulata* are quite numerous indicating a late B age.

Significant species

Lycospora spp. (A)
Vestispora pseudoreticulata
Florinites spp. (R)
V. cf. *foveata*

SAMPLE: CS94-253
Age: Indeterminable

Remarks

Palynomorphs are rare in this sample and are mostly modern species. They are probably all contaminants.

Seven samples from Tournaisian strata were analysed in this series and results are summarised and described below.

Sample	Age	Zone
S22 Series		
12	Tournaisian	no older than upper 3A
17	Tournaisian	no older than upper 3B
504	Tournaisian	no older than upper 3A
505	Tournaisian	4-5
523	Tournaisian	probably 4
525	Tournaisian	no older than upper 3A
S23 Series		
2A	Tournaisian	upper 3A-3B

SAMPLE: S22-012
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

Spores are relatively rare and poorly preserved. A specimen of *Crassispora trychera* indicates an age no older than upper 3A and a few poor specimens of *Vallatisporites* spp. suggests that a Zone 3 age is most likely but the assemblage is too poor to be definitive.

SAMPLE: S22-17
Age: Tournaisian
Zone: No older than upper 3B, Dolby (1993)

Remarks

This sample is rich in the simple spores typical of the Horton. *Schopfites claviger* indicates an age no older than upper 3B and numerous *Crassispora trychera* suggest a post 3 age. *Vallatisporites* spp. are abundant and although corroded, do not appear to belong to *V. vallatus* and *V. verrucosus* which can dominate Zones 2 and 3. It could be as young as Zone 5 but this is not certain.

Significant species

Schopfites claviger
Vallatisporites spp. (A)
V. cf. *galearis*
Converrucosisporites parvinodosus (A)
Crassispora trychera (C-A)
V. cf. *ciliaris*
Verrucosisporites nitidus
Knoxisporites literatus

SAMPLE: S22-504
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

In this sparse assemblage, *Crassispora trychera* is abundant indicating that the sample is most likely post Zone 3 and possibly as young as Zone 5 in age. The composition is too limited to be more precise. *Spelaeotriletes crenulatus* is numerous as it is in CS94-110, 126B and 174. The assemblage most closely resembles CS94-174 but neither is particularly diverse and the correlation must remain tenuous.

Significant species

Crassispora trychera (A)
Retusotriletes crenulatus (A)
Colatisporites decorus (R)
Auroraspora macra
S. echinatus
Knoxisporites literatus

SAMPLE: S22-505
Age: Tournaisian
Zone: 4-5 transition, Dolby (1993)

Remarks

This sample resembles the assemblages in this study which are assigned a 4-5 transitional age. *Crassispora trychera* is abundant but there are rare specimens of *Spelaeotriletes* cf. *cabotii* indicating some Zone 4 influence.

Significant species

Crassispora trychera (A)
S. echinatus (A)
Schopfites claviger
Spelaeotriletes cf. *cabotii* (R)
S. ciliaris (F)
Vallatisporites cf. *ciliaris*

SAMPLE: S22-0523
Age: Tournaisian
Zone: probably 4, Dolby (1993)

Remarks

Crassispora trychera is numerous but not so abundant as in the 505 sample. In addition, there are several good specimens of *Spelaeotriletes cabotii* indicating an age no younger than 4. *S. crenulatus* is also abundant and the remainder of the assemblage is essentially similar to 505.

SAMPLE: S22-525
Age: Tournaisian
Zone: No older than upper 3A, Dolby (1993)

Remarks

This sample is rich in simple Horton type spores which dilute the remainder of the assemblage. The presence of *Crassispora trychera* indicates an age no older than upper 3A but in these numbers it is more likely of Zone 4 or 5 age. However, the assemblage is not very diverse and in this respect it resembles S22-504 and CS94-174.

Significant species

Crassispora trychera (C-A)
S. echinatus
Spelaeotriletes crenulatus (C-A)
S. cf. *pretiosus*

SAMPLE: S23-2A
Age: Tournaisian
Zone: upper 3A-3B, Dolby (1993)

Remarks

Spelaeotriletes cabotii is relatively numerous in this sample which is dominated by simple Horton species. *Crassispora trychera* is present but as a small variety. There are also a few specimens of *Vallatisporites vallatus* and *V. verrucosus* and the general character of the assemblage is more typical of Zone 3. *Anapiculatisporites hystrichosus* is also present. This species is typical of Zones 2B-3.

Significant species

Spelaeotriletes cabotii (F)
S. echinatus (C)
Crassispora cf. *trychera* (F)
S. crenulatus (A)
S. cf. *pretiosus*
Anapiculatisporites hystrichosus

Five Tournaisian samples were analysed in this series, one of which was too poor to date.

Sample	Age	Zone
T21 Series		
13	Tournaisian	2-lower 3A
29	Indeterminable	
31	Tournaisian	2
526	Tournaisian	2B-3A
T22 Series		
502	Tournaisian	4-5

SAMPLE: T21-13
Age: Tournaisian
Zone: 2-lower 3A, Dolby (1993)

Remarks

Simple Horton spores dilute the assemblage which has an unusual component: a spore which resembles *Neoraistrickia logani* and *Umbonatisporites baculatus* and is prominent. The former does not range above lower Zone 4 in Europe whereas the latter, a higher latitude species probably has a similar range.

There are no specimens of *Crassispora trychera* and this factor is tentatively used to confine the age to older than upper 3A. *Leiozonotriletes insignitus* is present and this species is more prominent in Zones 2 and 3 although it does range into the adjacent zones.

Significant species

Umbonatisporites/Neoraistrickia sp. (A) *Spelaeotriletes crenulatus* (A)
Verrucosisporites nitidus (R) *Leiozonotriletes insignitus*

SAMPLE: T21-29
Age: Indeterminable

Remarks

Spores are extremely rare and at least some are contaminants.

SAMPLE: T21-31
Age: Tournaisian
Zone: 2, Dolby (1993)

Remarks

This unusual sample resembles T21-13 in some ways with a number of specimens of *Neoraistrickia/Umbonatisporites* sp. Specimens of *Verrucosisporites congestus* confine the age to Zone 2. *Spelaeotriletes crenulatus* is rare but *Grandispora uncata* is very abundant.

Significant species

Umbonatisporites/Neoraistrickia sp. (F)
Grandispora uncata (A)
Pustulatisporites gibberosus
Spelaeotriletes crenulatus (R)
Verrucosisporites congestus
V. nitidus

SAMPLE: T21-526
Age: Tournaisian
Zone: 2B-3A, Dolby (1993)

Remarks

This is a rich 2-3 assemblage with numerous *Spelaeotriletes cabotii*. Rare *Crassispora trychera* indicate an upper 3A age but *Verrucosisporites congestus* suggest a strong 2 influence. Specimens of *Umbonatisporites/Neoraistrickia* sp. are present but rare. *Anapiculatisporites hystrichosus* does not range below 2B.

Significant species

Spelaeotriletes cabotii (C-A)
S. echinatus
Crassispora trychera (R)
Umbonatisporites/Neoraistrickia sp.
Anapiculatisporites tersus
S. crenulatus (F)
Grandispora uncata
Verrucosisporites congestus (R)
V. nitidus
A. hystricosus

SAMPLE: T22-502
Age: Tournaisian
Zone: 4-5 transition

Remarks

Simple Horton spores dominate and dilute the remainder of the assemblage. *Crassispora trychera* is relatively abundant and there is also a specimen of *Spelaeotriletes* cf. *cabotii* suggesting a Zone 4 influence. The assemblage is of very limited composition.

Significant species

Crassispora trychera (C-A)
S. echinatus (F)
Schopfites claviger (F)
Spelaeotriletes cf. *cabotii* (R)
S. crenulatus (R)
Auroraspora macra (R)

Only two samples were analysed in this series, one of which was barren of *in situ* spores.

SAMPLE: NB413-100-110
Age: Indeterminable

Remarks

A barren sample.

SAMPLE: NB433-220/230
Age: Late Westphalian B
Zone: *Vestispora magna - V. pseudoreticulata*, Dolby (in press)

Remarks

This is a rich Cumberland Group assemblage. The presence of *Vestispora pseudoreticulata* indicates a late B or younger age in Nova Scotia. *Endosporites globiformis* is numerous. This species appears at the base of the Westphalian B but in the Sydney Basin is abundant from the late B onwards. There is no evidence for a Westphalian C age.

Significant species

Vestispora pseudoreticulata
Lycospora spp. (EA)
Knoxisporites triradiatus
Endosporites globiformis (C)
Florinites spp. (A)
Cyclogranisporites aureus (A)

Two samples were analysed with the AM prefix, both of Tournaisian age.

SAMPLES: AM-84-2, 17
Age: Tournaisian
Zone: upper 3B, Dolby (1993)

Remarks

Both samples yielded similar species but in different proportions. *Schopfites claviger* is present in both samples which indicates that the samples are no older than upper 3B. *Crassispora trychera* is also present but in small numbers. *Vallatisporites vallatus* and *V. verrucosus* are numerous to abundant in #17 but fewer in number in #2. A small number of *Spelaeotriletes pretiosus* is also present in both. An upper 3B age is favored.

Acritarchs are present in both samples. At least some have been reworked from the Early Palaeozoic. There is also evidence in #2 of Strunian reworking.

Significant species

Schopfites claviger (R)
Vallatisporites vallatus
Spelaeotriletes pretiosus
Retusotriletes avonensis
Crassispora trychera (F)
V. verrucosus (C-A)
S. crenulatus
Rugospora polyptycha

Three samples from Area #1 in New Brunswick were analysed and all yielded reasonable assemblages.

Sample	Age	Zone
536-018-4B	Probably Namurian C	
536-020-1A	Early Westphalian A	*S. arenaceus* - *Florinites* spp.
536-085-1A1	Probably Namurian C	

SAMPLES: 536-018-4B, 085-1A1
Age: Probably Namurian C

Remarks

Florinites visendus is abundant in these samples which is typical of the Late Namurian - Early Westphalian. However, the lack of the smaller species of this genus suggests that a Namurian age is more appropriate.

Significant species

Florinites visendus (A)
Auroraspora solisorta (A)
Anapiculatisporites cf. *vergrandis*
Potonieisporites spp. (F)
Schopfipollenites ellipsoides
Colatisporites decorus (F-A)

SAMPLE: 536-020-1A
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

Smaller species of *Florinites* are present in this sample as well as a questionable specimen of *Lycospora orbicula*. These criteria suggest a basal Westphalian A age. There is evidence of reworking of Devonian and Early Palaeozoic rocks.

Significant species

Florinites florinii (F)
F. visendus (A)
Lycospora cf. *orbicula* (R)
Spelaeotriletes arenaceus
F. pumicosus (A)
Potonieisporites spp. (A)
Anapiculatisporites cf. *vergrandis*
Crassispora kosankei

Three samples from this area were analysed, one of which yielded a poor assemblage.

Sample	Age
536-012-1A1	Westphalian A (undifferentiated)
536-012-1B1	Westphalian A (undifferentiated)
536-012-2A2	Westphalian A (undifferentiated)

SAMPLES: 536-012-1A1, 1B1, 2A2
Age: Westphalian A (undifferentiated)

Remarks

These samples are typical of the Cumberland Group in that they contain numerous or abundant species with long stratigraphic ranges with few, if any, restricted forms.

Lycospora orbicula is present in 1A1 and 2A2 and questionable specimens in 1B1 which, with Spore type A present in all three, indicates a Westphalian A age. Sample 1B1 is much less rich than the other two.

Significant species

Lycospora spp. (A)
Spore type A
Anapiculatisporites cf. *vergrandis*
L. orbicula
Florinites spp. (C-A)
Plicatipollenites malabarensis

These six samples yielded typical Cumberland Group Assemblages often with reworked Early Palaeozoic acritarchs.

Sample	Age	Zone
527-017-3B	Westphalian A (undifferentiated)	
527-019-2A	Late Westphalian A	*V. tortuosa*
527-019-2B	Early Westphalian B	*F. junior*
527-021-2G	?Westphalian B	
527-102-2A	Westphalian A (undifferentiated)	
538-104-1A	Westphalian A (undifferentiated)	

SAMPLE: 527-017-3B
Age: Westphalian A (undifferentiated)

Remarks

This sample closely resembles those from Area 2. Early Palaeozoic acritarchs, at least some of which are Ordovician, are abundant.

SAMPLE: 527-019-2A
Age: Late Westphalian A
Zone: *Vestispora tortuosa*, Dolby (in press)

Remarks

This sample contains a rich assemblage of long-ranging species typical of the Cumberland Group. The presence of Spore type A, *Vestispora tortuosa* and *Cannanoropollis mehtae* indicates a Late Westphalian A age. Fragments of striate pollen are also present and these are interpreted as contaminants.

Significant species

Vestispora tortuosa	Spore type A
Cannanoropollis mehtae	*C. janakii*

SAMPLE: 527-019-2B
Age: Early Westphalian B
Zone: *Florinites junior*, Dolby (in press)

Remarks

This assemblage is similar to 019-2A but also contains *Florinites junior* a Westphalian B marker. This species effectively appears just above the base of the B but the presence of *Raistrickia fulva* cf. *var micra* and a questionable specimen of Spore type A indicates that the Westphalian A influence is strong and an early B age is favored. Reworked Ordovician acritarchs are prominent.

A specimen of the striate grain *Illinites* cf. *unicus* is present. This is interpreted as contamination although it does occur in the Namurian and Westphalian A of Europe.

SAMPLE: 527-021-2G
Age: ?Westphalian B

Remarks

This is a poor Cumberland Group assemblage. The presence of *Vestispora tortuosa* indicates that the sample is no older than latest Westphalian A, however, a questionable specimen of *Endosporites globiformis* suggests that the age might be younger. This species is rare below the B. There is some evidence of contamination present.

SAMPLES: 538-102-2A, 104-1A
Age: Westphalian A (undifferentiated)

Remarks

These are rich assemblages typical of the Cumberland Group in that they are dominated by long-ranging forms similar to most of the samples in Areas 2 and 3. *Kraeuselisporites ornatus* is prominent in both samples. This species ranges into the late Westphalian A of Europe. There is nothing else present to refine the age assignment. Early Palaeozoic acritarchs, at least some of Ordovician origin, are present in both samples but are abundant in 2A.

Of the four Cumberland Group samples in this group one was very poor.

Sample	Age	Zone
508-203-1B	Westphalian A	
512-137-8C	probably Early Westphalian A	*S. arenaceus* - *Florinites* spp.
526-073-5-1	probably Late Namurian	
526-073-5D2	Possibly Late Namurian - Early Westphalian A (undifferentiated)	

SAMPLE: 508-203-1B
Age: Westphalian A (undifferentiated)

Remarks

This is a rich Cumberland Group assemblage similar to 538-102-2A in that Early Palaeozoic acritarchs are abundant. The presence of Spore type A and *Florinites florinii* indicate a Westphalian A age. There are no zonal markers present but specimens of *Cannanoropollis* aff. *mehtae* suggest that the sample could be of mid Westphalian A age.

Contamination is prominent.

SAMPLE: 512-137-8C
Age: probably Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

This is an extremely rich assemblage but of very limited composition. There are no small forms of *Florinites* spp. which favors a Namurian age but the presence of *Granulatisporites microgranifer* is more typical of the Westphalian. Specimens of *Spelaeotriletes arenaceus* indicate an age no younger than early A.

Significant species

Lycospora spp. (EA)
Florinites visendus (A)
Granulatisporites microgranifer
Crassispora kosankei (A)
Colatisporites decorus (A)
Spelaeotriletes arenaceus

SAMPLE: 526-073-5-1
Age: Probably Late Namurian

Remarks

There is an abundance of species present which are characteristic of the Windsor-Canso but in proportions which suggest reworking. *Florinites visendus* is prominent but not abundant, which favors a Late Namurian age. However, this species does range down into the Early Namurian albeit in sporadic occurrences and in small numbers. There is nothing else present to help in assigning an age and although an early Namurian age cannot be ruled out, a Late Namurian age is assigned.

SAMPLE: 526-073-502
Age: Possibly Late Namurian - Early Westphalian A (undifferentiated)

Remarks

This is an extremely poor sample with few palynomorphs. Apart from species of *Lycospora* there are only single specimens of *Florinites visendus*, *Schopfipollenites ellipsoides* and *Colatisporites decorus* present. With this sparse residue, the age assigned is very tentative.

Only two samples were analysed from this area. Both yielded Westphalian D assemblages.

SAMPLES: 535-082-2A, 4B1
Age: Westphalian D (undifferentiated)

Remarks

These are quite rich assemblages although 4B1 is of somewhat limited composition. The age is based on the presence of *Cadiospora magna* which is abundant in both samples. There are no obvious signs of Stephanian influence.

Significant species

Cadiospora magna (A)
Vestispora fenestrata
Triquitrites tribullatus
Illinites unicus
C. cf. *magna* (C)
Raistrickia cf. *aculeata*
Punctatosporites oculus
I. boehneri

Four productive samples were examined from this area, three of them from coreholes.

Sample	Age	Zone
507-081-1B	Westphalian D - ?Stephanian	
DAE-19-001		
956.8m - 972.9m	Early Westphalian A (undifferentiated)	
972.9m - 991.2m	Early Westphalian A (undifferentiated	
IOL-60-001		
691.9m - 704.1m	Early Westphalian A (undifferentiated)	*S. arenaceus* - *Florinites* spp.

SAMPLE: 507-081-1B
Age: Westphalian D - ?Stephanian

Remarks

This is a confusing assemblage. There are numerous specimens of Association 3 which characterises the Westphalian C to Stephanian. Some of these, however, are pre-early middle C and are interpreted as reworked. There are also numerous Silurian and Ordovician acritarchs.

Numerous *Triquitrites sculptilis* suggest an age no younger than Westphalian D based on published ranges for this species although it may range into the Stephanian in Nova Scotia. *Torispora securis* is a mostly C-D species but does range into the Stephanian in the Saar-Lorraine. *Thymospora obscura* indicates an age no older than Westphalian D.

Striate pollen are numerous but not abundant. One group of these strongly resembles *Vittatina* a Permian genus which is sporadically present in small numbers in strata as old as mid Stephanian A in Europe.

An undifferentiated Westphalian D - ?Stephanian age is assigned since the data are somewhat equivocal.

Significant species

cf. *Vittatina* sp. (F)
Protohaploxypinus spp. (F)
I. boehneri
Torispora securis (C)
Thymospora obscura
Triquitrites sculptilis
Striatoabieites spp. (F)
Illinites unicus
I. annosus
Punctatosporites minutus (A)
P. granifer (F)
Reticulatisporites reticulatus

COREHOLE: DAE-19-001
Depths: 956.8 - 972.9m, 972.9m - 991.2m
Age: Early Westphalian A (undifferentiated)

Remarks

These assemblages resemble other lower Cumberland Group samples from New Brunswick described in this report. *Lycospora orbicula* and *Florinites florinii* are present in the higher sample indicating a Westphalian A age.

The lower sample is of much poorer quality with evidence of reworking of Early Palaeozoic rocks. The age of this sample may extend into the latest Namurian but not by much.

COREHOLE: IOL-60-001
Depth: 691.9m - 704.1m
Age: Early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

This sample resembles other lower Cumberland Group samples in this study. The presence of *Cannanoropollis* cf. *mehtae* with *Plicatipollenites malabarensis* suggests an Early Westphalian A age equivalent to the upper part of the *S. arenaceus* - *Florinites* spp. Zone.

Five samples were analysed covering the 948' - 1105' interval in this corehole. The results are described below and the data are plotted on Enclosure 10.

INTERVAL: 948' - 1105'
Age: Late Westphalian B
Zone: *V. magna* - *V. tortuosa* to ?*I. boehneri*, Dolby (in press)

Remarks

Species of *Vestispora* are present in most of the samples, especially 986' where *V. magna* and *V. pseudoreticulata* are quite numerous. This is a feature of the late Westphalian B in the Cumberland Basin. These species do range up into the Westphalian C but there is no evidence of a Westphalian C influence even in the uppermost sample.

The presence of several questionable specimens of *Illinites boehneri* suggest that the section may be of latest B age.

Significant species

Vestispora magna
V. tortuosa
Punctatosporites sp.
Dictyotriletes muricatus
Illinites sp.
V. pseudoreticulata
Raistrickia fulva
Endosporites globiformis
D. reticulocingulum
I. aff. *boehneri*

This series of miscellaneous slides are from samples in the G.S.C. archives.

G.S.C. #	Age	Zone
6555	Westphalian D	*V. witneyensis*
6556	Probably late Westphalian D	
6561	Westphalian A	
6848	?Westphalian D	
6855	Westphalian D	
6856	Stephanian	
7977	Late Namurian	
8882	Indeterminable	
D1445	Late Namurian - Early Westphalian A	
D1915/16028	Possibly late Westphalian C	
D1915/16029	?No older than early Middle Westphalian C	

SAMPLE: 6555
Age: Westphalian D
Zone: *V. witneyensis*

Remarks

This is a rich assemblage typical of Association 3. Specimens of *Thymospora pseudothiesseni* and *Raistrickia aculeata* indicate an age no older than Westphalian D. Indeed, the numbers of the former species suggest an age well into the D. Specimens of *Vestispora* cf. *witneyensis* are used to assign this sample to the mid to late D, *V. witneyensis* Zone.

SAMPLE: 6556
Age: Probably late Westphalian D

Remarks

This assemblage belongs to Association 3 and most of the species have long ranges within the late Westphalian. There are several specimens of *Vestispora laevigata* present. The upper range of this species is not completely known but it seems to die out in the late Westphalian D. There are also several specimens of a faintly verrucose monolete species present. Alpern et al. (1970) indicate that forms like this first appear in the late D and become abundant in the Stephanian.

Significant species

Vestispora laevigata
cf. *Verrucososporites* sp.
Punctatosporites spp. (A)
T. additus
V. fenestrata
Illinites unicus
Triquitrites sculptilis
T. tribullatus

SAMPLE: 6561
Age: Westphalian A (undifferentiated)

Remarks

This is a typical lower Cumberland assemblage of long-ranging forms. The only species of note is Spore type A which occurs in abundance and indicates a Westphalian A age.

SAMPLE: 6848
Age: ? Westphalian D

Remarks

This is a poor assemblage containing a lot of blackened corroded spores which were presumably reworked. There is also some well-preserved Ordovician present. A specimen of *Thymospora* sp., if *in situ* indicates an age no older than Westphalian D. The only other species of note are *Illinites unicus* and *Punctatosporites* cf. *rotundus*.

It is possible that the above species are contaminants.

SAMPLE: 6855
Age: Westphalian D

Remarks

This assemblage resembles 6556 except that it is much richer. The age is based on the presence of *Thymospora* spp., *Raistrickia aculeata*, *Schopfipollenites dimorphus* and *Mooreisporites inusitatus* in an Association 3 assemblage. There is no sign of a Stephanian influence.

SAMPLE: 6856
Age: Stephanian

Remarks

The age is based on the presence of abundant striate bisaccate pollen (Association 3B) and *Potonieisporites* spp.

Significant species

Illinites unicus (A)
Hamiapollenites tractiferinus (A)
Striatoabieites spp.
Potonieisporites spp. (A)
I. annosus
Protohaploxypinus spp.
cf. *Vittatina* sp.
Latosporites cf. *minutus* (A)

SAMPLE: 7977
Age: Probably Late Namurian

Remarks

This is a typical lower Cumberland assemblage from Association 1. *Florinites visendus* and *Potonieisporites* spp. are both abundant but small species of *Florinites* are absent. *Kraeuselisporites ornatus* is very abundant. This species ranges into the late Westphalian A. A specimen of the early Westphalian A and older species *Spelaeotriletes arenaceus* is also present.

Although this assemblage could from the earliest Westphalian A, a Late Namurian age seems more appropriate.

SAMPLE: 8882
Age: Indeterminable

Remarks

This is a poor assemblage with a mixture of preservational states due, most likely, to laboratory contamination.

SAMPLE: D1445
Age: Late Namurian - early Westphalian A

Remarks

This is an extremely poor assemblage of only 34 specimens. There is evidence even in this slide of reworking of Devonian and possibly Windsor-Canso rocks. A few specimens of *Florinites visendus* are used to assign the age. A questionable specimen of Spore type A suggests that the sample is Westphalian but there are too few data to be certain.

SAMPLE: D1915/16028
Depth: 250' - 260'
Age: Possibly late Westphalian C

Remarks

This sample yielded abundant *Striatosporites ovalis*. This distinctive spore first appears in the late Westphalian B and may have been strongly environmentally controlled. It has two abundance peaks in the Sydney Basin: the first in the late Westphalian C and the second, smaller peak in the Stephanian. The remainder of the assemblage is typical of Association 3A and apart from a questionable, highly corroded *Mooreisporites* sp. specimen, there is no evidence of anything younger than Westphalian C. The presence of *Punctatosporites granifer* and *Triquitrites tribullatus* indicate an age no older than early middle Westphalian C.

SAMPLE: D1915/16029
Depth: 260' - 270'
Age: ?no older than early middle Westphalian C

Remarks

Apart from a clump of *Lycospora pusilla* there are only 19 palynomorphs in this slide. If they are *in situ* and not contaminants, the presence of *Illinites unicus* indicates an age no older than early Middle Westphalian C.

Six cuttings samples from this well were prepared by Chevron Canada Resources and were originally studied by Robertson Research Canada Ltd. They were re-examined as part of this project with the aim of refining the stratigraphy using the results from recent palynological studies. The data are plotted on Enclosure 11.

Sample Depth	Age	Zone
235m	Early to early middle Westphalian C	*V. fenestrata*
260m	Probably transitional Westphalian B-C	
315m	Early Westphalian (undifferentiated)	
360m	Mid to early Westphalian A	*S. arenaceus* - *Florinites* spp.
400m	Mid to early Westphalian A	*S. arenaceus* - *Florinites* spp.
1300m	Probably Early Visean	NS

SAMPLE DEPTH: 235m
Age: Early to early middle Westphalian C
Zone: Probably *Vestispora fenestrata*, Dolby (in prep.)

Remarks

Since this is the uppermost sample the assumption has been made that this is the first productive interval and that cavings contamination is minimal or absent.

The presence of *Illinites unicus* indicates an age no older than early middle Westphalian C in the Maritimes although it has been found in older rocks in Europe. There is only one specimen of *Punctatosporites* sp. and important mid-C and younger species such a *Torispora securis* and *P. granifer* are absent. There are several specimens of *Vestispora* cf. *pseudoreticulata* and *Endosporites globiformis* is abundant. Although these species have longer ranges they are prominent in the B-C transition in the Sydney Basin. An early to early middle Westphalian C age is proposed, equivalent to the upper part of the *Vestispora fenestrata* Zone.

SAMPLE DEPTH: 260m
Age: Probably transitional Westphalian B-C

Remarks

This is a rich assemblage but mostly of long-ranging species. Specimens of *Florinites junior* indicate an age no older than Westphalian B and rare specimens of *Vestispora pseudoreticulata*, if *in situ*, suggest a late B - early C age. Although the latter species does range to the base of the B, in Nova Scotia it is effectively absent below the late B.

Assuming these species have not caved significantly, a transitional B-C age is assigned.

SAMPLE DEPTH: 315m
Age: Early Westphalian undifferentiated

Remarks

This sample yielded a small assemblage of long-ranging spores and pollen typical of the Cumberland Group and Association 2. A precise age cannot be assigned.

SAMPLE DEPTHS: 350 - 60m, 390 - 400m
Age: Mid to early Westphalian A
Zone: *S. arenaceus* - *Florinites* spp., Dolby (in press)

Remarks

These two samples resemble many of the lower Cumberland Group assemblages described in this report. Reworked Ordovician - Silurian acritarchs are present as well as some Windsor spores. Cavings contamination does not appear to be that prominent and the mixture of *Florinites* spp. is therefore interpreted as being indicative of Westphalian strata.

Reticulatisporites polygonalis is present in both samples. This species may range into the Namurian in the UK but only rarely and in sporadic occurrences. Its principal range is early-mid A onwards and it is found in the *S. arenaceus* - *Florinites* spp. Zone in the Joggins section. A specimen of *Cingulizonates* cf. *bialatus* indicates a Namurian influence on the section. Other species present which are frequently found in assemblages of this age in this study include *Anapiculatisporites vergrandis*, *Secarisporites remotus*, *Kraeuselisporites* sp. and *Rugospora calderi*.

SAMPLE DEPTH: 1300m
Age: Probably Early Visean
Zone: NS, Utting (1987)

Remarks

This assemblage is dominated by spores typical of the Windsor Group including *Retusotriletes incohatus*, *Crassispora trychera* and *Rugospora minuta* with smaller numbers of *Auroraspora macra*, *R. polyptycha* and *Schopfites claviger*.

There are two specimens of *Florinites visendus* and *Schopfipollenites ellipsoides* present which are interpreted as cavings contaminants. If the former is *in situ*, the age would be no older than Namurian. However, given the limited composition of the assemblage excluding these species, an Early Visean age is more probable.

Twenty-two samples were examined from a section through part of the Riversdale Group exposed in the bank of Salmon River. The data are plotted on Enclosure 12.

Recoveries were usually good although the moderately high level of thermal maturation has prevented identification of the majority of the palynomorphs. It also has masked preservational differences in potentially recycled forms.

The assemblages are relatively uniform in composition and there are no obvious trends. The presence of numerous to abundant monosaccate gymnosperm pollen throughout the section indicates that the section is no older than Namurian. The lack of Westphalian species and the presence of *Cingulizonates* cf. *bialatus* high in the sequence (F35) suggests that the section is no younger than Namurian. The abundance of *F. visendus* suggests that the section could be of Late Namurian age.

The assemblages here are different to those from transitional Namurian - Westphalian Boss Point sections in this report in that they often contain abundant spores typical of the Windsor and Canso Groups. It is impossible to determine whether this fraction has been fully or even partially reworked. There is some evidence of recycling, however. Specimens of *Spelaeotriletes echinatus* in R38, R39, ?F31 and F34 indicate reworking of Tournaisian or Visean (Horton or Windsor) rocks.

Two R series and sixteen F series samples are described in this section. None of the F series samples yielded identifiable *in situ* palynomorphs. The results are summarised and described below.

Sample	Age	Zone
R Series		
79	Tournaisian	?3B
84	Tournaisian	?3B
F Series		
15	Indeterminable	
16	Indeterminable	
18	Indeterminable	
19	Indeterminable	
20	Indeterminable	
22	Indeterminable	
23	Indeterminable	
41	Indeterminable	
55	Indeterminable	
56	Indeterminable	
59	Indeterminable	
60	Indeterminable	
62	Indeterminable	
64	Indeterminable	
65	Indeterminable	
71	Indeterminable	

SAMPLES: R79, 84
Age: Tournaisian
Zone: ?3B; Dolby (1993)

Remarks

These are poorly preserved, highly thermally altered assemblages. Spores are relatively rare but the most prominent group comprises specimens of *Vallatisporites* resembling *V. verrucosus* and *V. vallatus* which are most abundant in Zones 2 and 3. Specimens of *V.* cf. *ciliaris* suggest a possible 3B age.

Significant species

Vallatisporites cf. *vallatus* (F)
V. cf. *ciliaris*
Retusotriletes incohatus
Spelaeotriletes sp.
V. cf. *verrucosus* (F)
Crassispora cf. *trychera*
Spinozonotriletes aff. *uncatus*
Anapiculatisporites cf. *tersus*

SAMPLES: F15, 16, 18, 19, 20, 22, 23, 41, 55, 56, 59, 60, 62, 64, 65, 71
Age: Indeterminable

Remarks

Most of the residues consist of highly carbonised organic debris including unidentifiable sporomorphs. Sample 51 yielded modern contaminants only.

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