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A SUMMARY OF THE RESULTS OF A PALYNOLOGICAL INVESTIGATION OF BRITISH COLUMBIA'S NORTHEAST COALFIELD*[1]

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INTRODUCTION

The strata of the Peace River coalfield, in the foothills of northeastern British Columbia (Figure 4-4-1), formed in a tectonically active region near the western margin of the craton. The complex pattern of intertonguing marine and nonmarine strata which resulted was subsequently deformed by folding and thrusting, making interpretation and correlation extremely difficult.

The present palynologic study was undertaken in an attempt to resolve some of the stratigraphic problems, where sedimentological and geophysical methods have failed. The primary aim of the study is to generate a composite palynologic section that can be used to zone, correlate and date the coal-bearing strata in the southern half of the coalfield.

Eleven drill holes, representing nearly 3000 metres of section from the Gething, Moosebar and Gates formations (Figure 4-4-2) were sampled at 15-metre intervals. The 199 samples examined for palynomorphs yielded a total assemblage containing 350 species of pollen, spores, dinoflagellate cysts, acritarchs, algal cysts and fungal spores. Of these, 256 species are restricted in their occurrence within the section, and have been used to zone and correlate the strata.

Open-marine, restricted-marine and nonmarine horizons are identified on the basis of type and relative abundance of palynomorphs. Contact relationships are examined and clarified, the palynologic section is compared with lithologic information, and a geologic age is established for the rocks.

RESULTS

Of the 197 core samples used for this study, 163 samples (83 per cent) contain indigenous palynomorphs and 34 samples (17 per cent) are barren or contain palynomorphs considered to be recycled. A total of 350 species have been identified, including 232 pollen and spore species, 96 dinoflagellate cyst and acritarch species, and 22 algal cyst and fungal spore species.

Recycled palynomorphs are present in varying amounts in a large number of samples and have been excluded from the results. Although often difficult to recognize, in this study recyclants have been identified as those specimens which exhibit a significantly higher TAI value, and/or greater corrosion (chemical degradation) or pitting (abrasion) of the wall relative to similar types of palynomorphs in the sample.

ZONATION AND CORRELATION

The edited data, when plotted on a cross-section, reveal a pattern of frequent inundations from the north by a shallow sea (Figure 4-4-3). Six major and four minor transgressions are identified in the Gething through Gates section. All of the major transgressions, as well as the intervening nonmarine deposits of the regressive phases, can be characterized by a unique palynomorph assemblage.

Although a single nonubiquitous species rarely occurs throughout a particular zone, each zone can be recognized on the basis of palynomorph type, abundance and diversity. This allows all but a few palynologic zones to be correlated through the entire length of the study area. The remaining zones can be traced to facies equivalents.

The zonation and correlation are illustrated in Figure 4-4-3. Of the 350 species identified in this study, 94 are ubiquitous. The remaining 256 species, made up of 150 pollen and spore species, 85 dinocyst and acritarch species and 21 algal cyst and fungal spore species, are restricted in occurrence[2].

Figure 4-4-3 shows the location of the drill holes used in this study and their relative position in the section. The Gething-Moosebar lithologic contact, as determined by company geologists from core and geophysical logs, has been used as the datum as there is generally good agreement on its position. Lithologic contacts (solid lines) are placed according to company drill-hole data or, where unavailable, by average thickness (dashed lines) based on measured sections or nearby drill-hole information (Stott, 1968, 1973; Duff and Gilchrist, 1981; Carmichael, 1983). The occurrence of coal, as single or multiple seams exceeding 0.5 metre in thickness, is plotted where geophysical or stratigraphic information is available.

The palynologic contacts (dotted lines) separate marine from nonmarine strata, based on the presence or absence of marine dinocyst and acritarch species. Although spores and pollen are not uncommon in marine strata, particularly re-

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[1] This paper is excerpted from an M.Sc. thesis, available through The University of British or the British Columbia Ministry of Energy, Mines and Petroleum Resources.

[2] The figure illustrating biostratigraphic ranges of the zoneable species has not been included in this report due to space constraints.

stricted-marine (or near-shore) facies, dinocysts and acritarchs are absent from terrestrial strata with the exception of occasional flood or storm-deposited specimens. In addition to recognizable marine and nonmarine (terrestrial) palynologic zones, there are parts of the section in which the samples contain only rare ubiquitous species and abundant recyclants, or no palynomorphs whatsoever. The distribution of these "barren" samples is consistent enough to allow them to be recognized as distinct palynologic units.

Two types of marine zones, open and restricted marine, are identified in this study, based on the type(s) of palynomorph(s) present and the relative abundance and diversity of each. Open-marine strata are characterized by an abundant and diverse dinocyst/acritarch assemblage and an absence of

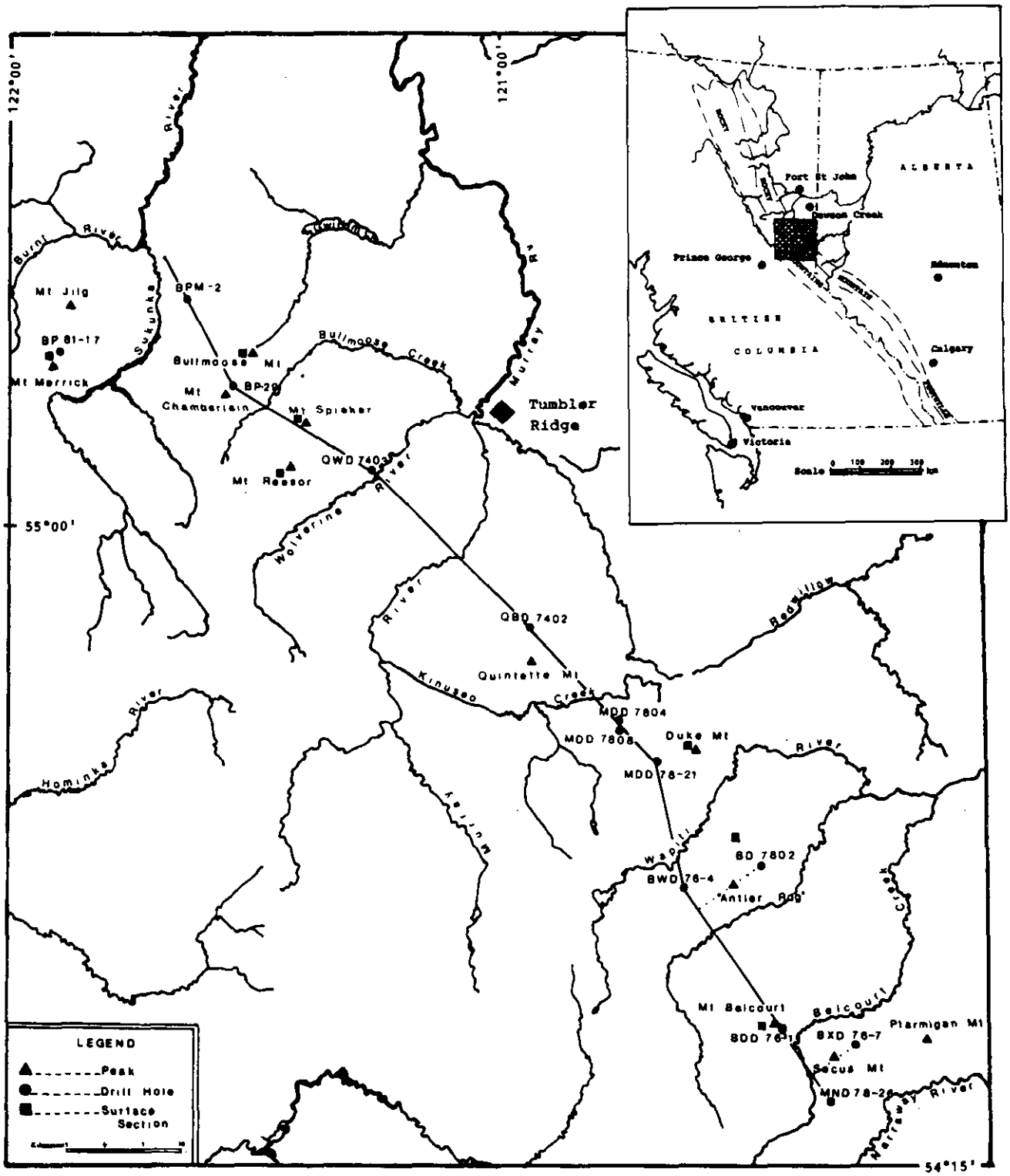

Figure 4-4-1. Map showing study area and drill-hole locations.

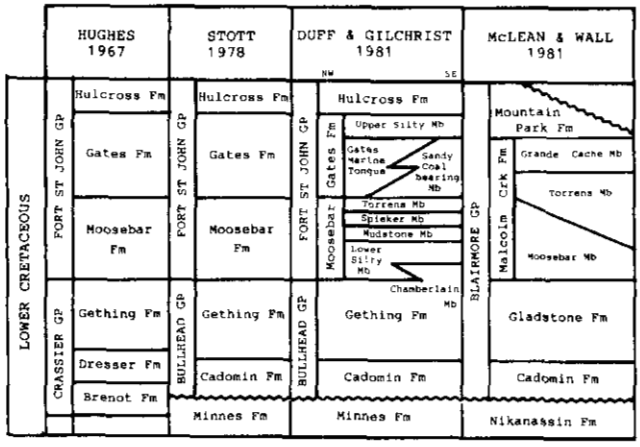

Figure 4-4-2. Stratigraphic nomenclature of the Peace River coalfield.

pollen and spores, algal cysts and fungal spores. Restricted-marine strata contain all types of palynomorphs in relative abundances that reflect proximity to open-marine or terrestrial environments.

Terrestrial strata are characterized by an absence of dinocysts and acritarchs (except as qualified earlier), and the presence of variable quantities of pollen and spores, plus or minus algal and fungal debris. Barren zones, considered here to be predominantly nonmarine, are characterized by an absence of diagnostic species and/or the presence of a large number of recycled specimens, or by a total absence of palynomorphs.

It should be emphasized here that the palynologic zones, as determined by the density of sampling used in this study, identify the prevailing depositional influence. Marine zones may contain nonmarine strata and vice versa.

The marine-nonmarine units have been determined solely on the basis of palynologic evidence. Placement of a palynologic boundary is somewhat arbitrary depending on the distance between samples in a vertical section. Occasionally, coal will persist along, or close to, palynologic horizons and a boundary will be placed to emphasize probable concurrent episodes of coal development without compromising palynologic data.

Six major marine transgressions, defined here as marine strata which can be correlated the entire length of the study area, and four minor marine incursions have been identified. Major transgressions occur at the base of the Gething Formation, in the lower half of the Moosebar Formation, at the base and the top of the basal Gates marine-nonmarine unit, in the upper middle Gates, and at the top of the Gates Formation. Two marine tongues are identified in the upper half of the Gething, and another two occur in the basal Gates marine-nonmarine unit, all in the northwest half of the study area.

The intervening nonmarine strata, representing marine regressions, occur in the Gething Formation above the basal marine unit and below the marine tongues and in the basal Gates marine-nonmarine unit in the southeast half of the study area. Two more are present in the upper half of the Gates Formation. Barren zones are identified above the marine tongues in the Gething, and in the upper half of the Moosebar Formation.

Gething Formation

The marine unit at the base of the Gething Formation is approximately 30 metres thick from Sukunka to Monkman Pass. Southeast of Monkman Pass it splits into an upper and lower tongue. The upper tongue thins rapidly and may be absent southeast of Secus Mountain. The lower tongue maintains a thickness of 20 to 30 metres, but evidence suggests that it splits again in the vicinity of Secus Mountain, and that both tongues persist beyond the limits of the study area. The unit contains both marine and nonmarine palynomorphs, indicating a restricted-marine environment with the terrestrial influence notably stronger in the southeast. There are four spore species (*Clavatipollenites couperii*, *C. minutus*, *Cooksonites reticulatus*, *Podocarpidites naumovai*) and one dinocyst species (*dino sp. A*) exclusive to the Gething basal marine unit.

The Gething strata which lie between the basal marine unit and the lower marine tongue are considered to be terrestrial, despite poor recovery of palynomorphs. Only a single spore species (*Reticulisporites semireticulatus*), of the 12 present in the Gething Formation, is confined to the nonmarine zone. The unit contains numerous ubiquitous species and recyclants, although many of the samples are barren. The poor preservation and pervasive recycling are consistent with the interpretation by Stott (1973) of deposition in the fluctuating, moderate to high-energy conditions of an alluvial-deltaic environment.

The upper half of the Gething Formation north of Quintette Mountain contains two marine tongues. The lower tongue is approximately 30 to 35 metres thick between Sukunka North and Bullmoose Mountain, and thins to less than 10 metres at Monkman Pass. Palynologic evidence suggests that it extends as far south as the Antler Ridge–Triad Creek region. The upper marine tongue is also approximately 35 metres thick at Sukunka North, but thins rapidly and disappears just south of the Wolverine section. Of the twelve spore species and four dinocyst species found in the Gething, two spore (*Coptospora striata*, *Cicatricosisporites potomacensis*) and two dinocyst species (*Apteodinium sp.*, *Palaeoperidinium sp.*) are restricted to these marine zones. No attempt was made to distinguish the upper and lower tongues palynologically, since there are insufficient data to do this reliably.

The strata which overlie the marine tongues are also barren of palynomorphs. This zone, referred to by Duff and Gilchrist (1981) as the Chamberlain member, is an important coal-bearing unit of limited lateral extent. Approximately 25 metres thick at Bullmoose Mountain, it thins rapidly to the southeast, disappearing between Wolverine River and Quintette Mountain. Duff and Gilchrist indicate that the coal zone also thins in a northwesterly direction, cut off by marine strata. At present no palynologic data are available for the region north of Bullmoose Mountain.

The barren strata in the upper part of the Gething Formation do not differ significantly from the underlying terrestrial strata and are presumed to have been deposited under similar conditions.

Moosebar Formation

The base of the Moosebar Formation is identified palynologically by the first major influx of marine species. A

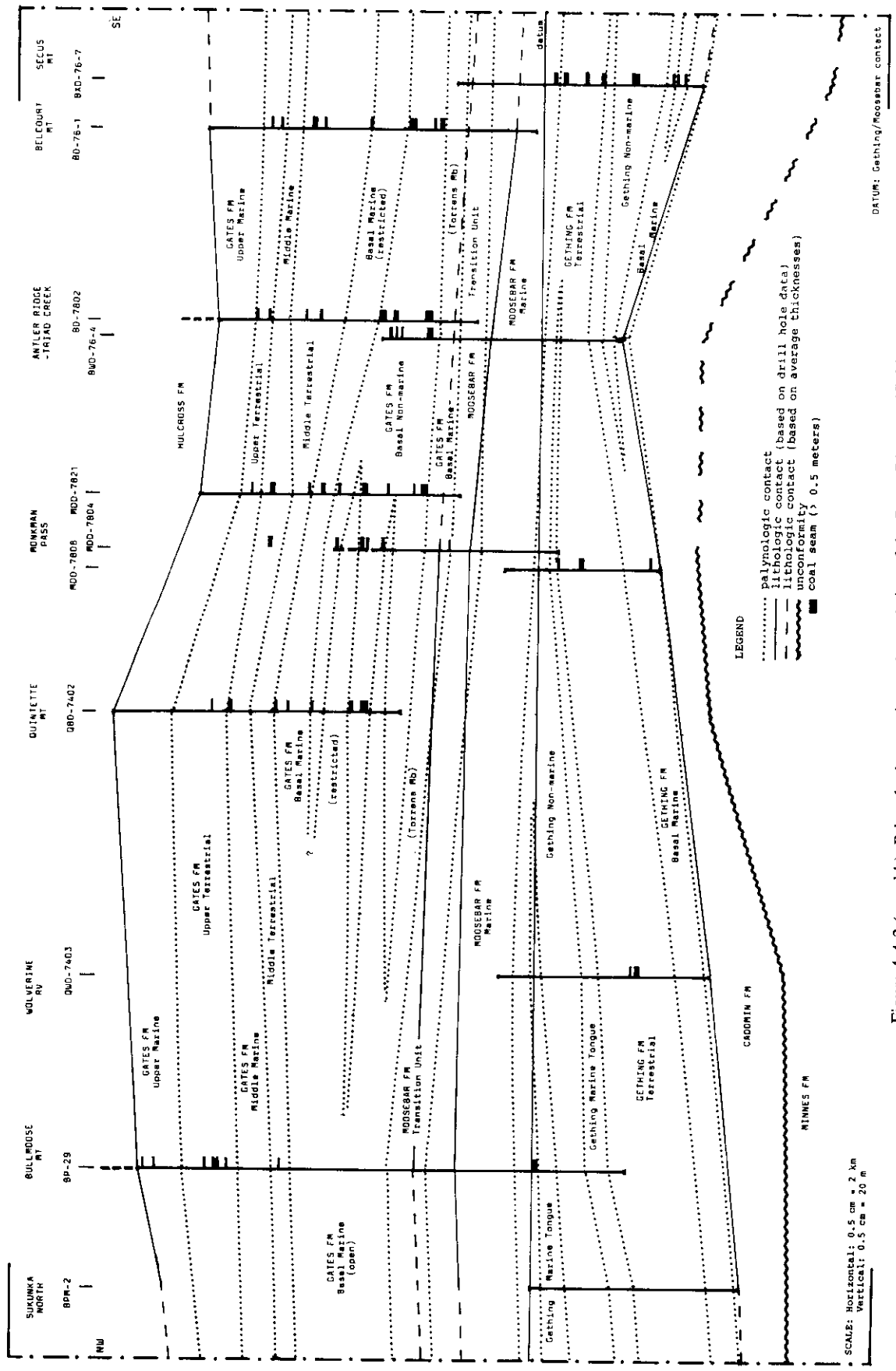

Figure 4-4-3 (a and b). Palynologic zonation and correlation of the Peace River coalfield.

lower marine zone containing 27 dinocyst and acritarch species and 30 spore species, and an upper "transition unit" completely barren of palynomorphs, make up the Moosebar Formation.

The marine unit varies in thickness from 100 metres in the northwest to 70 metres in the southeast and is characterized palynologically by nine dinocyst/acritarch species and five spore species. Although it is dominated by marine species throughout most of the study area, indicating open-marine conditions, there is an increase in terrestrial palynomorphs in the Mount Belcourt–Secus Mountain region, suggesting proximity to a terrestrial source. In addition, three of the drill holes contain a single barren sample in the middle of the marine sequence, and a fourth hole contains a sample with only a few spores, indicating a regressive or emergent phase at this level.

Lithologically, the Moosebar marine unit consists of two or three coarsening-upward cycles of fine to silty black shales (Leckie, 1981; Carmichael, 1983). At most locations the top of the second cycle corresponds to the regression identified palynologically.

Although the palynologic boundary between the Moosebar and Gething formations is fairly consistent with the lithologic contact in the southern half of the study area, it lies above the Gething-Moosebar contact in the northern half. This may be due in part to the presence of marine strata so close to the top of the Gething, and to the discontinuous nature of the Chamberlain member and the coal within it, making the lithologic contact somewhat difficult to locate accurately. Speculation by Duff and Gilchrist (1981) that their Gething marine tongue correlates with the Moosebar marine strata north of Bullmoose Mountain is not supported by palynologic evidence. Of the 32 zoneable marine species in the two formations, only a single dinocyst species was found to be common to both.

The transition unit lying above the marine shales is distinguished by a total absence of palynomorphs. The unit thins from 40 metres in the northwest to 30 metres in the southeast. Lithologically it is recognized by the introduction of bedded siltstones and sandstones into the dark shales, but the amount of coarse material is highly variable across the section. A comparison of the palynologic section with lithologs described by Carmichael (1983) indicates that between Wolverine River and Quintette Mountain in the northwest and south of the Antler Ridge–Triad Creek section, the transition unit consists of thick-bedded siltstones and sandstones overlain by thin interbeds of sandstone, siltstone and shale. In the intervening region the unit consists only of thin-bedded sandstone, siltstone and shale. Thin coals are occasionally present near the top. At Mount Spieker in the northwest, Leckie (1981) describes a section similar to the Wolverine-Quintette section, which he divides lithologically between the thick-bedded coarse material and the overlying finer sediments, placing the former at the top of one coarsening-upward cycle and the latter at the base of a second cycle. Outside his study area this division into coarsening-upward cycles is not always apparent, and would likely result in the correlation of different stratigraphic horizons. The "Spieker member" of Duff and Gilchrist (1981) "includes all strata between the mudstone member and the clean well-sorted sandstone of the upper Torrens member" and is equivalent to the transition unit with the exception of the top few metres, considered here to be palynologically part of the overlying unit (Torrens member). This is explained more fully in the following section.

Gates Formation

The base of the Gates Formation, as interpreted in this study, occurs as an influx of marine palynomorphs above the barren transition unit. The Gates contains three major palynologically distinct marine units: a basal marine unit which is divided into an upper and lower zone by a nonmarine wedge; a middle marine unit; and an upper marine unit which marks the top of the formation. Nonmarine strata are present in the basal Gates unit, immediately above the basal marine-nonmarine unit and between the middle and upper marine units.

The basal Gates unit is predominantly open marine in the northwest, rapidly giving way to a complex pattern of intertonguing marine and nonmarine strata and, further southeast, to upper and lower restricted-marine tongues, separated by 60 metres (on average) of nonmarine strata. The zone is characterized by 29 dinocyst and acritarch species, 7 of which are restricted to this unit, and 41 spore species, 9 of which are restricted.

At Bullmoose Mountain in the northwest, open-marine conditions are indicated by a 100-metre-thick succession containing an abundant and diverse dinocyst/acritarch assemblage. A few nonmarine species near the middle and top of the succession (Figure 4-4-3) indicate occasional regression. Four of the lower Gates seven dinocyst species (*Callaiosphaeridium asymmetricum*, *Gonyaulacysta* cf *cassidata*, *Gonyaulacysta* cf *episoma*, *Prolixosphaeridium* cf *mixtispinosum*) occur exclusively in the open-marine strata.

Between Bullmoose and Quintette mountains palynologic data are lacking. A somewhat simplified interpretation of the intertonguing of marine and nonmarine strata is based on a northward projection of the information from Quintette Mountain and Monkman Pass, and on comparison with lithologs from Carmichael's study. The data indicate that restricted marine conditions persist throughout the study area at the base and top of the Gates basal marine-nonmarine unit, and that at least two minor marine transgressions penetrate as far south as Monkman Pass. South of Monkman Pass, a thick succession of nonmarine strata lies between the upper and lower restricted-marine zones.

The lower restricted-marine zone is characterized palynologically by an assemblage of dinocysts, spores, algal cysts and fungal material. Of the seven dinocysts restricted to the Gates marine-nonmarine unit, two (*Fromea amphora*, *Hystrochokolpoma sp. A*) are found exlusively in this lower marine zone.

Carmichael's drill-hole lithologs indicate that this zone consists primarily of resistant, thick-bedded sandstone, containing thin interbeds of conglomerate in the southeast, becoming finer in the northwest. Lithologic and palynologic data show that the zone varies only slightly in thickness from 25 to 30 metres across most of the section, possibly reaching a minimum thickness of 20 metres in the northwest part of the study area.

This lower marine zone has been mapped in whole or in part as the Torrens member by a number of other workers. Carmichael (1983) accurately identifies the sandstone in most of his drill holes, but occasionally correlates it with thick nonmarine sandstone of the underlying transition unit. The "clean, well-sorted sands" mapped by Duff and Gilchrist (1981), using geophysical logs, are highly variable in thickness (from 5 to 20 metres), and correspond to the top of the marine sandstones identified palynologically. A closer look at the geophysical logs indicates a slight coarsening-upward cycle just below these clean sands. At most locations the combined thickness of the coarsening-upward cycle and the clean sands that overlie it ranges from 25 to 30 metres. Leckie (1981) identifies this sandstone unit at Mount Spieker at the top of his Torrens-Sukunka member. He describes an "amalgamated sandstone" which is "20 to 30 m thick and occurs as a continuous body, with occasional thick conglomeratic lenses, across the whole of the study area. Conglomerate lenses excluded, there is an overall upward increase in grain size from very fine, or fine grained to medium grained sandstone" (page 22).

Recognition of the Torrens member in the field has resulted in much confusion and likely will continue to do so. As Carmichael (1983) points out, "Coal companies working in the Foothills of northeastern British Columbia generally refer to the first thick sandstone interval beneath the lowermost economic coal seam as the Torrens Member" (page 14). Coal is present immediately above the Torrens member only in the region south of Quintette Mountain, where the sandstone is overlain by thick nonmarine deposits. North of Quintette Mountain the coal occurs above a stratigraphically higher marine sandstone, which marks the first minor transgression into the Monkman area.

The marine sandstones of the Torrens member are considered by some workers to mark the top of the Moosebar Formation (Duff and Gilchrist, 1981; Leckie, 1981), while others consider it to be equivalent to the basal Gates Formation (McLean, 1982; Carmichael, 1983). Palynologic evidence strongly supports the interpretation of the Torrens member as basal Gates. Although a distinct, restricted-marine unit in the southeast, it is palynologically inseparable from the open-marine strata of the basal Gates in the northwest. In addition, none of the eight marine species found in the Torrens member are restricted exclusively to it and Moosebar marine shales. The two units, in fact, are separated by the palynologically barren transition unit.

Above the Torrens member in the northwest half of the study area is a thickened succession of intertonguing marine and nonmarine strata. Although palynologic data are lacking between Bullmoose and Quintette mountains, the consistency of the data at Quintette and Monkman Pass allows reasonable extrapolation into this region. A marine regression lying immediately above the Torrens member over much of the study area stopped short of Bullmoose Mountain and was followed by a minor transgression into the Monkman Pass region. A second regression probably reached Bullmoose Mountain in the northwest, as evidenced by the presence of several nonmarine species in the middle of the open-marine sequence. The transgression overlying this can also be traced southward to Monkman Pass. A third regression, shown just north of Quintette Mountain, is located primarily on the basis of abundant spores, relative to dinocysts, and a persistent coal horizon at this position in the section.

The top of the basal Gates unit is marked by a second major trangression (the upper restricted-marine zone in Figure 4-4-3). A 40-metre-thick sequence of restricted-marine strata, characterized by near equal numbers of marine and nonmarine species, can be traced southward to Secus Mountain and beyond the study area. Two of the seven basal Gates dinocyst species (*Ascotomocystis maxima*, cf *Kalyptea monoceras*), and eight of the nine spore species (*Callialasporites segmentatus*, *Cerratosporites* cf *morrinicolus*, *Cibotiumspora juriensis*, *Concavissimisporites minor*, *Cooksonites variabilis*, *Densoisporites microrugulatus*, *Januasporites spiniferus*, *Polycingulatisporites sp. A*) are restricted to the upper marine unit. The upper restricted-marine unit and the open-marine strata to the northwest correspond to the Gates marine tongue of Duff and Gilchrist (1981).

The nonmarine component of the basal Gates marine-nonmarine unit lies immediately above the Torrens member. It is 30 metres thick in the southeast, increasing to 90 metres at Monkman Pass where it first begins to interfinger with marine strata. The unit contains only one characteristic spore species (*Psilatricolpites parvulus*) and is a major coal-bearing succession. It corresponds approximately to the sandy coal-bearing unit of Duff and Gilchrist (1981), which they trace as far northwest as Sukunka River using geophysical logs. Palynological evidence indicates that all strata in the lower Gates from Bullmoose Mountain northwestwards are predominantly marine.

The Gates middle terrestrial unit lies above the basal marine-nonmarine unit and contains 17 spore species, 4 of which are exclusive to this zone. It consists of 80 metres of strata at Belcourt Mountain in the southeast, but thins rapidly to 20 metres at Monkman Pass. It appears to maintain this thickness to the northwest limit of the study area, although it may pinch out or interfinger with marine strata in the vicinity of Bullmoose Mountain.

A thin restricted-marine unit overlies the middle nonmarine unit. It is identified palynologically by the presence of a few zoneable and numerous ubiquitous marine species, in a thin zone between two distinctly nonmarine zones. Of the 25 nonmarine and 4 marine species present, only 3 spores and a single dinocyst species are exclusive to this unit. It thins from 30 metres in the northwest to 10 metres in the southeast.

The Gates upper terrestrial zone is only weakly defined, both palynologically and lithologically. Palynologically, it is recognized as a thin zone, lacking marine species, between two marine units. It contains a total of 19 spore species, 2 of which are unique to the zone. The unit is thickest in the northwest (50 to 60 metres) and thins to 25 to 30 metres between Monkman Pass and Belcourt Mountain. Although this is a reversal of the normal trend, gaps in sampling of the upper Gates at Bullmoose and Quintette mountains, and the distance between the two sections, may obscure a more complex relationship between marine and nonmarine strata in this region.

The top of the Gates Formation is restricted marine, and contains a rich assemblage of 24 marine and 44 nonmarine

species, including 4 species of dinocysts and 11 species of spores that are unique to this zone. The Gates upper marine unit consists of 40 to 60 metres of predominantly thick-bedded sandstone, with minor siltstones, shales and thin coals.

AGE DETERMINATION

According to Singh (1975), the appearance of early angiosperm pollen in North America follows a consistent pattern with respect to time, and allows fairly accurate dating of mid-Cretaceous rocks. Monosulcate (reticulate) grains first appear in sediments in the eastern United States in Barremian-Aptian time, but in western Canada and United States they have not been recorded in strata older than Middle Albian. Tricolpate (reticulate) grains make their appearance in Middle Albian rocks throughout North America, and tricolporate (smooth, triangular) grains mark the Albian-Cenomanian boundary.

In the present study several monosulcate pollen species (*Clavatipollenites hughesii*, *C. couperii*, *C. minutus*) have been found throughout the Gething Formation and a single tricolpate grain (*Tricolpites crassimuras*) is present near the top of the Gething terrestrial unit. Another tricolpate grain (*Psilatricolpites parvulus*) was found in the nonmarine horizon of the basal Gates unit. *Tricolpites crassimuras* was recorded by Singh (1975) from late Middle Albian to early Late Albian rocks in northwestern and central Alberta, but he notes an Albian age for the species. *Psilatricolpites parvulus* was recorded in early Late Albian rocks by Singh (1975) and given a Late Albian to Cenomanian age in North America.

The palynological evidence indicates that the entire Gething through Gates section in the Peace River coalfield is of Middle Albian to early Late Albian age.

REFERENCES

Broatch, J.C. (1982): An Investigation of the Palynology of the Peace River Coalfield, Northeastern British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1981, Paper 1982-1, pages 113-121.

——— (1986): Palynological Zonation and Correlation of the Peace River Coalfield, Northeastern British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1985, Paper 1986-1, pages 321-326.

——— (1987): Palynological Zonation and Correlation of the Peace River Coalfield, Northeastern British Columbia, an Update, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 379-384.

Carmichael, S.M. (1983): Sedimentology of the Lower Cretaceous Gates and Moosebar Formations, Northeast Coalfields, British Columbia, Unpublished Ph.D. Thesis, *The University of British Columbia*, 285 pages.

Duff, P.McL.D. and Gilchrist, R.D. (1981): Correlation of Lower Cretaceous Coal Measures, Peace River Coalfield, British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1981-3, 31 pages.

Leckie, D.A. (1981): Shallow-marine Transitional to Nonmarine Sedimentation in the Upper Moosebar–Lower Gates Member, Fort St. John Group, Northeast British Columbia: Storm and Tidally Influenced Shorelines, *McMaster University*, Tech-Memo 81-1, 64 pages.

McLean, J.R. (1982): Lithostratigraphy of the Lower Cretaceous Coal-bearing Sequence, Foothills of Alberta, *Geological Survey of Canada*, Paper 80-29, 31 pages.

Singh, C. (1975): Stratigraphic Significance of Early Angiosperm Pollen in the Mid-Cretaceous Strata of Alberta, *in* The Cretaceous System in the Western Interior of North America, W.G.E. Caldwell, Editor, *Geological Association of Canada*, Special Paper 13, pages 365-389.

Stott, D.F. (1968): Lower Cretaceous Bullhead and Fort St. John Groups, between Smokey and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia, *Geological Survey of Canada*, Bulletin 152, 279 pages.

——— (1973): Lower Cretaceous Bullhead Group between Bullmoose Mountain and Tetsa River, Rocky Mountain Foothills, Northeastern British Columbia, *Geological Survey of Canada*, Bulletin 219, 228 pages.