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RECONNAISSANCE OF PEEL RIVER
COAL EXPLORATION LICENCES

August, 1977

Mayo Mining District

N.T.S. 106-E-14

Lat. $65^{\circ}50'N$ Long. $135^{\circ}10'W$

This report has been examined; declared acceptable as Representation Work under Section 32 and Schedule B of the Canada Mining Regulations and valued in the amount of \$6180.45

Chief, *J. M. [Signature]*

Date: *June 22, 1978.*

By:

Roderic P. Hill

CYPRUS ANVIL MINING CORPORATION

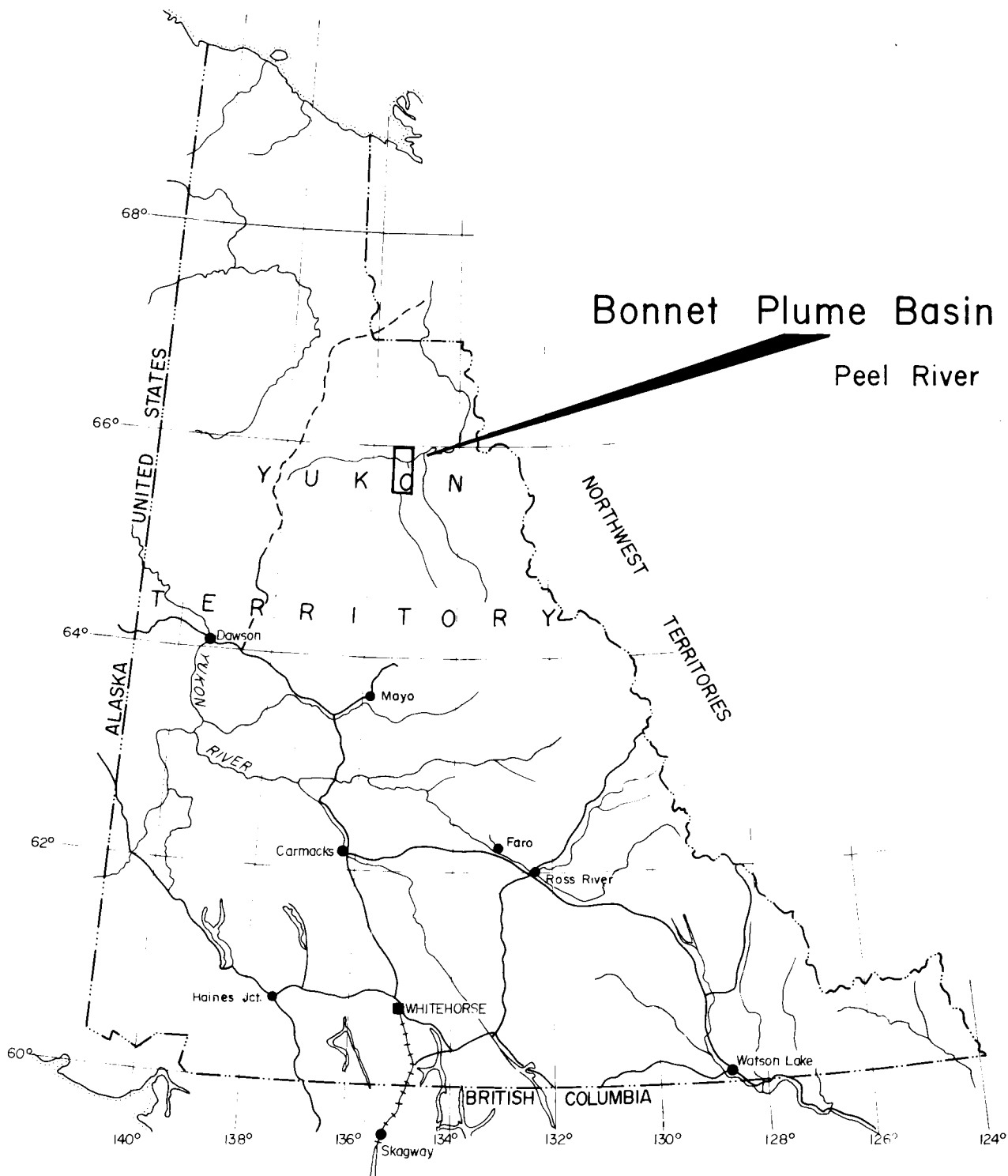
May, 1978

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CYPRUS ANVIL MINING CORPORATION

PROPERTY LOCATION MAP

YUKON

SCALE : 1" = 100 MILES

(ii)

RECONNAISSANCE OF PEEL RIVER

COAL EXPLORATION LICENCES

1. INTRODUCTION

In 1976, Cyprus Anvil Mining Corporation applied for, and was granted, two Territorial Coal Exploration Licences in part of the Bonnet Plume Basin, northern Yukon. The licences were designed to cover an area interpreted to be underlain by commercially important coal seams; the two licences are for approximately 79,000 acres, as follows:

Licence No. 46 - sheet 106 E/14, SE $\frac{1}{4}$

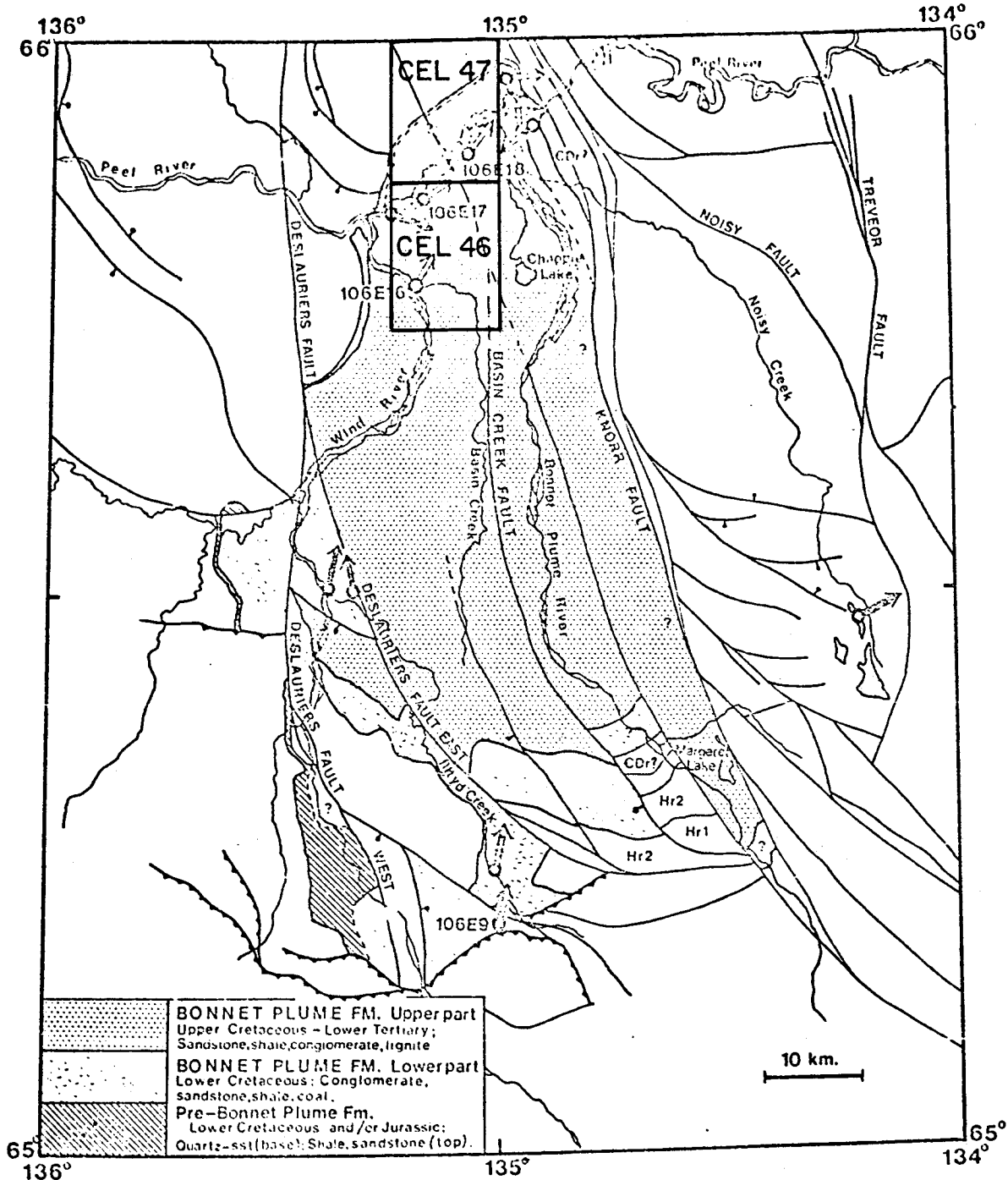
Licence No. 47 - sheet 106 E/14, NE $\frac{1}{4}$

At the end of the first licence year, Licence No. 46 was reduced to 29,390 acres and Licence No. 47 was reduced to 9,823 acres.

During August 1977, the writer spent four days in the licence area undertaking a preliminary reconnaissance of the Bonnet Plume Basin. The purpose of the study was to locate, describe and sample the coal seams at outcrop, to examine the surrounding area for rock outcrops and any sign of further coal occurrences, and to give a preliminary assessment of the potential for mining the coal deposits.

2. LOCATION AND ACCESS

The Bonnet Plume Basin covers much of the central part of N.T.S. sheet 106-E, Wind River, northern Yukon Territory. Approximate location of the coal exploration licences is $65^{\circ}50'N$, $135^{\circ}10'W$ (see Figures 1 and 2). This location is sixty miles due east of the Dempster Highway, which is the nearest road. Several winter trails and seismic cut-lines cross the basin. The only access to the property in summer is by air; the property is 150 miles due north of Mayo.



Geology (modified after Norris and Hopkins, 1977) and paleocurrents, of the Bonnet Plume Basin. For details of geology see Norris (1975), Norris and Hopkins (1977). Numbers are section locations mentioned in Norris and Hopkins (1977). Black arrows indicate inferred paleocurrents in the lower part of the Bonnet Plume Formation, and open arrows indicate paleocurrents in the upper part (Hr1 = Rapitan Fm., diamictite; Hr2 = Rapitan Fm., mudstone dolomite; CDr = Road River Fm.). Paleocurrent observations, east of the Knorr fault zone based on only one observation, and are not considered significant.

GEOLOGY MAP
(FROM G. S. C. PAPER 78 - 1A)

3. PHYSIOGRAPHY

The Bonnet Plume Basin is a physiographic and structural depression, about 700 square miles in area, surrounded by upland terrain and is a very prominent feature on topographic maps. It lies at the southern end of the Richardson Mountains, and is bounded on the west and south by the Wernecke Mountains and on the east by the Trevor and Knorr Ranges of the Mackenzie Mountains. The Wind and Bonnet Plume Rivers, both major rivers, drain the Wernecke Mountains and flow into the basin from the south to join the Peel River. The Peel flows in from the west and flows out to the east before turning north to join the Mackenzie River.

Much of the floor of the basin is a flat-lying terrace at around 1,000 feet A.S.L., and about 100 feet above the level of the major drainage channels. This terrace is formed of glacial and fluvial gravels, sands and silts which probably exceed fifty feet in thickness, and is covered by thick moss and stunted spruce with abundant small lakes and swampy areas. The entire basin is subject to permafrost at or near land surface.

4. HISTORY AND PREVIOUS WORK

Coal was first reported in the area by Count Edonard de Sainville in 1893. He ascended the Peel River by canoe from the Mackenzie River, walked about 25 miles up the Bonnet Plume River, crossed the basin to the Wind River and returned to his canoe by way of the Wind and Peel Rivers. During 1898, about ninety persons en route from Edmonton to the Klondike goldfields wintered in the area at "Wind City", near the mouth of Wind River. Some of these prospectors are said to have explored the surrounding countryside.

In 1905, Camsell explored the area for the Geological Survey (Camsell, 1906). He was the first to make specific reference to a "basin", and referred the clastic sequence overlying the Palaeozoic limestones to the Cretaceous and Tertiary systems. He described six feet of lignite on Wind River, about 12 miles below Mount Deception.

The first meaningful geological maps and structure sections were made by C. R. Stelck (1944), who gave the name "Bonnet Plume Basin" to the structural depression between the Peel and Bonnet Plume Rivers. This work has formed the basis of all future studies. Further stratigraphic and structural data were published by Norris, Price and Mountjoy (1963) and Mountjoy (1967). Rouse and Srivastava (1972) reported on palynological zonation of the coal-bearing rocks, and the superficial geology of the area was described by Hughes (1972). The first 1:250,000 geology map (by Norris) was published in 1975, and continued studies by Norris and Hopkins were published in 1977.

5. GEOLOGY

The Bonnet Plume basin is underlain by a thick sequence (4,500 feet) of sandstones and conglomeratic rocks of alluvial fan and braided stream facies known as the Bonnet Plume Formation, which has been divided informally into lower and upper parts (see Figure 2). Available lithostratigraphic and biostratigraphic data indicate that the lower part is of Middle or Late Albian (Lower Cretaceous) age and that the upper part is Maastrichtian and Palaeocene in age (Uppermost Cretaceous to early Tertiary). Hence the upper and lower parts are separated by an unconformity representing a hiatus of considerable duration.

The lower Bonnet Plume Formation consists predominantly of chert-pebble conglomerate with minor sandstone, shale and coal seams. The best exposures are to be found along Illyd Creek, a tributary of Wind River, in the southern part of the basin. The upper Bonnet Plume Formation consists of interbedded conglomerate, sandstone, shale and coal seams, and is well exposed in cliffs along the south bank of Peel River between the mouths of Wind and Bonnet Plume Rivers.

The structure is relatively simple; the basin forms a single, broad, northerly trending syncline. The structure is dominated, however, by a series of faults trending north-northwesterly. It has been interpreted that deposition in the basin was controlled by relative downward movements of the central portions of the basin along these faults. It is known from recent seismicity data that these faults are still active. It had previously been supposed that inward dips of the strata around the edge of the basin were very shallow, of the order of 10^0 or so, but more recent work has shown that steeper dips are present locally.

Mountjoy (1967) reported three lignite seams more than five feet thick in the Upper Bonnet Plume Formation at Section 106-E-18 and two seams at Section 106-E-17, both on Peel River (see Figure 2). Norris and Hopkins (1977) estimated that an aggregate thickness of forty feet of coal in seams greater than five feet thick to a stratigraphic depth of 400 feet underlay a canoe-shaped area of 35 square miles extending south from Peel River, giving a reserve potential of 1.5 billion short tons in place.

Norris and Hopkins (1977) described carbonaceous shale horizons within the lower Bonnet Plume Formation in the Illyd Creek area, but discovered no commercial coal seams.

6. THIS STUDY

This study was facilitated by foot traverses from camps established by helicopter, together with two days of aerial reconnaissance. A preliminary visit to the property was made by Dr. J. G. Simpson of Cyprus Anvil on 11 August, 1977.

On August 18, 1977, the writer, accompanied by an assistant, drove from Whitehorse to Mayo, where all field equipment and supplies were loaded aboard a Hughes 500 of Mayo Helicopters. A single trip was made to the property late that evening and the first camp was established at the north end of Section 106-E-17 on Peel River, and the helicopter returned to Mayo. The following day, August 19th, was spent examining and sampling Section 106-E-17. On August 20th, the helicopter returned and moved the camp to a location near the south end of Section 106-E-18, and the remainder of that day was spent in aerial reconnaissance along the Bonnet Plume, Peel and Wind Rivers and Illtyd Creek, and the areas in between. The following day, August 21st, was spent examining and sampling Section 106-E-18. It had been planned that the field party would be brought out on the morning of August 21st. However, because of breakdown of the Hughes 500, the crew was not brought out until very late that day when a Bell 206 of Trans North Turbo Air was sent in its place.

6.1 Section 106-E-17 - Peel River

Three thick seams of lignite were found at this section. The section was not measured in detail because of lack of time and because of overlying unconsolidated glacial material which, warmed by the sun, had melted and flowed down the cliffs from above. The sequence at Section 106-E-17 may be summarised as follows:

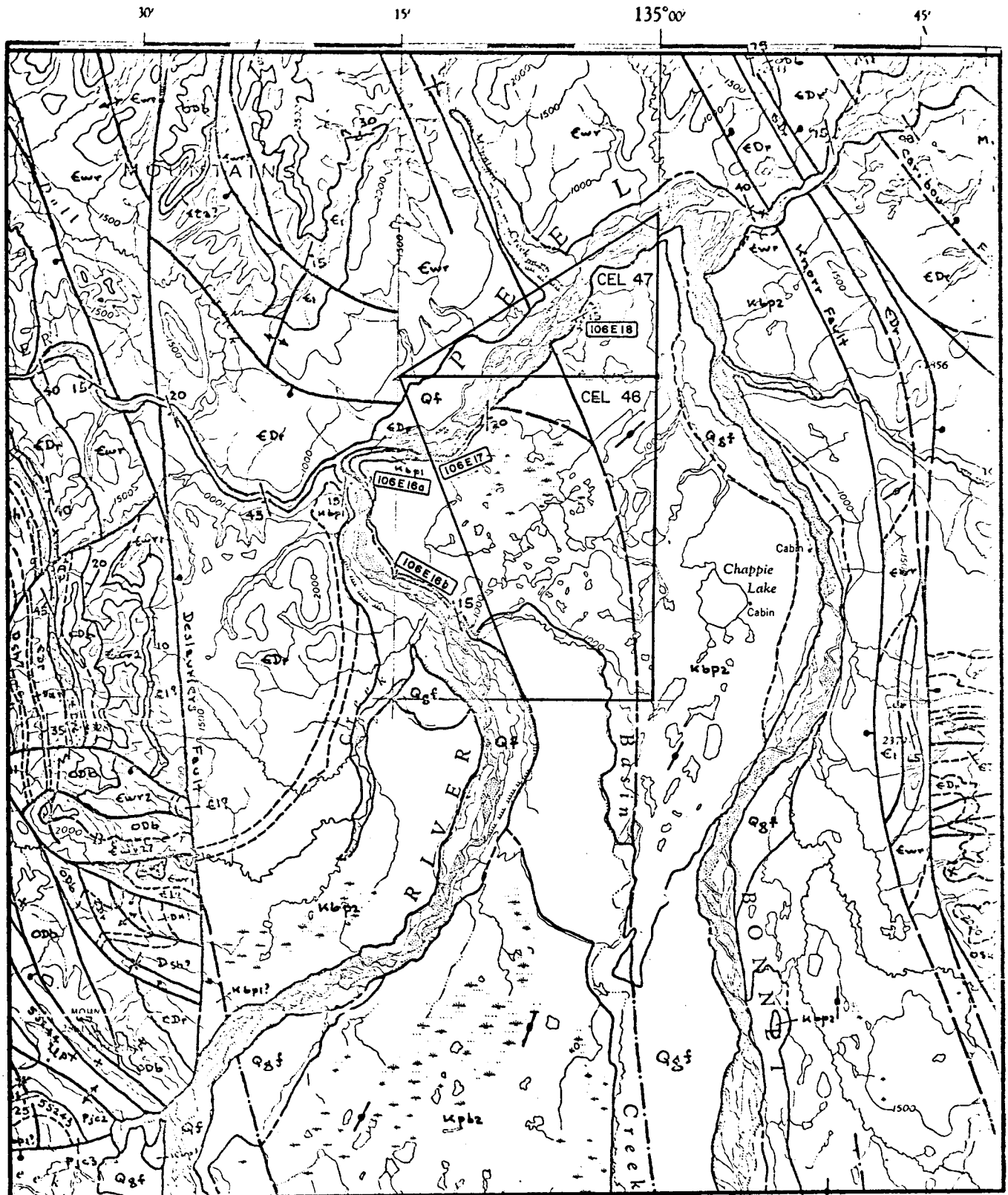


Figure: 3

RECONNAISSANCE OF PEEL RIVER
COAL EXPLORATION LICENCES
AUGUST, 1977

<u>Unit No.</u>	<u>Lithology</u>	<u>Approximate Thickness</u>
KTbp-25	Light grey clay.	+10 ft. (top not exposed).
24	Coal with clay interbands.	Approx. 20 ft.
23	Light grey clay.	+6 ft. (base not exposed).
22	(covered interval).	Approx. 100 ft.
21	Chert-pebble conglomerate.	Approx. 50 ft. exposed.
20	Light grey clay.	3 ft.
19	Coal with clay interbands.	16 ft.
18	Medium grey clay.	3 ft. exposed.
17	(covered interval).	(not measured).
16	Pebble conglomerate with sandstone lenses.	Approx. 100 feet.
15	Cross-bedded sandstone.	Base not exposed.
14	(covered interval).	(not measured).
13	Greenish-grey mudstone.	+2 ft. (top not exposed).
12	Coal.	6 ft.
11	Light grey-green clay.	+2 ft. (base not exposed).

Both upper and middle coal seams are cut out by feather edge beneath the Quaternary unconformity. All the conglomerate and sandstone units are poorly consolidated and only slightly cemented - most are really gravels and sands. The coal seams, by contrast, are well indurated and are the most resistant lithology. Each seam was described in some detail and sampled. Channel samples of about 20 to 30 lbs. each were taken over seam intervals of up to 12 feet. They were obtained by removing a layer of weathered material up to one foot thick from the surface of the outcrop and sampling relatively unweathered coal beneath. Where clay (bentonite) bands were present, some care was taken to sample coal and bentonite in approximately the right proportions.

Upper Seam

The upper seam outcrop was found to be affected by block slumping, and it proved difficult to obtain a measured section. Lithological and structural observations made may be summarised as follows:

<u>Interval</u>	<u>Lithology</u>	<u>Bedding</u>	<u>Sample No.</u>
Roof	Light grey clay.		
12 ft.	Lignite - mostly dull, dark brown with some black vitreous bands.	004/50E	PR-1
1 ft.	Light grey mud.		
————— (Discontinuity (slumping)) —————			
4 ft.	Lignite - mostly dull, dark brown with some black vitreous bands, with white bentonite bands an inch or so thick every few inches.	081/26N	PR-2
9 ft.	Lignite with bentonite bands - as above. Good cleat developed in vitreous bands.	102/31N	PR-3
————— (Discontinuity (?fault)) —————			
4 ft.	Lignite (as above) with thin bentonite bands and a few thin grey clay bands.	153/20NE	PR-4
Floor	Light grey clay with interbeds of dark brown carbonaceous mudstone.		

Middle Seam

The middle seam appeared rather harder and better indurated than the top seam, and was less affected by slumping. Observations made may be summarised as follows:

<u>Interval</u>	<u>Lithology</u>	<u>Bedding</u>	<u>Sample No.</u>
Roof	Light grey clay.		
8 ft.	Dark brown lignite, apparently rather muddy.	121/4 ⁰ NE	PR-5
8 ft.	Dark brown to black lignite with a few grey clay bands up to one inch thick.		PR-6
Floor	Medium grey clay.		

Lower Seam

The lower seam was discovered during helicopter reconnaissance, and outcrops in a small creek valley at the west end of the section. A single sample, No. PR-7, was taken over the six-foot seam, which had an attitude of 156/13NE. A description of the seam follows:

<u>Interval</u>	<u>Lithology</u>
Roof	Greenish-grey mudstone.
15 inches	Hard, dark brown lignite.
12 inches	Soft, black lignite.
24 inches	Hard, dark brown lignite.
12 inches	Soft, black lignite.
12 inches	Hard, dark brown lignite.
Floor	Light grey-green clay.

6.2 Section 106-E-9 - Illtyd Creek

A brief helicopter reconnaissance was made of the section along Illtyd Creek. In a small creek immediately to the south of the section described by Norris and Hopkins (1977), two coal horizons were found, an upper horizon about twenty feet thick and a lower horizon about six feet thick. These appear to correspond to carbonaceous shale units 9 and 14 respectively of Norris and Hopkins (1977). Because of very poor exposures, these seams were not sampled. On Illtyd Creek itself, a well-exposed coal seam about 18 feet thick was found, dipping 197/12E. This coal, which has apparently not been previously reported, is apparently rather higher in rank than the coals found along Peel River. It consists of massive, hard, vitreous black coal apparently without bentonite or clay partings. The seam occurs within the lower part of the Bonnet Plume Formation, and is overlain by chert-pebble conglomerate and underlain by a thickly bedded, light brownish-grey sandstone. These sediments are much better indurated than those found along

Peel River. One small channel sample (about five pounds) was taken across the lowest five feet of this seam (sample PR-8).

6.3 Section 106-E-18 - Peel River

Section 106-E-18 was found to contain east and west limbs of an anticline - dip on the east limb is approximately 172/50E and on the west limb about 260/14S. One coal seam, about 25 feet thick, is well exposed on the east limb; at present it is not possible to correlate this directly with one of the seams on Section 106-E-17. The lignite here is thin bedded and is rather dirty, but contains some clean, bright bands and a few white bentonite bands. A description of the seam follows:

<u>Interval</u>	<u>Lithology</u>	<u>Sample No.</u>
Roof	Grey clay, overlain by unconsolidated gravels.	
14 feet	Brown lignite with black vitreous bands and white bentonite bands.	JGS-1
1 foot	Grey clay.	
10 feet+ (base not exposed)	Soft, black carbonaceous mudstone containing lignite bands a few inches to a foot thick (less than 50% lignite).	Not sampled.

On the west limb of the anticline, the upper, relatively clean portion of the seam is reduced to about six feet in thickness, while the lower, dirty part consists of ten feet or so of interbedded lignite, black mudstone and light grey clay. In both localities, most of the remainder of the section is obscured by pleistocene and recent unconsolidated sediments.

6.4 Sample Analysis

Samples PR-1 to 8 inclusive and JGS-1 were sent to Cyclone Engineering Sales Ltd., Edmonton for analysis. The following data were obtained for air-dried samples: Proximate Analysis (Ash, Residual Moisture, Volatile Matter, Fixed Carbon), Calorific Value (B.T.U./lb.) and Sulphur. Values for equilibrium moisture were also obtained. The results are presented in Appendix I and summarized in Table 1. These results show that sample PR-8, from Illtyd Creek, is of considerably better quality than the others, a reflection of its slightly greater age. The remainder are of lignite to subbituminous rank, and have relatively high ash-contents due to interbanded bentonite. The analyses are comparable with coal from the Tulameen basin in south-central British Columbia.

TABLE 1

Summary of Analytical Data

<u>Samp. No.</u>	<u>Ash %</u>	<u>Moist. %</u>	<u>Volatiles %</u>	<u>F.C. %</u>	<u>S %</u>	<u>BTU/lb. (raw)</u>	<u>Equil. Moist. %</u>
PR-1	18.19	10.29	41.48	30.04	0.29	8,890	26.1
PR-2	27.33	7.74	35.35	29.58	0.29	7,740	20.5
PR-3	13.91	10.41	39.42	36.26	0.30	9,070	26.4
PR-4	14.74	10.95	38.55	35.76	0.34	8,810	24.7
PR-5	28.98	8.11	33.57	29.34	0.28	7,460	25.0
PR-6	39.54	9.49	30.30	20.67	0.14	5,860	21.7
PR-7	43.04	9.06	24.51	23.39	0.27	5,260	26.1
PR-8	4.70	9.29	36.81	49.20	0.22	10,740	16.6
JGS-1	10.77	12.71	36.92	39.60	0.40	8,630	18.7

6.5 Petrographic Analysis

Samples PR-3 and PR-8 were selected for petrographic analysis, and specimens were sent to Robertson Research (North America) Ltd., Calgary. The samples were forwarded to C.S.I.R.O. in Australia for analysis under a contractual arrangement with Robertson Research. Their report, which includes samples collected elsewhere in the Yukon, is presented in Appendix II. The data for PR-3 and PR-8 are summarised in Table 2.

The higher reflectance for PR-8 confirms its higher rank, the result of its greater age. On a mineral-matter-free basis, vitrinite plus exinite in both samples exceeds 90%, a characteristic of upper Cretaceous and Tertiary coals of the Circum-Pacific belt. This characteristic may render them suitable for potential feedstocks for conversion to liquid or gaseous fuels.

TABLE 2
Petrographic Analysis

Sample	PR-3	PR-8
Vitrinite %	87	97
Exinite	4	1
Resinite	2	1
Fusinite	-	-
Semifusinite	1	Trace
Micrinite	Trace	Trace
Mineral Matter	6	1
Mean Max Reflectance %	0.29	0.43
Vitrinite + Exinite (M.M.F.)	94	97

7. CONCLUSIONS AND RECOMMENDATIONS

The writer's observations indicate that the area underlain by coal-bearing strata in the Bonnet Plume Basin is much larger than was originally supposed. This conclusion is supported by recent observations of the G.S.C. (see Long, 1978). Large volumes of lignite and sub-bituminous coal are present, but as yet insufficient data are available to permit reserve calculations to be made. Much of the coal present is very low in sulphur but high in ash, much of the ash being present as discrete bentonite bands. It is very probable that a simple washing technique designed to separate coal and bentonite could be designed to produce relatively clean coal with a calorific value of the order of 9,000 B.T.U./lbs. Such a product should be suitable for a mine-mouth generating station or for conversion to clean gaseous or liquid fuels.

The presence of a relatively thick cover of unconsolidated but frozen overburden would render any mining activity extremely difficult, as would the high dips (up to 50°) seen in the coal seams locally. These factors suggest that in-situ gasification may be the only practical method of exploiting these resources.

Because of uncertainties regarding the number, thickness and lateral extent of the coal seams, exploratory drilling is recommended. Since much of the strata consists of unconsolidated or poorly consolidated sediments, rotary drilling, together with geophysical logging, is recommended for a first-phase programme. For ease of data compilation, a kilometre grid should be set up, with the initial holes spaced at 2-km centres. Because of the terrain characteristics of the area,

APPENDIX

DETAILS OF PETROGRAPHIC ANALYSES

PHOTOMICROGRAPHS

CSIRO

MINERALS RESEARCH LABORATORIES

FUEL GEOSCIENCE UNIT

COAL PETROGRAPHY OF TWELVE COAL SAMPLES
FROM THE YUKON TERRITORY, CANADA

N. J. RUSSELL

P.O. BOX 136
NORTH RYDE NSW
AUSTRALIA 2113

MARCH 1978

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APPENDIX

DETAILS OF PETROGRAPHIC ANALYSES

PHOTOMICROGRAPHS

1. INTRODUCTION

Twelve coal samples were submitted for petrographic analysis by the Robertson Research Group of Companies* on behalf of the Cyprus Anvil Mining Corporation. These coals, which are of Mesozoic or Tertiary age, were collected from outcrops at various localities in the Yukon Territory, Canada.

It is quite likely that the coals have undergone some degree of oxidation and weathering, since they represent outcrop samples. As a result, the measured values for certain of the coal utilization parameters might be expected to be at variance with the values for these parameters as determined on unweathered coal. It is possible that predicted values for coal utilization parameters, based on the coal petrographic data, may provide a more reliable assessment of coal quality than the results of chemical and physical testwork carried out on weathered coal.

Therefore, Cyprus Anvil Mining Corporation requested that vitrinite reflectivity and maceral analyses of the twelve coal samples be undertaken in order to compare the predicted coal utilization parameters with the measured values for these parameters.

In addition to the petrographic analyses, moisture, ash and sulphur values were determined for each coal in order that the maceral analyses could be corrected for calculated mineral matter.

2. GEOLOGICAL SETTING

Latour (1972) has listed the principal coal occurrences in the Yukon Territory; these occurrences may be summarized as follows

- | | | |
|----------------|---|---|
| TERTIARY COALS | { | (a) White River and Yukon River drainage area
(southwestern and west Yukon) |
| | | (b) Bonnet Plume area (north Yukon) |
| | | (c) Upper Liard River (southeastern Yukon) |
| MESOZOIC COALS | { | (d) Southwestern Yukon - Laberge (Lower
Jurassic - ? Upper Jurassic) and Tantalus
(Upper Jurassic - Lower Cretaceous)
Formations |

* In this instance Robertson Research (Australia) Pty Ltd and Robertson Research (North America) Ltd.

The Mesozoic coals are described as being mostly bituminous in rank, whereas, the Tertiary coals are described as being lignitic in rank.

Although, no locality maps were available at the time of writing, Cyprus Anvil Mining Corporation provided the following information in respect of sample location, sample age and the presence of intrusive rocks.

DM - 1	} Upper Jurassic
DM - 2	
DM - 3	
FF - 1	Lower/Middle Jurassic (Middle Tertiary)
GC - 1	Jurassic - Cretaceous (possible intrusives)
JC - 1	Cretaceous (Tertiary ?)
LP - 1	Middle/Upper Jurassic - Lower Cretaceous (possible intrusives)
PC - 1	} Upper Jurassic - Lower Cretaceous (possible intrusives)
PC - 2	
PR - 3	Upper Cretaceous
PR - 8	Lower Cretaceous
RR - 1	Tertiary (Jurassic - Cretaceous ?)

DM = Division Mountain

LP = Lone Pine Mountain

FF = Five Fingers

PC = Porters Coal

GC = Gudders Coal

PR = Peel River

JC = Jump Out Creek

RR = Ross River

Cyprus Anvil Mining Corporation indicated that the ages in parenthesis are possible alternative ages to those indicated on the geological maps, based presumably on their geologists' field observations.

3. COAL PETROGRAPHIC DATA

The vitrinite reflectivity and maceral analyses were carried out in accordance with the recommendations of the International Committee for Coal Petrology (I.C.C.P.), as set out in the I.C.C.P. Handbook (1963, 1971) (also, see Stach, 1975). Separate maceral analyses were performed on the low rank coals under incident-light, blue-light excitation. The

resultant fluorescence of the liptinite/exinite group macerals permits a distinction to be made between the various macerals within this group and between the maceral group and very low reflectivity mineral matter, in particular finely divided quartz and clay minerals. (I.C.C.P., 1976; Spackman *et al.*, 1976).

The details of the petrographic analyses for the coals are presented in an Appendix, together with a number of photomicrographs illustrating the petrography of these coals.

Coal Type:

The results of the petrographic analyses are summarized in Table 1. On the basis of their petrographic composition the coals may be divided into vitrinite-rich and vitrinite-poor types.

(A) Vitrinite-rich Coals

The Peel River (PR-3 and PR-8), Jump Out Creek (JC-1) and Five Fingers (FF-1) samples contain in excess of 90% of (vitrinite + exinite) on a mineral matter free basis; the inertinite content of the Peel River samples is 1% or less. The petrographic composition of these samples is similar to the restricted petrographic composition for uppermost Cretaceous (Senonian) and Tertiary coals of the western circum-Pacific region; in terms of coal rank and type the four samples are similar to the Neogene coals of Indonesia (Strauss *et al.*, 1976). The I.C.C.P. Handbook (1971) notes that inertinite is a minor component of most Tertiary brown coals and lignites, with the exception of certain individual occurrences in India and the Balkans. Furthermore, sclerotinite is the important, if not dominant, component of the inertinite found in these coals.

Although the ages assigned to the vitrinite-rich coals range from lower Jurassic to ? Tertiary, it seems likely that, on the basis of their petrographic composition, these coals are Upper Cretaceous to Tertiary in age. The petrography of these samples is illustrated in Plates I and 2.

(B) Vitrinite-poor Coals

With two exceptions, the remaining coal samples contain less than 36% of (vitrinite + exinite) on a mineral matter free basis. The Lone Pine Mountain (LP-1) sample represents a coked coal (natural coke).

Sample PC-2 is a high rank anthracite, with a maximum reflectivity (\bar{R}_0 max) in excess of 3%, and, as such, it is difficult to carry out a meaningful maceral analysis on this coal. Reference to Table 1 shows the marked contrast in petrographic composition of samples PC-1 and PC-2, which have been assigned the same age (Upper Triassic - Lower Cretaceous) and which were collected from the same general locality.

In terms of their petrographic composition and degree of coalification, the vitrinite-poor coals broadly resemble coals from the Oaklands (Permian, New South Wales), Galilee Basin (Permian, Queensland), Blair Athol (Permian, Queensland), Callide (Triassic, Queensland) and Leigh Creek (South Australia, Triassic) deposits in Australia (Bennett and Taylor, 1970; Strauss *et al.*, 1976).

Cook (1975) notes that the inertinite-rich, Cretaceous coals of the Maryborough and Styx Basins (Queensland) are very similar in maceral composition to the Cretaceous coals of British Columbia and Alberta. In particular, with respect to the abundant semifusinite/fusinite derived from well-preserved, thick-walled, woody tissue. Data presented by Cameron (1972) indicate a wide range in vitrinite content, i.e. 35-96%, for the Upper Jurassic - Lower Cretaceous coals in the Kootenay Formation in British Columbia and Alberta. The average value of 63% vitrinite is much higher than that for the Yukon samples examined. Vitrinite was distinguished from semifusinite of similar reflectivity (very low reflectivity semifusinite) by the presence of open slitlike cell lumens and/or the presence of granular (mottled) anisotropy in the semifusinite (Bennett, 1968).

The ages assigned to the vitrinite-poor coals range from Upper Jurassic to Lower Cretaceous. The Tertiary age given for sample RR-1 is based on the available geological map; however, it is understood that this coal is of Jurassic-Cretaceous age. The petrography of these samples is illustrated in Plates 3 and 4.

It appears that, in very general terms, the petrographic composition of the Yukon coal samples reflects their age, i.e. vitrinite-poor, Upper Jurassic - Lower Cretaceous coals and vitrinite-rich, ? Upper Cretaceous - Tertiary coals (see Figure 1).

Coal Rank

Reference to Table 1 indicates that the coal samples may be divided into two groups on the basis of their vitrinite reflectivity, namely lignite-subbituminous/high-volatile bituminous coal (\bar{R}_O max = 0.29-0.64%) and semianthracite - anthracite (\bar{R}_O max = 1.98-3.10%). None of the samples examined fall within the coking coal range of high- to low-volatile bituminous coals.

(A) Low-rank Coals

The vitrinite-rich coals, presumed to be of Upper Cretaceous-Tertiary age, exhibit a slightly lower range of vitrinite reflectivity values (\bar{R}_O max = 0.29-0.51%) than those exhibited by the vitrinite-poor coals (\bar{R}_O max = 0.56-0.64%), which are Upper Jurassic - Lower Cretaceous in age. This observation would be consistent with regional-coalification in relatively undeformed sediments, the differences in degree of coalification reflecting the different ages of the two groups of coal samples.

(B) High-rank Coals

The occurrence of semianthracite - anthracite in a region containing low rank coals of the same age suggests the presence of intrusive rocks which have resulted in localized thermal alteration of the coal. Reference to Stach (1975) suggests carbonization temperatures of 400°C to 500°C for the semianthracite - anthracite samples with vitrinite reflectivity values of 1.98% to 3.10%, assuming that the original coals were of low rank and that the thermal alteration occurred in the absence of excess pressure. The bireflectance (\bar{R}_O max % - \bar{R}_O min %) values of 0.59% to 1.03% indicate that the samples were not subjected to excess pressure during carbonization.

The Lone Pine Mountain (LP-1) sample consists of a natural coke that exhibits the development of small spherical vesicles and a very fine-grained anisotropic (see Plate 5 a & b) mosaic structure which suggests that the original coal falls outside the coking coal range, i.e. a relatively low rank coal. Data presented in British Carbonization Research Association (B.C.R.A.) Report 25 (1976) suggest that development of a fine-grain anisotropic mosaic is associated with the carbonization of caking coals in the 400-600 class (N.C.B. 1964). The reflectivity

value of 6.2% for the vitrinite coke in sample LP-1 indicates a carbonization temperature of 650°C to 700°C.

It is understood that intrusive rocks occur in the Porters Coal and Lone Pine Mountain localities. Although no intrusive rocks appear to be recorded from the area of the locality of sample RR-1, it is likely that the high rank of this coal is the result of local thermal alteration.

Reference to Barnes (1961) and Rao (1975) reveals the presence of subbituminous coal in neighbouring Alaska. The Eagle Field lies close to the Yukon-Alaska border where the Yukon River crosses the frontier between Canada and the U.S.A. The Jarvis Creek and Nenana Field in Central Alaska and the Susitna, Beluga and Kenai Fields in South Central Alaska contain lignite and subbituminous coal. Higher rank coals are also recorded in Alaska. The Bering River Field, which is located about 100 miles from the southwestern corner of the Yukon Territory, contains semianthracite-anthracite. The latter is reported to be badly crushed and faulted: in view of the mechanical deformation of the coal the high rank is probably due to regional metamorphism, rather than localized, thermal metamorphism. In the Matanuska Field, South Central Alaska, the coal rank ranges from subbituminous, through bituminous, to semianthracite-anthracite moving from west to east over a distance of about 60 miles. Both Tertiary and Cretaceous coals are known to occur in Alaska. The lower rank coals (subbituminous-bituminous) of the Matanuska Field include Tertiary coals which are characterized by their very high contents of vitrinite (CSIRO, 1964).

4. PREDICTION OF COAL UTILIZATION PARAMETERS

FROM THE COAL PETROGRAPHIC DATA

Coal utilization parameters can be predicted on the basis of coal petrographic data using graphs published by Bennett and Taylor (1970). These graphical solutions have proved to be quite successful in the prediction of the properties of Australian Gondwana (Permian) coals; however, caution should be exercised when attempting to predict the properties of other coals. In this study no attempt has been made to calculate composition balance index (CBI) or strength index (SI) in order to predict coke stability using the method of Schapiro *et al.* (1961).

In order to improve the quality of the predictions it is advisable to correct the maceral analysis to a calculated mineral matter basis. This correction avoids the problems inherent in accurately determining the mineral matter component by microscopic methods. The calculated mineral matter value is derived from the moisture, ash and total sulphur contents using a modification of Parr's equation (see Francis, 1961) as follows: -

$$\text{Calculated Mineral matter (volume \%)} = \frac{\left[\begin{array}{l} \text{Ash (wt.\%)} \times 1.08 + \text{Sulphur (wt.\%)} \times 0.55 \\ \text{(dry basis)} \qquad \qquad \qquad \text{(dry basis)} \end{array} \right]}{2}$$

Table 2 presents the values for the moisture, ash and sulphur determinations, the calculated mineral matter values and the corrected values for the maceral analysis for each sample.

Table 3 presents a comparison between the results of the moisture, ash and total sulphur analyses carried out by CSIRO and the results for these analyses provided by the Cyprus Anvil Mining Corporation. There appears to be a considerable discrepancy between the values for the ash analyses. This probably indicates that the subsamples forwarded to CSIRO for petrographic analysis are not representative of the subsamples analysed by the Cyprus Anvil Mining Corporation. The difference in composition between subsamples renders difficult the prediction of coal utilization parameters from the petrographic data.

Table 4 presents predicted coal utilization parameters for eight of the Yukon coal samples and measured values for the same parameters for six of these samples. The closest agreement between predicted and measured values for coal utilization parameters are yielded by samples PR-3 and PR-8, for which there is the closest agreement between CSIRO values for moisture and ash and the values for these analyses provided by the Cyprus Anvil Mining Corporation. Although some evidence of slight oxidation was observed in the low-rank coal samples, the discrepancies between predicted and measured values for coal utilization parameters appears to reflect a sampling problem rather than the influence of oxidation. Strong oxidation was observed in the semi-anthracite - anthracite samples, GC-1, PC-1 and PC-2 (see Plates 5c & 5d); however, the prediction of coal utilization parameters for coals with a reflectivity in excess of 2% is not possible with the graphical

solutions available. It is doubtful whether there is much value in attempting this exercise for coals that have undergone severe thermal alteration and which exhibit evidence of strong oxidation.

Figure 2, based on data presented by Bennett and Taylor (1970), Strauss *et al.* (1976) and Taylor and Shibaoka (1976), illustrates the petrographic data for the Yukon coal samples by comparison with that for Australian coals and their potential utilization. The high vitrinite Yukon coals, PR-3, PR-8 and FF-1 may have some application as potential feedstock for coal-oil conversion, although the rank of PR-3 is very low, i.e. high moisture and oxygen contents; the remaining coal samples can only be considered as thermal coals for electricity generation.

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TABLE 1. PETROGRAPHIC DATA FOR THE YUKON COAL SAMPLES

Sample Information			Maceral Analysis							Reflectivity Analysis	
Field identification	Laboratory number	Petrographic number	Vitrinite	Exinite	Resinite	Fusinite	Semifusinite	Micrinite	Mineral matter	Mean maximum reflectivity in oil at 546 nm	Bireflectance (\bar{R}_0 max. - \bar{R}_0 min)
DM-1	59503	29424	30	4	7	1	43	12	3	0.56	-
DM-2	59511	29432	18	5	1	2	62	11	1	0.58	-
DM-3	59513	29434	6	3	1	2	70	11	7	0.64	-
FF-1	59508	29429	83	2	5	trace	4	3	3	0.51	-
GC-1	59507	29428	3	-	-	3	90	3	1	2.71	0.97
JC-1	59506	29427	59	1	6	1	3	1	29	0.48	-
LP-1	59505	29426	Coked Coal (Natural coke)							6.20	1.47
PC-1	59504	29425	21	-	-	3	73	1	2	2.79	1.03
PC-2	59512	29433	82	-	-	-	16	-	2	3.10	0.97
PR-3	59502	29423	87	4	2	-	1	trace	6	0.29	-
PR-8	59510	29431	97	1	1	-	trace	trace	1	0.43	-
RR-1	59509	29430	6	-	-	2	86	5	1	1.98	0.59

TABLE 2. CORRECTION OF MACERAL ANALYSES TO A CALCULATED
MINERAL MATTER BASIS

Field identification	Laboratory number	Petrographic number	Air-dried moisture (wt. %)	Ash (wt. %)	Total sulphur (wt. %)	Calculated mineral matter (vol. %)	Vitrinite	Exinite	Inertinite	Total "Reactives"*	Total "Inerts"†
DM-1	59503	29424	11.5	12.6	0.28	8	29	10	53	39	61
DM-2	59511	29432	10.7	8.1	0.32	5	17	6	72	23	77
DM-3	59513	29434	8.4	15.3	0.26	9	6	4	81	10	90
FF-1	59508	29429	5.2	19.2	0.24	11	77	6	6	83	17
GC-1	59507	29428	9.9	13.6	0.60	8	3		89	3	91
JC-1	59506	29427	3.8	63.0	0.22	35	54	6	5	60	40
LP-1	59505	29426	3.4	4.6	0.15	3	Natural Coke				
PC-1	59504	29425	4.9	6.6	0.94	4	21		75	21	79
PC-2	59512	29433	3.3	6.5	1.04	4	80		16	80	20
PR-3	59502	29423	12.3	7.8	0.26	5	88	6	1	94	6
PR-8	59510	29431	11.6	4.4	0.22	3	95	2	-	97	3
RR-1	59509	29430	2.6	7.5	0.34	4	6		90	6	94

* "Reactives" = (vitrinite + exinite)%

† "Inerts" = (inertinite + mineral matter)%

TABLE 3. COMPARISON OF CHEMICAL ANALYSES

Sample Data			CSIRO Analyses			Analyses Provided by Cyprus Anvil Mining Corporation					
Field identification	Laboratory number	Petrographic number	Moisture %	Ash %	Total sulphur %	Moisture %	Ash %	Total sulphur %	Volatile matter %	Calorific value (Btu/lb)	British swelling index
DM-1	59503	29424	11.5	12.6	0.28	9.83	19.73	-	28.48	8100	0
DM-2	59511	29432	10.7	8.1	0.32	7.97	19.54	-	29.96	8500	0
DM-3	59513	29434	8.4	15.3	0.26	7.20	29.90	-	27.53	7390	0
PR-3	59502	29423	12.3	7.8	0.26	10.41	13.91	0.30	36.26	9070	-
PR-8	59510	29431	11.6	4.4	0.22	9.29	4.70	0.22	36.81	10740	-
RR-1	59509	29430	2.6	7.5	0.34	3.55	17.6	0.30	18.52	10940	-

TABLE 4. COMPARISON OF PREDICTED AND MEASURED VALUES FOR COAL UTILIZATION PARAMETERS FOR THE YUKON COAL SAMPLES

Sample Data			Petrographic Data		Predicted Values for Utilization Parameters				Measured Values for Utilization Parameters		
Field identification	Laboratory number	Petrographic number	Coal rank R ₀ max %	Coal type "reactives" %	Volatile matter % (d.a.f.)	Calorific value (Btu/lb)(d.m.m.f.)	British swelling index	Hydrogen % (d.a.f.)	Volatile matter % (d.a.f.)	Calorific value (Btu/lb)(d.m.m.f.)	British swelling index
DM-1	59503	29424	0.56	39	42	13600	-	5.1	40	11809*	0
DM-2	59511	29432	0.58	23	34	13800	-	4.7	41	12027*	0
DM-3	59513	29434	0.64	10	26	14100	-	4.5	44	12312*	0
FF-1	59508	29429	0.51	83	47	13400	2	6.1	-	-	-
JC-1	59506	29427	0.48	60	47	13200	-	5.6	-	-	-
PR-3	59502	29423	0.29	94	(56)	(12000)	-	-	52	12187	-
PR-8	59510	29431	0.43	97	51	12800	-	6.4	43	12542	-
RR-1	59509	29430	1.98	6	16	15400	-	< 4.2	24	14171	-

d.a.f. = dry ash free basis

d.m.m.f. = dry mineral matter free basis

$$\text{Volatile Matter (dry ash free)} = \frac{100(\text{Volatile Matter (air dried)})}{100 - (\text{Moisture} + \text{ash})}$$

The Queensland Coal Board (1972) employs the following equation to convert calorific value (air dried basis) to calorific value (d.m.m.f.).

$$\text{Calorific Value (d.m.m.f.)} = \frac{100 \left(\text{Calorific Value (air dried basis)} - \frac{54 \text{ Sulphur (pyritic)}}{100} \right)}{100 - (\text{Moisture} + 1.1 \text{ ash (air dried basis)})} \text{ Btu/lb}$$

(* CSIRO total sulphur values were used to calculate the calorific value (d.m.m.f.) since the sulphur values were not made available for samples DM-1, DM-2 and DM-3).

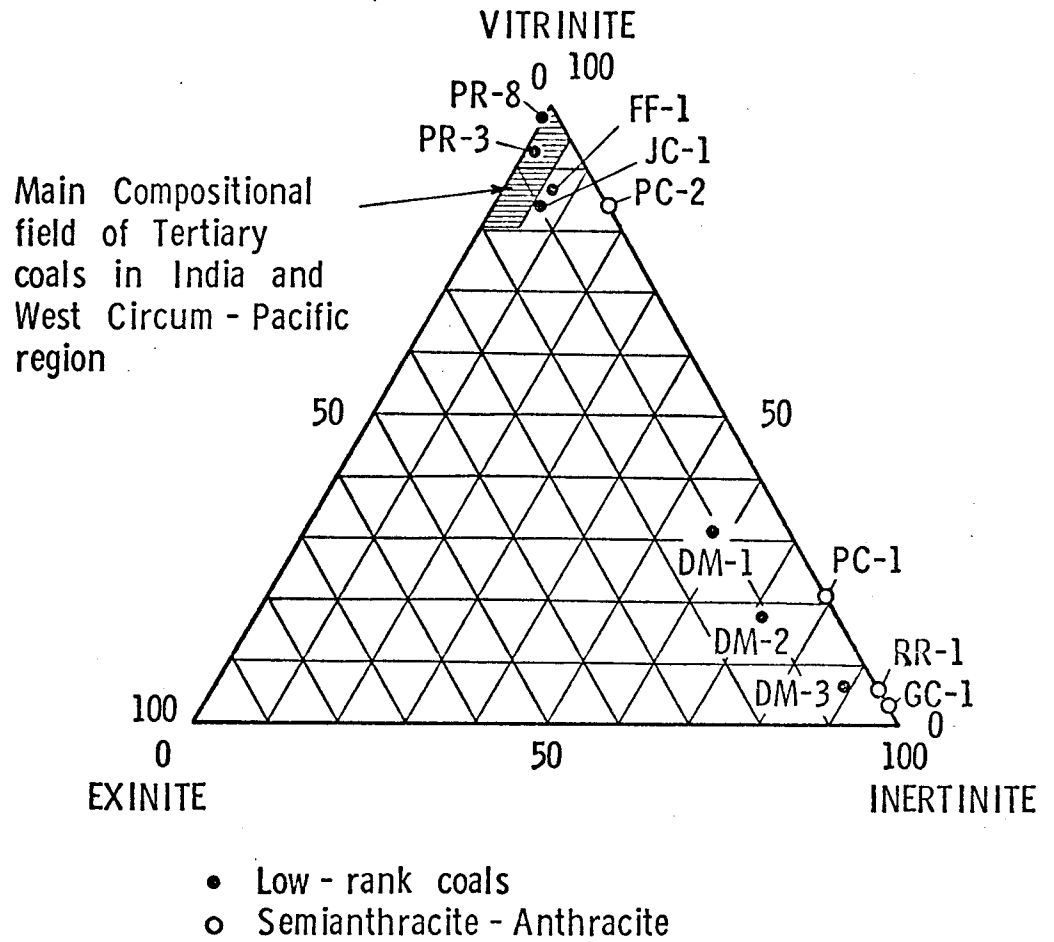


FIG. 1. PETROGRAPHIC COMPOSITION OF YUKON COAL SAMPLES

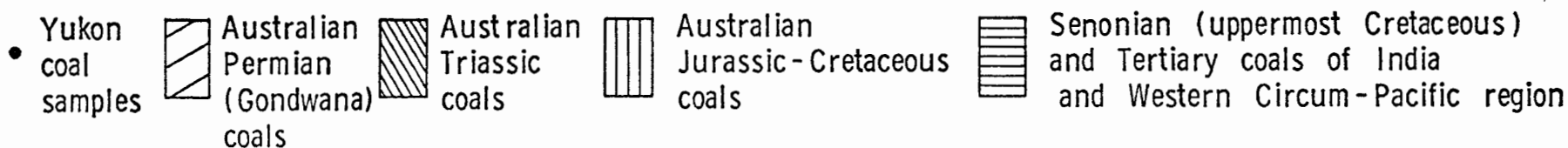
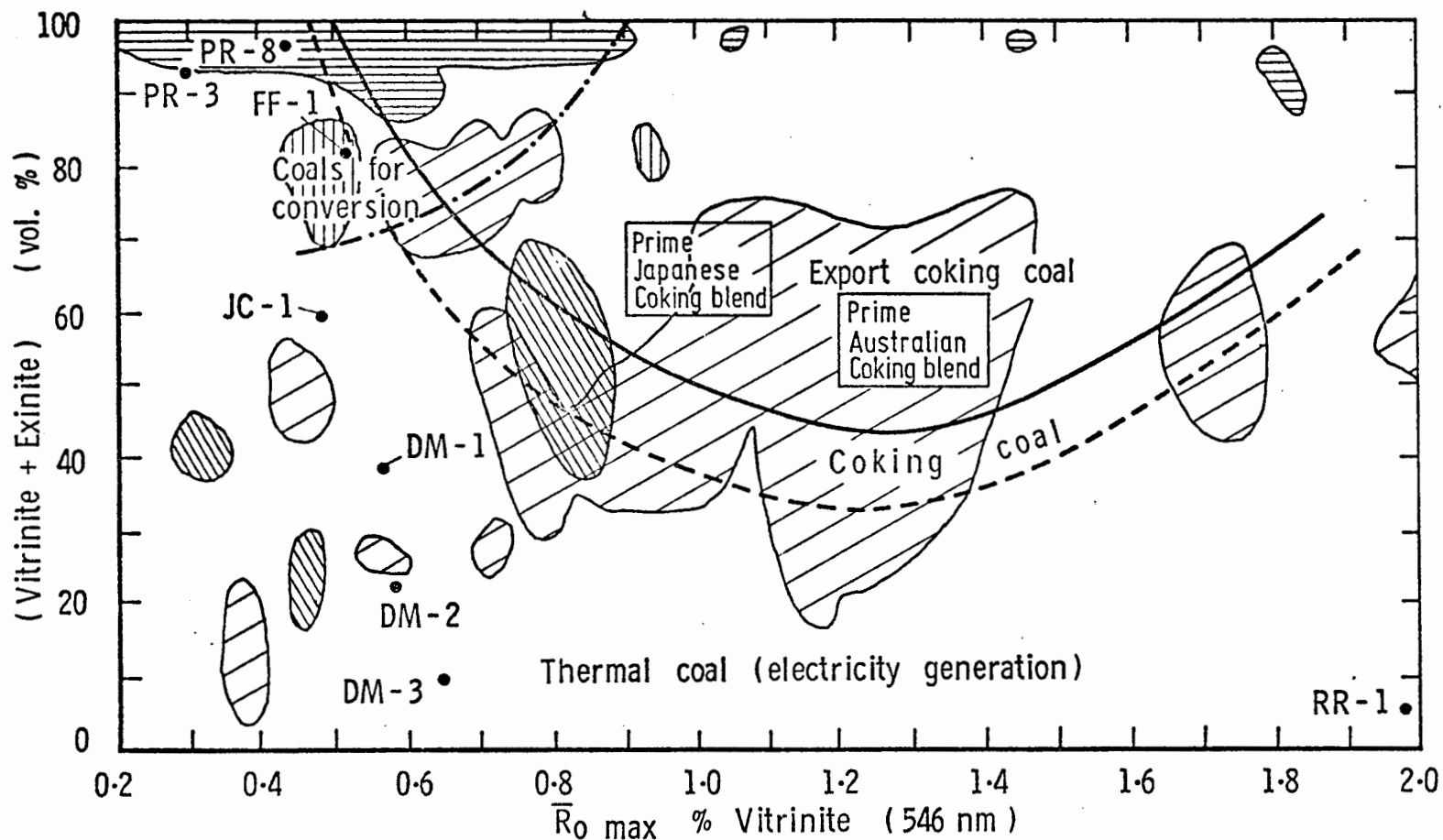
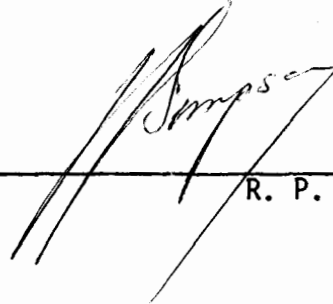


FIG. 2. COMPARISON OF COAL PETROGRAPHY DATA OF THE YUKON COAL SAMPLES WITH THAT FOR AUSTRALIAN COALS AND THEIR POTENTIAL UTILIZATION

crawler-mounted rotary rigs drilling in winter would probably be required.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "R. P. Hill", is written over a horizontal line.

R. P. Hill

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APPENDIX I

Project: Peel River

Sample No. PR-1

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	18.19	20.28
R.M. %	10.29	--
V.M. %	41.48	46.24
F.C. %	30.04	33.48
CALORIFIC VALUE (BTU/lb.)	8,890	9,910
SULFUR %	0.29	0.32

/11/11/77
11,067

Project: Peel River

Sample No. PR-2

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	27.33	29.62
R.M. %	7.74	--
V.M. %	35.35	38.32
F.C. %	29.58	32.06
CALORIFIC VALUE (BTU/lb.)	7,740	8,390
SULFUR %	0.29	0.31

Project: Peel River

Sample No. PR-3

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	13.91	15.53
R.M. %	10.41	--
V.M. %	39.42	44.00
F.C. %	36.26	40.47
CALORIFIC VALUE (BTU/lb.)	9,070	10,120
SULFUR %	0.30	0.33

Project: Peel River

Sample No. PR-4

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	14.74	16.55
R.M. %	10.95	--
V.M. %	38.55	43.29
F.C. %	35.76	40.16
CALORIFIC VALUE (BTU/lb.)	8,810	9,890
SULFUR %	0.34	0.38

Project: Peel River

Sample No. PR-5

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	28.98	31.54
R.M. %	8.11	--
V.M. %	33.57	36.53
F.C. %	29.34	31.93
CALORIFIC VALUE (BTU/lb.)	7,460	8,120
SULFUR %	0.28	0.30

Project: Peel River

Sample No. PR-6

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	39.54	43.69
R.M. %	9.49	--
V.M. %	30.30	33.48
F.C. %	20.67	22.83
CALORIFIC VALUE (BTU/lb.)	5,860	6,470
SULFUR %	0.14	0.15

Project: Peel River

Sample No. PR-7

November 3, 1977

PROXIMATE ANALYSIS

	<u>Air-dry basis</u>	<u>Dry basis</u>
Ash %	43.04	47.32
R.M. %	9.06	--
V.M. %	24.51	26.95
F.C. %	23.39	25.73
CALORIFIC VALUE (BTU/lb.)	5,260	5,780
SULFUR %	0.27	0.30

CYPRUS ANVIL MINING CORPORATION

SI-252

Project: General Coal Project

Sample #: PR8

PROXIMATE ANALYSIS

	<u>Air-dry Basis</u>	<u>Dry Basis</u>
Ash %	4.70	5.18
R.M. %	9.29	--
V.M. %	36.81	40.58
F.C. %	49.20	54.24
<u>CALORIFIC VALUE (BTU/lb.)</u>	10,740	11,840
<u>SULPHUR %</u>	0.22	0.24

CYCLONE ENGINEERING SALES LTD.
EDMONTON, ALBERTA, CANADA.

CYPRUS ANVIL MINING CORPORATION

SI-251

Project: Peel River Project

Sample #: JGS-1 (PR9+10)

PROXIMATE ANALYSIS

	<u>Air-dry Basis</u>	<u>Dry Basis</u>
Ash %	10.77	12.34
R.M. %	12.71	--
V.M. %	36.92	45.29
F.C. %	39.60	45.37
<u>CALORIFIC VALUE (BTU/lb.)</u>	8,630	9,890
<u>SULPHUR %</u>	0.40	0.46

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SEPARATION OF BULK MATERIALS

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Telephone: (403) 436-1385

Cable Address:
Cyclone, Edmonton
Telex: 037-3793

Ref: S1-251

December 12, 1977

Cyprus Anvil Mining Corporation
330, 355 Burrard Street
Vancouver, B. C.

Attention: Mr. R. Hill

Dear Sir:

Listed below are Equilibrium Moisture determinations on PR1 - PR7 inclusive.

<u>Sample #</u>	<u>Equilibrium Moisture</u>
PR-1	26.1
PR-2	20.5
PR-3	26.4
PR-4	24.7
PR-5	25.0
PR-6	21.7
PR-7	26.1

Calculation of BTU values on the moist, mineral-matter free basis using equilibrium moisture as the bed moisture show the coals are of a rank between subbituminous C and lignite A.

Attached herewith are also results of analysis on Sample JGS-1, Equilibrium Moisture values for PR-8 and JGS-1 will be forwarded when they are available.

Yours truly,

CYCLONE ENGINEERING SALES LTD.

Per: B. Y. H. Wong
B. Y. H. Wong

BYHM/cjr
Encl.



SEPARATION OF BULK MATERIALS

Manufacturing, Engineering, Testing Services

9751 - 51 Avenue
Edmonton, Alberta T6E 4Z5
Telephone: (403) 436-1385

Cable Address:
Cyclone, Edmonton
Telex: 037-3793

Ref: S1-252

January 27, 1978

Cyprus Anvil Mining Corporation
330, 355 Burrard Street
Vancouver, B. C.

Attention: Mr. R. Hill

Dear Sir:

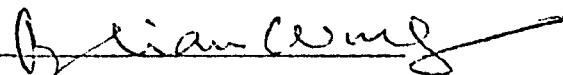
Listed below are repeated values of equilibrium moisture on samples PR-8 and JGS-1, together with the previous determinations.

<u>Sample #</u>	<u>Repeated Equil. Moisture</u>	<u>Previous Equil. Moisture</u>
PR-8	16.6 %	15.6 %
JGS-1	18.7 %	19.8 %

We believe that the low values 11.8 % for PR-8 and 15.5 % for JGS-1 are with errors from the other laboratory. The data in this letter should therefore be entered into the report.

Yours truly,

CYCLONE ENGINEERING SALES LTD.

Per: 
B. Y. H. Wong

BYHW/ejr

APPENDIX II

APPENDIX

VITRINITE RICH COALS:

PEEL RIVER SAMPLES:

	PR-3	PR-8
MACERAL ANALYSIS		
GROUNDMASS VITRINITE %	24	8
BAND VITRINITE %	3	79
RESINOUS (DARK) VITRINITE (NON-FLUORESCENT)	34	} 9
RESINOUS (DARK) VITRINITE (^a WEAKLY FLUORESCENT) %	17	
GELINITIC CELLS %	8	1
PORIGELINITE %	1	-
RESINOUS (DARK) VITRINITE CELLS %	trace	-
CORPOHUMINITE %	-	trace
TOTAL VITRINITE %	87	97
SPORINITE %	trace	1
CUTINITE %	-	-
RESINITE %	1	trace
SUBERINITE %	4	-
OTHER LIPTINITE/EXINITE %	b 1	c 1
TOTAL LIPTINITE/EXINITE %	6	2
FUSINITE %	-	-
SEMIFUSINITE %	1	trace
^d SCLEROTINITE %	trace	trace
TOTAL INERTINITE %	1	trace
QUARTZ %	-	-
CARBONATE %	-	trace
CLAY MINERAL %	5	1
SULPHIDE %	1	-
ALTERED IRON OXIDE %	-	trace
TOTAL MINERAL MATTER %	6	1
(VITRINITE + EXINITE) (m.m.f.) %	99	100
REFLECTIVITY DATA		
^e \bar{R}_O max. %	0.29	0.43
Standard deviation \pm	0.07	0.03
Range of R_O max % values	0.18 - 0.49	0.35 - 0.54
VITRINOID TYPES		
V ₁ %	6	-
V ₂ %	48	-
V ₃ %	39	4
V ₄ %	7	86
V ₅ %	-	10

APPENDIX

BLUE-LIGHT EXCITATION FLUORESCENCE OF LIPTINITE/EXINITE		
FLUORESCENCE COLOURS	^a PALE YELLOWISH GREEN TO YELLOW	YELLOW TO YELLOWISH ORANGE

- a. Low-reflectivity (dark) vitrinite exhibits
a very weak pale brown fluorescence
- b. Principally exsudates (exsudatinite)
- c. Principally liptodetrinite
- d. Represented by characteristic fungal bodies, e.g. sclerotia,
teleutospores
- e. The reflectivity data may be subdivided as follows
- | | |
|---------------------------|----------------------------|
| resinous (dark) vitrinite | 0.23 ± 0.03 (0.18 - 0.30%) |
| vitrinite | 0.34 ± 0.05 (0.24 - 0.45%) |
| gelinitic cells | 0.34 ± 0.05 (0.27 - 0.49%) |

The resinous (dark) vitrinite component could be regarded as
a maceral transitional between vitrinite and liptinite/exinite,
in which case the vitrinite reflectivity value for sample DM-1
would be 0.34%.

APPENDIX

JUMP OUT CREEK AND FIVE FINGERS SAMPLESVITRINITE-RICH COALS:JUMP OUT CREEK AND SAMPLES:

	JC-1	FF-1
MACERAL ANALYSIS		
GROUNDMASS VITRINITE %	trace	55
BAND VITRINITE %	40	20
VITRINITE PARTINGS IN CARBARGILLITE %	17	-
RESINOUS (DARK) VITRINITE %	2	8
TOTAL VITRINITE %	59	83
SPORINITE %	1	2
CUTINITE %	-	-
RESINITE %	trace	6
OTHER LIPTINITE/EXINITE %	a 6	b 1
TOTAL LIPTINITE/EXINITE %	7	7
FUSINITE %	1	trace
SEMIFUSINITE %	3	4
INERTODETRINITE %	1	2
MACRINITE %	-	1
FINE (GRANULAR) MICRINITE %	-	trace
SCLEROTINITE %	-	trace
TOTAL INERTINITE %	5	7
QUARTZ %	-	trace
CARBONATE %	-	trace
CLAY MINERAL %	29	3
SULPHIDE %	trace	-
ALTERED IRON OXIDE %	-	trace
TOTAL MINERAL MATTER %	29	3
(VITRINITE + EXINITE) (m.m.f.) %	93	93

REFLECTIVITY DATA

\bar{R}_0 max % VITRINITE	0.48	0.51
Standard deviation \pm	0.03	0.04
Range of \bar{R}_0 max % values		
VITRINOID TYPES		
V ₄ %	74	30
V ₅ %	26	65
V ₆ %	-	5

BLUE-LIGHT EXCITATION FLUORESCENCE OF LIPTINITE/EXINITE

FLUORESCENCE COLOUR	PALE YELLOWISH GREEN TO YELLOW (FAINT BROWN)	YELLOW TO YELLOWISH ORANGE (ORANGE TO PALE BROWN)
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- a. Principally yellowish-green fluorescent exsudatinitite; minor amounts of weakly fluorescent bituminite. These macerals are concentrated in the clay mineral bands.
- b. Principally liptodetrinite and exsudatinitite.

APPENDIX

VITRINITE-POOR COALS:

DIVISION MOUNTAIN SAMPLES

	DM-1	DM-2	DM-3
MACERAL ANALYSIS			
GROUNDMASS VITRINITE %	20	13	3
BAND VITRINITE %	7	3	3
RESINOUS VITRINITE %	3	2	-
TOTAL VITRINITE %	30	18	6
SPORINITE %	4	5	3
CUTINITE %	trace	trace	trace
RESINITE %	7	1	1
OTHER LIPTINITE/EXINITE %	trace	trace	trace
TOTAL LIPTINITE/EXINITE %	11	6	4
FUSINITE %	1	2	2
SEMIFUSINITE %	41	59	63
VERY LOW REFLECTIVITY SEMIFUSINITE %	2	3	7
INERTODETRINITE %	7	5	6
MACRINITE %	5	6	5
FINE (GRANULAR) MICRINITE %	trace	trace	trace
TOTAL INERTINITE %	56	75	83
QUARTZ %	trace	-	-
CARBONATE %	-	-	-
CLAY MINERAL %	2	1	7
SULPHIDE %	-	-	trace
FILTERED IRON OXIDE %	1	trace	trace
TOTAL MINERAL MATTER	3	1	7
(VITRINITE + EXINITE) (m.m.f.) %	42	24	11
REFLECTIVITY DATA			
\bar{R}_O max % VITRINITE	0.56	0.58	0.64
Standard deviation \pm	0.05	0.04	0.05
Range of R_O max % values	0.41-0.70	0.47-0.72	0.55-0.79
VITRINOID TYPES			
V ₄ %	7	2	-
V ₅ %	73	69	21
V ₆ %	19	27	60
V ₇ %	1	2	19
BLUE-LIGHT EXCITATION FLUORESCENCE OF LIPTINITE/EXINITE			
FLUORESCENCE COLOURS	YELLOWISH-ORANGE TO ORANGE	ORANGE (YELLOWISH ORANGE)	ORANGE (YELLOWISH ORANGE)

HIGH RANK COALS:

	GC-1	PC-1	PC-2	RR-1
MACERAL ANALYSIS				
GROUNDMASS VITRINITE %	-	1	} 82	1
BAND VITRINITE %	3	20		5
TOTAL VITRINITE %	3	21	82	6
FUSINITE %	3	3	} 11	2
SEMIFUSINITE %	82	56		79
LOW REFLECTIVITY SEMIFUSINITE %	8	17	5	7
INERTODETRINITE %	2	trace	} trace	3
MACRINITE %	1	1		2
FINE (GRANULAR) MICRINITE %	-	-	-	trace
TOTAL INERTINITE %	96	77	16	93
QUARTZ %	-	-	-	-
CARBONATE %	-	-	trace	trace
CLAY MINERAL %	1	2	2	1
SULPHIDE %	-	-	-	trace
ALTERED IRON OXIDE %	-	trace	trace	-
TOTAL MINERAL MATTER %	1	2	2	1
(VITRINITE + EXINITE) (m.m.f.) %	3	21	84	6

REFLECTIVITY DATA

\bar{R}_0 max % VITRINITE	2.71	2.79	3.10	1.98
Standard deviation \pm	0.10	0.09	0.09	0.08
Range of R_0 max % values	2.53-2.98	2.67-2.96	2.95-3.25	1.79-2.19
Birefringence	0.97	1.03	0.97	0.59
VITRINOID TYPES				
V ₁₇ %	-	-	-	2
V ₁₈ %	-	-	-	10
V ₁₉ %	-	-	-	44
V ₂₀ %	-	-	-	34
V ₂₁ %	-	-	-	10
V ₂₅ %	12	-	-	-
V ₂₆ %	39	8	-	-
V ₂₇ %	35	51	-	-
V ₂₈ %	8	22	-	-
V ₂₉ %	6	19	15	-
V ₃₀ %	-	-	30	-
V ₃₁ %	-	-	43	-
V ₃₂ %	-	-	12	-

PLATESPLATE ISAMPLE PR-3

- 1a Dark humotelinite (texto-ulminite A transitional to eu-ulminite A) (medium grey) containing dark, resin-filled cell lumens (black) and light corpohuminite (eu-gelinite? cells) (pale grey) (x 500, incident white light, oil immersion)
- 1b As above. Bright fluorescing resin-filled cells, weakly-fluorescent humotelinite and non-fluorescent corpohuminite (gelinitic cells) (x 500, incident, blue-light excitation, oil immersion)
- 1c Suberinite (dark cell-wall tissue), containing corpoluminite (eu-gelinite?) and porigelinite filled cell lumens, associated with humotelinite (eu-ulminite) (x 500, incident, white light, oil immersion)
- 1d As above, bright fluorescing suberinite; non-fluorescent huminite (x 500, incident, blue-light excitation, oil immersion)

PLATE IISAMPLE PR-3

- 2a Humodetrinite (densinite) groundmass containing fungal bodies (multicellular sclerotium and single-celled teleutospores) and inertinite (lower part of photomicrograph) and dark liptinite/exinite and mineral matter (x 500, incident white light, oil immersion)
- 2b As above, brightly fluorescent sporinite and weakly fluorescent suberinite (upper left) and liptodetrinite. Mineral matter is non fluorescent in this photo-micrograph (x 500, incident, blue-light excitation, oil immersion)
- 2c Teleutospores (sclerotinite) in a humodetrinite groundmass. These fungal spores are typical of uppermost Cretaceous (Senonian) and Tertiary coals (x 500, incident white light, oil immersion)

SAMPLE PR-8

- 2d Details of botanical structure in vitrinite (x 500, incident white light, oil immersion)

PLATE IIISAMPLE DM-1

- 3a Semifusinite associated with dark liptinite/exinite or mineral matter (?)
(x 500, incident white light, oil immersion)
- 3b As above, fluorescence behaviour indicates low reflectivity material is liptinite/exinite (resinite)
(x 500, incident, blue-light excitation, oil immersion)
- 3c Narrow band of vitrinite (grey) associated with semifusinite, which is typical of this inertinite-rich coal
(x 500, incident white light, oil immersion)
- 3d Brightly fluorescent cutinite in vitrinite (dark)
(x 500, incident, blue-light excitation, oil immersion)

PLATE IVSAMPLE PC-1

- 4a Vitrinite and semifusinite (cell structure clearly defined)
(x 500, incident white light, oil immersion)
- 4b As above, semifusinite exhibits granular (undulose) anisotropy by comparison with even extinction of vitrinite
(x 500, incident white light, oil immersion, x polarizers)
- 4c Vitrinite, exhibiting oxidation fissures, and semifusinite
(x 200, incident white light, oil immersion)
- 4d As above, granular anisotropy serves to distinguish vitrinite from semifusinite with a similar reflectivity
(x 200, incident white light, oil immersion, x polarizers)

PLATE V

SAMPLE LP-1

- 5a Vesicle structure in coked coal. Note thick coke walls
(x 500, incident white light, oil immersion)
- 5b As above. Fine grained anisotropic mosaic structure
(x 500, incident white light, oil immersion x polarizers)

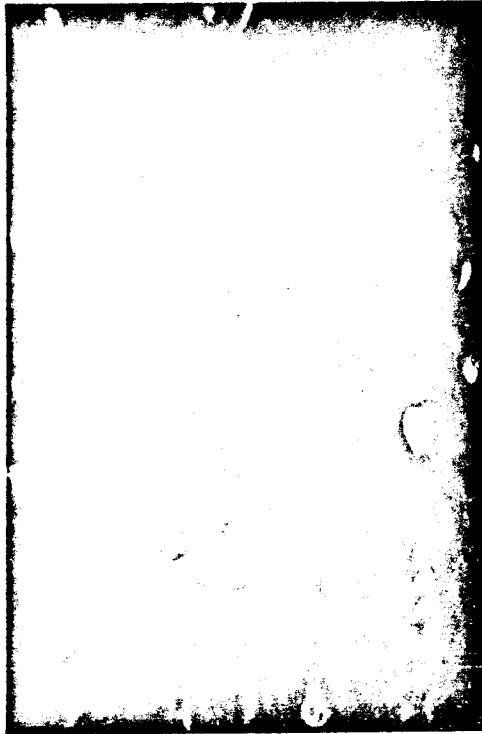
SAMPLE PC-1

- 5c Oxidation cracks and associated lowering of reflectivity in
vitrinite in semianthracite-anthracite
(x 500, incident white light, oil immersion)

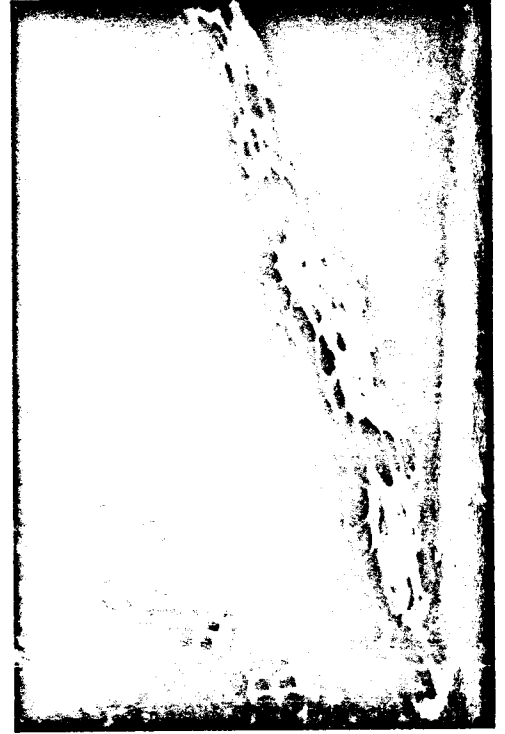
SAMPLE PC-2

- 5d Oxidation cracks and low reflectivity margins in
semianthracite-anthracite vitrinite
(x 500, incident white light, oil immersion)

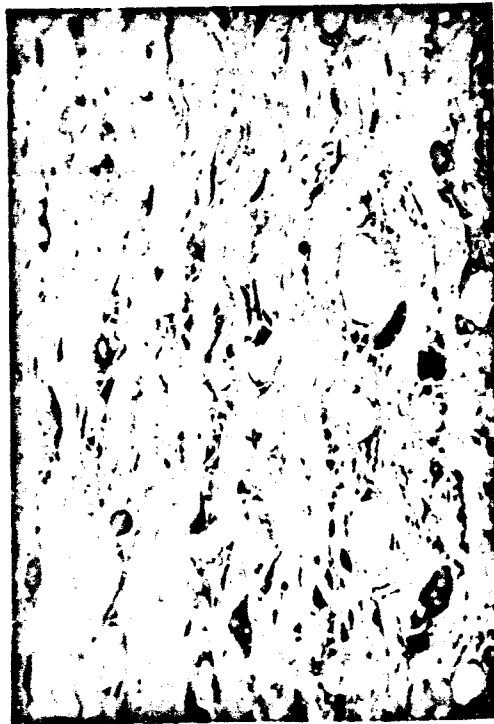
PLATE I



Ib



Id

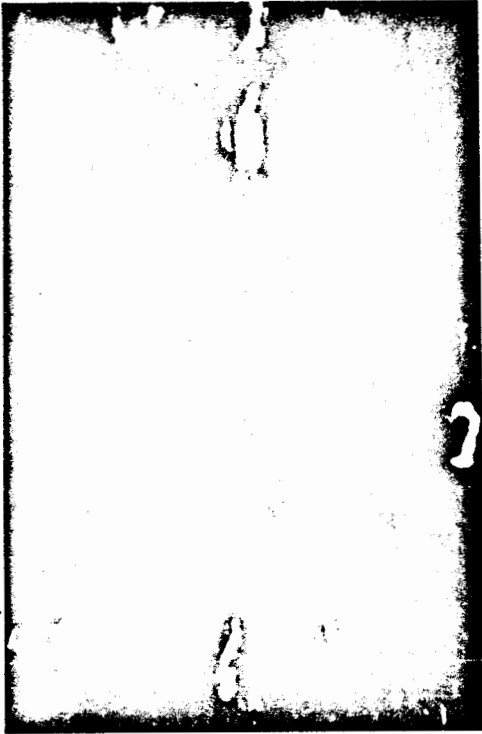


Ia



Ic

PLATE II



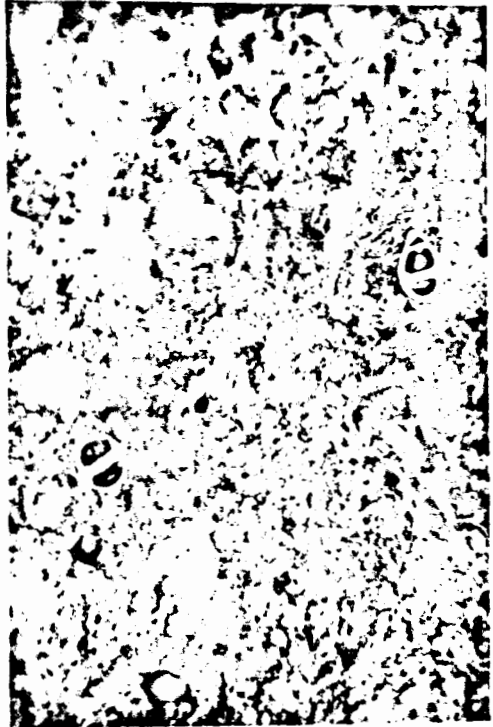
I1b



I1c



I1a



I1c

PLATE III



IIIb



IIIc

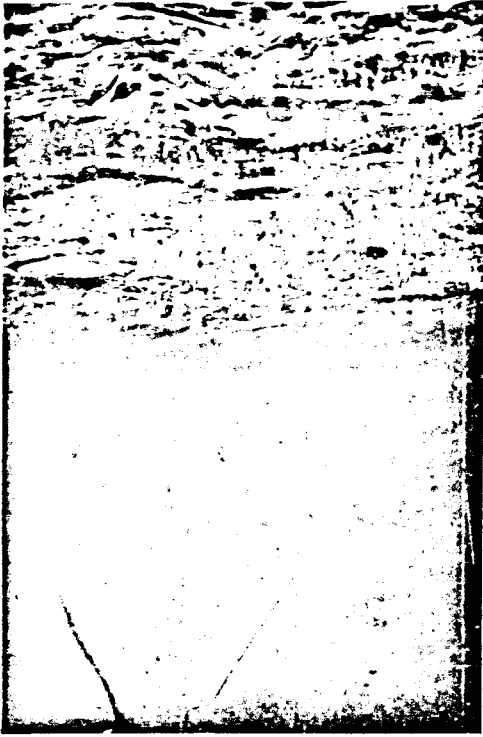


IIIa



IIIc

PLATE IV



IVb



IVc



IVa



IVc

PLATE V



Vb



Vd



Va



Vc