British Columbia Geological Survey
Geological Fieldwork 1985

# PALYNOLOGICAL ZONATION AND CORRELATION OF THE PEACE RIVER COALFIELD NORTHEASTERN BRITISH COLUMBIA

By Jane Broatch

## INTRODUCTION

Strata of the Peace River Coalfield formed along the southwestern edge of the Jurassic/Cretaceous Clearwater sea. The rocks were deposited during a series of major and minor transgressive-regressive cycles and reflect a complex depositional setting. Mapping and correlation of economic coal deposits are difficult, but the task is made more so by numerous thrusts and folds which occurred when the region underwent compression. A diverse body of geological information from a variety of disciplines is required to unravel the structure and stratigraphy.

## PREVIOUS WORK

Stratigraphic work in the area (Fig. 49-1) was carried out by Stott (1968, 1973, 1974, 1981) and Hughes (1964, 1967). Extensive drilling by coal companies has provided core samples and geophysical data for a number of more recent studies aimed at locating, identifying, and interpreting environmental indicators, rock-stratigraphic and time-stratigraphic horizons, and subtle distinctions between similar lithologies contained within and between formations (Duff and Gilchrist, 1981; Leckie, 1981; Leckie and Walker, 1982; McLean, 1977, 1982; Carmichael, 1983). Paleontological work has been attempted by Bell (1956) with leaves, McLean and Wall (1981) with foraminifera, Chamney (report in Stott, 1968) also with foraminifera, and Duff and Gilchrist (1981) with marine macrofossils; but the usefulness of these studies has been limited by a paucity of specimens and generally poor preservation. Regular symposiums sponsored by the British Columbia Ministry of Energy, Mines and Petroleum Resources have encouraged a cooperative attitude amongst the companies holding coal licences, and the many workers conducting research in the area. The resultant exchange of information has led to a better understanding of the complex structure, stratigraphy, and depositional setting.

The present palynological study was undertaken with the support of the Ministry in the hope of providing another tool for accurately identifying rock units, particularly where faulting has displaced or thickened them; for correlating units or horizons within units and ultimately the coal seams themselves; and for identifying minor marine incursions and tracing their extent. In addition, the palynomorphs will provide information for dating the rock units and for locating the Jurassic/Cretaceous boundary in the undifferentiated Minnes Formation.

## STRATIGRAPHY

The stratigraphy of the Peace River Coalfield is summarized on Figure 49-2. The following brief description of the rock units sampled for this study is intended to provide insight into problems specific to the region and into the interpretation of results.

**Minnes Formation:** The Minnes Formation south of Burnt River is a sequence of interfingering marine and non-marine rocks composed of thin to thick-bedded mudstone, siltstone, conglomeratic sandstone, and coal beds, that range from thin partings in the southern extremes to medium thick beds in the northwest; the sequence cannot be differentiated into mappable units. North of Burnt River, however, the character of the formation changes enough to allow four distinct members to be identified and for the Minnes Formation to become a target for coal exploration.

**Cadomin Formation:** The Cadomin conglomerate lies unconformably on the Minnes Formation. Although quite variable in thickness (3 to 200 metres), a general trend of thinning eastward and northward is evident (Stott, 1968). Within the study area the Cadomin Formation is predominantly conglomerate, but to the northwest it becomes a pebbly sandstone containing silty, shaly, and coaly lenses. Where this occurs it is mapped as the Dresser Formation, after the nomenclature of Hughes.

**Gething Formation:** The Gething Formation is a dominantly terrestrial sequence of interbedded conglomerate, sandstone, siltstone, and mudstone. Coal occurs in the upper half of the formation but is only of economic importance in the central regions of the coalfield. The conglomerates, which occur toward the base of the formation, are thickest in the southeast and are commonly confused with the Cadomin Formation. Although it has been noted that the Cadomin conglomerate exhibits a clean matrix sand response on geophysical logs (Duff and Gilchrist, 1981) and that the pebble content is more quartzitic, the conglomerates are rarely drilled to allow comparison. Furthermore, the differences are not consistent or easily recognizable in surface outcrop. In many places the Gething Formation resembles both the Minnes and Gates Formations, but its overall texture is somewhat coarser and average bedding is thicker.

**Moosebar Formation:** The Gething Formation passes abruptly into black marine shales of the Moosebar Formation. At its base the formation is similar in appearance to the marine Hulcross shales that overlie the Gates Formation, however, the upper third of the unit is a transitional sequence of interbedded siltstones, mudstones, and thin sandstones. This sequence, although not recognized everywhere in the field, is identifiable on geophysical logs and is now mapped by most workers as a separate member of the Moosebar Formation. Southeast of the study area this transitional unit has been proposed as a formal member of the Gates Formation (McLean, 1982). Unfortunately the gradational nature of this unit and the uncertainty in locating the sandstone bed which marks the base of the Gates Formation in the coalfield increase the confusion regarding the actual location of the Moosebar-Gates contact.

**Gates Formation:** The Gates Formation consists of both marine and non-marine sandstones, siltstones, and mudstones; thin conglomerates are present. Coal occurs throughout, but mineable seams are more common in the southeast where the marine influence is less pronounced. Recognition of the marine component of the formation has been the focus of several recent studies (Leckie, 1981; Carmichael, 1983), particularly since it is thought to play a major role in truncating the coal in many areas.

Although familiarity with the rock units locally allows fairly accurate mapping of the formations, structural complexity often confuses interpretation. The region is dominated by imbricate thrusting and associated folding which have greatly shortened the section in a west to east direction. Identification of formations and thrust faults at surface does not guarantee what will be encountered

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1985, Paper 1986-1.

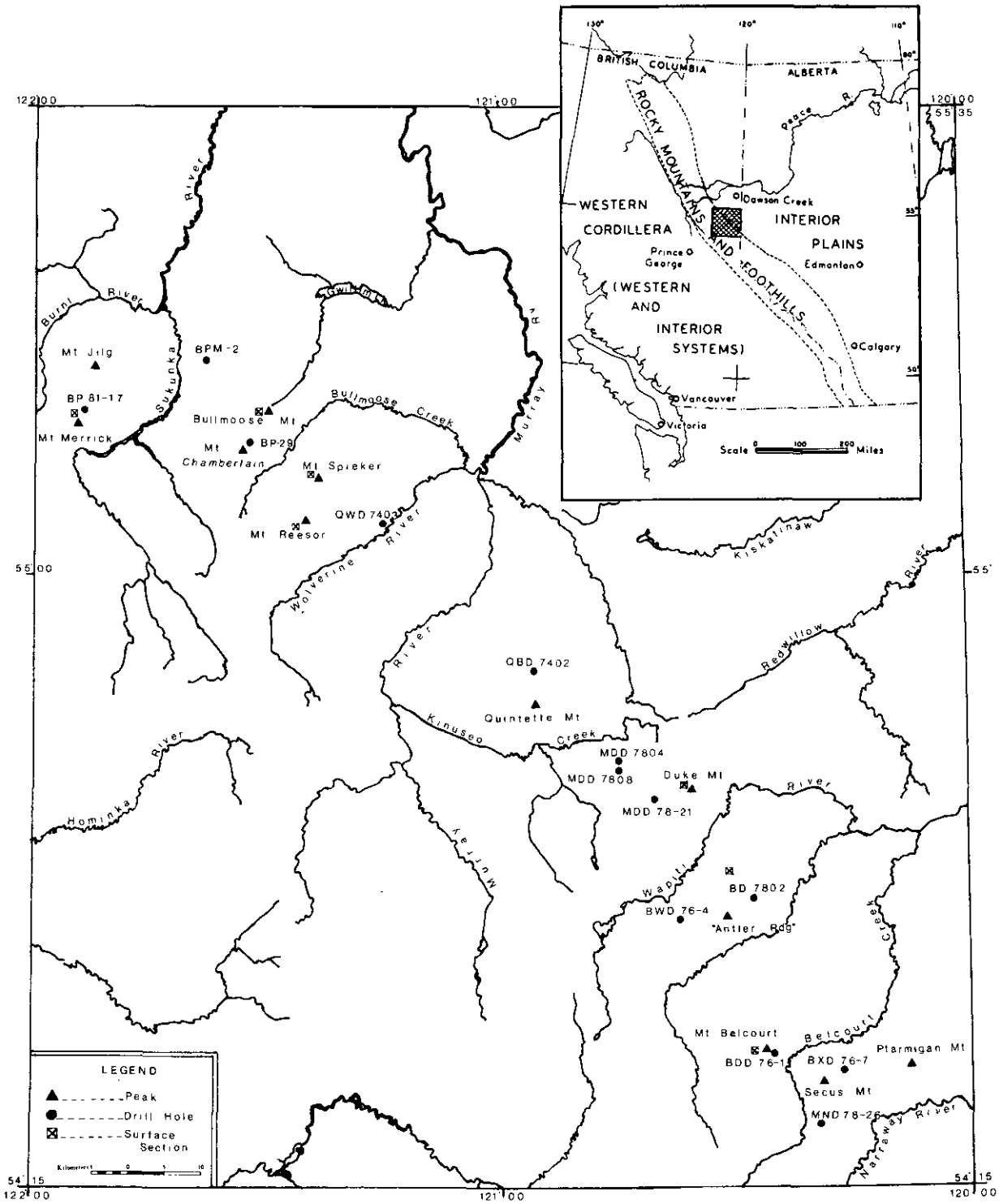
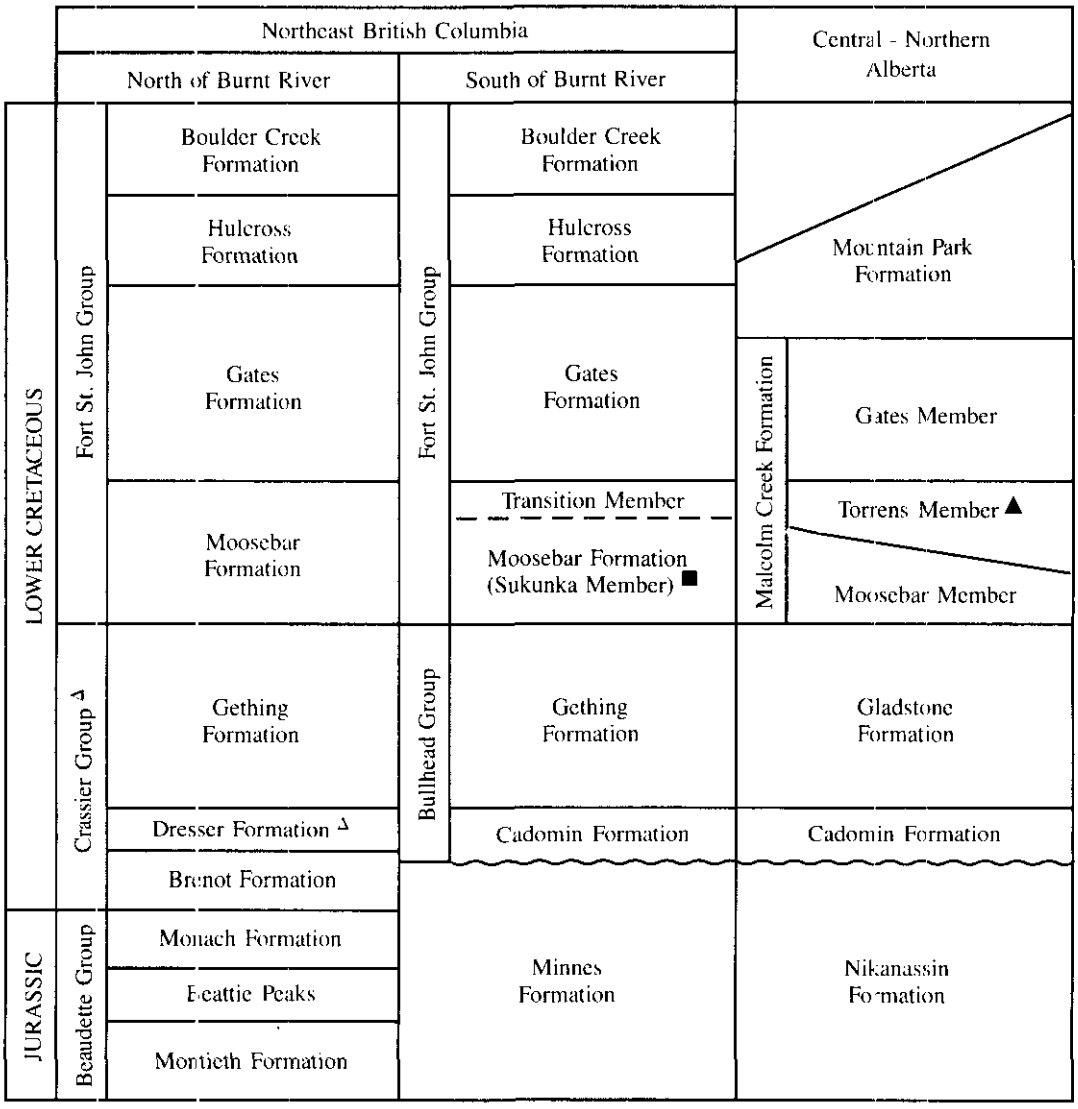



Figure 49-1. Peace River Coalfield study area and section locations.




■ after Duff & Gilchrist (1981)
▲ after McLean (1982)
Δ after Hughes (1964)

Figure 49-2. General stratigraphy (modified after Stott, 1968, 1974).

in drill holes. Units often appear unusually thick or are faulted off to be replaced by unexpected, and occasionally unidentifiable, units. Complex structures and rapidly changing facies present a need for highly specific information where correlation from one drill hole to another is required, particularly if the decision to mine a coal seam rests on the accuracy of that correlation.

## CURRENT STUDY

*In an attempt to identify and correlate horizons in the coal measures*, a study of fossil spores and marine dinocysts was undertaken. Two hundred thirty-eight core samples were collected from 13 drill-hole locations between Burnt River in the northwest and Narraway River in the southeast (Fig. 49-1). The cores represent approximately 3 600 metres of section, from the upper Minnes through Gates Formations, sampled at 15-metre intervals on average. The drill holes have been pieced together to obtain composite sections from the regions shown on Figure 49-3. An additional 89 samples were collected from surface sections adjacent to the drill-hole locations (Fig. 49-1) to determine the usefulness of surface 'grab' samples compared to the unweathered, relatively fresh core samples.

Processing and examination of the core samples are near completion. A preliminary zonation scheme has been worked out (Fig. 49-4); identification and correlation of marine facies are in progress, but still subject to revision. Eleven of the 89 surface samples were selected for processing, based on results obtained from approximately equivalent drill-hole samples. Slides from the surface samples have not yet been examined.

## RESULTS

Of the 204 samples examined to date 80 per cent have yielded palynomorphs. A species list containing approximately 370 spores and 115 dinocysts was compiled. Although some of the species identifications are subject to review, it is expected that this list will be slightly larger on completion because half the slides have not yet been examined and these represent a section of the Minnes Formation which is expected to yield exclusively Jurassic palynomorphs.

The generalized zonation shown on Figure 49-4 includes 25 of the 43 dinocyst species and 30 of the 85 pollen and spore species which are restricted to specific formations. The original plot of species was done on a formation basis, which does not allow for easy recognition of zones within the formations. The exception is the Minnes Formation where distinct zonation is apparent at the Jurassic/Cretaceous boundary (dotted line). The division occurs between 280 and 294 metres from the top of the Minnes Formation in the Belcourt section.

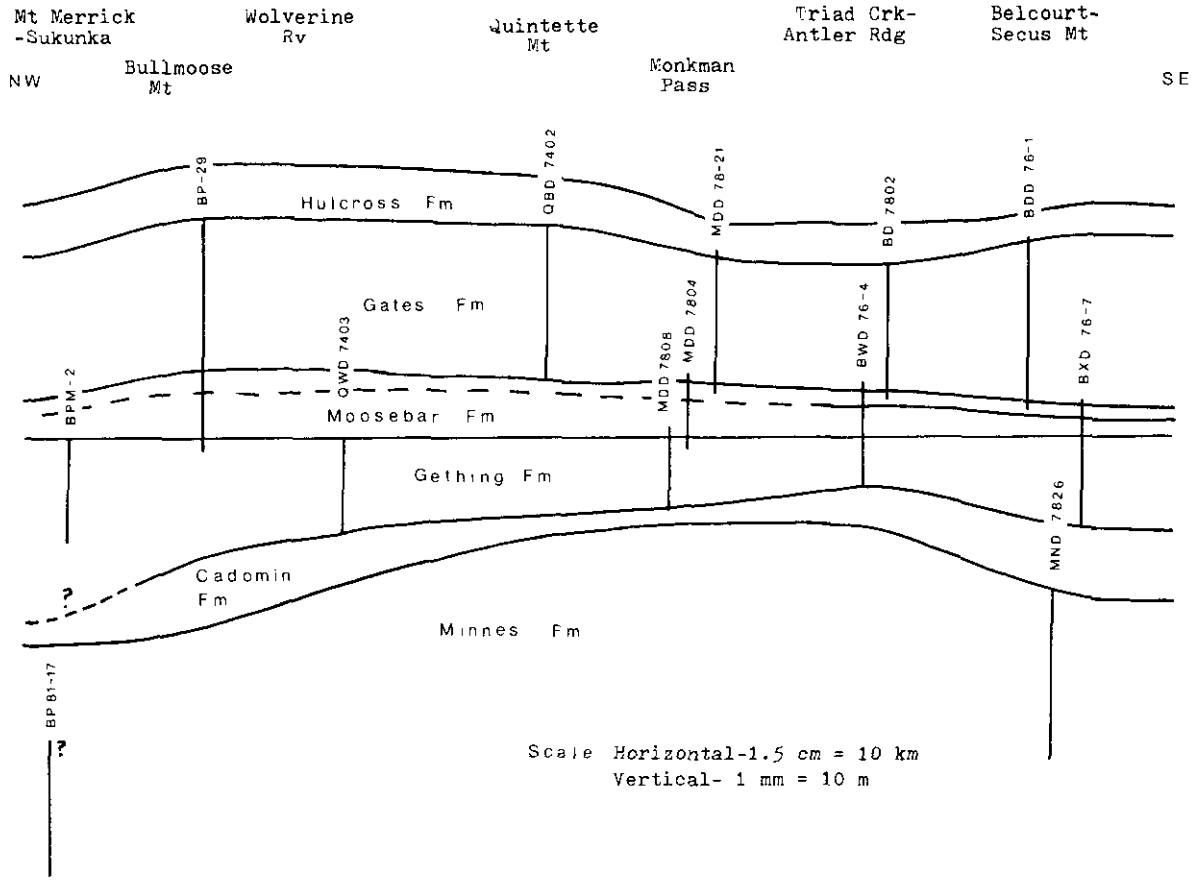



Figure 49-3. Generalized section from Burnt River to Narraway River showing diamond-drill hole sample distribution.

A plot of the age range of species has been completed for the Gething assemblage only. Initial data suggest a Middle Albian age for this formation. Plots of the species ranges for the remaining formations, coupled with information from other paleontological studies, will establish the accuracy of this dating. If a Middle Albian age is confirmed for the Gething Formation, and only the upper 300 metres of the Minnes Formation is Early Cretaceous in age, a considerable time gap (? Middle Berriasian through Early Albian) can be inferred at the Minnes/Cadomin unconformity.

Despite this age difference of approximately 30 million years, examination of slides and TAI mounts indicates a degree of preservation in reverse of what might be expected. The Minnes Formation exhibits good preservation of palynomorphs and a TAI value in the pale yellow through amber yellow (1.5-2.25) range. Preservation in the overlying units is highly variable from one section to the next and, commonly, from one formation to the next within a single section. TAI values also vary considerably and suggest that, at least on the scale of this study, TAI is related more to depositional environment than to depth of burial (*see* Manum, *et al.*, 1976). This relationship may be unique to coal measures where humic acids increase the oxidation rate of organic matter, but at the time of writing no attempt has been made to establish this through a literature search.

Interpretation of depositional environments is currently in progress. The original mudstone samples can, after processing and examination, be grouped by palynomorph content into four categories: marine, marine influenced, terrestrial, and barren. It is hoped that the marine-influenced samples, containing both terrestrial spores and marine dinocysts, will provide a time-stratigraphic link between the marine and non-marine facies.

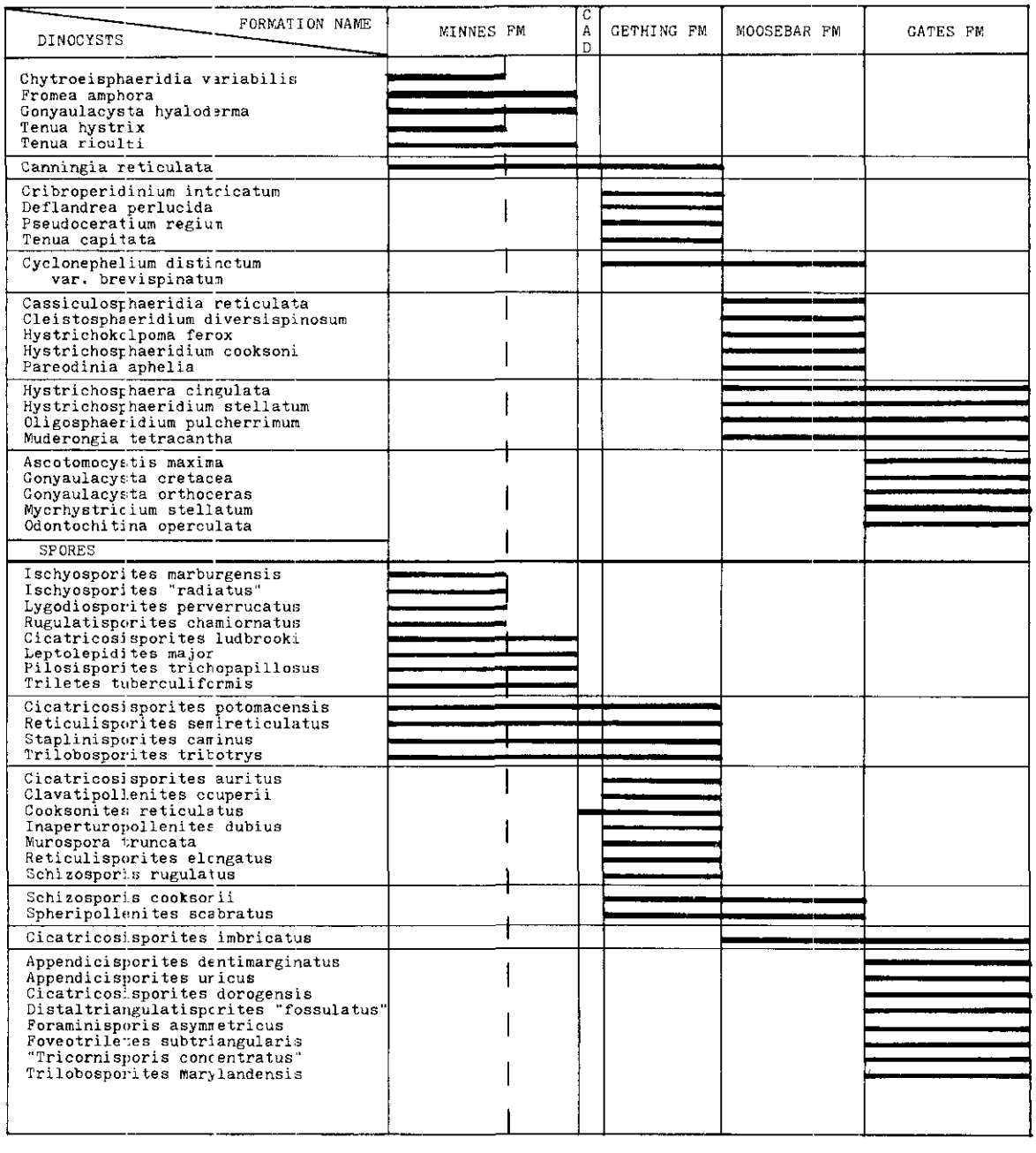



Figure 49-4. Palynological zonation of the Peace River Coalfield, northeastern British Columbia.

## COMMENTS

The results to date from this study have been encouraging. The detail of information indicates that the formations present in the Peace River Coalfield can be identified and dated by their palynomorph assemblages. Further plots of the spore and dinocyst species by location (that is, as continuous sections) may reveal further zonation and the specific relationship of the transition member occurring between the Moosebar shales and the coal-bearing Gates Formation. Correlation of the marine and non-marine facies may reveal time-stratigraphic horizons, in addition to those provided by tonstein and bentonite layers already recognized.

In the future it is hoped that coal companies will use the palynological results of this study for the more refined task of drill-hole correlation of coal seams using the palynomorph assemblages found in roof shales. The groundwork has also been laid for further studies of the rocks to the northwest and southeast of the study area where the application of a different nomenclature reflects the uncertainty of stratigraphic relationships.

## REFERENCES


Bell, W. A. (1956): Lower Cretaceous Floras of Western Canada, *Geol. Surv., Canada*, Mem. 285, 153 pp.

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

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 & Pet. Res.*, Paper 1981-3, 31 pp.

Hughes, J. E. (1964): Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills, *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 51, 73 pp.

———— (1967): Geology of the Pine Valley, *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 52, 137 pp.

Leckie, D. A. (1981): Shallow-marine Transitional to Non-marine Sedimentation in the Upper Moosebar-Lower Gates Member, Fort St. John Group, N.E. British Columbia: Storm and Tidally Influenced Shorelines, Tech-Memo 81-1, *McMaster University*, Hamilton, 57 pp.

Leckie, D. A. and Walker, R. G. (1982): Storm and Tide-dominated Shorelines in Cretaceous Moosebar-Lower Gates Interval — Outcrop Equivalents of Deep Basin Gas Trap in Western Canada, *Alta. Assoc. Pet. Geol.*, Bull., Vol. 66, pp. 138-157.

Manum, S. B., Bjaerke, T., Throndsen, T., and Ein, M. (1976): Preservation and Abundance of Palynomorphs, and Observations on Thermal Alteration in Svalbard, *Norsk Polarinstitutt Arbok*, Oslo, 1977, pp. 121-130.

McLean, J. R. (1977): The Cadomin Formation: Stratigraphy, Sedimentology, and Tectonic Implications, *Cdn. Pet. Geol.*, Bull., Vol. 25, pp. 792-827.

———— (1982): Lithostratigraphy of the Lower Cretaceous Coal-bearing Sequence, Foothills of Alberta, *Geol. Surv., Canada*, Paper 80-29, 31 pp.

McLean, J. R. and Wall, J. H. (1981): The Early Cretaceous Moosebar Sea in Alberta, *Cdn. Pet. Geol.*, Bull., Vol. 29, pp. 334-377.

Stott, D. F. (1968): Lower Cretaceous Bullhead and Fort St. John Groups, between Smokey and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia, *Geol. Surv., Canada*, Bull. 152, 279 pp.

———— (1973): Lower Cretaceous Bullhead Group between Bullmoose Mountain and Tetsa River, Rocky Mountain Foothills, Northeastern British Columbia, *Geol. Surv., Canada*, Bull. 219, 228 pp.

———— (1974): Lower Cretaceous Coal Measures of the Foothills of West-central Alberta and Northeastern British Columbia, *C.I.M.*, Bull., Vol. 67, pp. 87-101.

———— (1981): Bickford and Gorman Creek, Two New Formations of the Jurassic-Cretaceous Minnes Group, Alberta and British Columbia, *in* Scientific and Technical Reports, *Geol. Surv., Canada*, Paper 81-1B, pp. 1-9.