PR-PEACE RIVER CANYON 72(1) A-1

1972 WINTER DRILLING PROJECT ON PEACE RIVER CANYON COAL PROPERTIES

L.B. HALFERDAHL

MAY 17th, 1972

COAL BRANCH
ASSESSMENT REPORT

00170

PR-PEACE RIVER CANYON 72(1) A

MEMORANDUM

CONFIDENTIAL

OPEN

FROM THE DEPARTMENT OF MINES AND PETROLEUM RESOURCES

TO Mr. A.R. Corner,
Administrative Branch,
Mining Titles.

VICTORIA, B.C., January 15, 1973

WHEN REPLYING PLEASE REFER TO FILE No.

Re: Utah Mines Ltd. Coal Licenses in the Peace River area.

I have examined the attached geological report on the Carbon Creek Coal basin based on work completed in the 1971 field season. This report gives a thorough description and evaluation of work done and I would recommend acceptance of same. I understand a similar report on the work done in the 1972 season is to be submitted within a few weeks.

Under these circumstances I would recommend approval of the rebate. Perhaps you would kindly pass this report on to Mr. Bell.

A.R.C. James

A.R.C. James, P.Eng.,
Senior Inspector of Mines.

ARCJ:sl

JAN 16 '73 PM

DEPT. OF MINES AND PETROLEUM RESOURCES

REFERRED TO	DATE	INITIAL
D. M.		
C.G.G.		
C.C.		
D.C.G.G.		
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C.P.E.		
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617

Report passed to Mr Bell 18/1/73 CMB

PR- Peace River Canyon 72C/7A

CINNABAR PEAK MINES LTD.

1972 WINTER DRILLING PROJECT

ON

PEACE RIVER CANYON COAL PROPERTIES

NORTHEASTERN BRITISH COLUMBIA

Geographic Coordinates
55° 56' N
122° 8' W

NTS Sheet 93O/16E

by

G. A. VAN DYCK, B.Sc.

May 17, 1972

L.B. Halferdahl & Associates Ltd.
401 - 10049 Jasper Avenue
Edmonton, Alberta
T5J 1T7

CONFIDENTIAL

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INTRODUCTION

In February and March 1972 four test holes were drilled on the Peace River Canyon coal properties of Cinnabar Peak Mines Ltd. in northeastern British Columbia. They were drilled by a truck-mounted Mayhew "1000" rotary drill capable of using air or water. The work included drilling, sampling, coring, and analyzing cuttings and cores. Accommodation for the crew was rented in Hudson Hope, about 20 miles by road from the properties. Transportation was provided by a rented 4 x 4 truck. Bulldozers were required from time to time for ploughing snow, preparing sites, and moving drilling equipment.

This report presents the geological and engineering information obtained. Throughout all thicknesses of coal seams are in inches. Information on property, geographic setting, and geology has been briefly summarized. More complete information on them is given in the December 30, 1971 report on the properties by Checklin and Halferdahl.

SUMMARY AND RECOMMENDATIONS

Four holes totalling 1059 feet were drilled to obtain stratigraphic and structural information, and samples from coal seams in the upper part of the Gething Formation on the Peace River Canyon properties of Cinnabar Peak Mines Ltd. Two of the holes encountered overburden thicker than expected and were abandoned in it because of drilling difficulties. The third hole near Moosebar Creek tested a stratigraphic section of 415 feet at the top of the Gething Formation; it intersected the Superior, Trojan, Titan, Falls, and other thinner seams. Of these, the Superior and Trojan appear to have economic interest. The Superior Seam contains 42 inches of coal, and the Trojan 46½ inches but it has been faulted there. The fourth hole near Coalbed Creek tested a stratigraphic section of 121 feet near the top of the Gething Formation below the Superior Seam. It intersected the Trojan and other thinner seams. There the Trojan Seam contains

107 inches of coal in three benches. Previous work shows that the Trojan Seam dips 14° at Coalbed Creek and that dips decrease down dip.

Analyses of a composite sample of core from the Trojan Seam show that fractions separated at specific gravities of 1.40 to 1.60 contain from 3.7 to 5.3 per cent ash, about 27½ per cent volatiles, and have free swelling indexes of 6½ to 7. Yields determined by the laboratory were greater than 80 per cent, but with the inclusion of sandstone and mudstone partings not in the analyzed material, they have been reduced to 60 to 65 per cent. Analyses of core from the Superior Seam show a yield of 54 per cent at a specific gravity of 1.50, with the float fraction containing 6 per cent ash, 29.2 per cent volatiles, and having a free swelling index of 6½. Some thin seams below the Falls Seam at Moosebar Creek and above the Trojan at Coalbed Creek have free swelling indexes from 5½ to 9.

Data from the drill holes and from the 1971 field work indicate measured reserves in the Trojan Seam near Coalbed Creek of 8.9 million tons and indicated reserves within one mile of the measured reserves of 32 million tons. Of these 2.6 million tons are considered strippable with an average surface mine ratio of 15. This reserve will be increased and this ratio reduced by coal recovered from the Superior and the thin seams above the Trojan. Total reserves on the property have been previously estimated at 165 million tons for the Trojan Seam and 85 million tons for the Superior Seam.

It is recommended that a program be undertaken to learn the extent and thickness of the overburden along Johnson Creek, Coalbed Creek, Moosecall Lake, Lower Moosecall Creek where coal seams have been projected to the surface, and other places particularly where drilling is planned. Seismic methods are considered suitable. Additional drilling is required to obtain geological and engineering data on the coal seams on other parts of the property. All drill holes should be logged. The Gates Formation on the property should be checked for coal seams.

PROPERTY, GEOGRAPHIC SETTING, GEOLOGY, AND COAL SEAMS

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 railroad.

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. Much of the property is mantled with varying thicknesses of overburden. Outcrops are mostly along creek beds and ridges. 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.

Twenty coal seams with average thicknesses ranging from 22 to $129\frac{1}{2}$ 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.

DRILLING

Four test holes totalling 1059 feet were drilled during the project. The drill sites were located along the west flank and south nose of the southerly plunging anticline in the central structurally disturbed band on the properties south of the Peace River (Fig. 2). The holes are near Moosebar Creek, Johnson Creek, Coalbed Creek, and a place referred to herein as Strawberry Acres. They were chosen where access was easiest and to provide information on the upper part of the Gething Formation. All bedrock thicknesses are corrected for dip and thus footages are stratigraphic thicknesses.

Representative samples of cuttings were collected and retained for each 5-foot interval of bedrock. The cuttings from all coal seams were retained separately, but were extensively mixed with rock cuttings, particularly for seams at more than 200 feet.

The Superior Seam was cored at Moosebar Creek and the Trojan Seam was cored at both Moosebar Creek and Coalbed Creek. Core recovery from the Trojan Seam was 95 per cent in both holes while that for the Superior Seam was about 65 per cent. A VTM core barrel was used.

Side-wall sampling was attempted but satisfactory results were not obtained.

Logging of the drill holes was planned, but was not carried out, because of the small footage which could be logged. Attempts were made to leave the holes in a suitable condition for logging later.

Overburden

As sampling proved difficult in holes with thick overburden two of the drill holes were abandoned after penetrating more than 100 feet of the extensive surficial deposits that cover much of the area drained by Johnson, Coalbed, Burnt Trail and Moosebar Creeks. Topographic characteristics including major terraces at an elevation of 2300 feet and the silts, clays, and gravels now extensively exposed by stream erosion indicate that parts of this area were once occupied by a post glacial lake. The thickness of the deposits

is greater than 200 feet in places along Burnt Trail, Coalbed, and Johnson Creeks. The 234+ feet of overburden at Johnson Creek indicate that the old Johnson Creek channel was much deeper than the present one. Coalbed Creek and the valley occupied by Moosecall Lake and Lower Moosecall Creek may be similar.

TABLE 1: OVERBURDEN AT DRILL SITES

Drill Site	Elevation (feet above sea level)	Thickness of Overburden (feet)	Nature of Overburden
72-1 Moosebar Creek	2280	107	silts and clays
72-2 Johnson Creek	2000	234+	gravels at top silts and clays
72-3 Coalbed Creek	2280	8	gravels
72-4 Strawberry Acres	2325	101 16	silts and clays clays, sand and cobbles

Moosebar Creek

The Moosebar Creek drill site is 1000 feet north of the powerline crossing on Moosebar Creek. There the bedrock, which dips 15° SW is overlain by 107 feet of unconsolidated, water-saturated lake silts and clays. A thin gravelly layer rests directly on bedrock. Flowing water encountered at a depth of 50 feet forced a change from circulating air to water. The Moosebar-Gething contact was placed at a depth of 146 feet where black chippy mudstone of the Moosebar Formation grades into resistant thickly bedded to massive sandstone of the Gething Formation. The top 40 feet of the Gething Formation consists of hard, salt and pepper, fine- to medium-grained sandstone which was drilled at only about 2 feet per hour.

The Superior Seam is 38 feet stratigraphically below the top of the Gething Formation and is 42 inches thick. A 24-inch unnamed coal seam lies 98 feet stratigraphically below the contact (60 feet below the Superior Seam).

A coal seam containing 46½ inches of coal and lying 121 feet stratigraphically below the Moosebar-Gething contact is correlated with the Trojan Seam. Drill core from it contained a 4-inch layer of fault gouge, contorted shaly layers, and pronounced slickensides. This seam is separated from a lower 38½-inch coal seam by 15 feet of interbedded siltstone, sandstone, shale, and mudstone. This separation and the slickensides, fault gouge, and contorted shale indicate displacement within the Trojan Seam near Moosebar Creek.

The stratigraphic positions and thicknesses of coal seams encountered below the Trojan Seam are given in Table 4 and shown in Fig. 4. The Mogul Seam was expected 350 feet stratigraphically below the Moosebar-Gething contact as shown by Stott (1968) but was not encountered. The stratigraphic data of McLearn and Kindle (1950) indicate the Mogul Seam should be 450 feet stratigraphically below the Moosebar-Gething contact. Because of poor circulation and core recovery, and a drilling rate of 20 to 30 minutes per foot the hole was completed at 575 feet before reaching the Mogul Seam. It penetrated a stratigraphic section of 415 feet at the top of the Gething Formation. The casing was not pulled in order to facilitate deepening later.

Coalbed Creek

The Coalbed Creek drill site is located on the south bank of Coalbed Creek, immediately west of the crossing of the Mount Johnson access road. It was located very close to an outcrop to avoid thick overburden to the south. Below eight feet of gravelly clays and silts, bedrock was penetrated at a point approximately 30 feet below the Moosebar-Gething contact, as indicated by projecting the dip of 14° SW from an outcropping a few hundred feet southwest.

The Superior Seam was not penetrated because the site is apparently north of the trace of its outcrop. Several coal seams, all less than 14 inches in true thickness were intersected to a depth of 100 feet (Fig. 5).

The Trojan Seam is 133 feet stratigraphically below the Moosebar-Gething contact at Coalbed Creek. The coal is present in three benches totalling 107½ inches in a seam thickness of 129½ inches including partings. Two seams, both less than 6 inches thick were intersected below the Trojan Seam and the bottom of the hole at 133 feet. This represents a stratigraphic thickness of 121 feet of the Gething Formation.

CHARACTERISTICS OF THE COAL

The coal seams sampled herein are shown in Fig. 4 and 5; they are described in Appendix 1. The Trojan Seam at the Coalbed Creek drill site is 129½ inches thick and contains three benches of coal: from top to bottom, 57 inches coal, 6 inches sandstone parting, 20 inches coal, 16 inches sandstone and mudstone parting, 28 inches coal. An outcrop of the Trojan Seam along Coalbed Creek about ½ mile northwest of the Coalbed Creek drill site described and sampled during the 1971 field work contains two benches of coal: from top to bottom, 48 inches coal, 4 inches sandstone parting, 31 inches coal. Thus the Trojan Seam thickens from the outcrop to the Coal bed Creek drill site, but more information is needed to determine whether this thickening is stratigraphic or tectonic. The Trojan Seam appears to have been faulted at the Moosebar drill site where it is only 46½ inches thick.

At Moosebar Creek the Superior Seam contains 42 inches of coal in one bench; it was not intersected at Coalbed Creek because of the location of the drill site.

Analyses of Coal

The samples of coal obtained for analyses consisted of cuttings from some seams and cores from others. As the coal cuttings were contaminated with rock cuttings, they were separated at a specific gravity of 1.50 with only the floats being analyzed for inherent moisture, ash, and free swelling index (Table 4). Core samples were crushed and sized into +100 mesh and -100 mesh fractions, which were then analyzed (Table 2). A composite sample of the +100 mesh fractions from the three benches of the Trojan Seam at Coalbed Creek, fractions from this composite sample separated at three specific gravities, and gravity fractions of the +100 mesh size fraction of the Superior Seam at Moosebar Creek were similarly analyzed (Table 3).

The analytical results show that the free swelling indexes of the +100 mesh fractions of the raw coal from the three benches of the Trojan Seam at the Coalbed Creek drill site range from 4 for the top to 8 for the two lower benches, similar to results obtained for the upper and lower benches at the outcrop of the Trojan Seam $\frac{1}{2}$ mile northwest. The free swelling index for the +100 mesh fractions of a composite sample of the three benches improves from $4\frac{1}{2}$ for the raw coal to $6\frac{1}{2}$ or 7 depending on the specific gravity of the fraction analyzed. Faulting of the Trojan Seam at Moosebar Creek is believed responsible for its low free swelling index and high ash content there. Sink-float tests on the composite sample of the Trojan Seam at the Coalbed Creek drill hole show yields from 80 to 87 per cent on the parts of the seam analyzed but calculations show these are reduced to 59 to 64 per cent when the partings are included. The ash content on the composite sample ranges from 3.7 to 5.3 per cent with sulfur in the range 0.43 to 0.67 per cent.

The +100 mesh fraction of the Superior Seam at Moosebar Creek has a free swelling index of $4\frac{1}{2}$ and an ash content of 34.6 per cent. The free swelling index is improved to $6\frac{1}{2}$ and the ash reduced to 6.0 per cent in the float fraction at a specific gravity of 1.50.

for:

ANALYSES OF COAL (p. 8 thru 11)

- analyses of Raw Coal from drill cores
- analyses of +100 mesh specific gravity fractions from drill core
- analyses of +1.50 specific gravity fractions from drill cuttings

Refer to:

PR - PEACE RIVER CANYON 72(4)A

CONFIDENTIAL ANALYSIS FILE

Four seams, none of which exceeded 14 inches in thickness were intersected above the Trojan Seam at Coalbed Creek (Table 4) and have free swelling indexes ranging from $5\frac{1}{2}$ to 9. Two seams below the Falls Seam at Moosebar Creek have free swelling indexes of 8 (Table 4). Although 30 inches were sampled in one of these, the seam contains only $13\frac{1}{2}$ inches of coal (Fig. 4).

RESERVES

In the report of December 30, 1971, reserves in the Trojan and Superior Seams were estimated by projecting their extents from outcrops or traces of outcrops to the boundaries of the property. The estimates follow.

	Reserves Thousands of Tons	
Seam	Indicated	Inferred
Superior	35,904	49,612
Trojan	72,681	93,264

The Coalbed Creek drill hole and outcrop permit part of the reserves in the Trojan Seam to be termed measured. Projections $\frac{1}{2}$ mile from these points indicate an area of about one square mile. With an average thickness of 93 inches of coal, measured reserves are estimated at 8.9 million tons. The indicated reserves within one mile of these measured reserves are estimated at 32 million tons. Additional reserves are undoubtedly present near Moosebar Creek, but until more data from drilling are obtained on the extent of the faulting, reserves there cannot be reliably estimated. Reserves in the Superior Seam within $\frac{1}{2}$ mile from the drill hole at Moosebar Creek are estimated at 2 million tons. The holes drilled in February and March 1972 have changed some of the previously estimated coal reserves from indicated to measured, but have left the total reserves in the Superior and Trojan Seams largely unchanged.

At the Coalbed Creek drill site, whence samples showed an 80 per cent yield in the sink-float tests on 107 inches of coal, the surface mine ratio = 113 x 11.11/ 107 x 0.80 = 14.7. If coal can be recovered from the thin seams above the Trojan Seam this ratio will be reduced. Along Coalbed Creek between Johnson Creek and the fault which crosses Mount Johnson, the Trojan Seam is estimated to underlie 0.3 square miles at depths of less than 150 feet. With an average thickness of 93 inches the estimated strippable reserves are 2.6 million tons. These will be increased by coal recovered from the Superior and thin seams above the Trojan. With an average overburden depth of 100 feet and an 80 per cent yield the average surface mine ratio = 100 x 11.11/ 93 x 0.80 = 15, which will be reduced by any coal recovered from the Superior and the thin seams above the Trojan.

CONCLUSIONS

The drilling program conducted on the Peace River Canyon coal properties of Cinnabar Peak Mines Ltd. has shown that part of the Trojan Seam along Coalbed Creek is thicker than found in the outcrop there, and that at Moosebar Creek it has been cut by a fault. Analyzes show that coal in both the Trojan and Superior Seams near the top of the Gething Formation appears suitable for coking or blending. Reserves in the Trojan Seam on the property are estimated as measured 8.9 million tons, indicated 32 million tons, and inferred 124 million tons. Thick overburden in places, interferred with drilling and sampling.

Previous work on the property has permitted a preliminary estimate of total reserves of one billion tons, most of it in the other 18 seams in the Gething Formation below the Superior and Trojan Seams. Much of the coal is favorably situated for underground mining with few dips exceeding

15°. On the south and west sides of Mount Johnson and near Coalbed Creek, as much as 20,000,000 tons may be suitable for strip mining. The work on the properties recently undertaken is sufficiently encouraging to warrant further expenditures for continuing evaluation of the properties.

Respectfully submitted,

G. A. Van Dyck, B. Sc.

Edmonton, Alberta

May 17, 1972

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

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. B. HALFERDAHL

Expiry Date: August 5, 1972

REFERENCES

Checklin, G.A. and Halferdahl, L.B. (1971) - 1971 geological exploration of Peace River Canyon coal properties northeastern British Columbia; L.B. Halferdahl & Associates Ltd. Edmonton, 37 pp., 9 appendices, 12 figures, 5 tables, unpublished.

McLearn, F.H. and Kindle, E.D. (1950) - Geology of northeastern British Columbia; Geol. Surv. Can. Mem. 259, pp. 154 - 176, 213 - 218 and Fig. 11.

Stott, D.F. (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) - 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 drilling on the properties directed by G. A. Van Dyck from February 9 to March 23, 1972, and under my general supervision, and from published and unpublished reports.

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

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

Edmonton, Alberta
May 17, 1972

APPENDIX 1: DESCRIPTIONS OF COAL SEAMS

Superior Seam

Moosebar Creek	Shale	
	Coal, mainly clarain with ½-inch vitrain bands	38
	Coal, granular, dense, durain?	4
	Shale, black, carbonaceous	
	Total seam	42
	Total coal	42
	Thickness cored	49

60 Feet below Superior Seam

Moosebar Creek	Mudstone, black	
	Coal, clarain	24
	Mudstone, black, few coaly partings, slickensides	
	Total seam	24
	Total coal	24
	Thickness cored	41

Trojan Seam

Moosebar Creek	Mudstone (not cored)	
	Coal (not cored)	3½
	Coal and mudstone, mixed	10½
	Fault gouge, silver grey	4
	Coal, clarain, dense and breaks into ½ to 1" blocks	7
	Coal and shale, faulted contorted shale, slickensides	25½
	Sandstone, fine-grained, argillaceous, plant remains along bedding plane	6
	Clay-ironstone concretion	4½
	Total seam	50½
	Total coal	46½
	Thickness cored	57½

All thicknesses are in inches.

Coalbed Creek	Shale, black (not cored)	
	Coal (not cored)	2½
	Coal, granular, dull, hard	3
	Coal, vitrain	24
	Coal, vitrain and clarain	3
	Coal, clarain, well cleated	27
	Sandstone, brown, fine to medium grained (only 2" cored)	6
	Coal, vitrain	7
	Coal, broken, rubbly, vitrain?	7
	Coal, clarain 70% and vitrain 30%	6
	Mudstone, black, carbonaceous with coaly bands (only 5" cored) and sandstone	16
	Coal, mainly clarain, vitrain bands up to ¼-inch	13½
	Coal, granular, dull, hard	2
	Coal, vitrain	12½
	Mudstone, black, carbonaceous, with marcasite and carbonaceous plant remains	
	Total seam	129½
	Total coal	107½
	Thickness cored	119

For:

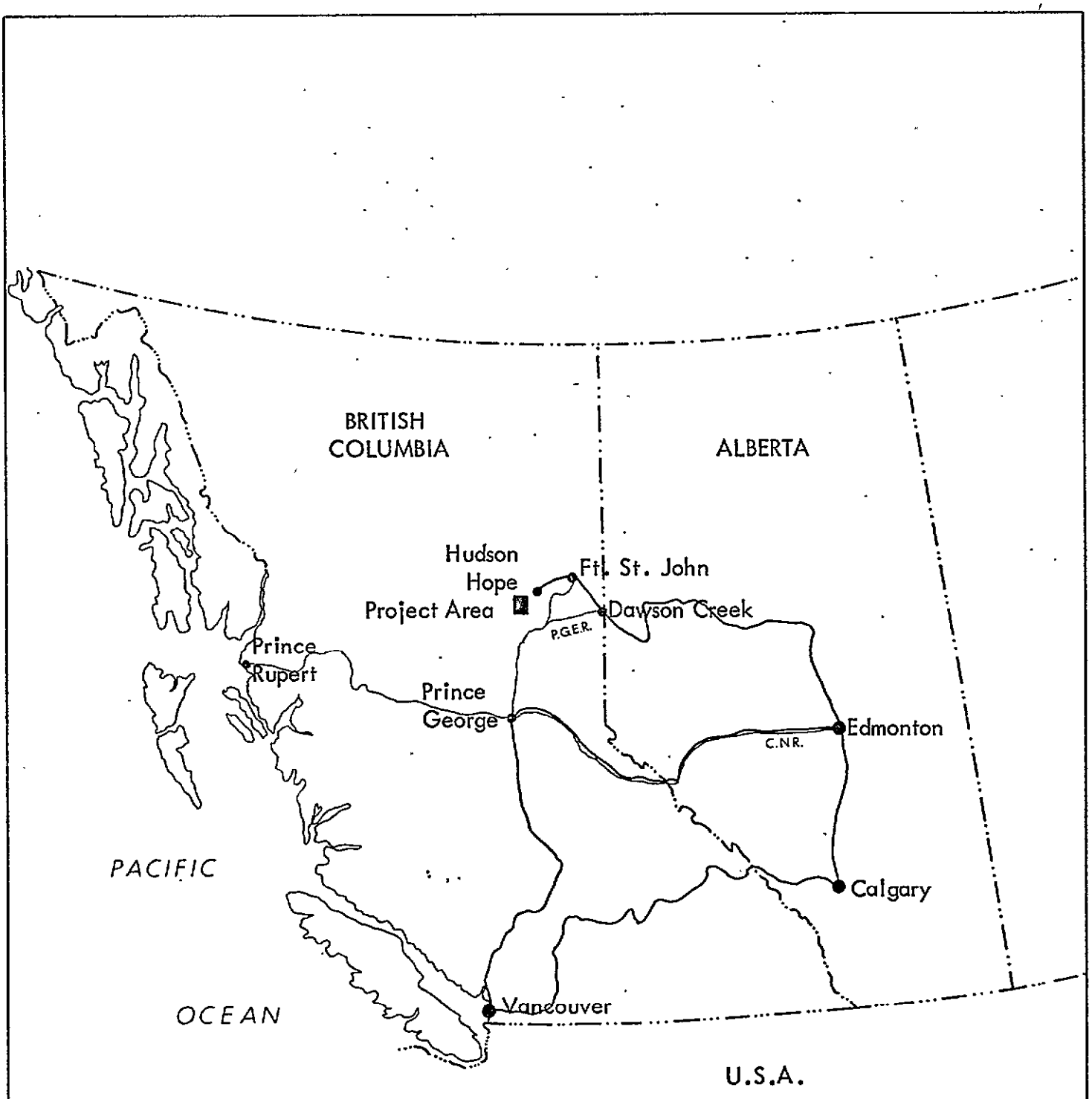
APPENDIX 2: REPORTS OF COAL ANALYSES

Refer to:

PR - PEACE RIVER CANYON 72(4)A
CONFIDENTIAL ANALYSIS FILE

APPENDIX 3: FIELD PERSONNEL

Name	Position	Time on Property 1972
A. Flemming	Driller	Feb. 19 - March 23
J. Gorham	Assistant	Feb. 19 - March 4
L. Halferdahl	Geologist	Feb. 9 - Feb. 10
E. Stadnek	Driller's Helper	Feb. 19 - March 23
G. Van Dyck	Geologist	Feb. 9 - Feb. 10 Feb. 16 - March 23



PR-PRC 72(1)A

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EDMONTON, ALBERTA

Fig. 1: Location Map

PEACE RIVER CANYON PROPERTIES

0 100 200 300 400
SCALE IN MILES

Drawn: LBH MAY, 1972

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L.B. HALFERDAHL

Expiry Date: August 5, 1972

LEGEND AND SYMBOLS TO ACCOMPANY FIGURE 2.

LOWER CRETACEOUS
FORT ST. JOHN GROUP

7	Gates Formation
6	Moosebar Formation

BULLHEAD AND MINNES GROUPS

5	Gething Formation
4	Cadomin and Pre-Cadomin Formations

Coal seam with name, defined and approximate . . . . . — —Tr— —

Superior . . . . . Su
Trojan . . . . . Tr
Titan . . . . . Tt
Falls . . . . . F
Mogul and Little Mogul . . . . . Mg
Castle Point . . . . . Cp
Milligan . . . . . Ml
Grant-King . . . . . GK
Murray - "48" M48

Geological boundary, defined and approximate . . . . . ——————

Strike and dip of bedding, inclined, vertical . . . . . ⊥ ⊥

Fault, defined, approximate . . . . . ∿∿∿

Anticlinal axis . . . . . ⊣⊢ ⊣⊢

Outcrop with lithology, sandstone, siltstone, shale, conglomerate, coal . . . . . × ss,st,sh, cg,c

Drill hole, February-March 1972,
1. Moosebar Creek; 2. Johnson Creek,
3. Coalbed Creek, 4. Strawberry Acres . . . . . ●

Mine adit . . . . . ⊱

Line of section in Fig. 3 . . . . . G——G'

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

Map based upon Fig. 4, in December 31, 1971 report on the properties by Checklin and Halferdahl.

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Note: See accompanying page for legend and symbols.

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EDMONTON, ALBERTA

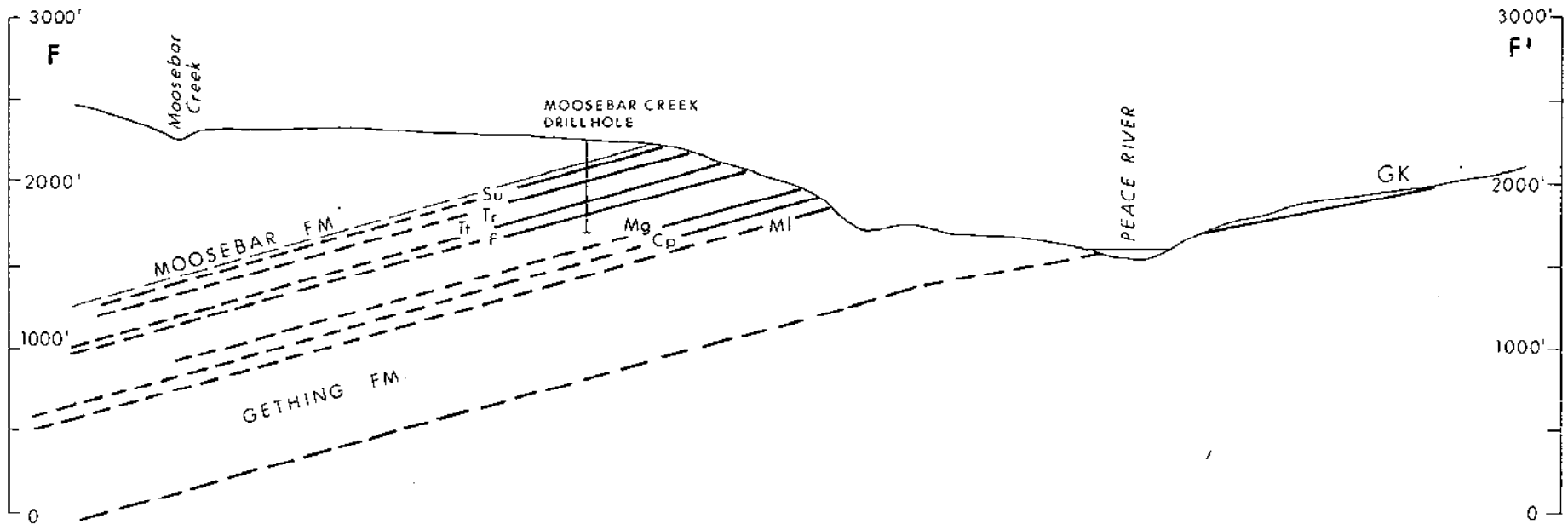
Fig. 2 Geology, Coal Seams and Drill Hole Locations
PEACE RIVER CANYON PROPERTIES

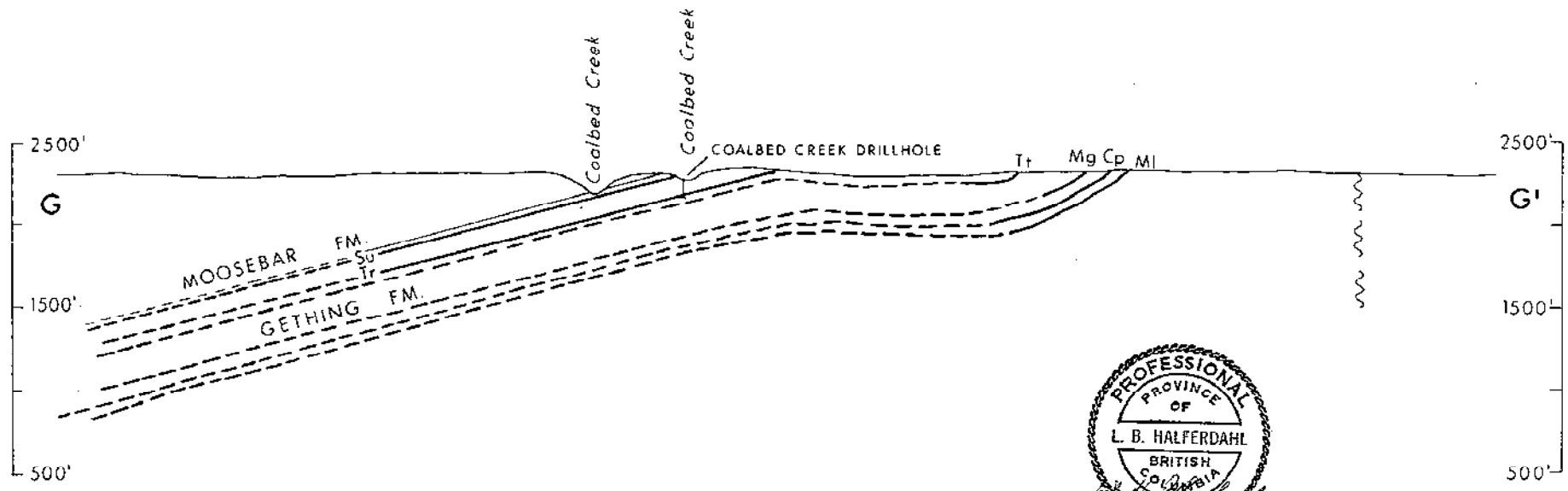
1000 0 1000
SCALE IN FEET

DRAWN: G.V.D. MAY, 1972

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. B. HALFERDAHL

Expiry Date: August 5, 1972





PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. B. HALFERDAHL
Expiry Date: August 5, 1972

PR-PRC 72(1)A

LEGEND

Geological contact .....

Fault .....

Coal seam with name .....

Superior	Su	Mogul and Little Mogul	Mg
Trojan	Tr	Castle Point	Cp
Titan	Tr	Milligan	Ml
Falls	F	Grant-King	GK

Only selected coal seams are shown in their approximate positions.

CINNABAR PEAK MINES LTD.

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EDMONTON, ALBERTA

Fig. 3 Cross Sections from Fig. 2

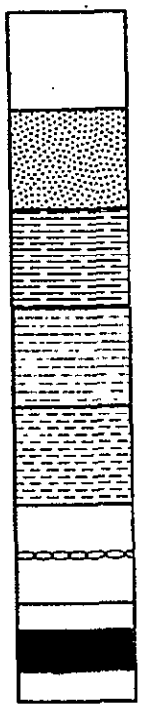
PEACE RIVER CANYON PROPERTIES

1000 0 1000
SCALE IN FEET

DRAWN: G.V.D. MAY, 1972

LEGEND TO ACCOMPANY COLUMNAR SECTIONS

OF DRILL HOLES, FIGURES 4 AND 5



Overburden

Sandstone

Siltstone

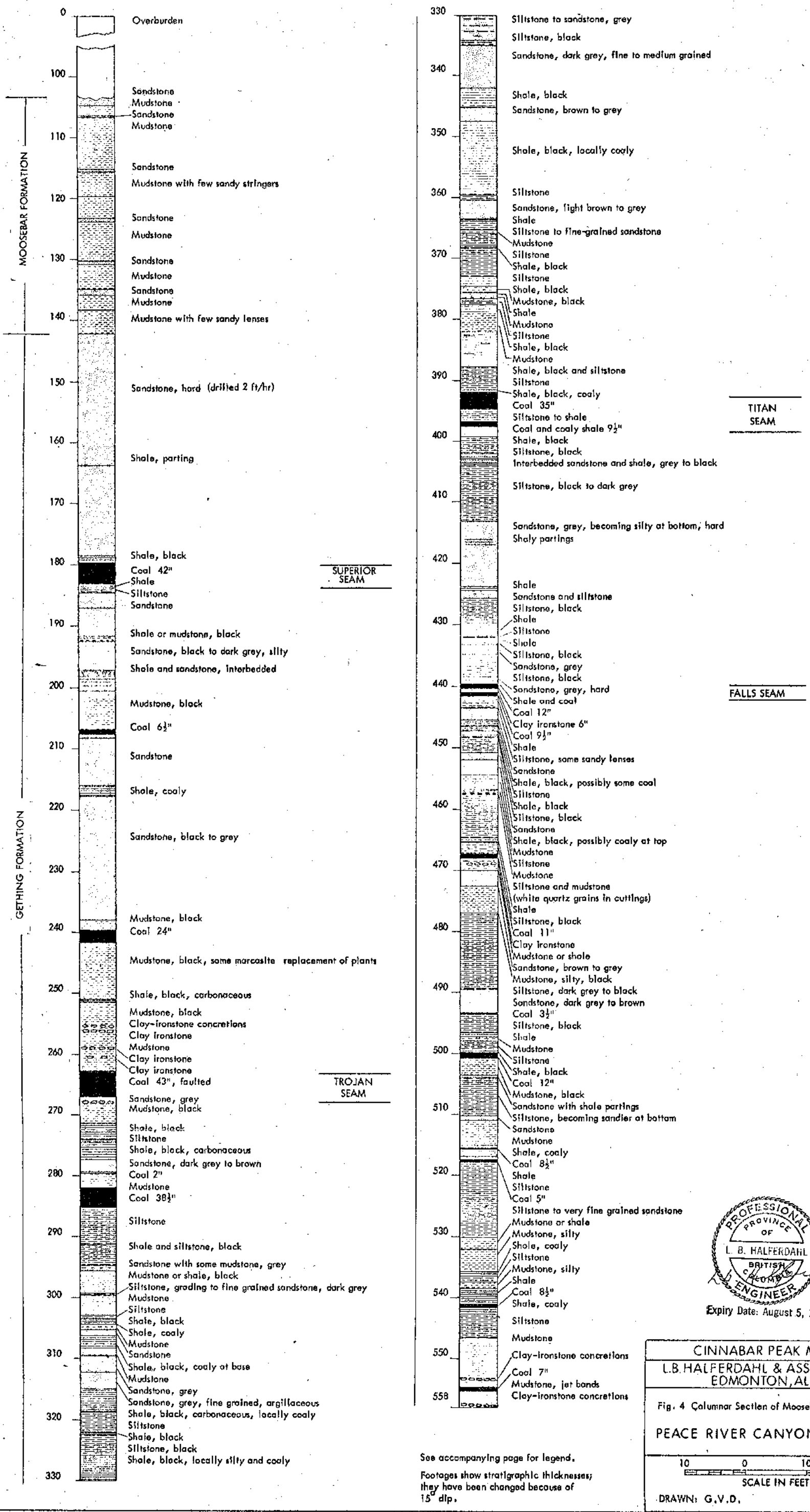
Shale

Mudstone

Clay-ironstone concretions

Coal with thickness in inches

Pr-Prc 72(1) A



See accompanying page for legend.

Footages show stratigraphic thicknesses; they have been changed because of 15° dip.

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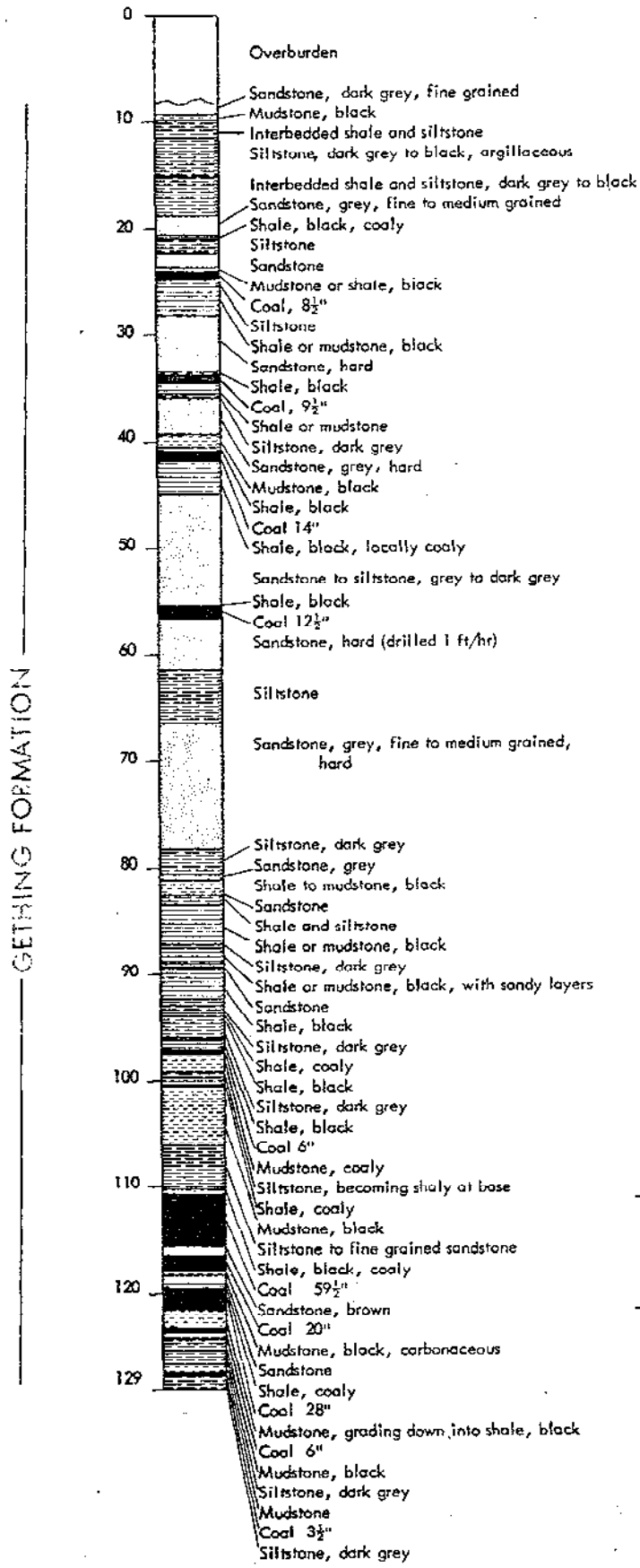
Fig. 4 Columnar Section of Moosebar Creek Drill Hole

PEACE RIVER CANYON PROPERTY

10 0 10 20
SCALE IN FEET

DRAWN: G.V.D. MAY, 1972

PR-PRC 72(1)A



See accompanying page for legend

Footages show stratigraphic thicknesses; they have been changed because of 14° dip.

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Fig. 5 Columnar Section of
Coalbed Creek Drill Hole
PEACE RIVER CANYON PROPERTIES

0 10 20 30 40
SCALE IN FEET

DRAWN: G.V.D. MAY, 1972

PR-PRC 72(1)A

CINNABAR PEAK MINES LTD.

1972 SUMMER 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. Van Dyck, B.Sc.

and

K.P. Ridell, B.Sc.

August 31, 1972

Halferdahl & Associates Ltd.
401 - 10049 Jasper Avenue
Edmonton, Alberta
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INTRODUCTION

In the summer of 1972 field work on the Peace River Canyon coal properties of Cinnabar Peak Mines Ltd. began on July 3 and ended July 22, with a field crew ranging from 4 to 7 men. Exposures of the Gates Formation were examined to determine whether coal occurrences within the Gates south of the Pine River are present on the property. Thick overburden near Johnson and Coalbed Creeks which caused difficulty during the 1972 winter drilling program was investigated by a hammer seismic survey. Clean-up along 1971 access routes and locating and flagging access to proposed drill sites was also carried out. Accommodation for the crew was rented in Hudson Hope, about 20 miles by road from the properties. Transportation was provided by a rented 4 x 4 truck.

SUMMARY AND RECOMMENDATIONS

The Gates Formation was examined but failed to reveal any major coal occurrences although sediments are locally carbonaceous. A hammer seismic survey conducted over a limited area showed a thick accumulation of overburden northwest of drill hole #2 and suggests a pre-glacial stream channel along parts of Johnson Creek. Access to the northwest corner of the property can be obtained via an old railway right-of-way which leads from Moosebar Creek to the W.A.C. Bennett Dam. A proposed drilling program has been outlined to test the Trojan Seam initially at a spacing of 4000 feet near the trace of the outcrop. The outline includes more closely spaced holes both near the outcrop and farther down dip.

It is recommended that a drilling program be undertaken to obtain additional geological and engineering data on the Trojan Seam and on the Superior Seam which is stratigraphically above it. A stratigraphic test hole located at drill hole #3 should be drilled through the Gething Formation to provide information on coal seams below the Trojan Seam.

PROPERTY, GEOGRAPHIC SETTING, GEOLOGY, AND COAL SEAMS

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 railroad.

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. Much of the property is mantled with varying thicknesses of overburden. Outcrops are mostly along creek beds and ridges. 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.

Twenty coal seams with average thicknesses ranging from 22 to $129\frac{1}{2}$ 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. Preliminary estimates of total reserves are more than one billion tons: indicated 400,000,000 tons and inferred 680,000,000 tons. Preliminary estimates of potential coking coal reserves in the Trojan and Superior Seams are 250,000,000 tons.

GATES FORMATION

At the Peace River Canyon the Gates Formation overlies the Moosebar Formation and is overlain by marine shales of the Hasler Formation. Sections of the Gates Formation totalling 245 feet and 430 feet have been measured at Steamboat Island and Johnson Creek, respectively (Beach and Spivak, 1944). The following regional description has been summarized mostly from Stott (1968). The Gates holds formation status only in the immediate vicinity of the Peace River Canyon and is reduced to member status to the south where it becomes the lower member of the Commotion Formation. To the north it forms part of the dominantly marine Buckinghorse Formation. The base of the Gates Formation is gradational into the underlying Moosebar mudstones and shales. The boundary is arbitrarily drawn at the base of the first thick and relatively continuous succession of fine-grained sandstone. The upper boundary of the Gates is reported to lie at a persistent stratigraphic position. The thickness of the Gates increases to the southeast with most of the increase due to mudstones of the Moosebar Formation grading laterally into sandstone and carbonaceous sediments that are included in the Gates Member. South of the Peace River Canyon, the lithology of the Gates changes gradually from off-shore marine sandstone and mudstone into delta and flood-plain facies in its upper part at and south of the Pine River. These upper continental beds, characterized by carbonaceous sediments and coal, thicken south of the Pine River.

On the south side of the Peace River Canyon the outcrop pattern of the Gates Formation forms an irregular U open to the north. It was checked for coal seams at a few places. On Coalbed Creek good exposures of the Gates Formation were examined adjacent to the Johnson Creek logging access road. The rocks strike 8° and dip 24° E. About 200 feet of sandstone and mudstone are exposed along the creek banks. At its base the section here consists of about 100 to 150 feet of olive grey mudstones and sandy mudstones with a few sandy units up to two feet thick near the top. Burrowing and trace fossils are present locally. Spherical concretions with marcasite cores are common. The base of this unit is gradational with the Moosebar Formation. Near the

contact a lens of vitrinite 4 inches thick and $2\frac{1}{2}$ feet long was found within the mudstones. Overlying the basal mudstone unit is 30 to 50 feet of sandstone, with beds from $\frac{1}{2}$ inch to 3 feet thick, separated by argillaceous partings. The sandstone is medium grained and locally ripple marked; thick sandstone units contain large-scale cross-bedding. Argillaceous partings and interbeds are chippy and contain discontinuous sandy lenses. Above the sandstone unit is 25 to 40 feet of black chippy mudstone containing a few sandy units. A 5-foot bed of massive sandstone overlies the mudstone and marks the upper limit of exposure of the Gates Formation on Coalbed Creek.

Exposures of the Gates Formation were also found along a north-trending ridge east of Moosecall Lake: There the rocks have variable dips to the east and southeast where they form part of the eastern limits of a southerly plunging anticline. Dark-grey to olive-grey mudstones and sandy mudstones overlie the Moosebar Formation. Locally they are carbonaceous and micaceous. The mudstones are overlain by a resistant sandstone unit forming a 20-foot cliff near the top of the ridge. Regular beds in the sandstone $\frac{1}{2}$ to 1 inch thick, are separated by argillaceous or micaceous partings. The sandstone contains brown laminae $\frac{3}{4}$ inch apart; it weathers into plates 1 to 2 inches thick. The resistant sandstone is overlain by recessive, poorly exposed, olive grey mudstone.

On Moosebar Creek less than 100 feet in the lower part of the Gates Formation is exposed. The Moosebar-Gates contact is gradational as at other localities. The beds strike 140° and dip 15° SW. The mudstones of the Gates Formation tend to be sandier than those of the Moosebar Formation. Black, spherical concretions with marcasite-rich cores are locally abundant. Cylindrical burrows $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter and up to 8 inches long, perpendicular to beds, are found locally near the contact. At the forks on Moosebar Creek is a resistant argillaceous, carbonaceous sandstone unit 3 feet thick.

Along Burnt Trail Creek the only exposure of the Gates Formation is one sandstone outcrop. The Gates Formation was not completely checked in the northwestern and western parts of the property, nor the northerly part of the band east of the pipeline.

OVERBURDEN

Parts of the areas drained by Johnson, Coalbed, Burnt Trail, and Moosebar Creeks, are covered with surficial deposits. Overburden thicknesses greater than 100 feet and even 200 feet in one place along Johnson Creek hindered drilling and sampling in the 1972 winter drilling program. In order to obtain information on the thickness of overburden to aid in selecting drill sites and mine planning, a hammer seismic survey was conducted on part of the property near Johnson Creek.

Six lines were run; they are located on Fig. 6. Lines 1,2,3, and 4 are near similarly numbered drill holes of the 1972 winter drilling program, previously named Moosebar Creek, Johnson Creek, Coalbed Creek, and Strawberry Acres, respectively. Line 4A was the initial experimental line, and line 5 was run along the logging road west of Johnson Creek more or less perpendicular to line 2. A Huntec FS-3 Facsimile Seismograph with 400 feet of cable was used. Energy was provided by an 18-pound hammer striking a 12-inch iron plate. Adequate response was obtained where the plate rested on well-consolidated silt. Near drill hole #1 where the silt was poorly consolidated, the energy was inadequate to penetrate to bedrock.

Minimum Spread Requirements

Reflection profiling: bedrock depth 50' to 100' : spread 50' to 150'
bedrock depth 100' to 200' : spread 100' to 250'

Refraction: 200'

Subsurface Coverage

Reflection spread at 100' intervals

Refraction spread at beginning and end of line and as required along line

Minimum Number of Hammer Blows

Reflection : 2 blows every 10 feet

Refraction : 1 blow every 5 feet to 20 feet beyond critical distance and 1 blow every 10 feet thereafter.

Interpretation of the seismic data involved sorting out sets of multiples in order to distinguish bedrock reflections from intra-overburden reflections. As many as three multiples can be expected from a shallow primary reflection within the overburden. The multiplying surface appears to be the base of the weathered zone. Cross sections (Fig. 4 and 5) were plotted for each line run: each point represents a reflection corrected for Δt and smoothed for near surface irregularities. Dipping beds have not been migrated. Velocities encountered were

weathered zone : 1000 to 1500 ft./sec.

silt-unconsolidated : 1500 to 2500 ft./sec.

silt-consolidated : 4500 ft./sec.

mudstone (Moosebar) : 5500 ft./sec.

The interpretations of lines 1,3,4, and 4A are shown in Fig. 4 and of line 5 in the lower part of Fig. 5. In relating the seismic data to the 1972 winter drilling data, the only criteria for distinguishing bedrock from intra-overburden reflections was the relative dip of each primary reflection and its set of multiples. With this relation established, both reflections could be continuously correlated in about 75 per cent of the records. Road cuts along line 5 show well consolidated silt which could well produce intra-overburden reflections.

The interpretation of line 2 is shown in the upper part of Fig. 5. The dips encountered suggest an increase in the depth to bedrock. An intra-overburden reflection, perhaps caused by gravel or well consolidated clay, or silt, appears along the line at or near the point where the depth to bedrock begins to increase. Interpretation would be ambiguous beyond this point if it were not for the well defined dips near the end of the line.

The seismic data, geology, and topography have been combined in Fig. 6 to show bedrock contours and thicknesses of overburden along and near part of Johnson Creek. Fig. 6 indicates a northerly trending pre-glacial bedrock channel which enters the present Peace River opposite Grant Flat. This channel has subsequently been filled with glacial-lacustrine silt, and partly re-excavated in places by the present Johnson Creek. Moosebar Creek and parts of Coalbed Creek are post-glacial streams. Except along the pre-glacial Johnson Creek stream channel the thickness of overburden is generally about 100 feet or less.

PROPOSED DRILL SITES AND ACCESS

A railway right-of-way leading from Moosebar Creek to the W.A.C. Bennett Dam was located and flagged almost to Aylard Creek. The trail will be useful in providing access to the northwest corner of the property. One drill hole was located and flagged on the east side of Mogul Creek about 1000 feet northeast of the railway right-of-way. Other areas for proposed drill sites between drill hole #1 and drill hole #2 were examined. Current logging in the area is continuing to open up the area and access will be relatively easy.

The proposed drilling is outlined in Appendix 1, and the locations of drill holes are shown in Fig. 2. The property is divided into two areas separated by the normal fault cutting through Mount Johnson in a northerly direction. Holes have been outlined on a spacing of about 4000 feet with more closely spaced holes intended to follow the evaluation of initial results. The footage to the Trojan Seam has been estimated with the aid of cross sections.

CONCLUSIONS

The Gates Formation outcrops on the Peace River Canyon coal properties south of the river in the form of a broad U open to the north. The sandstones and mudstones are locally carbonaceous and a minor occurrence of coal was noted on Coalbed Creek.

Hammer seismic techniques were successful in determining the overburden thickness except where intra-overburden reflections obscure the bedrock reflections. Thick overburden associated with a pre-glacial erosional channel was revealed. The overburden probably does not greatly exceed 100 feet in other areas.

Proposed access to the northwest part of the property follows an old railway right-of-way. Other areas can be easily reached by short additions to existing roads and trails. Proposed drilling which is warranted from the 1971 exploration and the 1972 winter drilling, has been outlined on a reconnaissance basis with estimated depths to the Trojan Seam ranging from 250 to 1650 feet.

Respectfully submitted,

G. A. Van Dyck, B.Sc.

K.P. Ridell, B. Sc.

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

Edmonton, Alberta
August 31, 1972

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
L. B. HALFERDAHL

Expiry Date: August 5, 1973

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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 work carried out on the properties directed by K. Ridell and G.A. Van Dyck from July 3 to July 22, 1972 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.

L.B. Halferdahl

Edmonton, Alberta
August 31, 1972

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

APPENDIX 1 : PROPOSED DRILLING

Class	Location		Estimated Footage to Trojan Seam	
Area West of Fault				
A	NE corner licence	1035	350	
A	SW corner licence	1026	250- 300	
A	N centre licence	1026	550	
A	Centre licence	1030	1800*	
A	NW corner licence	1021	800	
A	NE corner licence	1022	850	
A	E centre licence	1020	1100	
A	Centre licence	1019	300	
				6050
B	S centre licence	1035	1350	
B	Centre licence	1029	950	
B	E centre licence	1027	1200	
B	Centre licence	1021	1500	
B	NE corner licence	1041	1650	
				6650
C	W centre licence	1034	350	
C	SE corner licence	1030	300	
C	NW corner licence	1030	600	
C	E centre licence	1026	650	
C	Centre licence	1023	350 - 400	
C	E centre licence	1022	1090-1150	
C	N centre licence	1020	950-1000	
				4450
D	SE corner licence	1029	1100	
D	NW corner licence	1029	1050	
D	N centre licence	1027	1600	
D	SW corner licence	1020	1600	
				5350
Area East of Fault				
A	NE corner licence	1031	500	
A	SW corner licence	1047	500	
				1000

* Stratigraphic test hole through Gething Formation

Class	Location		Estimated Footage to Trojan Seam	
B	SW corner licence	1031	500	
B	NW corner licence	1047	500	
				1000
TOTAL				24,500