PR-PEACE RIVER CANYON 71(1)A

CINNABAR PEAK MINES LTD.

1971 GEOLOGICAL EXPLORATION OF PEACE RIVER CANYON COAL PROPERTIES NORTHEASTERN BRITISH COLUMBIA

Geographic Coordinates
55° 56' N
122° 8' W
NTS Sheet 83O/16E

by
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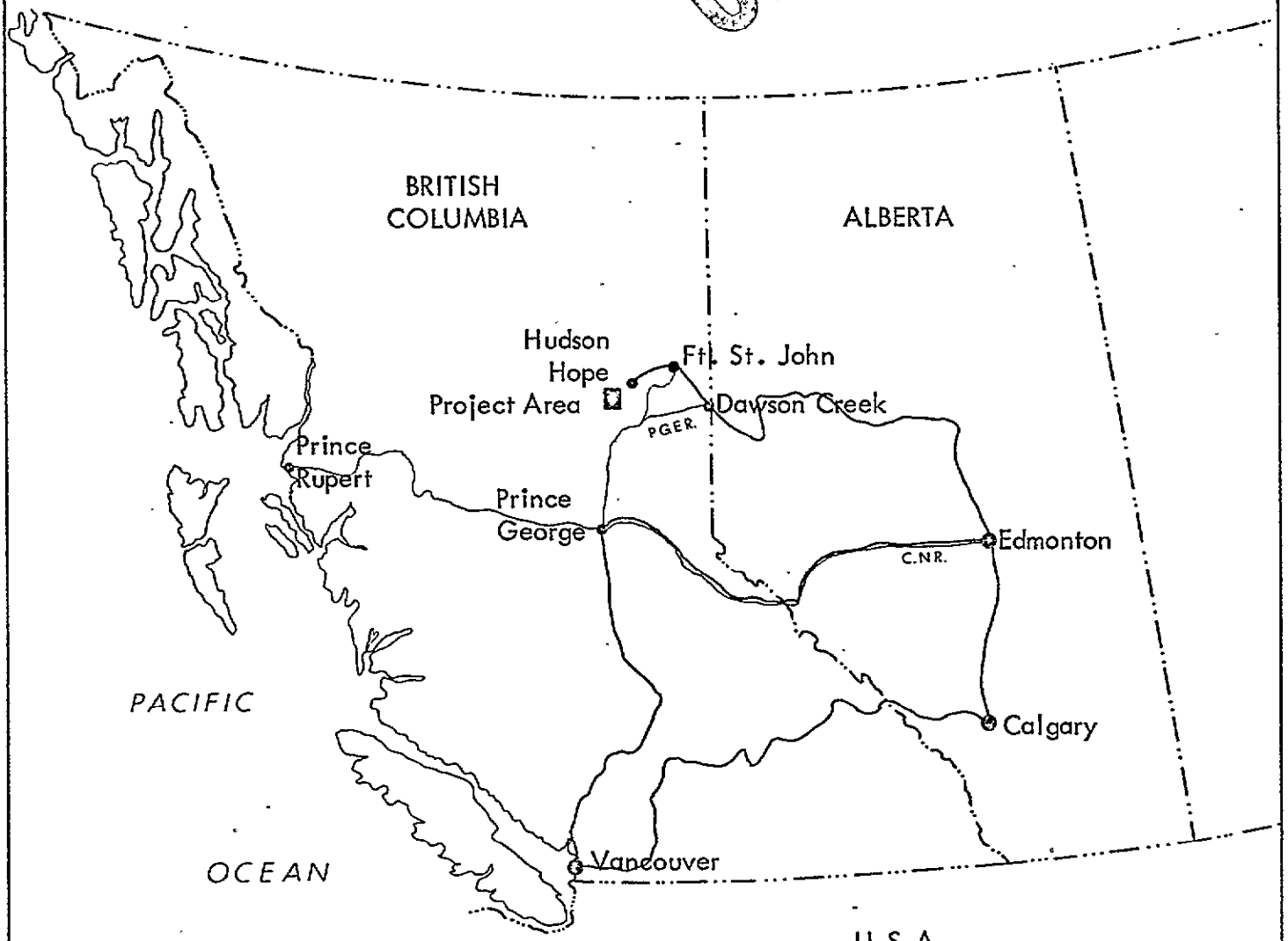

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
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Expiry Date: August 5, 1972

CINNABAR PEAK MINES LTD.
L.B. HALFERDAHL & ASSOCIATES LTD. EDMONTON, ALBERTA
Fig. 1: Location Map PEACE RIVER CANYON PROPERTIES
0 100 200 300 400 SCALE IN MILES
Drawn: LBH December 1971

PR-Prc 7(1)A

INTRODUCTION

Numerous coal seams in the Lower Cretaceous Gething Formation have been known in the Peace River Canyon of northeastern British Columbia since before the turn of the century. Although their stratigraphy has been investigated in considerable detail from time to time by government geologists, and small amounts were mined each year for more than 20 years, mostly for local heating purposes, it is the worldwide interest in coal, particuarly coking coal, in the past few years, that has provided the exploration incentives to obtain the geological and engineering information needed to decide whether large scale mining of these coal seams is economic.

Cinnabar Peak Mines Ltd. obtained coal rights in and near the Peace River Canyon in 1969 and 1970, and drilled three holes in late 1969.

In 1971 geological field work on the coal properties held by Cinnabar Peak Mines Ltd. began on July 4 and ended on November 4, with a crew ranging from 4 to 7 men. The work included locating, measuring, and sampling coal seams throughout the properties, geological observations on formations adjacent to the coal-bearing Gething Formation, cutting of trails and baselines, trenching of seams by both bulldozer and blasting, and constructing access roads to isolated areas as well as to potential drill sites. Accommodation for the crew was rented in Hudson Hope, about 20 miles by road from the properties. Transportation was provided by rented vehicles: one 4x4 and a $\frac{3}{4}$-ton pickup. A canoe was used to cross the Peace River to provide access to the south side of the Canyon. Two bulldozers, a D6 and a D8, were contracted for trenching and construction of access roads.

This report provides geological data from the first stage of the program designed to evaluate the coal seams on the Peace River Canyon properties of Cinnabar Peak Mines Ltd. It is based on available data in published and unpublished reports, on the 1969 drilling, and on the exploration undertaken in 1971. The section on Stratigraphy is based mostly on published

reports, and is longer than the usual brief summary because the previous stratigraphers who have studied the Peace River Canyon do not yet appear to agree on an entirely satisfactory sequence of formations. Throughout this report, all thicknesses of coal seams are in inches.

SUMMARY AND RECOMMENDATIONS

The property consists of 37 coal licences comprising 21,755 acres and options on 5 leases comprising 1600 acres. These are located on both sides of the Peace River Canyon in northeastern British Columbia, a few miles downstream from the Bennett Dam, and from 10 to 20 miles southwest of Hudson Hope. Access to the properties is by highway, logging roads, and other unimproved roads. They are about equally distant from Roberts Bank near Vancouver and Prince Rupert: less than 700 miles. A spur line 40 to 50 miles long will connect them to an existing railway.

The coal seams have received considerable attention from government geologists, but production from 5 mines in or adjacent to the property totalled less than 60,000 tons until 1963 when all production ceased due to depressed markets for coal.

The rocks in and near the Peace River Canyon consist of Lower Cretaceous sandstones, shales, mudstones, ironstone, conglomerates, and coal seams in the Minnes, Bullhead, and Fort St. John Groups. The Gething Formation contains the coal seams that are of interest. The area can be divided into three bands on the basis of geological structures: a western band with apparently uniform dips mostly less than 20° to the west and southwest and decreasing to the southwest, a central disturbed band with folds and faults, and an eastern band with mostly uniform dips up to 30° to the east.

Three of the formerly operated mines in the area produced coal from the King and "48" Seams which were intersected down the dip in two of the holes drilled in 1969.

Included in more than 35 coal seams, apparently in the middle part of the Gething Formation and uncovered by bulldozer trenching on Mount Johnson, are four seams with thicknesses ranging from 28 to 60 inches. On and near the southern part of Mount Johnson, these and other seams are at or close to dip slopes, which may make them suitable for strip mining.

Twenty coal seams with average thicknesses ranging from 22 to 84 inches have been correlated, some definitely, others less definitely, for as much as 11 miles along their strikes mostly on the properties of Cinnabar Peak Mines Ltd. They underlie much of the properties. Two of these seams have free swelling indexes in the range of coking coals; others may also be of coking or blending quality. Most of the coal is low to medium volatile bituminous with low ash, and almost all with less than one per cent sulfur, making it suitable for coal-burning power plants.

Preliminary reserve estimates are 402,233,000 tons indicated and 687,824,000 tons inferred. Of these there are 244,738,000 tons indicated and 464,206,000 tons inferred in seams with average thicknesses greater than 45 inches. Included in these estimates are 251,461,000 tons of potentially coking coal in two seams near the top of the Gething Formation. Most of the coal in the thicker seams appears suitable for underground mining; as much as 20,000,000 tons may be suitable for strip mining.

It is recommended that additional geological and engineering information on the coal seams in the Peace River Canyon properties of Cinnabar Peak Mines Ltd. be obtained. Initially holes should be drilled at the four or five sites prepared during the 1971 program. Additional drilling and sampling by the driving of adits are subsequent requirements.

PROPERTY

The coal properties near the Peace River Canyon (Fig. 3) held by Cinnabar Peak Mines Ltd. consist of 37 coal licences comprising 21,755 acres and options on 5 leases comprising 1,600 acres, which cover rights for all coal, petroleum, and natural gas. Details are given below. All the coal licences were issued November 27, 1970, and rentals and renewals have been paid to November 27, 1972.

Coal Licence No.	Lot No.
1019	1033
1020-2	1044-6
1023	1048
1024	Part N½ 1050 south of Peace River
1025	E½ 1054
1026-39	1056-69
1040-1	1072-3
1042-8	Unsurveyed (1 sq. mile each)
1049	Unsurveyed (½ sq. mile)
1050-2	Part of unsurveyed lots south of Peace River
1155	S½ and NE¼ 1039
1156	Part 1040 north of Peace River
1157	1041

Lease No.	Lot No.
2060	W½ 1054
2061	1055
2062	S½ 1050
2063	276
2064	NW¼ 1039

GEOGRAPHIC SETTING

The properties are in northeastern British Columbia, 10 to 20 miles southwesterly from the Town of Hudson Hope. The licences and leases are on both sides of the Peace River Canyon, a few miles downstream from the W.A.C. Bennett Dam of the British Columbia Hydro and Power Authority near Portage Mountain.

Hudson Hope has a population of about 2000 and is about 45 miles southwesterly from Fort St. John to which it is connected by a paved road about 60 miles long. Hudson Hope is about 25 miles northwesterly from Chetwynd to which it is connected by a paved highway about 40 miles long. Both Fort St. John and Chetwynd are on paved highways forming part of the British Columbia highway net and both are on the Pacific Great Eastern Railway which comes to within 18 or 20 miles of the property. Fort St. John is served by regularly scheduled airline flights from Edmonton and Vancouver.

From Hudson Hope parts of the property on the north side of the Peace River are reached via the paved road to the Bennett Dam for about 5 miles and thence southwesterly on an unimproved road passable for a late model car in wet weather for about another 5 miles. Other parts are accessible from access roads built in connection with the construction of the Bennett Dam. From Hudson Hope the property on the south side of the Peace River is reached via the highway to Chetwynd for 11 miles and thence westerly for about 8 miles on a well maintained gravel logging road constructed by Canadian Forest Products, but open to the public. This road continues west across the property and connecting roads cross other parts of the property.

The property is crossed by electric power lines from the Bennett Dam and by a natural gas pipe line.

The Canyon of the Peace River which crosses the property is about 1000 feet deep. The summit of Portage Mountain which is almost on the property on the north side of the Peace River rises 3000 feet above the bottom of the

Canyon. Mount Johnson on the south side of the Peace River rises about 1600 feet above the bottom of the Canyon. Except for these topographic features and the valleys of creeks tributary to the Peace River, the rest of the property has only moderate slopes. Much of the property was burned many years ago and is now covered with second growth stands of poplar, pine, and spruce. Some has been logged. Except for the Peace River Canyon and the canyons and beds of tributary streams, outcrops are scarce although some bedrock is exposed at depths of only a few feet at places along the Canadian Forest Products logging road.

PREVIOUS INVESTIGATIONS AND PRODUCTION

The coal seams and stratigraphy in the Peace River Canyon have been investigated many times by government and other geologists. The most detailed study of the coal seams is that of F.H. McLearn in 1922. Additional details were obtained by McLearn and Irish (1944), by Beach and Spivak (1944), by the British Columbia Hydro and Power Authority in their damsite investigations in the late 1950's and early 1960's, and by Stott (1968) and (1969). Some of the Annual Reports of the British Columbia Minister of Mines not listed in the references contain information on mining, production, and inspections.

Complete data on coal mining and production have not been obtained, but some information is summarized in Table 1. During the periods of production, high transportation costs and latterly competing fuels restricted most consumption of coal from these mines to heating for local use and along parts of the Alaska Highway.

TABLE 1: COAL MINES AND PRODUCTION

Dates	Mine	Location	Seam	Workings	Production (tons)
About 1923	Aylard	Grant Flat	Grant	Modest	65 in 1923 1,000 (est. total)
1928	-	Coalbed Creek	Trojan	Adit 35' Drift 65'	Not recorded
1940-48	Gething No. 1&2	King Creek	King	Extensive	4,000 (est.)
1944-51	Peace River	Larry Creek	Murray	Extensive	22,000 (est.)
1949-63	Gething No. 3	King Creek	"48"	Extensive	28,000 (est.)

STRATIGRAPHY

The exposed bedrock in and near the Peace River Canyon consists mostly of Lower Cretaceous Formations. One of these - the Dunlevy - much used in previous geological investigations of the area for Lower Cretaceous rocks stratigraphically below the Gething Formation, is now known to comprise strata which cannot be properly grouped into one formation according to stratigraphic principles. Its abandonment has been recommended by Hughes (1964) and by Stott (1967),(1968). Additional background information on the use and misuse of the Dunlevy Formation is given in some of the references.

As no new stratigraphic data on this part of the stratigraphic section were obtained during the 1971 field work, the stratigraphic names, intervals, and units used throughout this report (Table 2) are mostly those designated by Stott (1967) with some modifications to bring them closer to the views of Hughes (1964). The Cadomin Formation is used in spite of its long range correlations

TABLE 2: LOWER CRETACEOUS FORMATIONS AT THE PEACE RIVER CANYON

Group	Formation	Lithology	Thickness
Fort St. John	Cruiser	Marine shale and thin sandstone	800' to 900'
	Goodrich	Marine sandstone with interbedded shale	Up to 1320'
	Hasler	Marine shale with thin sandstone beds	700' to 868'
	Gates	Massive sandstone with interbedded mudstone	227' to 430'
	Moosebar	Dark marine mudstone, thin ironstone	958' to 1085'
Bullhead	Gething	Non-marine sandstone and shale; coal seams	1650' to 1850'
	Cadomin	Non-marine conglomerate, sandstone, shale, thin coal seams	343' to 556'
Minnes	Brenot	Non-marine sandstone, shale thin coal seams	485'
	Beattie Peaks	Marine sandstone, siltstone, shale, and ironstone	331'
	Monteith	Marine sandstone, quartzites, thin shale	583' to 1200'

with the type section of the Cadomin, and the difficulty in distinguishing it from some of the coarser sandstones of the Gething Formation. This difficulty may well account for its reported large change in thickness in and near the Peace River Canyon. The lower contact of the Gething Formation is placed where the fine-grained sandstones of the Gething become coarse-grained and conglomeratic; this is the same stratigraphic horizon used by Stott and most other investigators. In spite of Stott, it seems reasonable to correlate Hughes' Brenot Formation with its thin coal seams with Stott's unnamed unit at the top of the Minnes Group below the major pre-Cadomin unconformity. The Beattie Peaks Formation corresponds only to unit 1 of Stott (1967). If this is correct then the chief differences between Stott and Hughes seem to be the recognition or lack of recognition of unconformities above and below the Brenot Formation and their relative importance. Possibly there are two unconformities.

Monteith and Beattie Peaks Formations

In and near the Peace River Canyon, the Monteith Formation has been mapped by Hughes (1964) on Grant Knob. Although not mapped as such, it probably forms part of the undifferentiated pre-Gething strata on Mount Johnson on the south side of the Peace River. On Grant Knob, Hughes measured 583 feet in the upper part, and in a well about 10 miles north of Grant Knob, noted 960 feet for the whole Monteith Formation. Interpolation between known thicknesses on Beattie Peaks to the southwest and in a well 15 miles east indicates a thickness of about 1200 feet at the Peace River Canyon. The Monteith Formation is marine and consists dominantly of sandstones and quartzites with less thin shale. The sandstones can be grouped into quartzites and quartzitic sandstones, some with abundant granule size material, and argillaceous and feldspathic sandstones. Bitumen has been found in many of the sandstones in varying amounts.

The Beattie Peaks Formation has also been mapped by Hughes (1964) on Grant Knob, and probably forms part of the undifferentiated pre-Gething strata on Mount Johnson on the south side of the Peace River. On Grant Knob,

Hughes measured 331 feet of strata which comprise the entire formation there: it thickens to the west and thins to the east. The Monach Formation (unit 2 of Stott, 1967) which overlies the Beattie Peaks Formation to the west was not found on Grant Knob. The Beattie Peaks Formation is marine and consists of thick-bedded fine-to medium-grained sandstones, and thinly interbedded black, dark grey, and brown shales and siltstones, thin sandstones, and ironstone bands.

Brenot Formation

Like the two preceding formations, the Brenot Formation has been mapped by Hughes (1964) on Grant Knob and probably forms part of the undifferentiated pre-Gething strata on Mount Johnson. On Grant Knob, Hughes measured and estimated 485 feet of strata which comprise the entire formation there. This compares with 359 feet described by Hughes in a well about 10 miles north. According to Hughes, exposures of the Brenot Formation consist mostly of sandstone, but some cyclothems with fine-grained sandstones, silty, sandy, and carbonaceous mudstones, coals, black carbonaceous shales, dark grey sandstones and shales, and siltstone and sandstone are present. The coal seams noted by Hughes on Grant Knob are thin, the thickest being 4 inches. However, at the Packwood (Reschke) Mine on the west side of Butler Ridge about 11 miles northwesterly from Grant Knob, 2 or 3 seams ranging from 30 inches to 5 feet thick have been mined in strata which are probably equivalent either to the Brenot Formation or to part of the Cadomin Formation.

Cadomin Formation

The Cadomin Formation in and near the Peace River Canyon is present on the west sides of Mount Johnson, Grant Knob, and Portage Mountain. From there it extends northwesterly to the W.A.C. Bennett Dam and beyond on the southwest side of Williston Lake. The apparent thickness varies in the Peace River Canyon partly because of facies changes, and partly because the upper contact has been placed at different stratigraphic levels in different places in the

area. Stott (1968) measured 343 feet in part of the Cadomin Formation at the head of the Peace River Canyon. The Cadomin forms the lower part of Hughes' Dresser Formation; with the top of the Cadomin 41 feet below the Murray Coal Seam, the total thickness of the Cadomin Formation in the drill holes used by Hughes at the head of the Peace River Canyon is 556 feet. Exposures at the head of the Peace River Canyon measured by Stott (1968) show that the Cadomin consists mostly of medium-to coarse-grained sandstone and conglomeratic sandstone with pebbles to one or two inches in size. Beds of these rocks are up to 50 feet thick, and grade laterally into each other in short distances. Hughes' descriptions of drill core show in addition to the sandstones a number of coal seams up to 6 inches interbedded with shale in some intervals, and several thick intervals consisting dominantly of shales and siltstones.

Gething Formation

Strata of the Gething Formation outcrop along most of the upper part of the Peace River Canyon from the W.A.C. Bennett Dam to Grant Flats and intermittently along creeks tributary to the Peace River in this area. At Johnson Creek the outcrop belt of the Gething Formation leaves the Peace River, extends along the west, south, and east sides of Mount Johnson, crosses the Peace River and trends north along the east side of Portage Mountain. Measurements and estimates of the thickness of the Gething Formation in the Peace River Canyon ranging from 1000 feet to about 1800 feet have been made by McLearn (1923) and Stott (1968), (1969). No one has yet measured one complete section of the Gething Formation; the best available is that of Stott (1969) who measured all but 150 feet to 190 feet, mostly inaccessible, at the top of the formation, downstream along the west bank of the Peace River starting near the base of the W.A.C. Bennett Dam. In order to match coal seams on both sides of the Peace River, Stott postulated a fault* a short distance

* If present, this fault was apparently missed by those investigating sites for the W.A.C. Bennett Dam (Dolmage and Campbell, 1963).

upstream from Gething Creek. With this fault, the stratigraphic interval measured constitutes the lower 1460 feet of the Gething Formation up to the top of the Titan Coal Seam. With 190 feet in the Gething Formation above the Titan Seam in the Aylard Creek section, the total thickness of the Gething is 1650 feet in the upper Peace River Canyon. In a well 15 miles east, Stott (1968) assigned a thickness of 843 feet to the Gething Formation. This variation and possibly others in the lower Peace River Canyon are due to facies changes or to the fact that the Gething-Cadomin contact is not at the same horizon at different places.

The upper contact of the Gething Formation in the Peace River Canyon is marked by a bed of conglomerate one-half to one foot thick which contains pebbles of chert to one or two inches in size. This conglomerate was located in 1971 at Aylard Creek, Coalbed Creek, and at Contact Point. At Contact Point underlying the conglomerate is a unit of dark brownish-grey fine-grained sandstone and silty sandstone containing nodules of pyrite or marcasite.

The Gething Formation in and near the Peace River Canyon consists mostly of fine-grained sandstones, siltstones, mudstones, and shales of grey, brown, or black; and bands and concretions of clay ironstone, and orange to buff-weathering dolomitic rocks. The sandstone units range up to 30 feet or more, and are commonly thinly bedded. Units of siltstone, mudstone, and shales range up to 20 or 30 feet or more, but are mostly less. Numerous coal seams ranging up to 8 feet thick with many averaging more than 40 inches are present throughout the Gething Formation. They are described in later sections of this report.

Moosebar Formation

Southwest of the upper and middle parts of the Peace River Canyon, the Moosebar Formation forms a southeasterly trending band where it is exposed above the Gething Formation along parts of some creeks. South of Mount Johnson, the Moosebar swings to the east and then trends northerly past

Moosecall Lake and crosses the Peace River at Contact Point. Stott (1963) moved McLearn's type section from the north to the south side of the Peace River at Contact Point where he measured its thickness as 958 feet. Thicknesses greater than 1300 feet have been measured on Track Creek (a tributary of Gething Creek) (Stott, 1968; Beach and Spivak, 1944) but Stott indicates that there the Moosebar Formation has been thickened by faulting. As the Moosebar-Gething contact forms an excellent horizon marker, the thickness of the Moosebar Formation can be used in covered areas of the property to plot the Moosebar-Gething contact from the Moosebar-Gates contact. Accordingly, in September 1971, A. Kahil measured the Moosebar type section at Contact Point (Appendix 1). He obtained a thickness of 1085 feet. A compromise thickness of 1000 feet has been used in this report for the Moosebar from Contact Point to Coalbed Creek, thence increasing to 1350 feet northwesterly to Gething Creek.

The Moosebar Formation consists of a monotonous succession of recessive, rubbly, marine mudstones with a few sandstone intervals up to 3 or 4 feet thick near the top. A few layers are glauconitic. Clay ironstone concretions up to 6 inches or more are common throughout; they are mostly in layers and in places are the only means of determining the attitudes of the rubbly mudstone in which bedding is not distinct. The apparent lack of visible bedding may account for part of the variations in measurements of the thickness.

Gates, Hasler, Goodrich, and Cruiser Formations

The Gates, Hasler, and Goodrich Formations overlie the Moosebar Formation on the south side of the Peace River Canyon where their outcrop belts form an irregular U open to the north, with the Gates and Hasler trending north across the Peace River east of Portage Mountain. The Cruiser Formation outcrops only on the flank of Tworidge Mountain in the extreme southeast corner of the property. Near Steamboat Island in the Canyon, the Gates Formation is 227 feet thick and consists of two sandstone units separated by

silty mudstones (Stott, 1968). At the same locality, Beach and Spivak (1944) measured 245 feet of the Gates Formation, and on Johnson Creek 430 feet.

At the mouth of Starfish Creek in the lower part of the Canyon, the Hasler Formation consists of 700 feet of dark grey, thin-bedded marine shales with thin sandstone layers (Beach and Spivak, 1944). This compares with 868 feet in the type section about 20 miles to the south (Stott, 1968).

A complete section of the Goodrich Formation has not been measured near the Peace River Canyon. It consists mostly of sandstones and is 1320 feet thick about 20 miles to the south (Stott, 1968).

The Cruiser Formation consists mostly of recessive shales; nowhere has a complete section been measured. Beach and Spivak (1944) estimated a total thickness of 800 to 900 feet on Tworidge Mountain near the extreme southeast corner of the property.

STRUCTURE

The part of the Peace River Canyon which includes the properties of Cinnabar Peak Mines Ltd. can be divided into three northerly trending bands on the basis of geological structures. The central band is the most disturbed. It is about $1\frac{1}{2}$ miles wide, and crosses Portage Mountain, Grant Knob, and part of Mount Johnson. In 1971 field observations were made only on the southern part of Mount Johnson and on the east side of Portage Mountain. Therefore, the basis for the structural interpretation herein includes observations from Beach and Spivak (1944) and aerial photographs. The western border of the central structural band is gradational with westerly dips steepening from 20° or less to as much as 50° or 60°. Farther east the dips decrease toward the axis of the southerly extension of the Butler anticline. North of the Peace River the Butler anticline appears well established from dip and strike measurements. Its axis apparently is intersected by a well established high-angle fault on the east, but the location of this intersection is uncertain. One attitude indicates that the axis of the Butler anticline extends south of the Peace

River, but aerial photographs indicate uniform westerly dips west of the fault south of the Peace River. East of the high-angle fault north of the Peace River is a band about 1000 feet wide mapped as Gething Formation at the axis of a syncline by Beach and Spivak. Aerial photographs indicate a band of steeply dipping rocks with a structural discontinuity with more gently dipping strata on the east. The east boundary of these steeply dipping rocks is shown as a fault. Farther east on the east side of Portage Mountain the contact between the Cadomin and Gething Formations is shown as faulted in agreement with Beach and Spivak. The extent of the two easterly faults across to the south side of the Peace River is not known. Near the King Gething Mine, measured attitudes by McLearn and Irish (1944) indicate an anticlinal axis in the Gething Formation a few hundred feet east of the most easterly fault.

South of the Peace River on the southeast side of Mount Johnson the most westerly fault is well established by a linear topographic depression, changes in attitude of the beds as it is crossed, and a linear feature on aerial photographs. This fault appears to extend for at least several miles to the south, but it has not been precisely located. Changes in attitude of strata in the Gates Formation one to two miles south of Moosecall Lake may be related to it. East of the fault is what appears on aerial photographs to be a southerly plunging anticline, and then a syncline. These are confirmed by measured attitudes of beds. Farther to the east is a prominent northerly trending scarp which may be an extension of a fault from north of the Peace River. In this area, measurements were obtained in two places on southeasterly dipping strata. These may indicate an anticlinal axis near the scarp, but data are insufficient to choose between these two possibilities.

One or possibly more subsidiary faults from the major structures in the central structural band are shown. Others can be expected.

The western structural band is three to four miles wide, and comprises rocks of the Gething, Moosebar, Gates, and Hasler Formations. All strata strike northwesterly and dip southwesterly, mostly at less than 16°, but a few at 20° and even 25° where measured in and near the Canyon. However, on the

southwest side of the Canyon between Island and Johnson Creeks, the distance between the upper and lower contacts of the Moosebar Formation and its thickness requires an average dip of less than 10°, and in places as low as 3° or 4°. These dips are confirmed by measurements of Beach and Spivak along and near Johnson Creek in the Hasler Formation. Where rocks of the Gething Formation are visible on both sides of the upper Canyon, their attitudes appear regular and uniform. At the site of the W.A.C. Bennett Dam no faults of any type were observed in the rocks (Dolmage and Campbell, 1963). Farther downstream, Stott (1968) and (1969) accounted for thicker than normal sections of the Gething and Moosebar Formations by postulating faults.

The eastern structural band is up to about three miles wide on the properties of Cinnabar Peak Mines Ltd. North of the Peace River, strata of the Gething Formation strike northerly and dip from 15° to 30° east. South of the Peace River the strike is also northerly, but most of the dips are in the range of 5° to 20° east. Overburden and Moosecall Lake obscure the structure of most of the Gething and Moosebar Formations south of the Peace River away from the Canyon.

KING GETHING MINE AREA

The King Gething No. 1, 2, and 3 Mines are in Lots 276 and 1039 on the east slope of Portage Mountain. They are connected to the paved road from Hudson Hope to the W.A.C. Bennett Dam by a narrow unimproved road, but readily passable for an ordinary car even in wet weather. Almost all the area is covered with scrub poplar and other bushes. Overburden obscures the bedrock nearly everywhere except along creeks, but is only a few feet thick in places.

The King Gething Mines are in strata of the Gething Formation which consist of sandstone, siltstone, shale, mudstone, ironstone, and coal. As explained in the section on Structure, the area of the mines is on the eastern

flank of an anticline whose axis trends northerly. Most of the western flank is cut or obscured by what appears to be a thrust fault. In the mine area, the dips on the eastern flank range from 15° to 30°.

The King Gething No. 1 Mine was operated in the King Seam from 1940 to 1947 by driving a main entry which finally totalled 540 feet, a counter, and working rooms to the rise. Within 50 to 125 feet of the main entry, the rooms encountered glacial drift, and farther along the entry a burnt-out part of the seam. At 540 feet in the main entry a fault cut off the seam, and water flowing from it forced suspension of mining. Later, pillars were extracted. The mine is no longer accessible.

The King Gething No. 2 Mine was operated from 1947 to the spring of 1949. Entry was by means of a crosscut driven on the south side of King Creek to intersect the southerly extension of the King Seam which had been mined in the No. 1 Mine. Production ceased when a layer of clay ironstone within the seam made costs too high to continue operations. No data on the No. 2 Mine workings are available; they are no longer accessible.

The King Gething No. 3 Mine was operated from 1949 to 1963 with the last shipments made in early 1964. The No. 3 Mine is in a seam designated as the "48" Seam, about 3300 feet south of the No. 1 and No. 2 Mines. It was developed by a main entry which was driven almost due north along the strike of the seam and which finally totalled about 850 feet. A counter level was driven initially 75 feet and later increased to 100 feet up the rise from the main entry. It finally totalled 700 feet. Raises and rooms at intervals of 50 to 70 feet have been driven to the rise from the main entry past the counter; two reached the surface to provide ventilation and additional exits. In 1953 and 1954 strip mining was attempted down the dip of the "48" Seam from the main entry. Overburden ranging from 4 to 30 feet, including 8 to 14 feet of sandstone which roofed the coal and required blasting, made the operation unsuccessful. In 1954 some of the equipment was used to open a third entry for 120 feet, 100 feet on the slope from the main level. Falling markets for coal stopped production in 1963. Access to much of the main entry is still easy although

large slabs of sandstone have caved from the back in places in the first 300 or 400 feet. One of the raises extending about 300 feet to the surface from a point in the main entry is in very good condition. Methane has not been a problem in any of the three mines.

Other seams in addition to the King and the "48" Seams are the Quentin (32") and Gully (35") Seams and a few other thinner seams, which were located or named or both by McLearn and Irish (1944). In 1971, a 30-inch seam and other thinner seams were located on the road to the Peace River about 3000 feet south of the King Gething No. 3 Mine. Also in 1971, a coal seam with 58½ inches of coal was found along King Creek near where the Gully Seam was reported. This thicker seam has been correlated with the Trojan Seam on the basis of its stratigraphic position in the Gething Formation.

In late 1969, three holes drilled within 2000 feet east of the King Gething No. 1 and No. 3 Mines (Fig. 6) intersected a number of coal seams (Fig. 7). The drillers' reports indicate that the thicker coal seams were intersected at the following footages:

Hole No.	Footage	Apparent Thickness	True Thickness
1	567.8 to 574.8	96"	85"
2	327.0 to 333.4	76"	68"
2	718.5 to 726.8	99"	88"
3	243.5 to 248.5	60"	54"

With dips in the range 20° to 30° as indicated by surface measurements in the area, the seams at 182 feet in Hole No. 1 and 327 feet in Hole No. 2 (Fig. 7) can be correlated with the King Seam. Additional support for this correlation is obtained by the higher free swelling indexes (Appendix 3) in the lower parts of the seam intersections above. The intersection of 1½ or 2 feet at 182 feet in Hole No. 1 indicates that either the King Seam thins markedly to the south or the drillers' reports are inaccurate. With similar dips, the seams at 568 feet in Hole No. 1 and at 718½ feet in Hole No. 2 can be correlated with the "48" Seam. The seam at the top of Hole No. 2

is the Quentin Seam as indicated by the stratigraphic interval between it and the King Seam and the description of McLearn and Irish. With the strata striking north or slightly east of north and with the dips given above, the seam at 339 feet in Hole No. 3 is correlated with the Quentin Seam.

It is uncertain from the drillers' reports if the coal seam shown at 263 feet in Hole No. 2 (Fig. 7) is actually as thick as shown. The other seams in the three drill holes have not been correlated with any of the other named seams.

SOUTHERN PART OF MOUNT JOHNSON

Mount Johnson is near the southern end of the central structural band with its folds and faults, one of which trends north across it. The southern end of Mount Johnson rises steeply for about 800 feet from a broad, flat valley which is covered by thick glacial drift, and in which lie Moosecall Lake and part of Coalbed Creek. Much of Mount Johnson was burned many years ago; the resulting deadfall and second growth jackpine and scrub poplar make ground access difficult. Accordingly early in the field season trails and baselines were cut from the Johnson Creek road of Canadian Forest Products Limited. Later a 4-wheel-drive road about 2½ miles long was constructed from the Johnson Creek road across Coalbed Creek and part way along the east side of Mount Johnson to provide access to three bulldozed trenches and potential drill sites.

Narrow stream valleys on the southwest side and the bulldozer cuts along the east side indicate that the lower parts of Mount Johnson are covered with thick glacial deposits, some of which are light brown silty till, perhaps 30 feet thick. Resistant sandstone ledges outcrop higher up the mountain where trenches and pits indicate up to 1 or 2 feet of overburden which consists of angular float and other debris.

The southern part of Mount Johnson is underlain mostly by sandstones, siltstones, shales, and coal of the Gething Formation. The sandstones are

predominantly medium- or fine-grained, and are mostly hard and tough. Some are slightly calcareous; others contain carbonaceous spots and streaks. They include buff- and brown-weathering types, and finely-banded flaggy or massive types. The siltstones are variable; they are mostly dark-grey, blue-grey, or brown in color, some with carbonaceous patches and streaks. The shales vary in color from grey, through blue-grey to black; some weather grey or white. They are common above, below, and as partings in the coal seams where fissile black, carbonaceous, or coaly types are present. One 4-inch conglomerate bed with pebbles of varying size was uncovered near Trench #2. Material termed consolidated debris which consists of angular blocks of sandstone and fragments of shale and coal in a soft matrix is present at places along the east side of Mount Johnson. Similar material is present farther to the northeast along Watidu Creek. Its genesis is uncertain: fault breccia or unusual type of consolidated overburden.

The structure of Mount Johnson has been described in an earlier section. West of the northerly-trending fault, the strata strike NW and dip 20° to 50° SW. Hence the slope on the southwestern end of Mount Johnson is very close to the dip slope of the Gething rocks, but it steps across from lower beds to higher ones at successively lower elevations. Although the west side of Mount Johnson was not examined in 1971, there the dip slope probably steps similarly across from lower to higher beds in the Gething Formation at successive intervals from north to south. Exposures of sandstone on the low ridge between Coalbed Creek and Mount Johnson indicate generally northwesterly strikes and dips from 5° to 30° SW. These strata are in the upper part of the Gething Formation. With the apparently thin overburden, any coal seams encountered there appear to be suitably situated for strip mining. East of the northerly-trending fault along the east side of Mount Johnson, a bulldozer uncovered some Gething rocks with dip slopes to the south under variable thicknesses of overburden. Further work is required there to determine if strippable coal is present.

Coal Seams

Thirty-five coal seams ranging from ½ to 65 inches were found in the two larger bulldozed trenches (Fig. 8 and 9) with the lower trench exposing somewhat more and thicker seams. Prior to the trenching, a number of coal seams had been located in hand-dug pits; coal fragments in ant hills provided clues to coal seams under shallow overburden. Ten of these 35 seams are more than 15 inches thick; one is 60 to 65 inches thick. Four of the thicker seams in Fig. 9 have been correlated with those present elsewhere on the property: 28 inches - Little Mogul; 60 inches - Mogul; 44 inches - Castle Point; 30 inches - Milligan. The weathered nature of the coal in these seams restricted observations on its quality. The lower parts of the Mogul and Castle Point Seams are cleaner and brighter than the upper parts. Much of the Milligan Seam is canneloid coal. About 50 feet stratigraphically above the Little Mogul Seam is an interval which contains 47 inches of coal in several seams in a stratigraphic thickness of 67 inches. If the above correlations are correct, the coal seams exposed in the trenches are near the middle part of the Gething Formation. Farther down the southwest-facing slope, the coal seams present in the upper part of the Gething are to be expected successively closer to the surface.

Six coal seams were found east of the northerly-trending fault (Fig. 11). Three are more than 15 inches thick, and one is more than 36 inches. It has not been correlated with any of the other seams on the property.

CORRELATION OF COAL SEAMS

More than 60 coal seams were noted by McLearn in the Gething Formation along the Peace River Canyon in 1922. Many of these are less than one foot thick, but 20 are two feet or more thick in at least one place. McLearn named most of the thicker seams in Table 3; two or three other seams

TABLE 3: THICKER COAL SEAMS IN GETHING FORMATION

Coal Seam	Depth Below Moosebar Formation (feet)	Coal Seam	Depth Below Moosebar Formation (feet)
Superior	15 - 28	Ferro Point	552 - 692
Trojan	90 - 115	Quentin	748 - 838
Titan	155 - 210	Index	882 - 1055
Falls	225 - 251	Grant	1014 - 1135
Gething	296 - 312	King	1130
Little Mogul	338 - 455	Riverside	1134 - 1168
Mogul	348 - 464	Knight	1240
Castle Point	428 - 526	Upper Twin	1307
Milligan	452 - 575	Lower Twin	1319
Galloway	577	Boring	1481
Wendy	493 - 610	"48"	1470
Louise	536 - 665	Murray	1606

are included. Many of the seams have been correlated by McLearn (1923), McLearn and Kindle (1950), and Stott (1968), (1969) but some of their correlations are not well established. Nevertheless, in the attempted correlation of all the thicker coal seams in the Gething Formation in and near the Peace River Canyon, some of the previous uncertain correlations of McLearn and Stott have been retained because data were insufficient for reliable changes. The correlations of the seams in Fig. 12 are based on their stratigraphic distances below the Gething-Moosebar contact, their thicknesses, their vertical variations in lithology and analytical data, and projections from their outcrops.

The Superior, Trojan, and Titan Seams, all within the upper 210 feet of the Gething Formation, have been traced along strike from Gething

Creek southeasterly to Coalbed Creek, and thence northeasterly to Contact Point, and the Trojan Seam across the Peace River to King Creek, a distance of more than 11 miles, mostly on the properties of Cinnabar Peak Mines Ltd. Why the thickness of the Trojan Seam at Moosebar Creek measured by both McLearn and Stott is less than at the other locations is uncertain.

The Falls Seam has been traced along strike from Gething Creek southeasterly to Johnson Creek, a distance of more than 6 miles. Its continuation to Mount Johnson and thence northeasterly to the Peace River near Contact Point is expected to be established by further work.

The Gething Seam was named by McLearn for a seam below the Falls Seam on Gething Creek. Although stratigraphic measurements are insufficient for certainty, this seam has been correlated with one approximately 300 feet below the Gething-Moosebar contact on the West Bank and along Aylard Creek.

According to McLearn, the Mogul and Little Mogul Seams are 10 feet apart. Two seams uncovered by the trenching on Mount Johnson are 8 feet apart, have thicknesses comparable to the Mogul and Little Mogul Seams elsewhere, and from projections appear to be in the correct stratigraphic part of the Gething Formation. Accordingly they have been correlated with the Mogul and Little Mogul Seams. Although McLearn indicated that the Little Mogul Seam extends from Earle Narrows to Moosebar Creek, a distance of about $2\frac{1}{2}$ miles, and becomes much thinner at both places, if the above correlation is correct, it extends at least 5 miles from Earle Narrows to Mount Johnson. A seam tentatively correlated with the Little Mogul was located on Johnson Creek. With the preceding correlation, the Mogul Seam also extends at least 5 miles from Earle Narrows to Mount Johnson. There is some doubt about the correlation of the Mogul and Little Mogul Seams on Moosebar Creek because although Stott and McLearn apparently located these seams at the same place, Stott measured a much smaller interval between the Titan and Mogul Seams. The Mogul and Little Mogul Seams were not identified in the drilling at Dam Site #2 because

the seams where they might have been expected had been burned.

The Castle Point and Milligan Seams are from 15 to 20 feet apart. Although both have not been located on Gething Creek, there the Galloway Seam has been correlated with the Milligan, and both probably extend $6\frac{1}{2}$ miles from there to at least Mount Johnson where two seams about 10 feet apart and apparently in the correct stratigraphic position have been correlated with them. The correlation shown on Moosebar Creek in Fig. 12 is based on Stott's sequence of seams, and because of the smaller interval between the Titan and Mogul Seams as previously explained, the distance below the Gething-Moosebar contact for the Castle Point and Milligan Seams on Moosebar Creek is up to 100 feet less than elsewhere.

The Wendy and Louise Seams are named herein for two seams between the Milligan and Ferro Point Seams. Both have been correlated from the West Bank in the upper Canyon to Moosebar Creek, with the Wendy beyond to Johnson Creek.

The Ferro Point Seam extends for at least 4 miles from the West Bank of the upper Canyon southwesterly as far as Moosebar Creek, and possibly farther.

The Quentin Seam was described by McLearn and Irish as being about 320 feet stratigraphically above the King Seam. In this report, a seam apparently at about the same stratigraphic level in the Gething Formation has been correlated with the Quentin Seam in the upper Canyon, at Dam Site #2, and at Moosebar Creek.

The Grant Seam has been correlated with the King Seam on the basis of its apparent stratigraphic position in the Gething Formation, similar thickness and ranks of coal, and a bottom bench of jet coal with an F.S.I. of $5\frac{1}{2}$ in the Aylard Mine and with good caking properties in the King Gething No. 1 Mine. A 60-inch seam encountered in drilling at Dam Site #2 also has been correlated with the Grant Seam. If these correlations are correct, then the Grant-King Seam extends for about 8 miles along strike from near Aylard Creek to King Creek. It seems reasonable to expect a length similar

to those of the Superior, Trojan, and Titan Seams.

A seam on the West Bank of the upper Canyon has been correlated by Stott with McLearn's Riverside Seam about 30 feet below the Grant Seam at the Aylard Mine. This is a distance of about 4 miles; drilling is required to obtain intersections between these points and to extend the Riverside Seam beyond them.

The Knight, Twin, and Boring Seams were named by McLearn and Irish on the East Bank of the upper Canyon, and subsequently noted on the West Bank by Stott. They have not yet been extended beyond the upper Canyon.

The Murray Seam of the upper Canyon has been correlated with the "48" Seam of the King Gething No. 3 Mine and nearby drill holes on the basis of similar stratigraphic positions in the Gething Formation, thicknesses, coal ranks, and analytical data. The difference of about 160 feet in stratigraphic thicknesses - about 500 feet between the Grant and Murray Seams in the upper Canyon and about 340 feet between the King and "48" Seams at King Creek - does not appear unreasonable in a lateral extent of 11 miles.

CHARACTERISTICS OF COAL SEAMS

Descriptions of coal seams and analyses of coal samples are presented in the appendices. In general, where outcrops are sufficient to permit reliable correlation and samples have been analyzed, the coal seams appear to have little lateral variation in thickness and in analyses of the coal. They do vary laterally in both presence and thickness of partings and ironstone concretions. The chief variations in each seam are stratigraphic: ash contents, free swelling indexes or caking properties vary from bench to bench. The analyses indicate that most of the coal is low or medium volatile bituminous, with a few samples being high volatile bituminous. Ash contents seldom exceed 20 per cent with many less than 10 per cent, particularly in the thicker seams. Only one of 39 samples that have been analyzed for sulfur contains more than one per cent.

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Partial analyses of the samples collected in 1971 are shown in Appendix 6. As most of these samples were collected from outcrops and were expected to be more or less oxidized, only moisture, ash, and free swelling index were determined for preliminary evaluation. Even though the samples were partly oxidized, free swelling indexes in the range 4 to 8 were obtained consistently for the Superior and Trojan Seams, both near the top of the Gething Formation in a similar stratigraphic position to the well-known Chamberlain Seam of excellent coking quality currently being explored south of Chetwynd near the Sukunka River. Other significant free swelling indexes were obtained at some places or from some benches of the Mogul, Grant, and Knight Seams, and an unnamed seam 36 feet below the Milligan Seam on Johnson Creek. Hence, it appears that rapid mechanical erosion of the coal in some creek beds and at some places along canyon walls can prevent oxidation from reducing free swelling indexes to insignificant values. However, high moisture contents in samples of the 60-inch seam exposed in a bulldozed trench away from creeks on Mount Johnson indicate that oxidation may have been responsible for the non-agglomerating coal samples. For this reason, not all samples collected from Mount Johnson were analyzed. In order to obtain less-oxidized samples from the Trojan Seam, trenches were blasted at two places: Coalbed Creek and Lower Moosecall Creek (Table 4). A parting ranging from 2 to 4 inches in the Trojan Seam on Coalbed Creek has been included in the lower 20-inch bench. The low free swelling index in the upper 20-inch bench is probably due partly to the higher ash content and partly to oxidation. At Lower Moosecall Creek, the ash contents of about 20 per cent in the 36-inch and 15-inch benches have apparently reduced their free swelling indexes. Unoxidized coal from the Trojan Seam after any required processing to reduce the ash content to an acceptable value is expected to have a free swelling index of 8 or more. Although coke-oven tests of large unoxidized samples are required to assess adequately the coking quality of coal, the free swelling index is generally regarded as a good indicator. Free swelling

for:

TABLE 4:

'ANALYSES OF COAL FROM TROJAN SEAM AFTER BLASTING'

Refer to:

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indexes in the range 5 to 9 are characteristic of the better western Canadian coking coals.

Seams five feet or more thick at one or more places include the Trojan, Titan, Mogul, Grant-King, and Murray-"48". Of these, coal has been mined from the Grant-King and the Murray-"48" in the past. As previously indicated, free swelling indexes for samples obtained from the Trojan Seam in 1971 are consistently in the range of those for coking coal, and free swelling indexes from some benches in the Mogul and the Grant-King Seams are also in the range of those for coking coal. Coal from all five of these seams with its low ash and low sulfur contents is suitable for coal-burning power plants. Of the somewhat thinner seams, the Superior has free swelling indexes in the range of those for coking coal.

RESERVES

Information for estimating coal reserves on the Peace River Canyon properties of Cinnabar Peak Mines Ltd. consists of measured thicknesses of coal seams at intervals ranging up to three or more miles apart and the correlations made in a preceding section. An average of measured thicknesses for each seam, unweighted for length of projected outcrop nor for area, is used as the average thickness of the seam. At some locations measured, the thickness used is greater than the sampled thickness because part of the seam was covered when sampled. The area underlain by each seam on the properties has been measured from seam outcrops and projections of traces of seam outcrops, after allowing for mining restrictions within one-quarter mile of the 1650-foot contour, which is the reservoir level of a second dam proposed by the British Columbia Hydro and Power Authority. In measuring the area underlain by each seam, traces of outcrops have not been projected along strike for more than one mile beyond the last outcrop except for the Superior, Trojan, Titan, Grant-King, and Murray-"48" Seams, whose thickness, or continuity, or both

provide bases for projecting them farther along strike. Indicated reserves mean coal within one mile of the seam outcrop or within one mile of its projected trace in Fig. 4. Inferred reserves mean coal beyond one mile of the seam outcrop or its projected trace. For measuring the areas underlain by seams with limited outcrops in the upper Canyon, in the middle and lower parts of the Gething Formation, the Peace River has been arbitrarily chosen as the trace of the projected outcrops. For seams or parts of seams whose traces are not projected in Fig. 4, approximate traces have been used.

The reserve estimates for all the seams with average thicknesses greater than 20 inches are given in Table 5. For the Grant-King and Murray-"48" Seams the indicated reserves and the areas used to determine them have been subdivided as follows:

	Grant-King	Murray-"48"
Area within one mile of outcrop (sq. mi.)	2.7	0.5
Area within one mile of projected trace of outcrop (sq. mi.)	4.5	4.7
Reserves within one mile of outcrop (thousands of tons)	15,292	2,592
Reserves within one mile of projected trace of outcrop (thousands of tons)	25,488	24,364

Indicated reserves total 402,233,000 tons and inferred reserves 687,824,000 tons. For seams with average thicknesses of more than 45 inches, indicated reserves total 244,738,000 tons and inferred reserves 464,206,000 tons. The analyses in Appendix 6 indicate that coal in the Trojan and Superior Seams is potentially of coking quality. Presently estimated reserves in these seams are 108,585,000 tons indicated and 142,876,000 tons inferred for a total of 251,461,000 tons. Analyses of samples from some of the other seams have free swelling indexes which may indicate coking or blending quality. The coal in the other seams is mostly low to medium volatile bituminous, with less than one per cent sulfur and mostly low ash, making it suitable for use

TABLE 5: PRELIMINARY ESTIMATE OF COAL RESERVES ON PEACE RIVER CANYON PROPERTIES OF CINNABAR PEAK MINES LTD.

Seam	Range of Thickness (inches)	Average Thickness (inches)	Area of Seam (square miles) Indicated Reserves	Area of Seam (square miles) Inferred Reserves	Reserves (Thousands of Tons) Indicated	Reserves (Thousands of Tons) Inferred
Superior	24 - 48	34	11.0	15.2	35,904	49,612
Trojan	43 - 100	67	11.3	14.5	72,681	93,264
Titan	28 - 84	48	11.2	16.2	51,609	74,649
Falls	20 - 49½	34	5.2	5.2	16,972	16,972
Gething	18 - 25	22	1.5	2.6	3,168	5,491
Little Mogul	18 - 35	26	5.4	10.1	13,478	25,209
Mogul	42 - 65	51	6.3	10.3	30,844	50,428
Castle Point	25 - 48	35	5.9	10.8	19,824	36,288
Milligan	24 - 48	33	5.9	10.8	18,691	34,214
Wendy	18 - 54	32	4.5	5.7	13,824	17,510
Louise	23 - 48	34	3.0	3.8	9,792	12,403
Ferro Point	26 - 33	30	1.5	1.8	4,320	5,184
Quentin						
North of Peace River	26½	26	0.3	-	748	-
South of Peace River	24 - 54	36	1.5	1.8	5,184	6,220
Grant-King						
North of Peace River	66½	66	1.1	-	6,969	-
South of Peace River	36 - 79	59	7.2*	21.9	40,780*	124,041
Riverside	33½- 42	36	2.9	4.2	10,022	14,515
Knight	36 - 36½	36	0.5	-	1,728	-
Upper Twin	21 - 24	22	0.5	-	1,056	-
Lower Twin	25½- 27½	26	0.5	-	1,248	-
Boring	32	32	0.5	-	1,536	-
Murray-"48"						
North of Peace River	97	97	1.6	-	14,899	-
South of Peace River	36 - 73	54	5.2*	23.5	26,956*	121,824
TOTAL of all seams listed					402,233	687,824
TOTAL of seams with average thicknesses less than 32"					24,018	35,884
TOTAL of seams with average thicknesses 32" to 45"					133,477	187,734
TOTAL of seams with average thicknesses more than 45"					244,738	464,206
					402,233	687,824

* See text for a subdivision of these figures.

in coal-burning power plants.

Insufficient data are available to give more than a very rough estimate of the amount of the preceding reserves that are suitable for strip mining. North of the Peace River near the King Gething Mines with stripping to a depth of about 150 feet on the 66-inch King Seam, approximately 330,000 tons are available, and on the 97-inch "48" Seam 750,000 tons, for a total of just more than one million tons. Thin seams above the King and the "48" Seams will not greatly change these figures. Probably the most favorable place for stripping is on the south side of Mount Johnson where bulldozer trenching uncovered many coal seams ranging up to 60 inches thick. On the south end of Mount Johnson, these seams are close to a dip slope; to the northwest along strike they have not been trenched. Nevertheless, in one trench 4 seams ranging from 28 to 60 inches for a total of more than 13 feet of coal are present in a stratigraphic interval of less than 80 feet. This increases to 8 seams ranging from 16 to 60 inches for a total of 19 feet of coal in a stratigraphic interval of about 140 feet. These seams dip mostly between 30 and 40 degrees in the trenches, but have lower dips to the south. They may be close enough to the surface along a strike length of 6000 feet and down the slope as much as 2000 feet so that from 5,000,000 to 8,000,000 tons of coal may be suitable for strip mining there. Other seams higher in the Gething Formation such as the Falls, Titan, and Trojan are also to be expected on or near the dip slope on the south end of Mount Johnson at progressively lower elevations. Parts of these same seams are also expected in the drift-covered relatively flat area along the upper part of Coalbed Creek and between it and the logging road under overburden that may be shallow enough for stripping. Thus it is possible that an area of $\frac{3}{4}$ of a square mile is underlain by an additional 10,000,000 to 13,000,000 tons of strippable coal totalling 15 feet in more than one seam. Additional strippable coal may be present on the west flank of Mount Johnson.

TRANSPORTATION

The Pacific Great Eastern Railway traverses the Pine River Valley within 18 to 20 miles of the coal properties of Cinnabar Peak Mines Ltd. One possible route for a spur line would involve leaving the P.G.E. about 25 miles west of Chetwynd near Hulcross near the confluence of Brown Creek with the Pine River, crossing the Pine River, ascending the lower part of the southeast flank of Mount Hulcross, crossing a divide with elevations less than 3500 feet, thence down Hulcross Creek to the Moberly River, crossing the Moberly River and ascending it to Pete Creek, up Pete Creek to Pete Lake at an elevation of less than 3000 feet, and thence down Burnt Trail Creek to its confluence with Johnson Creek. Without careful consideration of grades, the length of this spur cannot be estimated precisely, but is expected to be between 40 and 50 miles. The route as far as Pete Creek might be the one chosen for the Carbon Creek coal field. An alternate route leaves the Chetwynd-Fort St. John line of the P.G.E. east of Moberly Lake near Demean or Bond, thence west past Moberly Lake and up the Moberly River. A spur line along this route is estimated to be 30 miles longer with about 35 more miles on the existing P.G.E. past Hulcross, but would eliminate a bridge across the Pine River.

Shipping of large amounts of commodities such as coal is least expensive if unit trains are used. Such trains shuttle back and forth between origin and destination with delays only for loading, unloading, crew changes, fueling, and maintenance. Freight cars are specially designed to permit bottom dumping, sometimes even while moving, or side dumping or inversion without uncoupling. In the eastern and central United States typical unit-train rates for shipping one to three million tons of coal annually for distances of 130 to 450 miles range from about 0.4 to 0.8 cents per ton-mile with the lower rates generally applying to the longer hauls. In western Canada unit-train rates for hauling coal to Vancouver or Roberts Bank range from about 0.4 to 0.55 cents per ton-mile for distances of about 675 to 750 miles. With the rail distance estimated at

700 miles from the coal properties of Cinnabar Peak Mines Ltd. to North Vancouver via the P.G.E. or slightly less to Prince Rupert via the P.G.E. and C.N.R., the rates for hauling about two million tons of coal annually in unit trains are estimated as follows:

0.4 cents/ton-mile	$ 2.80/ton
0.5 cents/ton-mile	$ 3.50/ton
0.6 cents/ton-mile	$ 4.20/ton

In order to use unit trains, considerable improvements to existing railroad beds may be required. If unit trains are not used, freight costs to Vancouver or Prince Rupert may be double the above unit-train rates.

Handling at the port is estimated to cost $1.00 to $2.00 per ton.

CONCLUSIONS

Twenty of the numerous coal seams in the Gething Formation, ranging in average thickness from 22 to 97 inches, have been tentatively correlated throughout the Peace River Canyon coal properties of Cinnabar Peak Mines Ltd. Three seams at the top of the Gething Formation are known to extend along strike for about 11 miles, and probably underlie more than 25 square miles of the properties. Many of the other seams are expected to have similar lengths and extents. Preliminary estimates of the total reserves are 1,090,057,000 tons with at least 251,461,000 tons of potential coking quality. The remainder is mostly low to medium volatile bituminous coal, some of which may also be of coking quality. Much of that which is not of coking or blending quality is favored for coal-burning power plants because of its low ash and its sulfur content of less than one per cent. Much of the coal appears favorably situated for underground mining with few dips exceeding 15°. Much additional data is required to choose the best method: continuous mining, longwall, hydraulic, or ploughing. As much as 20,000,000 tons, much of it near a dip slope, may

be suitable for strip mining. With the worldwide demand for coking coal, the shortage of energy supplies for power generation, and the proximity to an existing railway, the Peace River Canyon coal properties of Cinnabar Peak Mines Ltd. warrant substantial expenditures to obtain the geological and engineering data required for further evaluation of the feasibility of their being placed in production.

Respectfully submitted,

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Expiry Date: August 5, 1972

REFERENCES

Alberta Study Group (1954) - Lower Cretaceous of the Peace River region in Western Canada Sedimentary Basin, Rutherford Mem. Vol.; Am. Assoc, Petrol. Geol., Tulsa, Okla., p. 268-278.

Beach, H.H., and Spivak, J. (1944) - Dunlevy-Portage Mountain map-area, B.C.; Geol. Surv. Can. Paper 44-19.

Dolmage, V. and Campbell, D.D. (1963) - The geology of the Portage Mountain damsite Peace River, B.C.; Can. Inst. Min. Met. Trans., v. 66, p. 308-320.

Galloway, C.F.J. (1913) - The coal measures of the Peace River Canyon; Ann. Rept. B.C. Minister of Mines for 1912, pp. 125-136.

Galloway, J.D. (1924) - Coal; Ann. Rept. B.C. Minister of Mines for 1923, pp. A136-40.

Graham, Charles (1946) - Peace River Coal Mines Ltd.; Ann. Rept. B.C. Minister of Mines for 1945, pp. A174-5.

Hughes, J.E. (1964) - Jurassic and Cretaceous strata of the Bullhead succession in the Peace and Pine River Foothills; B.C. Dept. of Mines and Petrol. Resources Bull. 51.

Mathews, W.H. (1947) - Geology and coal resources of the Carbon Creek-Mount Bickford map-area; B.C. Dept. Mines Bull. 24.

_____ and Graham, Charles (1946) - King Gething Mine; Ann. Rept. B.C. Minister of Mines for 1945, pp. A172-3.

McLearn, F.H. (1923) - Peace River Canyon coal area, B.C.; Geol. Surv. Can., Sum. Rept. 1922, pt. B, pp. 1-46.

_____ and Irish, E.S.W. (1944) - Some coal deposits of the Peace River Foothills, British Columbia; Geol. Surv. Can. Paper 44-15.

_____ and Kindle, E.D. (1950) - Geology of northeastern British Columbia; Geol. Surv. Can. Mem. 259, pp. 63-7, 73-84, 154-76, and Figs. 11 and 14.

Millar, J.F.V. (1969) - Preliminary report on Portage Mountain coal properties: Cinnabar Peak Mines Ltd.; James Millar and Associates Ltd., Calgary, 31 pp., 2 appendices, unpublished.

Stott, D.F. (1967) - Jurassic and Cretaceous stratigraphy between Peace and Tetsa Rivers, northeastern British Columbia; Geol. Surv. Can. Paper 66-7.

_____ (1968) - Lower Cretaceous Bullhead and Fort St. John Groups, between Smoky and Peace Rivers, Rocky Mountain Foothills, Alberta and British Columbia; Geol. Surv. Can. Bull. 152.

_____ (1969) - Fernie and Minnes strata north of Peace River, Foothills of northeastern British Columbia; Geol. Surv. Can. Paper 67-19, Part A and Part B.

_____ (1969) - The Gething Formation at Peace River Canyon, British Columbia; Geol. Surv. Can. Paper 68-28.

CERTIFICATE

I, Laurence B. Halferdahl, with business and residence addresses in Edmonton, Alberta, do hereby certify that

1. I am a registered Professional Geologist and Professional Engineer in the Province of Alberta and a licensed Professional Engineer in the Province of British Columbia.

2. I am a graduate of Queen's University, Kingston, Ontario (B.Sc. in 1952 and M.Sc. in 1954 in Geological Sciences in the Faculty of Applied Science) and of The Johns Hopkins University, Baltimore, Maryland (Ph.D. in 1959 in the Department of Geology).

3. From 1957 to 1969 I was on the staff of the Research Council of Alberta as a mineralogist and geologist where I was in charge of the mineralogy laboratory and conducted various field and laboratory investigations.

4. Since 1969 I have been a consulting geological engineer conducting and directing property examinations and evaluations, and exploration programs for metallic minerals, industrial minerals, and coal.

5. The data in this report were obtained from published and unpublished reports and from exploration on the properties directed by G.A. Checklin from July 4 to November 4, 1971, and under my general supervision.

6. I have not received nor do I expect to receive any interest, directly or indirectly, in the property described in this report.

Respectfully submitted,

L. B. Halferdahl

Edmonton, Alberta
December 30, 1971

L. B. Halferdahl, Ph.D., P. Eng.

for:

APPENDIX : 3 : Coal Analyses from Seams Sampled by Drilling in December 1969

4 : Other Analyses of Coal from Seams at the Peace River Canyon

6 : 1971 Analyses of Coal Samples

7 : Reports of Coal Analyses

Refer to:

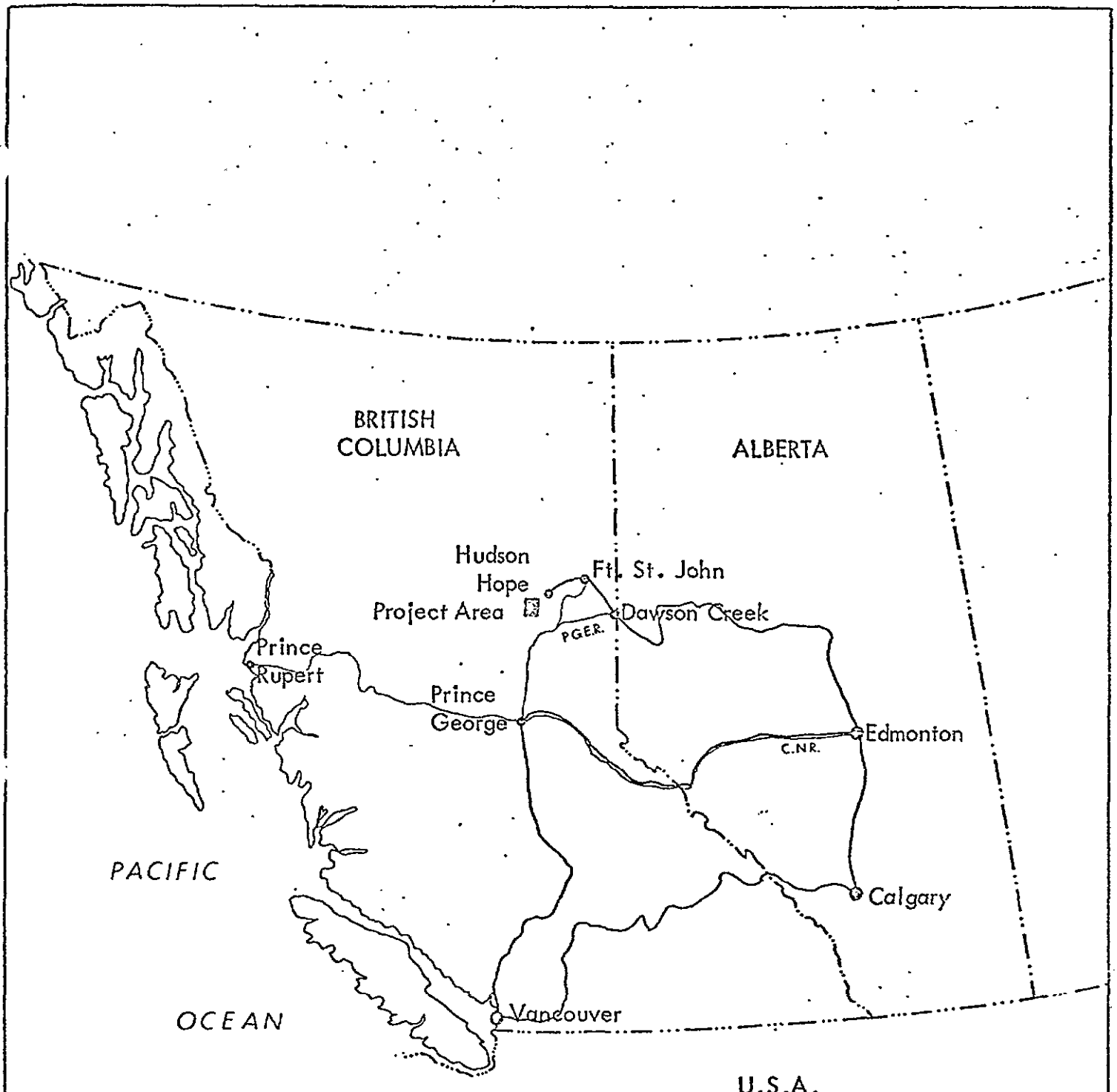
PR - PEACE RIVER CANYON 71C4)A
CONFIDENTIAL ANALYSIS FILE

APPENDIX 8 : IRONSTONE CONCRETIONS

APPENDIX 8: IRONSTONE CONCRETIONS

Ironstone concretions have been noted in and adjacent to some of the coal seams in the Peace River Canyon. Any ironstone produced with coal from these seams will be removed from the coal during its processing. In order to learn if it might have any value as a by-product, a sample from ironstone concretions in the shale overlying the Grant Seam at the Aylard Mine was analyzed. It contained 27.1 per cent Fe; other constituents are given in the accompanying assay report. This is a lower iron content than some other ironstone concretions from Cretaceous strata in western Canada, but with calcining or roasting, the iron content would be increased to about 36 per cent. Although this does not appear particularly encouraging, until more is known about the range of composition of ironstone concretions at the Peace River Canyon, the possibility of their becoming a by-product should not be entirely discounted.

for analysis refer to:
PR - PEACE RIVER CANYON 71(4)A
CONFIDENTIAL ANALYSIS FILE
p. A58



Expiry Date: August 5, 1974

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Fig. 1.1 Location Map

PEACE RIVER CANYON PROPERTIES

0 100 200 300 400
SCALE IN MILES

Drawn: LBH December, 1973

PR-PRS 7(10)A

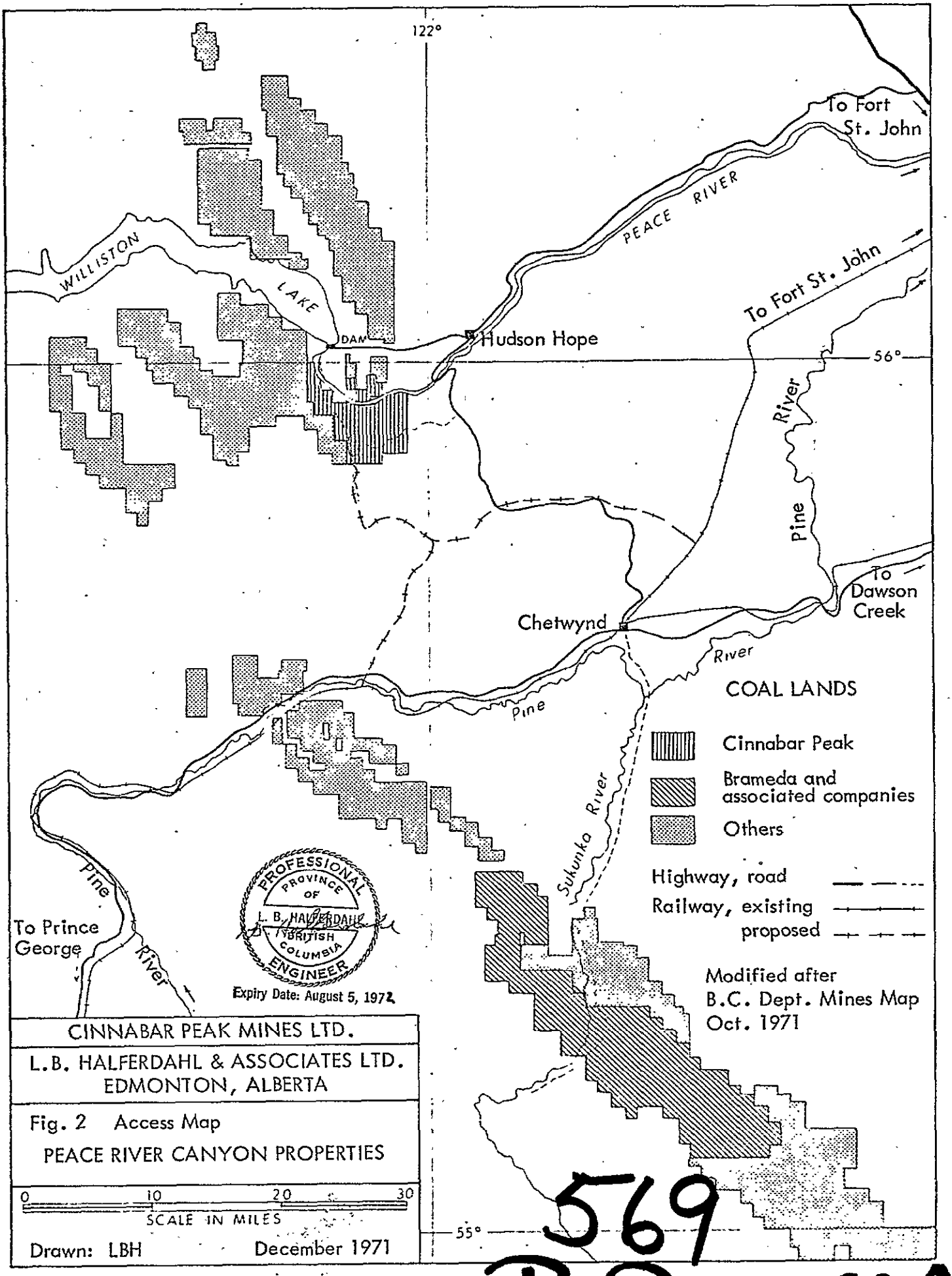

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Fig. 2 Access Map
PEACE RIVER CANYON PROPERTIES

0 10 20 30
SCALE IN MILES

Drawn: LBH December 1971

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Pe-Rec 71(2)A

PRE-EMPTOR SERIES

Revised to January 2, 1945

British Columbia
DEPARTMENT OF LANDS
HONOURABLE E. T. KENNEY, MINISTER
F. C. GREEN, SURVEYOR GENERAL

PEACE RIVER

Scale 4 miles to 1 inch

L 0 1 2 3 10 20

G. G. ATKEN, CHIEF GEOGRAPHER

MAP I

REFERENCE

Surveyed Lands alienated are coloured buff

Surveyed Lands available for purchase or lease only (under Land Act) are coloured light buff

All other surveyed lands not shown coloured are available for pre-emption, purchase or lease only (under Land Act) at the Government Agent's Office

Land District Boundaries

Land Recording District Boundaries

Park Boundaries

Municipalities, village (Dawson Creek and Pouce Coupe) V

Government Agent's Office

Sub-Mining Recording Office

Post Offices

Schools

Hospitals

Telegraph (and Main Telephone) Lines

Railways

Truck Highways

Main Highways

Local Roads

Roads (wagon or indistinct)

Trails

Trails indistinct

Elevations in feet above sea level

Triangulation Stations

Mining or Saw-mill

Contours (Interval 500 feet)

Form Lines

1500'

NOTE:—GETHING FORMATION

In allowing applications for pre-emptions the Department will take into consideration the following points:-

(1) Land applied for must be accessible and suitable for agricultural purposes.

(2) Quantity of Merchantable timber on the land must not exceed 5,000 feet B.M. per acre.

(3) Information as to whether land applied for covers any spring, waterfalls or valuable domestic water supply for general use.

(4) Information as to whether the land can be made an agricultural success within a reasonable time.

(5) Only Surveyed lands are open for pre-emption.

LAND RECORDING DISTRICTS	LAND RECORDING OFFICES
PEACE RIVER	POUCE COUPE
FORT GEORGE	PRINCE GEORGE

MAP I

NO INFORMATION

HUDSON HOPE COAL FIELD

POSSIBLE EXTENSION

CARBON CREEK COAL FIELD

NO INFORMATION

NO INFORMATION

PINE RIVER COAL FIELD

COAL INFORMATION REPORTED

NO INFORMATION

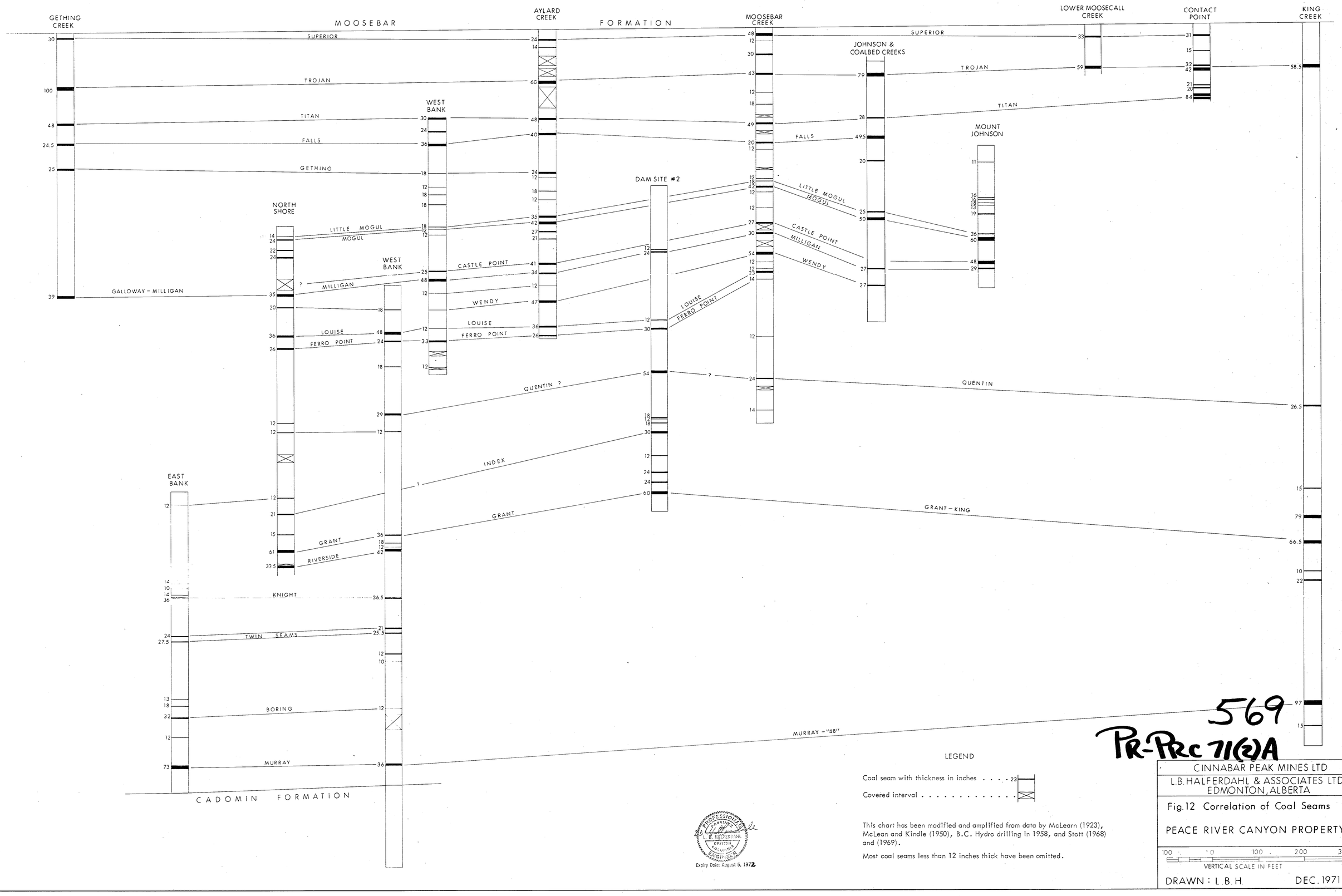
Compiled and Drawn by Geographic Division, Surveys Branch, Department of Lands.

Polyconic Projection

MAP NO. 3E

MAP I

568 PR-PRC 51(2)A



LEGEND

Coal seam with thickness in inches 23

Covered interval . . . . . .

This chart has been modified and amplified from data by McLearn (1923), McLean and Kindle (1950), B.C. Hydro drilling in 1958, and Stott (1968) and (1969).

Most coal seams less than 12 inches thick have been omitted.

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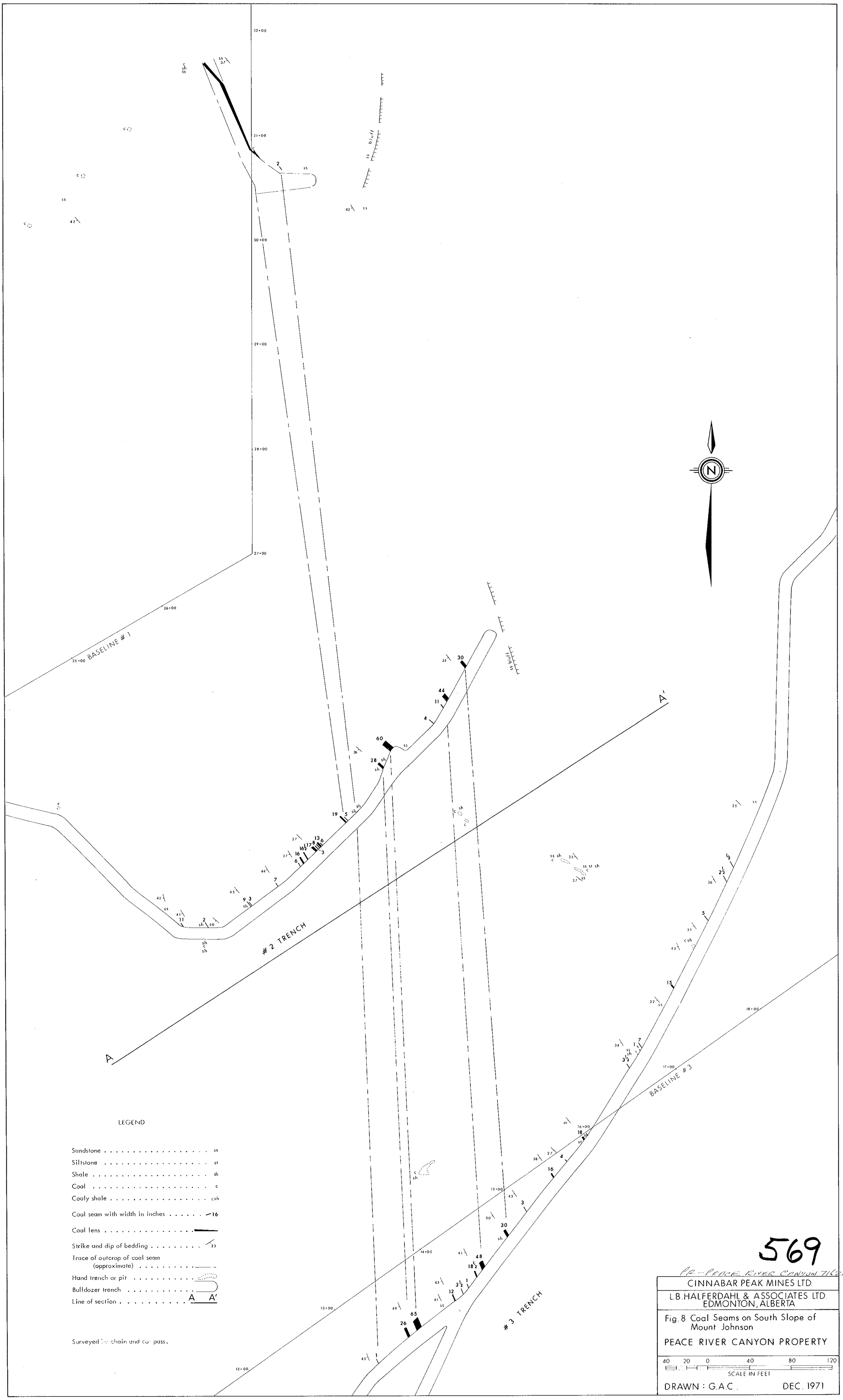
Fig. 12 Correlation of Coal Seams

PEACE RIVER CANYON PROPERTY

100 0 100 200 300

VERTICAL SCALE IN FEET

DRAWN : L.B.H. DEC. 1971



LEGEND

Sandstone . . . . . ss
Siltstone . . . . . st
Shale . . . . . sh
Coal c
Coaly shale . . . . . csh
Coal seam with width in inches . . . . . —16
Coal lens . . . . . ▬
Strike and dip of bedding 33
Trace of outcrop of coal seam (approximate) . . . . . ——
Hand trench or pit . . . . . ◠
Bulldozer trench . . . . . ⊃
Line of section . . . . . A A'

Surveyed by chain and compass.

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PR - PEACE RIVER CANYON 71C/9A.

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Fig. 8 Coal Seams on South Slope of Mount Johnson

PEACE RIVER CANYON PROPERTY

40 20 0 40 80 120
SCALE IN FEET

DRAWN : G.A.C. DEC. 1971

MINE # 1

MINE#2

CAMP

King Creek

2709'

KING SEAM

2489'

3

To Hudson Hope

2546'

2550'

2

2417

14-15-7 ss sh

2410'

CAMP

2405'

MINE # 3

48" seam

2525'

2482'

2462'

sh ss

coal stock

1969

To Peace River

1969

LEGEND

Outcrop x

Sandstone . . . . . ss

Siltstone . . . . . st

Shale . . . . . sh

Coal seam with width in inches 30

Coal seams with widths in inches 14-15-7

Strike and dip of bedding 33

Adit . . . . . ≻

Raise opening . . . . . ⊠

Underground working . . . . . ========

Trench . . . . . ▭

Road . . . . . ——————

Drill hole (1969) with number . . . . . • 2

Boundary of open area (approximate) . . . . . ~~~

Spot elevation . . . . . ▼2525'

Surface survey by chain and compass; underground workings of Mines #1 and #3 modified after plans from B.C. Dept. Mines.

Elevation of 2525 ft. of adit at Mine #3 is used as a base.

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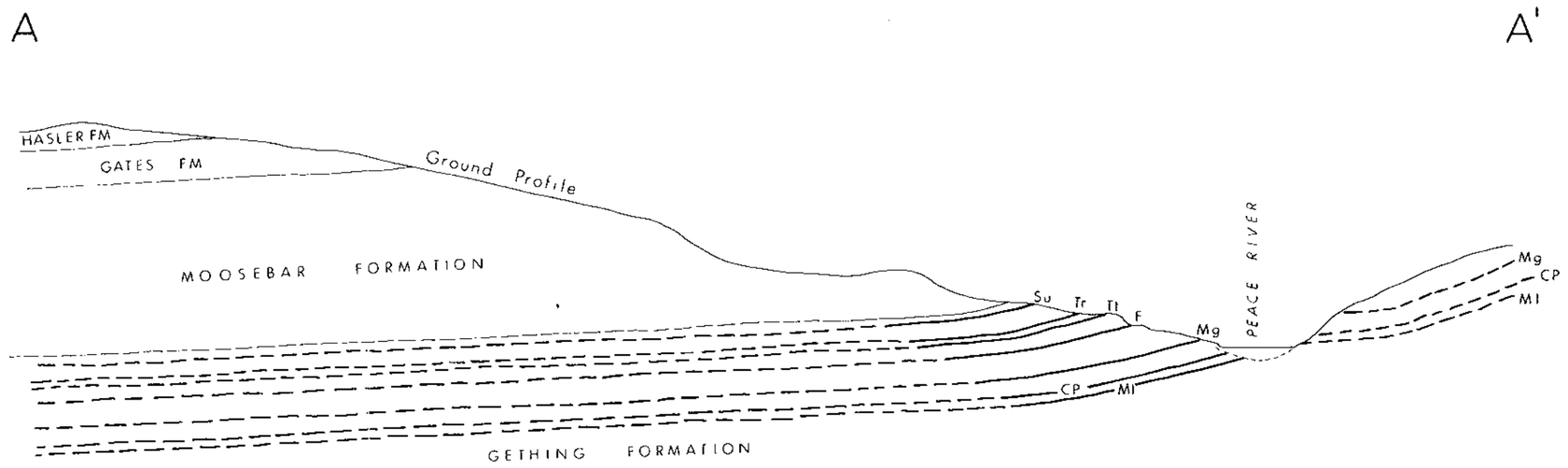
Fig.6 King Gething Mine Area

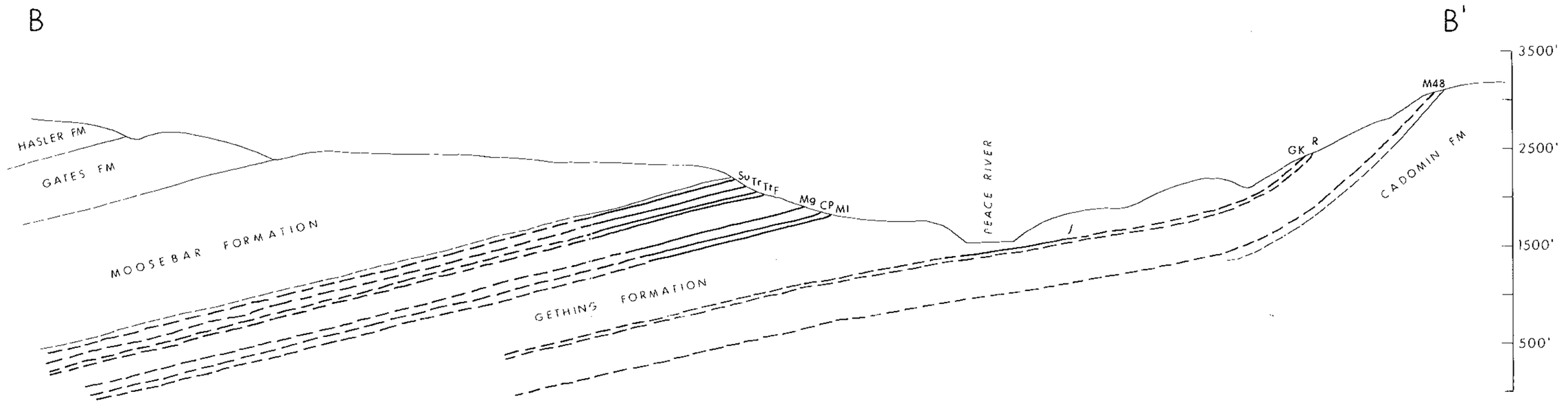
PEACE RIVER CANYON PROPERTY

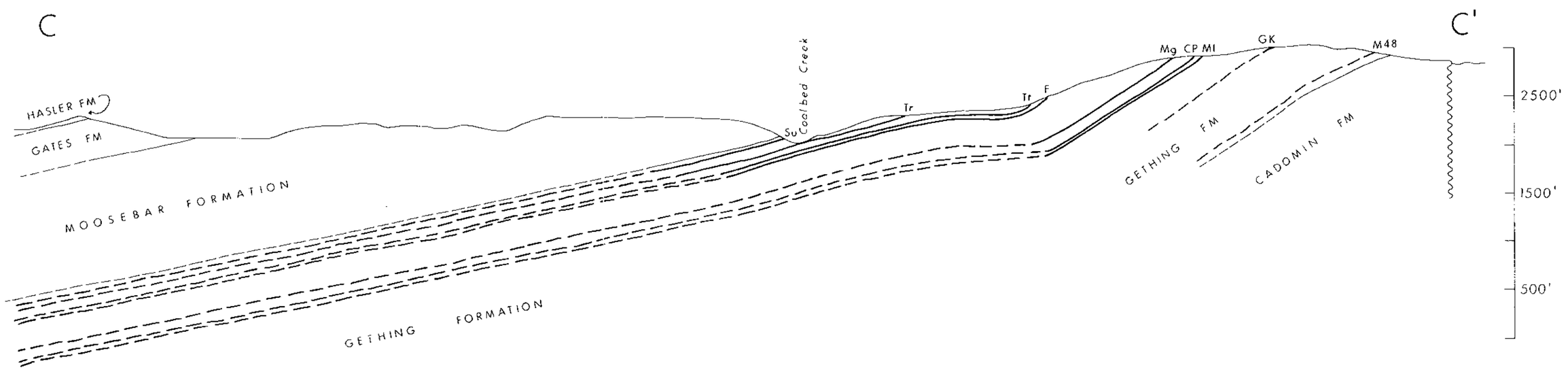
200 0 200 400 600
SCALE IN FEET

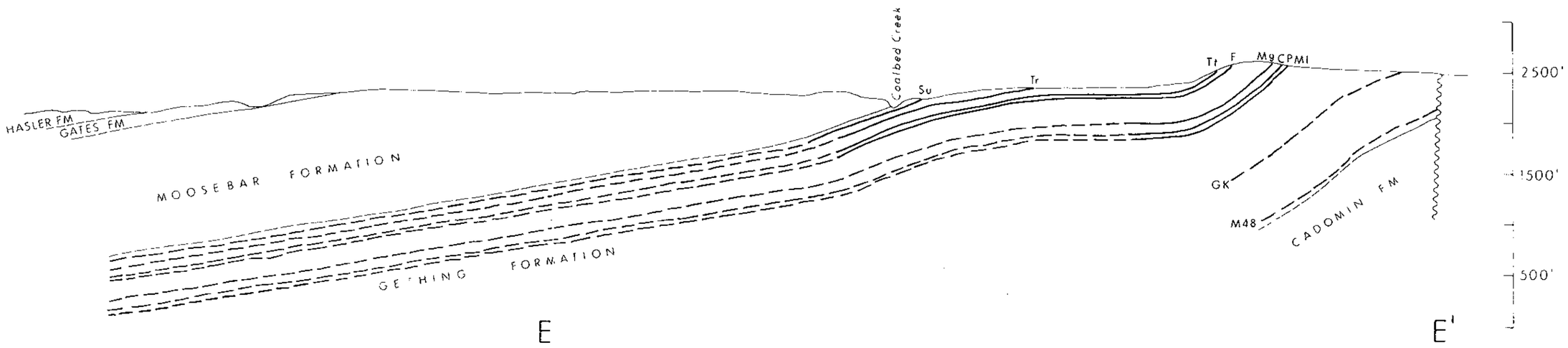
DRAWN : G.A.C. DEC. 71

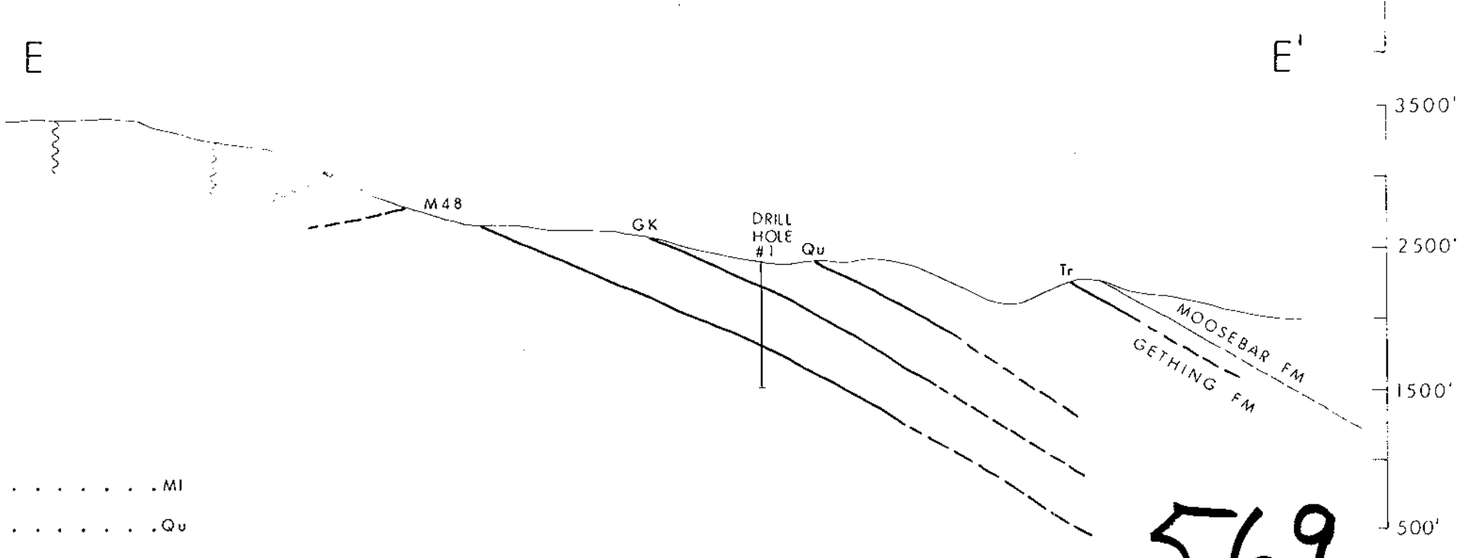
569











LEGEND

Geological contact . . . . . ~~~

Fault . . . . . ~~~

Coal seam with name . . . . . ~~~

Superior	Su	Milligan	MI
Trojan	Tr	Quentin	Qu
Titan	Tt	Grant-King	GK
Falls	F	Riverside	R
Mogul and Little Mogul	Mg	Murray-"48"	M48
Castle Point	CP		

Only selected coal seams are shown in their approximate positions. Other coal seams are shown in Fig. 12.

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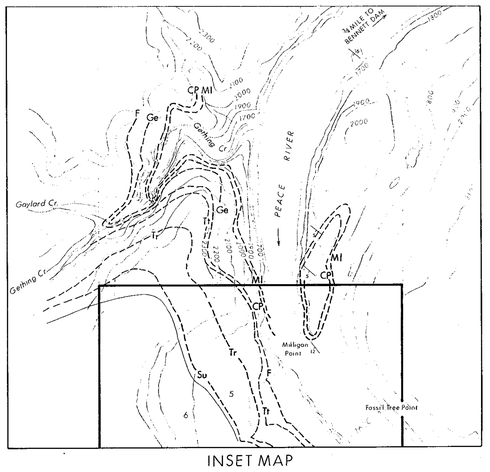
Fig 5 Cross Sections from Fig. 4

PEACE RIVER CANYON PROPERTIES

0 1000 2000
SCALE IN FEET

DRAWN G A C DEC 1971

SEE INSET



INSET MAP

LEGEND

LOWER CRETACEOUS
FORT ST. JOHN GROUP

10	Cruiser Formation
9	Goodrich Formation
8	Hasler Formation
7	Gates Formation
6	Moosebar Formation

BULLHEAD AND MINNES GROUPS

5	Gething Formation
4	Cadomin and Pre-Cadomin Formations

SYMBOLS

- Geological boundary, defined and approximate
- Strike and dip of bedding, inclined, vertical
- Fault, defined, approximate
- Anticlinal axis
- Synclinal axis
- Outcrop with lithology, sandstone, siltstone, shale, conglomerate, coal — ss,st,sh,cg,c
- Coal seam with name, defined and approximate — Tr
  - Superior . . . Su
  - Trojan . . . Tr
  - Titan . . . Tt
  - Falls . . . F
  - Gething . . . Ge
  - Mogul and Little Mogul . . . Mg
  - Castle Point . . . CP
  - Milligan . . . MI
  - Quentin . . . Qu
  - Grant - King . . . GK
  - Murray - "48" . . . M48
- Drill hole with number, 1958 B.C. Hydro at Daensite #2 . . . 5; 1969 Cinnabar Peak . . . 2
- Mine adit
- Line of section in Fig. 5 — C — C'
- Boundary of restricted mining area
- Boundary of lot, lease, coal licence
- Boundary of property
- Road, logging
  - unimproved
  - 1971 access
- Trails, baseline
- Contour, interval 25' — 2900

Contours obtained from aerial photographs by Lockwood Survey Corporation Limited.

Geology compiled from 1971 field observations and from Beach and Spivak (1944).

1971 access roads, baselines, and trails surveyed by chain and compass.

Positions of selected coal seams are based on located outcrops as noted in Appendix 5 and shown in Fig. 12, and projected between outcrops with the aid of cross sections.

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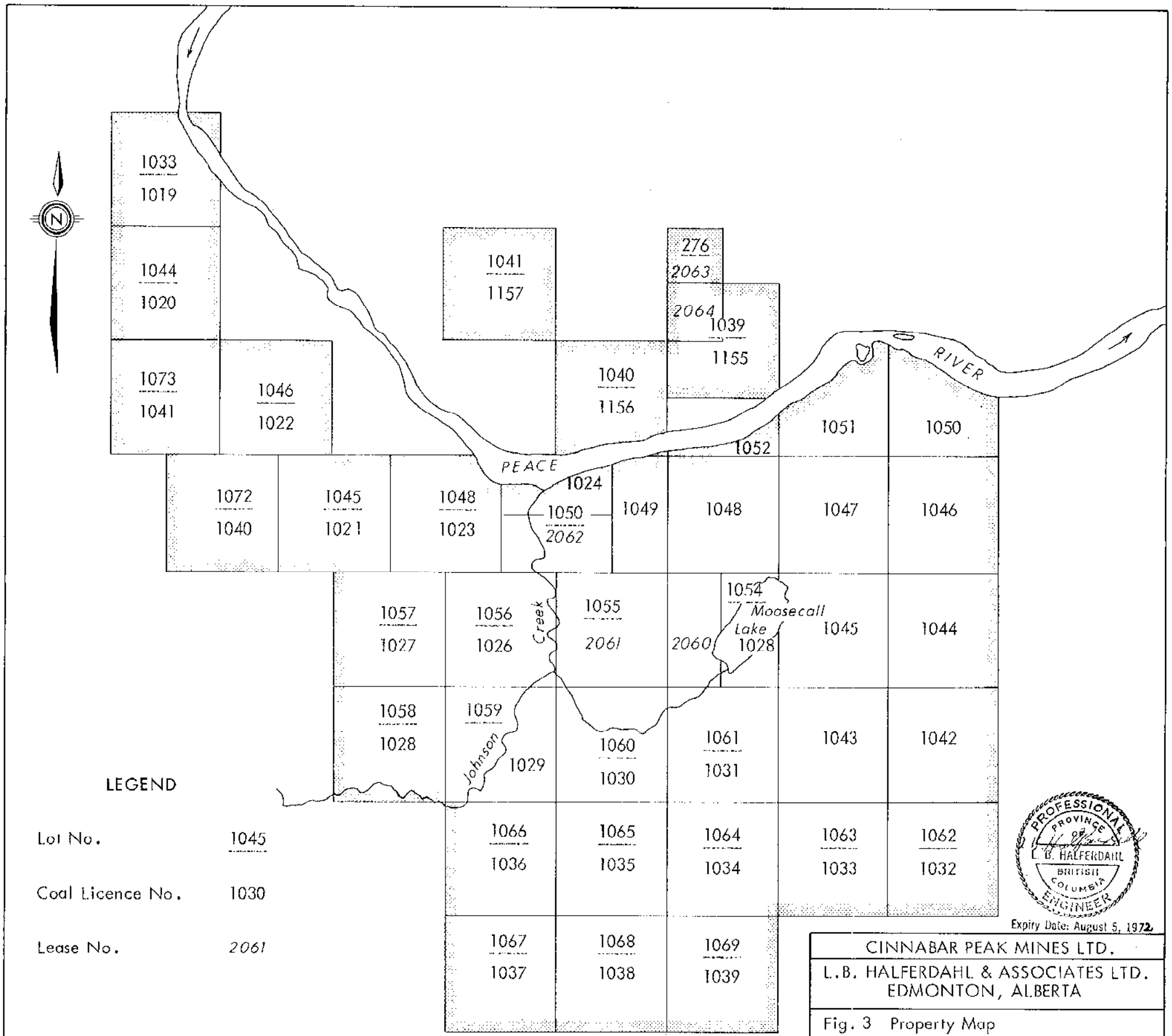
Fig. 4 Geology and Coal Seams

PEACE RIVER CANYON PROPERTY

1000 0 1000 2000 3000
SCALE IN FEET

DRAWN : G.A.C. DEC. 1971

Expiry Date: August 5, 1972



LEGEND

Lot No. 1045

Coal Licence No. 1030

Lease No. *2061*

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Fig. 3 Property Map

PEACE RIVER CANYON PROPERTIES

0 1 2
SCALE IN MILES

Drawn: LBH December 1971

569

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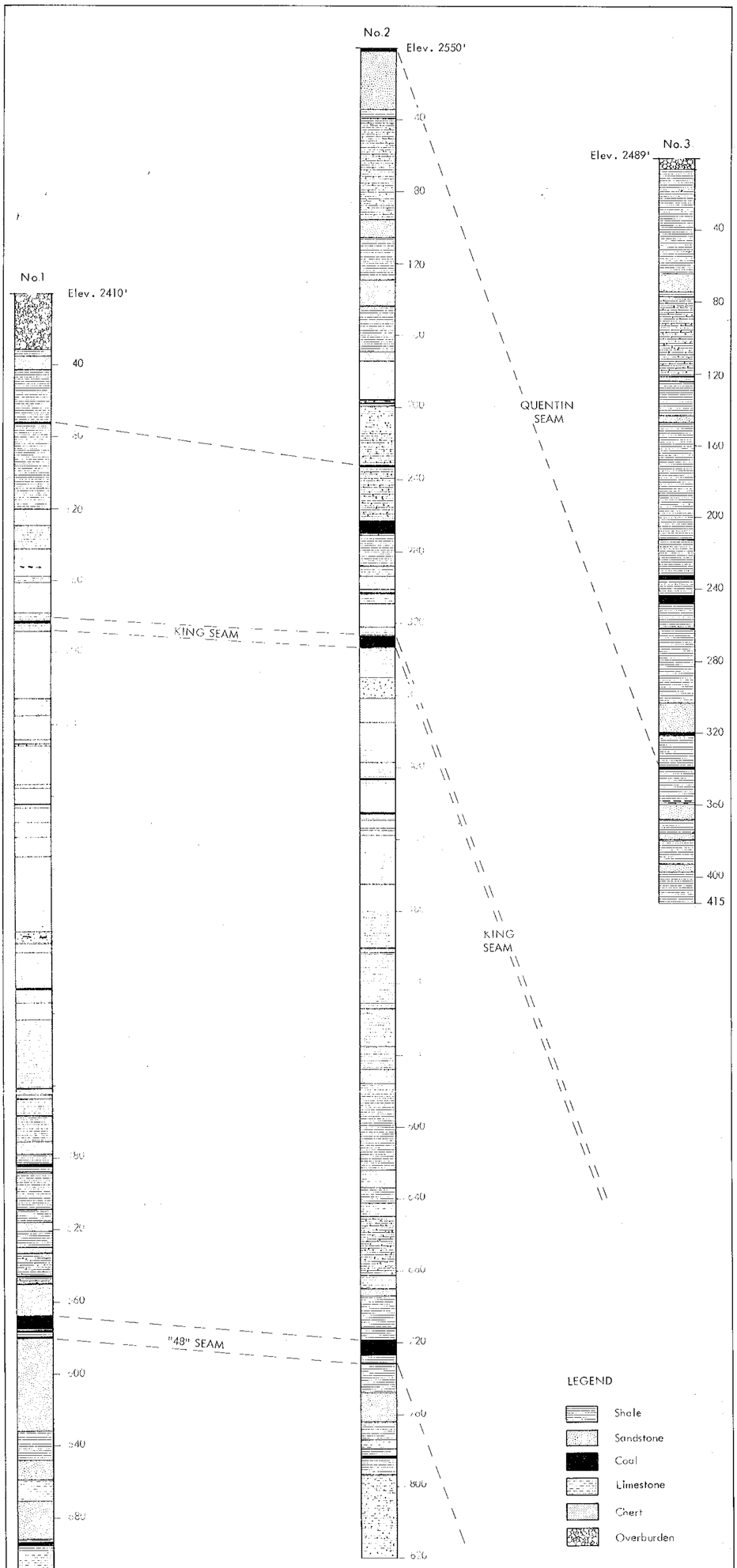

Note: Lithologies including limestone and chert are from drillers' reports. Elevations are based on chain and compass measurements.

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Fig. 7 1969 Drill Holes along Road to Gething Mine
PEACE RIVER CANYON PROPERTIES

500 0 500
HORIZONTAL SCALE IN FEET

Drawn: LBH December 1971

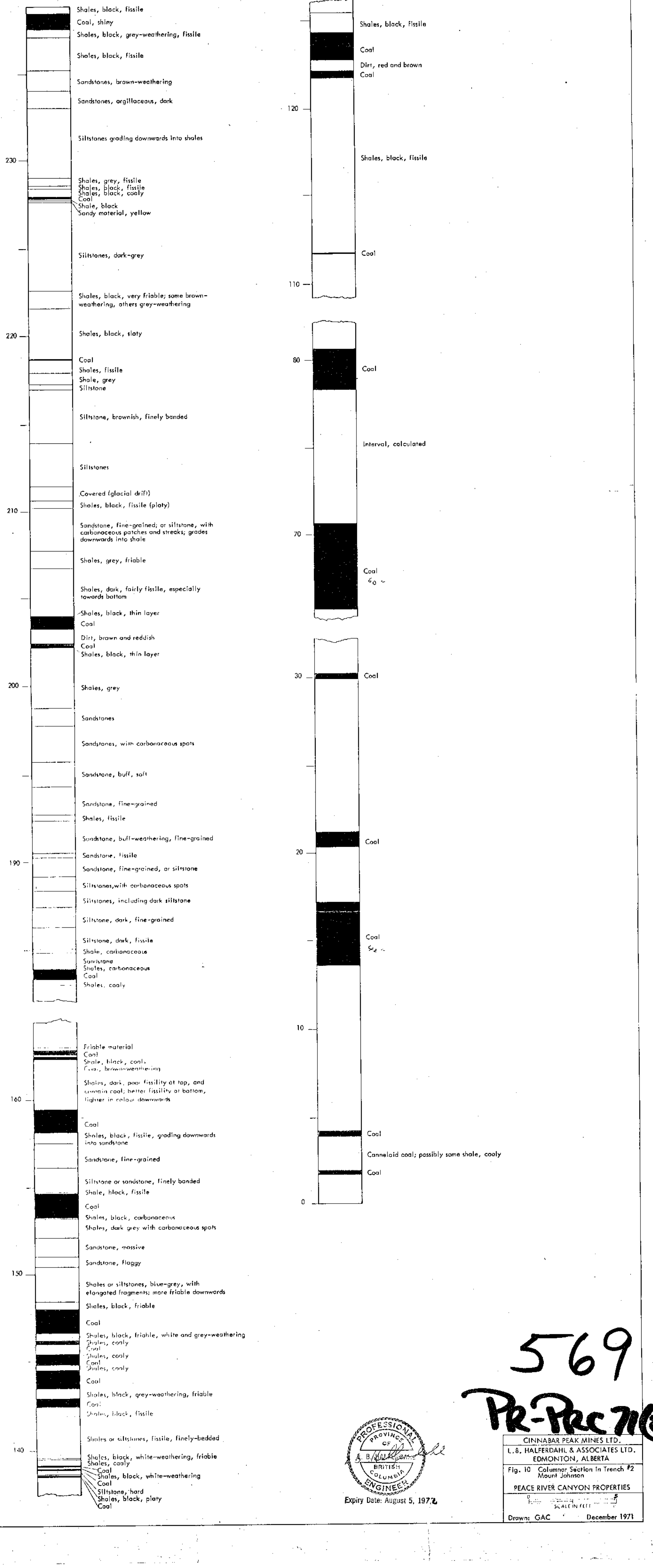

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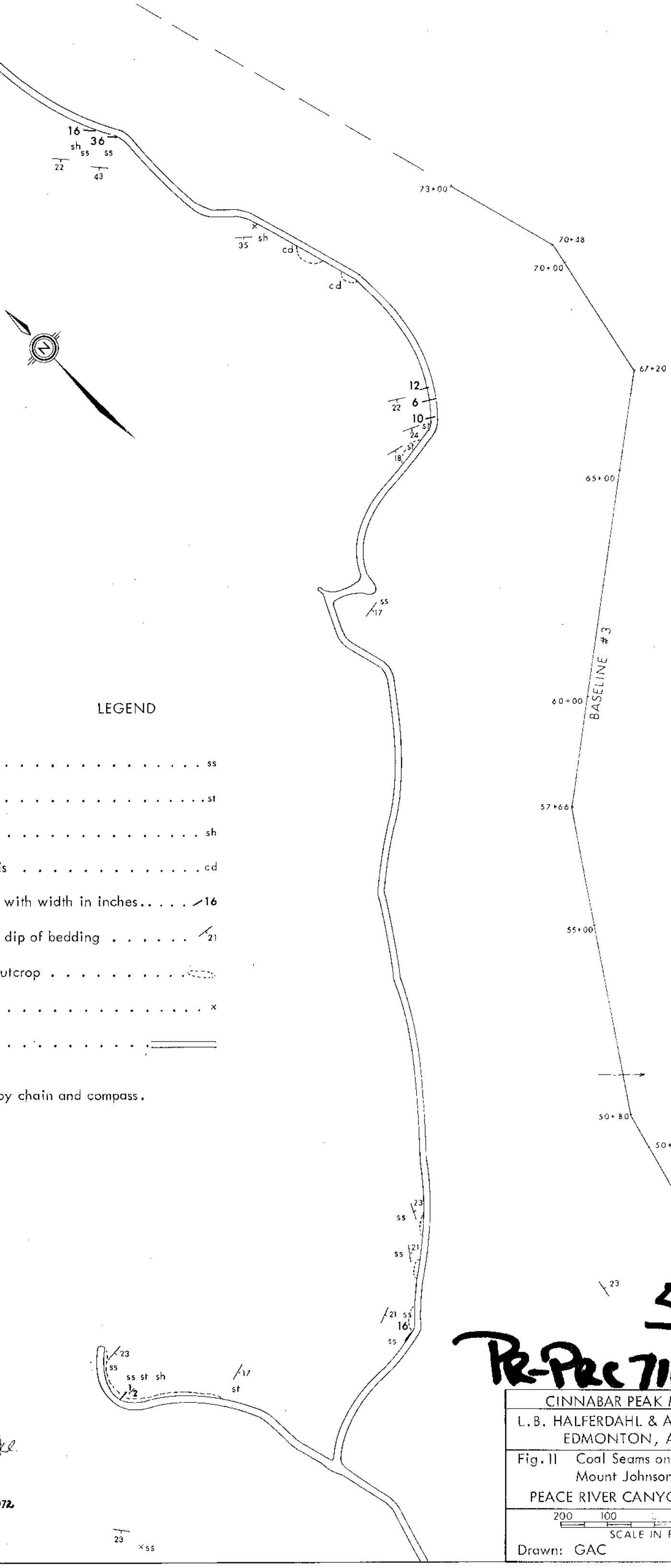
Fig. 10 Columnar Section in Trench #2
Mount Johnson

PEACE RIVER CANYON PROPERTIES

SCALE IN FEET

Drawn: GAC December 1971



LEGEND

Sandstone . . . . . ss

Siltstone . . . . . st

Shale . . . . . sh

Coal debris . . . . . cd

Coal seam with width in inches 16

Strike and dip of bedding 21

Trace of outcrop . . . . .

Outcrop x

Road . . . . .

Surveyed by chain and compass.

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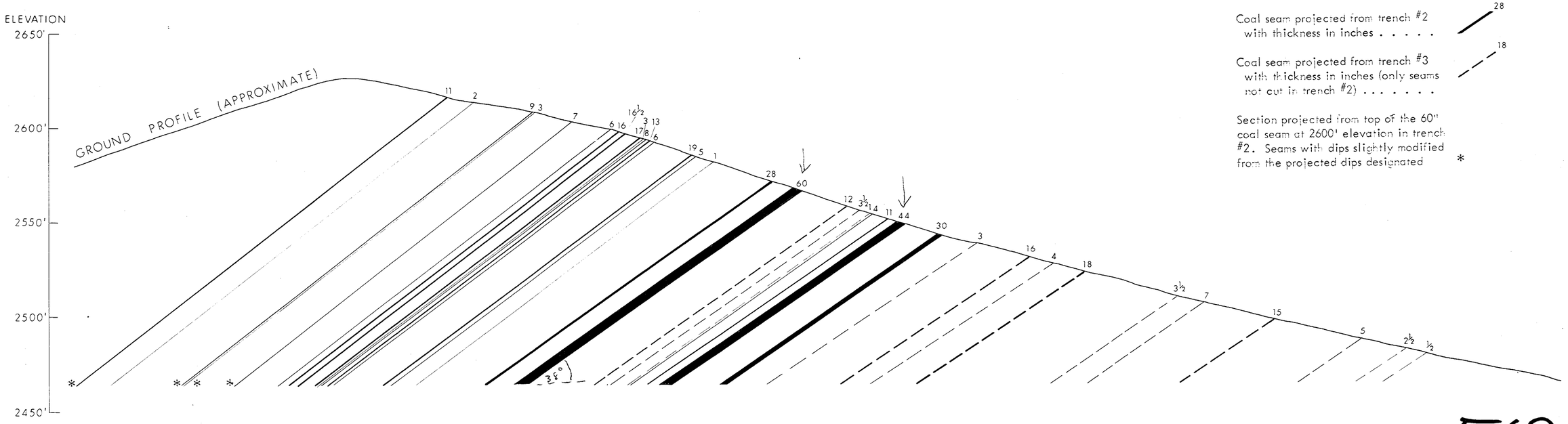
Fig. 11 Coal Seams on East Flank of Mount Johnson

PEACE RIVER CANYON PROPERTIES

200 100 200
SCALE IN FEET

Drawn: GAC December 1971



LEGEND

Coal seam projected from trench #2 with thickness in inches 28

Coal seam projected from trench #3 with thickness in inches (only seams not cut in trench #2) 18

Section projected from top of the 60" coal seam at 2600' elevation in trench #2. Seams with dips slightly modified from the projected dips designated *

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Pr-Prec 11(2)A

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Fig. 9. Coal Seams on South Slope of Mount Johnson - Section A-A' of Fig. 8
PEACE RIVER CANYON PROPERTIES

0 20 40 80
SCALE IN FEET

DRAWN G A C DEC. 1971

PR-PEACE RIVER CANYON 71(3)A

CINNABAR PEAK MINES LTD.

APPENDIX 2: DRILLER'S REPORTS FOR 1969 DRILL HOLES ALONG ROAD TO GETHING MINE

Company: Cinnabar Peak Mines Ltd.
Location: Road to Gething Mine

Drill Hole No. 1 Page 1
Dip: -90°
Total Length: 885'

Started: December 8, 1969
Completed: December 12, 1969
Driller: T. Mullen,
McAuley Drilling Co. Ltd.

Interval	Description
0' - 20'	Silty clay
20' - 24'	Clay, gravel
24' - 31'	Silty clay
31' - 34.5'	Shale
34.5' - 42'	Sandstone
42' - 65'	Shale
65' - 71.5'	Soft shale
71.5' - 72.5'	Coal
72.5' - 120'	Shale
120' - 129'	Sandstone, hard
129' - 142'	Grey shale
142' - 157.5'	Sandstone, hard below 144'; coal traces between 151' and 154'
157.5' - 160.5'	Grey shale, some soft bands
160.5' - 178'	Sandstone, hard
178' - 182'	Grey shale
182' - 183.5'	Coal; water
183.5' - 188'	Grey-brown shale
188' - 225'	Sandstone, hard; few hard shale bands; coal traces between 195.5' to 196.5'
225' - 234'	Soft shale
234' - 235'	Hard shale
235' - 248'	Sandstone
248' - 250.5'	Soft brown shale
250.5' - 252'	Sandstone
252' - 273'	Shale
273' - 275'	Sandstone
275' - 283.5'	Shale
283.5' - 284'	Coal
284' - 286'	Shale
286' - 294'	Sandstone
294' - 302'	Shale
302' - 313'	Sandstone
313' - 350'	Shale
350' - 354'	Shale, hard
354' - 354.5'	Coal
354.5' - 361'	Interbedded hard sandstone and shale; coal traces 359' to 360'
361' - 366'	Sandstone, very hard
366' - 385.5'	Grey and brown shale
385.5' - 387'	Coal
387' - 394'	Brown shale
394' - 403'	Sandstone, hard
403' - 445'	Grey and brown shales; hard sandstone ledges; 0.5' coal at 441'
445' - 447'	Sandstone
447' - 456.5'	Shale
456.5' - 456.8'	Coal
456.8' - 471'	Shale
471' - 478'	Hard sandstone
478' - 483.4'	Shale
483.4' - 485'	Shaly coal
485' - 488'	Shale
488' - 489'	Sandstone
489' - 508.2'	Shale
508.2' - 509'	Shaly coal
509' - 516'	Shale
516' - 521'	Hard sandstone

Company: Cinnabar Peak Mines Ltd.

Drill Hole No. 2 Page 1
Dip: -90°
Total Length: 820'

Location: Road to Gething Mine

Started: December 13, 1969
Completed: December 18, 1969
Driller: T. Mullen,
McAuley Drilling Co. Ltd.

Interval	Description	Interval	Description
0' - 2.5'	Soft exposed coal	288.6' - 294'	Shale
2.5' - 34.0'	Sandstone, hard; shale bands	294' - 301'	Sandstone
		301' - 302.8'	Shale
34' - 39'	Soft grey shale	302.8' - 303.5'	Coal
39' - 95.3'	Sandstone, hard; shale interbedded	303.5' - 309'	Shale
		309' - 322'	Sandstone
95.3' - 96'	Coal	322' - 327'	Shale
96' - 105'	Sandstone, hard; shale bands	327' - 328.5'	Coal
		328.5' - 333.4'	Coal (cored)
105' - 129'	Shale	333.4' - 350'	Shale
129' - 143.2'	Sandstone	350' - 362'	Sandstone, hard; shale bands interbedded
143.2' - 144'	Coal		
144' - 169'	Shale		
169' - 174'	Sandstone	362' - 375'	Chert, very hard
174' - 195.2'	Chert	375' - 395'	Limestone, very hard
195.2' - 195.8'	Coal		
195.8' - 197'	Brown shale; coal interbedded	395' - 397'	Limestone
		397' - 398.5'	Shale
197' - 198.4'	Coal	398.5' - 406'	Shale
198.4' - 199'	Brown shale; coal interbedded	406' - 407'	Coal
		407' - 424'	Shale
199' - 199.6'	Coal	424' - 426'	Coal (cored)
199.6' - 232.5'	Grey shale; sandstone interbedded	426' - 429'	Shale
		429' - 434'	Sandstone
232.5' - 233.4'	Coal	434' - 435'	Shale
233.4' - 262.9'	Grey-brown shale; hard sandstone bands	435' - 438'	Sandstone
		438' - 465'	Shale
262.9' - 264.5'	Coal	465' - 499.8'	Sandstone, hard; shale bands below 480'
264.5'	Ran core barrel		
265' - 269.5'	Cored		
269.5' - 271'	Sandstone	499.8' - 500.2'	Coal
271' - 288.2'	Shale	500.2' - 502.8'	Brown shale; coal interbedded
288.2' - 288.6'	Coal		

Drill Hole No. 1 Page 2

Interval	Description	Interval	Description
521' - 530'	Hard shale	735.4' - 737'	Grey shale
530' - 533'	Sandstone, hard	737' - 755'	Sandstone; very hard limestone traces throughout
533' - 545.5'	Grey shale; sandstone interbedded	755' - 764'	Sandstone
545.5' - 546'	Coal	764' - 765.5'	Shale
546' - 550'	Sandstone; shale bands	765.5' - 766'	Coal
550' - 550.5'	Coal	766' - 768'	Shale
550.5' - 567.8'	Sandstone, hard; few shale bands; coal traces below 554'	768' - 775'	Sandstone
		775' - 784'	Shale
		784' - 787'	Sandstone
		787' - 800'	Hard shale
567.8' - 574.8'	Coal	800' - 830.3'	Grey shale; coal traces at 803.5' to 806.5'
574.8' - 575.4'	Shale, hard, sandy		
575.4' - 576'	Coal		
576' - 579.4'	Brown shale; coal traces	830.3' - 830.8'	Coal
		830.8' - 832.5'	Grey shale
579.4' - 580.3'	Coal	832.5' - 855'	Sandstone, hard
580.3' - 625'	Sandstone, hard; few shale bands	855' - 874'	Grey shale
		874' - 877.5'	Sandstone, hard
625' - 632'	Sandstone	877.5' - 885'	Grey shale
632' - 634.5'	Shale		
634.5' - 636'	Soft brown shale; trace of coal		
636' - 648'	Shale		
648' - 659'	Sandstone		
659' - 671'	Limestone		
671' - 692'	Sandstone		
692' - 693.4'	Shale		
693.4' - 695.8'	Coal		
695.8' - 697'	Shale		
697' - 700'	Limestone		
700' - 709'	Limestone, very hard		
709' - 720.8'	Grey brown shale, hard		
720.8' - 721.4'	Coal		
721.4' - 728.5'	Grey shale; sandy traces		
728.5' - 729.3'	Coal		
729.3' - 733'	Grey shale		
733' - 735.4'	Coal		

Drill Hole No. 2 Page 2

Interval	Description	Interval	Description
502.8' - 531'	Grey shale	690' - 694'	Sandstone
531' - 534.5'	Brown shale; coal interbedded	694' - 711.5'	Black shale
		711.5' - 712'	Coal
534.5' - 555'	Sandstone, hard; shale bands	712' - 716'	Grey shale
		716' - 718.5'	Black shale
555' - 568'	Shale	718.5' - 726.8'	Coal
568' - 576'	Sandstone	726.8' - 731.5'	Shale
576' - 592'	Shale	731.5' - 732'	Coal
592' - 598'	Hard grey shale	732' - 748'	Shale
598' - 610'	Soft black shale	748' - 764'	Sandstone
610' - 624'	Hard grey shale	764' - 774'	Shale
624' - 627'	Limestone	774' - 779'	Limestone, very hard
627' - 634'	Limestone, very hard	779' - 782.8'	Grey shale
		782.8' - 784.2'	Coal; few shale traces
634' - 639'	Grey shale; few coal traces		
		784.2' - 793.5'	Grey shale
639' - 642.5'	Soft brown shale	793.5' - 820'	Sandstone; limestone, very hard
642.5' - 650'	Limestone, hard		
650' - 683'	Grey shale; sandstone bands		
683' - 690'	Limestone; sandy		

Company: Cinnabar Peak Mines Ltd.

Location: Road to Gething Mine

Drill Hole No. 3 Page 1
Dip: -90°
Total Length: 415'

Started: December 19, 1969
Completed: December 21, 1969
Driller: T. Mullen,
McAuley Drilling Co. Ltd.

Interval	Description
0' - 3'	Clay
3' - 6'	Sand
6' - 18'	Broken shale
18' - 30'	Soft shale
30' - 66'	Shale
66' - 74'	Sandstone, hard
74' - 76.8'	Grey shale
76.8' - 77.4'	Coal
77.4' - 121'	Sandstone; shale
121' - 123.8'	Grey shale
123.8' - 124.3'	Coal; shale traces
124.3' - 130'	Grey shale
130' - 143'	Shale
143' - 147'	Sandstone
147' - 192'	Soft shale
192' - 198'	Hard shale
198' - 212'	Soft shale
212' - 212.5'	Shaly coal
212.5' - 232.2'	Shale
232.2' - 235'	Coal
235' - 243.5'	Shale
243.5' - 248.5'	Coal
248.5' - 261.8'	Shale
261.8' - 262.5'	Coal
262.5' - 270'	Shale
270' - 303'	Grey shale
303' - 319.5'	Sandstone, hard
319.5' - 321.5'	Coal
321.5' - 338.8'	Grey shale
338.8' - 340.3'	Coal
340.3' - 360'	Grey shale; few sandstone bands; coal traces from 357.5' to 360'
360' - 368'	Sandstone
368' - 376'	Shale
376' - 379'	Sandstone
379' - 379.5'	Coal
379.5' - 393'	Shale
393' - 397'	Sandstone
397' - 415'	Shale

APPENDIX 1: TYPE SECTION OF MOOSEBAR FORMATION, CONTACT POINT, PEACE RIVER CANYON

(Measured by A. Kahil, September 23, 1971)

Lithology	Thickness (feet)	Height above base (feet)
Moosebar-Gates Contact		
Mudstone, dark grey, rubbly, recessive.	85	1085
Covered.	60	1000
Mudstone, silty, dark grey with brownish red rusty streaks on joint and fracture surfaces, rubbly with pieces $\frac{1}{4}$" to $\frac{1}{2}$" with conchoidal-like shapes, dark grey weathering, weathering tends to round conchoidal shapes producing a conglomeratic appearance.	105	940
Mudstone, silty, dark grey, blocky with blocks to 8".	5	835
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$".	380	830
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$", abundant clay ironstone concretions.	70	450
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$", some clay ironstone concretions.	57	380
Shale, greenish black, glauconitic, recessive, fissility planes a few mm apart.	1.7	323
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$" increasing to 2" near top.	36.3	321.3

Lithology	Thickness (feet)	Height above base (feet)
Covered.	273	285
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$", rusty spots possibly from weathering of pyrite.	7	12
Shale, greenish black, fissility planes a few mm apart.	0.5	5
Shale, greenish black, glauconitic, recessive, fissility planes a few mm apart.	0.4	4.5
Mudstone, silty, dark grey, rubbly with conchoidal pieces to $\frac{1}{2}$", with clay ironstone lenses up to 3' long and 2" thick oriented parallel to bedding.	4.1	4.1
Gething-Moosebar Contact marked by conglomeratic sandstone $1\frac{1}{2}$' thick.		

APPENDIX 5: DESCRIPTIONS OF COAL SEAMS AT THE PEACE RIVER CANYON

	Previous Data*		1971 Data	
Superior Seam				
Aylard Creek	Seam (2)	24	Argillite	
			Coal	24 a
			Sandstone	
			Total seam	24
			Total coal	24 r
Moosebar Creek	Seam (2)	48 r		
Contact Point			Argillite	
			Coal, vitrain	$3\frac{1}{2}$
			Coal, vitrain	2
			Coal, vitrain (?)	21
			Coal, vitrain	$\frac{1}{2}$
			Coal, crushed	1
			Coal, vitrain	3
			Shale	
			Total seam	31
			Total coal	31 ra
Lower Moosecall Creek			Coal	33 ra

* Previous data are designated: (1) McLearn; (2) Stott; (3) B.C. Hydro drilling; (4) B. C. Minister of Mines Reports.
All thicknesses are in inches.
Thicknesses used for reserve estimates are designated r.
Intervals with analyses in Appendix 6 are designated a.

	Previous Data		1971 Data	
Trojan Seam				
Gaylard Creek	Coal	25		
	Sandstone	2		
	Coal	25		
	Sandstone	4		
	Coal	16		
	Total seam	72		
	Total coal (1)	66 r		
Gething Creek	Shale			
	Coal	5		
	Sandstone	2		
	Coal	7		
	Sandstone	2		
	Coal	39		
	Sandstone	3		
	Coal	29		
	Sandstone	3		
	Coal	20		
	Shale			
	Total seam	110		
	Total coal (1)	100 r		
Aylard Creek	Shale		Sandy siltstone	
	Coal	3	Coal, vitrain	2
	Shaly sandstone	2	Sandy siltstone	3
	Coal	35	Coal, vitrain	6 a
	Shale	6	Sandy shale	1
	Coal	18	Coal, vitrain	12 a
	Bone coal	4	Coal, clarain	18 a
	Black carbonaceous shale		Coal, vitrain	5 a
			Base covered	
	Total seam	68	Seam	47
	Total coal (1)	60 r	Coal	43

	Previous Data		1971 Data	
Moosebar Creek	Shale			
	Coal	25		
	Sandstone	4		
	Coal	18		
	Carbonaceous shale			
	Total seam	47		
	Total coal (1)	43 r		
	Coal, few small lenses of coaly siltstone (2)	42		
Johnson Creek			Shales	
			Coal	36
			Parting	19
			Coal	15
			Parting	3½
			Coal	13
			Shales	
			Total seam	86½
			Total coal	64
Coalbed Creek	Canneloid coal	4½	Coal, clean	48 a
	Coal	19½	Sandstone parting	4
	White argillaceous sandstone	2	Coal	31 a
	Coal	24	Total seam	83
	White argillaceous sandstone	4	Total coal	79 r
	Coal	30		
	Total seam	84		
	Total coal (1)	73½		
Lower Moosecall Creek			Coaly shale	
			Coal	31 a
			Parting	19
			Coal	15 a
			Parting	3½
			Coal	13 a
			Coaly shale	
			Total seam	81½
			Total coal	59 r

	Previous Data		1971 Data	
Contact Point	Coal	32	Coal	31 a
	Arenaceous shale and sandstone	54	Sandstone	48
	Coal	42	Base covered	
			Seam	79
	Total seam	128	Coal	31
	Total coal (1)	74 r		
King Creek			Coal, vitrain	40 a
			argillite mostly	48
			Coal, vitrain	9
			Dark grey sandstone, some concretions	48
			Coal, vitrain, well cleated	9
			Siltstone and sandstone	
			Total seam	154½
			Total coal	58½ r
Titan Seam				
Gething Creek	Thin layers of sandstone and shale			
	Coal	48		
	Concealed	24		
	Shale and sandstone			
	Total seam	72		
	Total coal (1)	48 r		
West Bank	Coal (2)	30 r		
Aylard Creek	Coal (2)	48 r	Sandstone	
			Coal, clarain	8
			Canneloid coal	13
			Coal, vitrain, well cleated	10
			Sandy siltstone	
			Total seam	31
			Total coal *	31 a

* 26½" sampled. This may not be the Titan Seam, but a few feet below it.

	Previous Data		1971 Data	
Moosebar Creek	Dark shale			
	Coal	35		
	Shale and argillaceous sandstone	9		
	Coal	7		
	Sandstone	2		
	Coal	7		
	Shale with jet bands			
	Total seam	60		
	Total coal (1)	49 r		
	Coal and few silty lenses (2)	54		
Johnson Creek			Sandstone	
			Coal, durain	20
			Coal, clarain	8
			Sandstone and carbonaceous shale	
			Total seam	28
			Total coal	28 ra
Contact Point	Shale			
	Coal	32	Coal, clarain and durain	56
	Clay ironstone	12	Sandstone	20
	Coal	30	Coal, vitrain	28
	Sandstone		Total seam	104
	Total seam	74	Total coal	84 ra
	Total coal (1)	62	(77" sampled)	

	Previous Data		1971 Data	
Falls Seam				
Gething Creek	Coal	8	Sandy shale to sandstone	
	Canneloid coal	11	Coal, crushed	6½
	Coal	13½	Carbonaceous shale	½
	Jet coal	1½	Coal, durain	16½
	Total seam	34	Coal, vitrain	1½
	Total coal (1)	34	Shale	
			Total seam	25
			Total coal	24½ ra
West Bank	Canneloid coal	?		
	Coal	?		
	Large concretions	?		
	Total seam	36		
	Total coal (1)	?		
	Seam (2)	36 r		
Aylard Creek	Massive sandstone		Sandy siltstone	
	Coal	8	Coal, vitrain	6 a
	Canneloid coal	12	Canneloid coal	12
	Coal	23	Coal, durain	7 a
	Total seam	43	Coal, vitrain	15 a
	Total coal (1)	43	Sandy siltstone	
	Seam (2)	36	Total seam	40
			Total coal	40 r
Moosebar Creek	Clay ironstone			
	Coal	8		
	Shale	2		
	Coal and clay ironstone concretions	16		
	Canneloid coal	8		
	Total seam	34		
	Total coal (1)	20 r		

	Previous Data		1971 Data	
Johnson Creek			Dark grey argillite	
			Coal, durain	21
			Coal, vitrain	3
			Coal	3½
			Coal,durain, clarain, vitrain	22
			Black argillite	
			Total seam	49½
			Total coal	49½ ra
49 feet below Falls Seam				
Johnson Creek			Sandstone	
			Coal, clarain	4
			Coal, clarain	16
			Coaly argillite	
			Total seam	20
			Total coal	20 ra
Gething Seam				
Gething Creek	Coal	6	Shale and argillite	
	Shale	1	Coal, clarain	1¼ a
	Coal	22	Sandstone	¾
	Total seam	29	Coal, clarain	13 a
	Total coal (1)	28	Coal ?	3
			Coal, clarain	8½ a
			Black carbonaceous shale	
			Total seam	26½
			Total coal	25 r
West Bank	Seam (2)	18		
Aylard Creek	Coal, concretions, canneloid coal (1)	32		
	Seam (2)	24 r		

	Previous Data		1971 Data	
Little Mogul Seam				
Earle Narrows	Coal (1)	8		
Aylard Creek	Coal	?	Carbonaceous slate	
	Concretion	3	Coal, vitrain	4
	Coal	?	Coal, clarain	7
			Coal and concretion	15
	Total seam	36	Coal, clarain	$6\frac{1}{2}$
	Total coal (1)	33	Coal, vitrain	$2\frac{1}{2}$
	Coal (2)	$32\frac{1}{2}$	Carbonaceous sandy shale	
			Total seam	35
			Total coal	35 ra
Moosebar Creek	Coal (1)	11		
	Coal (2)	18		
Johnson Creek			Shale	
			Coal, durain	$8\frac{1}{2}$
			Coal	$2\frac{1}{2}$
			Coal, shaly	14
			Carbonaceous shale	
			Total seam	25
			Total coal	25 ra
Mount Johnson			Black shale	
			Coal	12
			Coal with impurities	$6\frac{1}{2}$
			Coal	$7\frac{1}{2}$
			Shale	
			Total seam	26
			Total coal	26 ra

	Previous Data		1971 Data	
Mogul Seam				
Earle Narrows	Coal	?		
	Concretion	?		
	Coal	?		
	Jet coal	5		
	Total seam	56		
	Total coal (1)	56 r		
Aylard Creek	Coal	2		
	Concretion	4		
	Coal	40		
	Total seam	46		
	Total coal (1)	42 r		
Moosebar Creek	Coal (1)	40		
	Coal (2)	42 r		
Johnson Creek			Shale	
			Coal, clarain-vitrain	37
			Argillite	9
			Coal, vitrain	13
			Total seam	59
			Total coal	50 ra
Mount Johnson			Shale	
			Coal	2
			Rusty coal	5
			Coal	8
			Rusty coal	3
			Coal, dull	18
			Coal with bright bands	12
			Canneloid coal	9
			Coal with bright bands	12
			Dark shale	
			Total seam	69
			Total coal	69 a

	Previous Data		1971 Data	
Castle Point Seam				
West Bank	Carbonaceous shale		Sandstone	
	Coal	8	Coal, durain	9
	Clay ironstone	12	Shale	7
	Coal	12	Coal	8
	Shale	12	Shale to argillite	
	Coal	5	Total seam	24
	Total seam	49	Total coal	17
	Total coal (1)	25 r		
	Coal (2)	24		
Aylard Creek	Coal	?	Top covered	
	Concretion band	4	Coal, clarain	18
	Coal	?	Shale	
	Black carbonaceous shale		Seam	18
			Coal	18 a
	Total seam	45		
	Total coal (1)	41 r		
Moosebar Creek	Shale			
	Coal	6		
	Clay ironstone	12		
	Coal	6		
	Shale	6		
	Coal	10		
	Shale	7		
	Coal	5		
	Total seam	52		
	Total coal (1)	27 r		
Mount Johnson			Grey shale	
			Coal	6
			Coal with red specks	7
			Coal, good	35
			Coaly shale	
			Total seam	48
			Total coal	48 ra

	Previous Data		1971 Data	
160 feet above Milligan Seam				
Peace River Canyon (Fossil Tree Point)			Coal, vitrain	2
			Coal, clarain	22
			Total seam	24
			Total coal	24 ra
Milligan Seam				
North Shore	Coal and concretions (1)	30	Coal, weathered	13
			Coal, durain	14
			Concretions	10
	Coal (2)	18	Coal, clarain	5
			Coal	3
			Total seam	45
			Total coal	35 ra
West Bank	Seam (2)	48 r		
Aylard Creek	Seam (1)	34	Shale	
			Coal, clarain	27
	Seam (2)	36	Coal, clarain	7
			Carbonaceous siltstone	
			Total seam	34
			Total coal	34 ra
Dam Site #2	Seam (3)	24 r		
Moosebar Creek	Seam (1)	29	Black carbonaceous shale	
	Sandstone			
	Coaly shale	4	Coal, durain	24
	Coal	32	Concretions	1
	Sandstone		Coal, durain	6
			Siltstone	
	Total seam	36		
	Total coal (2)	32	Total seam	31 a
			Total coal	30 r

	Previous Data		1971 Data	
Johnson Creek			Recessive unit	
			Coal, vitrain	5
			Coal, clarain	14
			Coal, vitrain	8
			Sandstone	
			Total seam	27
			Total coal	27 ra
Mount Johnson			Shale	
			Coal	$3\frac{1}{2}$
			Canneloid coal	22
			Parting	$\frac{1}{2}$
			Coal	1
			Parting	$\frac{1}{2}$
			Coal	$2\frac{1}{2}$
			Shale	
			Total seam	30 a
			Total coal	29 r
<u>Galloway Seam</u> (probably equivalent to Milligan Seam)				
Gething Creek	Canneloid coal	18	Shale	
	Coal	30	Canneloid coal	13
			Coal, durain	24 a
	Total seam	48	Coal, vitrain	2 a
	Total coal (1)	48	Argillite	
			Total seam	39
			Total coal	39 r

	Previous Data		1971 Data	
Wendy Seam				
North Shore	Seam (2)	20 r		
West Bank	Seam (2)	18 r		
Aylard Creek	Coal and concretions	39		
	Jet coal	8		
	Total seam (1)	47		
	Total coal	?		
Moosebar Creek	Seam (2)	54 r		
Johnson Creek			Coal, clarain	22
			Coal, vitrain	5
			Total seam	27
			Total coal	27 ra
Louise Seam				
North Shore	Seam (2)	36 r		
West Bank	Seam (2)	48 r		
Aylard Creek	Coal and concretions	36		
	Total seam (1)	36		
	Total coal	?		
Dam Site #2	Seam (3)	12		

	Previous Data		1971 Data	
Moosebar Creek			Shaly argillite	
			Coal, clarain	13
			Coal, vitrain	3
			Carbonaceous shale	$7\frac{1}{2}$
			Coal, clarain	7
			Carbonaceous shale	
			Total seam	$30\frac{1}{2}$
			Total coal	23 ra
Ferro Point Seam				
North Shore	Seam (1)	26 r		
West Bank	Coal (2)	24	Argillite	
	Seam (2)	48	Coal, clarain	25
			Coal, vitrain	8
			Carbonaceous shale	
			Total seam	33
			Total coal	33 ra
Dam Site #2	Seam (3)	30 r		
Moosebar Creek	Seam (2)	14		
Quentin Seam				
West Bank	Seam (2)	36	Carbonaceous shale	
			Coal, clarain	9
			Argillite	10
			Coal, clarain	20
			Shale	
			Total seam	39
			Total coal	29 ra
Dam Site #2	Seam (3)	54 r		

	Previous Data		1971 Data	
Moosebar Creek	Seam (2)	24 r		
King Creek	Bright and dull coal (1)	30 r	Top eroded Coal Sandstone Seam Coal	 26½ 26½ 26½
Grant Seam				
North Shore	Seam (2)	60	Coal Coal Seam Coal	36 25 61 61 r
West Bank	Seam (2)	36 r		
Dam Site #2	Seam (3)	60 r		
Aylard Mine	Coal Coal Jet coal Total seam Total coal (1)	35 34 10 79 79 r	Coal Coal Parting Coal Coal Total seam Total coal	19 a 16 a ½ 19 a 10 a 64½ 64
King Seam (equivalent to Grant Seam)				
King Creek	Dull coal Dull and bright coal Shale Bright and dull coal Total seam Total coal (1)	8½ 19 3½ 7 62 58½	Shale Coal Shale Total seam Total coal	 66½ 66½ 66½ r.

	Previous Data		1971 Data
King Creek	Carbonaceous shale		
	Coal	4	
	Bone	1½	
	Coal	11½	
	Concretions	18	
	Coal	12	
	Shale	1	
	Coal	24	
	Blacksmith coal	6	
	Total seam	78	
	Total coal (4)	57½	
	Shale		
	Coal	5	
	Bone	4	
	Coal	7	
	Rock streak	¼	
	Coal	12	
	Rock	4	
	Coal	31	
	Ironstone		
	Total seam	63¼	
	Total coal (4)	55	
Riverside Seam			
North Shore	Seam (2)	33½ r	
West Bank	Coal (2)	42 r	
Aylard Mine Area	Dark grey shiny coal	?	
	Jet coal	?	
	Total seam	34	
	Total coal (1)	34 r	

	Previous Data		1971 Data	
Knight Seam				
East Bank Upper Canyon	Coal	36		
	Sandstone			
	Total seam	36		
	Total coal (1)	36 r		
West Bank			Shale	
			Coal, clarain	$12\frac{1}{2}$
			Coal, vitrain	2
			Coal, clarain	2
			Coal, durain	6
			Coaly argillite	2
			Argillaceous coal	2
			Coal, vitrain	$7\frac{1}{2}$
			Coal, clarain	$6\frac{1}{2}$
			Argillite	
			Total seam	$40\frac{1}{2}$ a
			Total coal	$36\frac{1}{2}$ r
Twin Seams				
East Bank Upper Canyon	Upper seam, coal (1)	24 r		
	Siltstone	84		
	Lower seam, coal (1)	$27\frac{1}{2}$ r		
	Sandstone			
West Bank	Coal (2)	24	Carbonaceous siltstone	
	Parting			
	Seam (2)	18	Coal, vitrain	1
			Coal, clarain	8
			Carbonaceous clay	1
			Coal, clarain	12
			Total upper seam	22 a
			Total upper coal	21 r

	Previous Data		1971 Data	
West Bank (cont'd)			Carbonaceous argillite	72
			Coal, durain	5
			Coal, durain	19
			Coal, vitrain	1½
			Carbonaceous argillite	
			Total lower seam	25½
			Total lower coal	25½ ra
Boring Seam				
East Bank Upper Canyon	Canneloid coal	18		
	Coal, shiny and dull	2		
	Black shale	9		
	Coal, shiny	12		
	Total seam	41		
	Total coal (1)	32 r		
	Seam (2)	36		
West Bank	Coal (2)	12 r		
Murray Seam (correlated with "48" Seam)				
East Bank Upper Canyon	Shale			
	Coal	25		
	Clay ironstone	4½		
	Coal	27		
	Clay ironstone	6		
	Coal	24		
	Shale			
	Total seam	86½		
	Total coal (4)	73 r		
West Bank	Coal (2)*	36 r		

* It is uncertain whether this is the 7-foot seam worked in 1926 (Analyses 52-56, Appendix 4).

	Previous Data		1971 Data	
"48" Seam (equivalent to Murray Seam)				
King Creek	Sandstone		Coal	36 a
	Coal	19	Coal	28 a
	Inferior coal	9	Parting	11
	Coal	51	Coal	42 a
	Clay ironstone	8		
	Bottom coal	18	Total seam	81
			Total coal	70
	Total seam	105		
	Total coal (4)	97 r		
			Coal	21 a
			Coal	10 a
			Coal	15 a
			Coal	$17\frac{1}{2}$ a
			Coal	$14\frac{1}{2}$ a
			Total seam	78
			Total coal	78

APPENDIX 9: FIELD PERSONNEL

Name	Position	Time on Property 1971
G. Checklin	Geologist	July 4 - November 4
B. Christensen	Assistant	July 6 - October 24
David Forester	Laborer	September 28 - November 3
Douglas Forester	Laborer	October 6 - October 22
J. Gorham	Assistant	September 13 - September 21
L. Halferdahl	Geologist	June 11 - June 12 July 4 July 17 - July 20 July 26 August 21 - August 22 August 28 - August 29 September 9 - September 12 October 2 - October 3 October 17 - October 18
F. Hewko	Blaster	August 28 - August 29
A. Kahil	Geologist	August 10 - September 29
K. Karpiak	Laborer	August 7 - September 11
L. Leffler	Laborer	August 4 - August 31
T. Lewis	Laborer	October 11 - November 3
D. Lobdell	Geologist	July 6 - July 26
G. Phillips	Laborer	September 8 - October 18
B. Redpath	Assistant	July 6 - September 5
T. Smith	Laborer	September 7 - September 21

In addition to those above, casual labor was hired for 16 days in July and August.

PR - PEACE RIVER CANYON 71(4)A

NOTE: COAL ANALYSIS DATA HAS BEEN TAKEN FROM OPEN FILE - 71(4)A

CINNABAR PEAK MINES LTD.

1971 GEOLOGICAL EXPLORATION OF PEACE RIVER CANYON COAL PROPERTIES NORTHEASTERN BRITISH COLUMBIA

Geographic Coordinates
55° 56' N
122° 8' W
NTS Sheet 93O/16E

by
G. A. CHECKLIN, B.Sc., P. Eng.
and
L. B. HALFERDAHL, Ph.D., P. Eng.

December 30, 1971

L. B. Halferdahl & Associates Ltd.
401 - 10049 Jasper Avenue
Edmonton 15, Alberta

NOTE: ALL COAL ANALYSIS DATA WAS EXTRACTED FROM OPEN FILE - 71(1)A

CHARACTERISTICS OF COAL SEAMS

Descriptions of coal seams and analyses of coal samples are presented in the appendices. In general, where outcrops are sufficient to permit reliable correlation and samples have been analyzed, the coal seams appear to have little lateral variation in thickness and in analyses of the coal. They do vary laterally in both presence and thickness of partings and ironstone concretions. The chief variations in each seam are stratigraphic: ash contents, free swelling indexes or caking properties vary from bench to bench. The analyses indicate that most of the coal is low or medium volatile bituminous, with a few samples being high volatile bituminous. Ash contents seldom exceed 20 per cent with many less than 10 per cent, particularly in the thicker seams. Only one of 39 samples that have been analyzed for sulfur contains more than one per cent.

Partial analyses of the samples collected in 1971 are shown in Appendix 6. As most of these samples were collected from outcrops and were expected to be more or less oxidized, only moisture, ash, and free swelling index were determined for preliminary evaluation. Even though the samples were partly oxidized, free swelling indexes in the range 4 to 8 were obtained consistently for the Superior and Trojan Seams, both near the top of the Gething Formation in a similar stratigraphic position to the well-known Chamberlain Seam of excellent coking quality currently being explored south of Chetwynd near the Sukunka River. Other significant free swelling indexes were obtained at some places or from some benches of the Mogul, Grant, and Knight Seams, and an unnamed seam 36 feet below the Milligan Seam on Johnson Creek. Hence, it appears that rapid mechanical erosion of the coal in some creek beds and at some places along canyon walls can prevent oxidation from reducing free swelling indexes to insignificant values. However, high moisture contents in samples of the 60-inch seam exposed in a bulldozed trench away from creeks on Mount Johnson indicate that oxidation may have been responsible for the non-agglomerating coal samples. For this reason, not all samples collected from Mount Johnson were analyzed. In order to obtain less-oxidized samples from the Trojan Seam, trenches were blasted at two places: Coalbed Creek and Lower Moosecall Creek (Table 4). A parting ranging from 2 to 4 inches in the Trojan Seam on Coalbed Creek has been included in the lower 20-inch bench. The low free swelling index in the upper 20-inch bench is probably due partly to the higher ash content and partly to oxidation. At Lower Moosecall Creek, the ash contents of about 20 per cent in the 36-inch and 15-inch benches have apparently reduced their free swelling indexes. Unoxidized coal from the Trojan Seam after any required processing to reduce the ash content to an acceptable value is expected to have a free swelling index of 8 or more. Although coke-oven tests of large unoxidized samples are required to assess adequately the coking quality of coal, the free swelling index is generally regarded as a good indicator. Free swelling

TABLE 4: ANALYSES OF COAL FROM TROJAN SEAM AFTER BLASTING

		Residual Moisture	Volatile Material	Fixed Carbon	Ash	S	B.T.U. per lb.	F.S.I.
Coalbed Creek								
Top	20"	1.46	23.22	52.94	22.38	0.44	9,010	½
Next	29"	1.43	30.07	56.23	12.27	0.44	12,430	5½
Next	20"	1.25	33.13	53.30	12.32	0.50	11,580	7½
Bottom	13"	1.53	34.09	53.78	10.60	0.62	13,540	6½
Composite	82"	-	-	-	-	-	-	6
Lower Moosecall Creek								
Top	36"	1.27	24.81	52.27	21.65	0.60	11,570	4½
Parting	19"							
Middle	15"	1.26	24.16	54.19	20.39	0.67	11,760	4
Parting	3½"							
Bottom	13"	1.26	29.56	61.61	7.51	0.71	14,010	8½
Composite	64"	-	-	-	-	-	-	5

Coalbed Creek: The upper two samples were collected about 6 feet in from the original outcrop face. The lower two samples were collected about 10 feet in from the original outcrop face.

Lower Moosecall Creek: The samples were collected about 5 feet in from the original outcrop face.

indexes in the range 5 to 9 are characteristic of the better western Canadian coking coals.

Seams five feet or more thick at one or more places include the Trojan, Titan, Mogul, Grant-King, and Murray-"48". Of these, coal has been mined from the Grant-King and the Murray-"48" in the past. As previously indicated, free swelling indexes for samples obtained from the Trojan Seam in 1971 are consistently in the range of those for coking coal, and free swelling indexes from some benches in the Mogul and the Grant-King Seams are also in the range of those for coking coal. Coal from all five of these seams with its low ash and low sulfur contents is suitable for coal-burning power plants. Of the somewhat thinner seams, the Superior has free swelling indexes in the range of those for coking coal.

APPENDIX 3 Coal Analyses for Seams Sampled by Drilling in December 1969.

APPENDIX 3: COAL ANALYSES FROM SEAMS SAMPLED BY DRILLING IN DECEMBER 1969

Analyses by Cresk Laboratories Ltd., Edmonton

Footage	Inherent[1] Moisture	Volatile Matter	Fixed[2] Carbon	Ash	B.T.U. per lb.	F.S.I.	Seam[3]
Hole No. 1							
182 -183	0.4	20.8	57.4	21.4	11,730	1	King
183 -184	0.4	24.3	71.2	4.1	14,650	3½	King
283 -284	0.4	25.5	58.3	15.8	12,750	8	94 feet below King
568.5-570	0.3	16.5	57.6	25.6	13,580	1	"48"
570 -571	0.4	15.6	1.8	22.2	11,600	1	"48"
571 -572	0.4	18.2	76.3	5.1	14,350	1½	"48"
572 -573	0.4	17.7	76.3	5.6	14,390	1½	"48"
573 -574	0.3	19.4	76.3	4.0	14,680	1½	"48"
574 -575	0.4	20.8	72.1	6.7	14,060	1½	"48"
575 -576	0.3	30.1	29.2	40.4	6,570	1	"48"
693.4-694.5	0.4	21.1	66.9	11.6	13,330	1½	117 feet below "48"
694.5-695.5	0.4	21.5	63.0	15.1	12,840	1½	117 feet below "48"
695.5-695.8	0.4	12.9	23.7	63.0	5,260	1	117 feet below "48"
733 -734	0.3	18.1	59.0	22.6	11,370	1	154 feet below "48"

[1] Inherent moisture percentages are not available for samples marked with a dash. They are expected to have the same range, 0.3 to 0.7, as the other samples. Other data for these samples is on a dry basis.

[2] Stated as free carbon in the analytical reports.

[3] Seams are based on correlations in this report, and distances are measured stratigraphically.

Footage	Inherent Moisture	Volatile Matter	Fixed Carbon	Ash	B.T.U. per lb.	F.S.I.	Seam
734 -735	0.3	23.9	66.1	9.7	13,680	7	154 feet below "48"
735 -736	0.3	17.0	33.2	49.5	7,370	3	154 feet below "48"
Hole No. 2							
195 -196	-	11.0	22.8	66.2	4,950	1	114 feet above King
196 -197	-	9.9	27.4	62.6	5,360	N.A.	114 feet above King
197 -198	-	25.4	66.0	8.6	13,980	7	114 feet above King
198 -199	-	9.4	21.3	69.3	4,240	N.A.	114 feet above King
199 -199.5	-	13.9	69.1	17.0	12,580	7½	114 feet above King
327 -328.5	0.7	17.7	45.9	35.7	9,360	1	King
328.5-331.5	0.3	24.1	73.6	2.0	14,830	2	King
718.5-720	-	18.0	39.2	42.8	8,390	1	"48"
720 -721	-	17.4	71.9	10.8	13,510	1	"48"
721 -722	-	18.7	69.2	12.1	13,390	1	"48"
722 -723	-	17.7	65.4	17.0	12,450	1	"48"
723 -724	-	16.8	66.1	17.1	12,380	1½	"48"
724 -725	-	17.3	74.4	8.2	13,960	1	"48"
725 -726	-	18.3	76.0	5.7	14,310	1	"48"
726 -726.8	-	19.6	76.9	3.5	14,680	1	"48"
Hole No. 3							
232.2-233	-	28.4	62.2	9.5	13,420	1½	92 feet above Quentin
234 -235	-	28.4	64.7	6.9	13,950	7	92 feet above Quentin

APPENDIX 4: OTHER ANALYSES OF COAL FROM SEAMS AT THE PEACE RIVER CANYON

APPENDIX 4: OTHER ANALYSES OF COAL FROM SEAMS AT THE PEACE RIVER CANYON

No.	Moisture	Volatile Matter	Fixed Carbon	Ash	S	B.T.U. per lb.	Caking Property	Rank	Reference*
1	1.0	24.5	65.9	8.6	0.7	13,820	N.A.	Mvb	1
2	1.6	26.0	64.0	8.4	0.5	13,350	N.A.	Mvb	1
3	1.1	18.8	58.6	21.5	-	-	N.A.	Mvb	1
4	1.2	24.1	64.1	10.6	-	-	Poor	Mvb	1
5	0.7	28.6	64.6	6.1	-	-	Good	Mvb	1
6	1.9	20.5	69.5	8.2	0.8	12,853	-	Mvb	2
7	0.7	24.8	58.4	16.1	-	-	Agglom.	Mvb	1
8	0.6	26.7	61.5	11.2	-	-	Good	Mvb	1
9	1.1	24.0	69.4	5.5	-	-	Poor	Mvb	1
10	1.0	23.8	71.9	3.3	-	-	N.A.	Mvb	1
11	0.9	25.9	70.9	2.3	-	-	Poor	Mvb	1
12	0.8	20.7	71.1	7.4	0.07	13,820	N.A.	Mvb	1
13	1.0	25.2	70.3	3.5	-	-	N.A.	Mvb	1
14	2.7	24.3	62.5	10.5	-	-	N.A.	Mvb	1

Trojan Seam

1. Gaylard Creek, 66" coal without 2 partings totalling 6".
2. Gething Creek, 100" coal without 4 partings totalling 10".
3, 4, 5. Coalbed Creek, top 54" coal, middle benches 19" and 26" coal, lowest bench upper 15" coal.
6. Coalbed Creek, sample interval not stated, F.S.I. -1, soft.
7, 8. Contact Point, upper 32" coal, lower 42" coal.

Falls Seam

9, 10, 11. Gething Creek, top 8" coal, middle 11" coal, bottom 15" coal.
12. Johnson Creek, 49" coal (correlation uncertain).

Gething Seam

13. Gething Creek, 28" coal and a 1" parting.

Little Mogul Seam

14. Mogul Creek, 32" coal.

* 1 - McLearn & Kindle (1950); 2 - Millar (1969); 3 - McLearn & Irish (1944); a year refers to a B.C. Minister of Mines report.

No.	Moisture	Volatile Matter	Fixed Carbon	Ash	S	B.T.U. per lb.	Caking Property	Rank	Reference
15	1.2	22.9	71.3	4.6	-	-	N.A.	Mvb	1
16	1.4	22.7	71.7	4.2	0.9	14,220	N.A.	Mvb	1
17	0.6	19.0	76.3	4.1	-	-	N.A.	Lvb	1
18	0.8	18.9	76.6	3.7	0.8	14,590	N.A.	Lvb	1
19	0.9	19.3	76.1	3.7	0.9	14,550	N.A.	Lvb	1
20	2.0	21.8	72.7	3.5	-	-	N.A.	Mvb	1
21	2.3	21.2	73.0	3.5	-	-	N.A.	Mvb	1
22	24.1	23.0	40.0	12.9	0.6	7,720	N.A.	Hvbb	1

Mogul Seam

15. Mogul Creek, 38" coal and a 14" concretion.
16. Earle Narrows, 56" coal and 2 small concretions.
17. Johnson Creek, 34" coal (correlation uncertain - upper part of seam?).

Milligan Seam

18, 19. Gething Creek, upper 18" canneloid coal, lower 30" coal (correlation very uncertain; McLearn's Galloway Seam).
20. N Bank Earle Narrows, 33" coal.
21. Moosebar Creek, 29" coal.

Quentin Seam

22. Road to King Gething Mine, 32" coal.

No.	Moisture	Volatile Matter	Fixed Carbon	Ash	S	B.T.U. per lb.	Caking Property	Rank	Reference
23	0.8	20.4	75.4	3.4	-	-	Poor	Lvb	1
24	0.6	23.6	72.4	3.4	-	-	Good	Mvb	1
25	0.6	18.7	78.1	2.6	-	-	N.A.	Lvb	1
26	0.7	24.6	72.6	2.1	-	-	Good	Mvb	1
27	0.7	19.6	74.4	5.3	0.7	14,420	N.A.	Lvb	1
28	0.6	19.5	77.0	2.9	0.7	14,940	N.A.	Lvb	1
29	0.7	22.0	70.8	6.5	0.7	14,440	Good	Mvb	1
30	0.7	18.7	74.5	6.1	0.6	14,300	N.A.	Lvb	1
31	0.8	19.3	77.3	2.6	0.7	14,960	Agglom.	Lvb	1
32	0.7	22.9	74.0	2.4	0.7	15,130	Good	Mvb	1
33	0.6	20.1	75.2	4.1	-	-	N.A.	Lvb	1
34	0.6	19.5	77.3	2.6	-	-	N.A.	Lvb	1
35	0.6	24.8	72.2	2.4	-	-	N.A.	Mvb	1
36	1.3	16.5	78.9	3.3	-	-	-	Lvb	1924
37	2.2	23.0	71.5	3.3	-	-	-	Mvb	1924
38	1.1	18.5	75.5	4.9	-	-	-	Lvb	1924
39	3.8	22.1	63.6	10.5	1.8	12,900	Agglom.	Mvb	3
40	5.9	26.8	51.2	16.1	0.8	11,080	Agglom.	Hvab	3
41	5.7	21.4	69.1	3.3	0.8	13,840	Agglom.	Mvb	3
42	4.5	26.2	68.0	1.3	0.9	14,480	Good	Mvb	3
43	1.7	17.4	70.0	10.9	0.77	13,237	-	Lvb	1940
44	0.7	18.8	74.9	5.6	0.8	14,000	Agglom.	Lvb	1

Grant Seam at Grant Flat and Aylard Mine

23, 24. Cliff 300' W of W Xcut, middle and top 60" coal, bottom 9" coal.
25, 26. Cliff entrance to W Xcut, middle and top 54" coal, bottom 11" coal.
27, 28, 29. Adit 35' from portal, top 38" coal, middle 23" coal, bottom 8" coal.
30, 31, 32. Adit at E Xcut, top 36" coal, middle 21" coal, bottom 9" coal.
33, 34, 35. Adit face, September 26, 1923, top 32" coal, middle 22" coal, bottom 9" coal.
36, 37, 38. Adit face, 1923, top 54" coal, bottom 11" coal; total 65" coal.

King Seam in King Gething No. 1 Mine

39, 40, 41, 42. Adit in 1943, top 8" coal, next 19" coal, next 24" coal, bottom 7" coal.
43. Adit face 1940, 57½" coal without partings or concretions.

Riverside Seam

44. Grant Flat 35' below Grant Seam, 34" coal.

No.	Moisture	Volatile Matter	Fixed Carbon	Ash	S	B.T.U. per lb.	Caking Property	Rank	Reference
45	2.6	20.7	67.6	9.1	0.8	13,510	Poor	Mvb	1
46	11.0	21.7	52.4	14.9	0.6	9,980	N.A.	Mvb	1
47	11.0	22.2	57.5	9.3	0.7	11,870	N.A.	Mvb	1
48	3.5	20.3	70.4	5.8	0.6	13,810	Agglom.	Mvb	1
49	2.3	20.5	69.0	8.2	0.8	13,510	Agglom.	Mvb	1
50	2.2	19.5	66.8	11.5	0.7	13,060	Agglom.	Mvb	1
51	4.3	21.6	68.5	5.2	0.8	14,070	Good	Mvb	1
52	0.6	17.0	79.0	3.0	-	-	-	Lvb	1926
53	0.6	16.9	80.0	2.5	-	-	-	Lvb	1926
54	0.6	17.2	75.4	6.8	-	-	-	Lvb	1926
55	0.9	14.1	82.5	2.5	-	-	-	Lvb	1926
56	0.6	19.6	75.8	4.0	-	-	-	Lvb	1926
57	13.1	22.0	51.2	13.7	0.4	9,750	N.A.	Mvb	1
58	1.5	19.3	72.7	6.5	-	13,830	-	Lvb	1945
59	0.9	17.3	70.6	11.2	0.5	13,370	-	Lvb	1953
60	1.1	18.0	74.4	6.6	0.5	13,658	-	Lvb	2
61	1.1	13.1	60.1	25.7	0.3	10,608	-	Lvb	2
62	0.8	16.3	78.3	4.6	0.4	13,932	-	Lvb	2

Knight Seam

45. River shore NE of Cust Island, 36" coal.
46. Trench on Galloway slope, 47" coal.
47. Trench on Galloway slope, lower 18" of previous sample.

Twin Seams

48. Boring Point, upper seam 24" coal.
49. Boring Point, lower seam 28" coal.

Boring Seam

50, 51. Boring Point, upper 18" coal, lowest 12" coal.

Murray Seam

52, 53, 54, 55, 56. S side upper canyon, benches 1 to 5 in 84" coal seam.
57. Trench near Larry Creek, 60" coal.
58. Peace River Mine No. 1 left level, 76" coal.

"48" Seam - King Gething No. 3 Mine

59. 88" coal without 9" inferior coal and clay ironstone; soft coke, no swelling.
60, 61, 62. Top 12" coal, F.S.I. 1 soft; middle 8" coal, F.S.I. 1 soft; bottom 52" coal, F.S.I. 1 soft.

APPENDIX 6: 1971 ANALYSES OF COAL SAMPLES

APPENDIX 6: 1971 ANALYSES OF COAL SAMPLES

(Analyzed by Loring Laboratories Ltd., Calgary)

Seam	Sampled Interval (inches)	Inherent Moisture	Ash	F.S.I.	Date Sampled 1971	Remarks*
Superior Seam						
Aylard Creek	24	0.94	6.10	6	Sept. 16	1
Lower Moosecall Creek	33	0.69	7.24	8½	Oct. 14	2
Contact Point	31	1.40	6.82	4½	July 18	1
Trojan Seam						
Aylard Creek	41	0.70	6.28	4	Sept. 16	1
Coalbed Creek	48	1.17	14.29	½	July 18	1
	4 (parting)					
	31	0.82	14.95	8	July 18	1
Contact Point	31	1.62	12.69	1	July 22	3
King Creek	40	1.49	10.10	2	Aug. 29	1
Lower Moosecall Creek	73	.99	11.44	2½	July 25	1
Titan Seam						
Aylard Creek	26½	0.83	6.70	1½	Sept. 16	1
Johnson Creek	28	1.11	5.98	N.A.	Aug. 18	1
Contact Point	30	1.56	10.14	1)		
	20 (parting)			)	July 18	3
	47	1.41	4.61	½)		

* 1 - Creek sample; 2 - Trench; 3 - River bank; 4 - Trench No. 3; 5 - Canyon wall; 6 - Adit; 7 - West end of underground drift; 8 - Trench No. 2; 9 - Old trench; 10 - Outside adit; 11 - Face 850' in main entry.

Seam	Sampled Interval (inches)	Inherent Moisture	Ash	F.S.I.	Date Sampled 1971	Remarks
Falls Seam						
Gething Creek	24½	1.61	5.15	1	Sept. 18	1
Aylard Creek	28	1.33	4.65	1½	Sept. 16	1
Johnson Creek	49½	1.17	7.02	N.A.	Aug. 17	1
49 feet below Falls Seam						
Johnson Creek	20	1.16	10.73	N.A.	Aug. 16	1
Gething Seam						
Gething Creek	23	0.89	17.84	4	Sept. 22	1
Little Mogul Seam						
Aylard Creek	35	0.75	11.83	1½	Sept. 15	1
Johnson Creek	25	0.89	47.40	1	Aug. 17	1
Mount Johnson	26	7.40	13.84	N.A.	Oct. 11	4
Mogul Seam						
Johnson Creek	37	0.97	4.84	N.A.	Aug. 16	1
	9 (parting)					
	13	1.01	5.31	2½	Aug. 16	1
Mount Johnson	36	4.72	6.18	N.A.	Oct. 11	4
	33	5.30	6.23	N.A.	Oct. 11	4
Mount Johnson	30	8.50	9.73	N.A.	Oct. 16	8
	33	5.23	6.77	N.A.	Oct. 16	8

Seam	Sampled Interval (inches)	Inherent Moisture	Ash	F.S.I.	Date Sampled 1971	Remarks
Castle Point Seam						
Aylard Creek	18	1.18	4.06	N.A.	Sept. 15	1
Mount Johnson	23	7.00	19.50	N.A.	Oct. 10	4
	25	5.47	11.84	N.A.	Oct. 10	4
Mount Johnson	44	4.20	7.89	N.A.	Oct. 16	8
160 feet above Milligan Seam						
Peace River Canyon (Fossil Tree Point)	24	1.40	5.28	N.A.	Aug. 28	5
Milligan Seam						
North Shore	35	1.80	5.76	N.A.	Aug. 26	5
Aylard Creek	34	2.37	5.18	N.A.	Sept. 15	1
Moosebar Creek	31	3.11	5.83	N.A.	Aug. 21	1
Johnson Creek	27	1.00	6.62	½	Aug. 16	1
Mount Johnson	30	5.12	19.70	N.A.	Oct. 10	4
Galloway Seam						
Gaylard Creek	26	1.50	2.21	N.A.	Sept. 22	1
Wendy Seam						
Johnson Creek	27	0.82	8.72	5½	Aug. 16	1
Louise Seam						
Moosebar Creek	23	1.43	11.66	1	Aug. 21	1

Seam	Sampled Interval (inches)	Inherent Moisture	Ash	F.S.I.	Date Sampled 1971	Remarks
Ferro Point Seam						
Peace River Canyon (West Bank)	33	1.52	18.34	N.A.	Aug. 23	5
Quentin Seam						
Peace River Canyon (West Bank)	29	1.39	12.25	1	Aug. 23	5
Grant Seam						
Aylard Mine	36	0.96	6.62	½	July 20	6
	25	0.92	2.64	1½	July 20	6
	19	0.97	4.66	N.A.)		
	16	0.91	3.20	½)		
	½ (parting)			)	July 26	7
	19	0.95	3.11	N.A.)		
	10	0.86	6.27	5½)		
Knight Seam						
Peace River Canyon	40½	1.21	8.13	2	Aug. 23	5
Twin Seam (Upper)						
Peace River Canyon	22	2.46	15.38	N.A.	Aug. 23	5
Twin Seam (Lower)						
Peace River Canyon	25½	1.28	22.14	½	Aug. 23	5

Seam	Sampled Interval (inches)	Inherent Moisture	Ash	F.S.I.	Date Sampled 1971	Remarks
"48" Seam						
King Gething Mine #3	36	10.24	14.84	N.A.	July 15	9
King Gething Mine #3	28	0.83	14.85	N.A.)		
	11 (parting)			)	July 15	10
	42	0.87	3.65	N.A.)		
King Gething Mine #3	21	1.15	8.55	1)		
	10	0.97	33.73	N.A.)		
	15	1.15	7.57	N.A.)	July 19	11
	$17\frac{1}{2}$	1.05	3.79	N.A.)		
	$14\frac{1}{2}$	1.32	3.11	$\frac{1}{2}$)		
Uncorrelated 30" Seam						
(On road to Peace River below King Gething Mine)	30	8.84	16.49	N.A.	July 24	9

APPENDIX 7: REPORTS OF COAL ANALYSES

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: Mr. Halfer Dahl & Associates

DATE: Sept. 10, 1971.

PROJECT:

C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 1576

C.E.S. SAMPLE NO.: 1

ANALYSES ON AIR DRY BASIS:

ASH:	10.60%
VOLATILE MATTER:	34.09%
RESIDUAL MOISTURE:	1.53%
FIXED CARBON:	53.78%
FREE SWELLING INDEX:	6½
B.T.U./lb.:	13,540
SULPHUR:	0.62%
RANK:	

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: _____

R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: Mr. Halfer Dahl & Associates

DATE: Sept. 10, 1971.

PROJECT:

C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 1577

C.E.S. SAMPLE NO.: 2

ANALYSES ON AIR DRY BASIS:

ASH:	12.32%
VOLATILE MATTER:	33.13%
RESIDUAL MOISTURE:	1.25%
FIXED CARBON:	53.30%
FREE SWELLING INDEX:	7½
B.T.U./lb.:	11,580
SULPHUR:	0.50%
RANK:	

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: _____

R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: Mr. Halfer Dahl & Associates

DATE: Sept. 10, 1971.

PROJECT:

C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 1580

C.E.S. SAMPLE NO.: 3

ANALYSES ON AIR DRY BASIS:

ASH:	12.27%
VOLATILE MATTER:	30.07%
RESIDUAL MOISTURE:	1.43%
FIXED CARBON:	56.23%
FREE SWELLING INDEX:	5½
B.T.U./lb.:	12,430
SULPHUR:	0.44%
RANK:	

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: _____

R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL .

CLIENT: Mr. Halfer Dahl & Associates

DATE: Sept. 10, 1971.

PROJECT:

C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 1581

C.E.S. SAMPLE NO.: 4

ANALYSES ON AIR DRY BASIS:

ASH:	22.38%
VOLATILE MATTER:	23.22%
RESIDUAL MOISTURE:	1.46%
FIXED CARBON:	52.94%
FREE SWELLING INDEX:	½
B.T.U./lb.:	9,010
SULPHUR:	0.44%
RANK:	

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: L.B. Halferdahl & Associates Ltd. DATE: Oct. 22/71

PROJECT: C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 135 & 136 C.E.S. SAMPLE NO.: 5

ANALYSES ON AIR DRY BASIS:

ASH:	20.39%
VOLATILE MATTER:	24.16%
RESIDUAL MOISTURE:	1.26%
FIXED CARBON:	54.19%
FREE SWELLING INDEX:	4
B.T.U./lb.:	11,760
SULPHUR:	0.67%
RANK:	mvb

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: _____
R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: L.B. Halferdahl & Associates Ltd. DATE: Oct. 22/71

PROJECT: C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 137 & 138 C.E.S. SAMPLE NO.: 6

ANALYSES ON AIR DRY BASIS:

ASH:	7.51%
VOLATILE MATTER:	29.56%
RESIDUAL MOISTURE:	1.26%
FIXED CARBON:	61.61%
FREE SWELLING INDEX:	8½
B.T.U./lb.:	14,010
SULPHUR:	0.71%
RANK:	hvAb

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: _____

R. S. Sehgal, P. Eng.
Laboratory Manager.

BOREHOLE SAMPLES: REPORT OF ANALYSES ON RAW MATERIAL

CLIENT: L.B. Halferdahl & Associates Ltd. DATE: Oct. 22/71

PROJECT: C.E.S. PROJECT NO.: S1-113

CLIENT SAMPLE NO.: 139 & 140 C.E.S. SAMPLE NO.: 7

ANALYSES ON AIR DRY BASIS:

ASH:	21.65%
VOLATILE MATTER:	24.81%
RESIDUAL MOISTURE:	1.27%
FIXED CARBON:	52.27%
FREE SWELLING INDEX:	4½
B.T.U./lb.:	11,570
SULPHUR:	0.60%
RANK:	mvb

REMARKS:

C.E.S. Form 17

CYCLONE ENGINEERING SALES LTD.

Per: R. S. Sehgal, P. Eng.
Laboratory Manager.

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4302
Date July 21st 1971
Samples Coal

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
9701-B	10.24	14.84	N.A.
9702-B	.87	3.65	N.A.
9703-B	.83	14.85	N.A.
9704-B	1.17	14.29	½
9705-B	.82	14.95	8

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

A. L. McInnes
Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4306
Date July 22nd 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
1571	1.15	8.55	1
1572	.97	33.73	N.A.
1573	1.15	7.57	N.A.
1574	1.05	3.79	N.A.
1575	1.32	3.11	½
5234-A	.96	6.62	½
5235-A	.92	2.64	1½

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

C. Lima

Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 - Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4315
Date July 26th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H2O %	Ash %	F.S.I.
RAW COAL			
9706 - B	1.40	6.82	4½
9707 - B	1.62	12.69	1
9708 - B	1.41	4.61	½
9709 - B	1.56	10.14	1

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

A. L. McLennan
Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4359
Date July 28th 1971
Samples Coal

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	Inherent H2O %	Ash %	F.S.I.
RAW COAL			
5236-A	8.84	16.49	N.A.
5237-A	.99	11.44	2½
6092-A	.97	4.66	N.A.
6093-A	.91	3.20	½
6094-A	.95	3.11	N.A.
6095-A	.86	6.27	5½

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

C. Loring Jacobs

Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4432
Date August 20th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
101	.82	8.72	5½
102	1.00	6.62	½
103	1.01	5.31	2½
104	.97	4.84	N.A.
105	.89	47.40	1
106	1.16	10.73	N.A.
107	1.17	7.02	N.A.
108	1.11	5.98	N.A.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

A. Loring Jacques
Licensed Assayer of British Columbia

To: L.B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4440
Date August 25th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
109	1.43	11.66	1
110	3.11	5.83	N.A.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

C. L. McIsaac

Licensed Assayer of British Columbia

To: I. E. HALFERDAHL & ASSOCIATES LTD.
401 Northrate Bldg.,
10049 Jasper Avenue,
EDMONTON 15, Alberta.

File No. 4458
Date August 30th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
111	2.46	15.38	N.A.
113	1.21	8.13	2
114	1.39	12.25	1
115	1.52	18.34	N.A.
116	1.80	5.76	N.A.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

A. L. McInnes
Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No: 4531
Date September 7th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
112	1.28	22.14	½
117	1.40	5.28	N.A.
118	1.49	10.10	2

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

A. Lorne Loring

Licensed Assayer of British Columbia

To: L. R. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
Edmonton, Alberta.

File No. 4587
Date September 20th 1971
Samples Coal

Certificate of ASSAY
LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
RAW COAL			
119	2.37	5.18	N.A.
120	1.18	4.06	N.A.
121	.75	11.83	1½
122	.94	6.10	6
123	.70	6.28	4
124	1.33	4.65	1½
125	.83	6.70	1½

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.
Pulps Retained one month unless specific arrangements made in advance.

C. L. McIsaac
Licensed Assayer of British Columbia

To: L.B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
Edmonton 15, Alberta.

File No. 4663
Date September 27th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F.S.I.
126	1.50	2.21	N.A.
127	.89	17.84	4
128	1.16	5.15	1

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4635
Date October 14th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H2O %	Ash %	F.S.I.
129	5.12	19.70	N.A.
130	7.00	19.50	N.A.
131	5.47	11.84	N.A.
132	5.30	6.23	N.A.
133	4.72	6.18	N.A.
134	7.40	13.84	N.A.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

Licensed Assayer of British Columbia

To: L. B. HALFERDAHL & ASSOCIATES LTD.
401 Northgate Bldg.,
10049 Jasper Ave.,
Edmonton 15, Alberta.

File No. 4690
Date October 18th 1971
Samples Coal

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	Inherent H20 %	Ash %	F. S. I.
141	.69	7.24	8½
142	8.50	9.73	N.A.
143	5.23	6.77	N.A.
144	4.20	7.89	N.A.

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

Licensed Assayer of British Columbia

APPENDIX 8: IRONSTONE CONCRETIONS

APPENDIX 8: IRONSTONE CONCRETIONS

Ironstone concretions have been noted in and adjacent to some of the coal seams in the Peace River Canyon. Any ironstone produced with coal from these seams will be removed from the coal during its processing. In order to learn if it might have any value as a by-product, a sample from ironstone concretions in the shale overlying the Grant Seam at the Aylard Mine was analyzed. It contained 27.1 per cent Fe; other constituents are given in the accompanying assay report. This is a lower iron content than some other ironstone concretions from Cretaceous strata in western Canada, but with calcining or roasting, the iron content would be increased to about 36 per cent. Although this does not appear particularly encouraging, until more is known about the range of composition of ironstone concretions at the Peace River Canyon, the possibility of their becoming a by-product should not be entirely discounted.

To: L. B. HALFERDAHL & ASSOCAITES LTD.
401 - Northgate Bldg.,
10049 Jasper Ave.,
EDMONTON 15, Alberta.

File No. 4397
Date August 4th 1971
Samples Chip

Certificate of ASSAY

LORING LABORATORIES LTD.

SAMPLE No.	L.O.I.	Si02 %	Al203 %	Fe203 %	Mn %	S %	P205 %
6096 A	25.25	22.66	5.94	38.77	.61	.07	.28

I Hereby Certify THAT THE ABOVE RESULTS ARE THOSE ASSAYS MADE BY ME UPON THE HEREIN DESCRIBED SAMPLES . . . .

Rejects Retained one month.

Pulps Retained one month unless specific arrangements made in advance.

A. L. McLeod

Licensed Assayer of British Columbia