TY - Tuya River 79(1)A

GEOLOGICAL MAPPING OF THE TUYA RIVER PROPERTY, BRITISH COLUMBIA

NTS 104J/2

Coal Licenses 3904-3913 Incl.

PROFESSIONAL GEOLOGIST ALBERTA
BRUCE D. VINCENT

Bruce D. Vincent, P. Geol.
Esso Minerals Canada
Coal Department
Calgary, Alberta

July 30, 1979

SUMMARY

The geological mapping and coal sampling program of the combined Tuya River coal licences of W.E. Kleinhout and Esso Minerals Canada was conducted from June 1 to June 23, 1979. The field work allowed division of the Lower Tertiary Sustut Group into a fine-grained, coal-bearing Lower Member, a coarser-grained, coal-bearing Middle Member, and an Upper Member consisting of interbedded conglomerate and basalt flows. The stratigraphic relationships between the units and their areal extent is not well defined. The structural geology is moderately complex mainly consisting of northerly-trending open folds and minor faults.

The coal is estimated to be high volatile C bituminous in rank. Reserves were not estimated due to insufficient data. The Lower Member coals are in two seams up to 4 metres thick each with the best potential being west of the property. The Middle Member coals are in a zone exposed on the east side of the property with individual seams up to 2 metres thick.

The Tuya River property has the potential of holding coal reserves of the size and quality to be of interest to Esso Minerals. Therefore, it is recommended Esso Minerals retain the option on W.E. Kleinhout's coal licences and continue active exploration. A six-hole diamond drilling program is proposed for the spring of 1980.

INDEX

LIST OF FIGURES AND TABLES

1. INTRODUCTION

1.1 Objective

As part of the obligations of the option agreement between Esso Minerals Canada and Mr. W.E. Kleinhout, a geological mapping program was conducted over Mr. Kleinhout's Tuya River coal licences in June, 1979. The mapping was planned to collect information on the stratigraphy, structural geology, and coal geology on and around the licences. This report documents the findings of the mapping program, provides an interpretation, and assesses the economic potential of the property.

1.2 Location and Access

The Tuya River property is situated in northwestern British Columbia covering portions of NTS map sheets 104J/2 and 104J/7. The approximate center of the property is 46 kilometres southwest and 44 kilometres northeast of the communities of Dease Lake and Telegraph Creek respectively. (See Figure 1.) A gravel road joins those two communities and passes within 1.5 kilometres of the southeastern boundary of the coal licences. An unused trail connects the road and the property. No other vehicular access is present. Airstrips are maintained at both Telegraph Creek and Dease Lake.

The area is 260 kilometres north of Stewart. From Dease Lake, B.C. Highway 37 travels north to Cassair and connects with the Alaska Highway in the Yukon. Southward it joins Highway 16

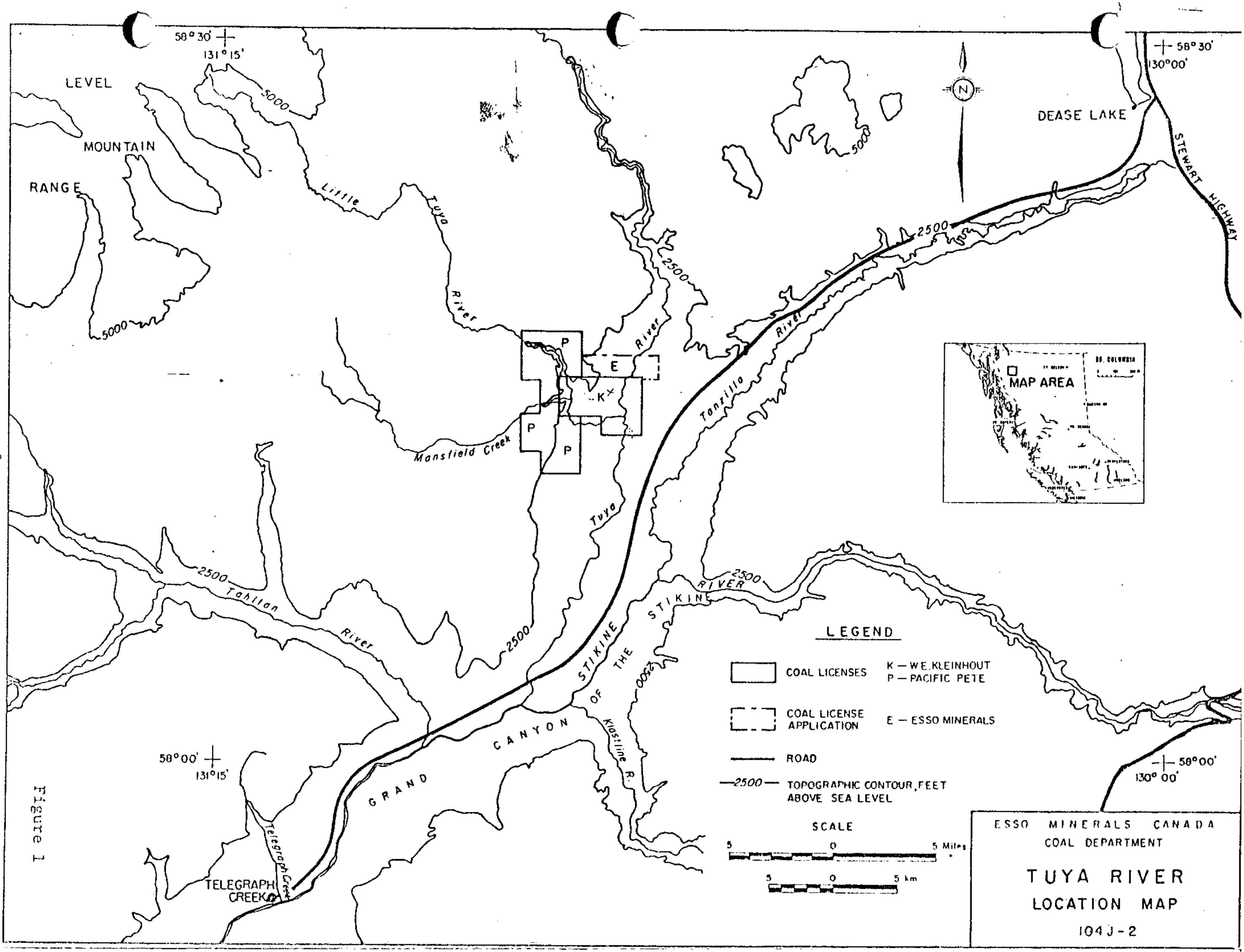

58° 30'
131° 15'
130° 00'
LEVEL
MOUNTAIN
RANGE
DEASE LAKE
STEWART HIGHWAY
N
5000
2500
Little Tuya River
Tuya River
Mansfield Creek
Tanzilla River
Tahltan River
STIKINE RIVER
GRAND CANYON OF THE STIKINE
Klastline R.
Telegraph Creek
TELEGRAPH CREEK
P
E
K
MAP AREA
58° 00'
131° 15'
130° 00'
LEGEND
COAL LICENSES
K — W.E. KLEINHOUT
P — PACIFIC PETE
COAL LICENSE APPLICATION
E — ESSO MINERALS
ROAD
2500 TOPOGRAPHIC CONTOUR, FEET ABOVE SEA LEVEL
SCALE
5 0 5 Miles
5 0 5 km
ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER
LOCATION MAP
104 J - 2

Figure 1

at Terrace and a second road from Stewart joins at Meziadin Junction. The road distance form Dease Lake to Stewart is 340 kilometres.

1.3 Geography

The project area lies within the Stikine Plateau, an area of subdued topography rising into the northeast to the Cassair Mountains and to the southwest into the Coast Mountains. Elevations in the map area range from 490 metres above sea level in the deeply-incised river valleys to over 820 metres on the plateau surface.

Tuya River and its tributaries flow southerly into Stikine River which flows into the Pacific Ocean. At the mouth of the Tuya, the Stikine flows rapidly through the steep gorge known as the Grand Canyon of the Stikine. Tuya and Little Tuya Rivers are also swiftly-flowing rivers, entrenched in valleys up to 200 metres deep. On the plateau surface, drainage is very poor with many areas of swamp. The rest is covered by coniferous to mixed forests.

1.4 Previous Work

One of the first recorded examinations of the Tuya River coal occurrences was by R.D. Featherstonhaugh in 1904 (Dowling, 1915) for the Atlin - Tuya Coal Prospecting Syndicate. A Dr. W. Smitheringale re-examined the coal in 1953 (Dolmage Campell and Associates, 1975) while the first of the more recent geological maps of the region was published in 1957 (GSC, 1957). Subsequently, Gabrielse and Souther (1962), Souther (1972), and the GSC (1974) have updated the geological interpretation of that portion of B.C. Little work has been done on the coal-bearing sediments in the Tuya River area in particular but they have been correlated to formations to the southeast studied by Eisbacher (1974).

1.5 Land Status

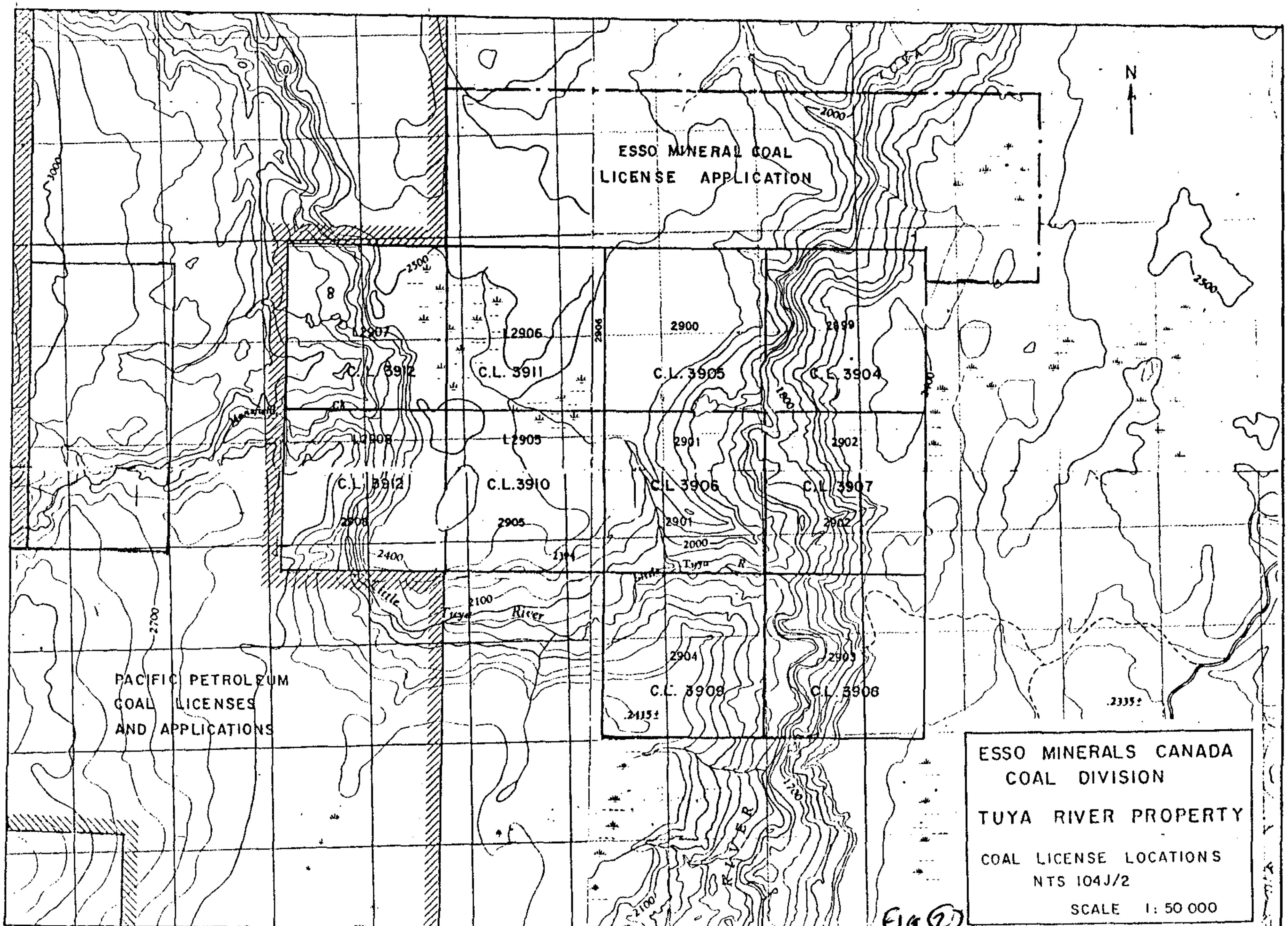
Mr. W.E. Kleinhout was granted ten coal licences totalling 2590 hectares in the Tuya River area on June 23, 1978. The numbers and locations are listed in Table 1 and their locations shown on Figure 2. On May 4, 1979, Mr. Kleinhout and Esso Minerals Canada signed an agreement in which Esso received an option to purchase the coal licences from Mr. Kleinhout and, in return, agreed to pay the licence rental costs and fulfill the exploration obligations as required by the British Columbia Government.

In addition, Esso has applied for four coal licences, approximately 1100 hectares, to the north of Mr. Kleinhout's licences. The descriptions of these are also included in Table 1.

Pacific Petroleums of Calgary had fourteen coal licences to the west of Kleinhout's and Esso's licence area, granted June 23, 1978, and has recently applied for three more licences. Their licence and application area is approximately 11.5 kilometres in length from north to south and 5 kilometres in width for a total area of approximately 3900 hectares. There are no other coal licences or leases in the area.

1.6 Other Features

The only mining operation in the region is that of Cassiar



ESSO MINERAL COAL
LICENSE APPLICATION
N
C.L. 3912
C.L. 3911
C.L. 3905
C.L. 3904
C.L. 3912
C.L. 3910
C.L. 3906
C.L. 3907
C.L. 3908
C.L. 3908
L2907
L2906
L2908
L2905
2900
2901
2902
2899
2904
2903
2905
2906
Little Tuya River
PACIFIC PETROLEUM
COAL LICENSES
AND APPLICATIONS
ESSO MINERALS CANADA
COAL DIVISION
TUYA RIVER PROPERTY
COAL LICENSE LOCATIONS
NTS 104J/2
SCALE 1: 50 000

FIG ②

Coal licenses of W. E. Kleinhout within the Tuya River Area, Cassair Land District, B.C.:

License Number	Surface Lot Number
3904	2899
3905	2900
3906	2901
3907	2902
3908	2903
3909	2904
3910	2905
3911	2906
3912	2907
3913	2908

Coal license applications of Esso Minerals Canada within the Tuya River Area, B.C.:

Within NTS Map 104J/7:

Block B: Portions of Units 25 and 26 not included in coal licenses 3904 and 3905, all of Units 35 and 36. Portions of Units 27 and 28 not included in coal licenses 3904 and 3905, all of Units 37 and 38. Portions of Units 29 and 30 not included in coal licenses 3904 and 3905, all of Units 39 and 40.

Block C: Portions of Units 21 and 22 not included in coal license 3911, all of Units 31 and 32.

Table I. Descriptions of Coal Licenses and Coal License Applications Controlled by Esso Minerals Canada in the Tuya River Area, British Columbia.

Asbestos at Cassiar, north of Dease Lake. There are no other large industrial employers in the area. Electricity is generated locally in diesel-fired units. However, B.C. Hydro has a large crew along the Stikine this summer studying its suitability for a hydro-electric project.

Cassair Asbestos trucks its product to tidewater at Stewart. No rail transportation is available, however, Dease Lake was to be the terminus for a British Columbia Railroad line from Prince George. This project has been postponed indefinitely since the summer of 1977.

2. REGIONAL GEOLOGY

The Stikine Plateau lies within the Intermontane Belt of the Cordillera, an area underlain mainly by Paleozoic and Mesozoic sedimentary and volcanic rocks and flanked by the Coast and Cassair-Omineca Crystalline Complexes. Within the belt are remanents of Late Cretaceous to Early Tertiary sedimentary rocks, such as those at Tuya River, which lie unconformably on deformed Paleozoic and Mesozoic strata. From the Late Tertiary to the Recent, predominantly basic igneous rocks were extruded as plateau basalts, shield volcanoes such as Level Mountain, and complex composite volcanoes such as Mount Edziza (Souther and Armstrong, 1966).

The deformation of the Paleozoic strata ranges from slight to intense with some areas exhibiting more than a single phase of deformation. The Mesozoic rocks are characterized by folding and a multitude of faults. The Tertiary-aged clastic rocks have been faulted, tilted, and folded into generally open folds. No folds have been observed in the Tertiary-Quaternary volcanics, however, faults have offset some Pliestocene and younger lava flows (Gabrielse and Souther, 1962; Souther, 1972). In the Telegraph Creek map area, south of the Tuya River area, the major fault zones are oriented north-south. Souther (1972) believes the system may have been established as early as Late Jurassic and some remained active into the Quarternary.

The coal-bearing Tertiary rocks at Tuya River have been correlated with the Upper Cretaceous to Eocene Sustut Group, the main area of which lies southeast of Tuya River. The Sustut Group was deposited into a non-marine successor basin which was formed during the final phases of the Cretaceous-Tertiary orogenic activity which caused the intrusion and subsequent uplift of the Coast Crystalline Complex and the contemporaneous deformation (Eisbacher, 1974b). Figure 3 shows the regional correlation of Tertiary and Quaternary units of northwestern British Columbia.

The Sustut Group in Sustut Basin proper consists of a lower Tango Creek Formation and an upper Brothers Peak Formation. The Tango Creek Formation is a sandstone-mudstone sequence grading up into the Brothers Peak Formation which consists of pebbly sandstones to coarse conglomerates interbedded with ash-fall tuffs and mudstones (Eisbacher, 1974a).

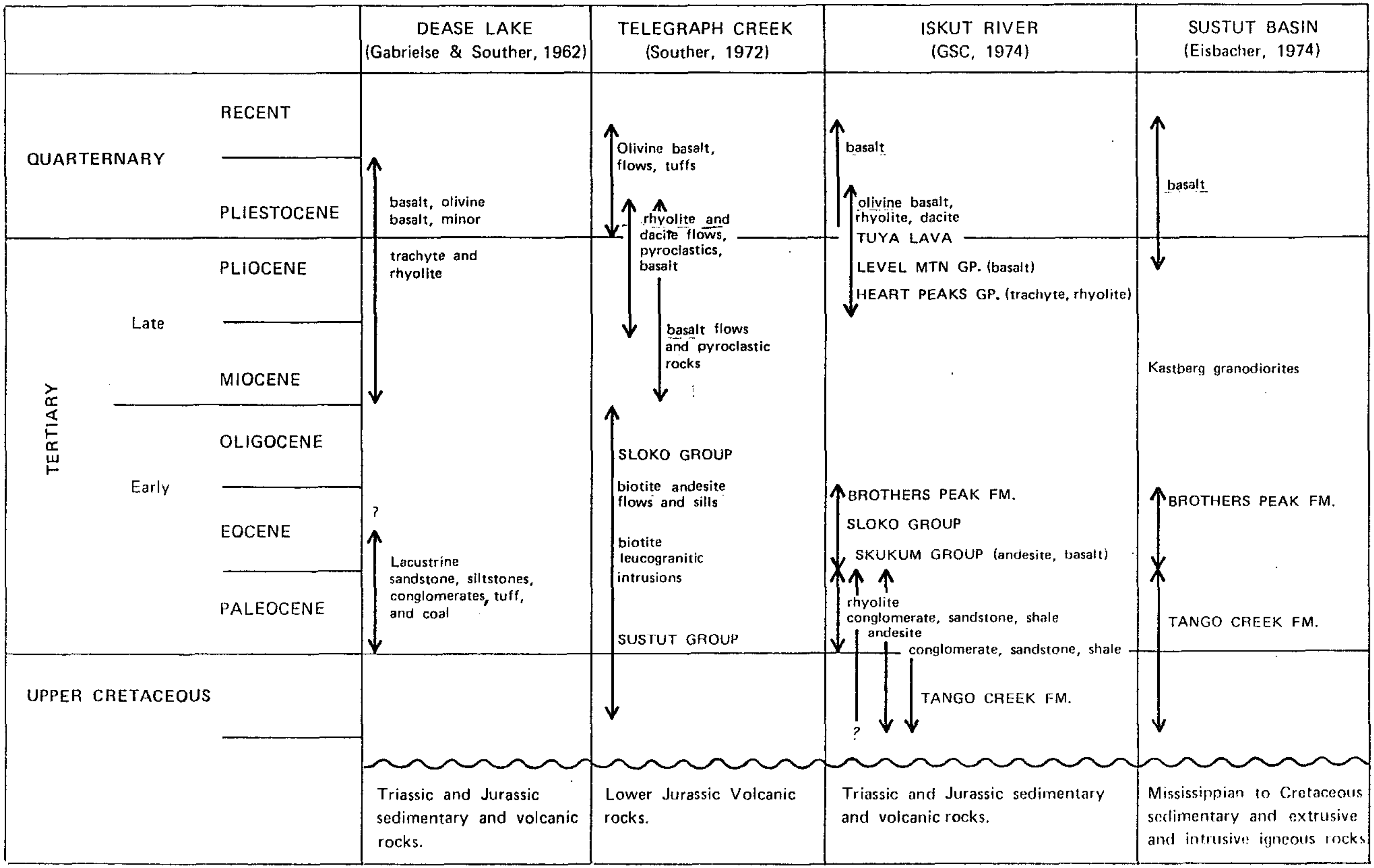


Figure 3. Regional Correlation Chart of Upper Cretaceous, Tertiary, and Quaternary Rocks of Northwestern British Columbia

3. PROPERTY GEOLOGY

3.1 Stratigraphy

The clastic and volcanic rocks on the Tuya River property have been correlated with the Upper Cretaceous-Lower Tertiary Sustut Group (GSC, 1974) as defined by Eisbacher (1974). The Sustut Group of the Tuya River area have been tentatively subdivided into three informal "members" based upon lithologic differences. The characteristics of and the relationships between these members are summarized in Figure 4 and discussed below. The lower contact of the sequence on or near the property is thought to be an unconformity over Triassic-Jurassic sedimentary and volcanic rocks. Unconsolidated Quaternary sediments lie unconformably on the Sustut Group.

The basal or Lower Member is a fining-upward sequence of mudstone, siltstone, sandstone, and coal. A five metre thick basalt flow is present near the middle of the unit. Characteristic of this member in comparison with the higher members is the lack of sedimentary rocks with a grain size larger than coarse grained sandstone. The coal seams of this member appear to be the thickest and to have the least number of partings in the area; the coal occurrences will be discussed further in Section 3.3. The upper contact of the member was placed at the base of the first conglomerate above a siltstone-mudstone sequence. Over the property, the contact is probably gradational. The lower contact was not identified being west of the property.

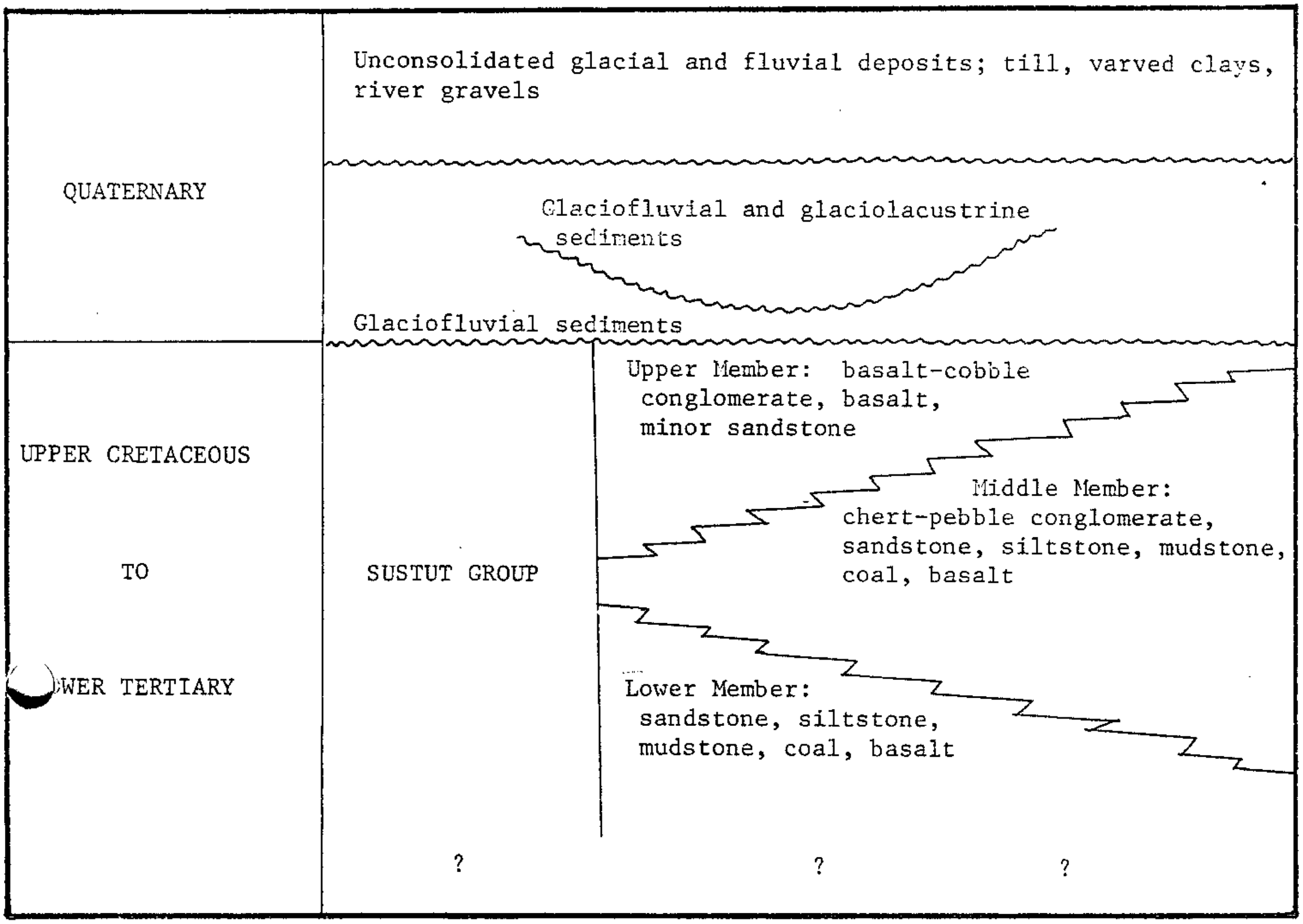


Figure 4. Stratigraphic Column for the Tuya River Property Showing Informal Members of the Sustut Group. No Vertical Scale or Geographic Location Implied.

June 30, 1979

The Lower Member was identified only along Mansfield Creek, a tributary of Little Tuya River. A siltstone-mudstone-coal sequence, located along Little Tuya River, 4 kilometres north of Mansfield Creek, is tentatively correlated with the Lower Member. (See Figure 5.)

The Middle Member consists of chert-pebble conglomerate, sandstone, siltstone, mudstone, and coal. The top of the member is dominantly conglomerate and sandstone grading downward into a mixture of all lithologies with conglomerate still totalling about 50% of the outcrop areas.

The conglomerates are one to seven metres thick and characteristically consist of chert-pebbles with clasts of other lithologies totalling up to 5%. The clastic rocks commonly show repeated fining-upward sequences one to fifteen metres thick. The coal seams may best be described as zones with numerous partings.

The Middle Member-Upper Member contact is gradational, chosen where conglomerate clasts become dominantly basalt cobbles. The thickness is thought to increase from west to east. The Middle Member may be in part laterally equivalent to the Upper and/or Lower Members.

The Upper Member consists of basalt, basalt cobble to boulder conglomerate, and sandstone. The basalt occurs generally as single flows about 10 metres thick. Columnar jointing is common and the upper surfaces are generally vesicular and quartz filled. Occasionally there is a 0.5 to 1.0 metre thick paleosol beneath a flow. The conglomerate clasts are predominantly basalt cobbles to boulders and the matrix is a sandy, black-chert-pebble conglomerates similar to the conglomerates of the Middle Member. Sandstones up to one metre thick, are present within the conglomerates. A single coal seam was found in the area of the gradational contact between the Middle and Upper Members along Little Tuya River.

The Upper Member is found over the northern and western portions of the property. Its thickness and number of basalt flows probably vary over the property.

The top of the Upper Member is an unconformity on which lie erratic but widespread glacio-fluvial sediments of rusty-brown and grey sands and gravels, 0 to 8 metres thick. In a single outcrop, additional 10 metres of glacio fluvial and glacio lacustrine sediments are present and consist of brown sands and gravels and buff varved clays. Superimposed over the whole property is a 1.5 to 20 metres sequence of glacial till and varved clays along with fluvial deposits.

The Sustut Group regionally is a totally non-marine sequence. At Tuya River, a preliminary interpretation of the sequence coincides with the regional paleogeography. The Lower Member could be a meandering or braided fluvial deposit grading upward into a gravel-dominated, braided stream environment in the Middle Member. The Upper Member probably represents alluvial fan deposits contemporaneous with nearby basic volcanic eruptions.

Regional geological maps (Gabrielse and Souther, 1962; GSC, 1974) date the Sustut Group as Upper Cretaceous to Lower Tertiary and any basalt flows as Upper Tertiary to Recent. No dating has been done on the Tuya River Sustut Group but if its upper limit is Eocene, the basalts in the Sustut Group indicate volcanic activity began in the Lower Tertiary as opposed to the Upper Tertiary. A logical source of the volcanic rocks would be the Level Mountain Complex located 35 kilometres to the northwest of the Tuya River property.

3.2 Structural Geology

The structural geology of the Tuya River property appears to be moderately complex. The dip of bedding surfaces range from horizontal to 80 degrees, generally being toward the east or northeast at 25 to 35 degrees. Some folding and faulting was observed and more hypothesized.

(a) Tuya River shear zone - The position of Tuya River appears to be controlled by a zone of fracturing or shearing which strikes approximately north-south, roughly parallel with the orientation of the river valley. Where the Sustut rocks are exposed along bends of the river, they are highly fractured with displacement of less than one metre to a few metres along several fracture planes. Quartz and calcite veining or vug filling is founded near the fracture planes. Overall displacement along the shear zone is probably in the order of 10 metres; similar lithologies are present on both sides of the assumed trace of the zone.

Two examples of the shear zone, represented by numerous minor faults, are at the southern boundary of Lot 2903 and along the major bend in the river in Lots 2901 and 2902. (See Figure 5.)

The fracturing is most intensive in the coal seams and mudstones. The coals have been highly jointed and fractured. The mudstones exhibit both brittle and ductile deformation along the shear planes. In the more competent lithologies of conglomerate and sandstone, the shear zone appears as an area of jointing more intense than in adjacent strata

(b) *Mansfield Creek folds and fault* - Along Mansfield Creek, at the western boundary of lot 2908, a normal fault zone dipping 55^{o} southeast was observed in the Lower Member sandstone-siltstone sequence. The fault is poorly exposed but thought to consist of several planes some of which have been filled with quartz viens a few centimetres thick. Above the fault is an easterly-dipping basalt flow and below, the sandstone-siltstone sequence is folded into a gentle open anticline, possibly a result of the faulting. One half kilometre west is a syncline with a 200 metre wavelength. In the syncline is a basalt correlative to the flow in the hanging wall of the fault. This structure is shown in Figure 6.

(c) Little Tuya River folds - A sequence of syncline-anticline-syncline was interpreted to be present along the easterly-flowing portion of Little Tuya River. These open folds may be used to tie the geology of the eastern and western parts of the property together. Their trend is approximately north-south, however there are no exposures which verify the existance of these folds or their orientation.

(d) Other tectonic deformation - The linearity of Little Tuya River, Mansfield Creek and some tributary streams suggest they also may be controlled by some type of tectonic deformation. The trends are generally east-west or north-south, plus or minus 15°. A number of other minor faults striking north or northeast were observed along Tuya and Little Tuya Rivers.

The hypothesis of a north-south trending, Tuya River shear zone and tectonic controls on the Little Tuya River are reinforced by the existance of regional northerly-striking faults in the Telegraph Creek map area immediately south of Tuya River (Souther, 1972). These faults found to the south were active from the Jurassic into the Quaternary, a situation which could have been duplicated in the Tuya River area.

(e) Glacial thrusting - In an outcrop two kilometres up Little Tuya River from the northern boundary of Lot 2907, a coal seam has been thrust over itself during a phase of glaciation. A single failure plane dips gently to the west and displacement was in the order of a few tens of metres from west to east. Drag folding extends vertically for about one metre below the fault plane.

To the east where the displaced seam is not present, the surface of the in-place seam is broken and crenulated at its contact with the overlying till indicating previous contact with the glacial ice.

(f) Surficial deformation - A large number of rotational landslides or slumps are present along the valleys of Tuya and Little Tuya Rivers. (See Figure 4.) The slumps are from small to large and commonly are imbricate (multiple).

One of the best examples is the large slump on the west bank of Tuya River which covers large portions of Lots 2900 and 2901.

Combined with the slumps on the east side of the river, the outcrops of the area must be viewed with some suspicion.

3.3 Coal Occurrences

The coal seams outcropping in the Tuya River map area can be grouped according to stratigraphic position and geographic location and the following discussion is so arranged. Graphic logs of the seams examined in detail are included in Appendix II.

Lower Member coals:

Along Mansfield Creek, some of the best coal in the area is exposed on the western boundary of Lot 2908 and west of that on Pacific Petroleums' property. There are seams present above and below a basalt flow (the flow correlated across the fault zone). These seams were not examined in detail and thicknesses are only approximate. The seam below the basalt seems to vary from 2 metres thick with partings in outcrop B53 to 3 metres thick in outcrop B54. It was also observed in outcrops B55 and B56. Above the basalt flow, the upper seam is thought to be 4 to 5 metres thick.

At outcrop B62 in the northwest corner of the map area, two seams are separated by 1.15 metres of dark grey mudstone. The upper one is 1.5 metres thick with one parting of 5 centimetres of shaley coal, is dominantly attrital coal, and has numerous globular masses of resin up to 1 centimetre in diameter. The lower seam floor is brown-grey mudstone in sharp contact with 20 centimetres of sideritic coal. The main seam above that is 1.45 metres thick with minor iron staining on the joints.

Middle Member coals:

In the lower part of the Middle Member along Mansfield

Creek, coal is present only as lenses a few centimetres thick.

In outcrop W28 on Little Tuya River near its confluence with the Tuya, 10 centimetre and 30 centimetre thick coal seams are separated by 20 centimetres of brown coaly mudstone.

South of the Little Tuya along Tuya River, outcrops B33 and B38 contain coal seams. A total of three seams of coal and/or shaley coal were observed but not measured in detail. The thickness of each is about 1 metre and the two which are exposed in one outcrop are about 3 metres apart stratigraphically. Slumping and faulting make the relative positions of these seams indeterminate.

Further north on the Tuya, at the common corner of Lots 2899, 2900, 2901, and 2912 are the greatest concentration of coal outcrops in the map area. The faulting and the large scale slumping has made seam correlation over the area nearly impossible and the outcrops unreliable.

In outcrop B24 there is a sequence of coal and mudstone which could be properly called a coal zone. At the south end and base of the outcrop are four seams of 10 to 30 centimetres thickness over 1.7 metres. Five to 10 metres stratigraphically above that is a 40 centimetre seam, a 10 centimetre parting and a 1.0 metre seam. Two to four metres above that are 4 seams, 20 to 40 centimetres thick over 1.8 metres. The coal is 20% to 100% vitrain with very little to no fusain. The joint surfaces in the vitrain is commonly faceted to produce circular surfaces termed "eye coal" (Schopf, 1960). Iron staining on the joints in the coal is common and calcite less common. These seams are thought to correlate with seams in outcrop W23 on the west side of the river.

Outcrop B25 just to the south of B24 contains a seam 2.15 metres thick which includes a 0.1 and a 0.2 metre thick parting. Three additional thin seams are present below that. On the same side of the river outcrops B26, B27, and B28 all include coal seams but all are poorly exposed and each individual seam is less than 1 metre thick.

On the west side of the river a 6 metre sequence in outcrop W23 contains numerous coal seams of 0.1 to 0.7 metres thickness. These seams generally appear dirty with shale partings and iron staining on the joint surfaces.

To the south in outcrop W24, 4 seams, 0.5 to 0.7 metres thick, total 2.35 metres of coal over 3.6 metres of section. The coal components again are vitrain and attrital coal with iron staining on the joint surfaces. An additional 0.6 metre seam is present in outcrop W26 further south.

Upper Member coals:

The only coal seam found in rocks assigned to the Upper Member was in outcrop W12f. Over 1.1 metres of section there is a sequence of coal (total of 0.5 m), shaley coal, and mudstone. The amount of fusain in the coal is much higher in this seam than others in the area.

ADDENDUM TO STRATIGRAPHY

The Paleontology Division of Esso Resources Production Research Department has separated and identified pollen from the Tuya River coals. Small portions of a few coal channel samples were submitted for palynological examination and all contained abundant and well-preserved pollen and all proved to be of Early Eocene age.

The sample numbers, outcrop of origin, and characteristics are listed below.

1. Samples W3 and W4, outcrop W12f, Upper Member: characterized by common small tricolporate pollen, common Osmunda and taxodoids.
2. Samples W8 and W9, outcrop W23, Middle Member: characterized by abundant medium-sized bisaceates, small older pollen.
3. Sample W25, outcrop B26, Middle Member: characterized by abundant Laevigatosporites and moderate fungi, rare metasequoia pollen.
4. Sample W28 and W29, outcrop B24, Middle Member: similar to sample W25.

REFERENCE: Memo from Frank L. Staplin to B.D. Vincent entitled "Tuya River Property Coals", August 28, 1979.

4. COAL QUALITY

Channel samples were taken of selected coal seam outcrops during the mapping program but as yet have not been analyzed. The analyses and interpretations will form another report later this year.

The only analyses available for Tuya River date from 1904 and 1953 and are as follows on an "as received" basis:

	Featherstonhaugh, 1904 (Dowling, 1915)	Smitheringale, 1953 (Dolmage Campbell and Assoc, 1975)
Moisture	11.35%	16.9%
Ash	9.92%	5.1%
Volatile Matter	28.36%	35.6%
Fixed Carbon	49.22%	42.4%
Sulphur	1.15%	0.9%
Calorific Valve	11,401 BTU/lb	9680 BTU/lb

Using the standard Parr formulas for computations, the moist, mineral-matter free calorific values in BTU/lb for the 1904 and 1953 analyses are 12,704 and 10,250 respectively. The first indicates a rank of high volatile C bituminous and the second subbituminous B.

The value of these analyses are limited. An optimistic estimate of the rank is high volatile C bituminous. This will decrease with the amount of ash included from partings. The raw coal quality may be 10 to 15% moisture, 5 to 10% ash, 0.9 to 1.2% sulphur, and 10,000 to 11,000 BTU/lb. Again, these figures will vary with the amount or number of partings included in a sample.

5. COAL RESERVES

Insufficient control on the positions, thicknesses, and lateral continuity of the coal seams and on the structural geology of the Tuya River property was obtained during the mapping program due to the lack of outcrops to calculate even speculative coal reserves. However, a few comments may be made on the reserve potential.

The coal seams in the Lower Member, as exposed along Mansfield Creek, appear to dip rapidly to depths of 600 metres under the surface of the Tuya River property. Assuming constant stratigraphic thicknesses, the Lower Member seams are laterally continuous, and the structural interpretation of Figure 6 is true, the minimum cover over the Lower Member coal seams would be between 200 and 300 metres. These seams have their best potential west of Mr. Kleinhout's coal licences on Pacific Petroleums' property where they should be nearer surface, possibly surface mineable.

These Lower Member seams could be nearer surface on the Tuya River property if faulting as opposed to folding is present between the Little Tuya and Tuya Rivers. Other possibilities are that the stratigraphic thicknesses could vary or the members laterally interfinger with each other. These situations could cause the coal seams to be at unexpected elevations, pinch out, or laterally grade into the coals of the Middle Member.

Along Tuya River, the Middle Member coal zone or zones is in the northern third of the property. Because of the presence of the shear zone and the large slumps in the valley walls, the correlation of seams, their orientation, and their lateral continuity cannot be estimated. Assuming the seams are in their approximately true location at river level, they are about 200 metres below the surface of the surrounding plateau. No estimate can be made on where the seams intersect the plateau surface if they do at all.

It is possible the Middle Member seams coalesce into thicker seams or, alternatively, their lateral extent may be limited by lateral facies changes. The Middle Members' seams exposed on Tuya River at the south end of the property may thicken and become more attractive. Presently, any extension of Middle Member seams appears to lie within the Tuya River property.

Overall, the property could hold substantial in-place reserves of subbituminous to high volatile bituminous coal. Further definition of the reserves is possible only with additional exploration.

6. CONCLUSIONS

The combined Tuya River coal properties of W.E. Kleinhout and Esso Minerals Canada have the potential of holding substantial in-place coal reserves. The coal is estimated to be high volatile C in rank with 5 to 10% ash, 0.9 to 1.2% sulphur, and 10,000 to 11,000 BTU/lb.

Outcrops of the area are insufficient to estimate the number or extent of coal seams. However, the Lower Member coals appear to be nearest surface to the west of Kleinhout's licences in the area controlled by Pacific Petroleums. The Middle Member coal zone have their best potential in the area held between Kleinhout and Esso Minerals.

It is concluded that the Tuya River property contains coal of suitable quality and sufficient thickness to warrant further exploration.

7. RECOMMENDATIONS AND PROPOSAL

It is recommended Esso Minerals Canada retain the option on W. E. Kleinhout's Tuya River coal licenses, fulfill the obligations, and maintain in good standing any other licenses granted to Esso in the area. Additional exploration, which will meet the following objectives, should be conducted over the Tuya River property:

1. Stratigraphic unit identification should be verified and thicknesses, lithologies, and distributions must be better defined.

2. True coal seam thicknesses must be determined along with seam correlations and their areal extent. Coal samples must be obtained which will provide more accurate analyses than will outcrop samples.

3. Information must be gained in order to more accurately interpret the structural geology.

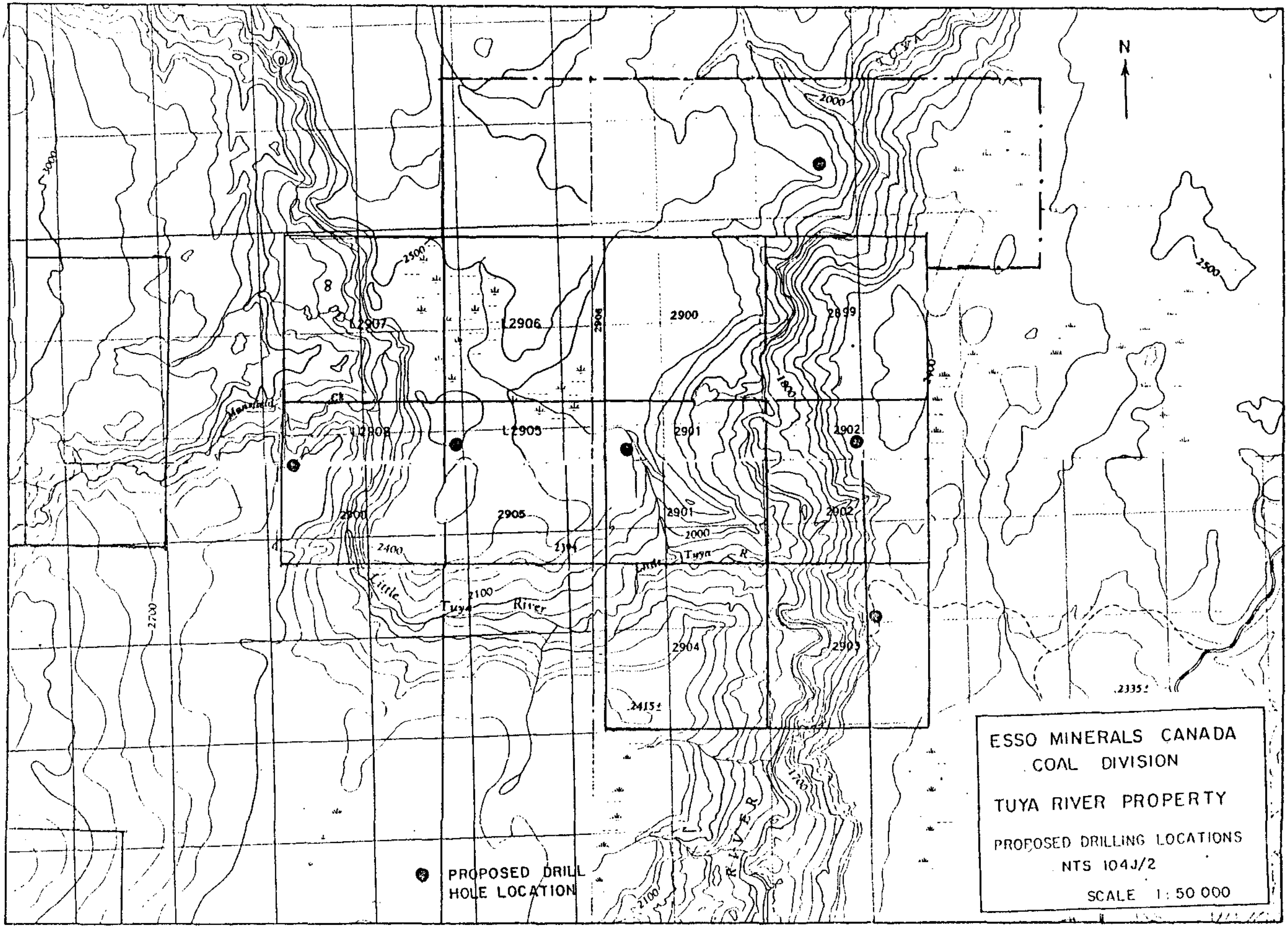
4. Exploration must be done prior to June 23, 1980 in order to meet the British Columbia Government's work obligation.

The following proposal will meet the above objectives. Six drill holes, located as shown in Figure 7, with coring and geophysical logging would be sufficient for a preliminary phase of exploration.

Mr. O. D. Gorgichuk has recommended the drilling to be done by diamond drilling and continuous coring. The drilling rig would be moved by helicopter; drilling would total 1500 metres or 250 metres per hole; and downhole geophysical logging with gamma, density, and resistivity tools would be done. Accommodations would be in a hotel. Mr. Gorgichuk's estimated costs for such a program are:

Drilling	$100,000
Helicopter	45,000
Logging	16,000
Room and Board	4,000
Mobilization and Demobilization	5,000
Miscellaneous	8,000
TOTAL =	$178,000

He estimates the program would last 21 days and would be best conducted in July, August, or September; September being the best.



N
2000
2500
L2907
L2906
2904
2900
2899
1800
L2908
L2905
2901
2902
2906
2905
2400
2000
Little Tuya R
Little
Tuya
River
2904
2903
2700
3000
2100
ESSO MINERALS CANADA
COAL DIVISION
TUYA RIVER PROPERTY
PROPOSED DRILLING LOCATIONS
NTS 104J/2
SCALE 1:50 000
PROPOSED DRILL HOLE LOCATION

REFERENCES

Dolmage Campbell and Associates

1975: "Thermal Coal Resources of British Columbia, Volume V, Northern Coalfields of the Interior Belt of British Columbia", p. 27.

Dowling, D.B.

1915: "Coal Fields of British Columbia", GSC Memoir 69, p. 350.

Eisbacher, G.H.

1974a: "Sedimentary History and Tectonic Evolution of the Sustut and Sifton Basins, North-Central British Columbia"; GSC Paper 73-31, p. 57.

1974b: "Evolution of Successor Basins in the Canadian Cordillera"; in Dott, R.H., Jr., and Shaver, R.H. (Eds.), "Modern and Ancient Geosynclinal Sedimentation"; SEPM Spec. Pub. 19, pp. 274-291.

Gabrielse, H. and Souther, J.G.

1962: "Dease Lake, British Columbia", GSC Map 21-1962.

Geological Survey of Canada

1957: "Operation Stikine: Stikine River Area, British Columbia"; GSC Map 9-1957.

1974: "Iskut River"; Open File #214.

Schopf, J.M.

1960: "Field Description and Sampling of Coal Beds"; U.S.G.S. Bull. 1111-B, p. 70.

Souther, J.G.

1972: "Telegraph Creek Map-area, British Columbia" GSC Paper 7-44, p.38 with GSC Map 11-1971.

Souther, J.G. and Armstrong, J.E.

1966: "North Central Belt of the Cordillera of British Columbia" in "Tectonic History and Mineral Deposits of the Western Cordillera"; CIMM Spec. Publ. Vol. 8, pp. 171-184.

STATEMENT OF QUALIFICATIONS

Bruce D. Vincent

This is to certify that I obtained a Bachelor of Science Degree in Geology from the University of New Brunswick in 1974 and a Master of Science Degree in Geology at the University of Alberta in 1974.

I am registered with the Association of Professional Engineers, Geologists, and Geophysicists of Alberta as a Professional Geologist.

My experience was gained during university by geological mapping in New Brunswick and Alberta. Since 1977, I have been employed as a coal geologist with Esso Minerals Canada and have been actively engaged in coal exploration during that period.

Bruce D. Vincent, P. Geol.
June 30, 1979

PROFESSIONAL GEOLOGIST
BRUCE D. VINCENT
ALBERTA

STATEMENT OF QUALIFICATIONS

Peter M. Waters

This is to certify that I obtained a Bachelor of Science Degree in Geology from the University of Alberta in 1978 and I am presently enrolled in a Master of Science program at the same university.

My relevant experience has included geological mapping in Newfoundland, Quebec, and various parts of British Columbia.

Peter M. Waters

Peter M. Waters
June 30, 1979

APPENDIX I

1979 EXPLORATION PROCEDURES AND COSTS

1979 EXPLORATION PROCEDURES

The geological mapping program over the Tuya River property was conducted from June 1 to June 23, 1979. The mapping party consisted of Peter M. Waters (Party Chief), Jane C. Broatch (Senior Assistant), and Roberta L. Donald (Junior Assistant), all geology students along with staff member James J. Lehtinen (Junior Assistant). Direct supervision was by Bruce D. Vincent (Project Geologist).

The field party was based at Tenajon Center, Eddontenajon Lake. Transportation to and from the field each was supplied by an Associated Helicopters Bell 206B contracted to Esso Minerals. Daily work consisted of standard geological mapping of all outcrops and detailed measurement and sampling of most coal seams or coal-bearing zones. Traverses were plotted in the field on approximately 1:30,000 air photos and were transferred to a 1:10,000 topographic base map.

The outcrops are strictly limited to the river valleys which in turn restricts the amount of structural and stratigraphic information available. Otherwise field conditions were fairly good. Three and one-half days were lost due to bad weather. The rivers were very high at the beginning of the program and additional outcrops were exposed late in the mapping. The snow cover was gone from the area by the first of May.

1979 EXPLORATION COSTS

The following is a list of costs incurred during the 1979 exploration program as compiled by Brian E. Nowak.

On-Property Costs

Salaries, Wages, and Benefits		
Professional Staff	$ 6,281.76	
Field Base Costs		
Tenajon Motel, Iskut	$ 5,352.92	
Helicopter Fuel	996.33	1
Supplies	147.98	
Transportation		
Truck rental	850.00	
Helicopter charter	10,888.29	11
Travel Expenditures		
To and from field	2,475.17	2.5
Subtotal	$26,992.45	

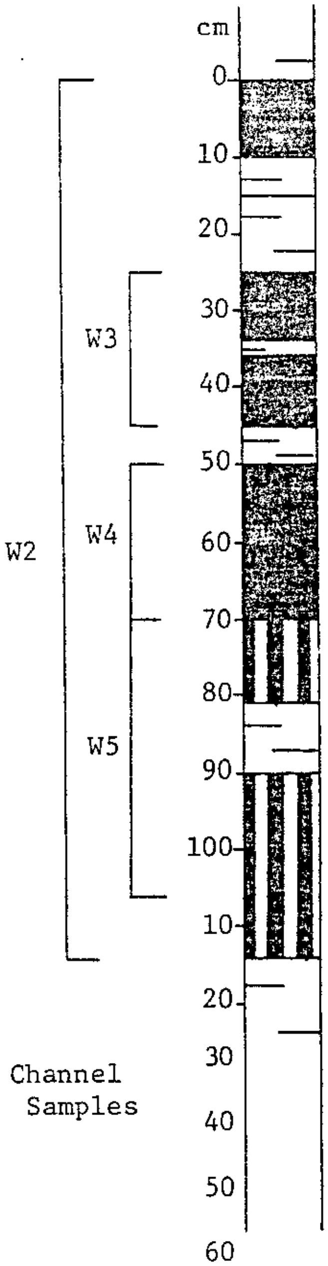
Off-Property Costs

Logistics and field support	1,437.01
Report preparation	1,683.71
Total Expenditures	$30,113.21

STOFF & EXP 11.5
TSP 14.5

APPENDIX II

GRAPHIC LOGS OF COAL SEAMS



Medium grey mudstone to medium grain sandstone.

COAL -- 90% vitrain, 10% attrital; bright thick vitrain bands.

Coaly mudstone.

Mudstone.

COAL - 50% vitrain, 10% fusain, 40% attrital, iron stain on joints.

Mudstone.

COAL - 10% vitrain, 90% fusain; iron stain on joints in fusain.

COAL - 10% vitrain, 50% fusain, 40% attrital; moderately thickly banded vitrain, moderately bright; fusain and attrital coal silky and iron stained.

Shaley COAL.

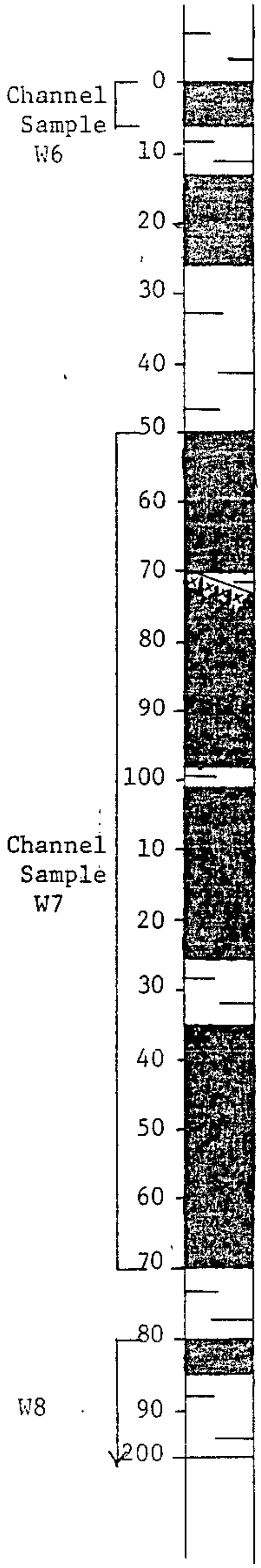
Grey brown mudstone.

COAL with abundant mudstone partings.

Medium grey mudstone.

June 30/79

Outcrop W23, Middle Member; Page 1/2



Medium grey mudstone with sideritic nodules.

COAL - 100% attrital, yellow staining.

Brown mudstone.

COAL - 50% attrital, 35% vitrain, 15% mudstone; iron-staining on cleats.

Brown mudstone.

COAL - 10% vitrain, 80% attrital, 10% mudstone; iron and sulphur staining on cleats; presence of resin.

Brown mudstone.

COAL - 5% vitrain, 85% attrital, 10% ironstone (xxx); iron-stain on joints.

Brown mudstone.

COAL - 30% vitrain, 50% attrital, 20% shale; iron and sulphur staining on joints.

Brown mudstone.

COAL - 10% vitrain, 90% attrital; iron staining on cleats.

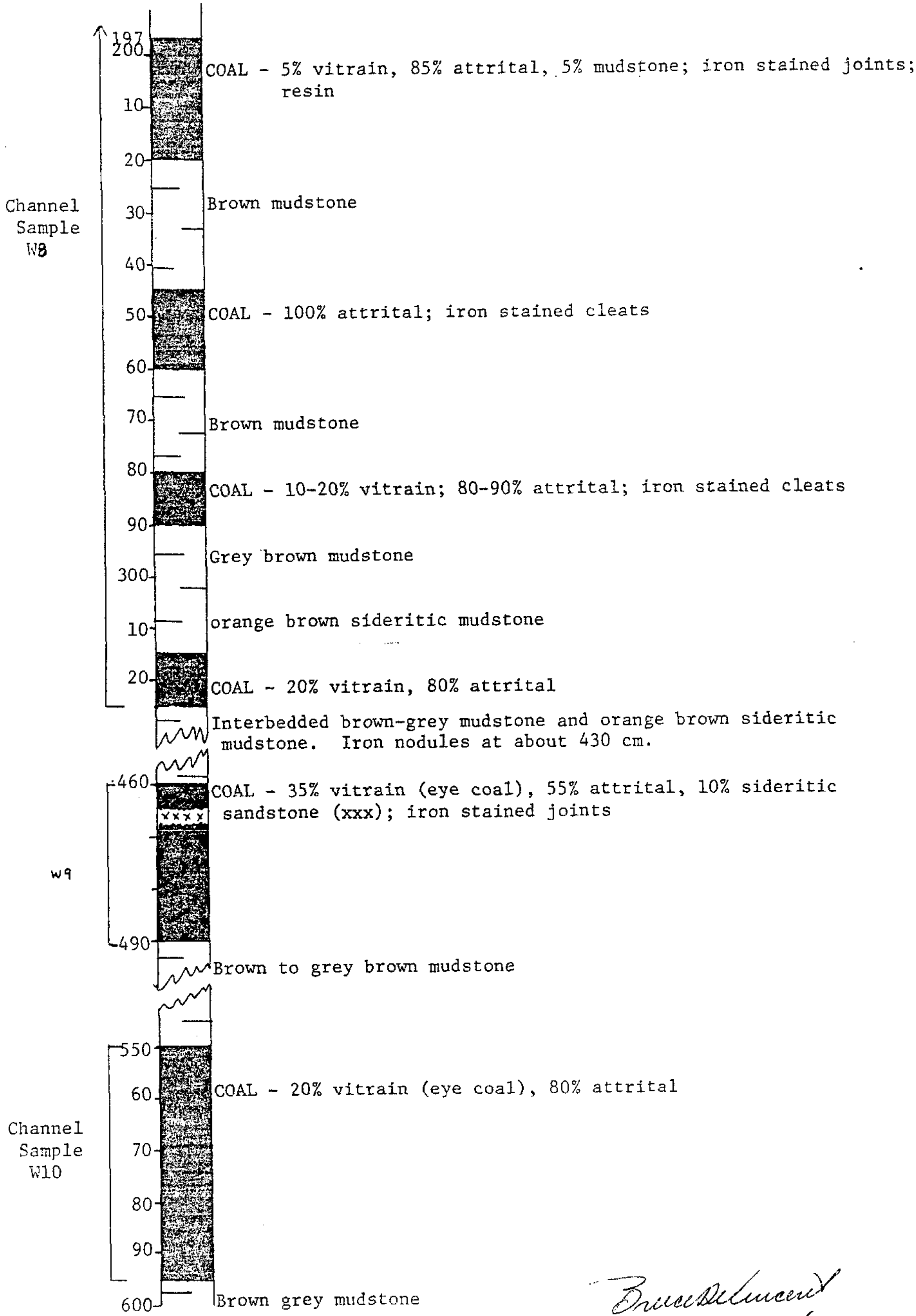
Brown mudstone.

COAL - 50% vitrain, 50% attrital; iron stained joints.

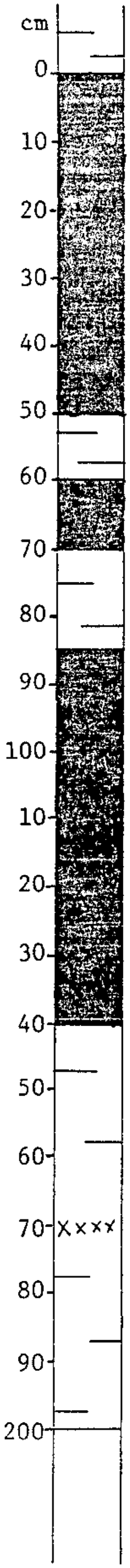
Brown grey mudstone.

June 30/79

Outcrop W23; Middle Member; Page 2/2



Bruce DeLuca... (signature)
June 30/79



Orange to brown grey mudstone, moderately soft

COAL - 50% vitrain (eye coal), 50% attrital; iron stained joints, calcite on joints

Brown mudstone

COAL - 40% vitrain, 60% attrital, iron stained on joints

Brown mudstone; moderately soft

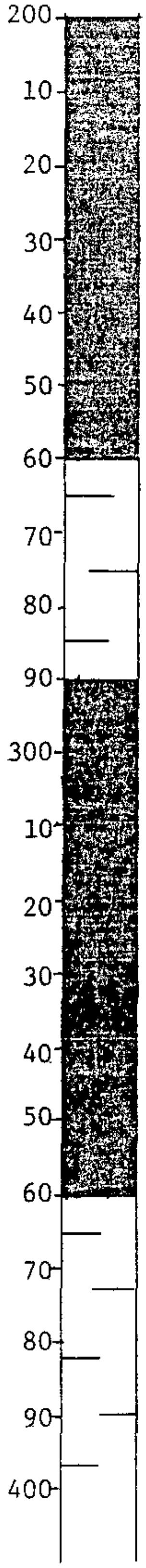
COAL - 20% vitrain, 80% attrital

Grey brown to orange brown mudstone

Siderite nodules

B.D. Vincent
June 30/79

Outcrop W24; Middle Member; Page 2/2



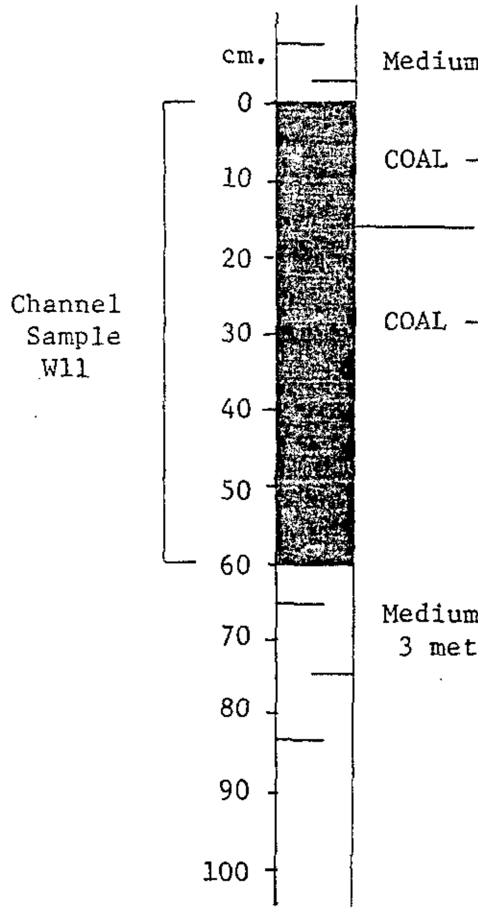
COAL - 50% vitrain (eye coal), 50% attrital

Brown mudstone

Brown grey mudstone; 0.9 m + thick; moderately soft

B.A. Vincent
June 30/79

Outcrop W26; Middle Member, Page 1/1



Medium grey mudstone, moderately hard; plant debris

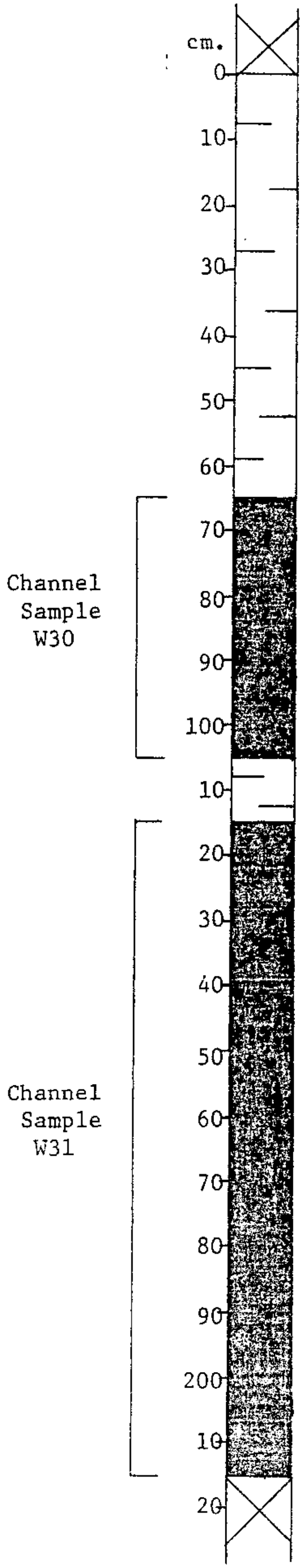
COAL - 100% vitrain; iron stained joints; massive and blocky

COAL - 20% vitrain, 80% attrital; massive and blocky, not strongly weathered

Medium grey to brown grey mudstone and silty mudstone; 3 metres + thick; moderately soft.

B D Vincent
June 30/79

B24b is 5 to 10 metres above B24a.



COVERED

Brown to dark brown coaly mudstone; 20% vitrain as 1 to 3 cm lenses

COAL - 100% vitrain (eye coal); very massive and tough; calcite on joints

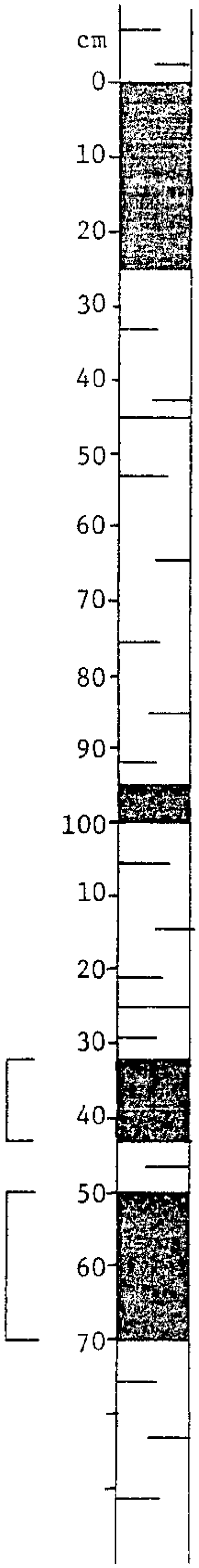
Rustbrown sideritic mudstone; very hard

COAL - 20% vitrain, 80% attrital; poorly exposed, possibly some parting not observed

COVERED

B. Vincent
June 30/79

Outcrop B24a; Middle Member; Page 1/1



Light brown sideritic mudstone; 10 to 15 cm. exposed; hard

COAL - 10% vitrain, 90% attrital; iron stained joints

Brown mudstone, soft

Brown to dark brown coaly mudstone
10% vitrain as 1 to 3 cm bands or lenses

COAL - 80% vitrain, 20% attrital; iron stain and calcite on joints

Brown to dark brown coaly mudstone

Rustbrown coaly mudstone

COAL - 80% attrital, 20% mudstone; ironstain on joints

Brown to dark brown coaly mudstone

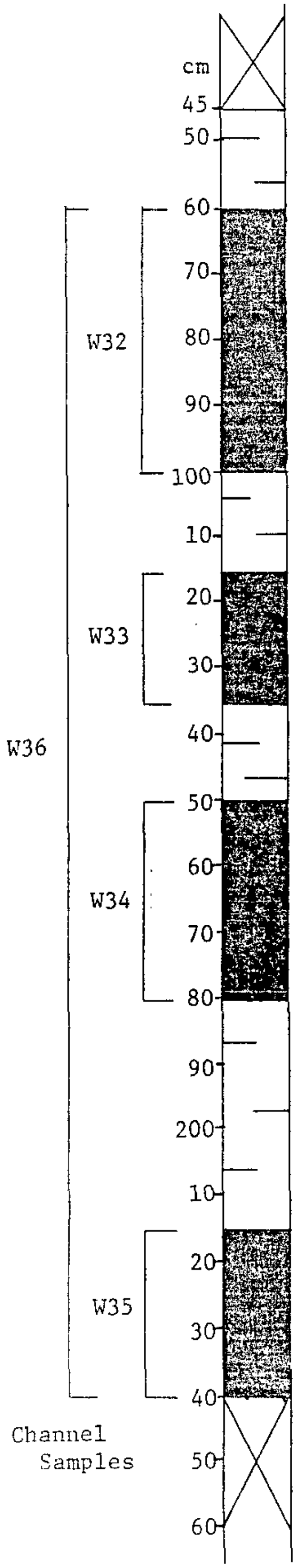
COAL - 20% vitrain, 80% attrital; iron and white stain on joints

Light grey-brown sandy mudstone; one metre exposed; soft

Channel Sample W29

B. Vincent
June 30/79

B24c is 2 to 4 metres above B24b.



COVERED

Brown coaly mudstone

COAL - 20% vitrain, 50% attrital, 30% mudstone

Dark brown mudstone

COAL - 20% vitrain, 60% attrital, 10% mudstone; iron stain on joints

Medium to dark brown mudstone; 20% vitrain as 1 cm. bands

COAL - 10% vitrain, 90% attrital coal; iron stain on joints

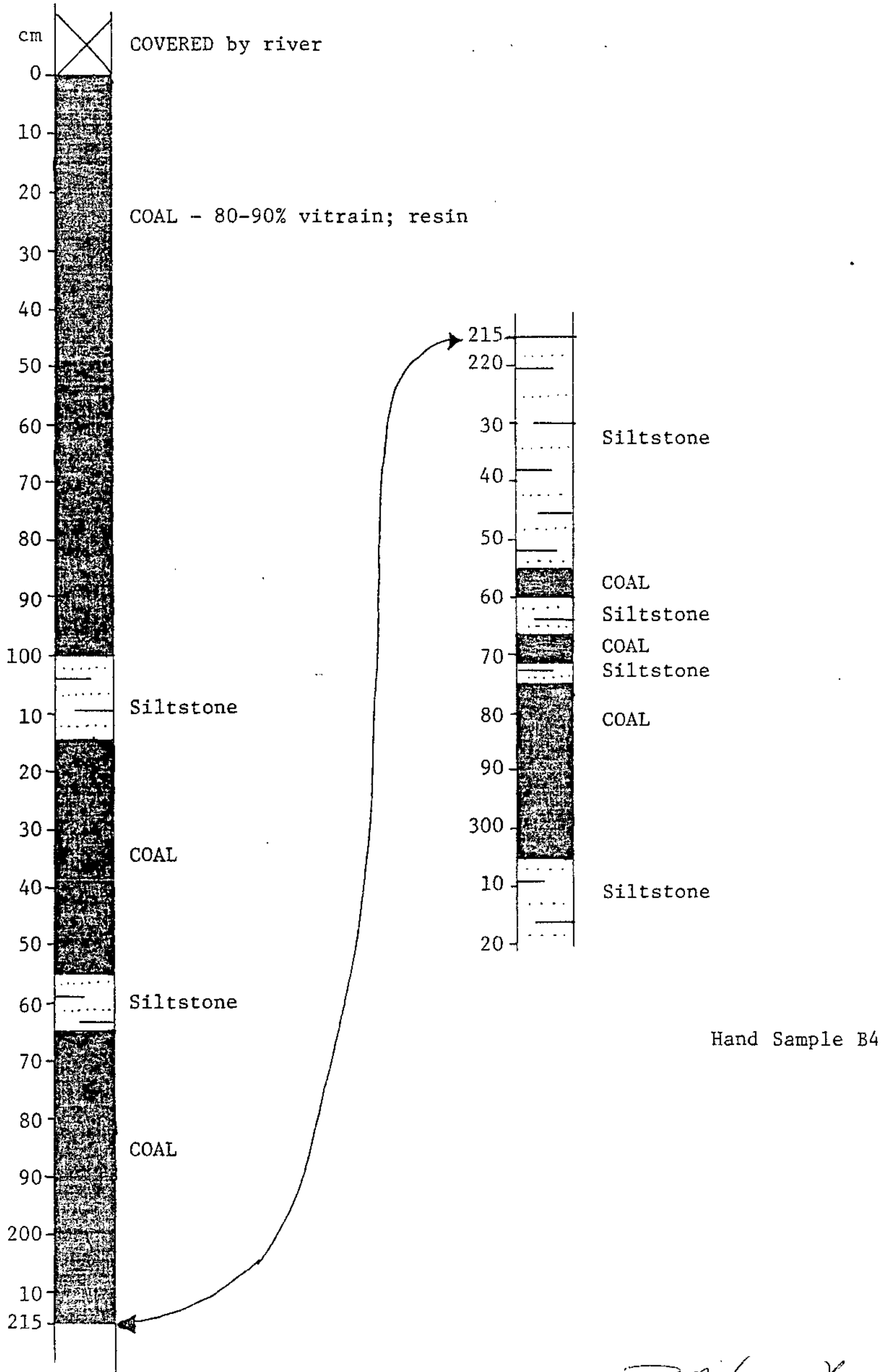
Dark brown coaly mudstone interbedded with very shaly coal; 30% vitrain as 1 to 2 cm. lenses

COAL - 40% vitrain, 60% attrital

COVERED, probably dark brown coaly mudstone

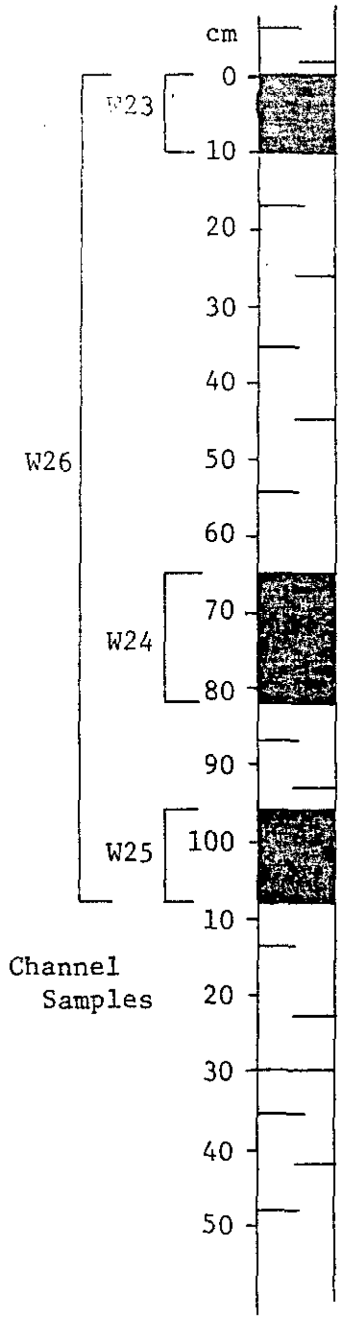
June 30/79

Outcrop B25; Middle Member; Page 1/1



B Vincent
June 30/79

Outcrop B26a; Middle Member; Page 1/1;
10 m ± west of B26b



Dark brown coaly mudstone, 0.3 m exposed, moderately soft

COAL - 60% vitrain, 20% attrital, 20% shale

Dark brown coaly mudstone, 20% vitrain as 0.5 to 3.0 cm thick bands and lenses

COAL - 20% vitrain, 80% attrital

Dark brown coaly mudstone, 10% vitrain as 1 mm lenses

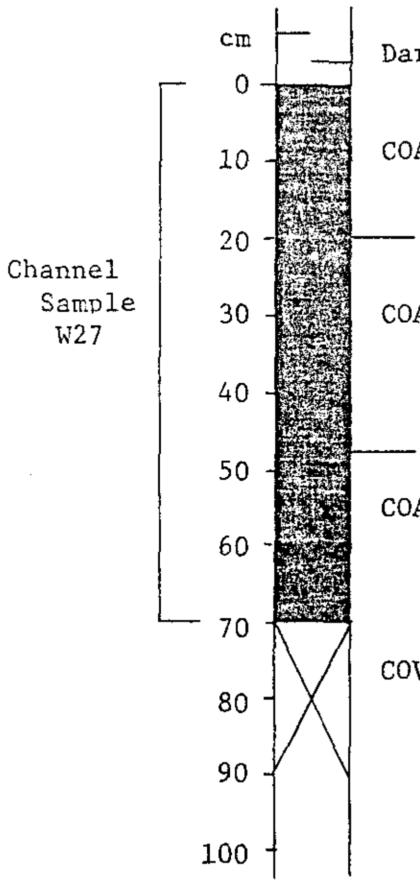
COAL - 100% attrital

Dark brown coaly mudstone, 10% vitrain as 3 mm lenses

Dark brown coaly sideritic mudstone

B D Vincent
June 30/79

Outcrop B26b: Middle Member: Page 1/1:
10 ± metres east of B26b



Dark brown coaly mudstone, 10 cm thick, soft

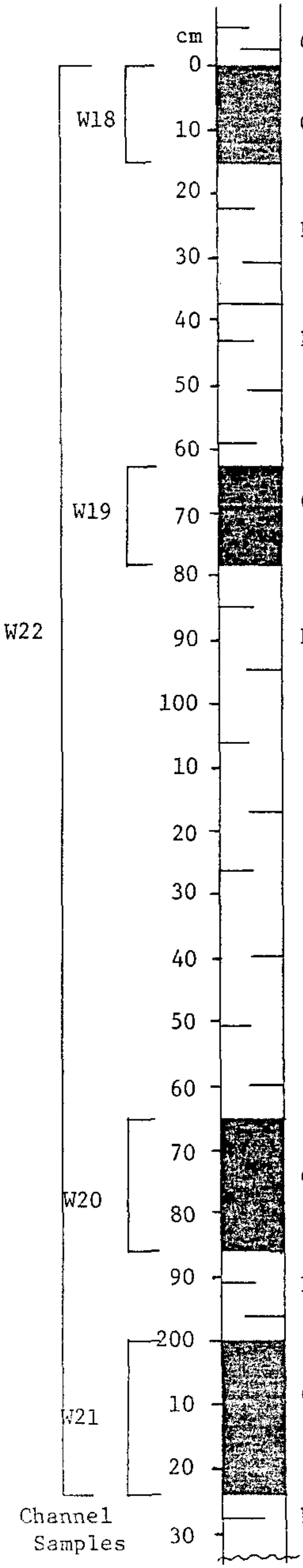
COAL - 10% vitrain, 80% attrial, 10% shale; iron stain on joints and bedding planes

COAL - 80% vitrain, 20% attrital; vitrain predominantly eye coal; trace of iron stain on joints

COAL - 20% vitrain, 60% attrital, 20% shale; iron stain on joints and some bedding planes

COVERED

J Vincent
June 30/79



Grey to brown grey mudstone: soft

COAL - 90% vitrain, 10% attrital

Brown grey mudstone with 1 cm vitrain lenses which make up to 10% of unit

Dark brown coaly mudstone; 30% vitrain in lenses up to 2 cm thick

COAL - 10% vitrain, 80% attrital, 10% mudstone; trace calcite on joints

Dark brown coaly mudstone, 20% vitrain and attrital coal in lenses up to 3 cm thick; calcite on joints

COAL - 10% vitrain, 80% attrital, 10% mudstone; calcite and trace of iron stain on joints

Dark brown coaly mudstone

COAL - 10% vitrain, 60% attrital, 30% shale

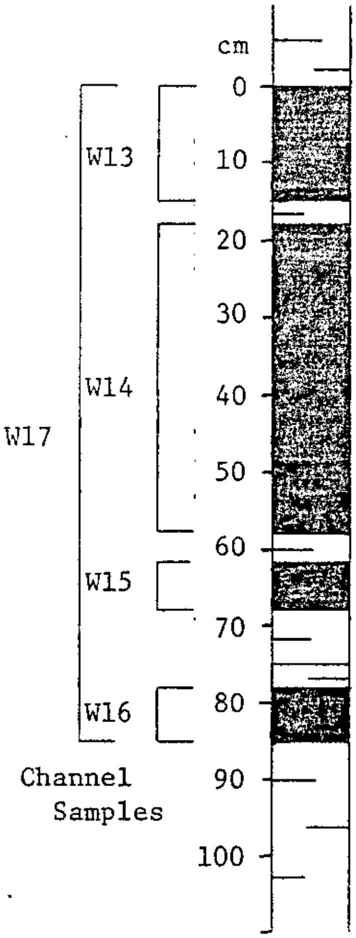
Dark brown coaly mudstone, soft, 0.4 metres

Fault

Light grey mudstone

B. D. Vincent
June 30/79

Outcrop B28; Middle Member; Page 1/1



Brown grey to grey mudstone; 3 m thick; soft

COAL - 20% vitrain, 70% attrital, 10% shale; iron stain on joints

Dark brown coaly mudstone, moderately soft

COAL - 30% vitrain, 70% attrital; some vitrain shows eyes on joints; iron stain on joints

Brown grey mudstone and dark brown coaly mudstone; soft

COAL - 10% vitrain, 80% attrital, 10% mudstone; iron stain on joints

Rustbrown sideritic mudstone, very hard

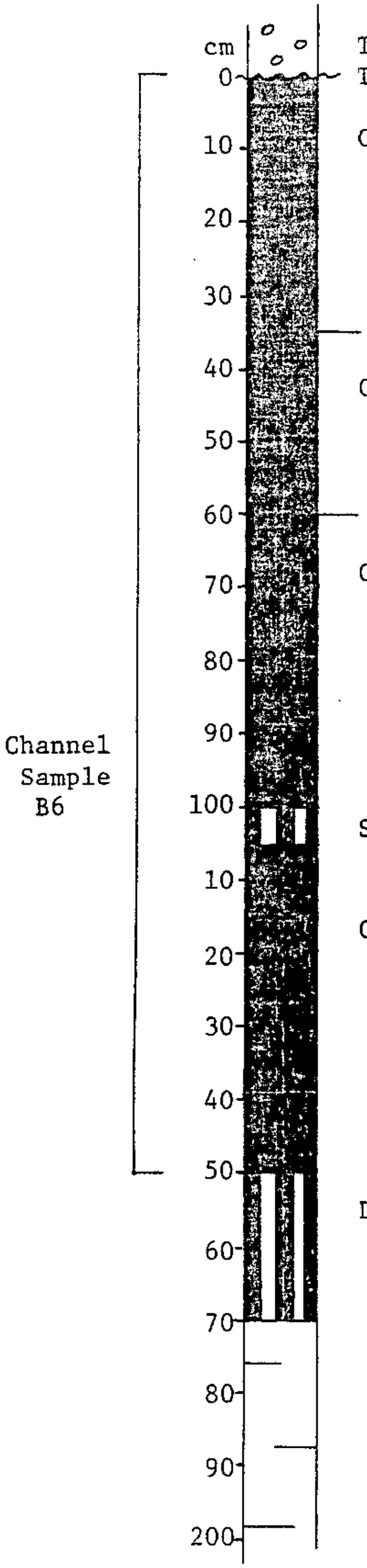
Dark brown coaly mudstone

COAL - 80% vitrain, 20% attrital

Grey to brown grey mudstone interbedded with dark brown coaly mudstone and medium grey sandstone; 4 metres thick; moderately soft

B.R. Vincent
June 30/79

Outcrop B62; Lower Member; Page 1/2



Till

Thrust Fault - Glacial

COAL - 20% vitrain as 1 cm bands, 80% attrital

COAL - 5% vitrain; 75% attrital, 20% mudstone

Trace iron staining on joints

COAL - 5% vitrain, 95% attrital

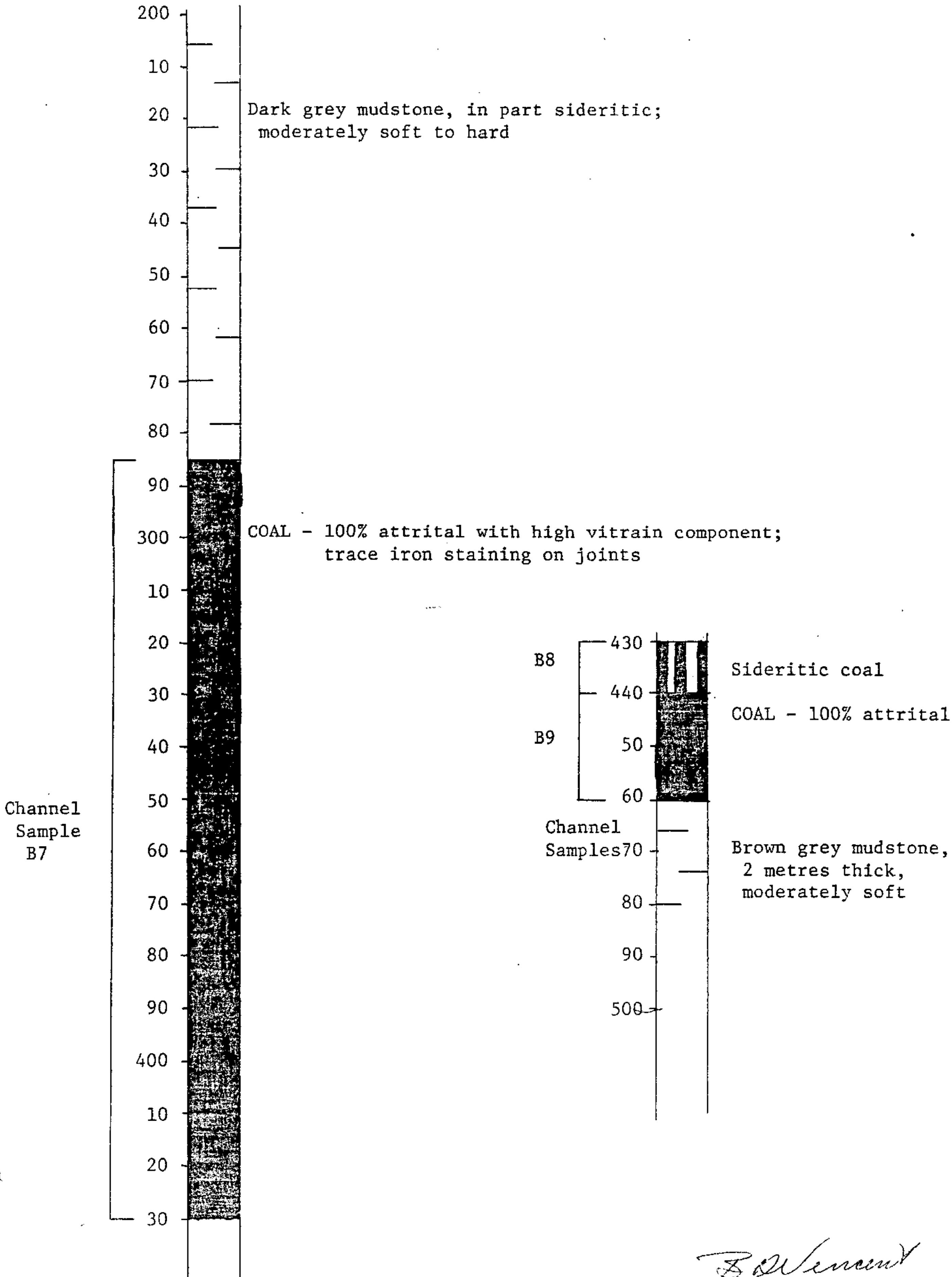
Shaley Coal

COAL - 5% vitrain, 95% attrital; trace of white mineral on joints

Whole seam has abundant (0.5% of total seam) resin in globular masses up to 1 cm in diameter

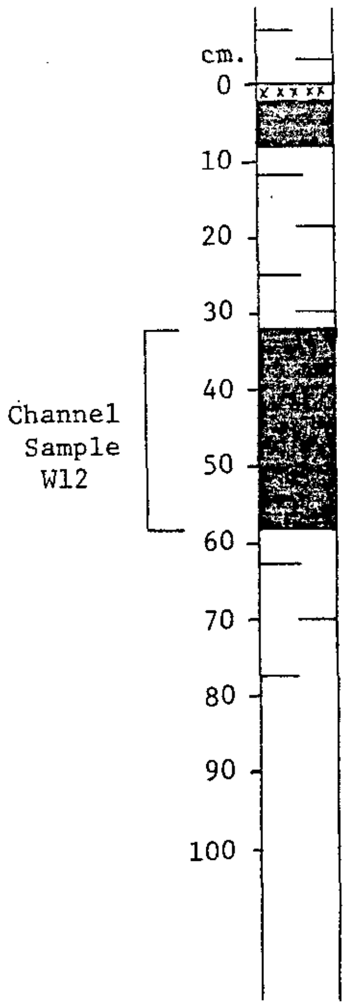
Dark brown shaley coal

B.R. Vincent
June 30/79



B. Vincent
June 30/79

Outcrop W28b; Middle Member, Page 1/1



Brown coaly mudstone, moderately soft

COAL - 30% vitrain (eye coal), 50% attrital, 20% sideritic; iron stained cleats

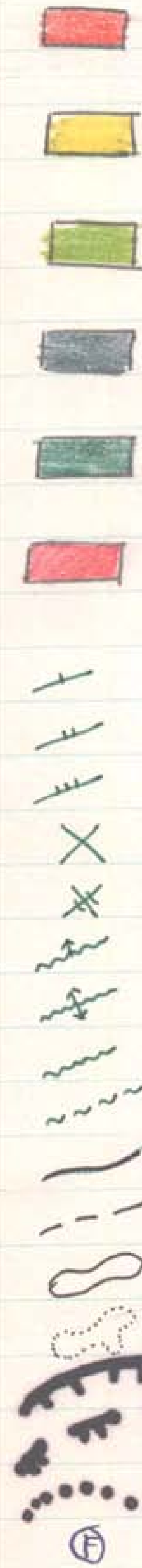
Brown coaly mudstone, moderately hard

COAL - 50% vitrain (eye coal), 45% attrital, 5% mudstone; iron stained cleats; hard and blocky.

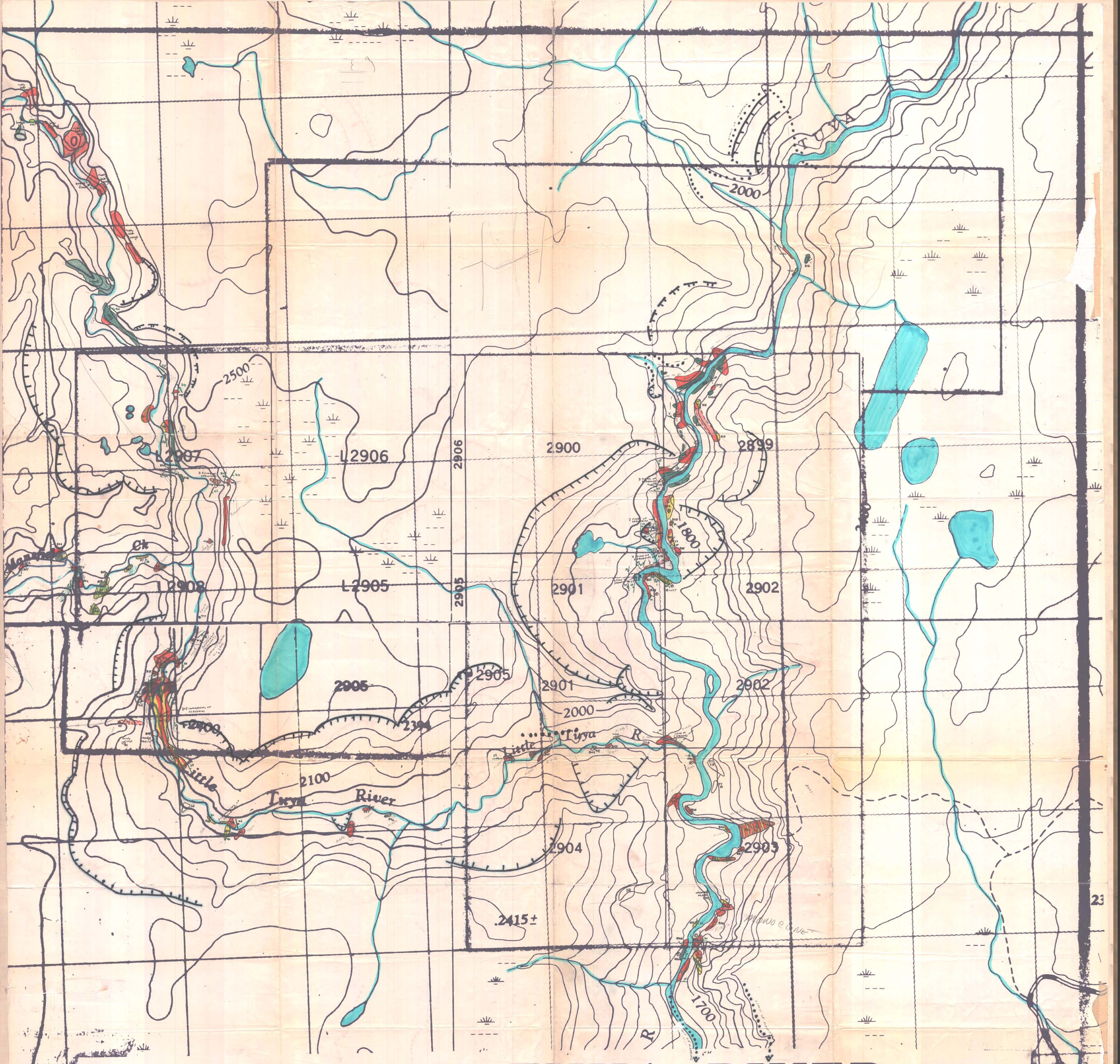
Brown coaly mudstone, 0.7 m thick; lower contact gradational to medium grained sandstone

B.D. Vincent
June 30/79

TUYA LEGEND



CONGLOMERATE		921
SANDSTONE		915
SILTSTONE		912
SHALE		936
BASALT		908
COAL		924
BEDDING	GOOD READING	
	POOR READING	
	VERY POOR READING (IN A SLUMPED AREA)	
	HORIZONTAL	
	HORIZONTAL - VERY POOR READING	
FAULT	DIP KNOWN	
	VERTICAL	
	DIP UNKNOWN	
	ASSUMED TRACE OF FAULT	
CONTACT	OBSERVED	
	INFERRED	
OUTCROP		
	AREA OF OUTCROP	
SLUMP SCAR	FOR CERTAIN	
	POSSIBLE	
LIMIT OF MAPPING IN VALLEYS		
FOSSIL LOC'N		



LITTLE TUYA RIVER

CASSIAR DISTRICT

BRITISH COLUMBIA

Scale 1:10,000 Échelle

Miles 1 0 1 2 3 Miles

Metres 1000 0 1000 2000 3000 4000 Mètres

Yards 1000 0 1000 2000 3000 4000 Verges

BASE MAP

TUYA RIVER Field Map

June, 1979

104 J/2

246

COAL OUTCROP SAMPLE ANALYSES,

TUYA RIVER PROPERTY,

BRITISH COLUMBIA

NTS 104J/2

Coal Licences 390~~3~~4-3913 Incl.

PROFESSIONAL GEOLOGIST
BRUCE D. VINCENT
ALBERTA

Bruce D. Vincent, P. Geol.
Esso Minerals Canada
Coal Department
Calgary, Alberta

September, 1979

ABSTRACT

Thirty-nine outcrop channel samples from the Tuya River coal property (NTS 104J/2) were submitted for coal analyses including moisture content, proximate analysis, calorific value, and specific gravity. A thickness-weighted average of 19% moisture was assumed to be representative of the seams. The other analytical results were then prorated to a 19% moisture basis; weighted averages were found and are ash 21.5%, volatile matter 29.4%, fixed carbon 30.1%, calorific value 16159 kJ/kg (6950 BTU/lb), sulphur 0.46%. The average mineral matter was found to be 23.5% on a 19% moisture basis and specific gravity 1.57 on an air-dried basis. The moist (19% moisture) mineral matter-free calorific value is 9828 BTU/lb (22850 kJ/kg) which determines the coal rank is subbituminous B.

TABLE OF CONTENTS

List of Figures

1. INTRODUCTION

1.1 Purpose

During the geological mapping of the Tuya River coal property conducted in June of 1979, most of the outcrops of coal seams were sampled for laboratory coal analysis. This report contains the results of the analytical work and discussion of the results.

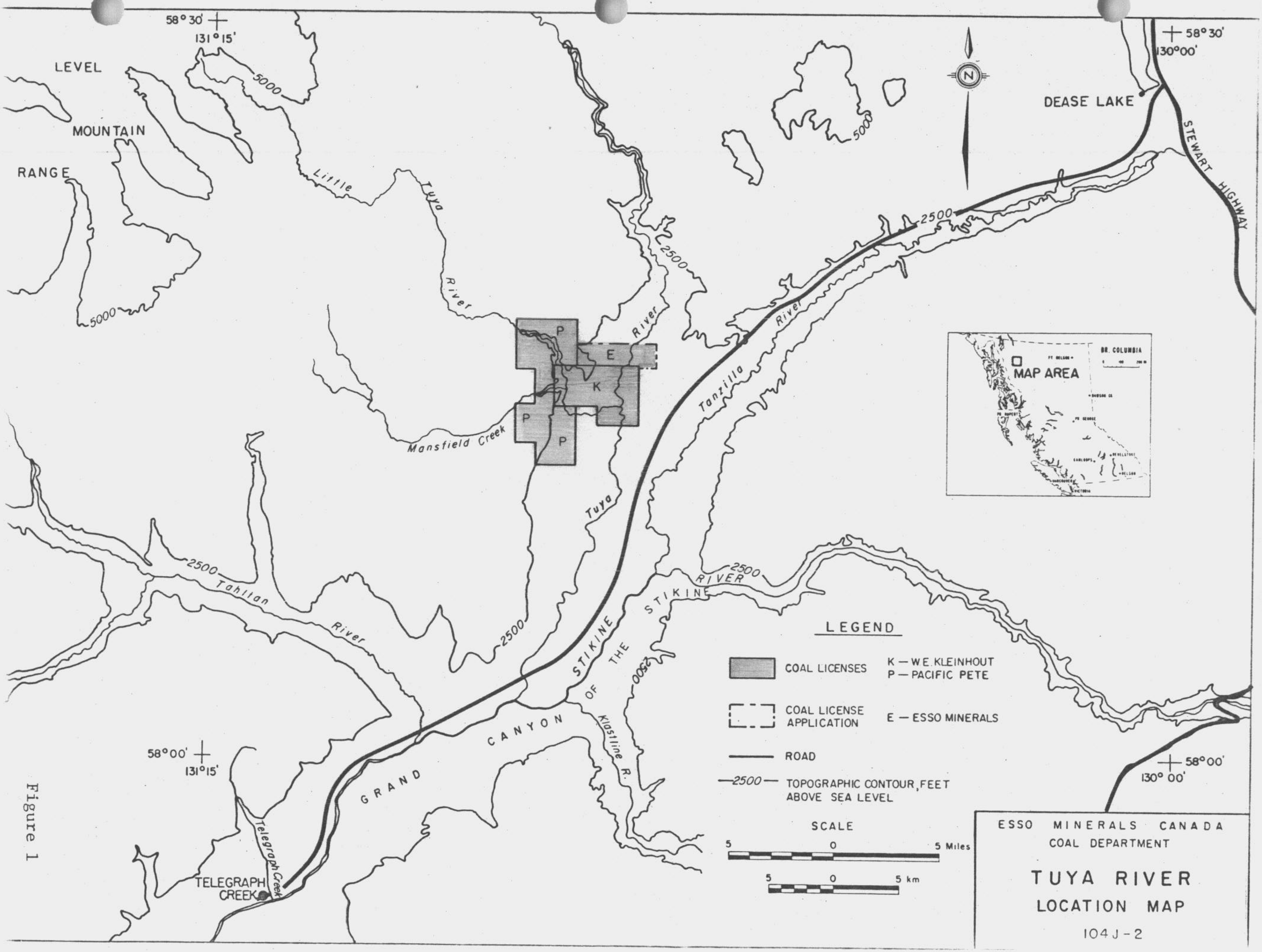
1.2 Location

The Tuya River coal licenses are situated in northwestern British Columbia with their center approximately equidistant from the communities of Dease Lake and Telegraph Creek as shown in Figure 1. For a further discussion on the region, its geology, and the property geology, the reader is referred to the exploration report by Vincent (1979).

The locations of the outcrops from which the samples were taken are shown in Figure 2. More detailed locations are shown on the property geological map contained in the exploration report mentioned above.

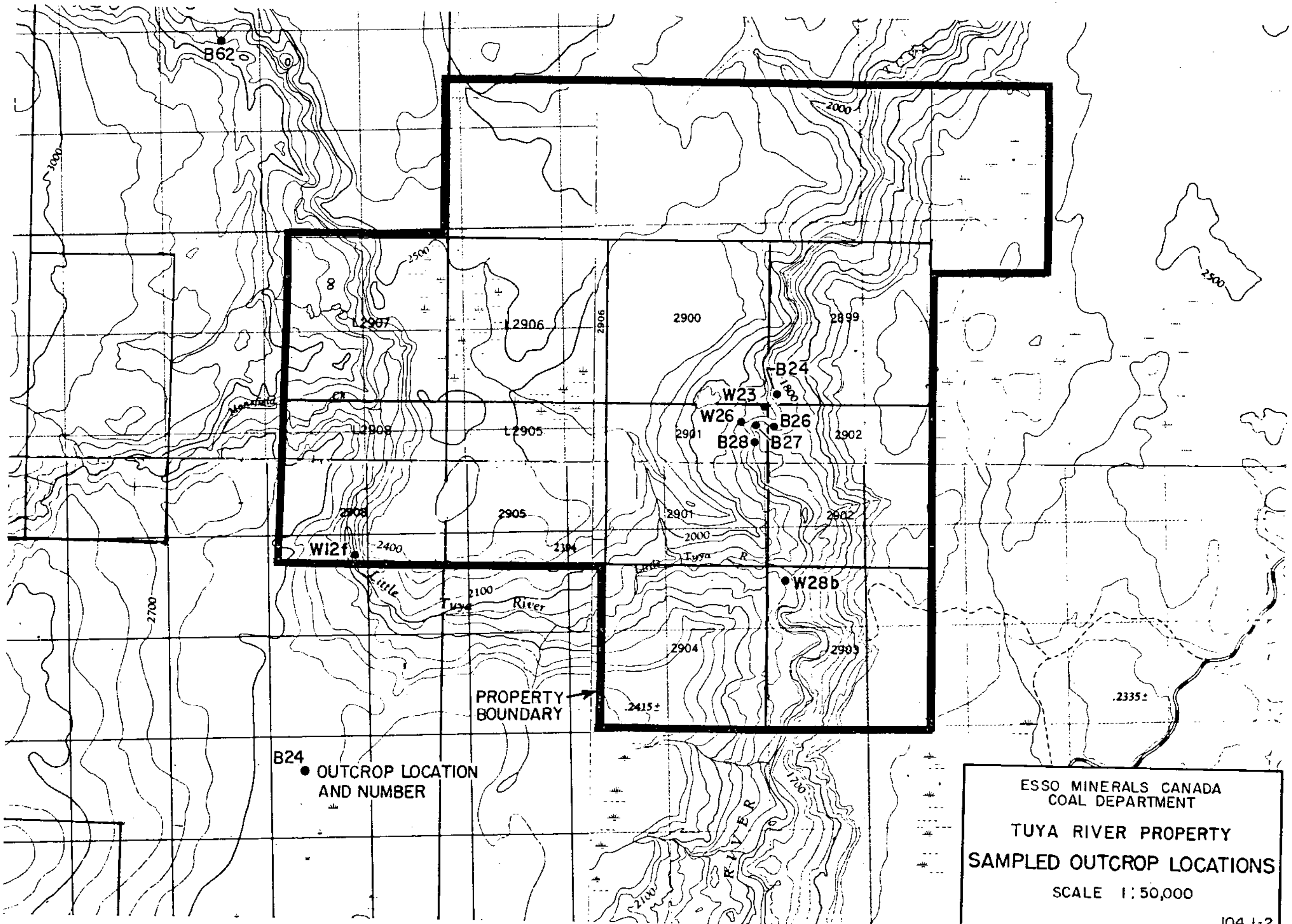
1.3 Sampling and Analyses

During geological mapping all coal seams encountered were noted and described. Near the end of the program, the most representative seams were chosen for sampling and were revisited.



58°30'
131°15'
LEVEL
MOUNTAIN
RANGE
5000
Little
Tuya
River
Mansfield Creek
P
E
K
P
P
River
2500
Tuya
Tanzilla
River
DEASE LAKE
STEWART HIGHWAY
58°30'
130°00'
N
MAP AREA
BR. COLUMBIA
2500
Tahltan
River
STIKINE
RIVER
STIKINE OF THE
GRAND CANYON
Klastline R.
58°00'
131°15'
TELEGRAPH CREEK
Telegraph Creek
58°00'
130° 00'
LEGEND
COAL LICENSES
K — W.E. KLEINHOUT
P — PACIFIC PETE
COAL LICENSE APPLICATION
E — ESSO MINERALS
ROAD
2500
TOPOGRAPHIC CONTOUR, FEET ABOVE SEA LEVEL
SCALE
5
0
5 Miles
5
0
5 km
ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER
LOCATION MAP
104 J - 2

Figure 1



ESSO MINERALS CANADA
COAL DEPARTMENT

TUYA RIVER PROPERTY

SAMPLED OUTCROP LOCATIONS

SCALE 1:50,000

104 J-2

1.3 Sampling and Analyses (Cont'd)

The outcrops were prepared for sampling by removing a section of coal and overburden, by pick and shovel, up to 0.3 metres wide perpendicular to the seam top and bottom from the seam top to bottom if at all possible. The purposes of this were to get as clean and unoxidized a sample as possible and to obtain as accurate a seam thickness as possible.

The coal seam was then examined and described in detail which included estimations of coal constituents. If possible, the seam was subdivided into portions based on varying constituent proportions or by the presence or absence of mudstone partings.

Continuous channel samples of each of the subdivisions of the seam were then taken by chipping off a small portion of the exposed face. Care was taken to remove roughly equal portions from all parts of the seam for an equal representation. These were immediately placed in plastic bags and labelled in the field and packed in metal cans upon return to base for shipment.

After the samples were shipped to Calgary, small portions of a few samples were removed for palynological analyses and then resealed and all were sent to Birtley Coal and Minerals Testing of Calgary for analyses. Birtley performed the standard analyses for moisture, proximate analysis, total sulphur, calorific value, and specific gravity on the samples.

2. ANALYTICAL RESULTS AND CALCULATIONS

2.1 Introduction

The results as received from Birtley Coal and Minerals Testings form Appendix I of this report. The results are also displayed along with graphic logs of the coal seams in Appendix 2.

2.2 Moisture Content

The moisture content of the Tuya River samples were analysed on an as-received basis. That is, the total water content of the sample when initially analysed. As no other analytical work was done on moisture content, the as-received moisture was assumed to be an approximation of the natural moisture of the seams. It is only an approximation since the samples were taken from outcrops, a location which may increase or decrease the natural bed moisture.

The moisture contents of the samples ranged from 13.9 to 25.4 weight percent. The weighted average for the samples is 19% and this value is assumed to be the average for the property.

2.3 Proximate Analyses

The determination of the ash, volatile matter and fixed carbon content of thirty-nine samples was done and reported on an as-received basis and also reported on a dry basis. In addition, seven samples were composited into 3 additional samples and analysed. The results are presented in Appendices I and II.

In order to determine an average for the property, the ash and volatile matter were recalculated for an average moisture content of 19% by the following formulas:

2.3 Proximate Analyses (Cont'd)

$$A_{19} = A_D(1.0 - \frac{M}{100})$$

and $$VM_{19} = VM_D(1 - \frac{M}{100})$$

where A_{19} = ash at 19% moisture,

A_D = ash on dry basis,

M = moisture = 19%,

VM_{19} = volatile matter at 19% moisture,

and VM_D = volatile matter on dry basis.

Fixed carbon was calculated by difference. The results of these calculations are included in Appendix II.

In addition, the mineral matter content of the samples was calculated by the Parr formula.

$$M_M = 1.08A + 0.55\ S$$

where M_M = mineral matter,

A = ash,

and S = total sulphur

with the ash and sulphur contents having been reported on the same basis. The calculation of the mineral matter contents and use of them instead of ash contents makes corrections necessary due to losses of ash and sulphur during the analytical process. The mineral matter content was calculated for each sample on as-received and dry bases and for 19% moisture.

2.3 Proximate Analyses (Cont'd)

The weighted averages of the ash, volatile matter, and mineral matter were calculated using the seam thickness from which representative samples or composite samples were taken. The average fixed carbon was calculated by difference. The weighted averages at 19% moisture are:

Ash	21.5%
Volatile Matter	29.4%
Fixed Carbon	30.1%
(Mineral Matter	23.52%)

2.4 Sulphur

The total sulphur content of each sample and composite sample processed in the proximate analyses was found and reported on an as-received and a dry basis. The as-received values ranged from 0.11% to 0.92%. The sulphur content was also calculated for 19% moisture and the range was between 0.26% and 0.87%. The weighted average sulphur content was determined to be 0.46%.

2.5 Calorific Value and Coal Rank

Calorific values for 34 samples and 3 composite samples were founded and reported as BTU/lb on as-received and dry bases. These have been converted to the standard SI unit of kiloJoules per kilogram (kJ/kg). The values were prorated from a dry basis to a 19% moisture basis by the following formula:

$$CV_{19} = CV_D(1.0 - \frac{M}{100})$$

where CV_{19} = calorific value at 19% moisture

CV_D = dry calorific value,

and M = moisture = 19%

In order to determine an average calorific value least-squares linear regression was done for calorific value versus ash and calorific value versus mineral matter (Figures 3 and 4). These graphs were possible by plotting the values previously calculated to a 19% moisture basis.

The regression line of the plot of calorific value versus ash (Figure 3) is described by the formula with the format

$$Y = mx + b$$

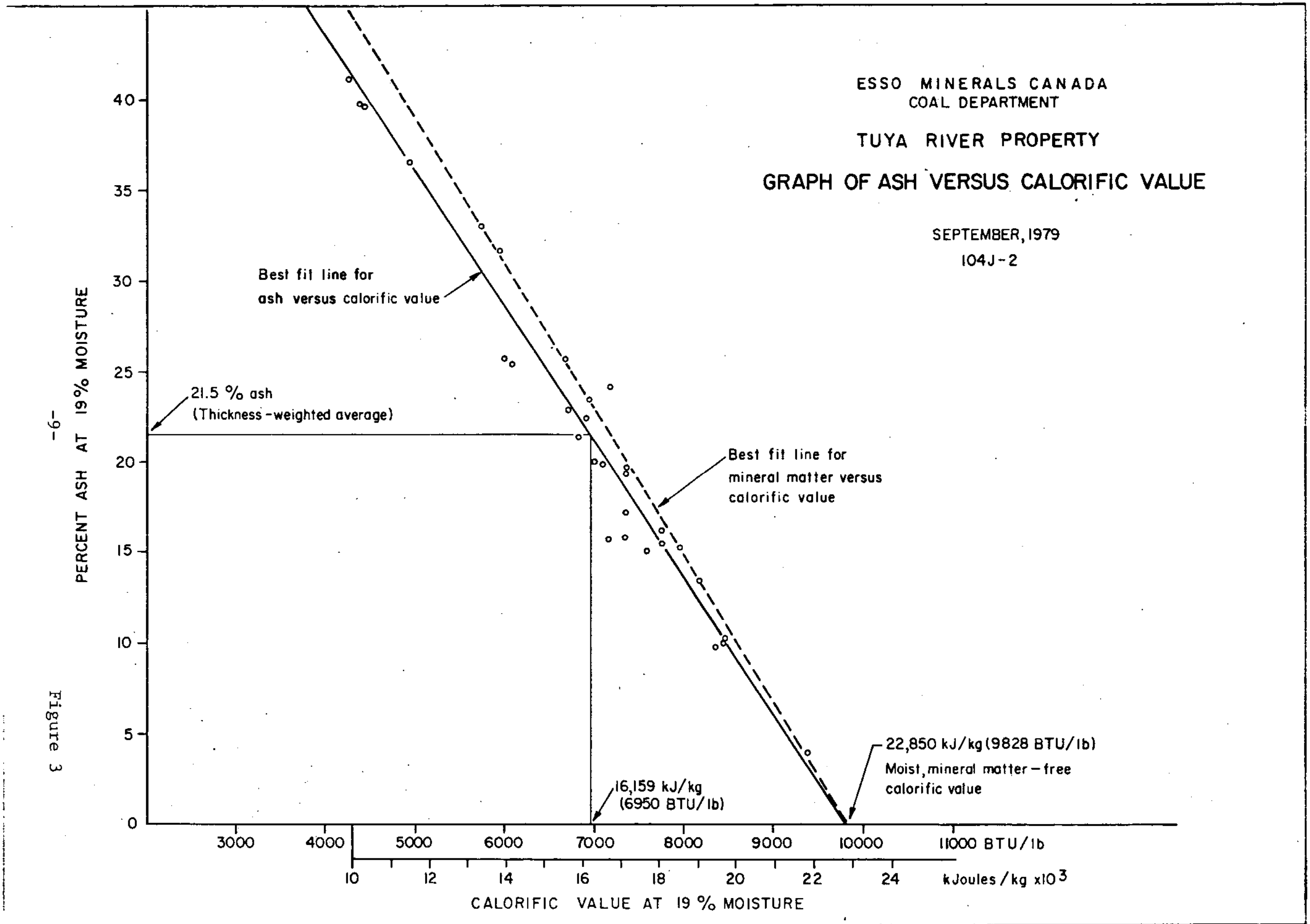
where m is the slope and b is the y-intercept which in this case becomes

$$A_{19} = (-0.0075)CV_{19} + 73.38$$

where A_{19} = ash content at 19% moisture

CV_{19} = calorific value at 19% moisture

The calorific value corresponding to the weighted-average ash content at 19% moisture of 21.5% was determined to be 16,159 kJ/kg (6950 BTU/lb). The calorific value at 0% ash is 22771 kJ/kg (9794 BRU/lb). The correlation coefficient of the plot of calorific value versus ash content is -0.982.



ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER PROPERTY
GRAPH OF ASH VERSUS CALORIFIC VALUE
SEPTEMBER, 1979
104J - 2
PERCENT ASH AT 19% MOISTURE
40
35
30
25
20
15
10
5
0
Best fit line for
ash versus calorific value
21.5 % ash
(Thickness - weighted average)
Best fit line for
mineral matter versus
calorific value
22,850 kJ/kg (9828 BTU/lb)
Moist, mineral matter - free
calorific value
16,159 kJ/kg
(6950 BTU/lb)
3000
4000
5000
6000
7000
8000
9000
10000
11000 BTU/lb
10
12
14
16
18
20
22
24
kJoules / kg x10^3
CALORIFIC VALUE AT 19 % MOISTURE

Figure 3

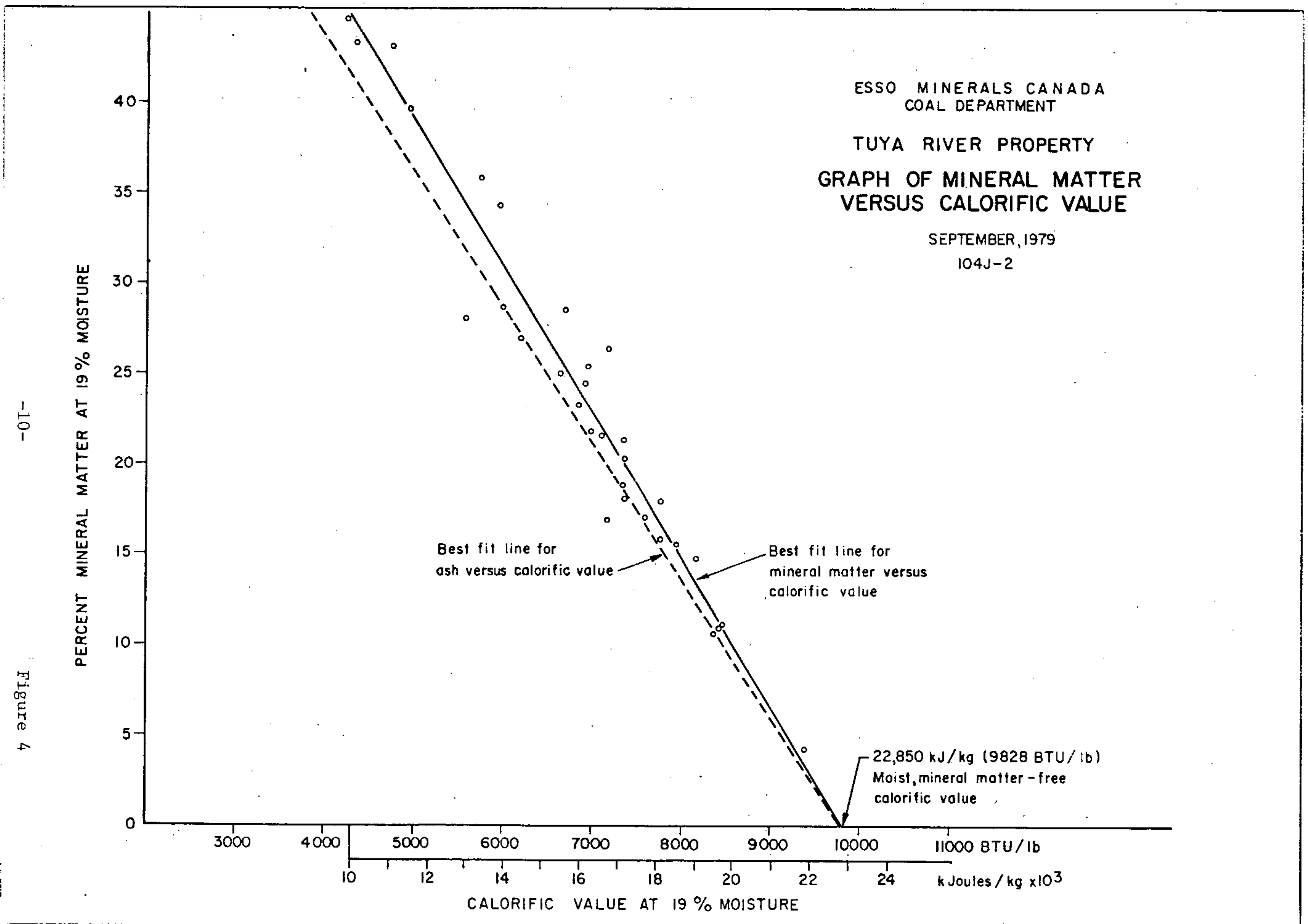

ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER PROPERTY
GRAPH OF MINERAL MATTER VERSUS CALORIFIC VALUE
SEPTEMBER, 1979
104J-2
PERCENT MINERAL MATTER AT 19 % MOISTURE
40
35
30
25
20
15
10
5
0
Best fit line for ash versus calorific value
Best fit line for mineral matter versus calorific value
22,850 kJ/kg (9828 BTU/lb) Moist, mineral matter-free calorific value
3000
4000
5000
6000
7000
8000
9000
10000
11000 BTU/lb
10
12
14
16
18
20
22
24
k Joules/kg x10^3
CALORIFIC VALUE AT 19 % MOISTURE

Figure 4

2.5 Calorific Value and Coal Rank (Cont'd)

For the plot of calorific value versus mineral matter content at 19% moisture (Figure 4) the regression line may be described as

$$Mm_{19} = (-0.0081)CV_{19} + 79.57.$$

For the weight-average mineral matter content of 23.5% calculated above, the corresponding calorific value was found to be 16,043 kJ/kg (6900 BTU/lb). At 0% mineral matter, the calorific value is 22850 kJ/kg (9828 BTU/lb). This is better termed moist, mineral matter-free calorific value. The correlation coefficient of this plot is -0.981.

The American Society for Testing and Material has subdivided low-rank coal on the basis of moist, mineral matter-free calorific value. At 19% moisture, the moist, mineral matter-free calorific value of the Tuya River samples is 9823 BTU/lb which is in the range of values for coal with a subbituminous B rank.

2.6 Specific Gravity

The air-dried specific gravity was reported for 3 composite samples and their individual portions. The weighted-average was found to be 1.57 for the samples. This value may be assumed to be the average for the field while remembering it is reported on an air-dried basis while the other averages are reported on a 19% moisture basis.

3. DISCUSSION OF RESULTS

3.1 Quality of the Results

From the fact that all of the Tuya River samples are from outcrop exposures of coal seams and associated strata, it can be assumed all of the samples have been oxidized and the components altered to some degree. This is true even though the outcrops were cleaned to expose as fresh a face as possible. But, the results of the analyses are of use and thought to be a close representation of the actual coal quality. Points in favour of this assumption are the small range of values for moisture content and the close correlations between calorific value and each of mineral matter and ash.

Any further analytical work using drill core samples would probably increase the coal quality by reducing the ash content and thereby increasing the calorific value. It is unlikely the increase would be dramatic. It is also unlikely the rank of the coal would change and if it did, probably only up to subbituminous A.

3.2 Ash Versus Mineral Matter

The mineral matter content of coal is the inorganic constituents of coal and is composed primarily of clayey materials (aluminum silicates and silica), pyrite, and calcite. The ash is the non-combustible residue left after the ashing of coal. This residue originates from extraneous mineral matter and inorganic material combined with the organic fraction of the coal. The ash value is always less than the mineral matter value because, during ashing, some of the inorganic material is altered. The most common

reactions are the loss of water of hydration from clay minerals and the oxidation of pyrite and calcite. These reactions are compensated for in the Parr formula for determining mineral matter (Rees, 1966).

In this report, the mineral matter values are used to determine the rank of the coal with the weighted-average value for mineral matter used as a constituent of the coal. The average calorific value of the samples was derived from the calorific value versus ash plot and reported with the weighted-average ash value since that calorific value is the one actually achieved upon burning as opposed to one derived from the average mineral matter. Both plots and regression lines are included here because of the two distinct uses of the data.

4. SUMMARY

From the laboratory analyses of outcrop channel samples, a good approximation of the unoxidized coal quality and rank of the Tuya River coal seams has been obtained.

The average quality, using thickness-weighted averages, for the property is

Moisture	19.0%
Ash	21.5
Volatile Matter	29.4
Fixed Carbon	30.1
Total Sulphur	0.46
Calorific value	16159 kiloJoule/kilogram (6950 BTU/lb)
Mineral Matter	23.5%
Specific gravity, air-dried basis	1.57

The coal rank was determined to be subbituminous B from a moist (19% moisture), mineral matter-free calorific value of 9828 BTU/lb (22850 kJ/kg). This is within the range of values defined to be that of subbituminous B coal of 9500 to 10,500 BTU/lb.

5. REFERENCES

Rees, O.W. (1966)
"Chemistry, Uses, and Limitations of Coal Analyses"; Illinois State Geol. Surv. Rept. Inv. 220, 55p.

Vincent, B.D. (1979)
"Geological Mapping of the Tuya River Property, British Columbia, NTS 104J/2"; Unpublished internal report for Esso Minerals Canada, Coal Department, 30p.

APPENDIX I

Coal Analyses Laboratory Report

Birtley Coal
& Minerals Testing
A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD.

RECEIVED
SEP 13 1979
EMC · COAL

BIRTLEY

August 31, 1979

Mr. Bruce Vincent
Esso Minerals Canada
Coal Department
500 - 6 Avenue SW
Calgary, Alberta
T2P 0S1

Dear Mr. Vincent:

Re: TUYA RIVER 104J/2

Please find enclosed the analyses requested in your letter dated August 1, 1979 on samples identified as "Tuya River Outcrop Channel Samples".

Yours truly,

BIRTLEY COAL AND MINERALS TESTING

Frank J. Horvat

Frank J. Horvat
General Manager

cas
Encl.

505 - 50th Avenue S.E., P.O. Box 5488, Station "A", Calgary, Alberta T2H 1X9 Telephone (403) 253-8273

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3200	16.6	57.5	14.7	11.2	0.11	---	---	arb
W12F,W2		68.9	17.6	13.5	0.13	---	---	db
3201	17.4	60.3	13.6	8.7	0.14	---	---	arb
W12F,W3		72.9	16.4	10.7	0.17	---	---	db
3202	17.2	52.1	16.7	14.0	0.17	---	---	arb
W12F,W4		62.9	20.2	16.9	0.20	---	---	db
3203	15.5	55.2	15.7	13.6	0.12	---	---	arb
W12F,W5		65.3	18.5	16.2	0.14	---	---	db
3204	18.8	39.9	23.0	18.3	0.79	4383	---	arb
W23,W6		49.1	28.4	22.5	0.97	5396	---	db
3205	20.7	25.8	28.2	25.3	0.56	5869	1.60	arb
W23,W7		32.5	35.6	31.9	0.70	7396	---	db
3206	25.0	23.0	26.2	25.8	0.37	5743	---	arb
W23,W8		30.6	35.0	34.4	0.49	7654	---	db
3207	20.0	16.4	32.8	30.8	0.37	7233	---	arb
W23,W9		20.5	41.0	38.5	0.46	9044	---	db
3208	21.4	15.2	30.1	33.3	0.41	7334	---	arb
W23,W10		19.3	38.3	42.4	0.52	9325	---	db

Birtley Coal
& Minerals Testing
A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3209	14.4	14.1	37.2	34.3	0.71	8602	---	arb
W26,W11		16.5	43.5	40.0	0.83	10054	---	db
3210	14.0	20.6	30.2	35.2	0.74	7437	---	arb
W28b,W12		24.0	35.1	40.9	0.90	9065	---	db
3211	21.2	9.8	32.1	36.9	0.45	8197	---	arb
B24a,W28		12.4	40.7	46.9	0.58	10397	---	db
3212	16.2	20.3	32.5	31.0	0.74	7028	---	arb
B24a,W29		24.2	38.8	37.0	0.88	8397	---	db
3213	16.4	4.0	33.3	46.3	0.27	9664	1.39	arb
B24b,W30		4.8	39.8	55.4	0.32	11561	---	db
3214	18.6	20.1	31.8	29.5	0.49	7017	1.57	arb
B24b,W31		24.7	39.1	36.2	0.60	8620	---	db
3215	17.6	41.9	21.9	18.6	0.32	4297	---	arb
B24c,W32		50.9	26.5	22.6	0.39	5216	---	db
3216	20.1	22.6	28.5	28.8	0.74	6543	---	arb
B24c,W33		28.2	35.7	36.1	0.92	8191	---	db
3217	18.4	15.5	30.2	35.9	0.43	7818	---	arb
B24c,W34		19.0	37.0	44.0	0.53	9586	---	db

14

Birtley Coal & Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3218	20.3	15.0	29.5	35.2	0.38	7803	---	arb
B24c,W35		18.8	37.0	44.2	0.47	9766	---	db
3219	21.7	35.4	22.9	20.0	0.35	4754	---	arb
B24c,W36		45.2	29.2	25.6	0.45	6070	---	db
3220	16.1	20.3	30.1	33.5	0.44	7586	---	arb
B26a,W23		24.2	35.9	39.9	0.53	9042	---	db
3221	14.9	25.0	29.8	30.3	0.92	7519	---	arb
B26a,W24		29.3	35.0	35.7	1.08	8833	---	db
3222	14.4	23.8	36.8	25.0	0.64	7278	---	arb
B26a,W25		27.7	42.9	29.4	0.75	8507	---	db
3223	17.6	32.1	26.2	24.1	0.69	6025	---	arb
B26a,W26		39.0	31.8	29.2	0.84	7308	---	db
3224	20.1	16.0	30.1	33.8	0.81	7633	---	arb
B26b,W27		20.0	37.7	42.3	1.01	9550	---	db
3225	14.8	20.9	34.1	30.2	0.47	7439	---	arb
B27,W18		24.5	40.1	35.4	0.55	8733	---	db
3226	14.6	24.6	32.7	28.1	0.61	7291	---	arb
B27,W19		28.8	38.3	32.9	0.72	8541	---	db

Birtley Coal & Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3227	13.9	27.9	31.2	27.0	0.57	7093	---	arb
B27,W20		32.4	36.3	31.3	0.66	8234	---	db
3228	15.4	34.4	25.6	24.6	0.43	5984	---	arb
B27,W21		40.7	30.2	29.1	0.51	7072	---	db
3229	17.0	40.7	27.8	14.5	0.43	4849	---	arb
B27,W22		49.0	33.6	17.4	0.52	5845	---	db
3230 B28 W13	22.5	16.9	30.5	30.1	0.61	6967	---	arb
W14,W15, W16,W17		21.7	39.3	39.0	0.79	8991	---	db
3231	25.0	14.4	29.1	31.5	0.30	6602	1.53	arb
B62,B6		19.2	38.9	41.9	0.40	8807	---	db
3232	25.4	8.9	30.2	35.5	0.38	7611	1.47	arb
B62,B7		12.0	40.5	47.5	0.51	10278	---	db
3233	20.5	41.8	20.2	17.5	0.31	---	1.86	arb
B62,B8		52.6	25.3	22.1	0.39	---	---	db
3234	23.1	16.3	20.0	30.6	0.45	6932	1.51	arb
B62,B9		21.2	39.0	39.8	0.58	9018	---	db
								arb
								db

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

39

COMPOSITES

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
W7	21.7	25.0	27.7	25.6	0.50	5856	---	arb
W8		31.9	35.4	32.7	0.64	7476	---	db
W30	17.1	10.5	32.8	39.6	0.36	8610	1.46	arb
W31		12.6	39.5	47.9	0.44	10387	---	db
W13,14	22.5	16.9	30.5	30.1	0.61	6967	---	arb
15,16		21.7	39.3	39.0	0.79	8991	---	db
17								
B7	23.8	20.1	27.0	29.1	0.37	6399	1.60	arb
B8		26.4	35.5	38.1	0.49	8396	---	db
B9								
								arb
								db
								arb
								db
								arb
								db
								arb
								db
								arb
								db

APPENDIX II

Coal Analyses on
Graphic Logs

Abbreviations used on graphic logs:

Moist.	moisture
V.M.	volatile matter
F.C.	fixed carbon
S	sulphur
C.V.	calorific value
M.M.	mineral matter
Sp.Gr.	specific gravity
As rec'd	As received basis
19% moist	19% moisture basis

Notes:

All values except calorific value are given as a percentage.

Calorific value is stated as kiloJoules per kilogram where 1 kJ/kg = 2.325 BTU/lb.

All interval values are given in centimetres.

2-6

GN-TUYA RIVER 79(4)A

(L1)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER
NTS LOCATION: 104J/2
DRILL HOLE OR OUTCROP NUMBER: 324a

SEAM NAME:
LOCATION:

FORMATION: MIDDLE MEMBER
ELEVATION:

COMMENTS:

ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____
GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST: P.M. WATERS
DATE:

DESCRIPTION

SAMPLE	INTERVAL	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
	0										LIGHT BROWN SIDERITIC MUDSTONE
W28	10, 20										COAL
	30, 40, 50										BROWN MUDSTONE
	60, 70, 80, 90										BROWN TO DARK BROWN COALY MUDSTONE
	100										COAL
	110, 120										BROWN TO DARK BROWN COALY MUDSTONE
	130										RUSTBROWN MUDSTONE
W29	140										COAL
W29	150										BROWN COALY MUDSTONE
W29	160	21.2 19.0	9.8 10.0	32.1 33.0	36.9 37.0	0.45 0.47	19058 19581	10.83 11.11	AS REC'D. 19% MOIST	–	COAL
	170, 180										LIGHT GREY-BROWN SANDY MUDSTONE

GN - TUYA RIVER 79(4)A

(L2)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER NTS LOCATION: 104J/2 DRILL HOLE OR OUTCROP NUMBER: B24b

SEAM NAME: ____ LOCATION: ____

FORMATION: MIDDLE MEMBER ELEVATION: ____

COMMENTS: ____ ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP: X

GEOLOGIST: P.M. WATERS DATE: ____

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												COVERED
	0 – 65 (0, 10, 20, 30, 40, 50, 60, 65)											BROWN TO DARK BROWN COALY MUDSTONE
W30	65 – 105 (70, 80, 90, 100, 105)		16.4 19.0	4.0 3.9	33.3 32.2	46.3 44.9	0.27 0.26	22468 21771	4.47 4.34	AS REC'D. 19% MOIST	1.39 AIR DRIED	COAL
	105 – 115 (110)											RUSTBROWN SIDERITIC MUDSTONE
W31	115 – 215 (120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 215)		18.6 19.0	20.1 20.0	31.8 31.7	29.5 29.3	0.49 0.49	16314 16233	21.97 21.87	AS REC'D. 19% MOIST	1.57 AIR DRIED	COAL
	215 – (220, 230)											COVERED
ANALYSIS OF COMPOSITE OF SAMPLES W30 AND W31			17.1 19.0	10.5 10.2	32.8 32.0	39.6 38.8	0.36 0.37	20018 19560	11.54 11.22	AS REC'D. 19% MOIST	1.46	

GN-TUYA RIVER 77(4)A

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(L3)

PROPERTY TUYA RIVER   NTS LOCATION 104J/2   DRILL HOLE OR OUTCROP NUMBER B26b

SEAM NAME ______   LOCATION ______

FORMATION MIDDLE MEMBER   ELEVATION ______

COMMENTS ______   ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______   OUTCROP X

GEOLOGIST P.M. WATERS   DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												DARK BROWN COALY MUDSTONE
	0											
	10											
	20											
W27	30		20.1	16.0	30.1	33.8	0.81	17747	17.73	AS REC'D.		COAL
	40		19.0	16.2	30.5	34.3	0.82	17966	17.95	19% MOIST		
	50											
	60											
	70											COVERED
	80											
	90											
	100											

GN- TUYA RIVER 79(4)A

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

L4

PROPERTY TUYA RIVER   NTS LOCATION 104J/2   DRILL HOLE OR OUTCROP NUMBER B24c

SEAM NAME ____________   LOCATION ____________

FORMATION MIDDLE MEMBER   ELEVATION ____________

COMMENTS ____________   ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______   OUTCROP X

GEOLOGIST P.M. WATERS   DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	VM	FC	S	CV	MM	BASIS	SP. GR.	LITHOLOGY
												COVERED
	45 50 60											BROWN COALY MUDSTONE
W32 (W36)	60 70 80 90 100		17.6 19.0	41.9 41.2	21.9 21.5	18.6 18.3	0.32 0.32	9991 9823	45.43 44.70	AS REC'D. 19% MOIST		COAL
	100 10											DARK BROWN MUDSTONE
W33	20 30 135		20.1 19.0	22.6 22.9	28.5 28.9	28.8 29.2	0.74 0.75	15212 15426	24.82 25.08	AS REC'D. 19% MOIST		COAL
	135 40 150											MEDIUM TO DARK BROWN MUDSTONE
W34	150 60 70 180		18.4 19.0	15.5 15.4	30.2 30.0	35.9 35.6	0.43 0.43	18177 18054	16.97 16.86	AS REC'D. 19% MOIST		COAL
	180 90 200 10 215											DARK BROWN COALY MUDSTONE AND VERY MUDDY COAL
W35	215 20 30 240		20.3 19.0	15.0 15.2	29.5 30.0	35.2 35.8	0.38 0.38	18141 18391	16.41 16.65	AS REC'D. 19% MOIST		COAL
	240 50 60 70											
W36 ANALYSIS			21.7 19.0	35.4 36.6	22.9 23.7	20.0 20.7	0.36 0.36	11053 11430	38.42 39.74	AS REC'D. 19% MOIST		WHOLE SEAM SAMPLE

W36 = 60–240

GN TUYA RIVER 79(4)A

L5

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER   NTS LOCATION: 104J/2   DRILL HOLE OR OUTCROP NUMBER: B26a

SEAM NAME: ______   LOCATION: ______

FORMATION: MIDDLE MEMBER   ELEVATION: ______

COMMENTS: ______   ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST P.M. WATERS   DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												DARK BROWN COALY MUDSTONE
W23 (W26)	0–10		16.1 19.0	20.3 19.6	30.1 29.1	33.5 32.3	0.44 0.43	17637 17028	22.17 21.41	AS REC'D 19% MOIST	–	COAL
	10, 20, 30, 40, 50, 60											DARK BROWN COALY MUDSTONE
W24	70, 80		14.9 19.0	26.0 23.7	29.8 28.3	30.3 28.9	.092 0.87	17482 16635	27.51 26.19	AS REC'D. 19% MOIST	–	COAL
W25	90											DARK BROWN COALY MUDSTONE
	100		14.4 19.0	23.8 22.4	36.8 34.7	25.0 23.9	0.64 0.61	16921 16022	26.06 24.57	AS REC'D. 19% MOIST	–	COAL
	110, 120, 130											DARK BROWN COALY MUDSTONE
	140, 150											DARK BROWN COALY SIDERITIC MUDSTONE
W26 ANALYSIS			17.6 19.0	32.1 31.6	26.2 25.8	24.1 23.6	0.69 0.66	14006 13762	36.05 34.49	AS REC'D. 19% MOIST	–	WHOLE SEAM ANALYSIS

GN-TUYA RIVER 29(a)A

(6)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER 827

SEAM NAME ______ LOCATION ______

FORMATION MIDDLE MEMBER ELEVATION ______

COMMENTS ______ ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST P.M. W.TERS DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS		LITHOLOGY
												GREY TO BROWN GREY MUDSTONE
W18 (W22)	0–10		14.8 19.0	20.9 19.8	34.1 32.5	30.2 28.7	0.47 0.45	17296 16447	22.83 21.68	AS REC'D. 19% MOIST	–	COAL
	20, 30											BROWN GREY MUDSTONE
	40, 50, 60											DARK BROWN COALY MUDSTONE
W19	63, 70, 78		14.6 19.0	24.6 23.3	32.7 31.0	28.1 26.7	0.61 0.58	16951 16084	26.9 25.3	AS REC'D. 19% MOIST	–	COAL
W22	80, 90, 100, 110, 120, 130, 140, 150, 160											DARK BROWN COALY MUDSTONE
W20 W20	165, 170, 180		13.9 19.0	27.9 26.2	31.2 29.4	27.0 25.3	0.57 0.53	16491 15506	30.46 28.64	AS REC'D. 19% MOIST	–	COAL
	190											DARK BROWN COALY MUDSTONE
W21	200, 210, 220		15.4 19.0	34.4 33.0	25.6 24.5	24.8 23.5	0.43 0.41	13913 13318	37.39 35.83	AS REC'D. 19% MOIST	–	COAL
	230											DARK BROWN COALY MUDSTONE
	240	FAULT										
	250											LIGHT GREY MUDSTONE
W22 ANALYSIS			17.0 19.0	40.7 39.7	27.8 27.2	14.5 14.1	0.43 0.42	11274 11006	44.19 43.10	AS REC'D. 19% MOIST	–	

GN-TUYA RIVER 79(4)A

L7

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER   NTS LOCATION: 104J/2   DRILL HOLE OR OUTCROP NUMBER: B62

SEAM NAME: ______   LOCATION: ______

FORMATION: LOWER MEMBER   ELEVATION: ______

COMMENTS: ______   ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______ GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST: P.M. WATERS   DATE: ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
	above 0		THURST FAULT – GLACIAL									TILL
B6	0–100		25,0 19,0	14,4 15,6	29,1 31,5	31,5 33,9	0,30 0,32	15360 16587	15,72 16,98	AS REC'D. 19% MOIST	1,53 AIR DRIED	COAL
	100–105											SHALEY COAL
	105–150											COAL
	150–170											DARK BROWN SHALEY COAL
	170–285											DARK GREY MUDSTONE
B7	285–430		25,4 19,0	8,9 9,7	30,2 32,8	36,5 38,5	0,36 0,41	17696 19356	9,82 10,72	AS REC'D. 19% MOIST	1,47 AIR DRIED	COAL
B8	430–440		20,5 19,0	41,8 42,6	20,2 20,5	17,5 17,9	0,31 0,32	– –	45,31 46,19	AS REC'D. 19% MOIST	1,86 AIR DRIED	SIDERITIC COAL
B9	440–460		23,1 19,0	16,3 17,2	20,0 31,6	30,6 32,2	0,45 0,47	16617 16984	17,86 18,80	AS REC'D. 19% MOIST	1,51 AIR DRIED	COAL
	460–500											BROWN GREY MUDSTONE
ANALYSIS OF COMPOSITE OF SAMPLES B7, B8 AND B9			23,8 19,0	20,1 21,4	27,0 28,8	29,1 30,8	0,37 0,40	14878 15812	21,91 23,31	AS REC'D. 19% MOIST	1,60 AIR DRIED	

Interval scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 105, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 285, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500

GR- TUYA RIVER 79 (4) A

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

L8

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER W12f

SEAM NAME ______ LOCATION ______

FORMATION UPPER MEMBER ELEVATION ______

COMMENTS ______ ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST P.M. WATERS DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												MEDIUM GREY SANDSTONE TO MUDSTONE
W2	0–10											COAL
	10											COALY MUDSTONE
	20–25											MUDSTONE
W3	25–45 (30, 40)		17.4	60.3	13.6	8.7	0.14	–	–	AS REC'D.	–	COAL / MUDSTONE / COAL
	45–50											MUDSTONE
W4	50–70 (60)		17.2	52.1	16.7	14.0	0.17	–	–	AS REC'D.	–	COAL
W5	70–80											SHALEY COAL
	80–90											GREY BROWN MUDSTONE
	90–114 (100, 106, 110)		15.5	55.2	15.7	13.6	0.12	–	–	AS REC'D.	–	SHALEY COAL
	114–130 (120, 130)											MEDIUM GREY SANDSTONE
W2 ANALYSIS			16.6	57.5	14.7	11.2	0.11	–		AS REC'D.	–	

GN-TUYA RIVER 79(4)A

L9

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY TUYA TIVER   NTS LOCATION 104J/2   DRILL HOLE OR OUTCROP NUMBER W23

SEAM NAME ____   LOCATION ____

FORMATION MIDDLE MEMBER   ELEVATION ____

COMMENTS ____   ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____   OUTCROP X

GEOLOGIST P.M. WATERS   DATE ____

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												MEDIUM GREY SANDSTONE
W6	0 6		18.8 19.0	39.9 39.8	23.0 23.0	18.5 18.2	.79 .79	10190 10163	43.53 43.38	As Rec'd. 19% Moist	–	COAL
	10 13											BROWN MUDSTONE
	20 26											COAL
	30 40											BROWN MUDSTONE
W7	50 60 70 80 90		20,7 19,0	26,8 26,3	28,2 25,8	25,3 25,8	0,56 0,57	13645 13929	28,17 28,74	AS REC'D. 19% MOIST	1,60 AIR DRIED	COAL BROWN MUDSTONE SIDERITIC NODULES COAL BROWN MUDSTONE
	100 10 20											COAL
	30											BROWN MUDSTONE
	40 50 60											COAL
	70											BROWN MUDSTONE
	80 185											COAL
	90 197											BROWN GREY MUDSTONE
	200 10 20											COAL
	30 40 245											BROWN MUDSTONE
W8	50 60		26,0 19,0	23,0 24,8	26,2 28,3	25,8 27,9	0,37 0,40	13362 14413	25,04 26,99	AS REC'D. 19% MOIST	–	COAL
	70 80											BROWN MUDSTONE
	90											COAL
	300 310											GREY BROWN MUDSTONE ORANGE BROWN MUDSTONE
	10 20 325											COAL
	30											INTERBEDDED BROWN GREY AND ORANGE BROWN MUDSTONE
W9	460 470 480 490		20,0 19,0	16,4 16,6	32,8 33,2	30,8 31,2	0,37 0,37	16817 17033	18,63 18,14	AS REC'D. 19% MOIST	–	SIDERITIC NODULES COAL
												BROWN TO GREY BROWN MUDSTONE
W10	550 560 570 580 590		21,4 19,0	16,2 16,6	30,1 31,0	33,3 34,4	0,41 0,42	17052 17561	16,64 17,11	AS REC'D. 19% MOIST	–	COAL
	600											BROWN GREY MUDSTONE
ANALYSIS OF COMPOSITE OF SAMPLES W7 & W8			21.7 19.0	26.0 26.8	27.7 28.7	25.6 26.5	0,60 0,62	13615 14080	27.27 28.19	AS REC'D. 19% MOIST	–	

GN TUYA RIVER 79 (4) A

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

L10

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER W26

SEAM NAME LOCATION

FORMATION MIDDLE MEMBER ELEVATION

COMMENTS ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST P.M. WATERS DATE

DESCRIPTION

SAMPLE	INTERVAL	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
											MEDIUM GREY MUDSTONE
W11	0–60	14.4 19.0	14.1 13.4	37.2 35.2	34.3 32.4	0.71 0.62	19920 18935	15.6 14.81	AS REC'D. 19% MOIST	–	COAL
	60–100										MEDIUM GREY TO BROWN GREY MUDSTONE

INTERVAL scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

GN-TUYA RIVER 79(4)A

(L11)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER W28b

SEAM NAME ______ LOCATION ______

FORMATION MIDDLE MEMBER ELEVATION ______

COMMENTS ______ ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST P.M. WATERS DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
	0											BROWN COALY MUDSTONE
												COAL
	10 20 30											BROWN COALY MUDSTONE
W12	32 40 50 60 68		14.0 19.0	20.8 19.4	30.2 28.4	35.2 33.2	0.74 0.73	17375 17072	22.65 21.39	AS REC'D. 19% MOIST	–	COAL
	70 80 90 100											BROWN COALY MUDSTONE

COAL OUTCROP SAMPLE ANALYSES,

TUYA RIVER PROPERTY,

BRITISH COLUMBIA

NTS 104J/2

Coal Licences 3903-3913 Incl.

Bruce D. Vincent, P. Geol.
Esso Minerals Canada
Coal Department
Calgary, Alberta

September, 1979

00246 (3)

ABSTRACT

Thirty-nine outcrop channel samples from the Tuya River coal property (NTS 104J/2) were submitted for coal analyses including moisture content, proximate analysis, calorific value, and specific gravity. A thickness-weighted average of 19% moisture was assumed to be representative of the seams. The other analytical results were then prorated to a 19% moisture basis; weighted averages were found and are ash 21.5%, volatile matter 29.4%, fixed carbon 30.1%, calorific value 16159 kJ/kg (6950 BTU/lb), sulphur 0.46%. The average mineral matter was found to be 23.5% on a 19% moisture basis and specific gravity 1.57 on an air-dried basis. The moist (19% moisture) mineral matter-free calorific value is 9828 BTU/lb (22850 kJ/kg) which determines the coal rank is subbituminous B.

TABLE OF CONTENTS

List of Figures

1. INTRODUCTION

1.1 Purpose

During the geological mapping of the Tuya River coal property conducted in June of 1979, most of the outcrops of coal seams were sampled for laboratory coal analysis. This report contains the results of the analytical work and discussion of the results.

1.2 Location

The Tuya River coal licenses are situated in northwestern British Columbia with their center approximately equidistant from the communities of Dease Lake and Telegraph Creek as shown in Figure 1. For a further discussion on the region, its geology, and the property geology, the reader is referred to the exploration report by Vincent (1979).

The locations of the outcrops from which the samples were taken are shown in Figure 2. More detailed locations are shown on the property geological map contained in the exploration report mentioned above.

1.3 Sampling and Analyses

During geological mapping all coal seams encountered were noted and described. Near the end of the program, the most representative seams were chosen for sampling and were revisited.

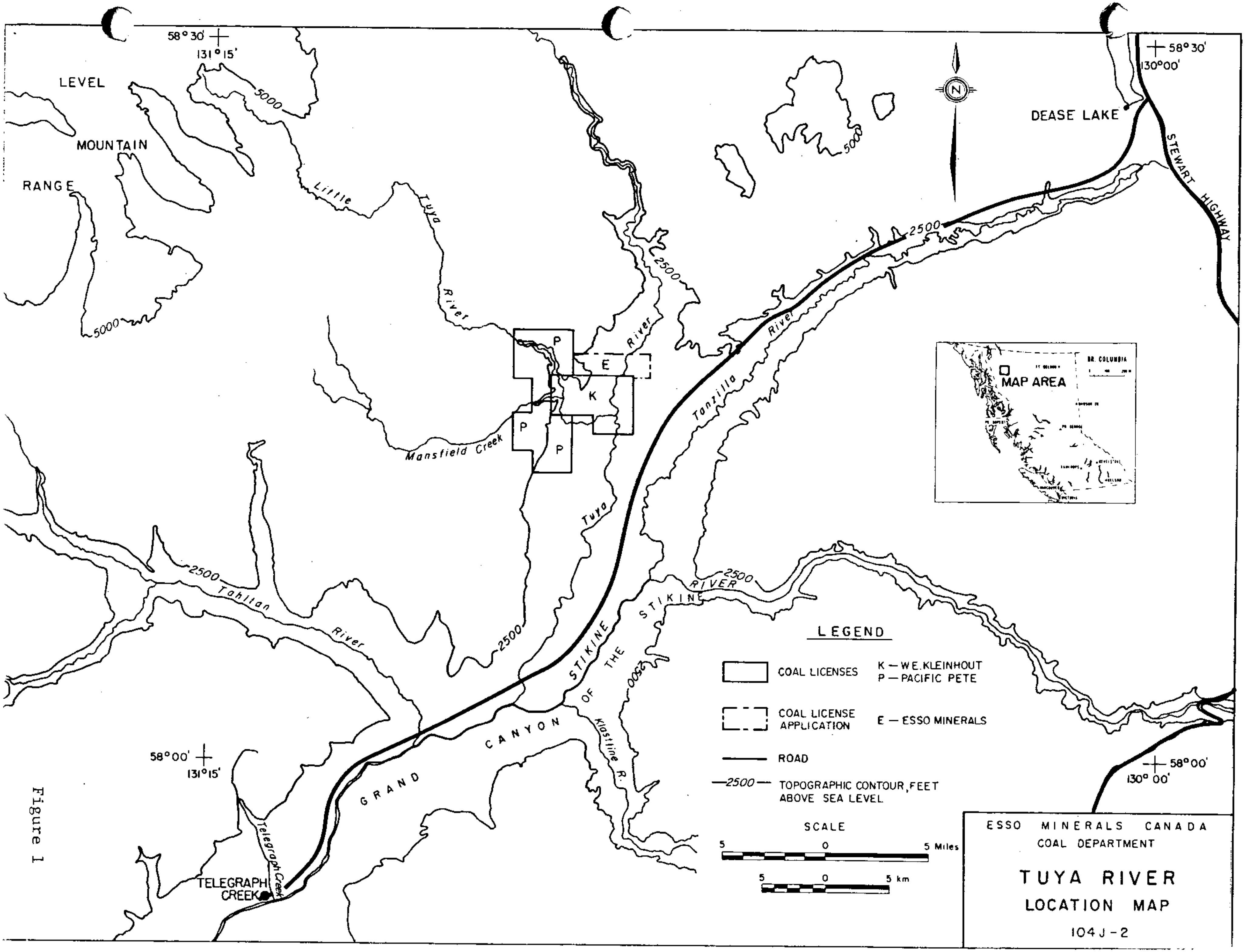
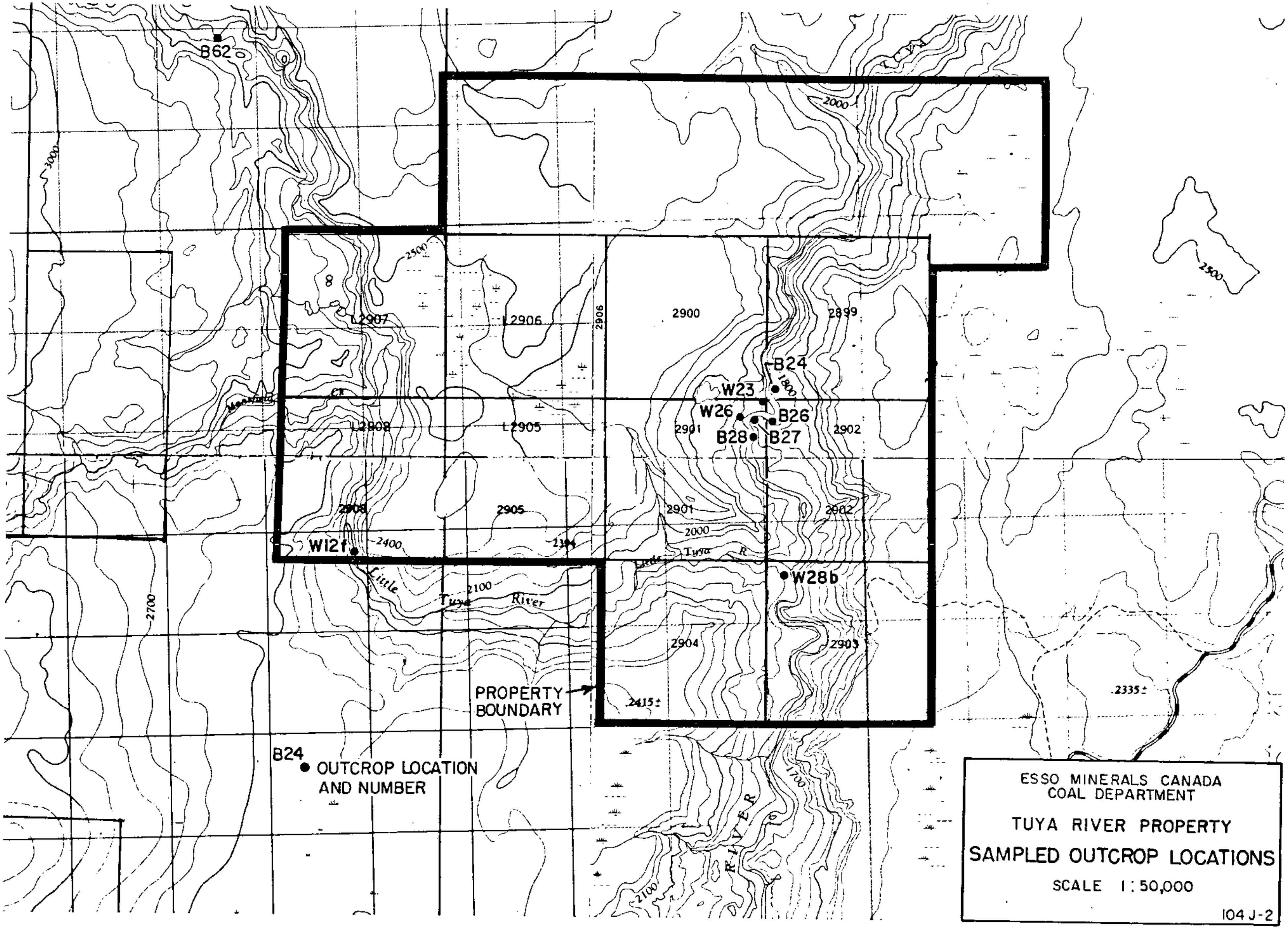

58° 30'
131° 15'
LEVEL
MOUNTAIN
RANGE
5000
Little Tuya River
Mansfield Creek
P
E
K
P
P
River
2500
Tuya
Tahltan
River
Tanzilla River
2500
DEASE LAKE
STEWART HIGHWAY
58° 30'
130° 00'
N
MAP AREA
STIKINE RIVER
GRAND CANYON OF THE STIKINE
Klastline R.
58° 00'
131° 15'
TELEGRAPH CREEK
Telegraph Creek
58° 00'
130° 00'
LEGEND
COAL LICENSES
K — W.E. KLEINHOUT
P — PACIFIC PETE
COAL LICENSE APPLICATION
E — ESSO MINERALS
ROAD
2500 TOPOGRAPHIC CONTOUR, FEET ABOVE SEA LEVEL
SCALE
5 0 5 Miles
5 0 5 km
ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER
LOCATION MAP
104 J - 2

Figure 1



B62
3000
2500
2000
L2907
L2906
2906
2900
2899
B24
1800
W23
W26
B26
B28
B27
2901
2902
L2908
L2905
2908
2905
2901
2902
2000
W12f
2400
2394
Tuya R
W28b
Little Tuya River
2100
2700
2904
2903
PROPERTY BOUNDARY
2415±
2335±
B24
OUTCROP LOCATION AND NUMBER
1700
RIVER
2100
ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER PROPERTY
SAMPLED OUTCROP LOCATIONS
SCALE 1:50,000
104 J-2

1.3 Sampling and Analyses (Cont'd)

The outcrops were prepared for sampling by removing a section of coal and overburden, by pick and shovel, up to 0.3 metres wide perpendicular to the seam top and bottom from the seam top to bottom if at all possible. The purposes of this were to get as clean and unoxidized a sample as possible and to obtain as accurate a seam thickness as possible.

The coal seam was then examined and described in detail which included estimations of coal constituents. If possible, the seam was subdivided into portions based on varying constituent proportions or by the presence or absence of mudstone partings.

Continuous channel samples of each of the subdivisions of the seam were then taken by chipping off a small portion of the exposed face. Care was taken to remove roughly equal portions from all parts of the seam for an equal representation. These were immediately placed in plastic bags and labelled in the field and packed in metal cans upon return to base for shipment.

After the samples were shipped to Calgary, small portions of a few samples were removed for palynological analyses and then resealed and all were sent to Birtley Coal and Minerals Testing of Calgary for analyses. Birtley performed the standard analyses for moisture, proximate analysis, total sulphur, calorific value, and specific gravity on the samples.

2. ANALYTICAL RESULTS AND CALCULATIONS

2.1 Introduction

The results as received from Birtley Coal and Minerals Testings form Appendix I of this report. The results are also displayed along with graphic logs of the coal seams in Appendix 2.

2.2 Moisture Content

The moisture content of the Tuya River samples were analysed on an as-received basis. That is, the total water content of the sample when initially analysed. As no other analytical work was done on moisture content, the as-received moisture was assumed to be an approximation of the natural moisture of the seams. It is only an approximation since the samples were taken from outcrops, a location which may increase or decrease the natural bed moisture.

The moisture contents of the samples ranged from 13.9 to 25.4 weight percent. The weighted average for the samples is 19% and this value is assumed to be the average for the property.

2.3 Proximate Analyses

The determination of the ash, volatile matter and fixed carbon content of thirty-nine samples was done and reported on an as-received basis and also reported on a dry basis. In addition, seven samples were composited into 3 additional samples and analysed. The results are presented in Appendices I and II.

In order to determine an average for the property, the ash and volatile matter were recalculated for an average moisture content of 19% by the following formulas:

2.3 Proximate Analyses (Cont'd)

$$A_{19} = A_D(1.0 - \frac{M}{100})$$

and $$VM_{19} = VM_D(1 - \frac{M}{100})$$

where A_{19} = ash at 19% moisture,

A_D = ash on dry basis,

M = moisture = 19%,

VM_{19} = volatile matter at 19% moisture,

and VM_D = volatile matter on dry basis.

Fixed carbon was calculated by difference. The results of these calculations are included in Appendix II.

In addition, the mineral matter content of the samples was calculated by the Parr formula.

$$M_M = 1.08A + 0.55\ S$$

where M_M = mineral matter,

A = ash,

and S = total sulphur

with the ash and sulphur contents having been reported on the same basis. The calculation of the mineral matter contents and use of them instead of ash contents makes corrections necessary due to losses of ash and sulphur during the analytical process. The mineral matter content was calculated for each sample on as-received and dry bases and for 19% moisture.

2.3 Proximate Analyses (Cont'd)

The weighted averages of the ash, volatile matter, and mineral matter were calculated using the seam thickness from which representative samples or composite samples were taken. The average fixed carbon was calculated by difference. The weighted averages at 19% moisture are:

Ash	21.5%
Volatile Matter	29.4%
Fixed Carbon	30.1%
(Mineral Matter	23.52%)

2.4 Sulphur

The total sulphur content of each sample and composite sample processed in the proximate analyses was found and reported on an as-received and a dry basis. The as-received values ranged from 0.11% to 0.92%. The sulphur content was also calculated for 19% moisture and the range was between 0.26% and 0.87%. The weighted average sulphur content was determined to be 0.46%.

2.5 Calorific Value and Coal Rank

Calorific values for 34 samples and 3 composite samples were founded and reported as BTU/lb on as-received and dry bases. These have been converted to the standard SI unit of kiloJoules per kilogram (kJ/kg). The values were prorated from a dry basis to a 19% moisture basis by the following formula:

2.5 Calorific Value and Coal Rank (Cont'd)

$$CV_{19} = CV_D(1.0 - \frac{M}{100})$$

where CV_{19} = calorific value at 19% moisture

CV_D = dry calorific value,

and M = moisture = 19%

In order to determine an average calorific value least-squares linear regression was done for calorific value versus ash and calorific value versus mineral matter (Figures 3 and 4). These graphs were possible by plotting the values previously calculated to a 19% moisture basis.

The regression line of the plot of calorific value versus ash (Figure 3) is described by the formula with the format

$$Y = mx + b$$

where m is the slope and b is the y-intercept which in this case becomes

$$A_{19} = (-0.0075)CV_{19} + 73.38$$

where A_{19} = ash content at 19% moisture

CV_{19} = calorific value at 19% moisture

The calorific value corresponding to the weighted-average ash content at 19% moisture of 21.5% was determined to be 16,159 kJ/kg (6950 BTU/lb). The calorific value at 0% ash is 22771 kJ/kg (9794 BRU/lb). The correlation coefficient of the plot of calorific value versus ash content is -0.982.

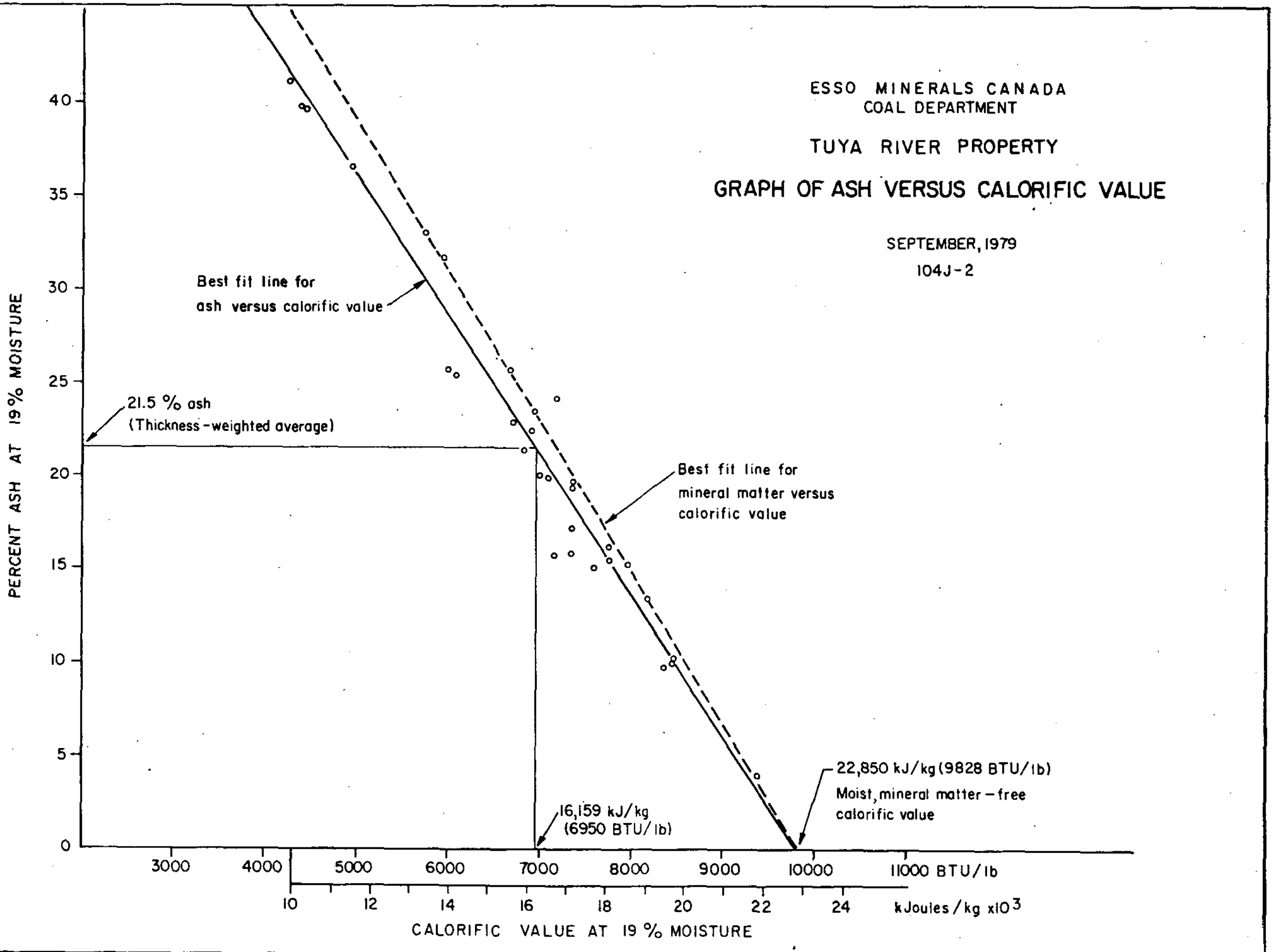
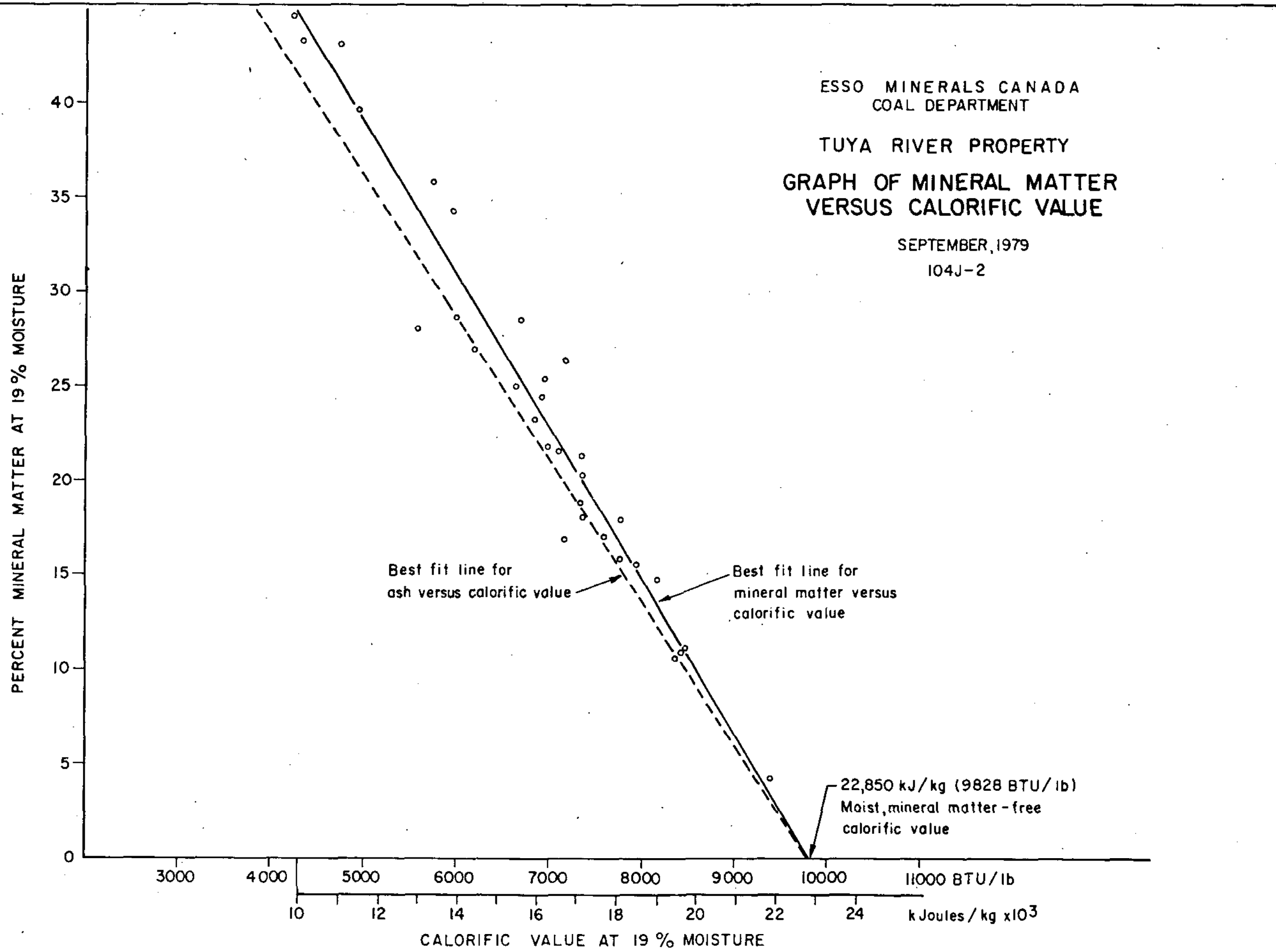

ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER PROPERTY
GRAPH OF ASH VERSUS CALORIFIC VALUE
SEPTEMBER, 1979
104J-2
Best fit line for ash versus calorific value
Best fit line for mineral matter versus calorific value
21.5 % ash (Thickness-weighted average)
16,159 kJ/kg (6950 BTU/lb)
22,850 kJ/kg (9828 BTU/lb)
Moist, mineral matter-free calorific value
PERCENT ASH AT 19% MOISTURE
0
5
10
15
20
25
30
35
40
3000
4000
5000
6000
7000
8000
9000
10000
11000 BTU/lb
10
12
14
16
18
20
22
24
kJoules/kg x10^3
CALORIFIC VALUE AT 19 % MOISTURE

Figure 3

Figure 4


ESSO MINERALS CANADA
COAL DEPARTMENT
TUYA RIVER PROPERTY
GRAPH OF MINERAL MATTER VERSUS CALORIFIC VALUE
SEPTEMBER, 1979
104J-2
PERCENT MINERAL MATTER AT 19 % MOISTURE
40
35
30
25
20
15
10
5
0
Best fit line for ash versus calorific value
Best fit line for mineral matter versus calorific value
22,850 kJ/kg (9828 BTU/lb) Moist, mineral matter-free calorific value
3000
4000
5000
6000
7000
8000
9000
10000
11000 BTU/lb
10
12
14
16
18
20
22
24
k Joules/kg x10^3
CALORIFIC VALUE AT 19 % MOISTURE

2.5 Calorific Value and Coal Rank (Cont'd)

For the plot of calorific value versus mineral matter content at 19% moisture (Figure 4) the regression line may be described as

$$Mm_{19} = (-0.0081) CV_{19} + 79.57.$$

For the weight-average mineral matter content of 23.5% calculated above, the corresponding calorific value was found to be 16,043 kJ/kg (6900 BTU/lb). At 0% mineral matter, the calorific value is 22850 kJ/kg (9828 BTU/lb). This is better termed moist, mineral matter-free calorific value. The correlation coefficient of this plot is -0.981.

The American Society for Testing and Material has subdivided low-rank coal on the basis of moist, mineral matter-free calorific value. At 19% moisture, the moist, mineral matter-free calorific value of the Tuya River samples is 9823 BTU/lb which is in the range of values for coal with a subbituminous B rank.

2.6 Specific Gravity

The air-dried specific gravity was reported for 3 composite samples and their individual portions. The weighted-average was found to be 1.57 for the samples. This value may be assumed to be the average for the field while remembering it is reported on an air-dried basis while the other averages are reported on a 19% moisture basis.

3. DISCUSSION OF RESULTS

3.1 Quality of the Results

From the fact that all of the Tuya River samples are from outcrop exposures of coal seams and associated strata, it can be assumed all of the samples have been oxidized and the components altered to some degree. This is true even though the outcrops were cleaned to expose as fresh a face as possible. But ~~However~~, the results of the analyses are of use and thought to be a close representation of the actual coal quality. Points in favour of this assumption are the small range of values for moisture content and the close correlations between calorific value and each of mineral matter and ash.

Any further analytical work using drill core samples would probably increase the coal quality by reducing the ash content and thereby increasing the calorific value. It is unlikely the increase would be dramatic. It is also unlikely the rank of the coal would change and if it did, probably only up to subbituminous A.

3.2 Ash Versus Mineral Matter

The mineral matter content of coal is the inorganic constituents of coal and is composed primarily of clayey materials (aluminum silicates and silica), pyrite, and calcite. The ash is the non-combustible residue left after the ashing of coal. This residue originates from extraneous mineral matter and inorganic material combined with the organic fraction of the coal. The ash value is always less than the mineral matter value because, during ashing, some of the inorganic material is altered. The most common

3.2 Ash Versus Mineral Matter (Cont'd)

reactions are the loss of water of hydration from clay minerals and the oxidation of pyrite and calcite. These reactions are compensated for in the Parr formula for determining mineral matter (Rees, 1966).

In this report, the mineral matter values were used to determine the rank of the coal and the weighted-average is given as being a constituent of the coal. However, the average calorific value of the samples was derived from the calorific value versus ash plot and reported with the weighted-average ash value since that calorific value is the one actually achieved upon buring as opposed to one drived from the average mineral matter. Both plots and regression lines are included here because of the two distinct uses of the data.

samples of the main seam in its thickest and best exposure?

of surface samples believed to be relatively unoxidized

4. SUMMARY

From the laboratory analyses of outcrop channel samples, a good approximation of the unoxidized coal quality and rank of the Tuya River coal seams has been obtained.

The average quality, using thickness-weighted averages, for the property is

Moisture	19.0%
Ash	21.5
Volatile Matter	29.4
Fixed Carbon	30.1
Total Sulphur	0.46
Calorific value	16159 kiloJoule/kilogram (6950 BTU/lb)
Mineral Matter	23.5%
Specific gravity, air-dried basis	1.57

The coal rank was determined to be subbituminous B from a moist (19% moisture), mineral matter-free calorific value of 9828 BTU/lb (22850 kJ/kg). This is within the range of values defined to be that of subbituminous B coal of 9500 to 10,500 BTU/lb.

5. REFERENCES

Rees, O.W. (1966)
"Chemistry, Uses, and Limitations of Coal Analyses"; Illinois State Geol. Surv. Rept. Inv. 220, 55p.

Vincent, B.D. (1979)
"Geological Mapping of the Tuya River Property, British Columbia, NTS 104J/2"; Unpublished internal report for Esso Minerals Canada, Coal Department, 30p.

2.5 Calorific Value and Coal Rank (Cont'd)

For the plot of calorific value versus mineral matter content at 19% moisture (Figure 4) the regression line may be described as

$$Mm_{19} = (-0.0081)CV_{19} + 79.57.$$

For the weight-average mineral matter content of 23.5% calculated above, the corresponding calorific value was found to be 16,043 kJ/kg (6900 BTU/lb). At 0% mineral matter, the calorific value is 22850 kJ/kg (9828 BTU/lb). This is better termed moist, mineral matter-free calorific value. The correlation coefficient of this plot is -0.981.

The American Society for Testing and Material has subdivided low-rank coal on the basis of moist, mineral matter-free calorific value. At 19% moisture, the moist, mineral matter-free calorific value of the Tuya River samples is 9823 BTU/lb which is in the range of values for coal with a subbituminous B rank.

2.6 Specific Gravity

The air-dried specific gravity was reported for 3 composite samples and their individual portions. The weighted-average was found to be 1.57 for the samples. This value may be assumed to be the average for the field while remembering it is reported on an air-dried basis while the other averages are reported on a 19% moisture basis.

3. DISCUSSION OF RESULTS

3.1 Quality of the Results

From the fact that all of the Tuya River samples are from outcrop exposures of coal seams and associated strata, it can be assumed all of the samples have been oxidized and the components altered to some degree. This is true even though the outcrops were cleaned to expose as fresh a face as possible. But, the results of the analyses are of use and thought to be a close representation of the actual coal quality. Points in favour of this assumption are the small range of values for moisture content and the close correlations between calorific value and each of mineral matter and ash.

Any further analytical work using drill core samples would probably increase the coal quality by reducing the ash content and thereby increasing the calorific value. It is unlikely the increase would be dramatic. It is also unlikely the rank of the coal would change and if it did, probably only up to subbituminous A.

3.2 Ash Versus Mineral Matter

The mineral matter content of coal is the inorganic constituents of coal and is composed primarily of clayey materials (aluminum silicates and silica), pyrite, and calcite. The ash is the non-combustible residue left after the ashing of coal. This residue originates from extraneous mineral matter and inorganic material combined with the organic fraction of the coal. The ash value is always less than the mineral matter value because, during ashing, some of the inorganic material is altered. The most common

reactions are the loss of water of hydration from clay minerals and the oxidation of pyrite and calcite. These reactions are compensated for in the Parr formula for determining mineral matter (Rees, 1966).

In this report, the mineral matter values are used to determine the rank of the coal with the weighted-average value for mineral matter used as a constituent of the coal. The average calorific value of the samples was derived from the calorific value versus ash plot and reported with the weighted-average ash value since that calorific value is the one actually achieved upon burning as opposed to one derived from the average mineral matter. Both plots and regression lines are included here because of the two distinct uses of the data.

4. SUMMARY

From the laboratory analyses of outcrop channel samples, a good approximation of the unoxidized coal quality and rank of the Tuya River coal seams has been obtained.

The average quality, using thickness-weighted averages, for the property is

Moisture	19.0%
Ash	21.5
Volatile Matter	29.4
Fixed Carbon	30.1
Total Sulphur	0.46
Calorific value	16159 kiloJoule/kilogram (6950 BTU/lb)
Mineral Matter	23.5%
Specific gravity, air-dried basis	1.57

The coal rank was determined to be subbituminous B from a moist (19% moisture), mineral matter-free calorific value of 9828 BTU/lb (22850 kJ/kg). This is within the range of values defined to be that of subbituminous B coal of 9500 to 10,500 BTU/lb.

5. REFERENCES

Rees, O.W. (1966)
"Chemistry, Uses, and Limitations of Coal Analyses"; Illinois State Geol. Surv. Rept. Inv. 220, 55p.

Vincent, B.D. (1979)
"Geological Mapping of the Tuya River Property, British Columbia, NTS 104J/2"; Unpublished internal report for Esso Minerals Canada, Coal Department, 30p.

APPENDIX I

Coal Analyses Laboratory Report

Birtley Coal
& Minerals Testing
A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD.

RECEIVED
SEP 13 1979
EMC - COAL

BIRTLEY

August 31, 1979

Mr. Bruce Vincent
Esso Minerals Canada
Coal Department
500 - 6 Avenue SW
Calgary, Alberta
T2P 0S1

Dear Mr. Vincent:

Re: TUYA RIVER 104J/2

Please find enclosed the analyses requested in your letter dated August 1, 1979 on samples identified as "Tuya River Outcrop Channel Samples".

Yours truly,

BIRTLEY COAL AND MINERALS TESTING

Frank J. Horvat

Frank J. Horvat
General Manager

cas
Encl.

505 - 50th Avenue S.E., P.O. Box 5488, Station "A", Calgary, Alberta T2H 1X9 Telephone (403) 253-8273

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3200	16.6	57.5	14.7	11.2	0.11	---	---	arb
W12F,W2		68.9	17.6	13.5	0.13	---	---	db
3201	17.4	60.3	13.6	8.7	0.14	---	---	arb
W12F,W3		72.9	16.4	10.7	0.17	---	---	db
3202	17.2	52.1	16.7	14.0	0.17	---	---	arb
W12F,W4		62.9	20.2	16.9	0.20	---	---	db
3203	15.5	55.2	15.7	13.6	0.12	---	---	arb
W12F,W5		65.3	18.5	16.2	0.14	---	---	db
3204	18.8	39.9	23.0	18.3	0.79	4383	---	arb
W23,W6		49.1	28.4	22.5	0.97	5396	---	db
3205	20.7	25.8	28.2	25.3	0.56	5869	1.60	arb
W23,W7		32.5	35.6	31.9	0.70	7396	---	db
3206	25.0	23.0	26.2	25.8	0.37	5743	---	arb
W23,W8		30.6	35.0	34.4	0.49	7654	---	db
3207	20.0	16.4	32.8	30.8	0.37	7233	---	arb
W23,W9		20.5	41.0	38.5	0.46	9044	---	db
3208	21.4	15.2	30.1	33.3	0.41	7334	---	arb
W23,W10		19.3	38.3	42.4	0.52	9325	---	db

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

August 10, 1979

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3209	14.4	14.1	37.2	34.3	0.71	8602	---	arb
W26,W11		16.5	43.5	40.0	0.83	10054	---	db
3210	14.0	20.6	30.2	35.2	0.74	7437	---	arb
W28b,W12		24.0	35.1	40.9	0.90	9065	---	db
3211	21.2	9.8	32.1	36.9	0.45	8197	---	arb
B24a,W28		12.4	40.7	46.9	0.58	10397	---	db
3212	16.2	20.3	32.5	31.0	0.74	7028	---	arb
B24a,W29		24.2	38.8	37.0	0.88	8397	---	db
3213	16.4	4.0	33.3	46.3	0.27	9664	1.39	arb
B24b,W30		4.8	39.8	55.4	0.32	11561	---	db
3214	18.6	20.1	31.8	29.5	0.49	7017	1.57	arb
B24b,W31		24.7	39.1	36.2	0.60	8620	---	db
3215	17.6	41.9	21.9	18.6	0.32	4297	---	arb
B24c,W32		50.9	26.5	22.6	0.39	5216	---	db
3216	20.1	22.6	28.5	28.8	0.74	6543	---	arb
B24c,W33		28.2	35.7	36.1	0.92	8191	---	db
3217	18.4	15.5	30.2	35.9	0.43	7818	---	arb
B24c,W34		19.0	37.0	44.0	0.53	9586	---	db

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3218	20.3	15.0	29.5	35.2	0.38	7803	---	arb
B24c,W35		18.8	37.0	44.2	0.47	9766	---	db
3219	21.7	35.4	22.9	20.0	0.35	4754	---	arb
B24c,W36		45.2	29.2	25.6	0.45	6070	---	db
3220	16.1	20.3	30.1	33.5	0.44	7586	---	arb
B26a,W23		24.2	35.9	39.9	0.53	9042	---	db
3221	14.9	25.0	29.8	30.3	0.92	7519	---	arb
B26a,W24		29.3	35.0	35.7	1.08	8833	---	db
3222	14.4	23.8	36.8	25.0	0.64	7278	---	arb
B26a,W25		27.7	42.9	29.4	0.75	8507	---	db
3223	17.6	32.1	26.2	24.1	0.69	6025	---	arb
B26a,W26		39.0	31.8	29.2	0.84	7308	---	db
3224	20.1	16.0	30.1	33.8	0.81	7633	---	arb
B26b,W27		20.0	37.7	42.3	1.01	9550	---	db
3225	14.8	20.9	34.1	30.2	0.47	7439	---	arb
B27,W18		24.5	40.1	35.4	0.55	8733	---	db
3226	14.6	24.6	32.7	28.1	0.61	7291	---	arb
B27,W19		28.8	38.3	32.9	0.72	8541	---	db

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
3227	13.9	27.9	31.2	27.0	0.57	7093	---	arb
B27,W20		32.4	36.3	31.3	0.66	8234	---	db
3228	15.4	34.4	25.6	24.6	0.43	5984	---	arb
B27,W21		40.7	30.2	29.1	0.51	7072	---	db
3229	17.0	40.7	27.8	14.5	0.43	4849	---	arb
B27,W22		49.0	33.6	17.4	0.52	5845	---	db
B28 3230 W13	22.5	16.9	30.5	30.1	0.61	6967	---	arb
W14,W15,		21.7	39.3	39.0	0.79	8991	---	db
W16,W17								
3231	25.0	14.4	29.1	31.5	0.30	6602	1.53	arb
B62,B6		19.2	38.9	41.9	0.40	8807	---	db
3232	25.4	8.9	30.2	35.5	0.38	7611	1.47	arb
B62,B7		12.0	40.5	47.5	0.51	10278	---	db
3233	20.5	41.8	20.2	17.5	0.31	---	1.86	arb
B62,B8		52.6	25.3	22.1	0.39	---	---	db
3234	23.1	16.3	20.0	30.6	0.45	6932	1.51	arb
B62,B9		21.2	39.0	39.8	0.58	9018	---	db
								arb
								db

Birtley Coal & Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

CLIENT: ESSO MINERALS CANADA

PROJECT: TUYA RIVER OUTCROP CHANNEL SAMPLES

RECEIVED AUGUST 3, 1979

COMPOSITES

Lab # & Sample #	MOISTURE%	ASH%	VOL.%	F.C.%	S.%	B.T.U.	AIRDRIED BASIS S.G.	CALC. FACTORS
W7	21.7	25.0	27.7	25.6	0.50	5856	---	arb
W8		31.9	35.4	32.7	0.64	7476	---	db
W30	17.1	10.5	32.8	39.6	0.36	8610	1.46	arb
W31		12.6	39.5	47.9	0.44	10387	---	db
W13,14	22.5	16.9	30.5	30.1	0.61	6967	---	arb
15,16		21.7	39.3	39.0	0.79	8991	---	db
17								
B7	23.8	20.1	27.0	29.1	0.37	6399	1.60	arb
B8		26.4	35.5	38.1	0.49	8396	---	db
B9								
								arb
								db
								arb
								db
								arb
								db
								arb
								db
								arb
								db

Birtley Coal
& Minerals Testing

A DIVISION OF GREAT WEST STEEL INDUSTRIES LTD

APPENDIX II

Coal Analyses on
Graphic Logs

Abbreviations used on graphic logs:

Moist.	moisture
V.M.	volatile matter
F.C.	fixed carbon
S	sulphur
C.V.	calorific value
M.M.	mineral matter
Sp.Gr.	specific gravity
As rec'd	As received basis
19% moist	19% moisture basis

Notes:

All values except calorific value are given as a percentage.

Calorific value is stated as kiloJoules per kilogram where 1 kJ/kg = 2.325 BTU/lb.

All interval values are given in centimetres.

(4)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER   NTS LOCATION: 104J/2   DRILL HOLE OR OUTCROP NUMBER: W12f

SEAM NAME: ____   LOCATION: ____

FORMATION: UPPER MEMBER   ELEVATION: ____

COMMENTS: ____   ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____ GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST: P.M. WATERS   DATE: ____

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												MEDIUM GREY SANDSTONE TO MUDSTONE
W2	0–10											COAL
W2	10											COALY MUDSTONE
W2	20, 25											MUDSTONE
W2 / W3	30		17.4	60.3	13.6	8.7	0.14	–	–	AS REC'D.	–	COAL
W2 / W3												MUDSTONE
W2 / W3	40, 45											COAL
W2	50											MUDSTONE
W2 / W4	60		17.2	52.1	18.7	14.0	0.17	–	–	AS REC'D.	–	COAL
W2 / W5	70											SHALEY COAL
W2 / W5	80											GREY BROWN MUDSTONE
W2 / W5	90, 100, 106, 110, 114		15.5	55.2	15.7	13.6	0.12	–	–	AS REC'D.	–	SHALEY COAL
	120, 130											MEDIUM GREY SANDSTONE
W2 ANALYSIS			16.6	57.5	14.7	11.2	0.11	–		AS REC'D.	–	

ESSO MINERALS CANADA — COAL DEPARTMENT

L2

GRAPHIC COAL SEAM LOG

PROPERTY TUYA TIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER W23

SEAM NAME ____ LOCATION ____

FORMATION MIDDLE MEMBER ELEVATION ____

COMMENTS ____ ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST P.M. WATERS DATE ____

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												MEDIUM GREY SANDSTONE
W6	0, 6		18.8 / 19.0	39.9 / 39.8	23.0 / 23.0	18.5 / 18.2	.79 / .79	10190 / 10163	43.53 / 43.38	As Rec'd. / 19% Moist	–	COAL
	10, 13											BROWN MUDSTONE
	20, 26											COAL
	30, 40											BROWN MUDSTONE
W7	50, 60, 70, 80, 90		20,7 / 19,0	25,8 / 26,3	28,2 / 25,8	25,3 / 25,8	0,56 / 0,57	13646 / 13929	28,17 / 28,74	AS REC'D. / 19% MOIST	1,60 AIR DRIED	COAL / BROWN MUDSTONE / SIDERITIC NODULES / COAL
	100											BROWN MUDSTONE
	10, 20											COAL
	30											BROWN MUDSTONE
	40, 50, 60, 70											COAL
	80											BROWN MUDSTONE
	185											COAL
	90, 197											BROWN GREY MUDSTONE
	200, 10, 20											COAL
	30, 40, 245											BROWN MUDSTONE
W8	50, 60		25,0 / 19,0	23,0 / 24,8	26,2 / 28,3	25,8 / 27,9	0,37 / 0,40	13352 / 14413	25,04 / 26,99	AS REC'D. / 19% MOIST	–	COAL
	70, 80											BROWN MUDSTONE
	90											COAL
	300, 310											GREY BROWN MUDSTONE / ORANGE BROWN MUDSTONE
	10, 20, 325											COAL
	30											INTERBEDDED BROWN GREY AND ORANGE BROWN MUDSTONE
W9	460, 470, 480, 490		20,0 / 19,0	16,4 / 16,6	32,8 / 33,2	30,8 / 31,2	0,37 / 0,37	16817 / 17033	18,63 / 18,14	AS REC'D. / 19% MOIST	–	SIDERITIC NODULES / COAL
												BROWN TO GREY BROWN MUDSTONE
W10	550, 560, 570, 580, 590		21,4 / 19,0	15,2 / 15,6	30,1 / 31,0	33,3 / 34,4	0,41 / 0,42	17062 / 17561	16,64 / 17,11	AS REC'D. / 19% MOIST	–	COAL
	600											BROWN GREY MUDSTONE
ANALYSIS OF COMPOSITE OF SAMPLES W7 & W8			21,7 / 19,0	25,0 / 25,8	27,7 / 28,7	25,6 / 26,5	0,50 / 0,52	13615 / 14080	27,27 / 28,19	AS REC'D. / 19% MOIST	–	

ESSO MINERALS CANADA — COAL DEPARTMENT

(L3)

GRAPHIC COAL SEAM LOG

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER W29

SEAM NAME LOCATION

FORMATION MIDDLE MEMBER ELEVATION

COMMENTS ORIGIN OF LOG: CORE ___ CHIP SAMPLES ___

GEOPHYSICAL LOG ___ OUTCROP X

GEOLOGIST P.M. WATERS DATE

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												MEDIUM GREY MUDSTONE
W11	0–60		14.4	14.1	37.2	34.3	0.71	19920	15.6	AS REC'D.	–	COAL
			19.0	13.4	35.2	32.4	0.62	18935	14.81	19% MOIST		
	60–100											MEDIUM GREY TO BROWN GREY MUDSTONE

INTERVAL scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

(L4)

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER NTS LOCATION: 104J/2 DRILL HOLE OR OUTCROP NUMBER: N265

SEAM NAME: ______ LOCATION: ______

FORMATION: MIDDLE MEMBER ELEVATION: ______

COMMENTS: ______ ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST: P.M. W[illegible]TERS DATE: ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												BROWN COALY MUDSTONE
	0	(shaded – coal)										COAL
	10, 20, 30											BROWN COALY MUDSTONE
W12 (32–68)	32, 40, 50, 60, 68	(shaded – coal)	14.0	20.8	30.2	35.2	0.74	17375	22.35	AS REC'D.	–	COAL
			19.0	19.4	28.4	33.2	0.73	17072	21.39	19% MOIST		
	70, 80, 90, 100											BROWN COALY MUDSTONE

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER

NTS LOCATION: 10-J/2

DRILL HOLE OR OUTCROP NUMBER: 324a

SEAM NAME:

LOCATION:

FORMATION: MIDDLE MEMBER

ELEVATION:

COMMENTS:

ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST: P.M. WATERS

DATE:

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												LIGHT BROWN SIDERITIC MUDSTONE
W28	0 10 20											COAL
	30 40											BROWN MUDSTONE
	50 60 70 80 90											BROWN TO DARK BROWN COALY MUDSTONE
												COAL
	100 110 120											BROWN TO DARK BROWN COALY MUDSTONE
	130											RUSTBROWN MUDSTONE
W29	140											COAL
												BROWN COALY MUDSTONE
	150 160		21.2 19.0	9.8 10.0	32.1 33.0	36.9 37.0	0.45 0.47	19058 19581	10.83 11.11	AS REC'D. 19% MOIST	–	COAL
	170 180											LIGHT GREY-BROWN SANDY MUDSTONE

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(Lb)

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER B24b

SEAM NAME LOCATION

FORMATION MIDDLE MEMBER ELEVATION

COMMENTS ORIGIN OF LOG: CORE CHIP SAMPLES

GEOPHYSICAL LOG OUTCROP X

GEOLOGIST P.M. WATERS DATE

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
	0											COVERED
	10, 20, 30, 40, 50, 60, 65											BROWN TO DARK BROWN COALY MUDSTONE
W30	70, 80, 90, 100, 105		16,4 19,0	4,0 3,9	33,3 32,2	46,3 44,9	0,27 0,26	22468 21771	4.47 4,34	AS REC'D. 19% MOIST	1,39 AIR DRIED	COAL
	110											RUSTBROWN SIDERITIC MUDSTONE
W31	120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 215		18,6 19,0	20,1 20,0	31,8 31,7	29,5 29,3	0,49 0,49	16314 16233	21,97 21,87	AS REC'D. 19% MOIST	1,57 AIR DRIED	COAL
	220, 230											COVERED
ANALYSIS OF COMPOSITE OF SAMPLES W30 AND W31			17,1 19,0	10,5 10,2	32,8 32,0	39,6 38,8	0,36 0,37	20018 19560	11,54 11,22	AS REC'D. 19% MOIST	1,46	

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(L7)

PROPERTY TUYA RIVER NTS LOCATION 104J/2 DRILL HOLE OR OUTCROP NUMBER 824c

SEAM NAME ______ LOCATION ______

FORMATION MIDDLE MEMBER ELEVATION ______

COMMENTS ______ ORIGIN OF LOG: CORE ______ CHIP SAMPLES ______

GEOPHYSICAL LOG ______ OUTCROP X

GEOLOGIST P.M. WATERS DATE ______

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	VM	FC	S	CV	MM	BASIS	SP. GR.	LITHOLOGY
	45											COVERED
	50, 60											BROWN COALY MUDSTONE
W32 (W36)	70, 80, 90, 100		17.6 19.0	41.9 41.2	21.9 21.5	18.6 18.3	0.32 0.32	9991 9823	45.43 44.70	AS REC'D. 19% MOIST		COAL
	10											DARK BROWN MUDSTONE
W33	20, 30, 135		20.1 19.0	22.6 22.9	28.5 28.9	28.8 29.2	0.74 0.75	15212 15426	24.82 25.38	AS REC'D. 19% MOIST		COAL
	40, 150											MEDIUM TO DARK BROWN MUDSTONE
W34	60, 70, 180		18.4 19.0	15.5 15.4	30.2 30.0	35.9 35.6	0.43 0.43	18177 18064	16.97 16.85	AS REC'D. 19% MOIST		COAL
	90, 200, 10, 215											DARK BROWN COALY MUDSTONE AND VERY MUDDY COAL
W35	20, 30, 240		20.3 19.0	15.0 15.2	29.5 30.0	35.2 35.8	0.38 0.38	18141 18391	16.41 16.66	AS REC'D. 19% MOIST		COAL
	50, 60, 70											
W36 ANALYSIS			21.7 19.0	35.4 36.6	22.9 23.7	20.0 20.7	0.35 0.36	11053 11430	38.42 39.74	AS REC'D. 19% MOIST		WHOLE SEAM SAMPLE

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(L8)

PROPERTY: TUYA RIVER
NTS LOCATION: 104J/2
DRILL HOLE OR OUTCROP NUMBER: 826a

SEAM NAME:
LOCATION:

FORMATION: MIDDLE MEMBER
ELEVATION:

COMMENTS:
ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____
GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST: P.L. WATERS
DATE:

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												DARK BROWN COALY MUDSTONE
W23 (W26)	0–10		16.1 19.0	20.3 19.6	30.1 29.1	33.5 32.3	0.44 0.43	17637 17028	22.17 21.41	AS REC'D 19% MOIST	–	COAL
	10, 20, 30, 40, 50, 60											DARK BROWN COALY MUDSTONE
W24	70, 80		14.9 19.0	26.0 23.7	29.8 28.3	30.3 29.9	.092 0.87	17482 16635	27.51 26.19	AS REC'D. 19% MOIST	–	COAL
W25	90											DARK BROWN COALY MUDSTONE
	100		14.4 19.0	23.8 22.4	36.8 34.7	25.0 23.9	0.64 0.61	16921 16022	24.06 24.57	AS REC'D. 19% MOIST	–	COAL
	110, 120											DARK BROWN COALY MUDSTONE
	130, 140, 150											DARK BROWN COALY SIDERITIC MUDSTONE
W26 ANALYSIS			17.6 19.0	32.1 31.6	26.2 25.8	24.1 23.6	0.69 0.66	14008 13762	35.05 34.49	AS REC'D. 19% MOIST	–	WHOLE SEAM ANALYSIS

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(19)

PROPERTY TUYA RIVER

NTS LOCATION [illegible]

DRILL HOLE OR OUTCROP NUMBER 526b

SEAM NAME

LOCATION

FORMATION MIDDLE MEMBER

ELEVATION

COMMENTS

ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST P.M. WATERS

DATE

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
												DARK BROWN COALY MUDSTONE
W27	0–70		20.1	16.0	30.1	33.8	0.81	17747	17.73	AS REC'D.		COAL
			19.0	16.2	30.5	34.3	0.82	17986	17.35	19% MOIST		
	70–90											COVERED

INTERVAL scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

(L10)

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY: TUYA RIVER
NTS LOCATION: 104J/2
DRILL HOLE OR OUTCROP NUMBER: 527
SEAM NAME:
LOCATION:
FORMATION: MIDDLE MEMBER
ELEVATION:
COMMENTS:
ORIGIN OF LOG: CORE ___ CHIP SAMPLES ___ GEOPHYSICAL LOG ___ OUTCROP X
GEOLOGIST: P.M. W TERS
DATE:

DESCRIPTION

SAMPLE	INTERVAL	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS		LITHOLOGY
											GREY TO BROWN GREY MUDSTONE
W18 (W22)	0–10	14.8 19.0	20.9 19.8	34.1 32.5	30.2 28.7	0.47 0.45	17296 16447	22.83 21.58	AS REC'D. 19% MOIST	–	COAL
	20–30										BROWN GREY MUDSTONE
	40–60										DARK BROWN COALY MUDSTONE
W19	63–78	14.6 19.0	24.6 23.3	32.7 31.0	28.1 26.7	0.61 0.58	16951 16084	26.3 25.3	AS REC'D. 19% MOIST	–	COAL
W22	80–160										DARK BROWN COALY MUDSTONE
W20 (W20)	165–180	13.9 19.0	27.9 26.2	31.2 29.4	27.0 25.3	0.57 0.53	16491 15505	30.45 28.64	AS REC'D. 19% MOIST	–	COAL
	190										DARK BROWN COALY MUDSTONE
W21	200–220	15.4 19.0	34.4 33.0	25.8 24.5	24.6 23.5	0.43 0.41	13913 13318	37.39 35.83	AS REC'D. 19% MOIST	–	COAL
	230										DARK BROWN COALY MUDSTONE
	240 (FAULT) – 250										LIGHT GREY MUDSTONE
W22 ANALYSIS		17.0 19.0	40.7 39.7	27.8 27.2	14.5 14.1	0.43 0.42	11274 11006	44.19 43.10	AS REC'D. 19% MOIST	–	

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

(L-11)

PROPERTY: TUYA RIVER NTS LOCATION: 104J/2 DRILL HOLE OR OUTCROP NUMBER: 862

SEAM NAME:

LOCATION:

FORMATION: LOWER MEMBER

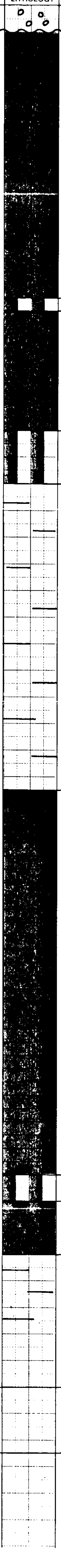
ELEVATION:

COMMENTS:

ORIGIN OF LOG: CORE ___ CHIP SAMPLES ___ GEOPHYSICAL LOG ___ OUTCROP X

GEOLOGIST: P.M. WATERS DATE:

DESCRIPTION



SAMPLE	INTERVAL	MOIST	ASH	V.M.	F.C.	S	C.V.	M.M.	BASIS	SP. GR.	LITHOLOGY
	above 0	THURST FAULT – GLACIAL									TILL
B6	0 – 100	25.0 19.0	14.4 15.6	29.1 31.5	31.5 33.9	0.30 0.32	15350 16587	15.72 16.98	AS REC'D. 19% MOIST	1.53 AIR DRIED	COAL
B6	100 – 105										SHALEY COAL
B6	105 – 150										COAL
	150 – 170										DARK BROWN SHALEY COAL
	170 – 285										DARK GREY MUDSTONE
B7	285 – 430	25.4 19.0	8.9 9.7	30.2 32.8	35.5 38.5	0.38 0.41	17696 19356	9.82 10.72	AS REC'D. 19% MOIST	1.47 AIR DRIED	COAL
B8	430 – 440	20.5 19.0	41.8 42.6	20.2 20.5	17.5 17.9	0.31 0.32	– –	45.31 46.19	AS REC'D. 19% MOIST	1.86 AIR DRIED	SIDERITIC COAL
B9	440 – 460	23.1 19.0	16.3 17.2	20.0 31.6	30.6 32.2	0.45 0.47	16617 16984	17.95 18.80	AS REC'D. 19% MOIST	1.51 AIR DRIED	COAL
	460 – 500										BROWN GREY MUDSTONE
ANALYSIS OF COMPOSITE OF SAMPLES B7, B8 AND B9		23.8 19.0	20.1 21.4	27.0 28.8	29.1 30.8	0.37 0.40	14878 15812	21.91 23.31	AS REC'D. 19% MOIST	1.60 AIR DRIED	

INTERVAL scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 105, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 285, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, 400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500