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NORTHERN ROCKY MOUNTAINS COAL RESOURCES.

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British Columbia Hydro & Power Authority

THERMAL COAL RESOURCES OF BRITISH COLUMBIA

VOLUME VII

NORTHERN ROCKY MOUNTAINS

COAL RESOURCES

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SUMMARY

The Northern Rocky Mountains coal belt is the northern portion of the Lower Cretaceous coal-bearing belt that includes the East Kootenay and Alberta coalfields. This northern portion is approximately 240 miles in length, extending from the Alberta border near the Narroway River (54° 15' N) northwestwards to the Halfway River (57° N). The coal belt ranges in width from six to thirty miles and encompasses a total area of 3500 sq. miles, of which 2400 lie north of Pine Pass and 1100 to the south. Coal production to date, from the entire belt, has consisted of approximately 97,000 short tons from small underground mines in the Peace River region.

Two formations of Lower Cretaceous age comprise the coal measures of the Northern Rockies: the Gething and the (higher) Gates Member of the Commotion Formation. Northwest-trending thrust faults and open folds have disrupted and deformed the coal-bearing formations in varying degrees along the belt. The Gething Formation contains significant coal (seams 3 feet or greater in thickness) from about the Halfway River in the northwest to Belcourt Creek in the southeast, a distance of approximately 220 miles. Its greatest potential lies in the central portion of the belt, the 130 miles between Graham River and Kinuseo Creek. The Gates Member, on the other hand, contains significant coal seams only from about the Sukunka River southeastwards into Alberta, a length within British Columbia of approximately 100 miles.

The coal in the Northern Rockies has been derived from lagoon and swamp formation in a deltaic environment along the emerging shoreline of the Early Cretaceous sea that covered the present Plains of Western Canada. Fluctuating conditions of sea level and rate of land emergence to the west resulted in the present variations in coal distribution with respect to the two coal-bearing formations, in the number of coal seams and in the areal distribution of coal.

The Northern Rocky Mountain coal is essentially identical in quality to that in the East Kootenay coalfields:

(i) Medium-low volatile bituminous

(ii) Low average moisture (1-5%), low ash (3-12%), low sulphur (0.3-1.0%).

(iii) High calorific value (12,000-14,500 Btu/lb.)

Most of the coal appears to have good coking characteristics; there is presently insufficient data available to determine how much of the coal is non-coking.

Because the Northern Rocky Mountain coal belt is less accessible and less developed than the southern Rockies it has received little exploration until the renewed interest in metallurgical coal in recent years. With the development of the Sukunka deposit, (underground coking coal), most of the belt has been taken to lease by companies who have subsequently conducted reconnaissance exploration throughout much of the coalbelt.

Estimates of the coal resources of the Northern Rockies are only broadly approximate at this time because of the lack of comprehensive data for most of the belt. Some reserves have been outlined in the Sukunka and Peace River deposits, otherwise the coal is categorized as a resource, mostly inferred, since its presence is primarily based on geological extrapolations from local data points.

The total in situ coal resources are:

Reserves	:	505 million short tons
Indicated Resources	:	10,043 million short tons
Inferred Resources	:	25 to 55,000 million short tons

Major deposits of strippable coal are indicated to occur throughout in the belt but they await definitive drill exploration for confirmation. Most of the Northern Rocky Mountain coal resources will require underground mining; the total recovery will depend on the type of mining employed by the coal owners, it could be as low as 50 percent and as high as 80 percent or more.

There are ample deposits of thermal coal in the Northern Rockies to sustain a 2000 MW generating plant for at least 30 years, and many of them will be surface mines; however, specific locations, reserves and costs are nebulous at the present time and consequently, more exploration is required by the owners if a coal-fueled thermal plant is considered for this region. The most favourable site for such a plant at this time would appear to be in the vicinity of the Pine Pass - Peace River.

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INTRODUCTION

In the assessment of the thermal coal resources of British Columbia, the province has been divided into three major belts: Coastal, Interior and Eastern. The Eastern Belt is principally the Rocky Mountains and Foothills, but with the inclusion of the Interior Plains of the Peace River region in the northeast corner of British Columbia. The coal-bearing rocks within this belt, which are Late Jurassic to Lower Cretaceous in age, occur along the eastern ranges and foothills of the Rocky Mountains and underlie part of the Interior Plains in the northeast corner of the province. The Jura-Cretaceous strata form a generally continuous belt some 850 miles in length from the U.S. border at the 49th parallel to the northern boundary of the province at the 60th parallel. Approximately 700 miles of this total length north from the 49th parallel, all within the Rocky Mountains, contains significant coal deposits. The southernmost 100 miles of the belt lies within British Columbia (the East Kootenays), the central 330 miles within Alberta, and the remaining northern portion within British Columbia again, (Figure 1).

The present report discusses the coal potential of the northern portion of the Rocky Mountain coal belt; the southern portion of the belt in British Columbia has been reported in this study under a separate report "Rocky Mountain Coal Resources, East Kootenay Coalfields".

TERMS OF REFERENCE

The purpose of this report is to review the potential for thermal coal in the northern Rocky Mountain Belt of northeastern British Columbia. No attempt is made to develop exploration programs, or to estimate mining costs because all of the properties are owned by companies who will have done their own such studies. Coal reserve estimates that have been made by the owner companies are included where available.

Coal reserves are the in situ quantities of coal that can be calculated from dimensions revealed in natural outcrops, in surface and underground workings, in drill hole data and from the experience derived from the development of a coalfield. Coal resources are the in situ quantities of coal that are estimated for areas, or entire districts, based on geological inferences and very broadly distributed, limited data; upon verification by exploration or development, coal resources can be recategorized to coal reserves.

In the case of the Northern Rocky Mountain Coal belt, comprehensive exploratory work has been done on only one property of significant size, namely Sukunka. Underground mining has been done on only a few properties in the Peace River area, but on too small a scale to prove more than very local reserve tonnages. Therefore, the majority of the coal tonnage in the northern Rockies is categorized as a resource rather than a reserve. It should be appreciated, however, that the drilling, trenching and mapping of the various properties, however widely distributed, has provided the prime basis for the estimates of the coal resource tonnages, and of course has outlined at least local reserve tonnages on several properties.

The basic estimate of coal resource tonnage used in this report is that of all the coal in the ground (in situ). In this study of the Northern Rocky Mountain belt most of the resource estimates have excluded any coal in seams less than 5 feet in thickness; however, some estimates made by MacKay (1947), using a minimum seam width of 3 feet, have been included, because they are the only data available for some parts of the belt. It should be appreciated that in situ coal might not all be mineable, either with existing technology or with future technology; however, its estimated quantity, property qualified, is a measure of the coal as a potential resource.

AVAILABLE DATA:

Companies with coal leases in the northern Rockies have done various amounts of exploration on these leases, including surface mapping of the rock units, diamond drilling, trenching and some underground work. Most of the results of this work are filed with the British Columbia Department of Mines and many have been published. These data, combined with data and information contained in government reports and maps, form the basis for all discussion, assessment and conclusions in this report.

Three senior members of Dolmage Campbell and Associates Ltd., who have contributed to this report, have had extensive field experience throughout the Rocky Mountain coal belt in general and in various parts of the northern Rocky Mountain belt in particular.

Following is a list of the principal references employed in the present study:

1947 "Coal Reserves of Canada",
Report of the Royal Commission on Coal,
R. B. MacKay.

1950 "Geology of Northeastern British Columbia",
Geological Survey of Canada, Memoir 259,
F. H. McLearn and E. D. Kindle.

1955 "The Climate of British Columbia and the Yukon Territory",
W. G. Kendrew and D. Kerr.

1955 "Coal Reserves of the Hasler Creek - Pine River Area, British Columbia",
British Columbia Department of Mines, Bulletin 36,
N. D. McKechnie.

1961 "Geology, Pine Pass Map-Area, British Columbia",
Geological Survey of Canada, Map 11-1961,
J. E. Muller.

1961 "Dawson Creek Map-Area, British Columbia",
Geological Survey of Canada, Paper 61-10,
D. F. Stott.

1963 "Trutch Map-Area, British Columbia",
Geological Survey of Canada, Paper 63-10,
B. R. Pelletier and D. F. Stott.

1964 "Landforms of British Columbia",
British Columbia Department of Mines, Bulletin 48,
S. S. Holland.

1964 "Jurassic and Cretaceous Strata of the Bullhead Succession in the Peace and Pine River Foothills",
British Columbia Department of Mines, Bulletin 51,
J. E. Hughes.

1967 "Geology of the Pine Valley, Mount Wabi to Solitude Mountain, Northeastern British Columbia",
British Columbia Department of Mines, Bulletin 52,
J. E. Hughes.

1968 "Geology, Halfway River Map-Area, British Columbia",
Geological Survey of Canada, Paper 69-11,
E. J. W. Irish.

1970 "Preliminary Estimates of Measured Coal Resources Including *Reassessment of Indicated and Inferred Resources in Western Canada*", Geological Survey of Canada, Paper 70-58, B. A. Latour and L. P. Chrismas.

1972 "Cretaceous Stratigraphy, Northeastern British Columbia", Research Council of Alberta, Information Series 60, D. F. Stott.

1972 "The Cretaceous Gething Delta, Northeastern British Columbia", Research Council of Alberta, Information Series 60, D. F. Stott.

1974 "Lower Cretaceous Coal Measures of the Foothills of West-Central Alberta and Northeastern British Columbia", Canadian Institute of Mining Bulletin, September, 1974, D. F. Stott.

1974 "The Stratigraphy and Structure of the Lower Cretaceous Gething *Formation of the Sukunka River Coal Deposit in British Columbia*", Canadian Institute of Mining Bulletin, March, 1974, G. R. Wallis and G. R. Jordan.

Reports of the Minister of Mines, British Columbia Department of Mines.

PHYSIOGRAPHY AND CLIMATE:

The foothills of the northern Rocky Mountains are moderately rugged, being somewhat subdued versions of the main ranges to the west. Relief is in the order of 3000 feet to occassionally 4000 feet; valley elevations are 2500 to 4000 feet and mountain tops, 6000 to 7000 feet. The upper limit of forest cover (timber line) averages 5000 feet elevation.

All major drainage is to the northeast into the MacKenzie River watershed and, ultimately, the Arctic Ocean. Major rivers, from southeast to northwest are the Narraway, Wapiti, Murray, Sukunka, Pine, Peace, Halfway, Sikanni Chief, and Prophet Rivers.

Access to the region is provided by the Hart and Alaska highways and some secondary roads which approach the mountains from the Interior Plains.

The climate of the northern Rocky Mountains is more uniform than in the south but also somewhat more severe. The chief characteristic is the long

cold winter, liable to intense cold when continental polar air sweeps out of the north. The mean daily temperature of the warmest month is 55° to 60° F., and of the coldest month, 10° to 15° F. Temperature extremes are 80° to 85° F. maximum and -50° F. minimum. Depending on latitude and elevation there are 5 - 7 months with mean temperatures below freezing. Precipitation is light, averaging 20-24 inches per year; snowfall is in the range of 50-100 inches per year, (ten inches of snow are approximately equivalent to one inch of precipitation).

HISTORY:

The occurrence of coal in the foothills of the northern Rocky Mountains has been known since the time of the earliest explorers; Alexander MacKenzie first noted "bituminous substance" in the Peace River canyon in 1801. The coal in the canyon was first described by A. R. C. Selwyn of the Geological Survey of Canada in 1877. Since then the whole northern Rocky Mountain area and the coal within it has been examined on a broad scale by a number of geologists of both the federal and provincial geological surveys. However, it is only in recent years that the area has received comprehensive, continuing examination, with resultant production of detailed geological maps and reports on specific coal deposits. Much of the area has still not been geologically mapped except on a reconnaissance basis.

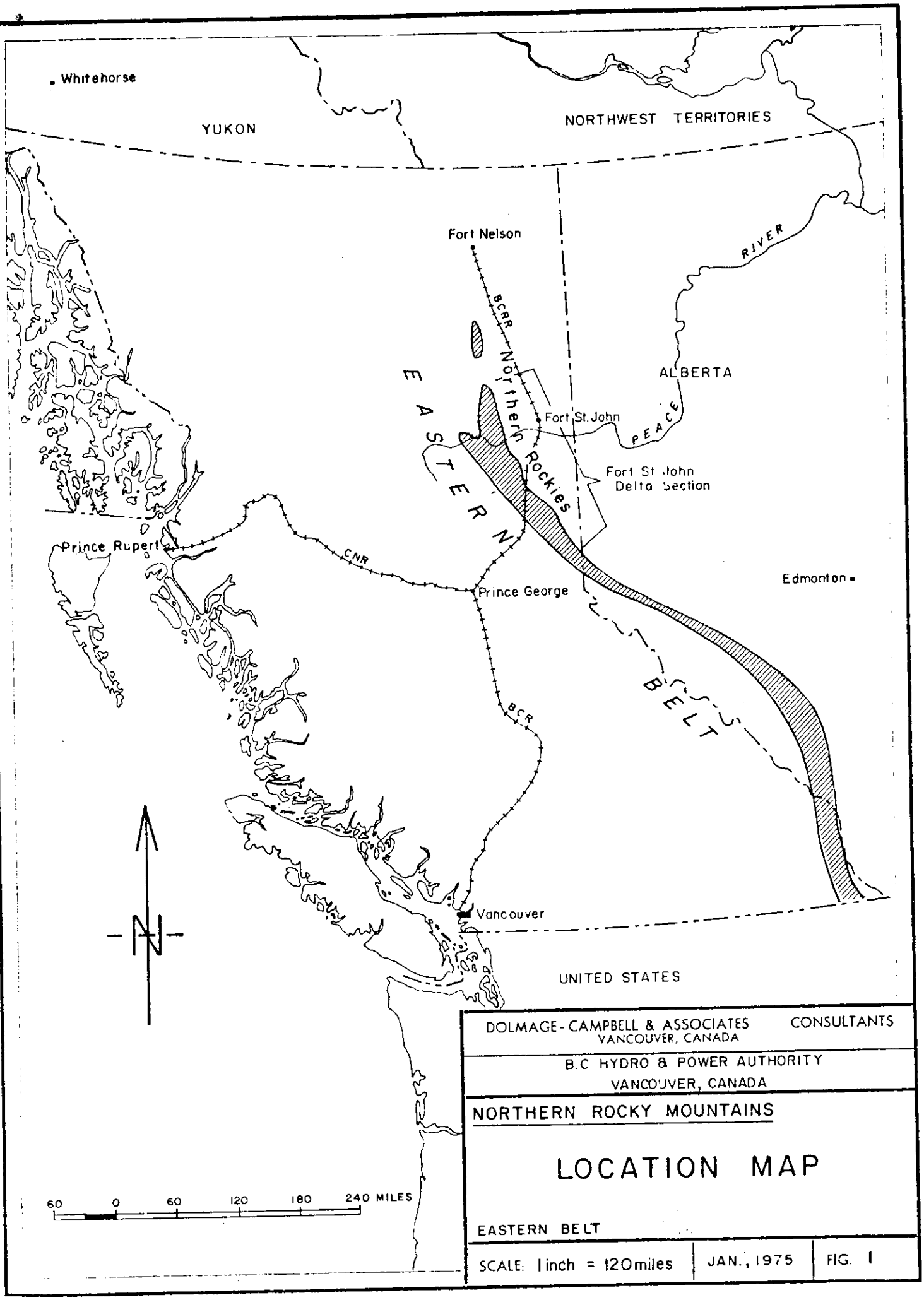
Mining activity in the Peace River region began in 1908 and continued intermittently until the late 1960's. Coal was mined underground from the King Gething mine on the east slope of Portage Mountain, from the Peace River mine at the head of the canyon and from the Packwood Creek mine on Butler Ridge. A mine on Hasler Creek, south of Pine River, was opened in 1941 and the main production occurred between 1943 and 1945, (See Figure 3 for mine locations). No other production is known from the northern Rockies. Total production from the small mines noted above is about 97,000 short tons.

Increased demands for coking coal after 1960 by the Japanese markets resulted in the development or reopening of several mines in the Alberta section of the Rocky Mountains and in the East Kootenay district of southern British Columbia. The less accessible Northern Rockies received little attention during this period and consequently, it was not until the late 1960's that serious exploration began in the area. With the discovery of the Sukunka deposits in 1969, exploration intensified and most of the potential coal-bearing area between the B.C. - Alberta border and the Peace River was soon taken to lease by mining companies.

OWNERSHIP:

At the time of writing this report all of the geologically promising potential coal land in the Northern Rocky Mountain belt in British Columbia has been leased by sixteen companies. However, due to the recently increased cost of holding coal leases, as well as the current softening of the market for metallurgical coal, much of this leased land may come open in the near-future.

Because of this possible temporary nature of the ownership of some of the holdings of the Northern Rocky Mountain belt, a current property map has not been included in this report. Such maps may be obtained at any time from the British Columbia Department of Mines. In some cases in this report a coal deposit is referred to by the name of the current owner company where a geographic name for the deposit is not in use.



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NORTHERN ROCKY MOUNTAINS

LOCATION MAP

EASTERN BELT

SCALE: 1 inch = 120 miles | JAN., 1975 | FIG. 1

GEOLOGICAL SETTING

REGIONAL:

The coal-bearing formations of the Northern Rocky Mountain belt in British Columbia are all Lower Cretaceous in age. They are included in one sequence of deltaic deposits that reflects relatively uniform general depositional conditions. This sequence extends from near the Alberta border to north of the Peace River and is termed here the Fort St. John delta, as a major segment of the Rocky Mountain coal belt, (Fig. 1). The sequence is composed of cyclically intercalated sandstone, shale and conglomerate, with coal occurring at different stratigraphic levels in different portions of the belt. This deltaic wedge of clastic rocks narrows to the east beneath the Plains and thickens westward where it is terminated by regional faults of the Rocky Mountain system.

ORIGIN OF THE ROCKY MOUNTAIN COAL BELT:

The Rocky Mountain coal belt is some 700 miles in length, extending northwestward from the International Boundary to about the Prophet River in north-eastern British Columbia. The coal seams of this belt all occur within Late Jurassic-Early Cretaceous strata that are similar in lithology and cyclic sequences throughout the belt but which are not continuous as specific formations throughout the belt. The striking similarity in the general sequences of coal-bearing rocks between the Peace River in the north and the East Kootenay in the south, even though they are tens of millions of years apart in age, is a function of the common geological environments during the deposition of the strata. The development of this coal-bearing belt resulted from the periodic formation of extensive river deltas along the emerging western shore of the Jura-Cretaceous sea that covered the present area of the Canadian Plains. Lagoons and swamps formed along the shoreline behind sandbars and islands, providing the environment for the formation of peat bogs which, by eventual burial and compaction, were transformed into coal.

The river deltas along this shoreline were of major size comparable with those of the present-day Mississippi and Amazon Rivers. The tectonic condition which gave rise to these deltas was primarily the uplift of the Columbia-Omineca landmasses to the west. This uplift provided periods of steeper gradients, more rapid erosion and generally coarser sediments, conditions favourable for the formation of deltaic deposits. This uplift, termed the Nevadan Orogeny, was not a brief geological event but was a profound, periodic occurrence extending over tens of millions of years, occurring in Late Jurassic time at the southeast end of the belt, (East Kootenay), and in Early Cretaceous time at the northwest end, (Ft. St. John). Also, as evidenced in the lithologies of the deltaic formations, the degree of uplift of the western landmass varied

considerably along the length of the shoreline during the orogenic period. These time and space variations of degree and rate of uplift account for the broad vertical and lateral lithological variations in the Rocky Mountain coal belt. The length of the Jura-Cretaceous shoreline and the size of the river deltas, on the other hand, provided the general continuity within the (coal-forming) sedimentary belt.

COAL BEARING FORMATIONS: (Figures 2 and 3)

Only two formations in the Lower Cretaceous clastic delta sedimentary units of the Northern Rocky Mountains contain significant quantities of mineable coal, although carbonaceous material and thin coal seams do occur in several other formations. The two coal-bearing formations are the Gething (lower) and the Gates member of the Commotion Formation. A somewhat idealized Lower Cretaceous stratigraphic section in the Northern Rocky Mountains is presented in Figure 2. Some of the problems of correlation and nomenclature are apparent from this section: different names apply to equivalent formations; formations may not be continuous (lense out); lithology within a formation changes both vertically and laterally; etc. There are however, a few reasonably firm lithological relationships that are useful in assessing or exploring the Northern Rocky Mountain coal belt. The Gething Formation, where it is coal-bearing, is characteristically underlain by the conglomeratic Cadomin Formation. The Moosebar or equivalent shale formation overlies the Gething Formation and underlies the coal-bearing Gates Member of the Commotion Formation.

The Gething Formation is approximately 1800 feet thick at the type locality on the Peace River but decreases southeastward to about 1300 feet at the Sukunka River and 250-300 feet at the Alberta border, (Fig. 3). North of the Peace River the formation averages about 1100 feet thick. It thins rapidly eastward beneath the Plains. The formation consists of heterogeneously interbedded fine-to coarse-grained sandstone, carbonaceous siltstone, silty shale, massive marine shale and coal. To the north, between the Halfway and Prophet rivers, it grades laterally into a fine-grained sandstone facies in which little or no coal is present, ie, representing the northern edge of the original delta.

The Commotion Formation comprises two sandstone-shale wedges separated by a thin interval of marine shale, (Figure 2). The lower wedge, the bottom member of the Commotion Formation, is the major coal-bearing unit. It is termed the Gates Member. It consists of a lower basal sandstone and an upper part comprised of a repetitive succession of carbonaceous sandstone, mudstone, siltstone, coal and some conglomerate. Its thickness increases from 226 feet at Steamboat Island on the Peace River to a maximum of 1700 feet near Belcourt Lake, (Fig. 3). In the southern part of the region, much of the upper part of the Gates was deposited in alluvial to deltaic environments, but in the region of the Pine and Peace Rivers much of it is marine and thus non-coal-bearing.

Thus, the economically important coal in the southern portion of the Northern Rocky Mountain coal belt occurs in the Gates Formation, and the Gething is thin and barren; conversely the coal in the northern portion of the belt occurs in the underlying Gething Formation, and the Gates Formation is thin and barren.

STRUCTURAL GEOLOGY:

In the Northern Rocky Mountains the configuration and locations of coal occurring in the Gething and Gates (Commotion) formations has been profoundly influenced by the structural geology of the region. The formations have been extensively deformed by folding and thrust faulting, (Figure 3), that accompanied the crustal stresses that resulted in uplift of the Rocky Mountains. The deformation is most intense in the western portion of the coal-belt and becomes slightly more subdued towards the east. Farther east, into the plains, very little deformation has taken place but the coal-bearing (deltaic) formations become progressively thinner and non-coal-bearing.

The faulting and folding, although resulting in quite complex geological structures, have provided repeated surface exposures of the coal-bearing formations and coal seams. Also, because of the structural complexity, it can be expected that potentially economic coal seams are present in a variety of mining situations: dips range from horizontal to vertical, cover rocks from a few feet to several hundreds of feet in thickness, coal seams may be artificially thickened by thrust faulting or tight folding, seams may be high in the mountains or low in the valleys, and so forth. It is probable that as the coal in the region is developed it will be mined in a variety of types of mines, such as underground, open pit and strip.

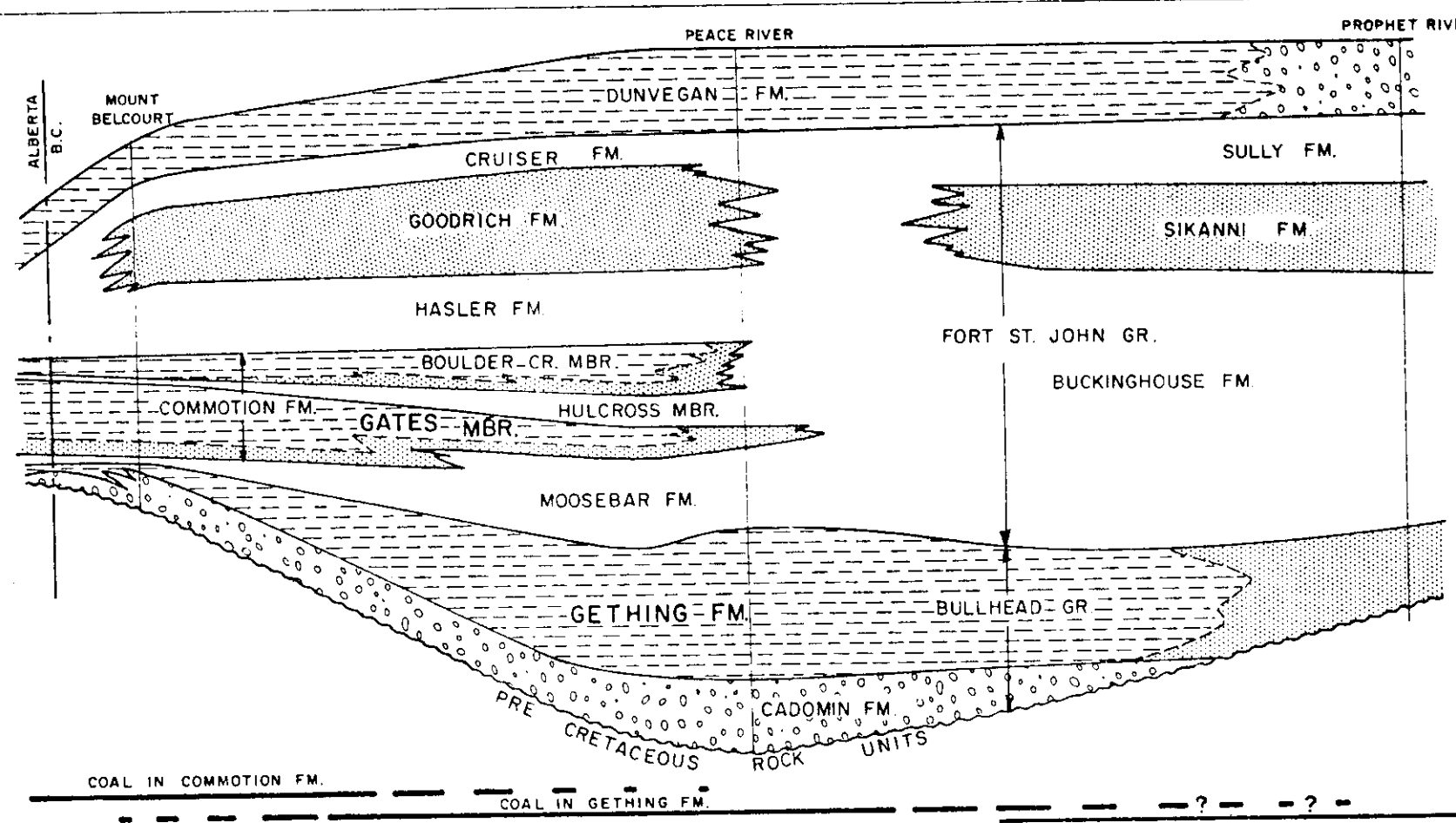
COAL DISTRIBUTION:

Gething Formation: Coal is present in the Gething Formation from the Alberta border in the south to the Sikanni Chief River in the north, and possibly to the Prophet River even further north. Numerous seams are present, as many as 50-60, but most are less than three feet thick. At the northern and southern extremities of the region there are essentially no seams of economic dimensions. However, throughout that portion of the coal-belt bounded approximately by Belcourt Creek to the south and the Graham River, or possibly the Halfway, to the north, the Gething commonly contains one or more seams of presently economic thickness and extent. Within this area there are, on the average, two to three seams that are five feet or more in thickness. Locally, as many as five such seams are present. The seams are generally 5 to 15 feet thick and average approximately 13 feet north of the Sukunka River and 8 feet south of that river.

Correlation of individual seams is not possible over regional areas from present data; however, local correlation based on drill hole results and seam exposures, will no doubt be extended as the nature and characteristics of the seams and of the Gething Formation become better understood in the Northern Rocky Mountains.

Commotion Formation: Only the lower portion, the Gates Member, of the Commotion Formation is coal-bearing (in significant quantities). In the Gates, coal is abundant from the Quintette region (approximately midway between the Sukunka and Murrary Rivers) southward into Alberta. The number of seams present at any one locality ranges from one to eight and averages about five. Seam thickness ranges from 3 feet to 37 feet and averages approximately 9 feet. The seams to the north contain more shale partings than those to the south.

As with the Gething seams, the Gates seams cannot be correlated over regional distances with reasonable confidence at the present time.



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NORTHERN ROCKY MOUNTAINS

MAJOR ROCK-UNITS IN LOWER CRETACEOUS STRATA

EASTERN BELT

SCALE	JAN. 1975	FIG 2

COAL CHARACTERISTICS

All of the coals in the Lower Cretaceous units of the Northern Rocky Mountains have reasonably similar characteristics regardless of their host formation (Gething or Gates), their stratigraphic position, or their location within the length of the coal-belt. Almost certainly some distinctive, though perhaps minor, differences do exist, but from presently available data they are difficult to isolate. Even trends in coal quality along the coal-belt are not readily apparent, although some are vaguely recognizable.

In this report only averaged or generalized coal characteristics are presented for the coals of the Northern Rockies since the available reported analyses are from relatively widely and erratically distributed sampling.

The coal seams do not usually contain appreciable quantities of partings except in the cases of the occasional thick seams (20-35 ft.). Seam continuity appears to be moderate to good; individual seams may be continuous for several miles although, as yet, few have been confidently traced for greater distances.

The general coal quality for the belt is indicated by the following ranges of proximate analytical data:

Moisture content (as received)	1 - 5%
Ash	3 - 12%
Volatile Matter	19 - 25%
Fixed Carbon	60 - 75%
Sulphur	0.3 - 1.0%
Gross Calorific Value	12,000 - 14,500 Btu/lb.
Coking ability	Fair to good
Rank	Medium to Low Volatile Bituminous

The proportion of the total coal that is non-coking is unknown.

COAL DEPOSITS

In the Northern Rocky Mountains regional and district studies by government agencies are far from complete and more detailed exploration by mining companies is still in reconnaissance to intermediate stages. Consequently, the descriptions of coal deposits which follow are generally sparse and, in fact, are, with few exceptions, descriptions of explored areas rather than of discrete deposits. (Refer to Figure 3 for location of the coal deposits.)

The coal areas described below are listed in north to south order for the belt and are segregated as convenient geographical and geological units.

(1) HALFWAY RIVER AREA:

At the base of the Gething Formation on Pink Mountain, immediately north of Halfway River and close to the crest of an anticline, is a seam of coal more than 5 feet thick. On the east side of the mountain the seam has been burnt out; on the west side only float is present. The anticlinal structure, termed the Pink Mountain anticline, is approximately 30 miles in length, extending from just north of the Sikanni Chief River southwards to about 5 miles south of the Halfway River. In 1971 the central Pink Mountain area was explored by two holes that traversed the upper 775 feet of the Gething Formation and found the formation to be very conglomeratic, with no coal seams greater than one foot in thickness.

In 1947 MacKay computed some coal resources for the Halfway River area, probably for an area analagous to the drilled portion of the Pink Mountain anticline; however, until more data is available, it must be assumed, for the purpose of the present study, that no computable resource is present in the Halfway River area, although some potential resource may exist there.

(2) BUTLER RIDGE COALFIELD:

Butler Ridge, and adjacent areas between the Graham and Peace Rivers, is underlain by units of the Bullhead Group which includes the coal-bearing Gething Formation. The predominant structure, striking NNW, is an anticline along Butler Ridge with a parallel syncline to the west and another anticline farther west. Dips range from 0° - 70°; thrust faults are common.

Exposures of coal seams in this area are not plentiful, partly due to extensive overburden cover and partly to an apparent lack of coal in the section.

No seams of appreciable thickness have been located on Dunlevy Creek (along the sycline) and only thin seams in Cust and Gravel Hill Creeks. The Packwood Mine, also called the Reschke Mine, is situated between Gravel Hill and Cust Creeks. Within and near the mine are two seams that are locally more than 3 feet thick.

Coal Reserves and Resources:

With the exception of the small area in the vicinity of the Packwood Mine at the south end of the Butler Ridge coalfield, there has been very little definitive development or exploration of the coal in the coalfield; therefore, the coal reserves for the field are insignificant, but the potential resources of coal are probably considerable. Aside from scattered outcrops of coal throughout the area, as well as coal intersected in oil drill holes along the ridge, the principal factor influencing the inferrence of potential coal resources in the Butler Ridge area is the known abundance of coal directly across the Peace River to the south, in the same (Gething) formation.

MacKay (1947) estimated the following total coal "reserve" for the southern half of the (present) Butler Ridge area:

Probable reserve	168,000 mill. tons
Possible reserve	336,000 mill. tons

In these estimates MacKay used a total coal thickness of 15 feet, in three seams, over an area of 30 square miles and above 2500 feet of cover.

In the present study MacKay's figures are regarded as representing essentially resources rather than reserves. In addition the depth limitation was an arbitrary one based on historical underground coal mining in the southern Canadian Rocky Mountains up to that time. Such a depth limitation is no longer valid in the compilation of the total in situ coal resource, since maximum coal mining depths are currently increasing everywhere in the world. Also, MacKay's selection of a total thickness of 15 feet of coal, from the 40 feet that have been measured in the area, would now appear to be overly conservative, considering the new data available in the last 20 years.

For the purpose of present estimates of the potential coal resources of the Butler Ridge area, the parameters are as follows:

Indicated Coal Resource: SE corner of area, along Peace River

Area = 30 sq. mi.; max. depth for most of coal = 3000 feet;
Total coal thickness = 30 feet
Total coal = 900 mill. short tons

Inferred Coal Resource: Most of area for 20 miles N of Peace River

Area = 180 sq. mi.; coal depth = same as above;
Total coal thickness = 8-foot min., 20-foot max.
Total coal = 1440 to 3600 mill. short tons

In the above estimates, the known decrease in total Gething coal thickness northward from the Peace River has been arbitrarily allowed for in the use of possible coal thicknesses ranging from 8 to 20 feet, in contrast to a measured thickness of over 30 feet south of the Peace River.

(3) PEACE RIVER CANYON COALFIELD:

All significant coal seams within the Peace River coalfield occur within the Gething Formation, which in the Peace River canyon area measures 1400 feet in thickness. Upwards of 50 separate seams have been identified, but the majority, (80%), are less than 3 feet in thickness. At least five principal seams have been measured and/or drilled in the Gething rocks immediately west and south of Portage Mountain and the Peace River Canyon. Average seam thickness is approximately 8 feet. Ash contents are low, 3-10%; calorific values are in the order of 14,000 Btu (dry basis).

The areal extent of some individual seams is at least 10 sq. miles, with further indications suggesting 20 sq. miles or more. In most places the seams dip at 5° to 25° with local steepening to 40° and perhaps more.

The total tonnage of coal in the Peace River Canyon area can be determined reasonably accurately by integrating the several available data sources; however, the rest of the coalfield, south and west of the Canyon, is a vast unexplored area underlain, at considerable depth in the south, by the Gething Formation, thus the coal there must be considered a potential resource, based entirely on extrapolation from known (sparse) outcrops.

Limited underground mining of an 8-foot seam has been done at the Peace River and the King Gething mines. Also, extensive exploration along the entire Peace River Canyon during the damsite investigators in the 1960's, together with more recent drilling by companies south of the river, have indicated extensive total coal resources in the area, a minor amount of which can be classed as reserves.

To the west, in the Gething Mountain part of the area along the Peace River, data is rather tenuous, although a number of seam exposures are well-described in the literature. As near as can be determined, it appears that about 100 million tons were considered "workable" by MacKay in this portion of the Peace River Canyon area.

Coal Reserves and Resources:

At least one 8-foot coal seam has been extensively exposed by drilling, mining and surface excavations along the Peace River Canyon around Portage Mountain. This eastern triangular-shaped slice of the Peace River coalfield is approximately 50 square miles in area, beneath which the coal in the Gething Formation is generally within 2000 feet of the surface. This one seam in this area is considered as a probable-possible reserve, the remaining coal in the area as an indicated resource.

West from Portage Mt., along the Peace River beyond Gething Mt., various coal exposures, together with the mapped continuity of the Gething Formation, attest to the probable existence of coal in this area. This is considered as an inferred resource.

Southeast of Gething Mt. is a 200 sq. mile area beneath which the coal in the Gething Formation lies at depths generally in excess of 2000 feet. The thickness of coal can only be inferred to be possibly as much as the 40 feet in the adjacent Peace River Canyon area. Potential coal in this southern half of the Peace River coalfield is categorized as an inferred resource.

Thus:

Probable-Possible Coal Reserve: Peace River Canyon and vicinity

Area = 50 sq. mi.; max. depth for most coal = 2000 feet;
Total thickness = 8 feet
Total coal = 400 mill. short tons

Indicated Resource: Peace River Canyon (as above)

Area = 50 sq. mi.; max. depth for most coal = 2500 feet;
Total thickness = 32 feet
Total coal = 1600 mill. short tons

Inferred Resource: (i) Gething Mt.

Area = 132 sq. mi.; max. depth for most coal = 2000 feet;
Total ave. thickness = 15-30 feet
Total coal = 1980 to 3960 mill. short tons

(ii) Southeast section of coalfield

Area = 200 sq. mi.; max. depth of most coal = 3500 feet;
Total ave. thickness = 15-30 feet
Total coal = 3000 to 6000 mill. short tons

For all of the above estimated coal reserves and resources, except

for those in the Southeast section, approximately 3 percent, more or less, is probably available to surface strip mining along outcrops and on dip slopes.

(4) CARBON CREEK AREA:

The Carbon Creek Coal area, which is presently inaccessible by road except at the south, lies west of the Peace River Canyon coal area, the two being separated by a major thrust fault lying 4-5 miles east of, and partly parallel to, Carbon Creek. The coal-bearing Gething Formation, underlying an area of about 400 sq. miles, is folded into two northwesterly trending synclinal basins separated by an anticline from which some of the Gething rocks have been removed by erosion. Carbon Creek flows northwesterly to the Peace River along the axis of the eastern syncline.

At least 15 seams, 3 feet or greater in thickness, have been located. There is, however, the possibility that some of these individual seams may in fact be the same seam at different localities. Thickness variability is not well understood because seam exposures have not been correlated for any appreciable distances. Measured thicknesses range from 3 feet (or less) to 17 feet. Much of the coal contains less than 5% ash and only 3-4% moisture. Calorific values are in the range of 12,500-14,000 Btu. There is the suggestion that some of the coals are non-coking.

Coal Resources:

MacKay (1947) reported a total reserve tonnage for a ten square mile area along Carbon Creek, to 2500 feet maximum depth and for 10 feet of coal, of 102 mill. tons.

For the purposes of the present inventory the coal potential of the entire Carbon Creek area, (400 sq. mi), is categorized as an inferred resource. Because the Gething Formation lies at or close to the surface throughout the entire area, and is relatively gently folded, the maximum depth for most of the coal is about 2000 feet. Also, judging from the existence of the broad folds in the strata, parallel to the trend of the mountain ridges, the liklihood of considerable strippable coal on dip slopes would appear to be good.

Inferred Coal Resource: Entire Carbon Creek area

Area = 400 sq. mi.; max. depth of most coal = 2000 feet;
Total ave. thickness = 10-40 feet
Total coal = 4000 to 16,000 mill. short tons

(5) PINE RIVER AREA:

The Pine River area encompasses the coal-bearing Gething and Commotion Formations from approximately five miles north of the Pine River to twenty miles south of the river, a coal area of some 150 sq. miles. It is traversed by the Hart Highway and the British Columbia Railway along Pine Valley. The Hasler Mine, from which a small tonnage, (3933 tons), was produced in 1944 and 1945, is reached from the Hart Highway by a nine-mile road along Hasler Creek.

Structurally, the area consists of a series of anticlines and synclines, with axes trending northwesterly, that have been disrupted by similarily trending, southwesterly-dipping thrust faults. Further complication for exploration and mining is the rugged terrain, wherein erosion has left isolated, remnant portions of rock units, and windows through rock units. Dips within the Gething Formation, in which all potentially mineable seams occur in this area, are mostly low to moderate, ranging from 0° to 25°. Locally, steeper dips are present.

Recent exploration, plus the results of earlier work done by the British Columbia Department of Mines, indicates numerous exposures of coal seams greater than 3 feet in thickness and suggests multiple seams within the Gething Formation. Up to five seams are present (aggregate thickness of 74 feet) in thicknesses ranging from 7.5 feet to 20 feet.

The coal is of low to medium volatile bituminous rank; is low in ash, averaging about 6%; of high calorific value, 13,000 to 15,000 Btu; and contains approximately 0.5% sulphur. The coking characteristics are reported as fair to good.

Coal Resources:

Some coal reserves can be estimated for the Norman Creek, Pan Ocean and Hasler deposits but they are an insignificant part of the coalfield potential; however, because these deposits represent measured exposures well distributed along the elongate field, they do serve to indicate the existence of a coal resource throughout the field. Most of the indicated coal lies within 2500 feet of surface.

Indicated Coal Resource: 50 sq. mile area

Total coal ave. thickness = 20 feet
Total coal = 1000 mill. short tons

Inferred Coal Resource: All 150 sq. mile area

Total coal ave. thickness = 20-60 feet
Total coal = 2000-8000 mill. short tons

(6) SUKUNKA COALFIELD:

The Sukunka coalfield lies approximately between Sukunka-Burnt Rivers in the northwest and Bullmoose Creek in the southeast; it encompasses about 95 sq. miles. Within it lies the most explored coal deposit in the Northern Rocky Mountains Region, the Sukunka deposit.

The area and the deposit are accessible by road (35-40 miles) from the town of Chetwynd on the Hart Highway. The northeastern branch of the British Columbia Railway also passes through Chetwynd.

Exploration in the Sukunka area was first undertaken in 1969 with initial diamond drilling getting underway late that year. To date, approximately 110,000 ft. of core holes have been drilled, with the bulk of the footage, about 107,000 ft., in the Sukunka deposit. As well, several adits, totalling over 600 ft. in length, have been driven into the two main seams which constitute the deposit, in order to obtain bulk samples.

The developed coal reserves in the Sukunka area occur within the Gething Formation. Coal is present in the Gates Member of the Commotion Formation but has not yet been located in economic quantities and thus does not contribute to the coal resource of the area at this time. However, considering that appreciable coal tonnage is present in the Gates a few miles to the southeast, (Quintette area), it is probable that some "in situ" tonnage will eventually be located within the Gates Member in the Sukunka area.

The Gething Formation lies within a relatively broad syncline bounded to the northeast by the Bullmoose Fault complex and 4 miles to the southwest by an unnamed parallel thrust fault. Moosebar and Commotion Formations overlie the Gething in the (unexplored) southeastern portion of the area where elevations are higher than in the northwesterly-dipping thrust faults. The faults have dissected the strata into three major blocks or plates within which smaller low-angle thrust faults have further disturbed the strata.

The Gething Formation is 800 to 1300 feet thick and occurs throughout the Sukunka area although, as mentioned above, it is overlain by Moosebar and Commotion Formations to the southeast, (Fig. 3). The best coal seams, those which comprise known reserves on the Sukunka property, occur in the upper 200 feet of the formation, that part of the sequence informally referred to as the "Upper Gething" sequence.

Two major seams are present in the "Upper Gething" sequence on the Sukunka property: The "Chamberlain" (lower) and the "Skeeter". The Chamberlain seam, the basal unit of the Upper Gething sequence, is apparently continuous throughout the Sukunka area and is generally in excess of 8 feet in thickness. From 15 to 40

feet stratigraphically above it lies the Skeeter seam which averages under 8 feet in thickness and, from present data, is thick enough to be economic only north and east of Chamberlain Creek. (Its thickness in the southeastern portion of the area, around Bullmoose and Chamberlain mountains, is unknown.) A third seam, the Bird, is situated approximately 130 stratigraphic feet above the Skeeter. It is too thin to be of economic consideration but does serve as a useful marker horizon located near the top of the Upper Gething sequence.

It has been reported that surface exploration at Sukunka has indicated the possible presence of a thick, (40 ft.), coal seam lying about 400 feet stratigraphically below the Chamberlain Seam; however, because the exposures of this coal do not exhibit coking characteristics, no further exploration has been done on it by the owners. The potential of such a seam, which may be what is termed the "Middle Coal", as a source of thermal coal, however, may be significant.

The coal from the Chamberlain and Skeeter seams has the following "as received" characteristics:

Moisture	1% (average)
Ash	3 - 6%
Volatile Matter	19 - 22%
Fixed Carbon	73 - 75%
Sulphur	0.3 - 0.5%
Calorific Value	14,000 - 15,000
Rank	Low to medium volatile
FSI (Raw Coal)	5 - 8

Coal Reserves and Resources:

The drilled coal reserve calculated by the owners for the Sukunka deposit, all coking and all in two seams in the Gething Formation, is:

	In Situ	Recoverable (Room & Pillar)
Proven	74.0	52.0 (Est.)
Probable	31.0	22.0
Totals	105.0 mill. short tons	74.0 mill. short tons

The indicated coal resource tonnage for the unexplored (undrilled) portion of the Sukunka coalfield is estimated from the know parameters as follows:

(i) Average in situ mineable coal in 7.17 sq. mi. of Sukunka Deposit 105 mill. tons, plus 20 ft. of Middle Coal etc. = 248 mill. short tons

(ii)	Approx. total area of Sukunka coalfield (less mine area)	= 88 sq. mi.
(iii)	Extrapolation = (88÷7.17) x 229	= 3044 mill. short tons
	Plus Middle Coal in mine area	= 143 mill. short tons
	Total Indicated Resource	= 3187 mill. short tons

(7) QUINTETTE COALFIELD

The Quintette coalfield is a large coal area that extends from the Sukunka coalfield at Bullmoose Creek in the northwest, southeastward across the Wolverine and Murray rivers to Kinuseo Creek, which occupies a prominent pass through the eastern Rocky Mountains. It encompasses approximately 220 square miles of the potentially coal-bearing Cretaceous belt. Quintette Mountain, 6044 feet, is located at the southeast corner of the coal area, forming the easternmost prominent peak in this part of the Rocky Mountain Foothills. The area lies along the rugged eastern Foothill Ranges and is generally accessible only by foot or by helicopter from the Sukunka road beyond the northwest end of the area and from a tote road on the Murray River and from the B.C. Forestry Access Road through the Kinuseo Creek pass at the south end of the area. The Forestry Access Road leads out of the Foothills to Beaverlodge, Alberta, 50 miles to the east and to Dawson Creek, B.C., 50 miles to the north.

The geological setting of the Quintette coalfield is dominated by a series of sub-parallel, northwest-trending open folds which are modified, particularly along the edges of the belt, by sub-parallel regional thrust faults. Dislocation by faulting does not appear to be as intense as it is farther to the northwest in the Sukunka and Pine River areas. The synclines and anticlines are generally narrow and linear with northwest striking axes; dips on the limbs are in the order of 20°-40° north of the Murray River and 60°-75° south of the river. The coal-bearing Cretaceous strata are most prominently exposed in elongate synclines and anticlines that underlie northwest-trending mountain ridges.

Coal seams of appreciable thickness occur in both the Gething Formation and the Gates Member of the Commotion Formation. From five available measured control sections that are representatively located in the Quintette area, a number of generalized characteristics of the coal measure are apparent. A maximum of six seams is present in the Gething Formation but only two or three are of mineable thickness in any one locality. The average seam thickness of seams greater than 5 feet in thickness is about 12 feet; average aggregate thickness is about 20 feet. In the Gates Member, seven to nine seams are present of which

six to eight are greater than 5 feet in thickness. These seams range up to 30 feet in thickness, with the average seam thickness being about 8 feet and the average aggregate thickness about 61 feet. Although on a stratigraphic basis the Gates Member contains approximately three times as much coal as the Gething Formation, the Gething is more widespread in the district, because of erosion of the higher Gates Member, and thus consists of a larger coal-bearing volume. However, the Gates still probably contains more mineable coal nearer the surface than does the Gething.

Analytical data concerning coal quality are not available other than in generalized terms: the coal is clean, has a Medium Volatile Bituminous rank, cokes well (FSI = 7-8), contains 20-25% volatiles and an average 7% ash. However, it is reasonable to expect some differences in quality between seams, between widely separated parts of seams and, in particular, between Gething and Gates seams. It may be that some seams or portions of seams are non-coking or oxidized and thus of interest for thermal purposes.

Coal Resources:

The coal resource of the Quintette coalfield has been roughly estimated at this time by compiling geological cross sections, from the excellent data available, at regular intervals through the belt and then by extrapolating known coal seams, as measured in the stratigraphic control sections throughout the district. Some additional control is available from a few reconnaissance diamond drill holes located near Wolverine Creek at the northwest end of the district and near Kinuseo Creek at the southeast end.

Assuming that the Gething Formation underlies 60 percent of the coalfield, and the Gates underlies 25 percent, and that the Gething contains up to 20 feet of total coal thickness, (min. 5 feet in seam thickness), and the Gates up to 60 feet of total coal thickness, the total in situ coal resource is estimated to be:

Indicated Resource: Within approximately 2000 feet of surface (outcrop)

Gething	=	1320 mill. short tons
Gates	=	1650 mill. short tons
Total		2970 mill. short tons

Inferred Resource: Down-dip of indicated resource

Gething	=	660 to 1320 mill. short tons. (Ave. 10-20 ft.)
Gates	=	550 to 1370 mill. short tons. (Ave. 20-50 ft.)
Total		1210 to 2690 mill. short tons.

Since most of the coal-bearing strata in this coalfield dip sharply down from outcrop, commonly into mountain sides, and since intense fold deformation of coal seams is rare in the area, the opportunity to mine much of the

Quintette coal by means of surface methods is limited to very local, favourable topographic situations. For all practical considerations, the coal resource in the Quintette coalfield should be considered primarily as underground coal.

(8) WAPITI AREA

The Wapiti area lies between Kinuseo Creek and Wapiti River. The area is relatively subdued topographically, lying along the edge of the Plains at the eastern fringe of the foothills. The Wapiti coal area is relatively readily accessible from the Kinuseo road at the north end and from a system of logging roads along its northeast side to the Wapiti River.

The Wapiti coal area represents the northwest end of a major branching of the coal-bearing Cretaceous strata that occurs between Kinuseo Creek and the Alberta border, (Fig. 3). Southeast of the Wapiti River the coal strata crop out in two diverging narrow bands that represent outward-dipping limbs of a geanticline that spans the eastern range of the Rocky Mountain Foothills in this area.

In the Wapiti area these two anticlinal limbs are represented by two parallel northwest-trending belts of coal-bearing strata, from two to four miles apart, that encompass a potential coal area of about 50 square miles. The southwest limb is a narrow strip of Gething-Gates strata dipping southwestward beneath a broad intermontane valley at about 30°. This strip is widened considerably by folding and faulting at the north end of the area. The northeast limb is a wider band of folded and complexly faulted Gething-Gates strata that has more structural promise for the occurrence of strippable coal but which is unfortunately largely overburden-covered. Dips range from 20° to 70° in the folded portions of both limbs.

Exploration in the area has been of a very preliminary nature and consequently available data concerning geological characteristics and coal content is sparse. A number of seam exposures have been located, particularly in the Commotion Formation (Gates Member?). Individual seams range from 5 to 15 feet in thickness; at one locality three seams have an aggregate thickness of 25 feet. Only one exposure is noted in the Gething Formation but it is an unusual 65 feet in thickness.

No tonnage determinations are available for the Wapiti area and it is difficult to calculate tonnages, with reasonable confidence, because of the sparse data. There is little doubt that a major potential resource of coal is present in the area, since there are major resources in the Quintette coalfield to the northwest and in the Belcourt areas to the southeast. The Wapiti in situ potential may be in the order of a billion tons. The following "inferred" resource, has been estimated, using a range of total coal thickness of 10 to 30 feet.

Inferred Coal Resource = 500 to 1500 million short tons.

There are no coal quality data for the Wapiti area.

(9) BELCOURT EAST AREA

Belcourt East comprises the northeast anticlinal limb of the belt of Lower Cretaceous sedimentary formations that lie along the eastern flank of the Rocky Mountain foothills from the Wapiti River to the Alberta border, where it is truncated by faulting. The belt is approximately 25 miles in length and ½ to 2 miles in width. It is accessible by trails and tote roads from the Plains along its northeast side.

The coal-bearing formations occur in the northeasterly dipping limb of the geanticline, the crest of which has been eroded to the southwest and the downdip extension of which is truncated under the Plains by thrust faults. Major thrust faults form the northeast boundary of the belt; lesser thrusts occur within it.

In the Belcourt East coal belt, the Gates Member of the Commotion Formation is in the order of 1700 feet in thickness, whereas the Gething Formation is only 300 feet in thickness. The Gates contains up to ten coal seams with an aggregate thickness of approximately 90 feet. However, the effects of erosion and truncation by thrust faults have reduced the number of available seams in any one locality. The Gething Formation contains up to three coal seams with a total thickness of 27 feet. Again, the average number of seams and the average total thickness is probably less than these maximum figures at any one locality.

Possible surface mining of coal is likely in parts of this coal area because of the repeated occurrences of dip slopes over coal-bearing strata.

No coal quality data are available but the Belcourt East coal is probably similar to that from the Saxon area to the south.

Because the Belcourt East coal area has been explored solely by mapping and some trenching, the only method available for estimating potential coal resources for the area is by constructing geological cross sections and extrapolating from them. In this area, where stratigraphic control sections are sparse, the results of such a calculation must be regarded as very rough estimates at best.

Coal Resources:

Most of the indicated coal in the Belcourt East area lies within 1500 feet of the surface. The coal in seams greater than 3 feet in thickness is estimated to be:

Indicated Resources:	Gates	=	345 mill. short tons
	Gething	=	44 mill. short tons
	Total		389 mill. short tons

Inferred Resources: (Depth projections) Total ave. thickness = 40-80 feet

Total coal = 560 to 1360 mill. short tons

(10) BELCOURT WEST AREA

Belcourt West consists of the outcrop trace or band, about 2 miles in width, of coal-bearing Lower Cretaceous Formations that trends southeasterly between the Wapiti River in the northwest and the Narraway River in the southeast. It is the most westerly of three individual coal-belts in this southern portion of which Belcourt East is the east limb. The southeast end of the Belcourt West belt has not been mapped; it probably extends beyond the Narraway River. The mapped length of the belt is 30 miles.

The Belcourt West belt extends down the spine of the central ranges of the Rocky Mountains, much of it being in extremely rugged and inaccessible mountainscape, particularly the northwest half of the belt. The southeast half trends along the east side of a broad intermontane valley.

The belt has been explored only by reconnaissance mapping and some bulldozer trenching; therefore, data regarding the coal measure are sparse.

The Belcourt West strata dip relatively shallowly (15°-35°) to the southwest beneath a wide, overburden-covered intermontane valley. It is relatively unfolded and is dislocated by only one major thrust fault, a few miles northwest of Belcourt Lake.

Very little information is available for the Belcourt West belt with respect to detailed geology, coal seam descriptions and so forth, and consequently, although the area may have the potential for large coal tonnages, only very restricted tonnages can be estimated on the basis of the sketchy data on hand. Coal is known to occur in the Gething and Gates units; however, the Gates Member is thicker and appears to contain more coal than the Gething. Of the several coal seams exposed by trenching the Gates strata, one that is 14 feet in thickness is believed to be correlative to No. 4 Seam, now in production at Smoky River in Alberta to the immediate southeast.

The following coal resource estimates for the Belcourt West coal area are very simply done by assuming an arbitrary total coal average thickness of 10 to 40 feet, and a one-mile down-dip projection:

Inferred Coal Resource: 320 to 1280 mill. short tons

No coal quality data are available for Belcourt West.

(II) SAXON AREA

The Saxon area, like Belcourt East and West, is a linear belt of coal-bearing formations trending northwestward and situated at the southern end of the Northern Rocky Mountain coal belt. The Saxon belt extends across the border into Alberta. It is 15 miles in length, from the Alberta border to Belcourt Creek, and is about two miles in width. The entire belt is readily accessible from the valley of the Narraway River, which bisects it.

The Saxon belt of coal-bearing Cretaceous strata represents a faulted slice of what appears to be the crest of the Belcourt geanticline. The coal-bearing units actually occupy a tightly folded syncline that is truncated by a regional thrust fault to the southwest. Dips range from 25° to 75°.

Four core holes have been drilled into the coal measures and provide data on the stratigraphy, coal seams and coal thicknesses. The Gething Formation is only 100 to 300 feet in thickness and contains no significant coal seams. The Gates Member of the Commotion Formation, on the other hand, is over 1200 feet in thickness and contains a number of thick coal seams. As many as 14 seams (and possibly more) may be present but many are too thin (less than 3 feet) to be mineable. The number of mineable seams ranges from two to eight, and individual seam thicknesses, from three to thirty-seven feet. Average seam thickness is 13 feet and average aggregate thickness of all mineable seams is 55 feet.

On the basis of two analyses, the coal has the following characteristics:

Ash	8 - 12%
Volatile Matter	21 - 25%
Fixed Carbon	66 - 68%
Sulphur	0.3 - 0.5%
Calorific Value	13,500 - 14,600 Btu
Free Swelling Index	3½ - 7

This appears to be a Medium Volatile Bituminous coal.

The in situ tonnage for four coal seams, all in the Gates Member, are reported for the Saxon area, to a maximum cover of 1500 feet, to be 240 million short tons. The potential resource, with no depth limitation, is estimated to be in the order of 500 million tons, most of which lies above 3000 feet of cover. The ultimate potential of the Saxon coal area can only be determined by extensive drill exploration.

COAL RESERVES AND RESOURCES

It is clear from the relatively small amount of definitive coal exploration done in the Northern Rocky Mountain coal belt of northeastern British Columbia, that the area should be considered primarily as a potential source of coking and thermal coal at this time. That the potential coal resource exists and is indeed vast, is corroborated by the natural coal exposures and the local developed deposits which are scattered, more or less evenly, from one end of the coal belt to the other. Coal exploration in the Northern Rocky Mountain belt has been a function of accessibility; therefore, the more accessible areas are the most explored, ie, Peace River (East), Pine River and Sukunka, and the less accessible, outlying areas are least explored, Halfway River, Quintette and Belcourt. This wide range in the amounts of comprehensive data available from the different areas in the belt is reflected in the present categorization of the total coal resources of the belt; the more explored areas contain coal "reserves" and "indicated resources", whereas the least explored areas contain either estimated ranges of "inferred resources" or simply "possible potential".

From the preceeding section of this report, 'Coal Deposits', the tonnages presented for each area can be tabulated to determine the total coal resources of the entire Northern Rocky Mountains. These results are shown in Table No. 1.

The reserve and indicated resource total approximately 10.5 billion short tons, split approximately 60% in the Gething Formation and 40% in the Gates Member. As more data becomes available for the Northern Rocky Mountains region a better measure of the total coal resources will evolve; however, the rough estimates made from existing data indicate a potential total resource of 25 to 55 billion short tons. It could be somewhat larger than the above maximum figure, because a basically conservative approach has been employed in the present study. The potential for recoverable coal is difficult if not impossible to estimate with any confidence. It will eventually be determined by basic energy costs, mining and transportation costs, technological advances in mining, possible gasification in place, etc..

The proportion of coal in the Northern Rockies that is non-coking and thus primarily of use for thermal purposes, can not be determined from available data.

The amount of surface mineable coal in the Northern Rocky Mountains is a small percentage of the total resource; however, it still comprises an economically important quantity. Most of the known coal seams that crop out

can be strip mined for local appreciable distances down-dip; however, since most of the more accessible areas are ubiquitously covered in overburden, the actual extent of such coal must await determination by extensive and comprehensive exploration by the lease owners.

TABLE No. 1

COAL RESOURCES - NORTHERN ROCKY MOUNTAINS

All figures in "millions of short tons"

COAL AREA	RESERVES	RESOURCES		TOTALS	
	(1) All	(2) Indicated	(3) Inferred	(1)+(2)	(1)+(2)+(3)
Halfway River	---	---	---	---	Unknown
Butler Ridge	---	900	1,440 - 3,600	900	2,340 - 4,500
Peace River	400	1,600	4,980 - 9,960	2,000	6,980 - 11,960
Carbon Creek	---	---	4,000 - 16,000	---	4,000 - 16,000
Pine River	---	1,000	2000 - 8,000	1,000	3,000 - 9,000
Sukunka	105	3,187	---	3,292	3,292 - 3,292
Quintette	---	2,970	1,210 - 2,690	2,970	4,180 - 5,660
Wapiti	---	---	500 - 1,500	---	500 - 1,500
Belcourt East	---	389	560 - 1,360	389	949 - 1,749
Belcourt West	---	---	320 - 1,280	---	320 - 1,280
Saxon	---	240	500	240	240 - 740
TOTALS	505	10,285	15,010 - 44,890	10,791	25,801 - 55,681

CONCLUSIONS

The Northern Rocky Mountain coal belt is the northwestern continuation of the East Kootenay - Alberta Foothills belt and is essentially proportionately identical to that belt in the character of its coal measure and in the quantity and quality of contained coal; it differs only in the fact that it has been far less explored than that part of the belt to the south and that the economic coal seams within it occur at somewhat different stratigraphic levels than do those in the southern extension of the Rockies. The belt comprises an area 240 miles in length and 6 to 30 miles in width, totalling approximately 3500 square miles, most of which is mountainous and generally inaccessible.

Comprehensive data on the distribution and quality of the coal in the Northern Rocky Mountain belt are generally sparse, but are fairly well distributed throughout the belt. In the central, most accessible, portion of the belt, a number of local coal deposits have been explored comprehensively enough to enable the establishment of some coal reserves; however, by far the majority of the belt has been explored only in a reconnaissance fashion, enough to establish the existence of a coal resource, but nothing more definitive. This disparity of exploration of the belt is reflected in the estimates of the total coal resources of the Northern Rocky Mountain belt, where the established in situ coal reserves are relatively small, compared to the vast indicated and inferred in situ coal resources, namely:

(i)	Reserves	= 505 mill. short tons
(ii)	Indicated coal resources	= 10,000 mill. short tons
(iii)	Inferred coal resources	= 25 to 55,000 mill. short tons

The above estimated coal resource tonnages for the Northern Rocky Mountain belt are based on the available data, with generally limited extrapolation therefrom. They are intended to be a measure of the probable and possible potential of the coal belt that is as reasonable as the geology and the exploration data warrant. The ultimate potential of the belt could be considerably larger, but any estimates of this potential at this time would be complete conjecture. Such estimates must await further data accumulated from future exploration.

The proportion of coal that is non-coking cannot be determined from available data for the belt, although there will certainly be some non-coking coal in the form of oxidized coking coal as well as coal seams that may be non-coking because of the inherent coal characteristics. Oxidation, enhanced by fracturing (in association with faults and folds), alters coking coal to non-coking. Since faults are common in the Northern Rockies, together with extremes in topography that tend to expose much of the coal measure to weathering, the probability of encountering large tonnages of oxidized (thermal) coal in the belt is high. Also, of course, the cost of beneficiation and transportation of metallurgical coal in this

generally remote area may also render coking coals non-economic for metallurgical purposes in some parts of the belt, and they would be available as high-yield domestic thermal fuel.

To date, the exploration of the Northern Rocky Mountain coal belt has been dominated by the search for metallurgical coal. No significant effort has been made by any of the property owners to develop thermal coal reserves or resources; thus, what appear to be promising exposures of surface coal deposits have not been investigated because the coal has not proved to have a high enough coking quality. Extrapolating from the essentially identical East Kootenay coalfields to the southeast, where a great mass of data on the coal quality is available, it is evident that the Northern Rocky Mountain coal belt holds a major potential for thermal coal, both surface and underground. As in the case of the East Kootenay portion of the Rocky Mountain belt, most of the coal reserves and resources in the Northern Rocky Mountain portion will have to be mined by underground means; however, again as at East Kootenay, there are no doubt coal deposits in the Northern Rockies that lend themselves to surface mining due to locally favourable structural and topographical conditions.

There is little doubt that sufficient thermal coal is available to sustain a 2000 MW generating plant for 30 years from many parts of the Northern Rocky Mountain belt. The present economics of such sources are severely hampered, however, by the lack of developed specific coal deposits in the belt and by the present relative difficulty of access to most of the belt. From these aspects, as far as sources for a thermal plant are concerned, the Sukunka-Peace River areas appear to be the most promising at this time. It remains for the owners of the coal licenses to have reason to pursue this aspect of developing the potential resource.

In summary, although the thermal energy potential of the Northern Rocky Mountain coal belt in northeastern British Columbia is immense, the Belt is presently too sparsely developed to provide an immediate source of fuel for a 2000 MW thermal plant. There are many properties in the belt on which the results of initial exploration indicate that they could be a fuel source for such a plant; however, the verification of this potential must await further exploration and development by the property owners.

As in the case of the East Kootenay district, much of the coal in the Northern Rocky Mountain belt is good quality metallurgical coal; therefore, the development of thermal coal in the belt will probably take second place to the development of mines to sell the higher priced metallurgical product.

Mining costs for coal in this belt will be comparable to those in the East Kootenay district; however, transportation costs will probably be higher on a district average.

RECOMMENDATIONS:

In the future, as the demand for high calorific thermal coal increases, the interest in finding and developing such sources in the Northern Rocky Mountain belt will increase. At that time the property owners will no doubt launch programs that will discover the most promising deposits most readily available to the markets (transportation) as they arise.

If a major thermal plant would be desirable at some time to serve the northeastern or the central part of British Columbia, the most logical potential source of fuel would be in those parts of the Northern Rocky Mountain belt adjacent to the Pine Pass; that is, Pine River and Sukunka to the south and Peace River to the north. At that time it would be warranted to more fully investigate these areas for surface-mineable thermal coal deposits. The most likely competition for this coal, as domestic feed, will be from the Tertiary coal deposits of the Interior Coal Belt, through Prince George; however, these interior coals have only about 50 percent of the calorific value of the Rocky Mountain coals.

Respectfully submitted,

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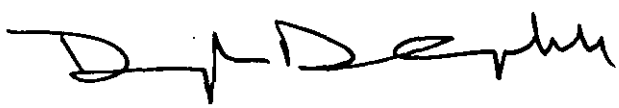

Douglas D. Campbell, P. Eng. PhD

C. R. Saunders, P. Eng.


HALFWAY RIVER AREA
BUTLER RIDGE COALFIELD
PEACE RIVER COALFIELD
PACKWOOD MINE
PEACE RIVER MINE
KING GETHING MINE
HUDSON HOPE
CHETWYND
PINE RIVER COALFIELD
SUKUNKA COALFIELD
QUINTETTE COALFIELD
WAPITI AREA
BELCOURT EAST
BELCOURT WEST
SAXON AREA
CARBON CREEK AREA
MASTER CR. DEPOSIT
SUKUNKA DEPOSIT
PAN OCEAN DEPOSIT
NOMAN CR. DEPOSIT
ALASKA HIGHWAY
PEACE RIVER
PINE RIVER
MURRAY RIVER
BURNT RIVER
ALBERTA
BRITISH COLUMBIA
LEGEND
Commotion Formation
Gething Formation
Thrust Fault
Syncline
Anticline
Road - Main
- Secondary
Explored Coal occurrences
10 0 10 20 MILES
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NORTHERN ROCKY MOUNTAINS
GEOLOGY
EASTERN BELT
SCALE 1:500,000
JAN., 1975
FIG. 3

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