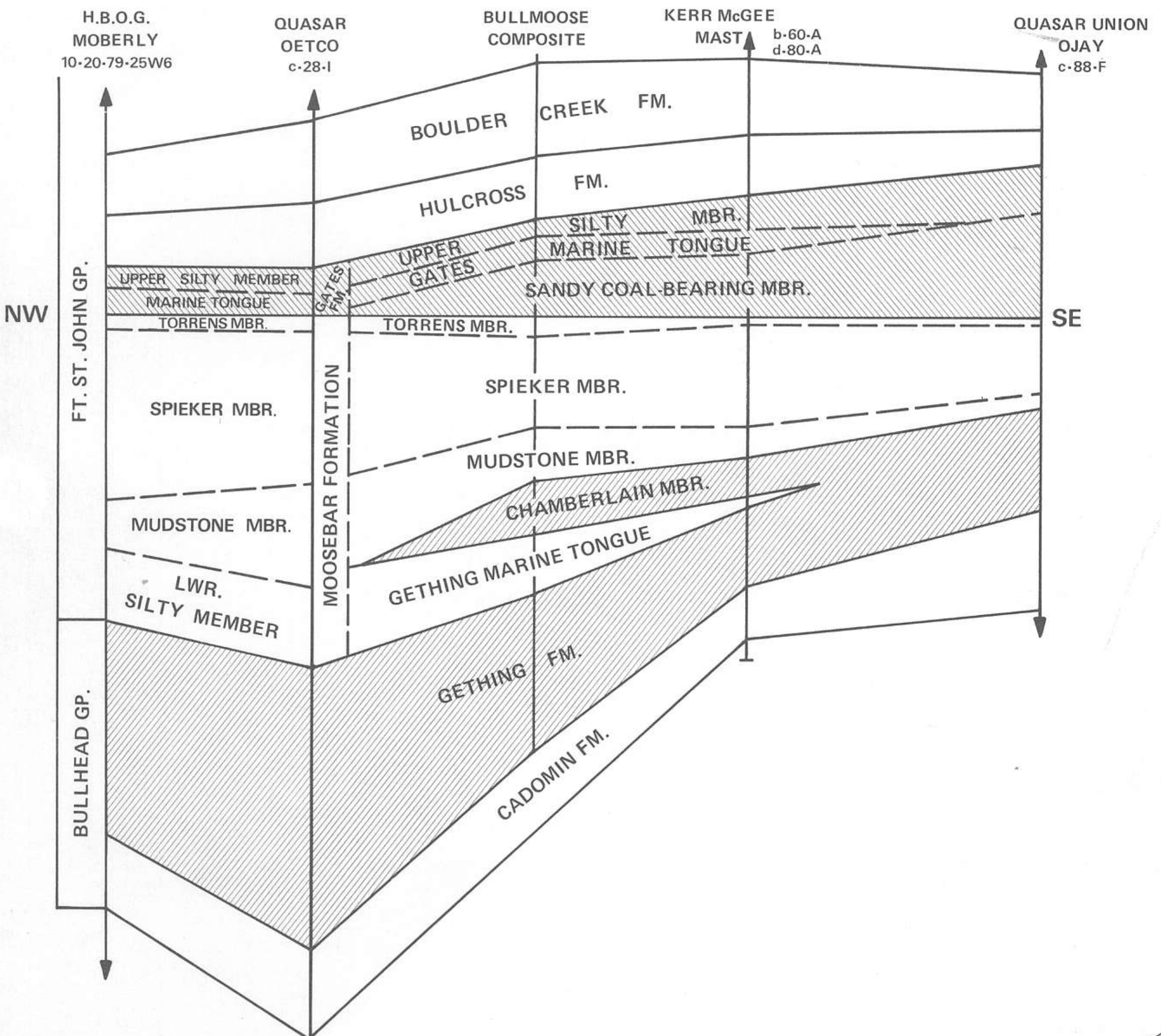
Correlation of Lower Cretaceous Coal Measures, Peace River Coalfield, British Columbia



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Province of British Columbia

Ministry of
Energy, Mines and
Petroleum Resources

GEOLOGICAL BRANCH
MINERAL RESOURCES DIVISION

CORRELATION OF LOWER CRETACEOUS COAL MEASURES
PEACE RIVER COALFIELD
BRITISH COLUMBIA

PAPER 1981-3

by

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INTRODUCTION

The 1970's saw the beginning of one of the most ambitious exploration programs ever undertaken in British Columbia when various companies decided to define the coal potential of the northeast part of the province. During a very short period of time an unprecedented number of cored boreholes were drilled in what is now termed the Peace River Coalfield, an area that extends 290 kilometres from the Alberta border to Williston Lake. In addition, rotary holes and geophysical logs of both these and the cored holes have provided a wealth of new information on the Lower Cretaceous rocks containing the coal.

In 1975 the Geological Division of the British Columbia Ministry of Mines and Petroleum Resources decided that an attempt should be made to collate this information in order to: (a) summarize the improvement in our knowledge of the stratigraphy of a structurally complex and poorly exposed area, (b) provide a useful framework for further exploration work, (c) assist in the meaningful assessment of coal resources and reserves, and (d) add to the sum of geological knowledge of the area and point to important areas of geological research.

As a preliminary to such studies it was decided to expand the petroleum core storage facility at Charlie Lake near Fort St. John, so as to be able to accept cores from coal exploration holes as well. There, the cores are available, under suitable restrictions, for examination by geologists.

This publication presents progress on the efforts made between 1975 and 1978 to improve methods of correlation in the coalfield and to amplify the excellent stratigraphic framework established by Stott (1968) which expeditod coalfield exploration.

Coal-bearing portions of the succession formed in alluvial-deltaic environments. Lateral facies changes in both the coal seams and the associated sedimentary rocks are the norm. Consequently, correlation is difficult, particularly in structurally complex areas. Early correlation attempts with a heavy reliance on geophysical logs often proved unsatisfactory. In some areas it was decided that coal seams were simply a series of disconnected lenses; in other areas correlations of individual beds were 'forced' because lateral continuity was assumed. As in most geological situations neither extreme is correct. To establish the detailed stratigraphy on any property thorough examination of drill core is essential and much information may be missed if the core is examined hastily or if the importance of certain sedimentary features is not recognized.

The correlation charts presented in this publication are a first attempt at an overview of the stratigraphy of the coalfield. The detailed logs show geophysical and geological features which are presently considered to be the most significant aids to correlation from the point of view of the exploration geologist. As in coal-bearing sequences of other ages in other countries, macrofossils, as well as the normal rock types, and sedimentary and other structures in the cores, play an essential part in correlation. In addition, recognition of volcanic ash horizons provide valuable stratigraphic markers and it is hoped that this publication will stimulate the search for them by geologists in the field. In due course, detailed palynological, paleobotanical, paleontological, geochemical, mineralogical, and other studies will undoubtedly modify details of the stratigraphy presented here.

The Carbon Creek basin originally was included in this study. A number of cores from it were examined but the macrofauna found were generally fresh with some brackish water nonmarine species. The stratigraphy was a problem because no Gething/Moosebar contact was found in the basin and there were no satisfactory Cadomin rocks. We have not included the Carbon Creek basin in our interpretations but we have given the fossil list for the holes examined in Appendix I as a reference for future workers.

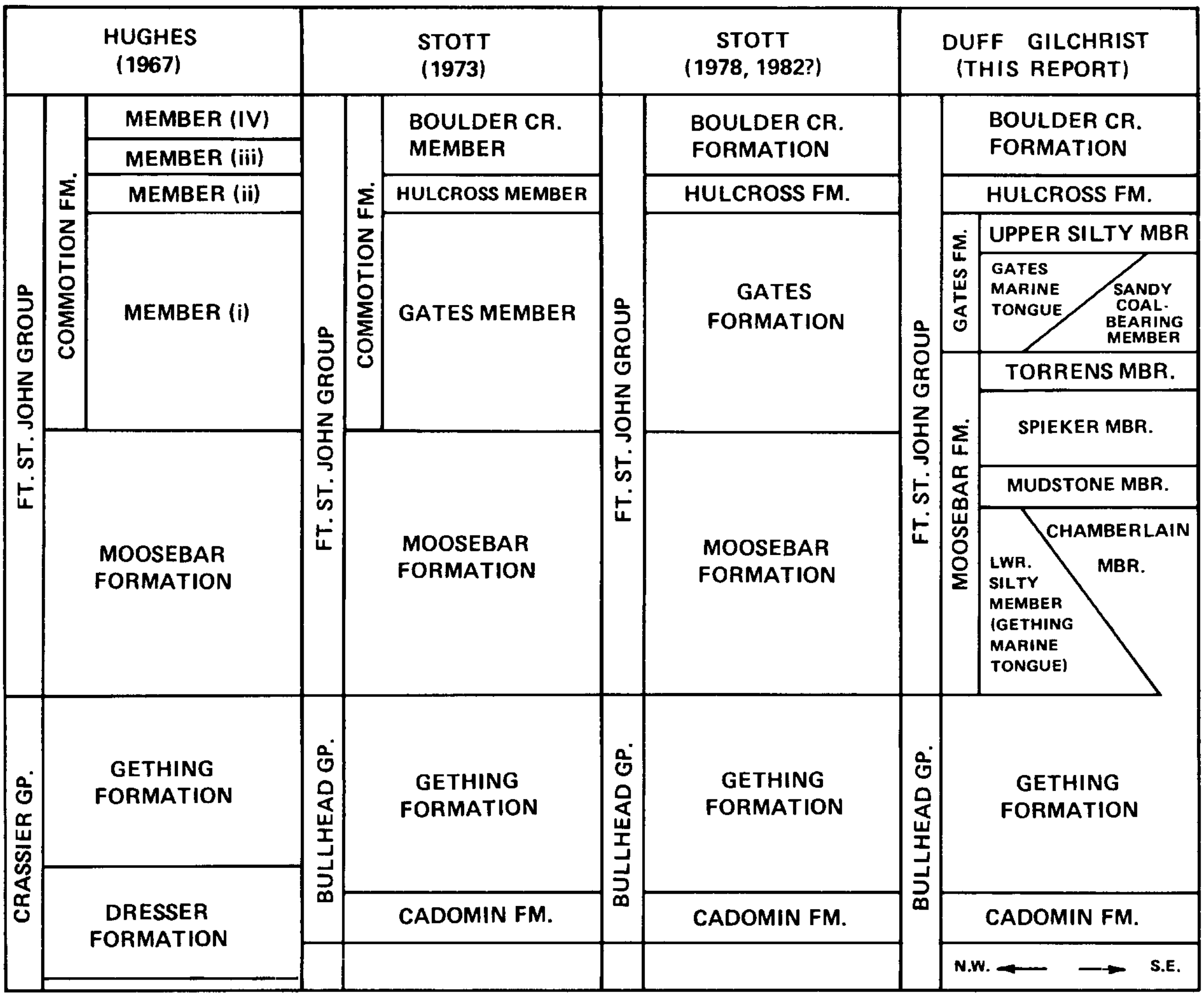
SELECTION OF HOLES FOR CORE EXAMINATION

The study began before the core storage program at Charlie Lake was completed. Hence some of the cores were examined on the properties; others were examined at the core storage facility.

Initially holes were selected to form composite sections covering strata from the Cadomin Formation to the Boulder Creek Formation. As well, structural settings had to bo simple; several holes penetrated the strata at something other than 90 degrees but corrections were made to provide true stratigraphic thicknesses. To the best of our knowledge no faults of major significance occur in the holes used.

FIGURE 8

CURRENT, INFORMAL & PROPOSED STRATIGRAPHIC NOMENCLATURE



A major consideration, especially in the older cores, was the physical condition of the core. Weathering of shales was especially rapid; Moosebar shales are reduced to rubble similar to that seen in outcrop after less than two years of exposure to the elements.

An attempt was made to select holes spaced less than 10 kilometres apart. However, gaps in the drilling (for example, Pine Pass to Peace River Canyon) occasionally made this impossible (*see* Fig. 1). As well, poor macrofauna recovery from a hole often prompted examination of more holes from the same area. All of the foregoing considerations made the line of section and strata coverage less than ideal.

SELECTION OF HOLES FOR PRESENTATION OF RESULTS

To make presentation of the results of the macrofaunal and volcanic ash (tonstein) study more meaningful, it was decided to use small-scale stratigraphic sections and to display geophysical logs (Figs. 3–7). Preparation of these sections became a study in itself. Additional holes (to those examined for fauna and tonsteins) with good section coverage and adequate logs were used in the sections. Section coverage was still incomplete, so seven gas wells lying east of the coalfield in relatively undisturbed rock were also studied. These are spaced more or less evenly along the length of the coalfield. Some holes were examined for macrofauna and tonsteins but were left off the sections because results were poor and it was necessary to limit the size of the sections.

On the index section only, two measured outcrop sections by Stott are shown. These are included because marine fossils found in them prove the southern continuity of the large marine tongue in the Gething Formation.

HOLE NUMBERING AND LOCATION

With the exception of the seven gas wells, all holes lie on coal properties and are referenced accordingly. The hole numbers are unique to each property; some have letters preceding them and these denote a program of drilling or a specific area on a property. They are necessary in some cases (such as the Quintette and Sukunka properties) to make the hole designation unique, but unnecessary on others (such as the Belcourt property). For three or four digit hole numbers the first two digits denote the year of drilling.

To provide a simple and uniform presentation, property names and hole numbers are shown on the geophysical stratigraphic sections, on the location map (Fig. 1), and in the appendices. The index section (Fig. 2) shows only abbreviated property names and hole numbers.

Although only one property underwent a name change (East Bullmoose to Mount Spieker), many of the properties were known better by the name of the owner and/or operator of the property and some of these have changed. Appendix III lists all the holes used in this study along with the names of properties and past and present owners and operators. Further, all the holes used are listed by property and a reference is made to where they were used in the study.

Because of space limitations, only holes used in the stratigraphic sections are shown on the location map (Fig. 1).

UNITS OF MEASUREMENT

Conversion to the metric system took place in the coal exploration industry during the course of our study. As a consequence, core measurements and geophysical logs use both systems, sometimes at the same time. It was tempting to convert all measurements to the metric system, however, we retained the units of measurements originally used and these are shown on the geophysical logs. Consequently, anyone wishing to correlate the appendix with the geophysical logs will find that no conversions are necessary.

Some minor apparent discrepancies in plotting on the geophysical logs may be due to inaccuracies of the recorded core meterage which are quite common. No attempt was made to justify these core measurements with the geophysical logs. Some of the tonsteins with differences up to one metre or more illustrate the problem.

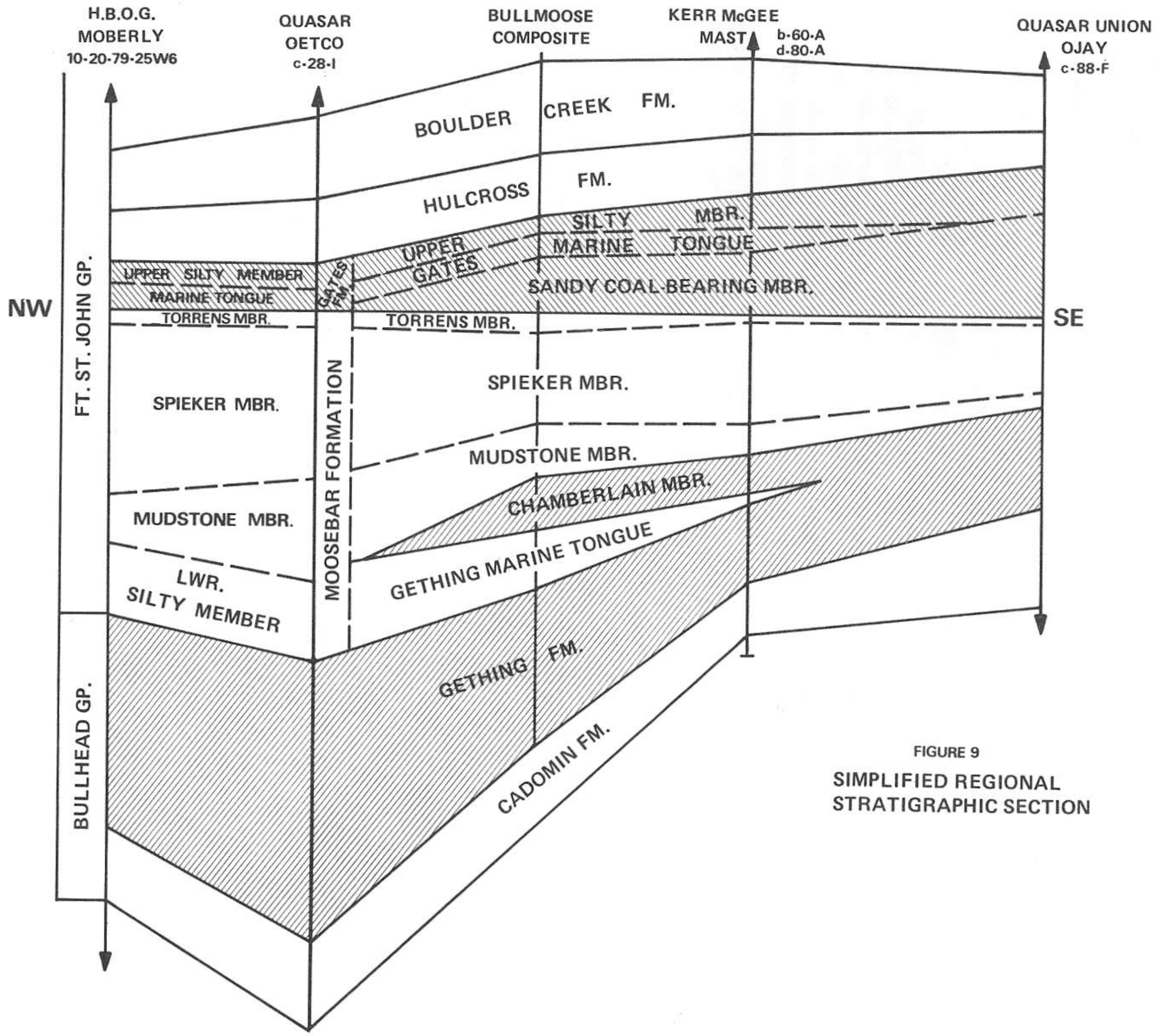


FIGURE 9

SIMPLIFIED REGIONAL STRATIGRAPHIC SECTION

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The writers wish to express their sincere gratitude to Dr. Charles R. Stelck, University of Alberta, for identifying all of the fauna (and flora); the project could not have been conducted without his contribution. Sincere appreciation is also extended to R. H. Karst, then District Geologist of the British Columbia Ministry of Energy, Mines and Petroleum Resources, for his contribution to the core examination phase and compilation of the sections. Dr. Alan Spears, University of Sheffield, England and John Kwong, British Columbia Ministry of Energy, Mines and Petroleum Resources, analyzed the clay bands and their work is gratefully acknowledged.

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Sincere thanks are extended to the following companies and their staff who made possible core examination on the properties and gave permission for the publication of their geophysical logs: BP Exploration Canada Limited, Cinnabar Peak Mines Ltd., Denison Coal Limited, Gulf Canada Resources Inc., Norcen Energy Resources Limited, Petro-Canada Exploration Inc., Ranger Oil Limited, Teck Corporation, and Utah Mines Ltd. We are appreciative of the fruitful discussions held with our many colleagues in industry and government; we especially want to thank Dr. D. W. Gibson, Geological Survey of Canada, and Dr. A. Chowdry, BP Exploration Canada Limited, for their comments and suggestions.

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STRATIGRAPHY

GENERAL DISCUSSION

Hughes (1964, 1967) and Stott (1968, 1973) have published detailed reviews and interpretations of the stratigraphy of the Lower Cretaceous rocks in the Peace River Coalfield. A display of their nomenclature and how it equates to that used in this report can be found on Figure 8. Because this study was primarily concerned with the coal measures lying above the Cadomin conglomerates, we found it necessary to enter the controversy regarding the base of the Bullhead Group and a possible major unconformity. Rather, we found the Cadomin to be a very workable formational unit from the Alberta border to Burnt River. From Burnt to Peace River the top of the Cadomin was still found to be a useful working contact for a general type of study such as this one. However, a number of unresolved difficulties exist on the detailed level in the stratigraphy in this region. Hughes recognizes some of these problems and considers them in his nomenclature.

The apparent intertonguing of the Gething and Moosebar Formations (*see* Fig. 9) has created some difficulties in the stratigraphic description. From Quintette Mountain to Sukunka River a lower coal-bearing Gething unit (lower Gething member), a middle marine unit (Gething marine tongue), and an upper coal-bearing unit (Chamberlain member) have been defined. Northwestward, the Chamberlain member, which may be correlative to the Bluesky Formation of the plains, appears to pinch out or lose its coal facies. The lower silty member observed in the Moosebar Formation may be correlative to the Chamberlain member and/or the Gething marine tongue.

The Torrens member, as defined by McLean (1982), was considered to be part of the Gates Formation. It includes all strata from the first well-developed sandstone above the Moosebar shales up to and including the very well-sorted, usually massive sandstone at the base of the coal measures. For reasons discussed in a following section, we restricted the Torrens member to well-sorted, massive, grey-weathering sandstone and have considered it to be the uppermost unit in the Moosebar Formation.

The Gates Formation has been restricted in this study to include only strata between the Torrens member and the Hulcross Formation. We also informally divided the Gates Formation into three members. In the northwest a fine clastic unit (Gates marine tongue), that is believed to be marine, lies directly on the Torrens sandstone, but southeastward it onlaps a major deltaic sequence of coal measures (sandy coal-bearing member). A paralic silty unit of marine and nonmarine strata (upper silty member) is developed throughout the coalfield and overlies the Gates marine tongue as far southeast as Quintette Mountain. From the furthest extent of the marine tongue to the Alberta border the upper silty member directly overlies the sandy coal-bearing member.

The Hulcross and Boulder Creek Formations have received only limited attention in this study and have not been changed from those defined by Stott (1968). The Hulcross thins rapidly in the southernmost part of the coalfield and we believe that this may be the result of a facies change. The upper part of the upper silty member may be the facies equivalent of the lower Hulcross to the northwest.

UNIT DESCRIPTIONS AND CONTACTS

Cadomin Formation

The Cadomin Formation is the lowest unit appearing on the sections. Until recently coal exploration has been concentrated on coal measures lying above the Cadomin and few exploration drill holes have penetrated more than a few metres into the Cadomin.

South of Burnt River, the Cadomin is always a conglomerate with a clean, well-sorted sandstone matrix. North of Burnt River, it is generally not conglomeratic but it is always a clean, well-sorted sandstone. It is easily picked out on geophysical logs.

McLean (1977) proposed the following working definition for the Cadomin/Gething contact: '. . . all conglomerate and medium- to coarse-grained sand units are included unless they are separated from the main body of the formation by a unit of finer sediments greater than 1.5 times the thickness of the overlying unit.'

All the gas wells used in this study penetrated the Cadomin Formation. The Cadomin is highly variable in thickness, from 35 metres in Quasar North Grizzly b-73-G, 93-I-15 to 150 metres in Quasar Union Ojay c-88-F, 93-I-9.

Gething Formation

From Bullmoose Mountain southward to Quintette Mountain, a large marine tongue divides the Gething Formation into three units: (a) a lower unit composed of mainly thin sands, silts, and numerous coal seams (lower Gething), (b) a middle marine unit consisting of a series of coarsening upward sequences of mudstones and siltstones (Gething marine tongue), and (c) an upper unit containing thick, continuous, coal seams and thick, clean sandstones (Chamberlain member).

If the middle marine unit of the Gething Formation south of Bullmoose Mountain correlates with the lower silty member of the Moosebar Formation north of it, then all strata now considered to be Gething north of Bullmoose Mountain are lower unit rocks. Thus, the coal-bearing upper Gething apparently pinches out north of Bullmoose Mountain.

South of Quintette Mountain the marine tongue is no longer traceable. The strata become considerably coarser and consist mainly of sands, conglomerates, and coals. In some holes (for example, Monkman MOD 76-8) the Gething consists mainly of very clean sands and conglomerates with well-sorted sand matrices and resembles the Cadomin Formation. To the southwest this coarsening trend is pronounced.

North of Sukunka River, the Gething Formation thickens from 425 metres at Quasar *et al* Oetco c-28-I, 93-P-5 to 460 metres at Skelly Getty CS Commotion a-23-D, 93-P-12 to 550 metres at Pine Valley. Tentative correlations indicate a thickness of 490 metres at the East Mount Gething property. Stott (1981) now believes that the coal measures explored at Carbon Creek are Gething. There, they are in the order of 900 metres thick. An eastward thinning is shown by the Moberly well where the Gething is only 335 metres thick.

Moosebar Formation

The Moosebar Formation represents the most important marine transgression in the Lower Cretaceous coal measures and extends southeast beyond the coalfield. It has an intertonguing relationship with the underlying Gething Formation.

The basal contact is usually abrupt and, while it may be disconformable, no evidence of a regional erosional unconformity was found (Stott, 1968). A 0.25 to 0.5 metre bed of chert pebble conglomerate, which Stott correlated to the Bluesky Formation in the subsurface of the plains, generally marks the contact. G. V. White (*pers. comm.*) has traced the unit from the foothills to plains and proven the correlation. In fact, the whole Chamberlain member may be correlative to the Bluesky of the plains. Even at Sukunka much of the member is marine; the paralic coal seams and a few thin sands appear to be nonmarine deposits. This would agree with Stott's (1968) suggestion that the Bluesky of the plains is equivalent to the Gething Formation, not the lower Moosebar.

The Moosebar Formation appears to develop its maximum thickness in the vicinity of Pine River. The Skelly Getty CS Commotion a-23-D, 93-P-12 well, just south of Pine River, contains 595 metres of Moosebar strata. It is thinner to the north; only 452 metres are recorded in the HB *et al* Moberly 16-20-79-25W6 well. Southward it also thins considerably; only 475 metres are recorded in the Quasar *et al* Oetco c-28-I, 93-P-5 well. Almost all of this thinning takes place in the lower silty member and at Bullmoose Mountain the Moosebar has split into two tongues with an aggregate thickness of 370 metres (*see* marine tongues section). At Babcock Mountain the lower tongue is only about 15 metres thick and the main tongue is 120 metres. At Saxon the lower tongue no longer appears and the Moosebar is only 70 metres thick. Correlation of two apparent clay layers or tonsteins (discussed in following section) that are visible on the geophysical logs suggests that the Moosebar is progressively older northward. Regional thinning to the south, deposition of marine tongues, and tonstein preservation, all support an incursion from the north. Rock type variations suggest transgression ended deposition of the lower silty member; transgression was followed by stable, deeper water conditions.

In this study the Moosebar Formation north of Sukunka River is divided into four units: lower silty member, mudstone member, Spieker member, and Torrens member. South of Sukunka River, the lower silty member is not recognized as such, but may be correlative to the Gething marine tongue. The first two are informal lithostratigraphic units; the third and fourth units are proposed by Gilchrist (in preparation) and McLean (1982) respectively.

LOWER SILTY MEMBER (GETHING MARINE TONGUE): The lower silty member has not been examined in core. From geophysical logs (mainly Skelly Getty CS Commotion a-23-D, 93-P-12 and Quasar *et al* Oetco c-28-I, 93-P-5), it apparently consists of a series of coarsening upward sequences of siltstone and sandstone. It is believed to be correlative to the marine tongue observed in the Gething Formation on Bullmoose Mountain and, as such, would be similar to the Spieker member.

MUDSTONE MEMBER: The mudstone member is dominated by mudstones with less than 5 per cent silt content. Unlike the enclosing members, it is devoid of small interbeds of silt and fine sand. In outcrop, only several 5 to 25-centimetre-thick, golden weathering ironstone concretion beds provide variety. The fauna, lack of any coarse fraction, and preservation of tonsteins (discussed in following section), suggest a distal shelf origin. On the geophysical logs (gamma and neutron) no general shift is evident; essentially a vertical trace is observed.

SPIEKER MEMBER: The Spieker member, proposed by Gilchrist (in preparation), includes all strata between the mudstone member and the clean, well-sorted sandstone of the upper Torrens member. The Torrens member is a name proposed by McLean (1982) but defined differently in this report (*see* following section). A regressive sequence of shelf sedimentary rocks grading upward from interbedded siltstones and mudstones at the base to fine to medium-grained sand beds at the top comprises the Spieker member. Bioturbation is common in much of the sequence. Numerous thin (0.1 to 0.3-metre) graded sand units, believed to be turbidites by Leckie (1981), are found within the lower siltstone-mudstone sequence.

TORRENS MEMBER: Stott (1968) defined the upper Moosebar/lower Gates contact as the bottom of the first thick and relatively continuous succession of fine-grained sandstone. McLean (1982) has used a similar definition, namely the succession becomes predominantly sand (90 per cent), to indicate the basal contact of the Torrens member. Gilchrist (in preparation) included all the interbedded siltstones and sandstones in the Spieker member and restricted the Torrens member to the clean, well-sorted sands at the top of the transitional sequence of the Spieker member. The contact is drawn when the sands have become uniformly clean and sorted. The Torrens sandstone, unlike those below it, is virtually continuous throughout the coalfield. It is the upper unit of what appears to be a regressive sequence from distal shelf muds (Moosebar Formation/mudstone member) to proximal shelf interbedded sands, silts, and muds (Spieker member) to beach barrier sands (Torrens member). These three units are always present. McLean considers the Torrens member to be part of the Gates Formation on grounds of lithologic similarity, however, genetically and stratigraphically it should be considered as part of the Moosebar Formation. Carmichael (*pers. comm.*) considers the Torrens to be shallow marine. The top of the Torrens member is certainly distinctive on geophysical logs and is one of the most consistent contacts in the strata under discussion. In fact, it is used as a datum on the upper sections and, as such, makes the best formational boundary. Admittedly, in areas of poor exposure, where units can only be delineated by their recessive or resistant characteristics, the Moosebar/Gates contact of Stott and McLean might be easier to apply. However, if any outcrop exists it usually includes the typically grey, resistant sandstones of the Torrens member. The underlying Spieker member can be differentiated by its distinctive, brown-weathering sandstones.

Gates Formation

In this paper the term Gates Formation refers only to strata lying above the Torrens member sandstone and below the Hulcross Formation. It has been divided into three informal members listed in ascending order: the sandy coal-bearing member, the Gates marine tongue, and the upper silty member. Only the latter member extends over the length of the coalfield.

SANDY COAL-BEARING MEMBER: The sandy coal-bearing member (*see* Figs. 5, 6, and 8) is an informal lithostratigraphic unit composed dominantly of massive beds of medium and coarse-grained sandstones and conglomerates and thick coal seams found immediately above the Torrens member (*see* following sections for coal seam description). It is best developed in the southern part of the coalfield, over 220 metres are included in the unit from Saxon 77-26, and thins gradually northward. The unit averages about 170 metres on the Belcourt property, thinning to about 150 metres in the Babcock Mountain area, and consists of only 90 metres of strata on Mount Spieker. Northward, the sandy coal-bearing member is poorly developed on Bullmoose Mountain and does not appear in Pine Pass 79-03 in the vicinity of Highhat Mountain. Northward thinning of the unit probably has a depositional origin because the upper contact with the overlying Gates marine tongue and the upper silty member appears to be conformable.

Local rapid changes of 20 or 30 metres in thickness are common in a sequence that contains an abundance of fluvial sandstones and conglomerates. For example, a massive sandstone is 40 metres thick in KM *et al* Mast d-80-A, 93-P-3, whereas in an adjacent well, b-60-A, 93-P-3, it is poorly developed and a thick coal seam is present (Leckie, 1981).

Although the holes used in this study are aligned primarily along the regional northwest-southeast structural trend, observations in selected holes, for example Monkman BWD 76-5 to Quasar Union Ojay c-88-F, 93-I-9 (Fig. 6), show no pronounced thickness changes from northeast to southwest in the sandy coal-bearing member.

GATES MARINE TONGUE: The Gates marine tongue overlies the Torrens member north of Bullmoose Mountain but southward it was deposited on the sandy coal-bearing member. It is well illustrated on Skelly Getty CS Commotion a-23-D, 93-P-12 (*see* Fig. 5) where it has a thickness of approximately 55 metres. Like the Hulcross Formation it has a lower fining upward and an upper coarsening upward sequence or hourglass shape representing transgression and regression respectively.

It thins southward to about 25 metres in Sukunka BP-6 and 15 metres in Mount Spieker 27. These two holes show only a coarsening upward or regressive sequence. The southward extent is difficult to assess from geophysical logs only, but it may extend as far as Quintette Mountain. The Gates marine tongue provides an excellent stratigraphic division of the Gates Formation and hopefully further work will be done to define and delineate it. The contact with the upper silty member appears to be conformable.

UPPER SILTY MEMBER: The upper silty member overlies the Gates marine tongue in the northern part of the coalfield. Southeastward it lies directly on the sandy coal-bearing member of the furthest advance of the Gates area (location unknown). There, the contact is placed on top of the last thick, well-developed sandstone. The upper silty member is relatively consistent in thickness and character throughout the coalfield. It has an average thickness of about 35 metres north of Wapiti River. Southward thickness appears to double but this may be partially due to the rather arbitrary method of placing the lower contact when the Gates marine tongue is missing. The upper silty member, as its descriptive name implies, is dominantly siltstones with fine-grained sandstones, mudstones, and one to three thin (1-metre) rather persistent coal seams. The upper contact is gradational and has been well described by Stott (1968).

Hulcross Formation

The Hulcross Formation represents a major marine incursion; it has both a lower fining upward transgressive unit and an upper coarsening upward regressive unit. It is composed dominantly of siltstones but lacks pure mudstones such as are found in the Moosebar Formation. Thin iron concretion bands are common throughout.

The Hulcross thins southeastward along section from a maximum of 132 metres in Skelly Getty CS Commotion a-23-D, 93-P-12 to 75 metres in Belcourt 78-02 to only 4 metres in Saxon 77-26. Rapid thinning from Belcourt to Saxon appears to be the result of a facies change to a coarser sequence in the lower part of the Hulcross.

Two tonsteins in the lower Hulcross have been tentatively correlated nearly the length of the coalfield (*see* Figs. 5 and 6). The interval between the two tonsteins decreases from 12 metres to 4 metres from northwest to southeast, a change that may be the result of a decreased sedimentation rate. The interval from the top of the Gates Formation to the upper of the two tonsteins decreases southward from 36 metres at HB *et al* Moberly 16-20-79-25W6 to 4 metres at Quasar Union Ojay c-88-F, 93-I-9. Even allowing the possibility of a reduced sedimentation rate southeastward, this decrease in thickness could only be explained by a southward transgressing sea. Correlation from Pine Pass 79-03 to Mount Spieker 27 indicates that part of the lower section is missing in Mount Spieker 27, which also demonstrates the diachronous nature of the Hulcross.

The upper Hulcross is a generally regressive sequence, grading upward from siltstones into a clean, fine to medium-grained sandstone which is occasionally conglomeratic. This unit is similar in appearance to the Torrens member and is, in fact, as continuous and constant in character. In this study the Hulcross/Boulder Creek contact has been placed at the bottom of the clean sand (in the same fashion as the Spieker/Torrens contact) and it is easily distinguished on geophysical logs. Stott (1968) argued that the contact appears to be lower in the section toward the southeast where Boulder Creek sandstone replaces the shales; no evidence of this was seen. The contact is usually gradational but may be erosional as in Pine Pass 79-03 and on Mount Spieker.

Boulder Creek Formation

The Boulder Creek Formation is a remarkably consistent, dominantly conglomeratic unit. In general, it is composed of a basal, well-sorted sandstone overlain by a set of two or three conglomerate units, each separated by a silty unit. With the exception of the basal sandstone, no widespread division of the formation was apparent, although Hughes (1964) proposed a four-fold division in the Pine Valley region. The upper contact with Hasler shales is fairly abrupt and easily recognized (especially on geophysical logs). Thin coal seams are sometimes developed above the lower conglomerate and in at least one locality they thicken to 3 metres (*see* Skelly Getty CS Commotion a-23-D, 93-P-12).

The Boulder Creek member is relatively consistent in thickness over the length of the coalfield. It thins very slightly southeastward, from an average thickness of 122 metres in the north to about 107 metres in the south. Thinning is more rapid northeastward toward the plains in the subsurface. This thinning can be seen in logs of the section running across regional strike, such as Quasar Union Ojay c-88-F, 93-I-9 to Saxon 77-06 and Quintette QBD 73-03 to Quasar North Grizzly b-73-G, 93-I-15. Maximum thickness of the unit observed is 132 metres in Skelly Getty CS Commotion a-23-D, 93-P-12. Minimum thickness is 86 metres in Quasar Union Ojay c-88-F, 93-I-9.

CLAY HORIZONS (TONSTEINS)

Centimetre-scale, laterally persistent kaolinite-rich beds were first described more than a century ago from coal-bearing sequences in Germany. More recently, interest in them has been revived in Europe because of their value in correlating coals in the deep boreholes that are now necessary for proving reserves in underground mines in Britain and Germany. Some tonsteins occur in coals, some in the accompanying sedimentary rocks. Various views as to their origin have been put forward, but now it is generally accepted that at least those in the British Carboniferous Coal Measures are volcanic (Price and Duff, 1969; Spears and Kanaris-Sotiriou, 1979); that is, they are kaolinitic bentonites. The clay mineralogy will vary depending on the environment into which the volcanic ash falls and subsequent diagenetic effects. The compositon varies from mixed layer mica-smectite (K-bentonites) to kaolinite (tonsteins), with the possibility of illite and other components if the ash is contaminated with normal sediment during deposition.

Bentonites were recorded in the Moosebar Formation by Stott (1968) and by several company geologists during exploration. To the east they have been known for a long time and widely used in correlations in the subsurface under the plains. In this study a considerable number of clay beds were found in the Moosebar and Hulcross Formations and a few were found in the upper 100 metres of the Gething Formatien. Their occurrenoe is generally restricted and they are preserved in the low energy, distal mudstones of these units. As one might expect, the only other environment where they survived is also one of low energy, namely the coals. Unfortunately nearly all the coal cores had been removed for analysis prior to our examination. Thus, we recovered only one tonstein from a minor coal in Pine Pass drill hole 75-4 and two tonsteins from the Bird seam in Sukunka C-35.

Ash units are time-marker beds and are useful in the marine sequences for paleogeographic and structural analysis. However, their most important use in the coal industry would be for correlating coal seams. Hopefully they will be found to occur in several seams and to have significant areal extent. There is, of course, the problem of identifying specific beds. To this end, Spears and Duff (1981) state: 'Although many elements are mobile in the alteration process there are elements which are immobile and these can be used not only to demonstrate the volcanic origin but also to determine the original ash composition.' Hence it may be possible to distinguish and map individual ash beds from their chemistry.

To make further studies of the coal tonsteins and K-bentonites possible, the Ministry is soliciting samples from company geologists that find them. If these studies prove fruitful, the composition of the tonsteins and K-bentonites will be published as an aid to correlation of units.

Clay bands analyzed in this study are listed by type and location in Appendix II. In this study they are shown as tonsteins, K-bentonites, or normal sediments. Some of the tonsteins are pure kaolinite and they are presumed to be volcanic. Their thin, areally extensive character is also satisfactorily explained if they represent an ash fall (Price and Duff, 1969). A number of the tonsteins have minor amounts of mixed layer mica-smectite that confirms their volcanic origin. That is, if the assemblage is dominated by or totally composed of mixed layer mica-smectite (K-bentonite), it is definitely of volcanic origin.

VOLCANIC ASH HORIZONS IN GETHING FORMATION

Several tonsteins occur in the upper 100 metres of the Gething Formation. They were preserved in apparently nonmarine, fine-grained, perhaps overbank, units. If they are sediment overbank deposits, it is unlikely that the ash layers would have been preserved over a significant lateral extent; consequently, no correlation was attempted at this time.

As mentioned, tonsteins were recorded from a minor seam in Pine Pass 75-4 and the Bird seam in Sukunka C-35. A thick bentonite band occurs in a coal seam on the Burnt River property.

VOLCANIC ASH HORIZONS IN MOOSEBAR FORMATION

Tonsteins and K-bentonites occur at a number of horizons in the Moosebar Formation where they are generally restricted to the fine-grained, usually mudstone, facies. Peace River Canyon 76-4 has four K-bentonites and two tonsteins recorded; the highest is 152 metres above the base of the Moosebar in the Spieker member of the upper Moosebar which is still quite muddy.

Two ash bands that occur near the base of the mudstone member have been correlated from Peace River Canyon 76-4 in the northwest to KM *et al* Mast b-60-A, 93-P-3 in the southeast (*see* Fig. 7). Both bands are K-bentonites in Peace River Canyon 76-4, the upper band is a tonstein in Sukunka C-35, and both bands are tonsteins in Mount Spieker 1. The correlation is subjective and assumes that the lithostratigraphic mudstone unit represents a single depositional event. Alternate correlations could be made, for example, connecting ash bands at 174 metres in Peace River Canyon 76-4, 1 058 metres (3,472 feet) in HB *et al* Moberly 16-20-79-25W6, 1 375 metres (4,518 feet) in Skelly Getty CS Commotion a-23-D, 93-P-12, and 1 752 metres (5,749 feet) in Quasar *et al* Oetco c-28-I, 93-P-5. This configuration suggests that the lithostratigraphic units were diachronous and perhaps represent a depositional event.

Both interpretations rest on circumstantial evidence. Only studies to determine original ash composition offer a chance to decide which is correct.

VOLCANIC ASH HORIZONS IN HULCROSS FORMATION

Only three tonsteins were recorded from the Hulcross Formation. However, the study concentrated on the coal measures and little effort was made to sample all potential tonsteins in the Hulcross. In fact, geophysical log traces suggest that six or more may be present. One of the identified tonsteins [Quintette QBD 73-03—269 metres (882 feet)] occurs toward the top of the basal transgressive part of the Hulcross and was tentatively correlated throughout the length of the section. A second possible tonstein (from geophysical logs only) lies approximately 6.7 metres below the first and was also correlated throughout most of the section but cannot be correlated south of Monkman MQD 76-10. The fact that this second tonstein was not seen in core examined from Quintette QBD 73-03 may be due to core loss during drilling or recovery. These beds are thin and rather incompetent, hence the core tends to break on them. A discussion of the stratigraphic significance of these tonsteins is dealt with in the section on Hulcross stratigraphy.

IDENTIFICATION OF TONSTEINS AND K-BENTONITES ON GEOPHYSICAL LOGS

Both tonsteins and K-bentonites have significantly higher than background radioactivity and hence produce a characteristic high reading on the gamma ray log. The neutron log frequently shows a porosity low for tonsteins and bentonites, although the amount of water held in the bentonite lattice could affect the reading. The densities of kaolinite (2.63 grams per cubic centimetre) and montmorillonite (2.0 to 2.7 grams per cubic centimetre) are not significantly different from other fine-grained sedimentary rocks, so density logs give little indication of tonsteins or K-bentonites. Ash bands tend to be thin, so resolution of the geophysical logs is another very important consideration when attempting to identify them. The ash bands identified from cores in this study have thicknesses in the order of 5 to 10 centimetres.

A number of the tonsteins and K-bentonites plotted on the geophysical logs do not correspond exactly with characteristic log kicks. We assume that these discrepancies result from using core footage which had not been adjusted to the geophysical log depths.

PALEONTOLOGY

The identification of macrofossils has played an essential part in the correlation of coal measures. In the Peace River Coalfield a limited number of macrofauna were collected from the coal measures but they were used primarily for dating.

In this study a collection of more than 850 specimens has been made from 50 holes drilled by companies exploring for coal. A few outcrop specimens were obtained; they did not contribute significantly to the study. In outcrop, most specimens found weather out differentially in sandstone. More often they are found in float which can usually provide only a rough stratigraphic level. In core, fossils are found along the bedding planes in shales. At one Gates Formation outcrop location on the Pine Pass property, a fresh exposure of mudstone in a road cut has a 10-centimetre-thick richly fossiliferous, laterally extensive zone. A drill hole penetrating this zone would almost certainly recover a specimen.

The fossil collection is dominated by nonmarine bivalves, but there are also a significant number that are believed to represent marine and/or brackish conditions. This study has not dealt with paleontology *per se,* rather the authors have used those fossils that were interpreted to be of marine affinity as indicators of marine strata. A portion of the collection was made from known marine strata in the Hulcross and Moosebar Formations. However, a large number of the fossils collected were from the Gates and Gething Formations. Most of these were freshwater bivalves, such as *Sphaerium,* but a number were brackish and marine bivalves. The following is a partial list of those fossils considered to indicate a marine environment: *Aucellina* sp., *Corbicula* sp. (shallow), *Entolium irenense, Inoceramus dowlingi, Melania multorbis, Pecten* sp., *Pleuromya* sp., *Psilomya* sp. (brackish marine or estuarial), *Protocardia* sp., *Pteria* sp. (shallow), and *Thracia kissoumi. Yoldia* sp. is brackish marine. *Brachydontes* sp., *Corbula* sp., and *Murraia* sp. are found in brackish waters.

Fossil identifications are shown on the geophysical logs on the stratigraphic sections (Figs. 3 to 7). Due to space and scale restraints, only the variety of species for 3-metre zones is shown. A complete listing of all fossils found and their exact depth comprise Appendix I. Horizons containing marine fossils are marked by an 'M' on Figures 3 to 7 and by a triangular symbol in the index section (Fig. 2). Horizons containing brackish water fossils are marked by a 'B.' These marine horizons are described later in the paper.

MARINE TONGUES

Gething Formation

Stott collected a few marine shells from the Gething Formation and he stated: 'The occurrence of these fossils, . . ., does suggest the occurrence of marine tongues within the dominantly continental sediments' (Stott, 1968, p. 39). Our investigations confirm that marine tongues exist in the Gething Formation. Specimens of *Pecten (Entolium)* sp. indet., recovered by Stott from his measured sections 59-11 and 61-12A, aided in the identification of a very large marine tongue (Gething marine tongue) in the Gething Formation (Fig. 2). This tongue consists of several coarsening upward sequences that apparently represent a rapid transgressive cycle and a somewhat slower regressive cycle. In Sukunka BP-53 the marine tongue is at least 88 metres thick, as shown on Figure 4 (Gething South), and probably extends down 6 metres further than is shown. It may also extend up in the section to include the next coarsening upward sequence. If this is correct, it would extend up to just below the Chamberlain seam (86 to 88 metres). The tongue thins southward and at Quintette QWD-7403 it consists of only one 23-metre-thick coarsening upward sequence. Stott's section 61-12A contains *Pecten* 58 metres below the top of the Gething. This is the most southward paleontological evidence of a marine tongue but the tongue can be projected further south from lithologic characteristics (constant rate of coarsening) shown on the geophysical logs, especially the gamma ray and neutron logs.

Such thick, coarsening upward sequences are characterized by an upward increase in the silt/shale ratio. The gradual change from mudstone up to fine-grained sandstone may be uniquely related to a marine regressive sequence. It appears that this sequence is a product of a proximal-distal sediment-sizing process. The constancy of energy levels and sediment supply and the areal requirements of the proximal-distal process indicate marine environment, probably shelf for the thicker tongues and estuarine for the thinner ones.

The log traces of these coarsening upward tongues are distinctive, and virtually all have been shown by paleontological evidence to be marine. This, of course, does not discount the possibility of marine tongues without distinctive log traces.

No marine fossils were found in the Gething Formation north of Sukunka River. However, a horizon containing brackish water fauna was found in the large syncline on both the Dowling Creek and Peace River Canyon properties. It lies approximately 30 metres below the top of the Gething Formation and may correlate with a slightly lower horizon containing glauconite in HB *et al* Moberly 16-20-79-25W6.

Gates Formation

From geophysical logs and stratigraphic correlations a thick marine tongue has been postulated in the Gates Formation. In the north it lies immediately above the Torrens member but southward it onlaps the sandy coal-bearing member. The upper silty member (*see* Fig. 2) of the Gates Formation is the upper contact of the marine tongue throughout the coalfield. Although no marine fossils were found at this horizon, no specific emphasis was accorded the interval during core examinations, so future examinations may prove more fruitful. A bioturbated and burrowed zone similar to the Spieker member is well known from core on the Sukunka property (Chowdry and Bickford, *pers. comm.*). This zone is discussed further in the stratigraphic unit section of the paper.

Marine fossils were found in four holes but it is not known if any are correlative. The fossils were all found in either the sandy coal-bearing member or the upper silty member, not the Gates marine tongue. The holes, the stratigraphic level, and the fossils are summarized below:

Quintette QWD 74-01	95 m above base of sandy coal bearing member	*Aucellina* *Pecten* *Murraia* *Unio* cf. *lacombei*
Quintette QWD 74-02	41 m above base of sandy coal bearing member	*Psilomya*
Quintette QMD 76-06	63 m above base of sandy coal bearing member	*Pleuromya*
Monkman MUD 77-4	161–163 (?) m above base of sandy coal-bearing member	*Entolium irenense Yoldia*

The marine horizon at Monkman is at approximately the same stratigraphic level as the postulated marine tongue in the upper silty member and could be correlative. Marine fossils found at the top of the upper silty member in Saxon 77-06 lie in strata believed to be a sandy facies equivalent of the Hulcross Formation. Carmichael (*pers. comm.*) also has evidence suggesting that marine incursions occur in the Gates Formation. Thus, as well as the thick Gates marine tongue, it appears that minor marine incursions occurred throughout nearly all Gates time. These minor marine units may be useful for local correlations.

THE EFFECTS OF THE PEACE RIVER ARCH ON LOWER CRETACEOUS STRATIGRAPHY

The stratigraphy in the Bullhead and Fort St. John Groups shows good continuity from the Alberta border north to the Sukunka property. In the general vicinity of Bullmoose Mountain, however, significant changes take place in nearly all the major units. Some or all of these abrupt changes may be related to movement on the aligned basement faults that produced the Peace River Arch (Stelck, 1975).

In the south the Cadomin Formation, which is highly variable in thickness but continuous, is a conglomeratic unit with a well-sorted sandstone matrix (McLean, 1977). North of Burnt River, it is no longer always conglomeratic and it continues northward as a very clean sandstone that is only locally conglomeratic. Northward, the Gething Formation thickens relatively rapidly from 300 metres at Bullmoose to 425 metres at Quasar *et al* Oetco c-28-I, 93-P-5. If, in fact, the Gething north of Bullmoose Mountain is equivalent to only the lower Gething member on Bullmoose Mountain, the change in thickness is considerably more dramatic (from 240 metres to 425 metres) (*see* Fig. 8 and section on Gething stratigraphy). The sandy coal-bearing member of the Gates Formation virtually disappears north of Bullmoose Mountain. As well, the Boulder Creek Formation, which contains only thin coal seams elsewhere, has a 3-metre coal seam in the Highhat Mountain area (from Skelly Getty CS Commotion a-23-D, 93-P-12 only).

Furthermore, a coal-bearing unit (informally called the Merrick member) lying immediately below the Cadomin (Gilchrist, 1979), thins rapidly as it is traced southward; it is 300 metres thick on Mount Merrick but less than 100 metres on Mount Reesor.

Although major marine units (for example, Moosebar Formation, Hulcross Formation) show little relation to the Peace River Arch, the development of coal swamps appears to be profoundly influenced by movement on the arch. Perhaps the growth and decline of the clastic wedge was controlled by local tectonic activity (highland and basin uplift and subsidence), whereas the major marine transgressions were controlled by eustatic sea level change (or cratonic downwarping).

COAL SEAM DEVELOPMENT

Summary

Coal is commonly developed in most of the Cretaceous continental sequences in northeastern British Columbia, but only in the Gething and Gates Formations is coal known to occur in economic thicknesses. In general, from the Alberta border to Sukunka River, the Gething Formation contains several extensive 2-metre seams. Northward, 20 or more seams from 1 metre to 60 metres in thickness are developed; commonly these have limited lateral extent. Thick, commonly 5 to 10-metre, laterally extensive seams, usually four or five in number, are developed in the Gates Formation from the Alberta border to Sukunka River. In general, thick Gates coals appear to be restricted to a narrow trough in what is now the inner foothills or disturbed belt and there is rapid thinning toward the plains. In contrast, Gething coals are developed more evenly across the present structural trend. The few exceptions mentioned earlier include some occurrences of coals of economic thickness beneath the Cadomin Formation.

Gilchrist (1979) reported a 3.2-metre-thick coal seam 50 metres below the Cadomin between Sukunka and Burnt Rivers. Gilchrist (1979) and Hughes (1964) reported that the 2-metre Murray seam in the Peace River area was in Hughes' Dresser Formation. In Skelly Getty CS Commotion a-23-D, 93-P-12, a 3-metre seam in the Boulder Creek Formation was interpreted from geophysical logs.

Gething Coals (*See* Figs. 3 and 4)

In this study all Gething strata lying above the marine tongue from Sukunka River to Quintette Mountain have been termed the Chamberlain member; all strata below it are referred to as the lower Gething member. South of Quintette Mountain and north of Sukunka River, the Gething Formation is undivided.

South of Quintette Mountain, the Gething contains several coal seams which generally do not average over 2 metres in thickness. A large amount of coarse clastic rock (especially to the southwest) characterize the Gething Formation in this region. Perhaps coal seams were eroded and channelled in places. Monkman MOD 76-8 provides an extreme example of the dominance of these coarse clastic rocks.

From Quintette Mountain north to Sukunka River, the lower Gething Formation is not well exposed in outcrop and is penetrated in only a few boreholes. The best coal development is recorded in Sukunka BP-53 where there are seams 2, 3, and 4 metres in thickness. The Chamberlain member in this region contains two coal zones. The lower zone is near the base of the member and contains two coal seams. On the Sukunka property they are termed the lower and upper Chamberlain seams and have average thicknesses of approximately 3 and 2 metres respectively; they appear to thin somewhat to the southeast. A second coal zone is developed near the top of the Chamberlain member and has been referred to as the Bird seam. It is usually between 2 and 3 metres in thickness but on the Mount Spieker property two coal seams mark this interval. The Bird seam lies between 0 and 10 metres below the base of the Moosebar Formation. It has a high sulphur content in areas where it is directly overlain by the Moosebar Formation.

North of Sukunka River, the Gething Formation thickens considerably but is essentially coal bearing throughout. In general, the seams are variable in thickness and laterally discontinuous. An 18-metre seam has been reported from the Burnt River property and 16 metres of coal were intersected in a hole at Noman Creek but 2 to 4-metre seams are more typical.

Between Sukunka and Pine Rivers, at least five seams greater than 1.5 metres are usually developed. North of Pine River, seams are considerably more numerous. In the upper 270 metres of the Gething Formation at Carbon Creek, more than 50 coal seams have been identified but only 12 are over 1.5 metres thick. The seams near the top of the formation, notably the Trojan, have fairly good lateral continuity from Peace River Canyon to Dowling Creek but 3 metres is generally the maximum thickness.

Gates Coals (*See* Figs. 5 and 6)

Virtually all economic coals in the Gates Formation are found in the lower sandy coal-bearing member. The seams are believed to be stratigraphic equivalents of coals in the Luscar Formation presently mined at Grande Cache, Alberta. They are well developed as far north as Bullmoose Mountain where the seams and the sandy coal-bearing member undergo a rapid pinch out.

In the most southerly part of the coalfield, four seams all over 2 metres in thickness are developed. They have a total thickness of 23 metres (*see* Saxon 77-26, Fig. 6). The lowermost seam, lying directly above the Torrens member, is well developed and contains approximately 4 metres of coal; 6, 11, and 2-metre seams lie stratigraphically above.

Northwestward, on the Belcourt property, Belcourt 78-02 shows three economic seams with thicknesses of 7, 3, and 6 metres. Elsewhere on the property, up to 46 metres of coal occur in 11 seams that range between 3 and 10 metres in thickness. Quasar Union Ojay c-88-F, 93-I-9, which lies toward the plains, contains only two seams greater than 2 metres; one is 3 metres, the other 4 metres.

A similar northeastward thinning of the coal seams is observed on the Monkman property. Monkman MUD 77-4 has a total thickness of 23 metres of coal developed in five seams; all exceed 3 metres in thickness. Monkman MDD 77-2B, perhaps more typically, has a total thickness of more than 16 metres of coal in four seams that exceed 2.5 metres in thickness. Toward the plains, in the Quasar North Grizzly b-73-G, 93-I-15 well, only the seam lying just above the Torrens member is still well developed; it has a thickness of 3 metres. Although several other seams are present, they are rarely over 1 metre in thickness.

The sandy coal-bearing member is only 145 metres thick on Babcock Mountain on the Quintette property as opposed to 220 metres at the Saxon property. However, coals are still well developed. There are generally five economic seams greater than 2 metres in thickness for an aggregate of 15 metres. The lowest seam is the thickest at 5 metres. In the northern part of the Quintette property between Murray and Wolverine Rivers QMD 76-06 shows only one thick (10-metre) seam, but two seams totalling nearly 15 metres in thickness have been the target of exploration. In the extreme northwest corner of the Quintette property north of Wolverine River, coal seams only appear in the lower part of the sandy coal-bearing member; the upper part has several large sand bodies which may have eroded any coals that were present.

The Mount Spieker property, lying just south of Bullmoose Creek, and the adjacent Bullmoose property have four well-developed seams with an aggregate thickness of approximately 12 metres. The thickest seam at 6 metres is the lowest, lying 10 metres above the Torrens member. On Bullmoose Mountain on the Sukunka property, about four seams occur in the sandy coal-bearing member but they are rarely thicker than 1 metre. Somewhere between Bullmoose Mountain and Highhat Mountain, the host sandy coal-bearing member stratigraphically pinches out.

One to three coal seams are found in the upper silty member above the Gates marine tongue. They are almost never greater than 1.5 metres in thickness but, at least as a zone, they appear to be laterally persistent. Unlike coals in the sandy coal-bearing unit, these coals appear to be unaffected by the Peace River Arch and are found throughout the Peace River Coalfield.

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APPENDIX I

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

CARBON CREEK DDH4 (1971)

DEPTH METRES	FEET	IDENTIFICATION
2.4	8	*Unio lacombei*
5	16.5	*Unio* ?
5.5	18	*Unio* ?
5.8	19	*Unio* ?
7.3	24	*Sphaerium* sp.
13.1	43	*Eupera onestae*
13.25	43.5	Unionid
13.7	45	Ostracodes
25.6	84	*Eupera onestae*
25.9	85	*Sphaerium* sp.
		Gastropod indet.
97.5	320	*Eupera* cf. *onestae*
		Lioplacodes sp.
100.9	331	Ostracodes
101.8	334	*Eupera onestae*
148.1-148.2	486-486.3	*Sphaerium* sp.
148.4	487	*Sphaerium* sp.
155.6	510.5	*Sphaerium* sp.
155.7	511	Ostracodes
158.75-158.8	520.8-521	*Sphaerium* sp.
		Chara sp.
		Lioplacodes sp.
159.6	523.7	*Sphaerium* sp.
		Chara sp.
		Lioplacodes sp.
		Ostracodes
161.6	530.2	*Scalez* sp.
		Sphaerium sp.
		Ostracodes
173.3-173.6	568.5-569.5	*Sphaerium* sp.
199.5-199.6	654.7-655	*Sphaerium* sp.
200.6	658	*Corbula* cf. *palliseri*
201.2	660	*Sphaerium* sp.
204.5	671.1	*Sphaerium* sp.
204.6	671.2	*Sphaerium* sp.
208	682.5	*Murraia* ?
215.3	706.5	Bivalve indet.
222.2	729	*Sphaerium* sp.
		Ostracodes
222.35	729.5	*Sphaerium* sp.
223.57	733.5	Bivalve indet.
223.63	733.7	*Corbula* sp.
223.9-223.92	734.5-734.7	*Scalez* sp.
		Sphaerium sp.
224.8	737.5	*Sphaerium* sp.
265.3-265.4	870.5-870.7	*Sphaerium* sp.
277.7	911	*Elliptio douglassi*
277.8	911.5	*Elliptio douglassi*
289.9	951.3	*Corbula* sp.
292.2-292.3	958.7-958.9	*Sphaerium* sp.
297.1	974.8	*Sphaerium* sp.
		Planorbid snail
		Ostracodes
302.1	991.3	*Sphaerium* sp.
		Lioplacodes sp.
		Ostracodes
302.3	991.8	*Psilomya* sp.
		Lioplacodes sp.

CARBON CREEK 75-59

DEPTH METRES	FEET	IDENTIFICATION
12.5	41	*Sphaerium* sp.
		Yoldia ?
		Ostracodes
13.15	43.2	*Chara* sp.
		Ostracodes
51.2	168	*Chara* sp.
90.2	296	*Scalez* sp.
		Chara sp.
		Fish scale
104.85	344	*Sphaerium* sp.
108.99	357.6	*Sphaerium* sp.
109	357.8	*Sphaerium* sp.
		Lioplacodes sp.
109.1	357.9	*Sphaerium* sp.
		Lioplacodes sp.
109.12	358	*Melania multorbis*
		Lioplacodes sp.
109.16	358.2	*Melania multorbis*
		Sphaerium sp.
		Lioplacodes sp.
109.2	358.3	*Sphaerium* sp.
		Gastropod
109.3	358.5	*Melania multorbis*
		Sphaerium sp.
		Lioplacodes sp.
109.32	358.7	*Lioplacodes* sp.
132.58	435	*Eupera onestae*
132.6	435.1	*Eupera onestae*
132.66	435.3	*Sphaerium* sp.
167.9	551	*Eupera onestae*
		Lioplacodes sp.

CARBON CREEK 75-62

49.7	163	*Chara* sp.
93.87	308	*Sphaerium* sp.
93.9	308.1	Bivalves indet.
101.8	334	*Chara* sp.
114.9	377	*Sphaerium* sp.
		Lioplacodes sp.

CARBON CREEK 75-68

52.3	171.5	*Murraia* n. sp.
54.2	177.8	*Sphaerium* sp.
54.25	178	*Murraia* n. sp.
72.8	239	*Corbula palliseri*
		Murraia sp.
		Ostracodes
72.9-73	239.3-239.5	*Murraia* sp.
		Sphaerium ?
		Ostracodes
73-73.1	239.5-239.8	*Solyma* ?
		Sphaerium
		Snails indet.
73.1-73.15	239.8-240	*Corbula palliseri*
73.15-73.3	240-240.5	*Murraia* sp.

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

CARBON CREEK 75-68—Continued

DEPTH METRES	FEET	IDENTIFICATION
73.8-73.9	242-242.5	*Sphaerium* ?
		Eupera onestae ?
74.4	244	*Solyma* ?
78.4-78.5	257.3-257.5	*Eupera onestae* McLearn
		Ostracodes
		Equesites
78.5-78.6	257.5-257.9	*Murraia* sp.
		Gastropods indet.
78.7	258.3	*Murraia fabensis* McLearn
		Lioplacodes ?
		Anatina ?
78.9	259	*Murraia* sp.
		Ostracodes
78.9-79.1	259-259.5	*Murraia* ?
85.2-85.3	279.4-279.9	*Melania* cf. *multorbis* McLearn
		Bivalves indet.

CARBON CREEK 76-68

DEPTH METRES	FEET	IDENTIFICATION
173	567.3	*Lymnaea* sp.
		Sphaerium sp.
175	575	*Eupera onestae*
180-180.4	591-592	*Eupera onestae*
		Snails indet.
		Ostracodes
183.4	601.8	*Eupera onestae*
183.6	602.3	*Sphaerium* sp.
		Gastropods indet.
183.64	602.5	*Lioplacodes* sp.
		Murraia sp.
193.5	635	*Panopea* ?
195.4	641	*Corbula* cf. *palliseri*
		Snails indet.
		Chara ?
199.5-199.6	654.5-654.8	*Eupera onestae*
199.6-199.7	654.8-655.2	*Eupera onestae*
		Lioplacodes bituminis
199.8	655.4	*Unio* cf. *douglassi* ?
230.9	757.5	*Panopea* sp.
		Seeds
238.8-238.98	783.5-784.1	*Melania multorbis*
		Lioplacodes ?
238.98-239.1	784.1-784.6	*Eupera onestae*
239.1-239.4	784.6-785.3	*Melania* cf. *multorbis*
		Bivalves indet.
239.4-239.5	785.3-785.8	*Eupera onestae*
		Lioplacodes cf. *bituminis*
		Panopea ?
243.5	799	*Panopea* ?
		Podozamites sp.
267.3	877	*Eupera onestae*
271.8	891.8	*Scalez* sp.
		Sphaerium sp.
		Chara sp.
295	968	*Scalez* sp.

CARBON CREEK 76-85

DEPTH METRES	FEET	IDENTIFICATION
83	272.5	*Sphaerium* sp.
83.2	273.1	*Eupera onestae*
		Sphaerium sp.
83.3	273.3	*Sphaerium* sp.
83.41	273.66	*Sphaerium* sp.
		Melania ?
		Lioplacodes sp.
83.42	273.7	*Sphaerium* sp.
		Gastropod indet.
83.43	273.75	*Eupera onestae*
		Sphaerium sp.
83.5	273.8	Bivalve indet.
83.6	274.3	*Sphaerium* sp.
		Ostracodes
83.64	274.4	*Sphaerium* sp.
		Ostracodes
83.66	274.5	Ostracodes
83.7	274.6	*Sphaerium* sp.
		Melania multorbis
83.8	275.1	*Sphaerium* sp.
		Lioplacodes sp.
83.9	275.3	*Sphaerium* sp.
		Gastropods
89.2	292.75	*Eupera onestae*
89.25	292.84	*Eupera onestae*
		Sphaerium sp.
89.3	293	Ostracodes
125.27	411	*Sphaerium* sp.
125.3	411.1	*Sphaerium* sp.
129.4	424.6	*Scalez* sp.
Chara sp.		
		Ostracodes
129.5	425	*Chara* sp.
		Gastropod
129.56	425.1	*Pseudomelania* ?
		Chara sp.
153.6	504	Ostracodes
177.1	581	*Eupera onestae*
		Sphaerium sp.
219	718.7	*Chara* sp.
232.2	761.8	*Sphaerium* sp.
232.4	762.5	*Sphaerium* sp.
233.8	767	*Sphaerium* sp.
234.1	768	*Sphaerium* sp.
234.39	769	*Sphaerium* sp.
234.4	769.1	*Murraia* sp.
236.9	777.2	Ostracodes
256.3	841	*Scalez* sp.
256.6-256.7	842-842.3	*Sphaerium* sp.
		Lioplacodes sp.
256.76	842.4	Gastropod indet.
256.9-257	843-843.4	*Sphaerium* sp.
		Ostracodes
257.1	843.5	*Sphaerium* sp.
257.1-257.25	843.5-844	*Sphaerium* sp.
		Eupera cf. *onestae*
		Pseudomelania ?
		Ostracodes

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

CARBON CREEK 76-85—Continued

DEPTH METRES	FEET	IDENTIFICATION
260.37	854.25	*Chara*
260.39	854.33	*Chara*
		Ostracodes
260.4	854.4	*Scalez* sp.
		Chara
		Ostracodes
260.45	854.5	*Scalez* sp.
		Chara
		Ostracodes
268.4	880.5	Ostracodes
308.2	1,011.1	Ostracodes
308.27	1,011.4	*Lioplacodes* sp.
		Ostracodes
308.3	1,011.5	*Unio* sp.
		Ostracodes
308.4	1,011.8	*Lioplacodes* sp.
		Unio ?
308.5	1,012.1	*Sphaerium* sp.
371.7	1,219.5	*Scalez* sp.
		Chara

EAST MOUNT GETHING 75-5

45.3	148.5	*Corbula* s.l.
45.7	150	*Eupera onestae* var. A
45.74	150.1	*Eupera onestae* var. A
46	151	*Eupera onestae* var. A
46.3	151.8	*Eupera onestae* var. A
73.55	241.3	(a) Pelecypods indet.
73.55	241.3	(b) Pelecypods indet.
73.8	242.2	Pelecypods indet.
73.84	242.25	*Eupera onestae* var. A
73.86	242.33	*Eupera onestae* var. A
74.1	243.2	(a) *Eupera onestae* var. A
74.1	243.2	(b) *Eupera onestae* var. A
160.3	526	(a) *Eupera* ?
160.3	526	(b) *Eupera* ?
161	528.2	Ostracodes
175-175.1	574.3-574.4	Ostracodes
175.11	574.5	Ostracodes
175.2	574.8	Ostracodes
		Bairdiocypris cf. *albertensis* Loranger
175.3	575	Ostracodes
175.31	575.2	Ostracodes
175.4	575.5	Ostracodes

EAST MOUNT GETHING 75-6

53	174	*Eupera onestae* var. A
53.1	174.3	*Eupera onestae* var. A
53.3	174.8	Pelecypods indet.
53.5	175.5	*Unio lacombei* ?
53.52	175.6	*Eupera onestae* var. A
		Eupera n. sp.
53.8	176.5	*Murraia* ? cf. *fabensis*

EAST MOUNT GETHING 75-6—Continued

DEPTH METRES	FEET	IDENTIFICATION
53.81	176.54	*Eupera onestae* var. A
54.2	177.8	*Eupera onestae* var. A
54.6	179.1	Pelecypods indet.
55	180.3	*Eupera onestae* var. A
55.3	181.3	*Sphaerium*
		Eupera onestae var. A
		Mutela ?
55.4-55.45	181.7-181.9	*Eupera onestae* var. A
		Mutela ?
55.5	182	*Eupera onestae* var. A
55.6-55.7	182.4-182.8	*Sphaerium*
		cf. *Eupera*
56.1	184	*Eupera onestae* var. A
56.4	185.2	*Eupera* ?
85	279.1	Pelecypod indet.
85.1	279.2	Pelecypod indet.
85.36	280.1	*Eupera* ?
85.39	280.2	*Sphaerium*
85.8	281.5	*Eupera* ?
86	282.3	*Eupera onestae* var. A
86.2	282.8	Gastropod indet.
		Eupera ?
87	285.5	Unionid indet.
87.6	287.5	*Eupera onestae* var. A
87.7	287.8	*Sphaerium*
88.2	289.4	Ostracodes
		Murraia sp.
88.23	289.5	*Scalez*
		Gastropod indet.
88.3	289.8	*Sphaerium*
		Mutela ?
164.5	539.7	Ostracodes
164.54	539.8	Plant remains indet.
164.6	540	Ostracodes
172.8	567	Ostracodes
172.85	567.1	Ostracodes
		Podozamites
172.9	567.2	*Eupera onestae*
173.3	568.75	Gastropod indet.
173.4	568.84	Ostracodes
178	584	Ostracodes
		Sphaerium
178.2	584.5	Ostracodes
178.26-178.3	584.8-585	Ostracodes
178.3-178.35	585-585.2	Ostracodes
178.46	585.5	Ostracodes
178.52	585.7	Ostracodes
179.6	589.2	Ostracodes
179.8	589.8	Ostracodes
		Mutela ?
179.83	590	*Eupera onestae*
		Mutela ?
237.7	780	*Eupera* ?
243.88	800.2	*Eupera onestae*
243.9	800.25	*Sphaerium*
		Reesidella sp. indet.
		Eupera onestae

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

EAST MOUNT GETHING 75-6—Continued

DEPTH METRES	FEET	IDENTIFICATION
243.94	800.33	*Circamelania* cf. *ortmanni* (Stanton)
		Sphaerium
244	800.7	*Eupera onestae*
		Mutela ?
244.1	801	*Eupera onestae* ?
244.3	801.4	*Eupera onestae*
244.44	802	*Eupera onestae*
		Sphaerium
		Mesoneritina ?
244.47	802.1	*Eupera onestae*
244.5	802.2	*Eupera onestae* s.s.
		Unionid

EAST MOUNT GETHING 77-10

62.46	204.9	Bivalve indet.
62.5	205.1	*Sphaerium* sp.
64.1	210.3	*Sphaerium* sp.
65.38	214.5	Bivalve indet.
65.4	214.6	*Sphaerium* sp.
65.5	215	*Sphaerium* sp.
65.8	215.8	*Sphaerium* sp.
110.4	364.2	*Sphaerium* sp.
162.9	534.6	*Sphaerium* sp.
163.42	536.2	Ostracodes
167.86	550.8	Ostracodes
168.3	552.3	Ostracodes
169.8	557	Ostracodes
169.9	557.5	Ostracodes
170.1	558	*Sphaerium* sp.
179.4	588.5	*Sphaerium* sp.
183.8	603	Gastropod
		Ostracodes
187.5	615.3	*Sphaerium* sp.
187.7	615.8	Ostracodes
190.5	625	Ostracodes
220.1	722	*Sphaerium* ?
236.1	774.5	Ostracodes
239	784	*Sphaerium* sp.
239.2	785	*Eupera onestae*
		Ostracodes
282.85	928	Ostracodes
336.5	1,104	Gastropod indet.
359.15	1,178.3	*Sphaerium* sp.

DOWLING CREEK 78-2

296.3	972	*Sphaerium* sp.
296.75	973.6	*Sphaerium* sp.
296.8	973.8	*Sphaerium* sp.
296.9	974	*Sphaerium* sp.
297.1	974.8	Ostracodes
297.3	975.3	*Sphaerium* sp.
		Ostracodes
297.4	975.8	*Sphaerium* sp.

DOWLING CREEK 78-2—Continued

DEPTH METRES	FEET	IDENTIFICATION
297.6	976.5	*Sphaerium* sp.
297.76	976.9	*Sphaerium* sp.
297.8	977	*Sphaerium* sp.
		Lioplacodes sp.
298.1	978	*Sphaerium* sp.
298.14	978.2	*Sphaerium* sp.
298.2	978.3	*Eupera onestae*
298.4	979	cf. *Corbula*
298.7	980	*Sphaerium* ?
298.9	980.6	*Sphaerium* sp.
299.3	982	*Sphaerium* sp.
		Lioplacodes sp.
299.5	982.5	*Sphaerium* sp.
325.5	1,068	*Sphaerium* sp.
		Ostracodes
333	1,093	*Chara* sp.
		Gastropod indet.
333.2	1,093.1	*Sphaerium* sp.
333.22	1,093.3	*Sphaerium* sp.
		Gastropod indet.
338.6	1,111	*Sphaerium* sp.
338.7	1,111.2	*Sphaerium* sp.
338.9	1,112	*Melania multorbis*

DOWLING CREEK 78-4

192.6	632	*Sphaerium* sp.
192.7	632.3	*Sphaerium* sp.
193.2	633.8	*Sphaerium* sp.
193.3	634.2	*Sphaerium* sp.
193.5	635	*Sphaerium* sp.
193.7	635.5	*Sphaerium* sp.
193.8	635.8	*Sphaerium* sp.
194.2	637.1	*Sphaerium* sp.
		Ostracodes
194.4	637.8	*Sphaerium* sp.
194.8	639.1	*Corbula* sp.
		Sphaerium sp.
195.25	640.6	*Sphaerium* sp.
195.86	642.6	*Sphaerium* sp.
195.9	642.7	*Sphaerium* sp.
196.3	644	*Sphaerium* ?
237.6	779.4	*Chara* sp.
		Fish bone
243.7	799.4	*Scalez* sp.
260.9	856	*Sphaerium* sp.
		Lioplacodes sp.
263.6	864.8	Bivalve indet.
290.8	954.2	*Sphaerium* sp.
291.27	955.6	*Scalez* sp.
		Sphaerium sp.
291.33	955.7	*Sphaerium* sp.
291.31	955.8	*Scalez* sp.
		Sphaerium sp.
291.4	956	*Sphaerium* sp.
291.5	956.5	*Scalez* sp.
		Sphaerium sp.

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

PEACE RIVER CANYON 76-2

DEPTH METRES	FEET	IDENTIFICATION
134.9	442.5	*Scalez* sp.
158.2-158.5	519-520	*Yoldia* sp.
158.6	520.3	*Eupera onestae*
158.8	521	*Eupera onestae*
159.1	522	Bivalves indet.
160	525	*Murraia* ?
1800.3	591.5	Bivalves indet.

PEACE RIVER CANYON 76-4

363	1,191	*Sphaerium* sp.
363.3	1,192	*Sphaerium* sp.
363.5	1,192.5	*Sphaerium* sp.
363.87	1,193.8	*Sphaerium* sp.
363.93	1,194	*Sphaerium* sp.
365.2	1,198.2	*Sphaerium* sp.
365.25-365.3	1,198.3-1,198.5	*Sphaerium* sp.
		Yoldia sp.
		Lioplacodes sp.
365.8	1,200	*Unio* sp.
366.6	1,202.8	*Sphaerium* sp.
		Lioplacodes sp.
367	1,204	*Unio* sp.
367.3	1,205	*Eupera* cf. *onestae*
367.6	1,206	*Sphaerium* sp.

PEACE RIVER CANYON 76-6

166.8	547.3	*Sphaerium* sp.
166.9	547.5	*Sphaerium* sp.
167.8	550.5	Ostracodes
		Sphaerium sp.
168.27	552.1	*Sphaerium* sp.
168.32	552.25	*Sphaerium* sp.
168.35	552.33	*Sphaerium* sp.
168.48-168.53	552.8-552.9	*Sphaerium* sp.
168.75	553.7	*Sphaerium* sp.
		Lioplacodes sp.
168.8	553.9	*Sphaerium* sp.
169.3	555.5	*Sphaerium* sp.
170.7	560	Gastropod indet.
171.3	562.2	*Sphaerium* sp.

PEACE RIVER CANYON 76-7

122.2	401	*Sphaerium* sp.
139.6	458.1	*Sphaerium* sp.
150.6	494	*Sphaerium* sp.
198.4	651	*Sphaerium* sp.
198.9	652.5	*Sphaerium* sp.
199	652.9	*Sphaerium* sp.
199.1	653.2	*Sphaerium* sp.
199.11	653.3	*Sphaerium* sp.
199.2	653.5	*Sphaerium* sp.
		Ostracodes
199.8	655.6	Ostracodes
199.84	655.7	*Sphaerium* sp.
		Ostracodes

PEACE RIVER CANYON 76-7—Continued

DEPTH METRES	FEET	IDENTIFICATION
200	656.2	*Sphaerium* sp.
200.45	657.7	*Sphaerium* sp.
201.4	660.8	*Sphaerium* sp.
201.5	661	*Sphaerium* sp.
201.55	661.3	*Sphaerium* sp.
201.78	662	*Sphaerium* sp.
		Ostracodes
201.8	662.1	*Sphaerium* sp.
201.83	662.2	*Sphaerium* sp.

PINE PASS 75-2

10.5	34.5	*Entolium irenense*
30.5	100	*Entolium irenense*
33.1	108.5	Bivalve indet.
35.8	117.5	*Yoldia* sp.
52.4	172	Bivalve indet.
53.8	176.5	*Entolium* sp.
269.7	885	*Pleuromya* sp.

PINE PASS 75-4

97.1	318.5	*Scalez* sp.
		Chara sp.
136.2	447	*Sphaerium* sp.
		Charophytes
136.7	448.5	*Sphaerium* sp.
206.9	679	*Sphaerium* sp.
		Ostracodes
237	777.5	*Eupera onestae*

SUKUNKA C-35

10.7	35	*Inoceramus dowlingi*
14	46	*Entolium* sp.
36.3	119	*Sphaerium* sp.
75.3-75.5	247-247.8	*Sphaerium* sp.
		Bivalves indet.
80.8	265	*Entolium irenense*
113.5	372.5	Gastropod indet.
262.96	862.8	*Eupera onestae*
263-263.95	863-866	*Eupera onestae*
265	869.5	*Corbula palliseri*
		Murraia sp.
		Entolium ?
265.3	870.5	Bivalves indet.
265.4-265.57	870.8-871.3	*Murraia* sp.
265.57-265.63	871.3-871.5	*Brachydontes* sp.
335.3	1,100	*Ostrea* ?
338.7	1,111.3	*Entolium* sp.
338.8	1,111.5	*Pecten* sp.
340.8	1,118	Bivalve indet.
342.3	1,123	Bivalves indet.
353.6	1,160	*Pecten* s.l.
354.5	1,163	*Pecten* s.l.
		Corbula ?
355.4	1,166	*Entolium* sp.

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

SUKUNKA C-35—Continued

DEPTH METRES	FEET	IDENTIFICATION
356.3	1,169	*Entolium* sp.
357.5	1,173	*Entolium* sp.
360	1,181	*Entolium irenense*
386.8	1,269	*Entolium irenense*
388	1,273	*Inoceramus dowlingi*
410.7	1,347.5	Bivalves indet.
410.74	1,347.6	Bivalves indet.

SUKUNKA M-2

17.4	57	*Sphaerium* ?
18.3	60	*Entolium* sp.
19.8	65	*Entolium irenense* McLearn
20.4	67	*Entolium irenense* McLearn
21	69	*Entolium* sp.
21.3	70	*Entolium* sp.
23.5	77	*Entolium* sp.
24.7	81	*Entolium irenense*
25.3	83	*Entolium* sp. cf. *E. irenense*
25.4	83.4	*Camptonectes* sp.
26.1	85.5	Bivalve indet. *Pecten* s.l.
26.5	87	*Nucula athabaskensis* *Yoldia kissoumi*
47.2	155	Bivalves indet.

SUKUNKA S-4

73.8	242	*Nucula* ?
74.7	245	*Entolium irenense*
87.2	286	*Nucula athabaskensis*
88.2	289.5	Bivalves indet.
88.8	291.5	Bivalves indet.
91.1	299	*Protocardia* ?
92	302	*Sphaerium* sp.
116	381	*Entolium* sp.
116.2	381.3	*Entolium irenense*
120.7	396	*Yoldia kissoumi* *Entolium irenense*
121	397	*Yoldia* sp.
121.3	398	*Sphaerium* sp.
121.4	398.3	*Sphaerium* sp.
132	433	*Onestia* sp.
137	449.5	*Astarte natosini*

SUKUNKA T-20

186.8	613	*Cladophlebis* sp. *Ginkgo* sp. *Pinus* cf. *nordenkjoldi*
201.9	662.5	Gastropods indet.

SUKUNKA T-20—Continued

DEPTH METRES	FEET	IDENTIFICATION
202.02	662.8	*Astarte* ? Gastropods (*Lioplacodes* ?)
202.08	663	*Astarte* sp. *Psilomya* ? (*Solyma* ?)
202.1	663.3	*Protocardia* ?
202.2	663.5	*Astarte* ? *Lioplacodes* ?
202.4	664	*Astarte* sp.
202.5	664.5	*Astarte* ? *Unio* ? cf. *Elliptio douglassi*
207.42	680.5	*Astarte natosini*
207.45	680.6	*Astarte* sp.
207.5	680.8	*Astarte* ?
207.6	681	*Astarte* ?
208	682.5	*Corbula palliseri* ?
210	689	*Sphaerium* sp. *Eupera onestae* ?
210.4	690.25	*Onestia onestae* ?
210.41	690.33	*Eupera onestae* McLearn ?
211.15	692.8	Bivalves indet.
211.2	693	*Corbula* ?
211.8	695	*Melania multorbis* *Sphaerium* sp.
211.99	695.5	*Melania multorbis*
212	696	*Melania multorbis*
212.16	696.1	*Eupera onestae*
212.18-212.4	696.2-697	*Astarte* ? *Brachydontes athabaskense*
212.6	697.7	*Elliptio* ?
212.75	698	*Brachydontes athabaskense*
413.9	1,358	*Astarte natosini* McLearn *Unio* ?
414.2	1,359	*Inoceramus dowlingi*
438	1,437	*Sphaerium* ?
612.2	2,008.5	*Scalez* sp.
617.5-617.7	2,026-2,026.5	*Eupera onestae*

SUKUNKA BP-2

457.65	1,501.5	Bivalves indet.
463.6	1,521	*Tancredia* sp.
464.3	1,523.3	Gastropod indet. Ostracodes
464.9	1,525.3	Bivalves indet.
467.21	1,532.8	*Pecten* sp.
476.1-476.2	1,562-1,562.5	*Entolium* sp.
476.55	1,563.5	*Entolium irenense*

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS (ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

SUKUNKA BP-2—Continued

DEPTH METRES	FEET	IDENTIFICATION
481.6	1,580.2	*Entolium irenense*
482.4	1,582.8	*Yoldia kissoumi*
483	1,585	*Entolium* sp.

SUKUNKA BP-42

355.4	1,166	*Sphaerium* sp.
355.9	1,167.7	*Sphaerium* sp.

SUKUNKA BP-47

129.5	424.8	*Sphaerium* sp.
138.6	454.8	*Ditrupa* sp.
139.8	458.7	*Inoceramus dowlingi*
140	459.3	*Sphaerium* sp.
144	472.4	*Entolium irenense*
200.3	657.2	Bivalves indet.

SUKUNKA BP-53

62.9	206.3	*Entolium irenense*
114.7	376.25	Bivalve indet.
114.9	376.3	*Eupera onestae*
149	488.9	*Entolium irenense*
154.1	505.5	*Murraia* ?
154.2	505.9	*Protocardia* sp.
164.5	539.7	*Entolium irenense*
167.5	549.6	Bivalve indet.
168.2	551.9	Bivalve indet.
173	567.5	*Scalez* ?
177.4	581.8	*Entolium irenense*
177.69	583	Bivalve indet.
177.72	583.1	*Entolium irenense*
204.5	670.8	*Entolium irenense*
204.6	671.1	*Entolium irenense*
207.6	681.1	*Entolium irenense*
209.2	686.3	*Sphaerium* sp.
2288.2	748.8	*Sphaerium* sp.

SUKUNKA BP S19

70	229.7	Bivalve indet.
102.6	336.6	*Entolium irenense*

MOUNT SPIEKER 1

26.4-26.5	86.5-87	*Unio douglassi*
		Psilomya sp.
27-27.2	89-89.3	*Elliptio douglassi*
27.3	89.5	*Sphaerium* sp.
30.3	99.5	Ostracodes
31.9	104.7	*Sphaerium* sp.
32	105	*Sphaerium* sp.
32.1	105.3	*Sphaerium* sp.
		Lioplacodes sp.
		Ostracodes

MOUNT SPIEKER 1—Continued

DEPTH METRES	FEET	IDENTIFICATION
32.15	105.5	*Sphaerium* sp.
		Elatides
36.3	119.1	*Psilomya* ?
36.4	119.5	*Brachydontes* sp.
36.5	119.8	*Unio lacombei*
36.8	120.8	*Psilomya* ?
36.9	121.2	*Sphaerium* sp.
37.2	122	*Unio lacombei*
37.3	122.5	*Corbula* ?
37.4	122.7	*Psilomya* sp.
		Sphaerium sp.
		Unio sp.
37.46	122.9	*Unio lacombei*
37.6	123.5	*Unio lacombei*
37.8	124	*Corbula onestae*
37.9	124.5	*Psiloyma* sp.
		Sphaerium sp.
		Unio sp.
98.45	323	Gastropod indet.
478.4	1,569.5	*Psilomya* ?
486.3	1,595.5	*Psilomya* ?

QUINTETTE QWD 74-01

114.3	375	*Pecten* ?
		Aucellina ?
114.9	377	*Unio* cf. *lacombei*
115	377.4	Bivalves indet.
115.7	379.5	*Pecten* s.l.
115.8	380	*Unio* ?
116	381	*Murraia* sp.

QUINTETTE QWD 74-02

82.9	272	*Psilomya peterpondi* McLearn
83.2	273	*Psilomya* sp.

QUINTETTE QWD-7403

71.6	235	*Pleuromya* sp.
		Sphaerium sp.

QUINTETTE QMD 76-06

32.3	106	*Pleuromya* sp.
32.5	106.5	*Pleuromya* sp.

QUINTETTE QMD 76-08

57.5	188.8	*Pleuromya* sp.
57.65	189.2	*Unio* ?
58.2	191	*Pleuromya* sp.

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS (ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

QUINTETTE QBD 72-02

DEPTH METRES	FEET	IDENTIFICATION
89.6	294	Fish scales
113.8	373.3	Fish scales
114.7	376.3	*Scalez* sp.
115.8	380	Fish scales
117.95	387	Fish scales
122.2	401	Fish scales
123.4	405	*Scalez* sp.

QUINTETTE QBD 72-19

174.95	574	*Pterophyllum* sp.
284.5	933.5	*Scalez* sp.

QUINTETTE QBD 73-03

183.5	602	Fish scales
184.1	604	Fish scales
184.2	604.3	*Sphaerium* sp.
184.23	604.4	Fish bone
184.25	604.5	Fish scales
196.3	644	Fish scales
357.7	1,173.5	*Sphaerium* sp.
357.8	1,174	*Sphaerium* sp.
360.3	1,182	*Sphaerium* sp.

QUINTETTE QBD 76-17

34.7	114	*Chara*
67.1	220	Indet.

QUINTETTE QBD 77-21

276.1	906(a)	*Sphaerium*
276.1	906(b)	*Sphaerium*
276.2	906.2	Pelecypod indet.
276.9	908.5	*Rubeyella* sp. *Sphaerium*
276.93	908.58	*Eupera* ?
276.94	908.6	Unionid indet.
278.1	912.3	*Lioplacodes stachei* (white)
278.4	913.5	*Sphaerium* *Reesidella* ?
278.6	913.9	Seed Pelecypods indet.
288.3	946	*Sphaerium* transitional to *Musculium*

QUINTETTE QBD 77-54

31.4	103	Fish scale
37.8	124	Fish scale
41.75	137	Fish scale
51.5	169	Fish scale
57	187.2	Fish bone

QUINTETTE QBD 77-54—Continued

DEPTH METRES	FEET	IDENTIFICATION
59.8	196.2	Fish bone
72.7	238.5	Fish scale ?
77.6	254.5	Fish bone

MONKMAN BWD 76-4

58.5	192	Gastropods indet.
114	472.5	*Sphaerium* sp.
146	479	*Entolium* sp.
149.5	490.4	*Podozamites* ?
167.2	548.5	*Pecten* s.l.
168.4	552.5	*Entolium* sp.
171.3	562	*Sphaerium* sp.
176.2	578	*Sphaerium* ?

MONKMAN BWD 76-5

2.4	8	*Scalez* sp.
10	33	*Scalez* sp..
64.4	211.3	Gastropod indet.

MONKMAN MDD 77-2B

15.17	49.8	*Pteria* sp.
15.19	49.9	*Thracia* sp. *Pteria* sp.
21.7	71.2	*Chara* sp.

MONKMAN MUD 77-4

14.7	48.35	Bivalve indet.
14.76	48.45	Bivalve indet. Gastropod indet.
14.77	48.48	*Lioplacodes* ?
110.3	362	*Sphaerium* ?
110.5	362.6	*Entolium irenense*
111.5	366	Bivalve indet.
112.5	369.1	*Entolium irenense*
112.6	369.3	*Entolium irenense*
117.5	385.6	*Entolium irenense*
118.3	388.3	*Yoldia* sp.

BELCOURT 78-02

108.5	356	Plant fragment
129.5	425	Indet.
159.1	522	Ginkgo seed
160	525	*Gastropod* sp. indet.
483.1	1,585	*Sphaerium* sp.

BELCOURT 78-11

85.6	281	*Podozamites lanceolatus* *Scalez*

APPENDIX I—Continued

FOSSIL IDENTIFICATIONS
(ALL BY C. R. STELCK, UNIVERSITY OF ALBERTA)

SAXON 76-02

DEPTH METRES	FEET	IDENTIFICATION
63.5	208.5	Ctenoid scales
64.8	212.5	Fish bones and scales
180.1	590.8	*Scalez* sp.
180.4	591.8	*Murraia* sp.
		Unio sp.
191.9	629.5	*Murraia* sp.
		Thracia kissoumi
202.4	664	*Astarte* sp.
		Tancredia
202.48-202.5	664.3-664.5	*Astarte* sp.
		Aucellina sp.
		Thracia sp.
202.9-203	665.8-666	*Solecurtus* ? sp.
203.4-203.6	667.3-668	*Melania* cf. *multorbis*
Unio lacombei		
204.1-204.2	669.5-670	*Inoceramus* sp.
		Melania multorbis
		Bivalves indet.
		Lioplacodes bituminis
204.53	671.1	*Unio* sp. indet.

SAXON 76-17

61.3	201	*Astarte* sp.
		Pleuromya sp.

SAXON 77-06

19.2	63	Fish scale
19.35	63.5	Fish scale
21.6	71	Fish scale (*Holocolepis*)
21.7	71.2	Fish scale
21.9	72	Fish scale
22	72.1	Fish scale
23.3	76.5	Fish scale
23.5	77	Fish scale
24.38	80	Fish scale
24.44	80.2	Fish scale
25	82	Fish scale
29.4	96.5	Fish scale
46.2	151.5	Fish scale
130.65	428.7	Gastropod
142.2	466.5	*Scalez* sp.
170.4	559	*Elliptio* sp.
		Scalez sp.
		Sphaerium sp.
170.45	559.3	*Thracia* sp.
		Yoldia sp.
170.5	559.4	*Sphaerium* sp.
170.56	559.6	*Sphaerium* sp.
170.58	559.7	*Operculum* sp.
170.63	559.8	*Sphaerium* sp.
		Gastropod

SAXON 77-06—Continued

DEPTH METRES	FEET	IDENTIFICATION
170.7	560	*Elliptio* sp.
171	561	*Sphaerium* sp.
217.9	715	*Astarte* sp.
218.16	715.75	*Lioplacodes* sp.
218.18	715.84	*Thracia* sp.
218.2	716	*Elliptio* sp.
		Thracia sp.
219.76	721	*Ostrea* ?
219.8	721.2	*Pleuromya* sp.
		Thracia sp.
221.3	726	*Thracia* sp.
221.6	727	*Thracia* sp.
222.2	729	*Thracia* sp.
227	745	*Thracia kissoumi*
227.1	745.2	*Thracia* sp.
		Melania sp.
228	748	*Melania* sp.
230.8	757.2	*Astarte natosini*
		Anchura sp.
		Lioplacodes sp.
231.28	758.8	*Thracia* sp.
		Unio ?
		Gastropod
231.3	759	*Corbicula* sp.
		Gastropod (indet.)
231.4	759.2	*Astarte* sp.
		Melania sp.
		Pecten sp.
231.43	759.3	Gastropods
232.5	762.8	*Corbicula* sp.
		Melania sp.
		Pleuromya sp.
234.5	769.3	*Thracia* sp.

SAXON 77-25

43.6	143	Bark fragment
178.2	584.6	*Camptonectes* sp.
190.8	626	*Cleoniceras* (Grycia) sp.
194.8	639	Mollusc (indet.)
223.7	734	Ginkgo

SAXON 77-26

48.8	160	Indet.
64.6	212	Roootlets
72.4	237.5	Concretions
210.3	690	Ginkgo seeds
352.5	1,156.5	*Athrotaxites* sp.
		Elatides sp.
		Nilssonia sp.

APPENDIX II

Clay Bands (Tonsteins and K-bentonites)

Property	Hole No.	Depth		Identification	Remarks
		Feet	Metres		
Carbon Creek	76-85	242.0′	73.76	tonstein	
East Mt. Gething	75-5	160.3′	48.8	tonstein	
		161.3′	49.1	tonstein	
	77-8	173′	52.7	normal detrital sediment	illite + mixed layer + kaolinite
Dowling Creek	78-2	426.8′	130.1	K-bentonite	
		540.0′	164.6	K-bentonite	
		542.5′	165.3	K-bentonite	
		874.5′	266.5	tonstein	
		881.0′	268.5	tonstein	
		1038.4′	316.5	tonstein	
	78-4	518.4′	158	tonstein	
		617.2′	188.1	tonstein	minor mixed-layer clay
Peace River Canyon	76-4	175′	53.3	tonstein	
		614′	187.1	K-bentonite	minor kaolinite
		626.5′	190.95	K-bentonite	minor kaolinite
		697′	212.4	K-bentonite	
		770′	234.7	K-bentonite	
		805′	245.4	siderite	
		1072′	326.7	tonstein	
	76-6	429′	130.75	tonstein	
		571′	174	tonstein	
	76-7	119′	36.3	K-bentonite	
		132.9′	40.5	K-bentonite	
		138′	42	K-bentonite	minor kaolinite
		167.3′	51	K-bentonite	
		187.2′	57	K-bentonite	
		539.5′	164.4	tonstein	
		570′	173.7	tonstein	minor quartz
Pine Pass	75-4	60.6′	18.5	tonstein	2.5′ band in coal*
		153.3′	46.7	tonstein	0.76 m (or 76.2 cm)
Burnt River	30	45.9′	14.0	normal detrital sediment	
	32	78.4′	23.9	tonstein	dominant kaolinite—trace of quartz
		387.2′	118.0	tonstein	dominant kaolinite—trace of K-mica
Sukunka	T-20	540.0′	164.6	K-bentonite	12″ band (30.5 cm)
		547.0′	166.7	tonstein	4″ band (10.2 cm)
	C-35	586′	178.6	K-bentonite	
		689′	210	K-bentonite	mica-montmorillonite + kaolinite
		704′	214.6	K-bentonite	
		736′	224.3	tonstein	
		741′	225.8	normal clay	
		748.3′	228.1	tonstein	
		749.5′	228.4	K-bentonite	mica-montmorillonite + kaolinite
		749.8′	228.5	tonstein	
		750′	228.6	K-bentonite	mica-montmorillonite
	63	63.7′	19.4	*tonstein	kaolinite + mixed layer
		113.5′	34.6	*tonstein?	kaolinite + quartz + minor mixed layer
		137.8′	42.0	altered tuff	siderite + mixed layer
		139.9′	42.65	*K-bentonite	mixed layer
		164.3′	50.1	*tuffaceous sediment?	quartz + kaolinite + mixed layer
	77-2	1219.2′	371.6	*tuffaceous sediment	quartz + kaolinite + mixed layer
	77-9	1564.3′	476.78	*tonstein	
		1564.4′	476.83	*tonstein	
		1568.3′	478	*tonstein	minor mica-montmorillonite

APPENDIX II—Continued

Clay Bands (Tonsteins and K-bentonites)

Property	Hole No.	Depth		Identification	Remarks
		Feet	Metres		
Mount Speiker	MS-1	1348′	410.9	tonstein	
		1385′	422.1	tonstein	kaolinite + mixed layer
		1415.3′	431.4	tonstein	
		1428.1′	435.3	tonstein	
		1430.6′	436	tonstein	4″ band (10.2 cm)
		1432.1′	436.5	tonstein	
	MS-3	280′	85.3	tonstein	
		296′	90.2	tonstein	
		317′	96.6	tonstein	
		317.5′	96.8	tonstein	
	MS-4	197′	60	tonstein	3″ band (7.6 cm)
		208′	63.4	tonstein	
		221.5′	67.5	tonstein	
Quintette	QWD-7403	476′	145.1	sediment?	
	QBD 72-02	304′	92.65	tonstein	
	QBD 73-03	663′	202.1	tonstein?	
		683′	208.2	calcite	
		822.0′	250.5	clay	
		822.8′	250.8	tonstein?	
	QBD 77-21	318′	96.9	tonstein	kaolinite
		364.8′	111.2	tonstein	
		386.0′	117.65	tonstein	
	QBD 77-54	70.5′	21.5	tonstein	kaolinite
		111.0′	33.8	K-bentonite	clay in sandstone
		139.8′	42.6	tonstein	3″ band—kaolinite + mixed layer (7.6 cm)
		196.0′	59.7	tonstein?	kaolinite + quartz
		272.0′	82.9	tonstein	
		439.0′	133.8	tonstein	
		439.3′	133.9	tonstein?	kaolinite, mixed layer, illite, part detrital, part volcanic
Monkman	BWD 76-4	428.8′	130.7	tonstein	kaolinite + mixed layer
	BWD 76-5	1000′	304.8	normal sediment	
		1000.7′	305.3	K-bentonite	mixed layer + kaolinite
		1002.7′	305.6	K-bentonite	
		1003.8′	305.94	K-bentonite	
		1005.9′	306.6	K-bentonite	
	MQD 76-10	757′	230.73	sediment?	
		868.5′	264.72	sediment?	
		961.5′	293.07	sediment?	
		973′	296.57	tonstein	
	MUD 77-4	278.9′	85.0	tonstein?	kaolinite + quartz
Belcourt	78-02	493′	150.27	quartz	
		662′	201.78	quartz + some mixed layer	
	78-11	182′	55.47	*tonstein	kaolinite + mixed layer
		184′	56.08	*tonstein	kaolinite + mixed layer
Saxon	76-2	1122′	342.0	sediment	
	77-06	476′	145.08	clay	
	77-25	639.4′	194.90	*	quartz + dolomite + illite
	77-26	404′	123.14	*	quartz + siderite

Analyses by Alan D. Spears, Dept. of Geology, University of Sheffield, unless noted by an asterisk, these analyses are by John Kwong, B.C.M.E.M.P.R. Laboratory.

APPENDIX III

Property Name	Owner and/or Operator	Drill Holes Used In This Study
Carbon Creek	Utah Mines Ltd	DDH4 (1971)*, 75-59*, 75-62*, 75-68*, 76-85*
East Mount Gething	Utah Mines Ltd.	75-5, 75-6, 77-8†, 77-10
Dowling Creek	Utah Mines Ltd., Bri Coal Mining Limited, Rainier Energy Resources Inc.	78-2, 78-4
Peace River Canyon	Cinnabar Peak Mines Ltd.	76-2, 76-4, 76-6, 76-7
Pine Pass	Norcen Energy Resources Limited, Pan Ocean Ltd.	H-1 (1974), 75-2, 75-4, 75-5†, 75-8†, 75-10†, 79-03†
Burnt River	Teck Corporation	BR-3*
Sukunka	BP Exploration Canada Limited, Brameda Resources Limited/Teck Corporation, Coalition Mining Limited	C-35, M-2, S-4**, T-20**, BP-2 (1977)*, BP-6 (1977), BP-42 (1978)*, BP-41 (1978), BP-53 (1978), BP-63 (1978)**, BP S19 (1978)*
Mount Spieker (East Bullmoose)	Ranger Oil Limited, Brameda Resources Limited/ Teck Corporation, Nichimen Resources	MS-1 (EB-1), MS-3 (EB-3), MS-4 (EB-4), MS-27
Quintette	Denison Coal Limited, Quintette Coal Limited	
Wolverine Area		QWD-77-15, QWD 74-01, QWD 74-02, QWD-74-03
Murray Area		QMD 76-06, QMD 76-08*
Babcock Area		QDH-1, QBD 71-02, QBD 72-02, QBD 72-19, QBD 73-03, QBD 76-17*, QBD 77-21*, QBD 77-54*
Monkman (Monkman-Belcourt) (Belcourt-Monkman)	Petro-Canada Exploration Inc., Pacific Petroleum Limited, Canadian Superior Oil Ltd., McIntyre Mines Limited	BWD 76-4, BWD 76-5, MOD 76-8†, MQD 76-10†, MDD 77-2B, MUD 77-4
Belcourt	Denison Coal Limited, Gulf Canada Resources Inc., Belcourt Coal Limited	78-02, 78-04†
Saxon	Denison Coal Limited, Saxon Coal Limited	76-2*, 77-06, 77-25, 77-26

* Core examined — does not appear on sections.
** Core examined — appears on index section only.
† Core not examined — appears on sections.

D-91

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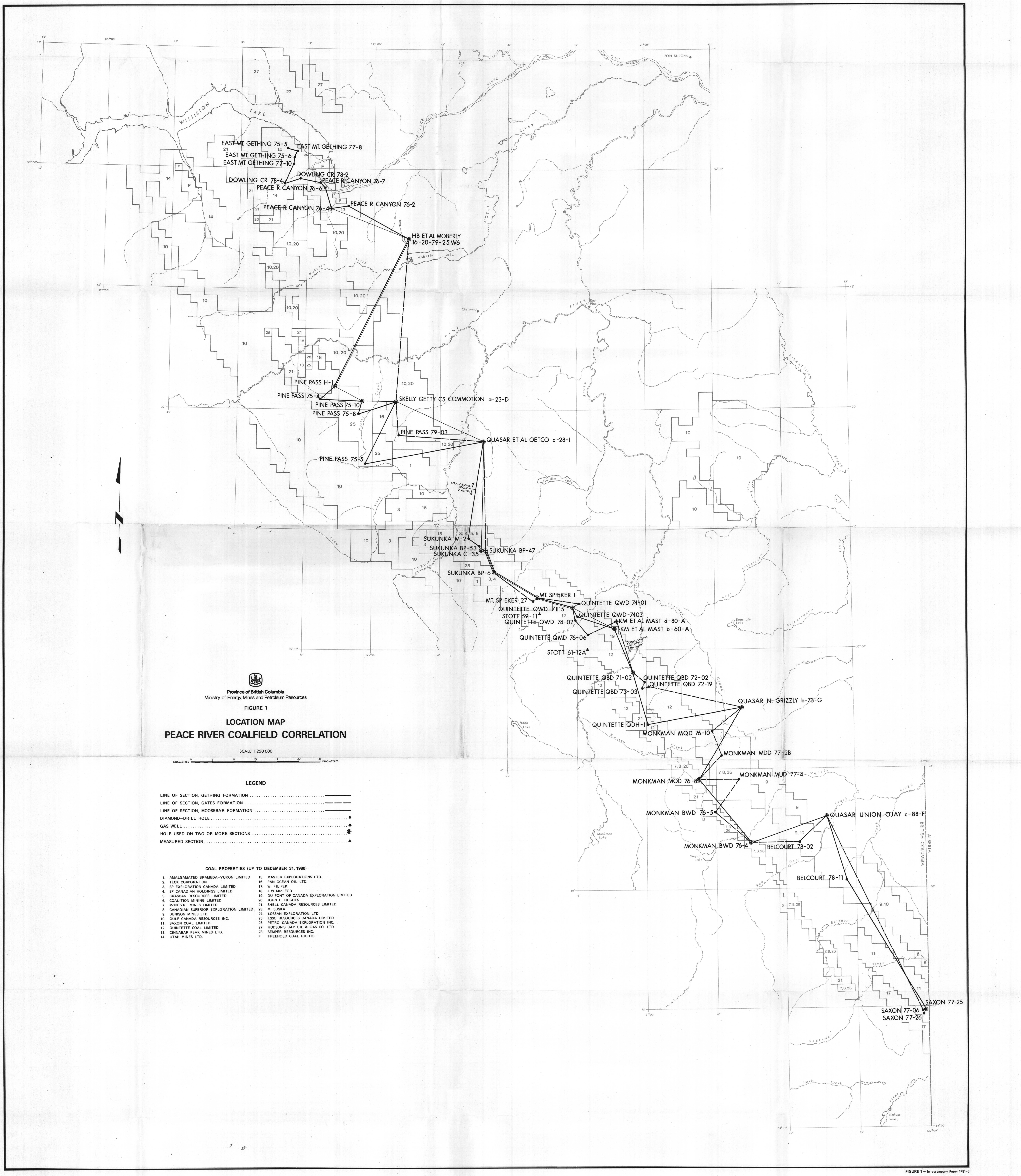


FIGURE 1 – To accompany Paper 1981-3

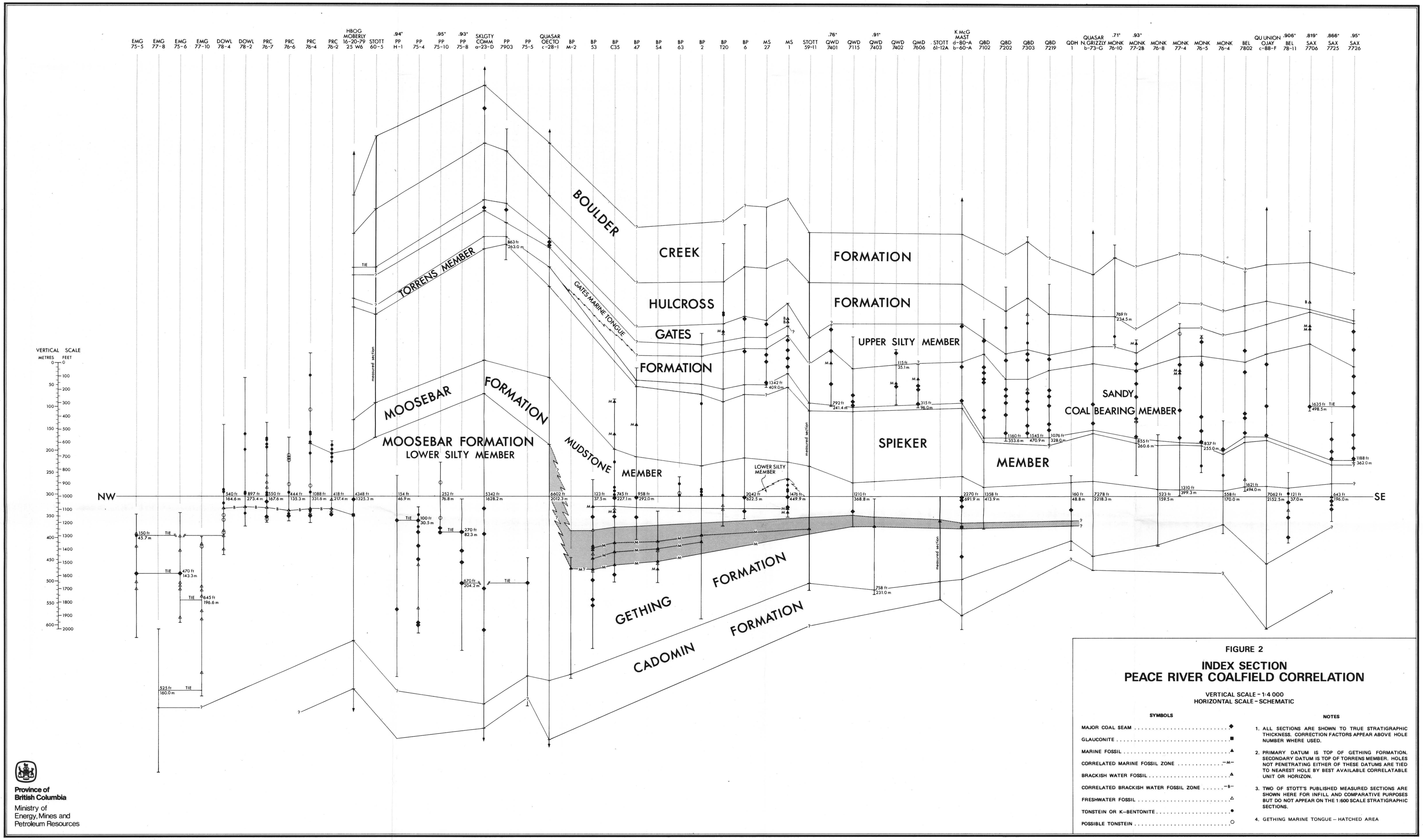


FIGURE 2

INDEX SECTION PEACE RIVER COALFIELD CORRELATION

VERTICAL SCALE - 1:4 000
HORIZONTAL SCALE - SCHEMATIC

SYMBOLS

MAJOR COAL SEAM .... ◆
GLAUCONITE .... ■
MARINE FOSSIL .... ▲
CORRELATED MARINE FOSSIL ZONE .... —M—
BRACKISH WATER FOSSIL .... ▲
CORRELATED BRACKISH WATER FOSSIL ZONE .... —B—
FRESHWATER FOSSIL .... △
TONSTEIN OR K—BENTONITE .... ●
POSSIBLE TONSTEIN .... ○

NOTES

1. ALL SECTIONS ARE SHOWN TO TRUE STRATIGRAPHIC THICKNESS. CORRECTION FACTORS APPEAR ABOVE HOLE NUMBER WHERE USED.
2. PRIMARY DATUM IS TOP OF GETHING FORMATION. SECONDARY DATUM IS TOP OF TORRENS MEMBER. HOLES NOT PENETRATING EITHER OF THESE DATUMS ARE TIED TO NEAREST HOLE BY BEST AVAILABLE CORRELATABLE UNIT OR HORIZON.
3. TWO OF STOTT'S PUBLISHED MEASURED SECTIONS ARE SHOWN HERE FOR INFILL AND COMPARATIVE PURPOSES BUT DO NOT APPEAR ON THE 1:600 SCALE STRATIGRAPHIC SECTIONS.
4. GETHING MARINE TONGUE – HATCHED AREA

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

To accompany Paper 1981-3

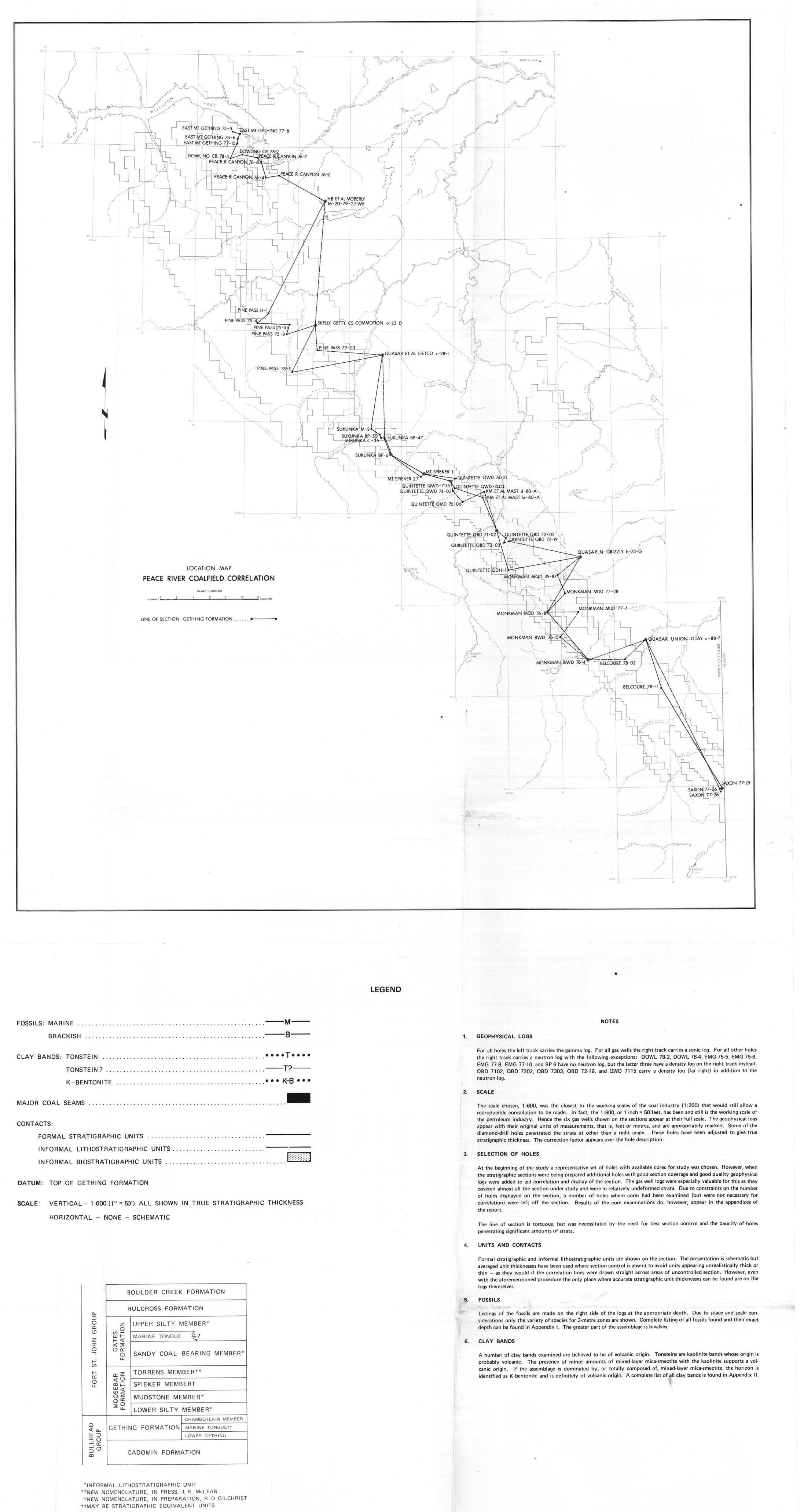


FIGURE 3

STRATIGRAPHIC SECTION

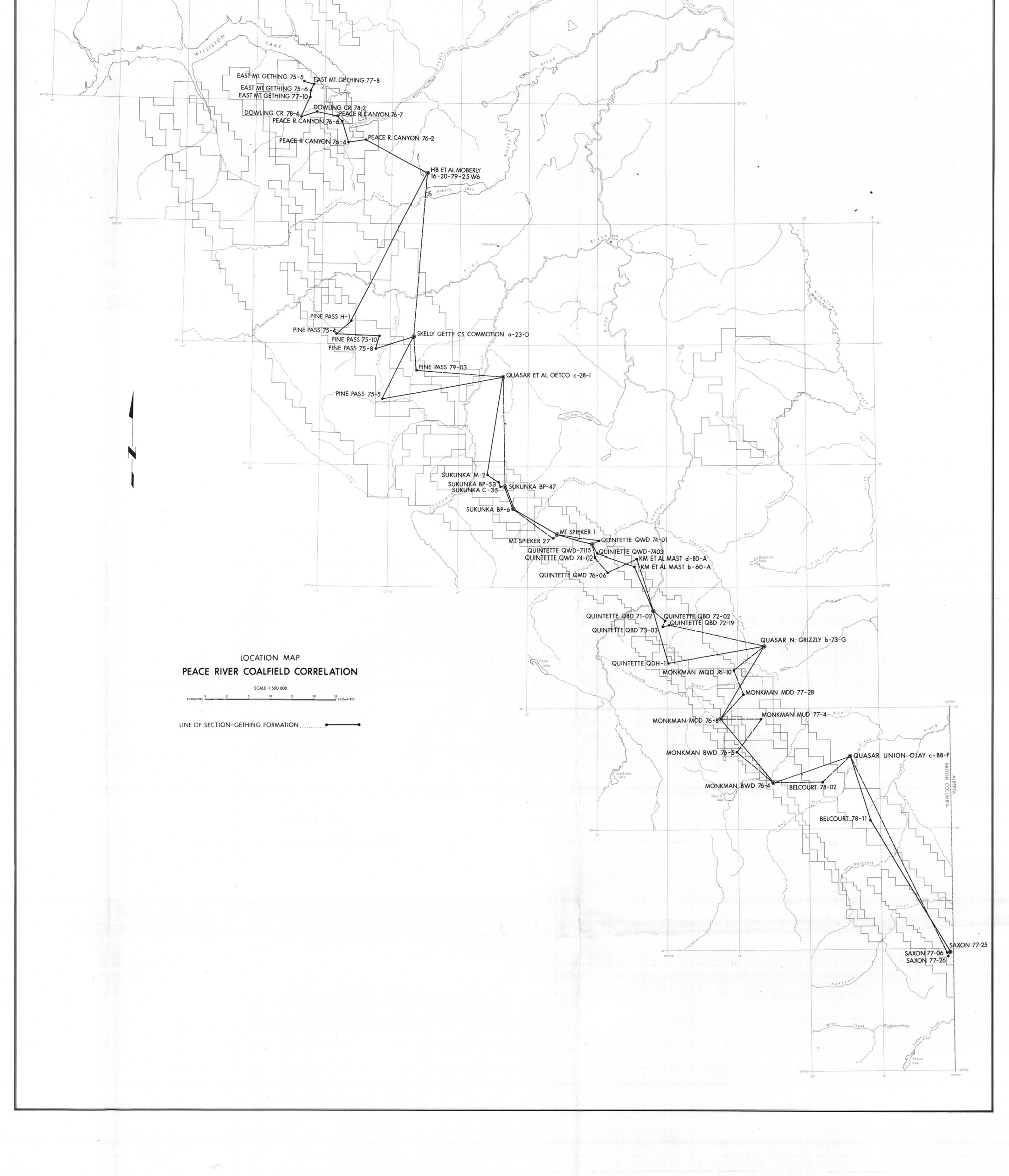
GETHING FORMATION-NORTH

INCLUDES CADOMIN AND MOOSEBAR FORMATIONS

COMPILED BY
P. McL. D. DUFF AND R. D. GILCHRIST, 1981

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

To accompany Paper 1981-3



LEGEND

FOSSILS: MARINE .... —M—

BRACKISH .... —B—

CLAY BANDS: TONSTEIN .... ••••T••••

TONSTEIN ? .... —T?—

K–BENTONITE .... ••• K-B •••

MAJOR COAL SEAMS ....

CONTACTS:

FORMAL STRATIGRAPHIC UNITS ....

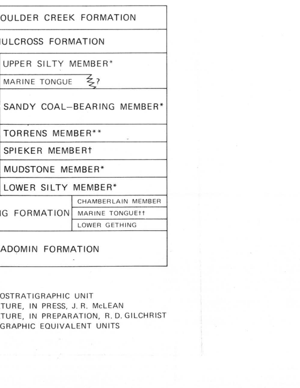
INFORMAL LITHOSTRATIGRAPHIC UNITS ....

INFORMAL BIOSTRATIGRAPHIC UNITS ....

DATUM: TOP OF GETHING FORMATION

SCALE: VERTICAL – 1:600 (1″ = 50′) ALL SHOWN IN TRUE STRATIGRAPHIC THICKNESS

HORIZONTAL – NONE – SCHEMATIC



*INFORMAL LITHOSTRATIGRAPHIC UNIT
**NEW NOMENCLATURE, IN PRESS, J. R. McLEAN
†NEW NOMENCLATURE, IN PREPARATION, R. D. GILCHRIST
††MAY BE STRATIGRAPHIC EQUIVALENT UNITS

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The line of section is tortuous, but was necessitated by the need for best section control and the paucity of holes penetrating significant amounts of strata.

4. **UNITS AND CONTACTS**

Formal stratigraphic and informal lithostratigraphic units are shown on the section. The presentation is schematic but averaged unit thicknesses have been used where section control is absent to avoid units appearing unrealistically thick or thin — as they would if the correlation lines were drawn straight across areas of uncontrolled section. However, even with the aforementioned procedure the only place where accurate stratigraphic unit thicknesses can be found are on the logs themselves.

5. **FOSSILS**

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6. **CLAY BANDS**

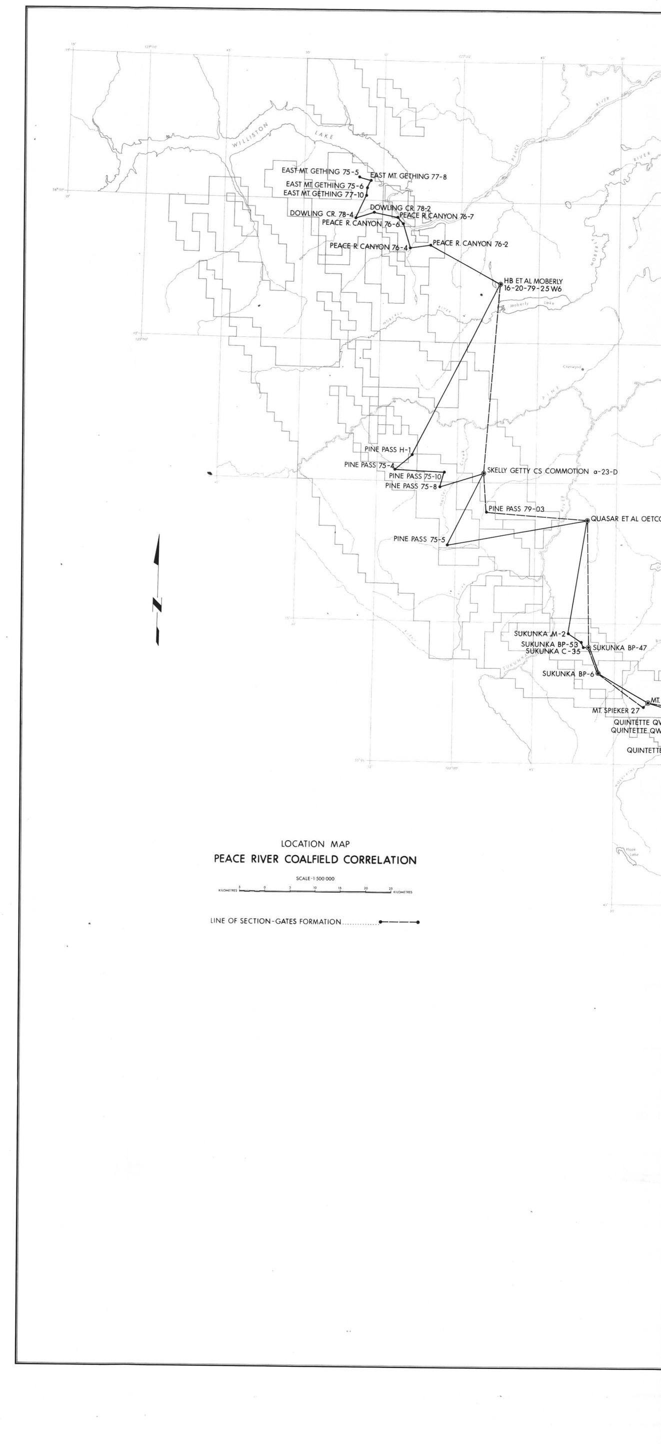
A number of clay bands examined are believed to be of volcanic origin. Tonsteins are kaolinite bands whose origin is probably volcanic. The presence of minor amounts of mixed-layer mica-smectite with the kaolinite supports a volcanic origin. If the assemblage is dominated by, or totally composed of, mixed-layer mica-smectite, the horizon is identified as K-bentonite and is definitely of volcanic origin. A complete list of all clay bands is found in Appendix II.

FIGURE 4

STRATIGRAPHIC SECTION
GETHING FORMATION-SOUTH
INCLUDES CADOMIN, MOOSEBAR, AND GATES FORMATIONS

COMPILED BY
P. McL. D. DUFF AND R. D. GILCHRIST, 1981

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources
To accompany Paper 1981-3



LEGEND

FOSSILS: MARINE
BRACKISH

CLAY BANDS: TONSTEIN
TONSTEIN ?
K-BENTONITE

MAJOR COAL SEAMS

CONTACTS:
FORMAL STRATIGRAPHIC UNITS
INFORMAL LITHOSTRATIGRAPHIC UNITS
INFORMAL BIOSTRATIGRAPHIC UNITS

DATUM: TOP OF TORRENS MEMBER

SCALE: VERTICAL – 1:600 (1" = 50') ALL SHOWN IN TRUE STRATIGRAPHIC THICKNESS
HORIZONTAL – NONE – SCHEMATIC

BOULDER CREEK FORMATION
HULCROSS FORMATION
UPPER SILTY MEMBER*
MARINE TONGUE
SANDY COAL-BEARING MEMBER*
TORRENS MEMBER**
SPIEKER MEMBER
BRIDGE MEMBER
LOWER SILTY MEMBER*
GETHING FORMATION
CADOMIN FORMATION

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FIGURE 5

STRATIGRAPHIC SECTION
GATES FORMATION-NORTH

INCLUDES MOOSEBAR, HULCROSS, AND BOULDER CREEK FORMATIONS

COMPILED BY
P. McL. D. DUFF AND R. D. GILCHRIST, 1981

Province of British Columbia
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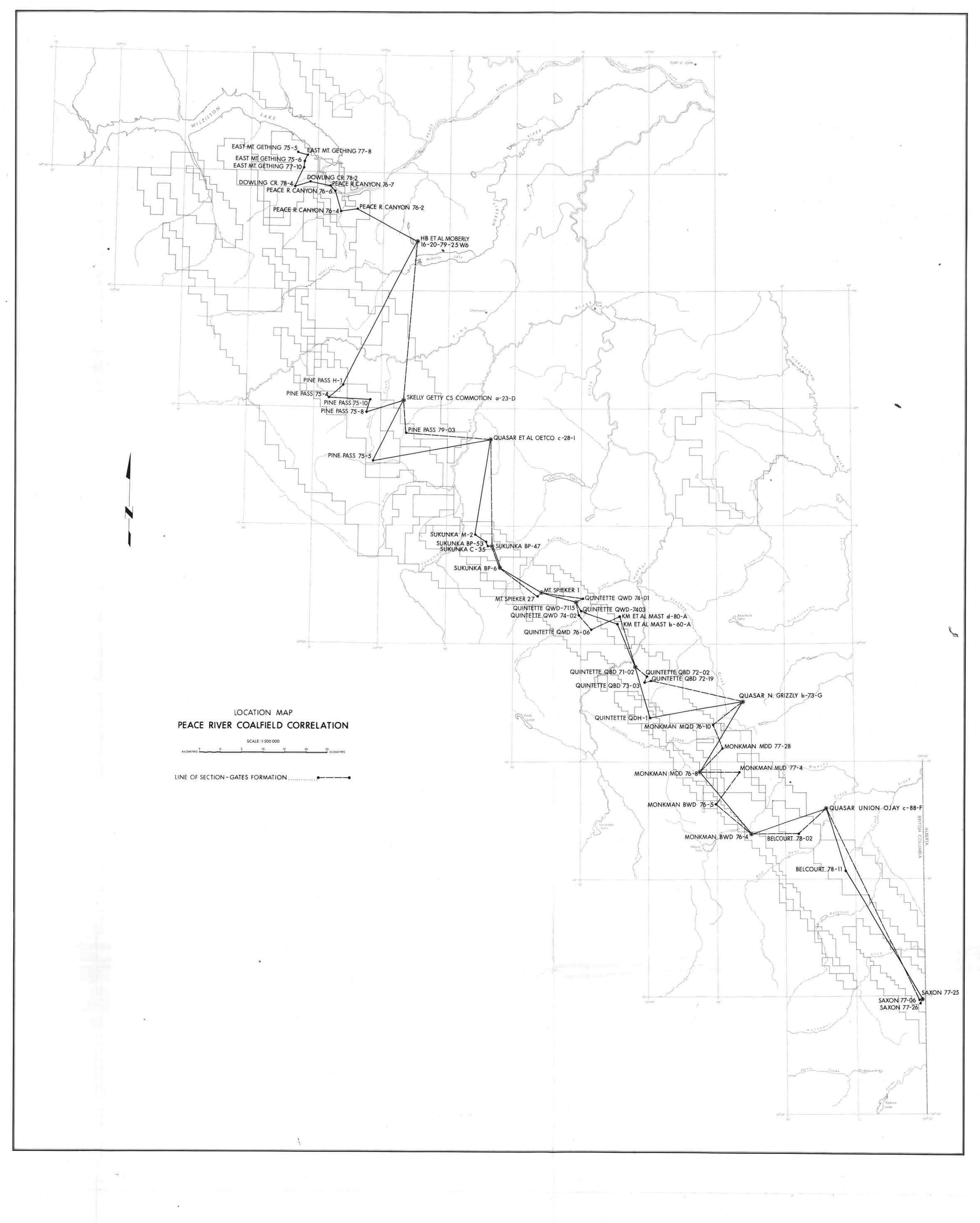
To accompany Paper 1981-3



LEGEND

FOSSILS: MARINE .... —M—

BRACKISH .... —B—

CLAY BANDS: TONSTEIN .... ••••T••••

TONSTEIN ? .... —T?—

K–BENTONITE .... ••• K-B •••

MAJOR COAL SEAMS ....

CONTACTS:

FORMAL STRATIGRAPHIC UNITS ....

INFORMAL LITHOSTRATIGRAPHIC UNITS ....

INFORMAL BIOSTRATIGRAPHIC UNITS ....

DATUM: TOP OF TORRENS MEMBER

SCALE: VERTICAL – 1:600 (1″ = 50′) ALL SHOWN IN TRUE STRATIGRAPHIC THICKNESS

HORIZONTAL – NONE – SCHEMATIC

Group	Formation	Member
FORT ST. JOHN GROUP	BOULDER CREEK FORMATION	
	HULCROSS FORMATION	
	GATES FORMATION	UPPER SILTY MEMBER*
		MARINE TONGUE ?
		SANDY COAL–BEARING MEMBER*
	MOOSEBAR FORMATION	TORRENS MEMBER**
		SPIEKER MEMBER†
		MUDSTONE MEMBER*
		LOWER SILTY MEMBER*
BULLHEAD GROUP	GETHING FORMATION	CHAMBERLAIN MEMBER
		MARINE TONGUE††
		LOWER GETHING
	CADOMIN FORMATION	

*INFORMAL LITHOSTRATIGRAPHIC UNIT
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FIGURE 6

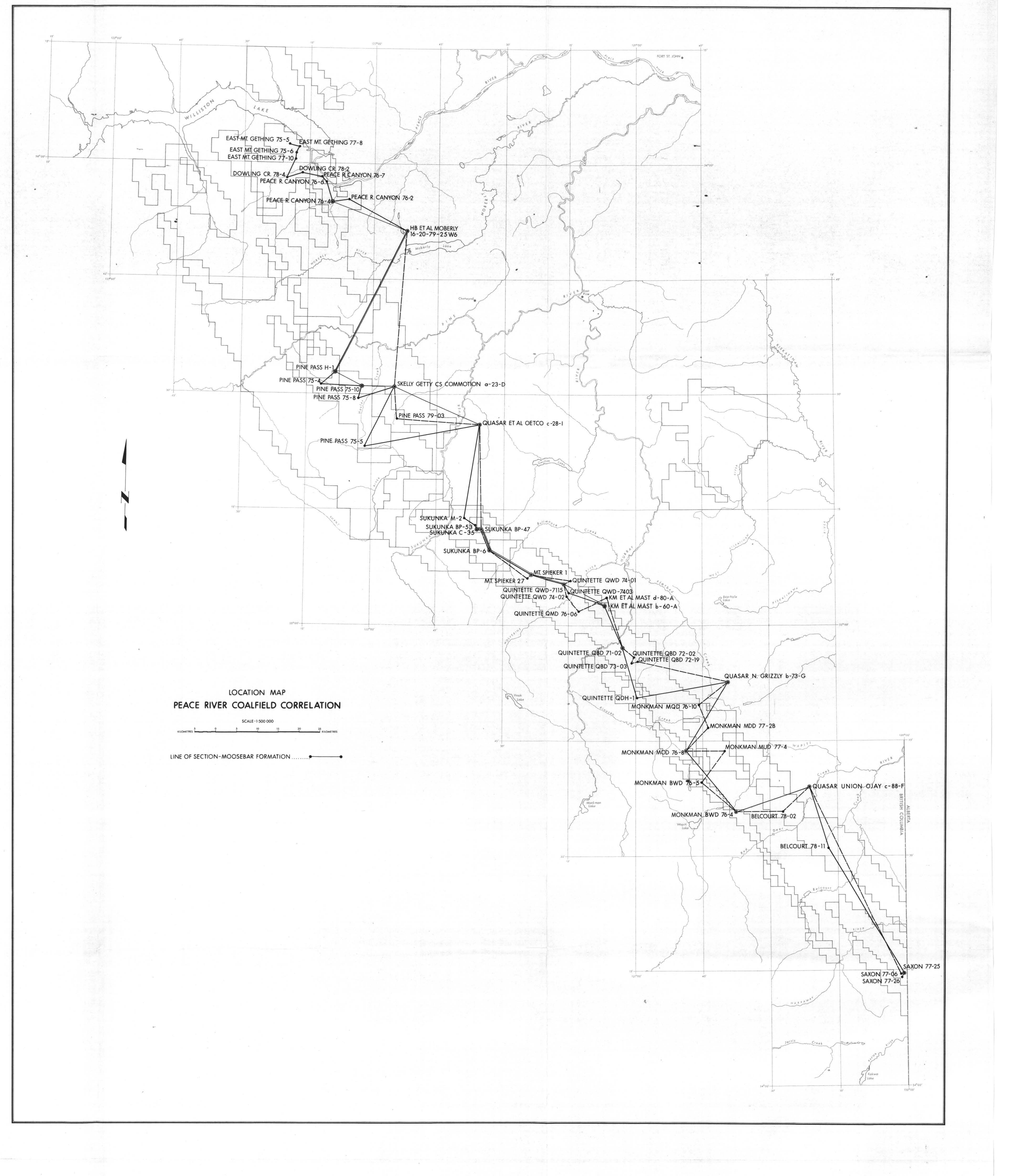
STRATIGRAPHIC SECTION
GATES FORMATION–SOUTH

INCLUDES MOOSEBAR, HULCROSS, AND BOULDER CREEK FORMATIONS

COMPILED BY
P. McL. D. DUFF AND R. D. GILCHRIST, 1981

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

To accompany Paper 1981–3



LEGEND

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BRACKISH .... —B—

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TONSTEIN ? .... —T?—
K–BENTONITE .... ••• K-B •••

MAJOR COAL SEAMS ....

CONTACTS:
FORMAL STRATIGRAPHIC UNITS ....
INFORMAL LITHOSTRATIGRAPHIC UNITS ....
INFORMAL BIOSTRATIGRAPHIC UNITS ....

DATUM: TOP OF GETHING FORMATION

SCALE: VERTICAL – 1:600 (1" = 50') ALL SHOWN IN TRUE STRATIGRAPHIC THICKNESS
HORIZONTAL – NONE – SCHEMATIC

Group	Formation	Unit
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	HULCROSS FORMATION	
	GATES FORMATION	UPPER SILTY MEMBER*
		MARINE TONGUE ?
		SANDY COAL–BEARING MEMBER*
	MOOSEBAR FORMATION	TORRENS MEMBER**
		SPIEKER MEMBER†
		MUDSTONE MEMBER*
		LOWER SILTY MEMBER*
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		MARINE TONGUE††
		LOWER GETHING
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FIGURE 7

STRATIGRAPHIC SECTION
MOOSEBAR FORMATION

INCLUDES GETHING AND MOOSEBAR FORMATIONS

COMPILED BY
P. McL. D. DUFF AND R. D. GILCHRIST, 1981

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

To accompany Paper 1981-3

Province of
British Columbia

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Energy, Mines and
Petroleum Resources