GR- MT. Klappan 79(1)A.

MT. KLAPPAN PROPERTY

Groundhog Coalfield
Northwest British Columbia
NTS 104 H/2

FIELD GEOLOGY

C.L. NOS. 3961 to 3985 INCL.

OPEN FILE

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00109 (1)

SUMMARY

The Mt. Klappan coal licenses and license applications total about 10,000 hectares of the Groundhog coalfield in northwest British Columbia.

The objectives of the 1979 field season were to map the geology, sample any coal encountered, make a preliminary evaluation of the economic potential of the area, and recommend further action.

The stratigraphy of the property is an Upper Jurassic to Lower Cretaceous regressive clastic sequence. Fluvial rocks, predominantly overbank siltstone and shale, overlie deltaic sandstones, siltstones and shales.

The structure is largely due to a push from the southwest. Folding is open to overturned northeastward. Some tight folds change to thrust faults. Steeply dipping faults cut across the folds.

Coal is found throughout the section but the thickest seams (3m to 4m) are found in the deltaic facies on "Hobbit Creek". Inferred reserves there are 1.5 million tons. "Lost Ridge" has 160,000 tons of speculative reserves. The coal quality is highly variable from semi-bituminous to semi-anthracite.

In view of the poor quality and folded nature of the coal found to date, it is recommended that the Mt. Klappan coal licenses and license applications be dropped.

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1 INTRODUCTION

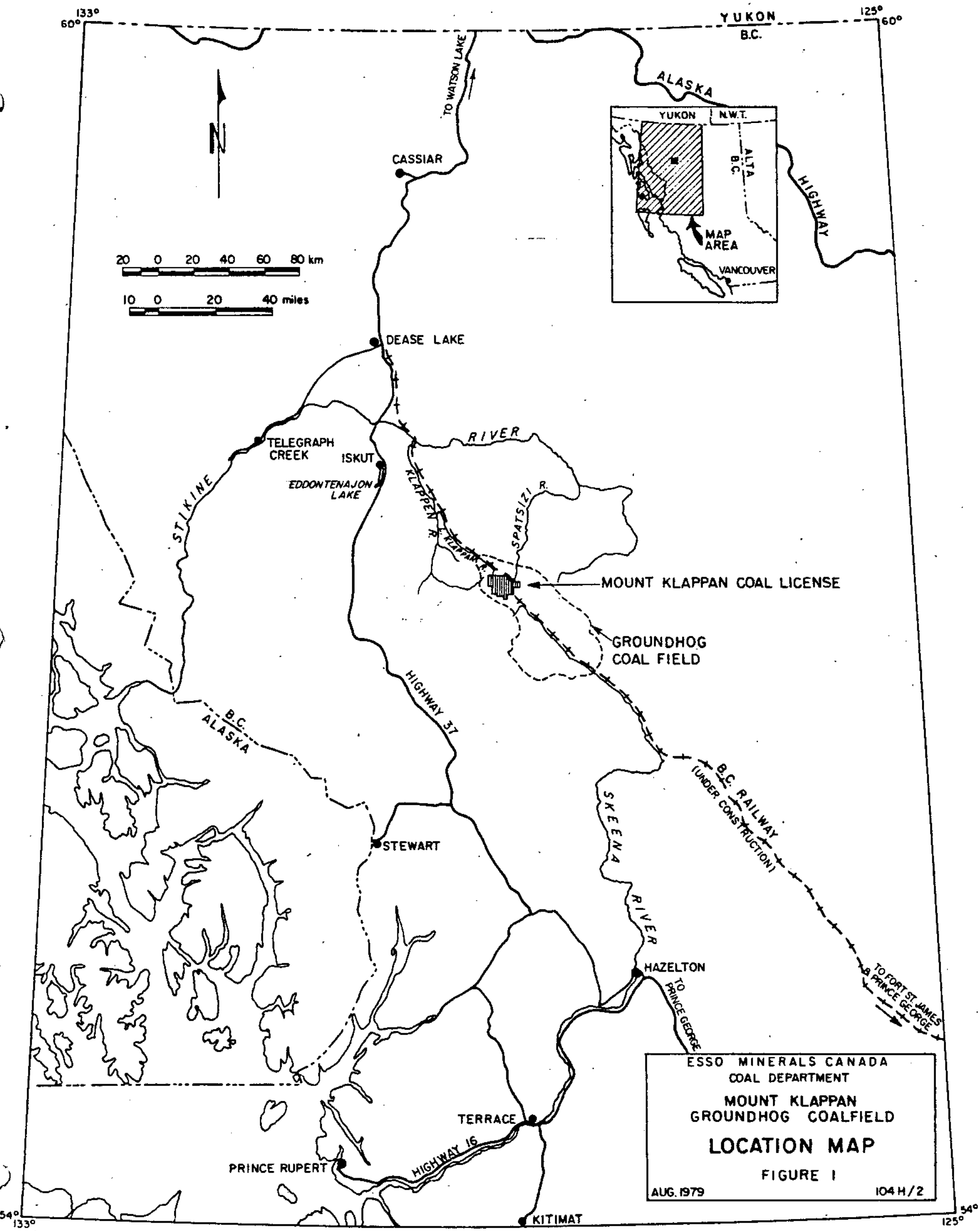
1.1 Objectives

The first phase of exploration of Esso Minerals' Mt. Klappan coal licenses was conducted by a geological mapping party from June 25th to August 15th, 1979. The objective was to collect information on the stratigraphy, structural geology, and coal geology on and around the licenses and to sample the best coal outcrops. All information gathered through these activities has been compiled and interpreted and is documented in this report. In addition, this report contains an evaluation of the potential for finding economically attractive coal reserves on the licenses and recommends further action.

1.2 Location and Access

Esso Minerals' coal licences on Mt. Klappan are situated in the Groundhog coal field of the Bowser Basin in north-central British Columbia. The licenses are 528 kilometres northwest of Prince George and 336 kilometres northeast of Prince Rupert (see the Location Map, Figure 1). The property covers portions of NTS maps 104 H/2 and 104 H/7 in the Cassiar land district.

The nearest community is the Indian village of Iskut (population about 500) on Eddontenajon Lake, 100 kilometres northwest of the coal licenses. Iskut is on Highway 37, which travels



ESSO MINERALS CANADA
COAL DEPARTMENT

MOUNT KLAPPAN
GROUNDHOG COALFIELD

LOCATION MAP

FIGURE 1

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from Terrace, B.C. to the Alaska Highway near Watson Lake, Yukon. From Iskut to Terrace by road is 420 kilometres. At Meziadin Junction, 220 kilometres south of Iskut, another highway travels 80 kilometres west to the mining and port town of Stewart. From Iskut, Dease Lake is 60 kilometres north along Highway 37 and Watson Lake is 300 kilometres north.

Access to the Iskut area is available on Highway 37 or by aircraft. Trans Provincial Airlines has scheduled flights from Terrace to Dease Lake and Iskut, using both float and wheel-equipped aircraft.

The easiest access to the Mt. Klappan licences is by helicopter. Tenejon Center, a motel complex two kilometres south of Iskut on Highway 37, has a good helicopter base. The only vehicular access would be along the British Columbia Railway road grade, which can be traveled from Highway 37 near Dease Lake to south of Mt. Klappan. A steel bridge is in place over the Stikine River; however, only wooden bridges were constructed over two smaller streams further south. It is doubtful these would withstand heavy or sustained traffic. However, the streams could be forded after the spring run-off. There are no roads or trails on the property other than those built for the rail line.

At several locations along the British Columbia Railway right-of-way, gravel airstrips were built for use by aircraft supplying construction crews. One, the Summit strip, is located just northwest of Mt. Klappan. Its length is 1454 metres (3600 feet) and its elevation is 1736 metres (4300 feet) above sea level.

The British Columbia Railroad began construction of a line from north of Prince George to Dease Lake, passing through some of the most isolated parts of British Columbia. In 1977, the British Columbia Government put a halt to further construction, pending a study on the provincially-owned railway. All construction equipment was removed from the right-of-way and no work has been done since then.

From the north, the roadbed has been built from Dease Lake south past Mt. Klappan to Kluatantan River at the south end of the Groundhog coalfield. Further south, the line is cleared for only 37 kilometres and roughed-in for the next 16 kilometres. From there to joining the B.C.R. system north of Prince George, the line is complete. Therefore, an additional 53 kilometres of steel must be laid to reach Mt. Klappan. Then the rail distance from Mt. Klappan to Prince George would be 580 kilometres and through Prince George to the port of Prince Rupert, 1240 kilometres.

1.3 History and Previous Work

The earliest known exploration of the Groundhog coalfield was from 1865 to 1867 during exploration by Western Union Telegraph Company for a telegraph line and for mineral deposits. During the Cassiar gold rush of 1872 to 1878, prospectors passed through Groundhog on their way north.

Three very old claim posts with no metal tags were found between Mt. Klappan and Tahtsedle Creek. They may have been associated with two old trenches in the same area that were blasted in sandstone cut by many quartz veins. There may be a record of this activity in the B.C. mineral files.

The first published reports concerning the Groundhog coal deposits appeared in 1900 after the Canada Department of Railways and Canals surveyed the region for the possibility of locating a rail-line from the Yukon to a seaport in British Columbia. At the same time, the Yukon Telegraph Line was built from Quesnel to Atlin, its route passing near the coalfield.

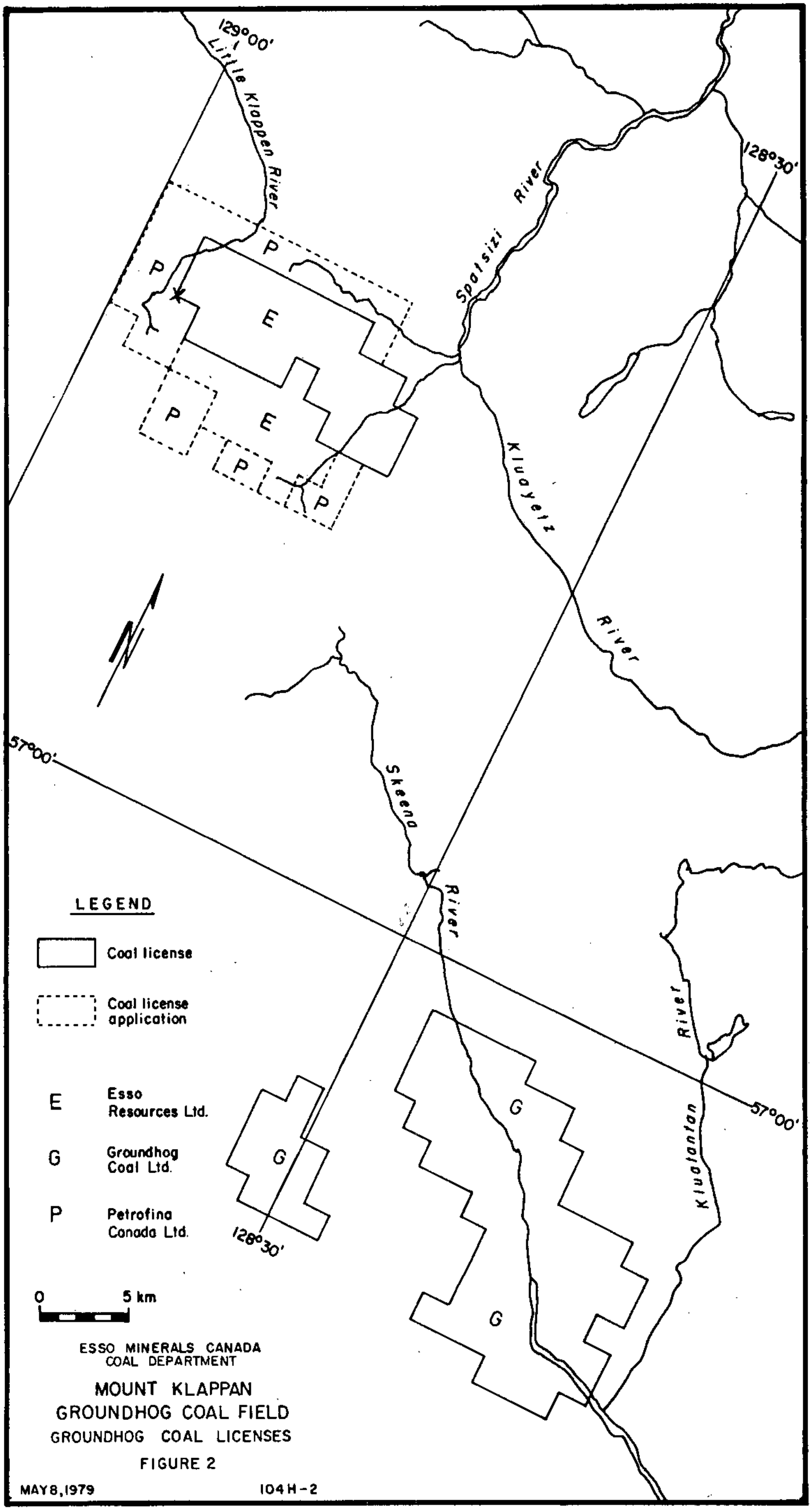
Concentrated coal exploration began in 1903 and continued until 1913, with the peak from 1910 to 1912. Some of the companies and individuals involved include Crowsnest Pass Coal Company with James McEvoy and W.W. Leach, Western Development Company, George M. Beirnes, B.C. Anthracite Company with F.A. Jackson, and B.C. Anthracite Syndicate with R.C. Campbell-Johnston and G.F. Monckton. Most of the work was done in the southern end of the coalfield, with little work done in the northern portion (Buckham and Latour, 1950). The first geological map was produced at the same time by G.S. Malloch (1914) of the GSC.

No further work was done until 1948 when a GSC party led by Buckham and Latour visited the area. Their report (Buckham and Latour, 1950) summarizes the history of the area and details many of the known coal occurrences.

From 1966 to 1968, Coastal Coal Limited held 24 coal licences at the southern end of the coal field. After a mapping program, these were allowed to lapse (J.T. Boyd and Associates, 1967).

In 1970, a joint-venture group composed of National Coal Corporation Ltd., Placer Development Ltd., and Quintana Minerals Corporation conducted a mapping and limited diamond drilling program over 80 coal licences at the southern end of the coalfield. These licences were subsequently dropped (Tompson et al, 1970).

Further regional geological mapping was done by the GSC in Operation Stikine (GSC, 1957) and some of the first stratigraphic studies were reported by Eisbacher in 1974. Recently the GSC and the British Columbia Government have begun more detailed studies of the Groundhog coalfield (Gilchrist, 1979; Richards and Gilchrist, 1979).



ESSO MINERALS CANADA
COAL DEPARTMENT

MOUNT KLAPPAN
GROUNDHOG COAL FIELD
GROUNDHOG COAL LICENSES

FIGURE 2

MAY 8, 1979

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Esso's involvement began in the early 1970's with a short reconnaissance of the area by company geologists. Their trip identified the area on the north slope of Mt. Klappan as the most prospective for surface-mineable coal. This report deals with the first exploration conducted by Esso for coal in the area.

1.4 Land Status

On March 23, 1976, Imperial Oil placed their first application for 41 coal licences covering 11,497 hectares in the northern part of the Groundhog coalfield. In April 1978, the B.C. Government lifted a moratorium on the issuance of coal licences and Esso was asked to reapply for the licences at Groundhog. The reapplication was made on May 12, 1978, but on a somewhat smaller area, as portions of the original application overlapped the Spatsizi Plateau Wilderness Park. The licences, a total of 25 covering 7006 hectares, were issued to Esso Resources on December 15, 1978. These are listed in Table I and shown in Figures 2 and 3.

An additional application for 3646 hectares was made on April 5, 1979, for coal licences to adjoin the southern boundary of those previously issued. The description of the application area is included in Table II and Figures 2 and 3.

TABLE II. Descriptions of Coal License Applications Controlled by Esso Minerals Canada in the Mount Klappan Area

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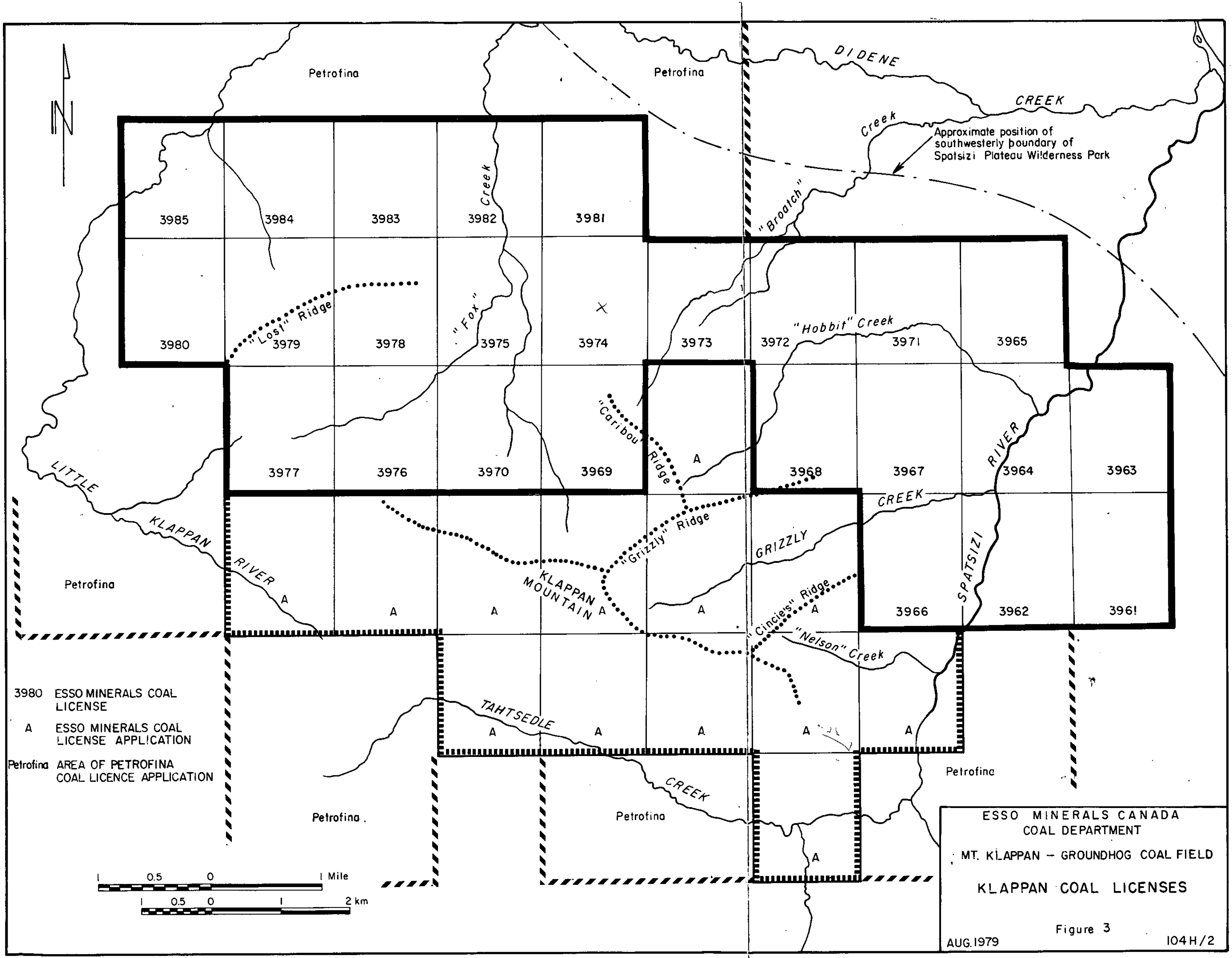
Areas for which Esso Minerals Canada made application for coal licenses in the Groundhog coal field, Cassiar Land District on April 5, 1979:

Description		Hectares
Map 104-H-2		
Block K,	Units 3, 4, 13 & 14	280.70
	Units 21, 22, 31 & 32	280.56
	Units 23, 24, 33 & 34	280.56
	Units 25, 26, 35 & 36	280.56
	Units 27, 28, 37 & 38	280.56
	Units 29, 30, 39 & 40	280.56
	Units 43, 44, 53 & 54	280.44
	Units 45, 46, 55 & 56	280.44
	Units 47, 48, 57 & 58	280.44
	Units 49, 50, 59 & 60	280.44
	Units 65, 66, 75 & 76	280.31
Block L,	Units 41, 42, 51 & 52	280.44
	Units 43, 44, 53 & 54	280.44
	TOTAL	3646.45

Table I. Descriptions of Coal Licenses Controlled by Esso Minerals Canada in the Mount Klappan Area, B.C.

Coal licenses granted to Esso Minerals Canada in the Groundhog coal field, Cassiar Land District, on December 15, 1978:

License Number	Description	Hectares
	Map 104-H-2E	
3961	Block J, Units 47, 48, 57 & 58	280.44
3962	Units 49, 50, 59 & 60	280.44
3963	Units 67, 68, 77 & 78	280.31
3964	Units 69, 70, 79 & 80	280.31
3965	Units 89, 90, 99 & 100	280.19
	Map 104-H-2W	
3966	Block K, Units 41, 42, 51 & 52	280.44
3967	Units 61, 62, 71 & 72	280.31
3968	Units 63, 64, 73 & 74	280.31
3969	Units 67, 68, 77 & 78	280.31
3970	Units 69, 70, 79 & 80	280.31
3971	Units 81, 82, 91 & 92	280.19
3972	Units 83, 84, 93 & 94	280.19
3973	Units 85, 85, 95 & 96	280.19
3974	Units 87, 88, 97 & 98	280.19
3975	Units 89, 90, 90 & 100	280.19
3976	Block L, Units 61, 62, 71 & 72	280.31
3977	Units 63, 64, 73 & 74	280.31
3978	Units 81, 82, 91 & 92	280.19
3979	Units 83, 84, 93 & 94	280.19
3980	Units 85, 86, 95 & 96	280.19
	Map 104-H-7W	
3981	Block C, Units 7, 8, 17 & 18	280.05
3982	Units 9, 10, 19 & 20	280.05
3983	Block D, Units 1, 2, 11 & 12	280.05
3984	Units 3, 4, 13 & 14	280.05
3985	Units 5, 6, 15 & 16	280.05
	TOTAL	7005.76



ESSO MINERALS CANADA
COAL DEPARTMENT

MT. KLAPPAN – GROUNDHOG COAL FIELD

KLAPPAN COAL LICENSES

Figure 3

AUG.1979

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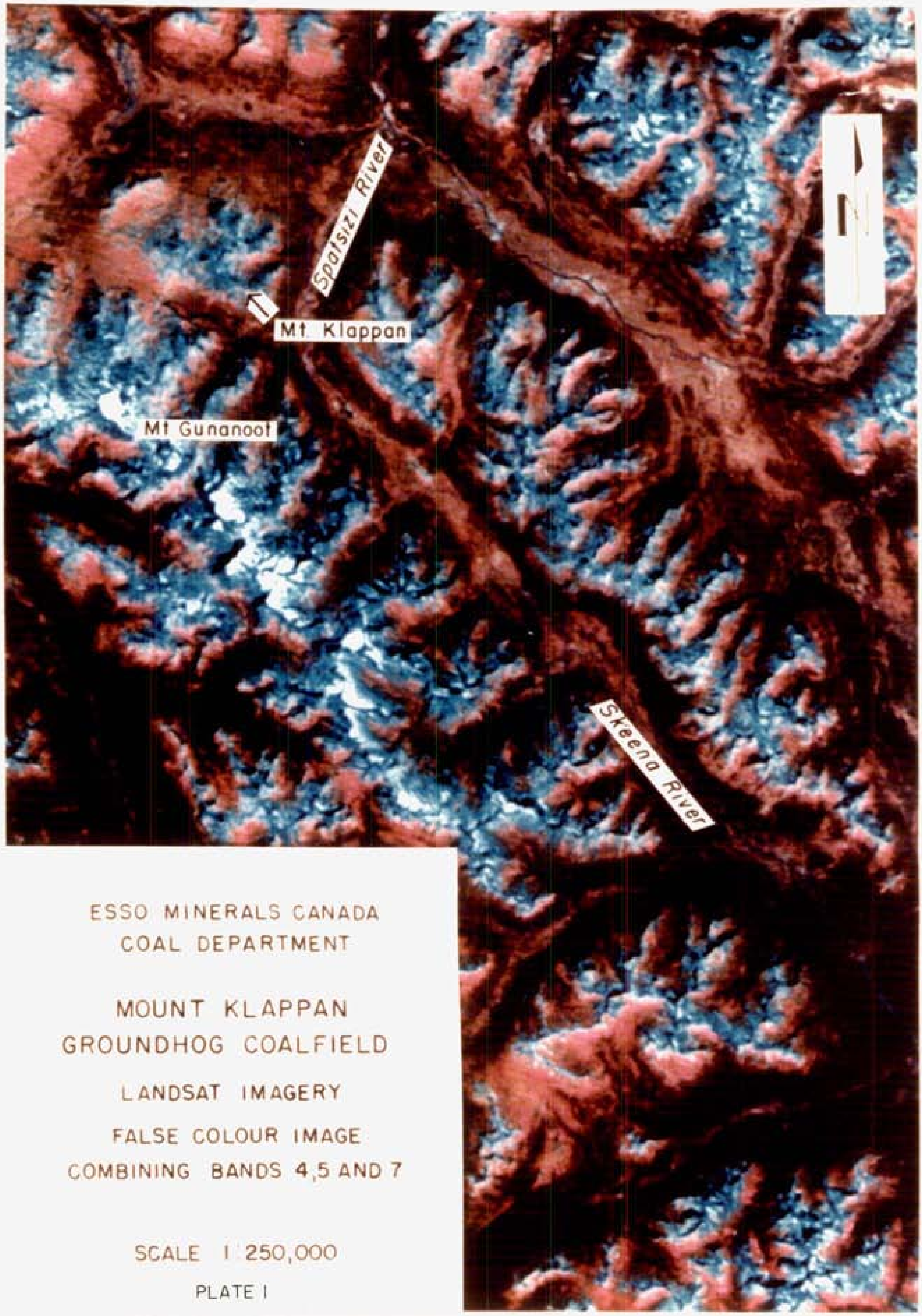
Petrofina Canada Ltd. have applied for 27 coal licences, approximately 7560 hectares, which nearly surround Esso's coal licence and coal licence application area (Figures 2 and 3). The only other coal licences held in the Groundhog coalfield are those of Groundhog Coal Ltd. The 77 licences total 19,943 hectares and are located 42 kilometres southeast of Esso's licences, mainly along the Skeena River (Figure 2).

1.5 Geography and Industry

The property is in the northern portion of the Skeena Mountains physiographic region. The ridge tops are at 6500 ft (2000 m) elevation. The ground falls gently to broad valleys at elevations between 4000 and 5000 ft (1200 m and 1500 m) over two to four kilometres horizontal distance.

The vegetation on the ridge tops, where most bedrock is exposed, is alpine tundra (pink on the Landsat image, Plate 1; blue is bare rock or dirt). The valleys are covered with coniferous forest (dark red on Plate 1) with scattered, small, string bogs. Grass and shrub meadows (greyish red on Plate 1) often cover the lower terraces of the rivers. The alpine tundra to conifer forest transition zone is at 5000 ft (1500 m). See Plate 2 for aerial views of Mt. Klappan.



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COAL DEPARTMENT

MOUNT KLAPPAN
GROUNDHOG COALFIELD

LANDSAT IMAGERY

FALSE COLOUR IMAGE
COMBINING BANDS 4,5 AND 7

SCALE 1:250,000

PLATE I

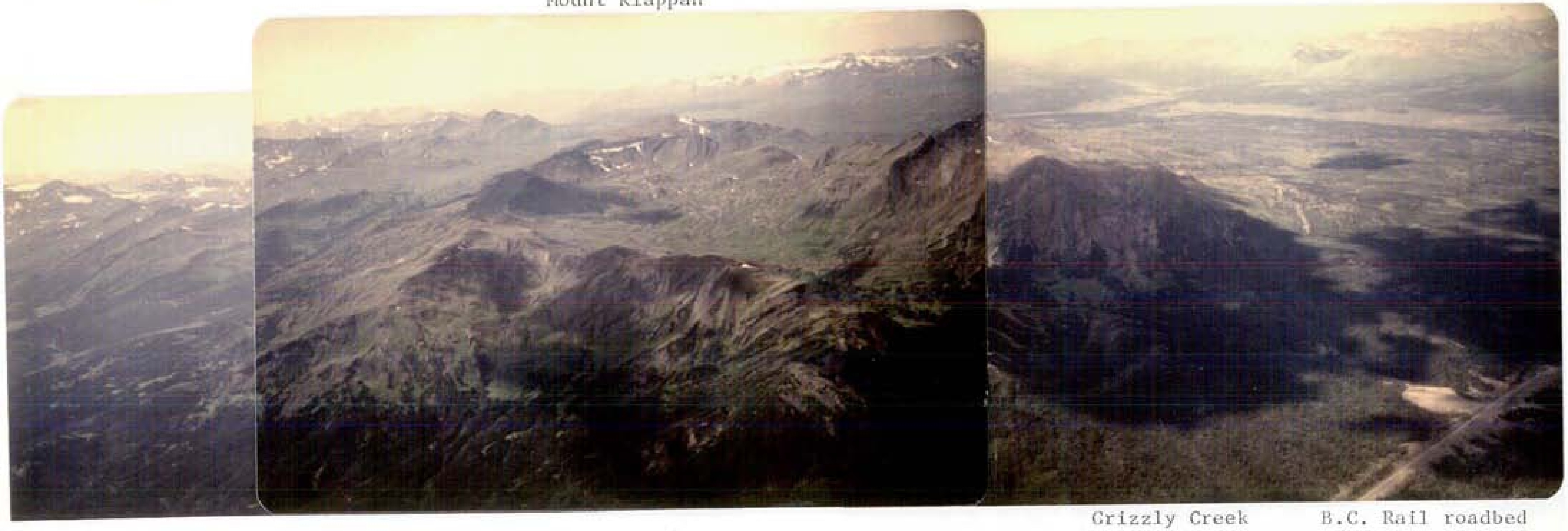


Plate 2a

general aerial view of Mount Klappan looking northwest.

Plate 2b

aerial view of "Hobbit" Creek looking northwest.

There is little industrial activity in the region. There is a large asbestos mine at Cassiar and several base and precious metal mines at Stewart. Esso Minerals has a base metal prospect at Kutcho Creek and Texasgulf has a porphyry copper prospect at Eddontenajon Lake. Both are in an advanced stage of planning. B.C. Hydro was doing field studies in 1979 for several proposed dam sites on the Stikine River; this also is in an advanced stage of planning.

2 REGIONAL GEOLOGY

The term Groundhog coalfield (Figure 1) identifies the northeastern portion of the Upper Jurassic - Lower Cretaceous Bowser Basin, which contains major coal seams. The Bowser Basin itself was a successor basin in which marine and non-marine sediments and minor volcanics were deposited. The boundaries of the basin on the north and south were the Stikine and Skeena arches, respectively. The eastern boundary was formed during the initial deformation and uplift of the Omineca Crystalline Belt, while the western boundary was at least partially open to the ocean. Presently, the outcrop distribution of the Bowser Basin strata terminates westerly against the Coast Crystalline Complex (Eisbacher, 1974b; Tipper and Richards, 1976).

The northeastern portion of the Bowser Basin is characterized by predominantly clastic sediments which were deposited in the complete range of environments from fluvial, though deltaic, to continental slope (Eisbacher, 1974a). Within this sequence, coal seams were deposited in the fluvial and deltaic environments.

The first attempt at stratigraphic identification of the Groundhog coal-bearing strata was made by Malloch (1914). He included the coal seams in his Lower Cretaceous Skeena Group which overlay the Upper Jurassic Hazelton Group. Buckham and Latour (1950) included the Skeena Group in an expanded Hazelton Group as the Upper Part. These and the following stratigraphic terms are compared in Table III.

TABLE III REGIONAL CORRELATION OF MOUNT KLAPPAN, GROUNDHOG COALFIELD

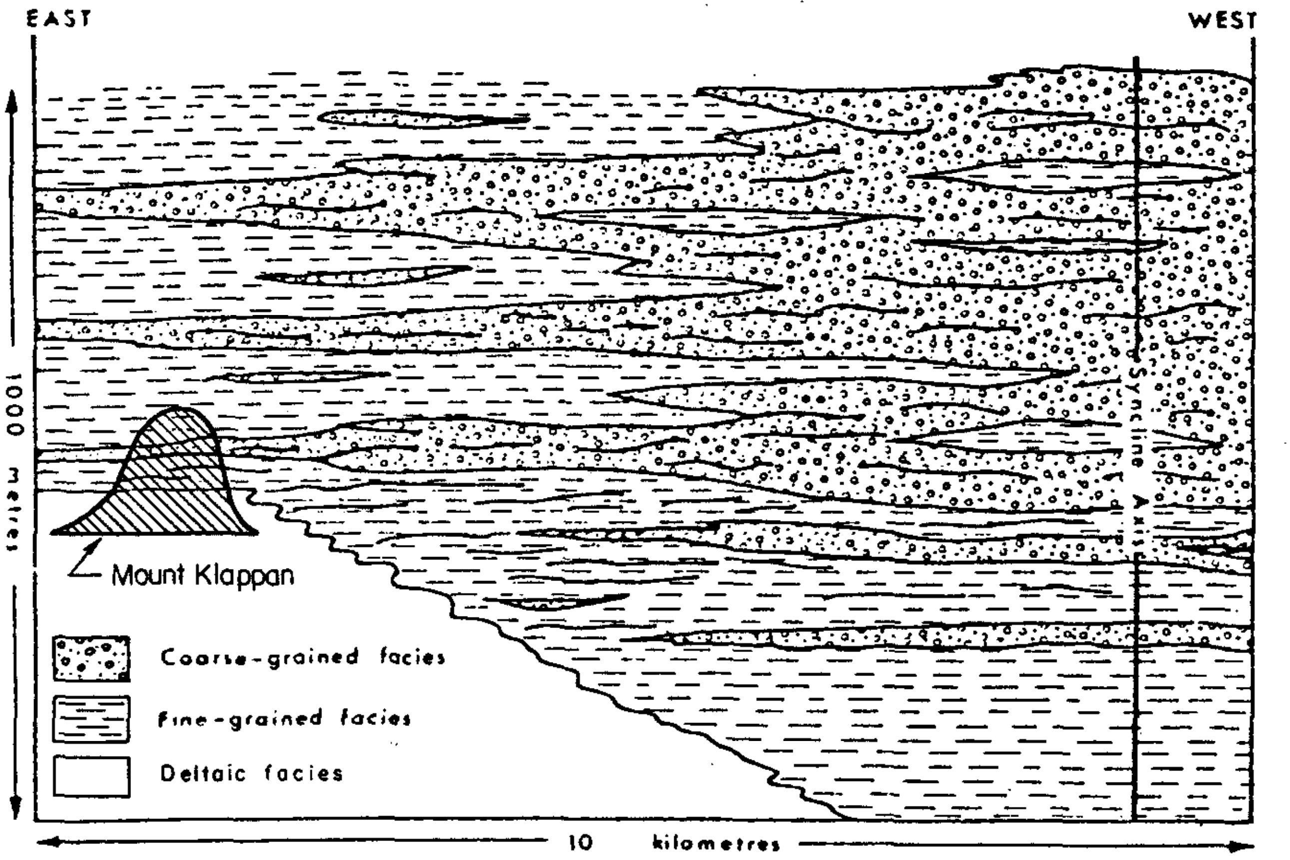
		MALLOCH, 1914	BUCKHAM & LATOUR, 1950	SOUTHER & ARMSTRONG, 1966	EISBACHER, 1974b	TIPPER & RICHARDS, 1976	RICHARDS & GILCHRIST, 1979
		SOUTHERN GROUNDHOG COALFIELD	GROUNDHOG COALFIELD	NORTHERN BRITISH COLUMBIA	NORTHERN BOWSER BASIN	SOUTHERN BOWSER BASIN	NORTHERN GROUNDHOG COALFIELD
CRETACEOUS	UPPER			SUSTUT – SIFTON ASSEMBLAGE	SUSTUT – SIFTON ASSEMBLAGE	SUSTUT GROUP	SUSTUT GROUP
	LOWER	SKEENA SERIES	HAZELTON GROUP UPPER PART	BOWSER ASSEMBLAGE	BOWSER ASSEMBLAGE JENKINS CREEK FACIES GUNANOOT – GROUNDHOG FACIES ▨ ■	SKEENA GROUP	GUNANOOT ASSEMBLAGE ▨ ■
JURASSIC	UPPER	HAZELTON GROUP	LOWER PART		DUTI RIVER SLAMGEESH FACIES	BOWSER LAKE GROUP	
	MIDDLE			TAKLA – HAZELTON ASSEMBLAGE	TAKLA – HAZELTON ASSEMBLAGE	HAZELTON GROUP	
	LOWER						
TRIASSIC	UPPER					TAKLA GROUP	
	MIDDLE						

▨ APPROXIMATE STRATIGRAPHIC POSITION OF THE ROCKS AT MOUNT KLAPPAN

■ APPROXIMATE STRATIGRAPHIC POSITION OF THE HOBBIT CREEK SEAMS

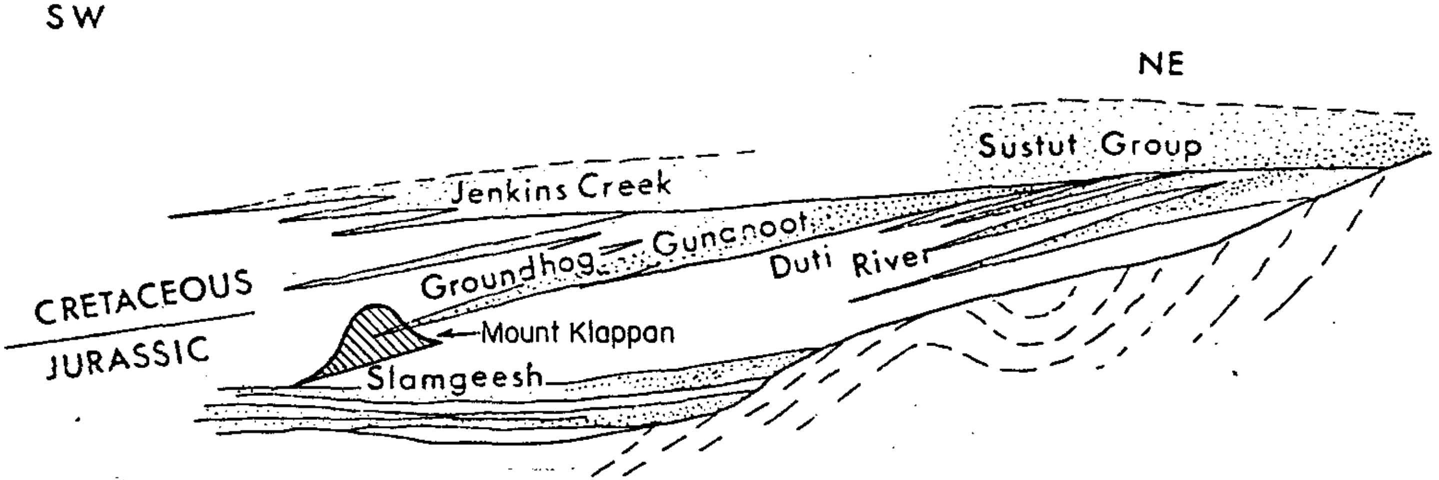
Souther and Armstrong (1966) were among the first to use the concept of tectonic-stratigraphic assemblages, each being identified by a unique environment of deposition and a unique history of deformation. For northern British Columbia, the Bowser Assemblage was identified as an Upper Jurassic - Lower Cretaceous succession of marine to fresh-water, clastic sedimentary rocks. This included the coal-bearing strata of Groundhog. The Bowser Assemblage was underlain by the Upper Triassic to Upper Jurassic Takla-Hazelton Assemblage and overlain by the Upper Cretaceous Sustut-Sifton Assemblage.

Eisbacher (1974a) extended the age of the Bowser Assemblage to include the uppermost Middle Jurassic and, for the northern part of the basin, subdivided it into three facies or groups of strata based on an interpreted mode of deposition. The lowest facies,.the Middle and Upper Jurassic Duti River-Slamgeesh facies, shows evidence of deposition in delta, prodelta, and continental-slope environments (Figure 4b). The second, the Upper Jurassic and Lower Cretaceous Gunanoot-Groundhog facies, was deposited as alluvial fans grading laterally into deltaic coal swamps. The youngest facies, the Lower Cretaceous Jenkins Creek, contains strata laid down in meandering rivers and small lakes. Eisbacher reports paleocurrent directions of south to southwest immediately to the east of the property and suggests unroofing of the Omineca Crystalline Belt as the source for the conglomerate clasts.



After Richards and Gilchrist,1979 P412

FIGURE 4A



After Eisbacher,1974a P11

FIGURE 4B

REGIONAL STRATIGRAPHY

Tipper and Richards (1976), in a study of the Jurassic of north-central British Columbia, separated the Bowser Assemblage into an Upper Jurassic Bowser Lake Group and an uppermost Lower Cretaceous - lowermost Upper Cretaceous Skeena Group. The Skeena Group included the coal seams in the southern part of the Bowser Basin.

The most recent interpretation was by Richards and Gilchrist (1979). They suggest the area between Mt. Beirnes and Mt. Gunanoot, bounded by the Skeena and Nass Rivers, is underlain entirely by fluvial clastic rocks of the Gunanoot assemblage (Figure 4A), a name derived from Eisbacher's (1974a) Gunanoot-Groundhog facies. They report southwest paleocurrent directions immediately to the southwest of the property.

The Gunanoot assemblage contains an Upper Jurassic - Lower Cretaceous flora but has lithologic differences with both the Bowser Lake Group and the Skeena Group. A possibility they mention is that the Gunanoot Assemblage is a separate tectono-stratigraphic assemblage between the Bowser Lake and Skeena Groups, with a great similarity to the latter.

The Cretaceous - Tertiary uplift of the Coast Crystalline Complex caused the mainly passive deformation of the Bowser Basin strata, and resulted in extensive shallow decollement, recumbent folds and thrust faults. The general trend of these structures is from southeast to northwest, and most axial planes and fault surfaces dip to the southwest (Eisbacher, 1974b). The Groundhog area is broken into rectilinear blocks by major river valleys, many of which have been interpreted as being fault-controlled. The intensity and type of folding varies with rock competence and proximity to faults, ranging from broad, open folds to tight, low to moderate-angle, recumbent folds (Richards and Gilchrist, 1979).

3 PROPERTY GEOLOGY

3.1 Introduction

The stratigraphy is a clastic regressive sequence, with fluvial rocks generally overlying deltaic rocks. The fluvial rocks are most similar to the fine-grained facies of Richards and Gilchrist (1979). The deltaic rocks are most similar to the Duti River - Slamgeesh facies of Eisbacher (1974a). The thickest and most numerous coal seams are in the deltaic rocks. See Figures 5a and 5b in the pocket for the geology of the property.

The structure is the result of a strong push from the southwest. This produced tight folding and steep thrust faults. Later, block faulting along the major creek valleys geologically isolated Mt. Klappan. The coal seams may be podded in the noses of the tighter folds. See Figure 6 in the pocket for structural cross-sections of the property.

3.2 Stratigraphy

3.2.1 Introduction

The stratigraphy is a generally regressive clastic sequence with meandering river facies overlying and partly intercalated with a deltaic and minor deep-marine facies. The river facies is composed mostly of silt and clay with lesser sand and minor marl and conglomerate. The deltaic facies is made of silt and clay with minor sand. Thin coal seams occur throughout the fluvial unit in the finer-grained portions. The thickest seams occur in the deltaic facies, usually near the upper transition to the fluvial facies. The total thickness exposed on the property may be 1000 metres.

3.2.2 Lithology

The lithologies found run the complete range of the usual clastic lithologies from shale to conglomerate. Most exposed rocks were fine-grained sand and silt. However, shale is probably under-represented because it is very recessive.

Conglomerate is medium to dark grey, weathering medium to light grey and resistant. It is clast-supported, usually only 10% to 40% matrix. The clasts are usually 75% dark to medium grey chert, 25% light grey chert and less than 10% acid volcanics. The clasts are pebble, rarely granule size, well sorted and well to subrounded. The matrix is medium-grained sandstone similar to the hard sandstone described below with about 75% quartz grains and 25% chert grains, which are predominantly dark grey. It is well sorted, and subangular to subrounded. The cement is siliceous, occasionally with a trace of calcite. Conglomerate is nonfossiliferous and joints are usually spaced at about one metre. This lithology is mineralogically and texturally mature, the clasts more so than the matrix.

Sandstone occurs in two varieties. About 98% of it is hard with a silica cement, the rest is very soft and probably cemented with kaolinite.

The hard sandstone (Plate 3b) is medium grey, weathering medium grey to brown grey and resistant. The clasts are predominantly quartz with minor amounts of dark grey chert, well sorted, subrounded to subangular and cemented with silica. Occasionally, fossil leaves are poorly preserved as impressions on the bedding surfaces. This sandstone usually shows one to three joint sets perpendicular to bedding and with a spacing of 0.3 to 1 metre.

The soft sandstone is light grey to cream, weathering very light grey and very recessive. The clasts are the same as the hard sandstone described above. The cement is probably kaolinite with minor calcite. This lithology is so incompetent that tectonic activity has often erased the bedding, sedimentary structures and any fossils that may be present. It is laterally continuous and distinctive enough that it can be used as a local marker bed (as long as the kaolinite is primary and not a secondary

Plate 3a

siltstone, banded weathering.

The 10 cm bed below the hammer is marly.

Hammer and Brunton compass for scale.

Plate 3b

Hard sandstone with casts of symmetric ripple marks. Hammer for scale.

alteration). Both sandstones are mineralogically and texturally mature.

Siltstone (Plate 3a) is medium to dark grey, weathering the same but sometimes in millimetre-thick bands of rusty brown and dark grey. It is moderately recessive and occasionally shaley. The clasts are probably similar to the sandstone, predominantly quartz with minor chert. The cement is usually silica, occasionally small amounts of calcite are present. It is usually blocky, occasionally fissile. Fossil leaves are locally abandant, preserved as impressions. This lithology is generally poorly jointed.

The term shale is used in this report for any lithified clastic rock with clay-size particles. It may or may not be fissile. Clay is used for any unconsolidated shale, usually associated with coal. The shale at Mt. Klappan comes in three varieties:

1) silty shale that grades to siltstone, described above
2) carbonaceous shale
3) marl or calcareous shale.

Silty shale is medium to dark grey, weathering medium grey and recessive. It is slightly to moderately silty and occasionally slightly calcareous, often fissile, occasionally blocky and rarely shows spheroidal weathering. Fossil leaves are locally abundant, preserved as impressions and thin carbonaceous films. It is poorly jointed but often weathers into one-centimetre blocks.

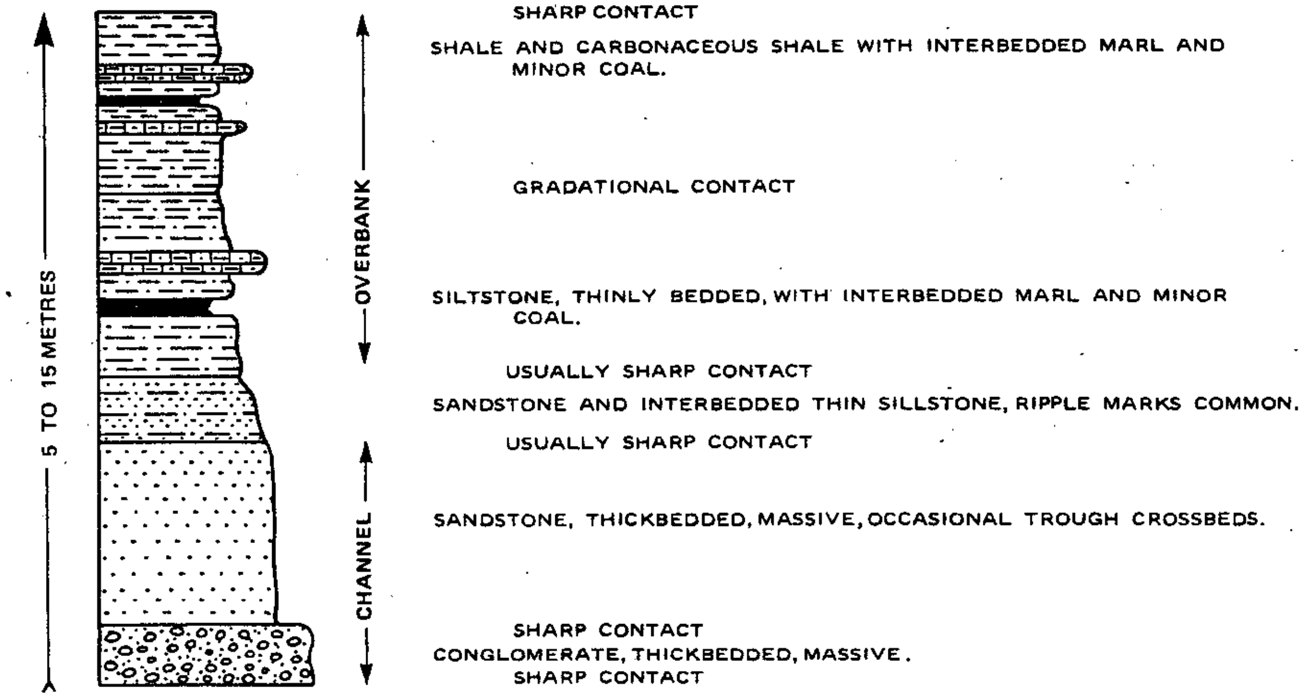
Carbonaceous shale is dark to very dark grey, weathering medium to dark grey. It is rarely slightly silty, usually fissile and rarely blocky. Occasionally it has scattered one-centimetre vitrain lenses, rarely it grades to shaley coal and coal. Otherwise it is similar to the silty shale described above.

Marl or calcareous shale is medium to light grey, weathering a very distinctive light brown to rust brown and resistant. It is slightly to moderately calcareous, rarely silty. It is moderately to highly fossiliferous; the leaves and twigs are usually preserved as casts, occasionally as molds. Joint spacing is usually about one metre.

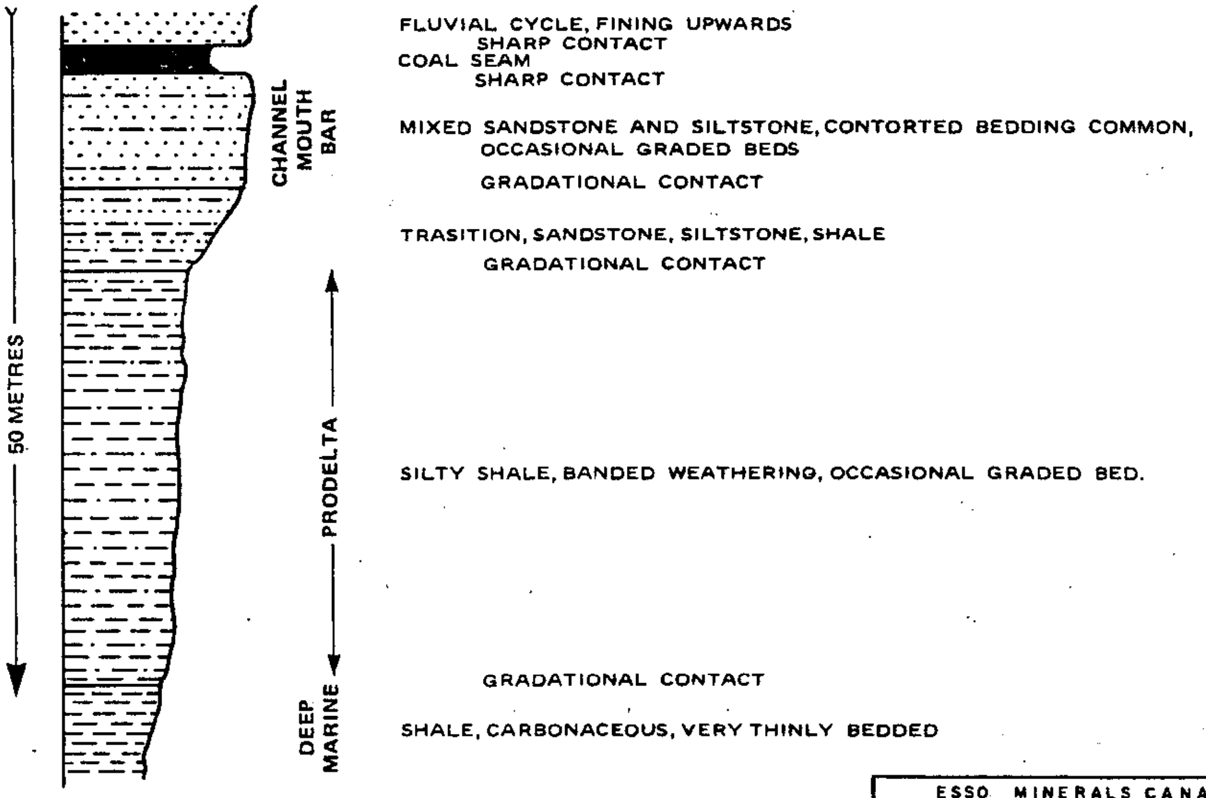
3.2.3 Depositional cycles

The lithologies described above repeatedly and predictably combine into cycles of strata that show the environment of deposition or facies. The facies found on this property are fluvial (about 90% of the exposed rocks) and deltaic (Figure 7). In the fluvial facies, the grain-size becomes finer upwards, while a deltaic facies coarsens

FLUVIAL CYCLE



DELTAIC CYCLE (from outcrop W-31)



ESSO MINERALS CANADA
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MOUNT KLAPPAN
GROUNDHOG COALFIELD

FLUVIAL AND DELTAIC
DEPOSITIONAL CYCLES

FIGURE 7

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upwards. This is the easiest and fastest way to make the distinction in the field. The cycles described below are ideal; most cycles observed in the field differ from them, usually missing the top and/or bottom, particularly the fluvial cycles. These cycles are not identical to those usually described in the literature, usually lacking the standard sedimentary textures.

3.2.3.1 Fluvial Facies

The fluvial facies, probably produced by a meandering river, has two parts:

1) The lower, coarser, lateral accretion portion deposited in the channel, usually one-third or less of the complete cycle.
2) The upper, finer, vertical accretion portion deposited over the bank of the river on the floodplain.

Coal seams, when found in a fluvial cycle, are always in the vertical accretion portion.

The channel portion of a fluvial cycle occasionally begins with conglomerate, probably a lag deposit, or interbedded conglomerate and sandstone. Bedding is usually 1-1/2 to 2 m thick with the whole unit up to 10 m thick. It is usually structureless, though occasionally large scale trough crossbeds are produced by alternating 2 cm to 5 cm interbeds of conglomerate and sand.

The channel portion of a fluvial cycle usually begins with and consists of a unit of massive sandstone. Bedding is 0.3 to 1 metre thick with the unit up to 5 metres thick. Usually, it is structureless, occasionally it has trough and regular crossbeds and, near the top, ripplemarks.

The next unit in the cycle is probably a transition from channel to floodplain deposition. It is interbedded sandstone and thin siltstone. The sandstone usually has one or two 10-cm thick beds, often with ripplemarks. The siltstone is usually 1 cm to 5 cm thick and almost always thinly laminated or rippled. The unit is usually 1 to five metres thick.

The floodplain portion of a fluvial cycle grades upwards from siltstone to shale and shows no structures. Bedding is thin, ranging from a few centimetres in siltstone to millimetres in shale. Within this unit are rare to occasionally discontinuous one-half to one metre beds of marl that were probably deposited in small ponds and lakes on the floodplain. The most complete cycles had carbonaceous shale on the top, which in places graded to coal seams up to one metre thick. Almost any of the thick sections exposed on the ridge tops have good examples of fluvial cycles.

3.2.3.2 Deltaic Facies

The deltaic facies (Figure 7) generally occurs in the valleys and so no complete cycles were found, only portions of cycles described in the literature (e.g. Clastic Facies Manual). The deltaic facies can be divided into two parts:

1) the marine prodelta
2) the fluvial and marsh delta top.

Coal seams, when found in the deltaic facies, occur just above the prodelta deposits or in the fluvial overbank deposits of the rivers which flowed over the delta top.

The prodelta coarsens upwards from distal, deep marine carbonaceous shales through silty shales to shallow proximal silts and sandy silts. The carbonaceous shales are often graded, probably formed of alternating A and E beds of the Bouma sequence. The silty shales are usually structureless but occasionally show soft sediment deformation. The coarser proximal silts often show very contorted bedding and slumping, probably due to mass flow down the foreset beds of a channel mouth bar.

This soft sediment deformation is very distinctive and useful for recognizing shallow marine deltaic sediments.

The delta top had meandering rivers on it and so the deltatop and fluvial facies are indistinguishable, except in that the delta top facies tends to contain a greater proportion of carbonaceous shale and coal.

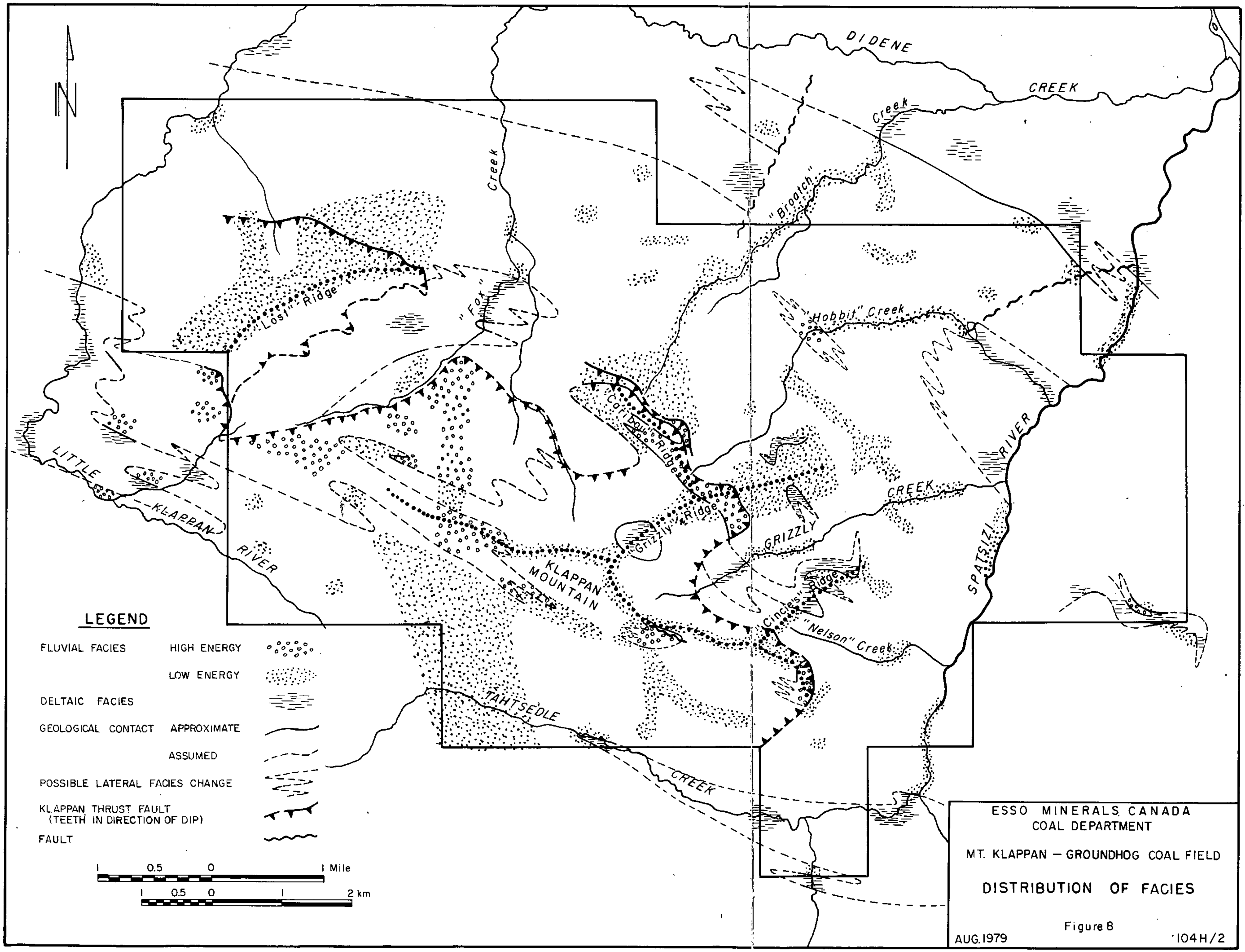
A rare sedimentary cycle, often associated with deltaic rocks, was interpreted to be a crevasse splay. It begins with interbedded sand (in 10 cm beds) and silt (in 2 cm to 5 cm beds). It grades upwards to thick sandstone in 1/2 m beds. It is usually 2 m to 5 m thick. Crevasse splays may be useful for distinguishing a continental meandering river from one on top of a delta, as long as it is not confused with an upsidedown fluvial cycle, which it closely resembles. The best exposure of a deltaic facies is in the quarry beside "Hobbit" creek and the B.C. railroad bed.

3.2.4 Map Units

The map units chosen (Figure 8) were the facies described above, because lithologies were not laterally continuous, thick or distinctive enough. Most of the map area is fluvial so it was arbitrarily subdivided into high-energy and low-energy units, depending primarily on the presence of conglomerate and the amount of shale.

The high-energy fluvial cycle begins with conglomerate and usually ends with silt or possibly a thin shale unit. It rarely contains any coal seams and never any thick ones.

The low-energy fluvial cycle begins with massive sandstone and ends with a thicker shale unit which is sometimes coaly. This division is not natural and there is a complete gradation between the two end-members described above. The middle portions of the cycles are identical.



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DISTRIBUTION OF FACIES

Figure 8

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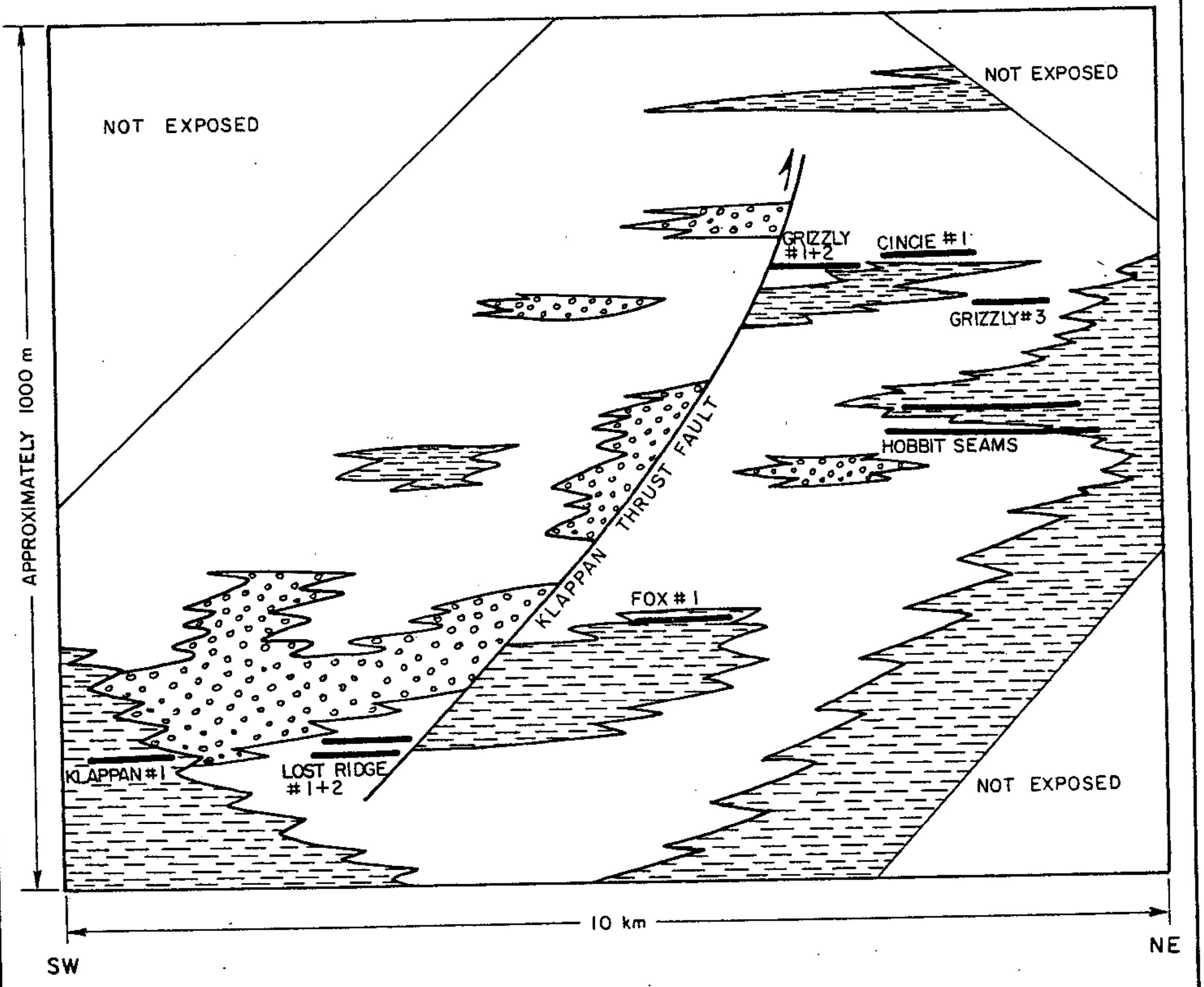
The deltaic facies was never exposed well enough to subdivide it, so the prodelta and delta top were mapped together as a deltaic unit.

3.2.5 Stratigraphy East of Spatsizi River

The stratigraphy east of Spatsizi River is poorly exposed, but it is probably fluvial. However, the lithologies are quite distinctive. The soft sandstone is much more common. A fast helicopter traverse was made along the ridge immediately to the northwest of Garner Creek and seven kilometres southeast of Spatsizi River. Fluvial facies with no coal still prevailed.

3.2.6 Stratigraphic Column and History

The stratigraphic column (Figure 9) and history is very generalized because of the problems dicussed below. The earliest deposition recorded is prodelta fine clastics. Southward regression then brought the delta top onto the property, probably from the northeast according to the paleocurrents measured by Richards and Gilchrist (1979) and Eisbacher (1974a). This most likely corresponds to the Duti River - Slamgeesh facies A1 and A2 of Eisbacher (1974a), except that there is no comglomerate in the deltas on Mt. Klappan. However, the property is 5 km to 25 km southwest of where Eisbacher mapped, so it may be the finer-grained, distal equivalents of Eisbacher's deltas. Continued southward regression brought



LEGEND

FLUVIAL FACIES	HIGH ENERGY	⁘
	LOW ENERGY	☐
DELTAIC FACIES		▤
COAL SEAM		▬

NOTE

- The stratigraphy is very generalized
- A regional dip to the south east is assumed
- Pollen analysis is not available, so any time lines are unknown
- Correlation is strictly lithostratigraphic

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STRATIGRAPHIC COLUMN

FIGURE 9

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meandering rivers onto the property, with minor transgressions to bring the occasional delta back onto the property. The meandering rivers correspond to the Gunanoot assemblage of Richards and Gilchrist (1979), in particular, their overbank facies. Mt. Klappan is dominated by overbank deposits because it is ten kilometres northeast of the axis of the Mt. Beirnes syncline, the probable center of channel deposition. The high-energy fluvial facies of this report were deposited by the main channels on their occasional appearance onto the property.

3.2.7 Problems in the Stratigraphy

The major problems in reconstructing the stratigraphy and history are that the structure is very complex and the stratigraphy is very uniform with no long distance marker beds or time lines. Poor exposure in the valleys obscures the deltaic stratigraphy and the deltaic/fluvial transition. For these reasons and the arbitrary division between high and low-energy fluvial units, the facies map (Figure 8) is very generalized.

3.2.7.1 Determination of Stratigraphic Top

Determining stratigraphic tops in the field was a continuing problem but essential to facies and structural interpretation. The most useful and reliable indicator is the slightly-thicker filling of silt in the troughs, in contrast to the crests, of sand ripples. Sandstone sometimes shows crossbeds distinctive enough to be reliable. Occasionally prodelta silts and shales show graded bedding that can be trusted. Fossil leaves that are preserved by casts generally have the cast on the upper bedding surface and the mold on the lower.

Occasionally the nose of an overturned fold was visible or its presence guessed. If a bed is dipping less than 35° it is almost certainly rightside up (overturned beds have an average dip of 52° and standard deviation of 13° for a sample size of 20). Rarely, the cleavage was dipping in the same direction as and less than the bedding, which means the beds are overturned.

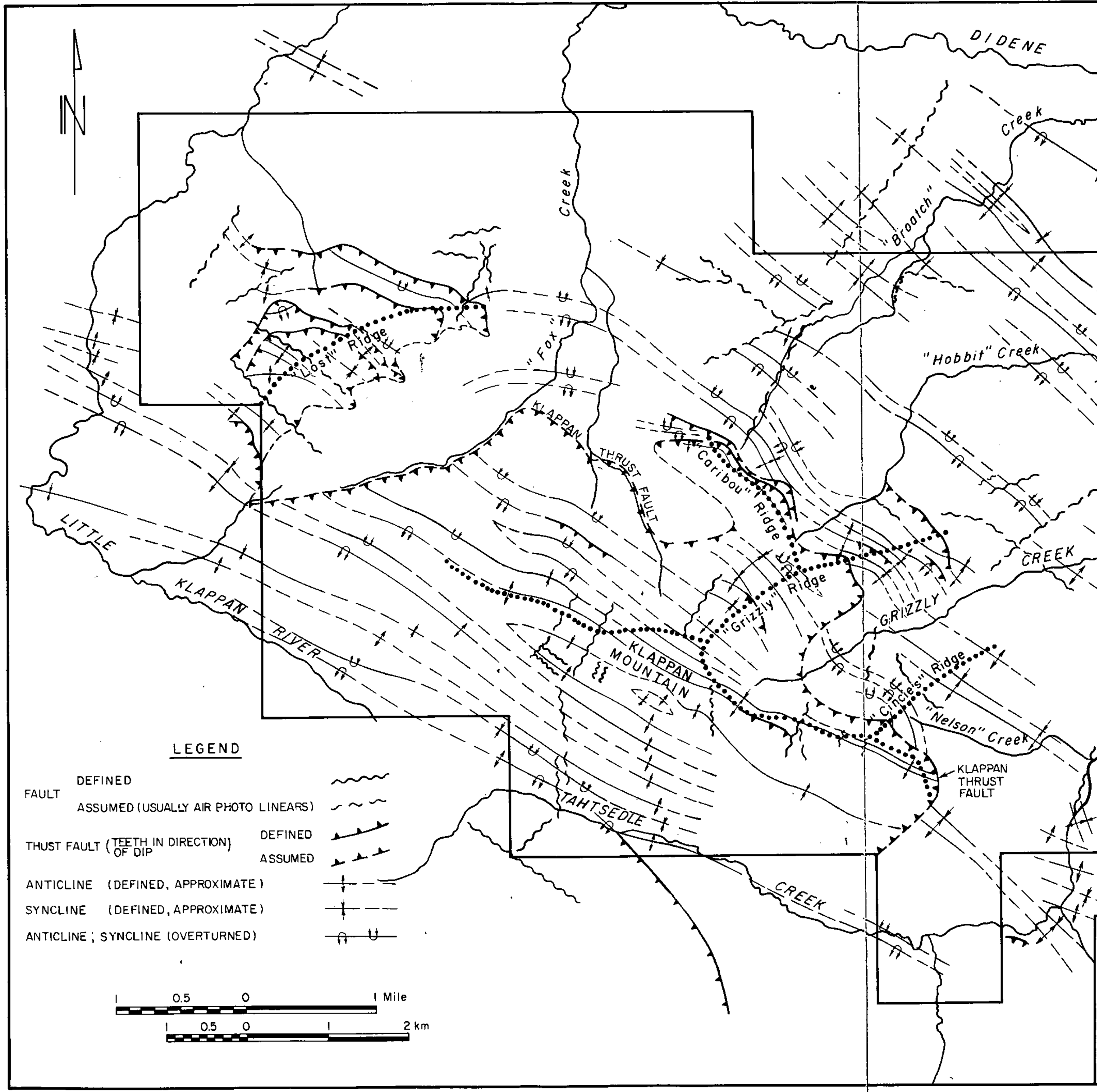
3.3 Structure

3.3.1 Introduction

The structure on the Klappan property (Figure 10) is complex but largely due to a strong push from the southwest. Folding is closely spaced and varies from open to overturned to the northeast. The Mt. Klappan thrust fault, imbricate in part, outcrops near the tops of the ridges. Possible block faults underlying the creeks around the edge of the property have structurally isolated it. Small displacement, steeply dipping faults, conjugate to the folds, are common. The structural style is partially controlled by the lithology. Thick conglomerate units tend to be broken by thrust faults, while siltstone and shale is more likely to be folded.

3.3.2 Folds

Folding is the commonest structural element on the property. The general style can be seen on a small scale in Plate 4b. It is intense and highly variable, changing within a few hundred metres both perpendicular and parallel to strike from broad, open folds to tight, overturned folds. The axial planes strike N50° to 60°W and dip from vertical for open folds to 30° to 50°SW for overturned folds. The only major exception is beneath the Klappan thrust fault between "Lost" ridge and Mt. Klappan, where airphoto linears show the structural grain to swing



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STRUCTURE

Figure 10

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Plate 4a

structure on the east end of "Grizzly" Ridge, looking northwest, outcrop W184. Fluvial channel sands and overbank shales. Note podding of soft sandstone.

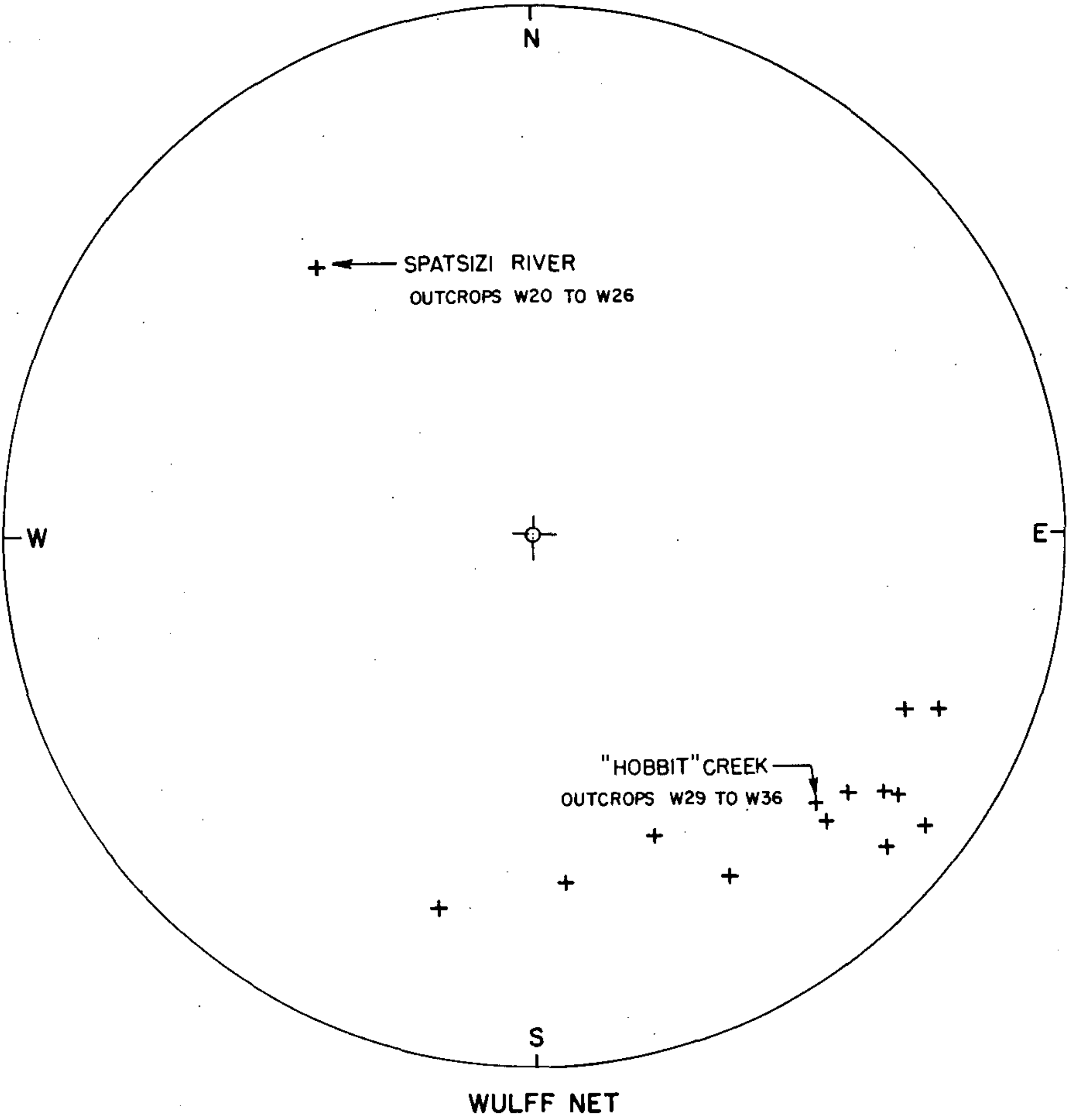
Plate 4b

Folded marine carbonaceous shales, outcrop W289.

around to NE - SW. The fold axes generally plunge about 20° southeast (Figures 11 and 12). The fold wavelength averages 500 m, but varies from 300 to 1500 m. Fold amplitude ranges from 100 to 200 m. Occasionally a syncline and anticline may combine and cancel out as on the top of Mt. Klappan. Occasionally anticlines pass vertically, both up and down, into thrust faults (Plate 4a).

Fold axes were generally recognized by a change in bedding attitude and rarely directly in outcrop. The exact location of the tighter folds can be determined from the effects of plastic and brittle deformation.

Plastic deformation, better developed in the more incompetent lithologies, shows as podding or cleavage. The less competent lithologies: shale, coal, and soft sandstone, may form pods in the noses of tight folds as in Plates 4b and 5 and coal seam Hobbit #1 described below. Cleavage is used in this report for the closely spaced joints that fan around the nose of a fold. In shale the cleavage can have penetrative to 1-cm spacing up to tens of metres from the nose. On overturned limbs the cleavage is in the bedding plane. In siltstone, the cleavage spacing is one-half to several centimetres, up to tens of metres from the nose. In sandstone the cleavage, more properly closely spaced joints, varies from one to



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STEREONET OF FOLD AXES FROM A RANDOM SAMPLING OF FOLDS
LOWER HEMISPHERE PROJECTION

Figure 11

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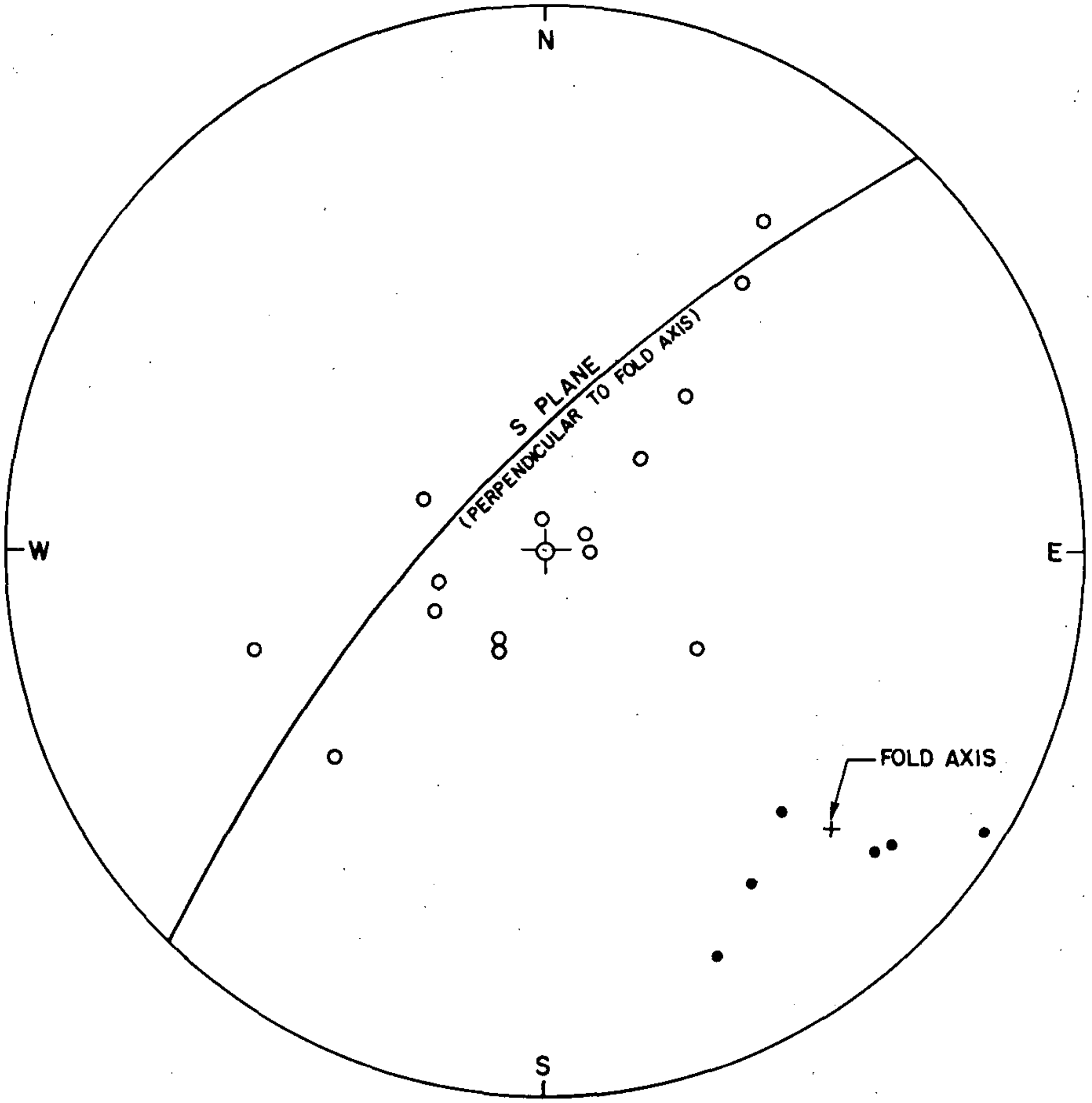

WULFF NET

LEGEND

○ POLES TO BEDDING PLANES

● LINEATIONS; INTERSECTION OF BEDDING PLANES AND CLEAVAGE

OUTCROPS W29 TO W36

FOLD AXIS TREND 134°
PLUNGE 18°

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STEREONET OF STRUCTURAL ELEMENTS
ALONG "HOBBIT" CREEK
OUTCROPS W-29 TO W-30
LOWER HEMISPHERE PROJECTION
Figure 12
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Plate 5

structure on "Cincie's" Ridge, west end at the head of "Nelson" Creek, looking northwest, outcrops W132 to W127. Fluvial channel sands and overbank silts and shales.

ten centimetres, up to a few metres from the nose.

Brittle deformation developed only in the competent lithologies (sandy siltstone, hard sandstone and conglomerate). It shows as jointing and in extreme cases, breccIation. Tight fold noses often show two sets of joints up to a few tens of metres from the nose. The transverse set is commonest; it is perpendicular to the fold axis. The other set contains two members conjugate to the fold axis. All sets are dilational and are filled with one to two centimetre quartz veins. Breccation is only developed in hard sandstone and conglomerate within a few metres of the nose of the tightest folds. The breccia is always cemented with quartz; occasionally there may be some calcite and/or vugs present. It is commonly cobble size but varies from pebble to boulder size. The larger breccias are more common in the coarser lithologies.

Small-scale folding is probably present throughout the area, but it is visible only in the best exposed areas, along ridges and creeks. They form secondary wrinkles on the large folds described above and have the same orientation. The wavelength and amplitude both range from a few metres up to tens of metres. Areas of disorganized bedding, such as that between Mt. Klappan and "Fox" creek, may be caused by these folds when the outcrop spacing is greater than the wavelength. The axial traces have been left off the maps for clarity.

3.3.3 Faults

Faults on this property are of three types:

1) thrust faults, the Klappan thrust fault and minor thrust faults
2) boundary faults around the edge of the property
3) minor faults, steeply dipping with little displacement

All observed fault planes on the property consist of 0.1 to 1 metre of slickensided fractures grading to cobble and pebble-size breccia. It is cemented, sometimes incompletely, with 1 centimetre quartz veins, occasionally with botryoidal calcite. The vuggy nature of the fault planes suggests that there has not been very much erosion since the faults were active.

3.3.3.1 Thrust Faults

Thrust faults occur in two varieties on the Klappan property":

1) Klappan thrust fault, approximately 10 km long.
2) minor thrust faults usually 0.5 km to 1 km long, grading laterally and vertically into anticlines.

The Klappan thrust fault outcrops along the top of the northeast faces of the ridges. It has a regional strike and dip of N45° to 50°W, 5° to 10°SW, but on nearing the surface, the dip increases to 20° to 50°SW (Figure 6). Along strike the fault varies from being a single plane at "Cincie's" ridge to an imbricate fault zone on "Lost" ridge and possibly dies out into folding on the Little Klappan river. The movement is possibly of the order of hundreds of metres, but certainly no more than a few kilometres or it would have moved the very thick conglomerate units that Richards and Gilchrist (1979) mapped on Mt. Gunanoot onto the property.

The Klappan thrust fault does not outcrop but it can be most easily recognized in the field by the change in structure and lithology across it. Very often above the fault plane are thick, flat or gently folded conglomerate beds. Below the fault plane there are usually tightly folded fine clastics; see Plate 5, which is just below the Klappan thrust fault. Also, its position can be extrapolated from a known location on one ridge to one of a very few possible sites on the next ridge, because the exposure is so good.

The minor thrust faults as in Plate 4a die out laterally within a few hundred metres and vertically into anticlines. The faults parallel the general strike of the folding, N50° to 60°W, and typically dip 30° to 50°SW. The maximum movement is probably of the order of tens of metres. These faults sometimes outcrop, but are usually recognized by a missing anticline.

3.3.3.2 Boundary Faults

The property is probably bounded by high-angle faults or fault zones. Plate 1 shows that the Spatsizi River, Tahtsedle Creek, Little Klappan River and Didene Creek are all local expressions of regional linear valleys that may be fault-controlled.

The Spatsizi River on the eastern boundary overlies a fault zone that is expressed as a swarm of subparallel airphoto linears. The one fault and linear that was directly observed just south of "Nelson" Creek offsets a fold axis 10 m to the left. However, the cumulative effect across the zone must be much more because to the east of Spatsizi River the structure and stratigraphy are different from the property.

There may have been Holocene movement on this zone that raised the west bank of the river. This lowered base-level may have been responsible for the ravines cut by Tahtsedle, "Grizzly", "Hobbit" and Didene creeks just before they enter Spatsizi River.

The lower portion of Tahtsedle Creek and the headwaters of the Little Klappan River may be an extension of the 100 km-long thrust fault Richards and Gilchrist (1979) postulated to control the Skeena valley. However, fair exposure along Tahtsedle Creek shows no evidence of a major fault. Another explanation for the Tahtsedle Creek linear is that the Skeena Valley fault changes to the tight folding along the creek. Then the broken, more easily eroded noses and probably associated minor thrusts produced the linear. The 20° bend at the Skeena Valley/Tahtsedle Creek junction and the confused folding there may be due to this change. There is not enough exposure to decide between these two possibilities.

The Little Klappan River, where it flows north, is just beyond the south end of a distinct 75 km-long Landsat linear. However, no discontinuities are visible across the river itself, so it may be controlled by a fault zone, as is Spatsizi River. The thicker fill in a wider valley and absence of recent movement may produce the lack of airphoto linears.

Didene Creek is at the northwest end of a linear valley 100 km long. It is probably fault-controlled because it offsets the Little Klappan linear 250 metres to the right. There is a 25° bend at the junction of Didene Creek and the linear valley proper, similar to that between Tahtsedle Creek and the Skeena Valley, so it may have a similar structure with the regional fault dying out into tight folding. The structure under Didene Creek can only be guessed at because there is no outcrop along the creek.

3.3.3.3 Minor Faults

Small displacement, steeply dipping faults are common throughout the property. They cluster into two sets similar to the joints on the noses of folds decribed above. The more common set is perpendicular to the fold axes, as along "Broatch" Creek. The other set is a pair of faults conjugate to the fold axes, as along

"Hobbit" Creek, though commonly only one member is well-developed. Occasional sub-horizontal slickensides were found. The sense of movement, from outcrop patterns, was always left-handed in the few cases seen. The amount of movement is usually a few metres to ten metres stratigraphic throw. These faults commonly offset the fold axes and therefore postdate the folding. These faults were usually recognized from airphoto linears. When outcropping, quartz-healed breccia and stratigraphic offset were the best indicators.

3.3.4 Joints

Joints are common in most lithologies; however, because of the structural complexity, joint sets are very local. Joint spacing varies from about one metre in conglomerate to a few centimetres in siltstone and shale. Joints never showed any alteration, but were occasionally filled with one centimetre milky quartz veins. When a consistent set was noted it was usually near the nose of a fold and was either perpendicular or conjugate to the fold axis and commonly filled with quartz, as mentioned above. At the nose itself there was usually a clean set sub-parallel to the axial plane which, in extreme cases, became the fold cleavage mentioned above.

3.3.5 Structure East of Spatsizi River

The structure east of Spatsizi River is probably different from the rest of the property. The folds are open and plunge to the northeast with a wavelength of about 700 m. There are a number of small scale irregularities, probably due to the incompetence of the abundant soft sandstone. However, the exposure along one traverse is too poor to be certain of any but the most general conclusions about the geology east of Spatsizi River.

3.3.6 Structural History

Folding and thrusting was driven by the Cretaceous - Tertiary uplift of the Coast Crystalline Belt (Eisbacher 1974b). The block faulting around the property probably began after most of the folding and thrusting was complete and may have continued to the present. The minor faulting certainly took place after the major folding events.

3.3.7 Problems in the Structure

The structural complexity of this area has two causes:

1) the property is towards the edge of the basin, where most of the deposition formed incompetent overbank silts and shales.

2) Spatsizi River and Tahtsedle Creek are the boundaries between areas of different regional strikes (Plate 1). To the southeast most major valleys run southeast-northwest, but to the northwest they trend closer to east-west. Mt. Klappan is caught in a corner between these two regimes. The complex structure may be due in part to the change from one to the other.

The main problem when studying the structure is that the exposure is rarely sufficient, other than on the ridge tops. Overturned limbs of folds, because they are so short, may have been hidden or, if exposed, misinterpreted as right-way up. A thrust fault in the outcrop-poor slope south of Didene Creek would be difficult if not impossible to find. Fold traces are not very straight but are close together, so that correlation across large distances is questionable.

3.4 Coal

3.4.1 Introduction

The best seams on the property outcrop along the lower half of "Hobbit" Creek. There are at least two seams and probably up to four seams, 3 to 4 m thick. The crest of an overturned fold, the "Hobbit" Creek anticline, runs down the southeast-flowing portion of the creek. Some of the seams may be podded in the fold along the creek.

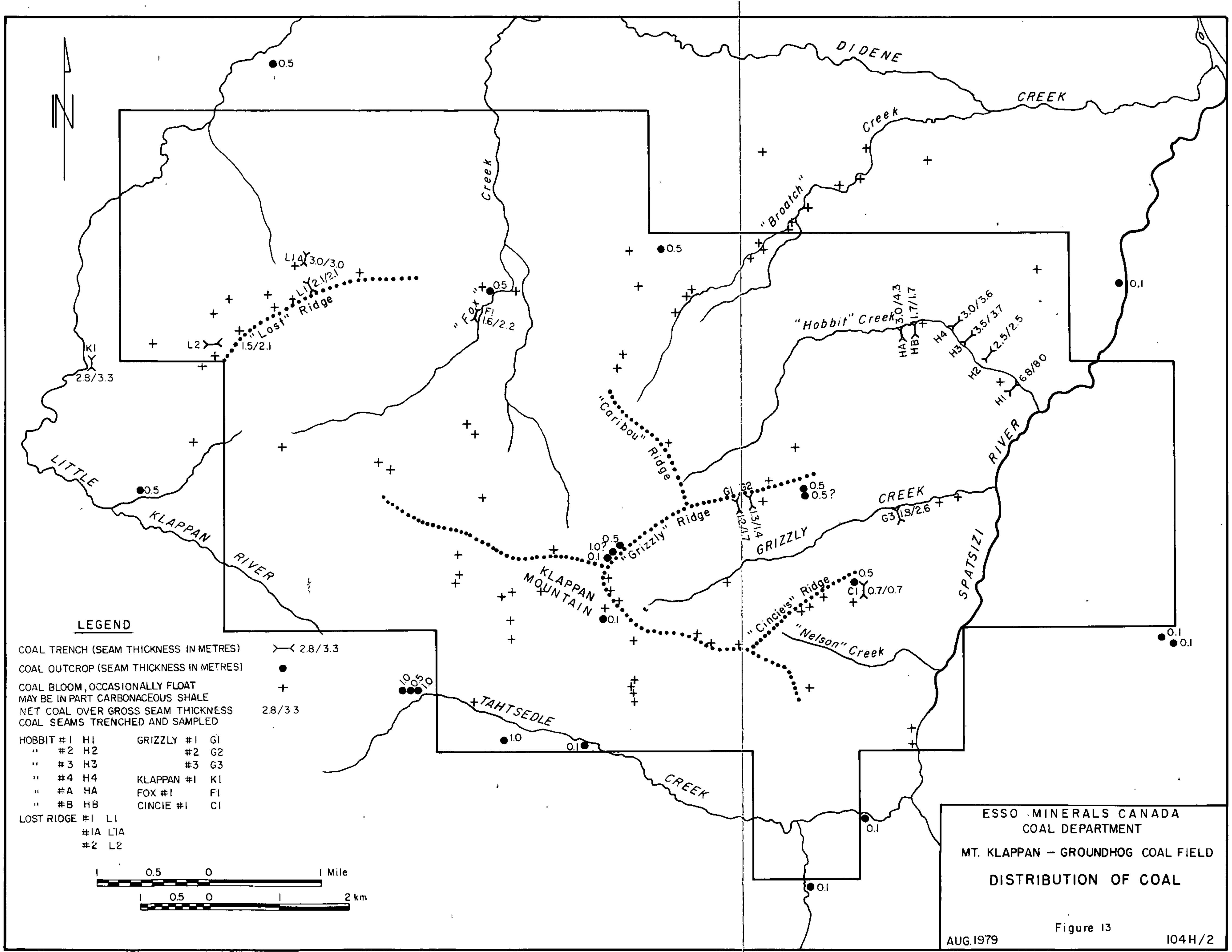
The next best seams are two that outcrop on "Lost" Ridge with a thickness of 2 to 3 m. They lie on both limbs of a recumbent syncline. See Figure 13 for the distribution of coal on the property.

3.4.2 Coal Description

The descriptions were made from field notes taken on trenched outcrops.

Detailed coal outcrop sections are in the pocket. Table IV summarizes that data. Below are general descriptions.

All the coal is banded and probably hard to moderately hard, though weathering, tectonic activity, and frost action have often made the outcrops very friable, often destroying the cleat and bedding surfaces. The coal is usually almost all attrital, but sometimes ranging up to



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DISTRIBUTION OF COAL

Figure 13

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TABLE IV

Summary of Coal Seam Descriptions

	Location UTM				Thickness (metres)						
Seam	East	North	License	Strat. Position	Gross	Net	Partings	Mineralization	Roof	Floor	Comments
Hobbit #1	515720	6342990	3964	above 2,= 3,4,A?	8.0	6.8	coaly clay	iron staining quartz & calcite	fault	clay	podded? Plate 6
#2	515380	6343280	3965	below 1 same as B?	2.5	2.5	--	--	shale	shale & sandstone	podded? Plate 7b
#3	515060	6343470	3965	same as 4,A	3.7	3.5	--	iron staining quartz	shale	shale	Plate 8a
#4	514940	6343650	3971	same as 3,A	3.6	3.0	shale	iron staining	sandstone & siltstone	shale	
#A	514240	6343670	3971	same as 3,4	4.3	3.0	clay & shale	iron staining quartz & calcite	sandstone & shale	shale	thinned? Plate 9
#B	514400	6343770	3971	below A	1.7	1.7	--	iron staining	?	shale	
Lost Ridge #1	505650	6344390	3979	same as 1A	2.1	2.1	--	tr. peacock	siltstone	sandstone & siltstone	
#1A	505670	6344650	3979	same as 1	3.0	3.0	--	iron staining	sandstone	shale & sandstone	
#2	504340	6343340	3980	--	2.1	1.5	shale & siltstone	iron staining	siltstone	shale	
Grizzly #1	511880	6341310	A	same as 2	1.7	1.2	shale	--	shale & siltstone	siltstone	
#2	511780	6341280	A	same as 1	1.4	1.3	shale	--	siltstone?	shale	
#3	511110	6341070	A	-	2.6	1.8	mud	iron staining sulphur?	siltstone	sandstone & shale	
Klappan #1	502590	6343060	P	--	3.3	2.8	shale & siltstone	iron staining	siltstone	sandstone	
Fox #1	508190	6343830	3975	--	2.2	1.6	shale & siltstone	iron staining sulphur	shale	shale	
Cincie #1	513640	6340140	3966	--	0.7	0.7	--	iron staining	shale	shale	Plate 8b

(A: Esso License Application)
(P: Petrofina License)

half vitrain and rarely almost all vitrain. No fusain was observed. Maceral classifications are from Schopf (1960).

Seam thickness in Table IV is reported as two numbers:

1) Gross thickess is the distance from the top of the highest good coal to the bottom of the lowest good coal.
2) Net thickness is the gross thickness less all partings.

Mineralization is common though rarely strong. Iron-staining is present throughout the property except Grizzly #1 and #2. It is very thin and easily rubbed off by hand. It is usually on the cleat and rarely on bedding surfaces. Half to one centimetre quartz veins and rare 1-mm calcite films are present between occasional cleats in some "Hobbit" Creek seams. These two minerals may be here because these seams are exposed in the tensional regime along or near the nose of the "Hobbit" Creek anticline. Possible sulphur staining and odour were noted on the Grizzly #3 and Fox #1 seams. Pyritized coal balls were found as float in "Hobbit" Creek just below the outcrop of Hobbit #1.

Partings average 15% of all the seams and average 25 cm thick. They are most commonly grey-brown shale to coaly shale, less commonly grey siltstone or soft brown clay.

The roof is usually shale to siltstone, often coaly. The floor is usually shale, occasionally siltstone or sandstone. Both roof and floor are moderately hard to soft and usually highly fractured, possibly due to weathering and frost action.

The facies of deposition of the coal seams is usually the overbank portion of the low-energy fluvial facies. However, the thickest seams were deposited in delta-top swamps.

3.4.3 "Hobbit" Creek Seams

The "Hobbit" Creek seams are numbered consecutively from the statigraphic uppermost down, and from the bottom of the creek up. The letter designations were chosen at random.

3.4.3.1 Correlations

Hobbit #3, #4 and #A are probably the same 3 to 4-metre seam, with Hobbit #B a separate 1.7-metre seam below it. It is possible, but unlikely, that Hobbit #1 and #2 are these two seams outcropping again. Hobbit #3, #4, and #A are correlated because:

1) similar thickness, 3.5 m, 3.0 m, and 3.4 m from the top to the gradational base.
2) same floor rock, about half-metre interbedded coal and shale grading to brown shale.
3) roof rocks that are coarser than usual, being sandy rather than pure shale or siltstone.
4) similar macerals: high in atrital coal, generally decreasing toward the top.
5) partings of approximately the same lithology and at the same stratigraphic position, that thin and pinch-out going down the creek from Hobbit #A to #4 to #3.

The repeated exposure of this seam along the nose of a plunging anticline (Figure 12) is due to cross-cutting faults. There is an observed fault between Hobbit #3 and #4 and a fault inferred from an airphoto linear between #4 and #A. They are both probably members of the conjugate minor fault set.

Hobbit #B is a separate seam below Hobbit #A. Hobbit #B is half the thickness of the overlying seam; it has a sharp lower contact and a high vitrain content. There is no room to squeeze a fault between the two outcrops.

Hobbit #2 is probably a distinct seam below Hobbit #1. #2 is largely vitrain, while #1 is mostly atrital coal. #1 has a thick parting which #2 lacks. The floor rocks are different. There are no faults or airphoto linears between the outcrops to produce the repeated section. The large difference in thickness could be due to tectonic activity.

The pattern of a thick seam overlying a thin seam is repeated along the creek. Hobbit #3, #4, #A overlies #B and Hobbit #1 overlies #2. Assuming a minimum number of seams, these sets of seams could be correlated, however they have few similarities. While Hobbit #2 and #B are both high in vitrain and lack significant partings, they have different thicknesses (2.5 m and 1.7 m) and different floor rocks. Hobbit #1 has no similarities to Hobbit #3, #4, #A other than thickness, which has been strongly affected by tectonics in Hobbit #1. There are no airphoto linears or faults between Hobbit #2 and #3, which would be necessary to produce a repeated section. It is most likely that there are four seams along "Hobbit" Creek, in stratigraphic order:

Hobbit #1	Highest
Hobbit #2	
Hobbit #3, #4, #A	
Hobbit #B	Lowest

3.4.3.2 Thickness

Tectonics have had a strong effect on the thickness because the exposures are along the nose of the "Hobbit" Creek anticline.

Hobbit #1 is much thicker than any other seam on the property. It is not possible to determine if this is due to podding, ice-thrusting, or deposition. The seam shows contorted bedding and minor faulting (Plate 6b) and it is near or on the nose of the anticline. The seam thickness changes from 2 metres to 8 metres (Plate 6a) with its top in fault contact with till. The ice may have thickened the seam by thrusting or eroded the top away in some areas. The minimum thickness for the Hobbit #1 seam is probably 6.8 metres of coal over an 8.0 metre section.

Hobbit #2 is probably podded; it shows extreme faulting, brecciation, and contorted bedding (Plate 7b) and it is exactly on the nose of the anticline. It is probably less than 2.5 m thick with no partings.

Plate 6a

Hobbit #1 coal seam, looking southwest, outcrop W29.

Note: glacial(?) thining of the seam.

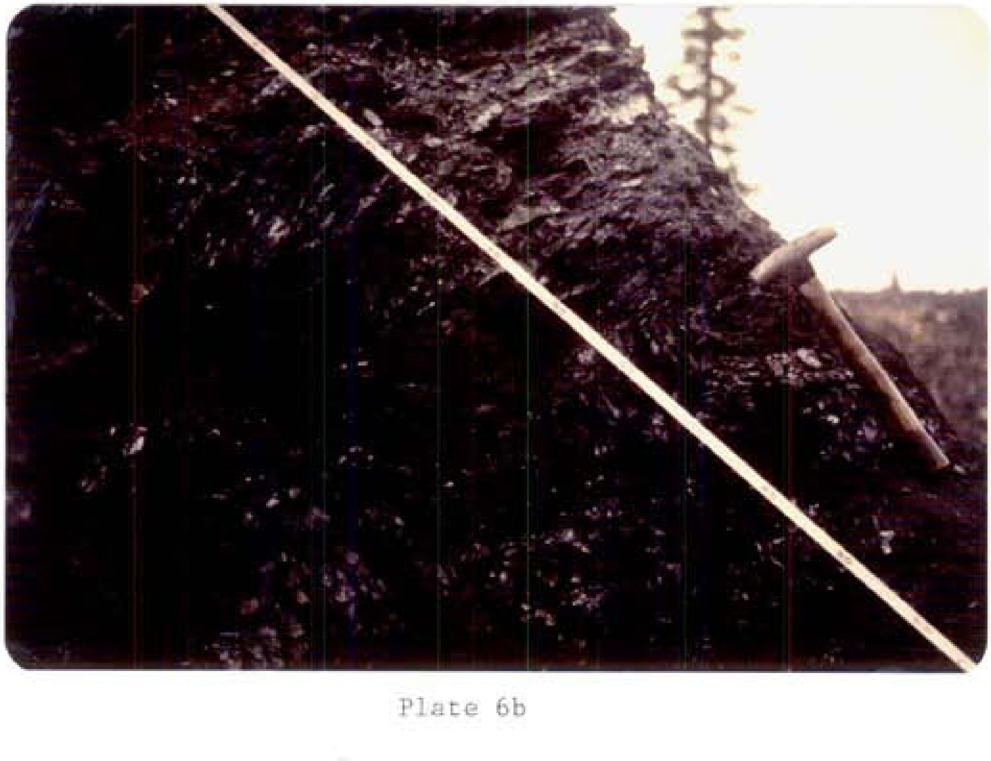


Plate 6b

Hobbit #1 coal seam, detail of complex folding and faulting. Outcrop W29.

Note: syncline and anticline under the hammer.

Plate 7a

Hobbit #1 coal seam, detail of coal ball(?). Outcrop W29.

Note: heavy iron staining above hammer.

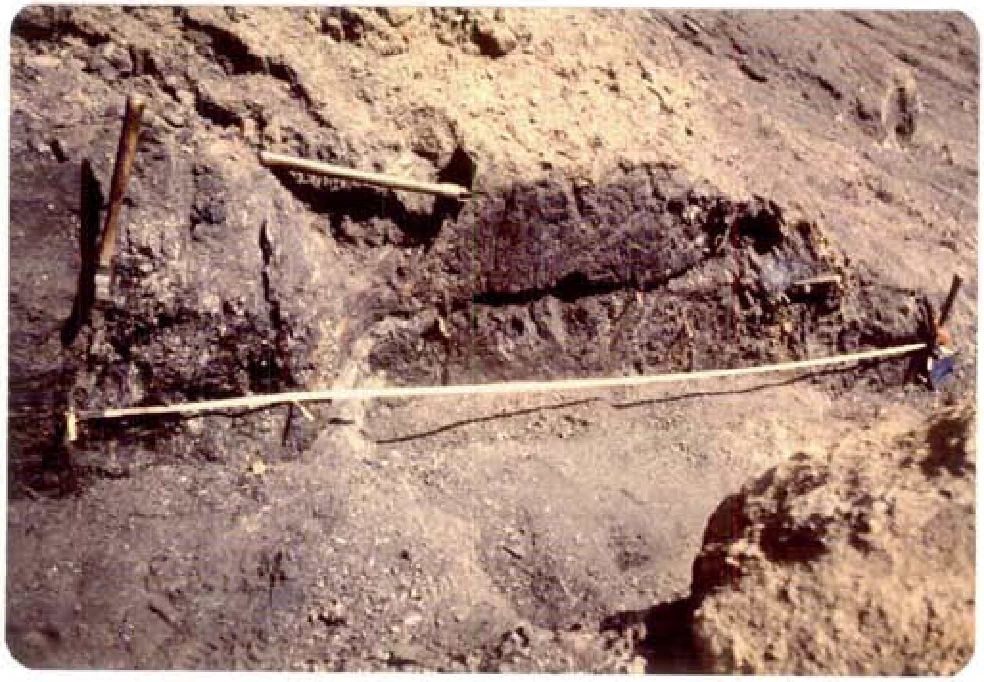


Plate 7b

Hobbit #2 coal seam, looking down the plunge of the fold. Outcrop W31. Hammers mark the top and bottom of the seam, the trench shovel and knife mark fault offsets.

Hobbit #3, #4, #A outcrops on the shallow-dipping southwest limb of the fold and shows little to no tectonic disturbance. However, Hobbit #A has been thinned by about 10 percent by a set of small conjugate faults (Plate 8). The average thickness (without taking the thinning into account) is 3.0 metres over 3.9 metres.

Hobbit #B is also on the same limb and may be slightly thickened by a small thrust fault. The minimum thickness for this seam is 1.7 metres over 1.7 metres.

3.4.3.3 Areal Extent

The areal extent of the "Hobbit" Creek seams is probably at least over the length and breadth of the southwest limb of the "Hobbit" Creek anticline, which extends over a rectangular area 3 kilometres by 0.5 kilometres. The seams may also be present to the northeast to the last anticline mapped south of Didene Creek. Along that fold, coal float was found near the deltaic facies outcrop B-44. This maximum area is 2.5 kilometres by 3 kilometres. These estimates are very tentative due to the poor exposure.

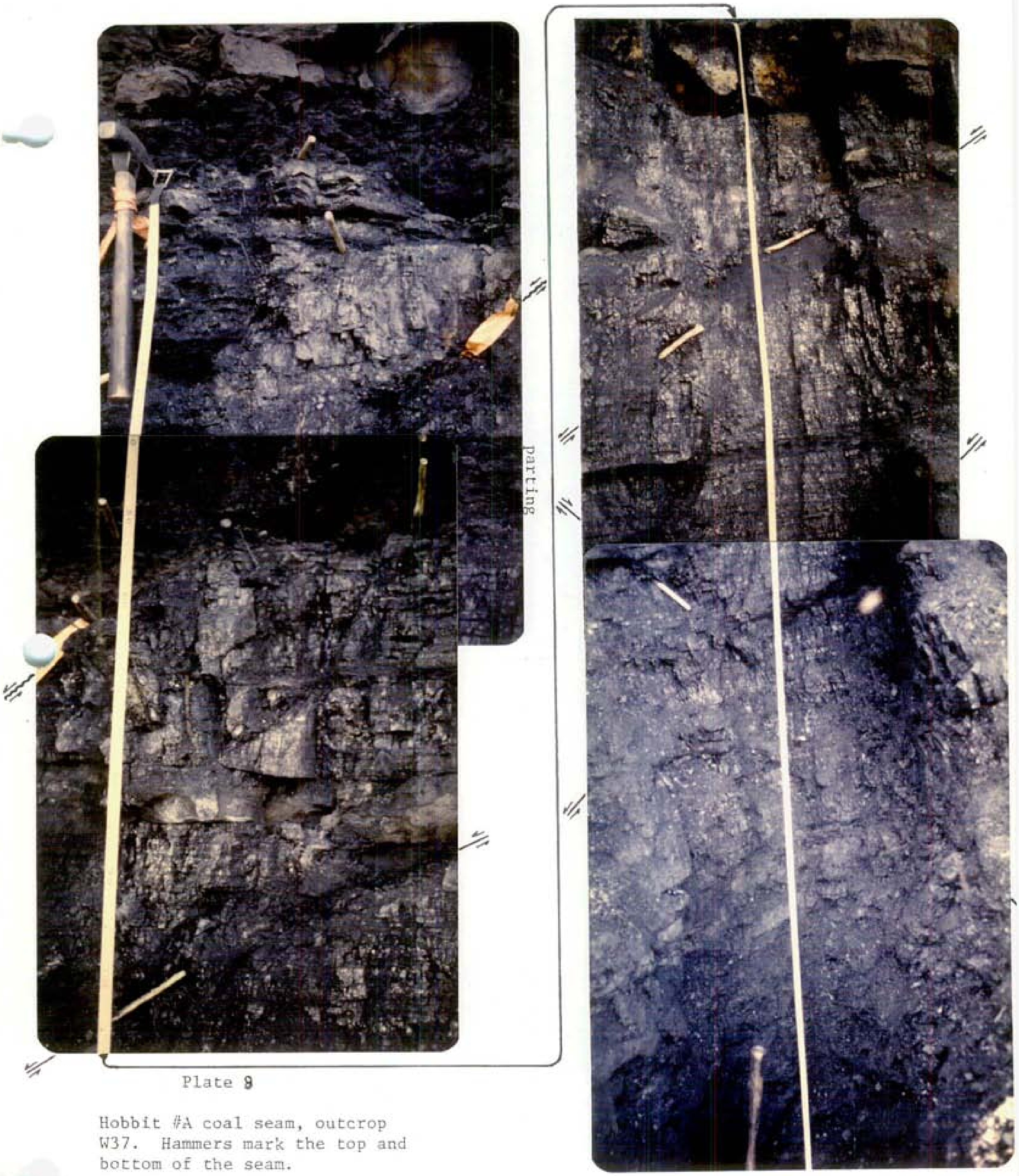


Plate 9

Hobbit #A coal seam, outcrop W37. Hammers mark the top and bottom of the seam.

Note: conjugate fractures and faults and the offset parting.

Plate 8a

Hobbit #3 coal seam.
Outcrop W32a.
Hammers mark the top and
bottom of the seam.

Plate 8b

Cincie #1 coal seam, outcrop W216.
Hammers mark the top and bottom of
the seam.

Note: irregular thin bands of iron
staining, possibly Leisegang
rings.

3.4.4 "Lost" Ridge Seams

Lost Ridge #1 and #1A are the same seam in different thrust slices and probably stratigraphically below a second seam, Lost Ridge #2, which is in a third fault slice.

Lost Ridge #1 and #1A are correlated because of:

1) similar thickness; 2.1 m and 3.0 m
2) the same floor rocks; interbedded coarse and fine clastics
3) the same macerals; almost pure vitrain
4) lack of partings.

Lost Ridge #2 is not correlated with the other two seams because of:

1) different floor rock; shale
2) different roof rock; interbedded shale and coal
3) different macerals; almost pure atrital coal
4) a thick parting.

The average thickness for Lost Ridge #1, #1A is 2.5 m over 2.5 m; Lost Ridge #2 is 1.5 m thick over 2.1 m. These thicknesses are not as reliable as those on "Hobbit" Creek becuase the trenching was very difficult and the ground was frozen. However, there were no structures that suggested tectonic thickening or thinning.

The areal extent of these seams is controlled by the ridge topography and the thrust faults. "Lost" Ridge #1, #1A exist over an area of approximately 1 kilometre by 3 kilometres. "Lost" Ridge #2 is present over a one by 1.5 kilometre area.

3.4.5 Grizzly Seams

Grizzly #1 and #2 are the same seam, outcropping on either side of an anticline, and may be correlated because of:

1) similar net thickness, 1.2 m and 1.3 m, assuming that the covered interval in Grizzly #2 is not coal
2) similar floor rocks, fine clastics
3) identical roof rocks, 0.3 m of interbedded coal and mudstone below fine clastics
4) similar macerals, a high concentration of vitrain
5) no partings.

The average thickness is 1.2 m over 1.5 m. The aerial extent is severely limited because the seam outcrops on top of Grizzly Ridge, which is quite narrow at this spot. The Grizzly #3 seam cannot be correlated with the other outcrops because of its distance from them.

3.4.6 Minor Seams

The other four seams, Grizzly #3, Klappan #1, Fox #1, and Cincie #1, are of limited economic interest. Grizzly #3, Fox #1, and Cincie #1 all have less than 1.8 m net thickness and occur alone. Klappan #1 has a net thickness of 2.8 m, but it is near-vertical, and is on Petrofina's property. However, it may extend onto the shallow-dipping limbs of folds on Esso's property, but this would take a lot of blind drilling to determine.

3.4.7 Unsuccessful Trenches

A few unsuccessful trenches were dug, either because the overburden was too thick, or because no coal was found under the "coal" bloom. Carbonaceous shale weathers into a black soil indistinguishable from coal bloom. The one-centimetre vitrain bands in the shale sometimes give the soil a sparkle usually associated with coal. The only sure indicator of coal, other than an outcrop, was coal float and coal bloom together.

3.4.8 Controls on Coal Occurrence

The controls on coal are both structural and stratigraphic. The structural control on the coal is that it may be podded, but this was not directly observed anywhere. However, the strongest effects of tectonic activity are seen on the nose of the "Hobbit" Creek anticline. The other incompetent lithologies, soft sandstone and shale, do pod in fold noses (Plates 4a and 5).

Stratigraphically, the coal is limited in occurrence to:

1) the overbank deposits of the low-energy fluvial facies, where it occurs as 1 to 2-metre thick seams, and
2) the top of the deltaic facies, where the seams are 2 to 4 metres thick and approximately 100 metres stratigraphically apart. If the thickest seams are near the deltaic-fluvial facies contact over the rest of the property, as they are on "Hobbit" Creek, then the largest area of this contact to be investigated is south of Didene Creek; an area of no outcrop. The next largest potential areas are towards the top ends of "Fox" Creek and the Little Klappan River; unfortunately, these areas also lack outcrop and the Little Klappan River is on Petrofina's property.

3.4.9 Problems in Coal Geology

There are several problems in the field study of coal on this property. It is not possible to correlate seams from one area of the property to another because of the structural complexities. For instance, it is not possible to correlate the Fox #1 seam with any of the "Hobbit" Creek seams. The conjugate faults have thinned some seams, while folding may have thickened others. The minor faults in general have cut the coal seams. Weathering, particularly frost action, has severely affected some coal outcrops, with cleat and bedding surfaces being destroyed in places so that some descriptions are correspondingly poor.

3.5 Miscellaneous Geology

Some geology not noted above is included below for completeness.

3.5.1 Macro-Fossils

Macro-fossils, usually leaves and occasionally twigs, are common throughout the property and particularly abundant in marly layers where they are usually well-preserved as molds. Fossils that have been identified are listed in Table V. The age is from possibly Late Jurassic to Early Cretaceous. Silicified tree trunks are scattered throughout the section in siltstone and fine sandstone. They are usually one-half metre in diameter, up to several metres tall and cut by half-centimetre quartz veins every half metre, parallel to bedding. No bark is preserved, so they are unidentifiable without cutting a thin section. The Esso Research Department is analyzing microfossils from the coal seams which may show the precise age of the rocks.

3.5.2 Mineralization

Pyrite mineralization is present as coal ball float in "Hobbit" Creek and also as rare 2-cm beds or veins in the deep marine carbonaceous shales on Little Klappan River.

TABLE V

Macro-fossils

Species	Age
Nilssonia brongiarti (Mantell) Dunker	Neocomian/Barremian
Gingko nana Dawson	Neocomian/Barremian to Aptian
Czekanowskia sp	
Cladophlebis sp	
Phoenicopsis sp	
Unio ?	

NOTE: The age given is only an upper age. The range could extend down into the Jurassic. These were identified using Bell (1956). No books on Western Canadian Jurassic flora are available. All the above are leaves except *Unio* which is a pelecypod.

TABLE VI

Permafrost Exposures

Outcrop	Trench	Ridge	Orientation	Depth
W-166	Grizzly #2	"Grizzly" Ridge	Southeast face	1.0-1.5 m
B-108	"Lost" Ridge #1A	"Lost" Ridge	Northwest face	2 m
B-111	"Lost" Ridge #1	"Lost" Ridge	Northwest face	0.8 m

3.5.3 Tertiary Erosion

An erosion surface remnant is present on the top of Mount Klappan where it slopes gently at 5° towards Tahtsedle Creek before dropping off suddenly into the present day valley. This has approximately the same slope and elevation as the ancient land surface that is better preserved west of Klappan River and southeast of Eddontenajon Lake. There it has been covered by columnar basalt flows of late Tertiary age.

3.5.4 Overburden Thickness

The overburden is generally quite thin. Ridge tops probably have about one metre commonly of felsenmeer, whereas ridge sides usually have up to about one metre of colluvium. The upper parts of the valleys including the "Hobbit" Creek area have one to several metres of colluvium and glacial drift. Side glacial channels immediately north of "Caribou" ridge have cut into bedrock through one to three metres of overburden. Valley bottoms on the periphery of the property are probably underlain by a thin-to-thick layer of glacial drift and alluvium. The "U" shape of a glacial valley has not been altered by any thick alluvial fill and some outcrops are preserved in the valleys, but they are very far apart. Buried glacial channels may be present and thicken the overburden.

3.5.5 Rockslides

Rockslides are very common and large on the south side of Mt. Klappan. The other ridges have the occasional small slide area. These slides are unmodified by glacial activity and some are recent enough that trees have not yet regenerated on the debris surface.

3.5.6 Permafrost

Permafrost was found in three trenches, 1 m to 2 m below the ground surface in August. The locations are listed in Table VI. The frozen ground on the northwest face of "Lost" ridge may have been frozen in winter and preserved under a late snowbank. However, this is unlikely on the other occurrence on the southeast face of "Grizzly" ridge. The National Atlas of Canada shows the property to be in an area of permafrost down to an elevation of about 4000 ft (1200 m). Discontinuous permafrost may be encountered when drilling on "Hobbit" Creek. Continuous permafrost will probably be encountered when drilling on "Lost" Ridge.

3.5.7 Salt Springs

There are three chemically-charged springs on the southeast end of Mt. Klappan. At the easternmost end of Mt. Klappan, south of "Nelson" Creek, are two small active springs above and below outcrop W-269. The spring above the outcrop is charged with calcium carbonate, but it has deposited only a few millimetres of calcite. The one below is charged with hydrogen sulphide. These two springs probably issue from, or very close by, the Klappan thrust fault. On the other side of Mt. Klappan from the headwaters of Grizzly Creek, around outcrop W-120, are patches of friable white limestone that are 1 to 2 metres on a side. They contain clasts of sandstone and siltstone from the Bowser Lake group and leaf impressions from dwarf willow, an alpine shrub that is growing alongside. This rock is travertine deposited from a carbonate charged spring. Though no spring is active now, it must have been active after the Altithermal period (6,000 to 8,000 years B.P.) when the tree-line was higher. This may also mark the location of a thrust fault, though no other evidence for it is available.

3.6 Summary of the Geological History

In late Jurassic or early Cretaceous time a delta prograded over the property, possibly from the northwest. 3 to 4 metre coal seams developed on top of it. Further regression brought floodplain deposits and their coal seams onto the property from meandering rivers flowing south to southwest from the rising Omineca geanticline. A few minor transgressions brought deltas back onto the property for brief periods. A total of at least 1000 metres of sediment was deposited.

During the Cretaceous and Tertiary the uplift of the Coast Crystalline Complex caused open to tight folding and thrust faulting towards the northeast. This was probably followed by block faulting.

Pre-Late Tertiary times saw the property uplifted and eroded to a subdued topography. During or after the late Tertiary there was renewed uplift and erosion, possibly continuing to the present.

Pleistocene glaciers eroded the valley walls and deposited a thin layer of drift. Isostatic rebound may have reactivated the Spatsizi fault zone. Travertine was deposited after the present day distribution of vegetation was established.

4 COAL QUALITY

During the mapping program, channel samples were taken of selected coal outcrops for coal analysis. The analyses have not yet been completed and will form a separate report later this year.

Buckham and Lautour (1950) listed all analyses available from the early exploration of Groundhog. Of those, the samples taken from tunnels driven into the seams yielded analyses, on an "as-received" basis, with the following ranges:

Moisture	1.4% - 5.9 %
Ash	4.05% - 34.6%
Volatile Matter	3.1% - 13.32%
Fixed Carbon	42.6% - 84.5%
Sulphur	0.44% - 3.05%
Calorific Value	9360 - 13,814 BTU/lb

The samples indicated coal ranks of low-volatile bituminous to anthracite.

During exploration for a joint venture headed by National Coal Corporation, Tompson et al (1970) had a number of drillcore samples analyzed. The analyses were done on the float fraction of the samples separated between 1.40 and 1.75 specific gravity. The portion of the samples floating varied between 23.7% and 98.8%, and the analytical results, on a "dry basis", ranged as follows:

Ash	4.91% - 19.76%
Volatile Matter	5.70% - 9.45%
Fixed Carbon	70.79% - 88.89%
Sulphur	0.43% - 0.84%
Calorific Value	11,746 - 14,012 BTU/lb

The most recently reported analyses were from surface samples taken by Gilchrist (1970). A sample from the west side of Mt. Gunanoot produced an ash of 15.53% and volatile matter 26.54% (dry basis, raw coal). A sample from Mt. Klappan yielded 23.55% ash and 13.3% volatile matter.

See Appendix III for coal analyses.

5 COAL RESERVES

5.1 Introduction

It is speculated that there may be 1.5 million tonnes of coal along "Hobbit" Creek. If this coal extends to the next folds then this number could be doubled or tripled.

Similarly, "Lost Ridge" may have 160,000 to 500,000 tonnes of coal to a 30 metre depth.

The above speculations are calculated by three-dimensional geometry. This method can only give a "ballpark" figure.

Since most coal seams have only one outcrop and there are no drillholes, calculations are not possible. Over the areas in question the structure and ground surface are regular enough that they can be represented approximately by planes. This mathematical approach has the advantage that all assumptions are explicit. The calculations are based on:

1) the thickness, given above in sections 3.4.3.2 and 3.4.4

2) the area, calculated below in sections 5.2 and 5.3

3) the density, assumed to be 1.5 tonnes/m^3.

5.2 "Hobbit" Creek Seams

The area of coal along "Hobbit" Creek was calculated using three-dimensional analytical geometry. For the purposes of this calculation all four seams can be aggregated into one seam with a total net thickness of 14 m. It is assumed that the coal occurs only on the southwest flank of the "Hobbit" Creek anticline and that it can be represented by an infinite plane. However, the mineable portion of the seam is a finite area on this plane. To find this area, it is necessary to know its boundaries. Two of these boundaries are determined by the ground surface and the maximum mineable depth. It is assumed that the ground surface can be represented by a plane, then the maximum mineable depth is a plane parallel to the ground surface and 30 m below it. Since these two planes are parallel their intersections with the plane of the coal seam will be parallel lines and they will define a thin infinitely long strip. Since the seam is assumed to be only on the southwest limb of the "Hobbit" Creek anticline, this strip will terminate against the axial planes of the "Hobbit" Creek anticline and the next fold to the southwest.

The origin for the calculations was put at UTM coordinates, easting 510 000 m, northing 6 340 000 m. The X-axis is directed northward, the Y-axis is directed eastward and the Z-axis downward.

From the topographic map the ground surface was assumed to have a strike and dip of N20°E, 5°SE at X = 3500 m, Y = 5500 m, Z =

−1280 m. This gives the equation for the ground surface as:

$$-0.0000184x + 0.0000505y - 0.000614z = 1;$$

and with a 30-metre mine depth the equation for the minefloor is:

$$-0.0000187x + 0.0000515y - 0.000626z = 1.$$

From the geological map and cross-sections (Figures 5b and 6) the fold axes were assumed to be parallel, with a strike and dip of N52°W, 45°SW at $x = 3300$ m, $y = 2350$ m, $z = -915$ m for the "Hobbit" Creek anticline, and at $x = 3700$ m, $y = 4100$ m, $z = -1395$ m for the next fold to the southwest. This gives the equation for the axial plane of the "Hobbit" Creek anticline as:

$$0.000170x + 0.000133y + 0.000216z = 1;$$

and for the next fold to the southwest:

$$0.000195x + 0.000152y + 0.000247z = 1.$$

From Figure 12 the combined coal seam is assumed to have a strike and dip of N70°W, 50°SW at $x = 3300$ m, $y = 5400$ m, $z = -1295$ m. This gives the equation:

$$0.000243x + 0.000886y + 0.000217z = 1.$$

The intersection of the first four equations with the last defines a long thin parallelogram of mineable coal with an area of 74 000 m^2. With a thickness of 14 m and a density of 1.5 tonnes/m^3 this gives 1.5 million tonnes of coal. This tonnage is directly proportional to mine depth. It is reasonable to assume that each fold limb in the area similar to the

"Hobbit" Creek southern limb has a similar amount of coal. If the coal extends to the next folds, the "Hobbit" Creek area will have two or three times as much coal.

If the coal is continuous then the critical assumption becomes the attitude of the coal seam. All other assumptions were conservative, for instance, podding and any coal on the steep northeast limb were not taken into account. The above figure is a minimum rather than a most-likely number and is an inferred estimate.

5.3 "Lost" Ridge seams

The area of coal on "Lost" Ridge was calculated using much simpler trigonometry. The ground surface and coal were assumed to have a parallel strike. Then the mineable area of the coal seam was determined by the width of the coal seam with less than 30 metres overburden, and its length.

In the outcrop the "Lost" Ridge #1 seam is almost flat. From the contours on Figure 5a, a 30 metre mine depth will expose about a 40 metre width of seam. It is approximately 400 m along strike from the thrust fault southwestward to the syncline, which presumably turns the seam up above the ground surface. This gives an area of 16 000 m^2. If, however, the seam is close enough to the ground surface all over the summit of "Lost" Ridge, this gives a square of mineable coal approximately 400 m on a side or 160 000 m^2. These two areas with a thickness of 2.1 m give 50 000 and 500 000 tonnes of coal. This latter case is considered more likely.

"Lost Ridge #1A dips at approximately 65° into a hillside dipping at about 25°, from the cross-sections on Figure 6. This gives a mineable width of 13 m. If it is assumed that the seam extends from the high-angle fault northwestward to the creek (another possible fault) a distance of 1300 m, then this seam has a mineable area of 16 000 m^2. If the 3 metres thickness observed in the outcrop extends over the area then there would be 75 000 tonnes of coal to 30 metres depth.

"Lost" Ridge #2 does not have a geometry simple enough to calculate in a similar manner. It is assumed to have a similar mineable area to the other two "Lost" Ridge seams, about 16 000 m^2. With a thickness of 1.5 m it would have about 36 000 tonnes.

The total of the above speculations is 160 000 tonnes of mineable coal if "Lost" Ridge #1 seam is flat and 0.6 million tonnes if this seam is within 30 m of surface over the summit of "Lost" Ridge.

6 CONCLUSIONS AND RECOMMENDATIONS

The stratigraphic sequence in the Mt. Klappan area of the Groundhog coalfield shows a regressive clastic pattern of a deltaic facies grading upward into a fluvial facies. The deltaic facies is predominantly in the northern portion of the property and contains the thickest coal seams (up to 4 metres) at the top of the deltaic sequence. The best exposures are in the northeastern and northwestern portions of the property with very little outcrop in the north-central area. Thinner seams (up to 2 metres) occur sporadically in the overbank sediments of the lower-energy phase of the fluvial facies. The area is complexly folded into tight-to-open folds and thrustfaulted. The coal seams may be podded in the noses of the tighter folds and are cut by minor faults perpendicular and conjugate to the fold axes.

On the basis of sinlge outcrops it is speculated that the four "Hobbit" Creek seams could contain 1.5 million tonnes of coal to a 30 m depth. Similarly, the three "Lost" Ridge seams could contain 160 000 tonnes depending on whether or not the seam remains shallow over the ridge.

It is recommended to drop the Mt. Klappan coal licenses and coal license applications.

7 SUGGESTIONS

7.1 Introduction

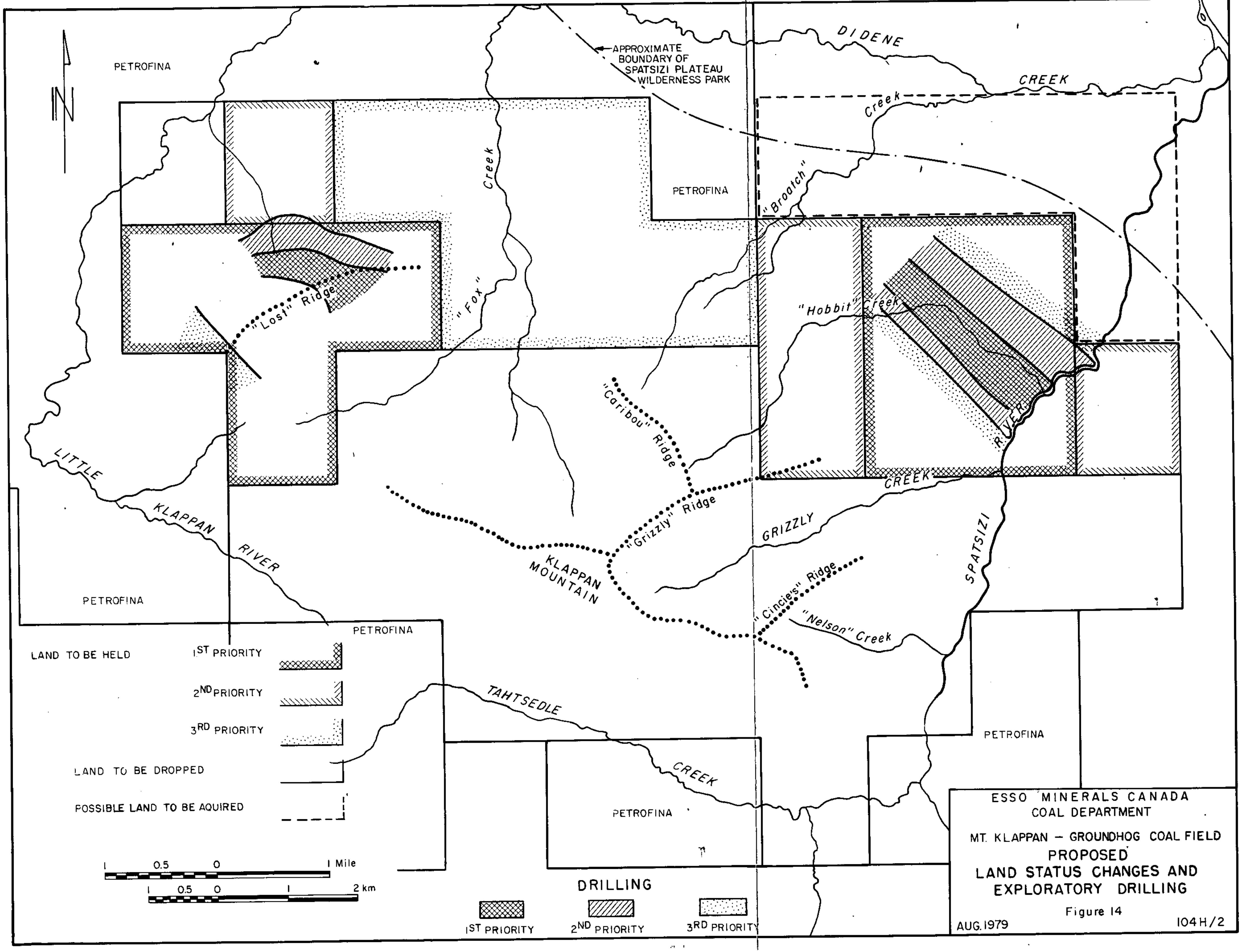
If a more detailed understanding of the Mt. Klappan coal occurrances were required the following would be recommended. It would be recommended that the "Hobbit" Creek and the "Lost" Ridge coal seams be drilled and the southern half of the property be dropped (Figure 14). The estimated costs for drilling are listed in Table VII. The first priority in drilling is "Hobbit" Creek because:

1) decent reserves
2) several fairly thick seams
3) fairly simple structure
4) easy access for the drill.

The second priority in drilling is "Lost" Ridge because:

1) fair reserves
2) the seams are on a topographic high.

However, the access is not as easy as on "Hobbit" Creek and the structure is more complicated. It is strongly recommended to use downhole geophysical logs to unravel the otherwise bland stratigraphy and complicated structure.



ESSO MINERALS CANADA
COAL DEPARTMENT

MT. KLAPPAN – GROUNDHOG COAL FIELD

PROPOSED LAND STATUS CHANGES AND EXPLORATORY DRILLING

Figure 14

AUG. 1979

104H/2

7.2 Drilling

7.2.1 "Hobbit" Creek

The main objectives of the drilling are to determine the volume of the seams and their structure. Drilling should find out the number of seams on "Hobbit" Creek, whether two or four. The program should determine the thickness of the seams, if there has been podding on the nose or thinning on the limb. Drilling should determine the area of the seams; if the seams thin or pinchout as they pass northwestward into the fluvial facies, if the conjugate faults cutoff the seam, and where the erosional edge is. Finally, drilling should provide a better picture of the structure; where the fold axes are and their attitude, whether the folds are overturned or not (particularly the pair immediately north of the "Hobbit" Creek pair), the location and throw of the conjugate faults.

The priorities in drilling "Hobbit" Creek should be to start from the outcrops and work outwards to the southwest, northwest and northeast. It is very unlikely that there is any coal to the southeast across Spatsizi River. The first priority should be to drill along the nose and the southwest limb of the "Hobbit" Creek anticline from Spatizi River to beyond the bend in "Hobbit" Creek. The second priority should be the southwest limb of the anticline to the north of "Hobbit" Creek, to investigate possible podding along this fold pair and also the noses of the fold pair to the south of "Hobbit" Creek. The third priority should be to drill outward till the edge of the coal is found.

7.2.2 "Lost" Ridge

The main objectives again are to determine the volume of the seams and its complex structure. There is the possibility of extra seams on the ridge since there is a lot of coal bloom (Figure 13). The drilling should give much more accurate thicknesses than is available in outcrop. The program should also determine the edge of the coal seams, probably structural or erosional in this area. Finally, drilling should provide a better picture of the structure, the complexity of folding next to the thrust faults (as in Plate 5), whether the folds become faulted out (as in Plate 4a), and if there is any podding.

The priorities in drilling "Lost" Ridge are based on amount of potential reserves and access. The first priority is the seam "Lost" Ridge #1, since it has relatively good reserves and very easy access on top of the ridge. The second priority is the "Lost" Ridge 1A seam with relatively good reserves but poor access on the north slope of the ridge. The third priority is "Lost" Ridge #2 seam with relatively poorer potential and poor access on the northwest face of the ridge.

7.3 Land Status Change

The first priority in land to be held is that around the drilling, licences 3964, 3965, 3967, 3971 on "Hobbit" Creek and licences 3977, 3978, 3979, 3980. The second priority to be held is any land under possible extensions to the drilling; licence 3963, 3968, 3972 on Hobbit Creek, and licence 3984 on "Lost" Ridge. The third priority is to hold onto land underlain by deltaic rocks, particularly near the contract with fluvial rocks. In addition to the licences listed above, this would include licences 3973, 3974, 3975, 3981, 3982, 3983. All the rest can be dropped, including the whole licence application and licences 3961, 3962, 3966, 3969, 3970, 3976, 3985. This is a total of approximately 5045 hectares to be retained and 5608 hectares to be dropped. If the drilling process is successful, it may be useful to acquire more land, particularly that to the north and northeast of "Hobbit" Creek up to the Spatizi Plateau wilderness park.

7.4 Suggestions for the Drill Geologist

Because the structure is so complex it will be necessary to continually reinterpret the geology as the results are available from each hole. To do this, the drill geologist must understand structural geology and geophysical log interpretation; he should also be able to use clastic facies and stratigraphy. Airphotos should also be used to reinterpret any faint linears because the minor faults will probably be very important in the detailed geology of the drilling. The drill geologist should also be given enough time in the field around the drilling to reinterpret the outcrop geology. For instance, outcrop W-259 is the main evidence for overturning of the folds north of "Hobbit" Creek; drilling may contradict this. If a bulldozer is available, it could be used to investigate a lot of coal float in the B.C.R. quarry at outcrop B45 north of "Hobbit" Creek.

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APPENDIX I

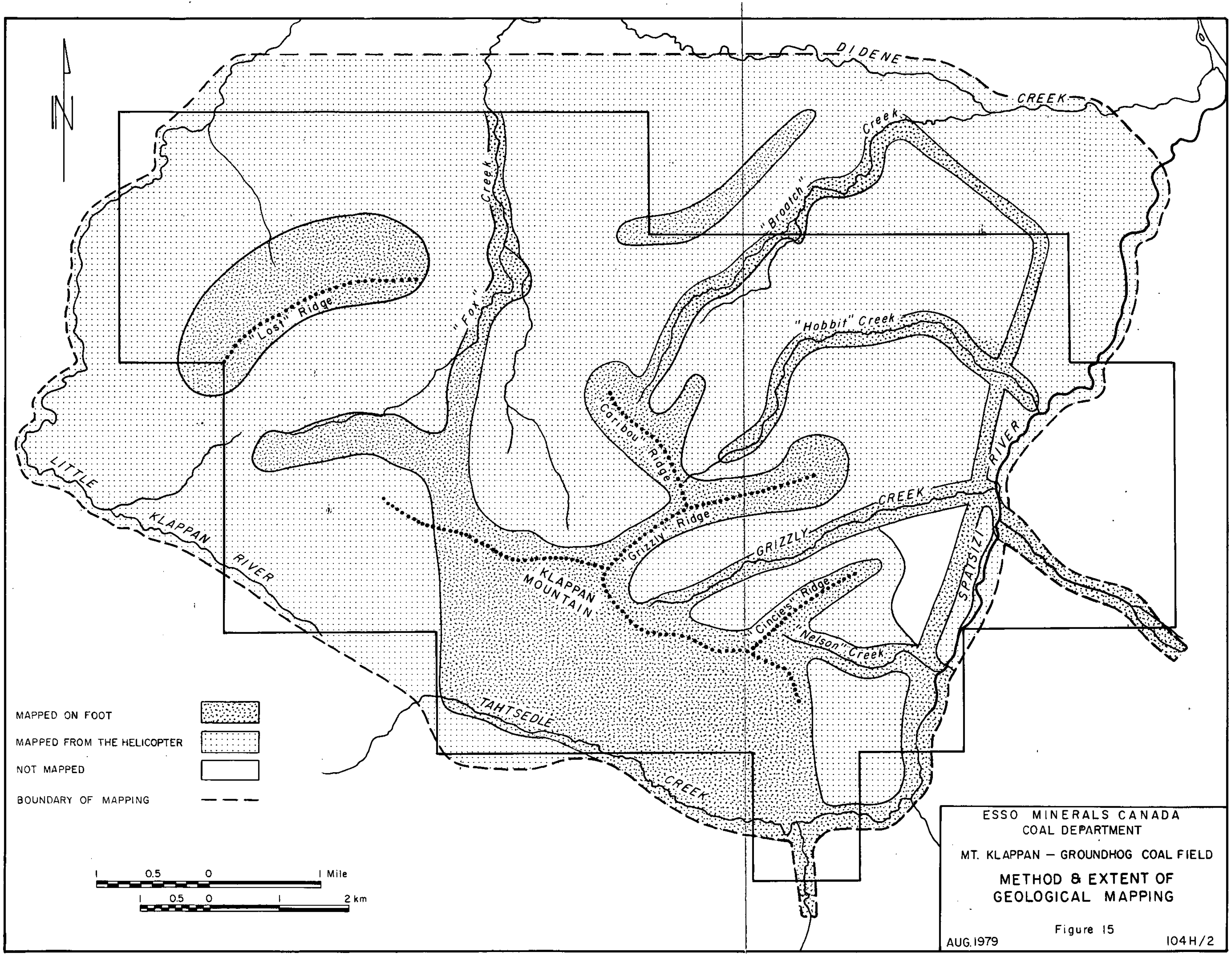
The field crew for most of the job was:

Job	Name	Education	Field experience
Party Chief	Bim Waters	1 yr. of MSc.	5 summers
Senior Assistant	Jane Broatch	3 yr. of BSc.	2 summers
Junior Assistant	Roberta Donald	3 yr. of BSc.	1 summer
Junior Assistant	Jim Lehtinen	Mining Technology Diploma	2 summers

To help with the sampling in the last week the party was increased by:

Project Geologist	Bruce Vincent	MSc.	4 summers
Junior Assistant	Arnold Baden	Petroleum Technologist Diploma	0 years

The crew stayed in the Tenajon Motel, 2 kilometres south of Iskut. They were flown out each day to the property by Bell 206 Jet-Ranger Helicopter, with an average one-way flight time of 0.6 hours. The weather was too poor to fly for five days, or 12% of the working days. Work on the property lasted from about 9:00 until 4:30, with a few hours of paperwork in the motel in the evenings. Geological mapping was done largely by foot traverse (Figure 15) in two groups of two, usually along the ridge edges and creeks. Outcrop locations were marked on 1:30,000 airphoto overlays and descriptions kept in fieldnotes.



ESSO MINERALS CANADA
COAL DEPARTMENT

MT. KLAPPAN – GROUNDHOG COAL FIELD

METHOD & EXTENT OF GEOLOGICAL MAPPING

Figure 15

AUG. 1979

104H/2

The data was transcribed to a 1:10,000 base map in the evening. Jane Broatch and Robbie Donald mapped the northwest portion of the sheet (outcrop numbers prefixed by B). Bim Waters and Jim Lehtinen mapped the southeast portion of the map (outcrop numbers prefixed by W). The helicopter was used for 12% of the mapping time by Bim Waters and Robbie Donald to map the valley-bottoms where exposure was poor. Work at Mt. Klappan began on 79 06 25 (when there was 80% snowcover on the north slopes above the treeline) and continued for 46 working days to 79 08 15. The last eight days were spent trenching and sampling 15 sites with an average of six samples per site. The full crew spent two weeks preparing for the field season. Jane Broatch and Bim Waters spent two and seven weeks respectively preparing this report. Henk Lantinga did the drafting. The costs incurred to 79 08 31 have been listed in Table VIII. A time breakdown is listed in Table IX.

TABLE VIII

Mount Klappan
Groundhog Coal Field

Summary of Estimated Costs
to August 31/79

Travel		4,150.05
Fuel		3,950.31
Hotel Accommodation		13,181.73
Misc. Supplies		341.85
Vehicle Rental		1,682.16
Helicopter		38,792.50
Land Rental		16,880.00
Overhead & Mgt. Fee		17,426.62
Maps & Reports		90.10
Other - Landsat		2,299.64
	TOTAL	98,794.96

TABLE IX

Time Breakdown

Category	Man-Days
Mobilization - collecting field gear	21
- safety courses	20
Mapping - on foot	100
- by helicopter	14
Trenching and Sampling	31
Paper Work in Camp	30
Travel	14
Time Off	23
Lost Days	0
Preparing this Report	
	55
TOTAL	308

APPENDIX II

STATEMENT OF QUALIFICATIONS

Bim 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.

Bim Waters

Bim Waters
November 30, 1979

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

Bruce D. Vincent, P. Geol.

1979 11 30

BRUCE D. VINCENT

APPENDIX III

OPEN FILE

00109 (2)

COAL SAMPLE ANALYSES

The following are the laboratory reports containing the results of the analyses done on the coal outcrop samples taken at Mt. Klappan during the 1979 mapping program.

The seam outcrops were prepared for sampling by removing by pick and shovel as much coal and overburden to give as fresh a face as possible. The coal seams were then examined and described in detail and subdivided into portions on the basis of varying proportions of constituents and/or by the presence of partings.

Channel samples of each division of the seam were taken by chipping off a small portion of the cheaned face and were immediately placed into a plastic bag and sealed. Care was taken to remove roughly equal portions from all parts of the seam.

After shipment to Calgary in sealed cans, small portions of the samples were removed for palynological analysis and the rest sent to Birtley Coal and Minerals Testing for analyses. Birtley performed the standard tests for moisture, proximate analysis, total sulphur, calorific value, and specific gravity on the samples.

The results have not been interpreted in detail and only the calculations necessary to derive the coal rank have been done and the results are included in the following tables.

In order to determine the rank of a coal with greater than 69% fixed carbon on a dry, mineral matter free basis (dmmf), it is necessary to find the volatile matter and fixed carbon content of the coal on that basis. To do so, the mineral matter content was calculated for each sample from the results given on a dry basis (db) by the following Parr formula:

$$\%\ \text{Mineral Matter} = 1.08(\%\text{Ash}) + 0.55(\%\text{Sulphur})$$

The volatile matter and fixed carbon content of each sample were then recalculated by "removing" the mineral matter by the formulae:

$$\text{dmmf Volatile Matter} = \frac{\text{db Volatile Matter}}{\left(1.00 - \frac{\text{db Mineral Matter}}{100}\right)}$$

$$\text{dmmf Fixed Carbon} = \frac{\text{db Fixed Carbon}}{\left(1.00 - \frac{\text{db Mineral Matter}}{100}\right)}$$

The rank could then be assigned using the ranges for each rank as defined by the American Society for Testing Materials (ASTM).

The rank of the Mt. Klappan samples ranged from low volatile bituminous to anthracite. There was one sample which ranked as medium volatile bituminous and several which were questionable inbetween low volatile bituminous and semi-anthracite.

Overall, the rank is probably semi-anthracite. The variations seen were within the seam and appear to be in relation to the proximity to faults or fold axes.

Outcrop W29
Seam Number Hobbit #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W1	8.9	8.0	83.1	0.52	13243	9.90	db
		8.88	92.22				dmmf
	Rank:	Semi-anthracite					
W2	21.8	7.3	70.9	0.54	11356	23.84	db
		9.58	93.09				dmmf
	Rank:	Semi-anthracite					
W3	20.4	6.1	73.5	0.44	11738	22.57	db
		7.85	94.56				dmmf
	Rank:	Anthracite					
W4	17.8	8.5	73.7	0.50	11940	19.50	db
		10.56	91.55				dmmf
	Rank:	Semi-anthracite					
W5	40.9	7.1	52.0	0.34	8083	44.36	db
		12.76	93.46				dmmf
	Rank:	Semi-anthracite					
W6	28.1	15.5	56.4	0.54	9450	30.64	db
		22.35	81.32				dmmf
	Rank:	Low volatile bituminous					
W7	34.9	7.0	58.1	0.41	9246	37.92	db
		11.27	93.58				dmmf
	Rank:	Semi-anthracite					
W28	25.3	8.0	66.7	0.50	10677	27.60	db
		11.05	92.13				dmmf
	Rank:	Semi-anthracite					
Comp W1, W2,W3,W4	18.9	7.1	74.0	0.49	11864	20.68	db
		8.95	93.29				dmmf
	Rank:	Semi-anthracite					
Comp W6, W7	32.4	10.0	57.6	0.43	9320	35.23	db
		15.43	88.93				dmmf
	Rank:	Semi-anthracite					

Outcrop W31
Seam Number Hobbit #2

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W14	14.1	14.6	17.3	0.68	11484	59.06	db
		17.30	84.48				dmmf
	Rank:	Low volatile bituminous					
W15	23.7	13.2	63.1	0.62	10178	25.94	db
		17.82	85.20				dmmf
	Rank:	Low volatile bituminous					
W16	22.4	9.6	68.0	0.68	10853	24.57	db
		12.73	90.14				dmmf
	Rank:	Semi-anthracite					
W17	28.7	7.5	63.8	0.68	10146	31.37	db
		10.93	92.96				dmmf
	Rank:	Semi-anthracite					
W27	24.7	9.8	65.5	0.54	10477	26.97	db
		13.42	89.69				dmmf
	Rank:	Semi-anthracite					

Outcrop W32a
Seam Number Hobbit #3

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W8	21.5	16.4	62.1	0.49	10285	23.49	db
		21.43	81.16				dmmf
	Rank:	Low volatile bituminous					
W9	16.6	13.1	70.3	0.49	11229	18.20	db
		16.01	85.94				dmmf
	Rank:	Low volatile bituminous					
W10	24.9	14.0	61.1	0.42	9734	27.12	db
		19.21	83.84				dmmf
	Rank:	Low volatile bituminous					
W11	10.6	15.5	73.9	0.54	12013	11.74	db
		17.56	83.73				
	Rank:	Low volatile bituminous					
W12	6.9	14.5	78.6	0.66	12832	7.82	db
		15.73	85.26				dmmf
	Rank:	Low volatile bituminous					
W13	19.6	12.8	67.6	0.55	11254	21.47	db
		16.30	86.08				
	Rank:	Low volatile bituminous					
W26	15.8	14.6	69.6	0.52	11255	17.35	db
		17.66	84.21				
	Rank:	Low volatile bituminous					
Comp W8, W9,W10, W11,W12	16.4	14.6	69.0	0.53	11180	18.00	db
		17.8	84.15				dmmf
	Rank:	Low volatile bituminous					

Outcrop W34
Seam Number Hobbit #4

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W18	14.3	11.9	73.8	0.57	11900	15.76	db
		14.13	87.60				dmmf
	Rank:	Low volatile bituminous?					
W19	18.5	11.7	69.8	0.59	11391	20.30	db
		14.68	87.58				dmmf
	Rank:	Low volatile bituminous?					
W20	16.5	13.6	69.9	0.64	11312	18.17	db
		16.6	85.42				dmmf
	Rank:	Low volatile bituminous?					
W21	12.1	14.3	73.6	0.61	12106	13.40	db
		16.5	84.99				dmmf
	Rank:	Low volatile bituminous					
W22	16.4	10.3	73.3	0.56	11775	18.02	db
		12.56	89.41				dmmf
	Rank:	Semi-anthracite					
W23	21.0	15.0	64.0	0.57	10637	22.99	db
		19.48	83.11				dmmf
	Rank:	Low volatile bituminous					
W24	39.9	12.4	47.7	0.43	7569	43.33	db
		21.88	84.17				dmmf
	Rank:	Low volatile bituminous					
W25	20.5	13.4	66.1	0.62	10828	24.48	db
		17.29	85.27				dmmf
	Rank:	Low volatile bituminous					
Comp W18, W19,W20, W21,W22, W23	16.3	12.7	71.0	0.60	11612	17.93	db
		15.47	86.52				dmmf
	Rank:	Low volatile bituminous					

Outcrop W37
Seam Number Hobbit A

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W29	52.3	6.3 14.5	41.4 95.58	0.37	--	56.69	db dmmf
	Rank:	Anthracite					
W30	16.4	9.9 12.0	73.7 89.90	0.56	11945	18.02	db dmmf
	Rank:	Semi-anthracite					
W31	84.6	11.0	8.1	0.11	--		db
W32	23.1	11.2 14.98	65.7 87.92	0.59	10987	25.27	db dmmf
	Rank:	Low volatile bituminous					
W33	58.7	7.6	33.7	0.40	--		db
W34	15.2	7.3 8.78	77.5 93.19	0.76	12599	16.83	db dmmf
	Rank:	Semi-anthracite					
W35	17.8	10.6 13.17	71.6 88.98	0.56	112201	19.53	db
	Rank:	Low volatile bituminous					
W36	44.6	9.7 18.79	45.7 88.53	0.38	7748	48.39	db dmmf
	Rank:	Low volatile bituminous					
W37	27.8	7.8 11.20	64.4 92.46	0.59	10381	30.35	db dmmf
	Rank:	Semi-anthracite					
Comp W31, W32,W33, W34,W35	34.7	9.2 11.20	56.1 92.46	0.51	8846	37.76	db dmmf
	Rank:	Low volatile bituminous?					

Outcrop W36
Seam Number Hobbit B

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B32	13.4	12.9	73.7	0.52	11966	14.76	db
		15.13	86.46				dmmf
	Rank: Low volatile bituminous						
B33	8.5	13.7	77.8	0.59	12887	9.5	db
		15.14	85.97				dmmf
	Rank: Low volatile bituminous						
Comp B32, B33	1.5	13.5	75.0	0.54	12378	12.72	db
		15.47	85.93				dmmf
	Rank: Low volatile bituminous						

Outcrop W216
Seam Number Cincie #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
W28	30.0	19.2	50.8	0.43	8432	32.64	db
		28.50	75.41				dmmf

Rank: Medium volatile bituminous

Outcrop W49
Seam Number

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B27	30.7	10.6	58.7	0.59	9447	33.48	db
		15.94	88.24				

Rank: Low volatile bituminous

Outcrop W51
Seam Number Fox #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B28	25.9	8.5	65.6	1.11	10587	28.58	db
		11.90	91.85				dmmf
	Rank:	Semi-anthracite					
B29	29.7	7.8	62.5	0.70	10125	32.46	db
		11.55	92.54				dmmf
	Rank:	Semi-anthracite					
B30	40.0	5.0	55.0	0.57	8218	43.51	db
		8.85	97.37				dmmf
	Rank:	Anthracite					
B31	35.8	7.3	56.9	0.78	8993	39.09	db
		11.98	93.42				dmmf
	Rank:	Semi-anthracite					

Outcrop B202
Seam Number Klappan #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B34	19.7	6.6	73.7	0.48	11297	21.54	db
		8.4	93.93				dmmf
	Rank:	Anthracite					
B35	20.6	5.2	74.2	0.47	11341	22.51	db
		6.70	95.75				dmmf
	Rank:	Anthracite					
B36	20.3	6.0	73.7	0.44	11112	22.17	db
		7.71	94.68				dmmf
	Rank:	Anthracite					

Outcrop W166E
Seam Number Grizzley #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
V2	53.5	10.6	35.9	0.30	--	57.94	db
		25.20	85.35				dmmf
	Rank:	Low volatile bituminous?					
V3	40.9	9.2	49.9	0.47	8093	44.43	db
		16.56	89.80				dmmf
	Rank:	Low volatile bituminous/semi-anthracite					
V4	24.3	11.1	64.6	0.51	10947	26.52	db
		15.11	87.92				dmmf
	Rank:	Low volatile bituminous					
V5	38.3	10.2	51.2	0.51	8272	41.64	db
		17.48	87.74				dmmf
	Rank:	Low volatile bituminous					
Comp V3, V4	31.6	10.0	58.4	0.49	9686	34.40	db
		15.24	89.02				
	Rank:	Low volatile bituminous?					

Outcrop W166 West
Seam Number Grizzley #2

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
V6	11.8	15.4	72.8	0.66	12176	13.07	db
		17.72	83.75				dmmf
	Rank:	Low volatile bituminous					
V7	68.3	8.0	23.7	0.52	--		db
V8	20.5	9.7	69.8	0.49	11420	22.41	db
		12.5	89.96				dmmf
	Rank:	Semi-anthracite					
V9	15.4	10.3	74.3	0.64	12262	16.98	db
		12.4	89.50				dmmf
	Rank:	Semi-anthracite					
Comp V8, V9	17.1	9.9	73.0	0.60	12056	18.80	db
		12.19	89.90				dmmf
	Rank:	Semi-anthracite					

Outcrop B30
Seam Number Grizzley #3

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B26	11.8	8.6	79.6	0.57	12864	13.06	db
		9.89	91.55				dmmf
	Rank:	Semi-anthracite					
B26A	19.0	7.0	74.0	0.59	12139	20.84	db
		8.84	93.49				
	Rank:	Semi-anthracite					

Outcrop B11
Seam Number Lost Ridge #1

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B9	14.6	12.8	72.6	0.55	11680	16.07	db
		15.25	86.5				dmmf
	Rank:	Low volatile bituminous					
B10	11.1	12.4	76.5	0.54	12258	12.28	db
		14.14	87.20				dmmf
	Rank:	Low volatile bituminous?					
B11	18.7	11.6	69.7	0.39	11028	20.41	db
		14.57	87.57				dmmf
	Rank:	Low volatile bituminous?					
B12	15.8	12.1	72.1	0.48	11992	17.33	db
		14.64	87.21				dmmf
	Rank:	Low volatile bituminous?					
B13	9.1	9.5	81.4	0.55	13034	10.13	db
		10.57	90.57				dmmf
	Rank:	Semi-anthracite					
B14	4.9	7.7	87.4	0.47	13647	5.55	db
		8.15	92.54				dmmf
	Rank:	Semi-anthracite					
B15	8.2	14.7	77.1	0.49	12401	9.12	db
		16.18	84.8				dmmf
	Rank:	Low volatile bituminous					
Comp B9, B10,B11, B12,B13, B14,B15	11.5	11.2	77.3	0.53	12355	12.71	db
		12.83	88.56				dmmf
	Rank:	Semi-anthracite					

Outcrop B108
Seam Number Lost Ridge 1A

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B20	5.7	5.9	88.4	0.66	14008	6.52	db
		6.31	94.56				dmmf
	Rank:	Semi-anthracite					
B21	14.1	5.9	80.0	0.5	12719	15.50	db
		6.3	85.58				dmmf
	Rank:	Semi-anthracite					
B23	21.4	7.8	70.8	0.54	11504	23.41	db
		10.18	92.44				dmmf
	Rank:	Semi-anthracite					
B24	21.4	6.0	72.6	0.48	11639	23.38	db
		7.8	94.75				dmmf
	Rank:	Anthracite					
B25	16.9	6.7	76.4	0.55	12190	18.55	db
		8.23	93.80				dmmf
	Rank:	Semi-anthracite					
Comp B21, B22,B23, B24,B25	18.4	6.2	75.4	0.50	12019	20.15	db
		7.76	94.4				dmmf
	Rank:	Anthracite					

Outcrop B218
Seam Number Lost Ridge #2

Sample Number	Ash	Volatile Matter	Fixed Carbon	S	BTU/lb	Mineral Matter	Basis
B16	35.2	6.8	58.0	0.52	9047	38.30	db
		11.02	94.01				dmmf
	Rank:	Semi-anthracite					
B17	21.8	9.3	68.9	0.51	11011	23.82	db
		12.21	90.45				dmmf
	Rank:	?					
B18	12.4	7.0	80.6	0.49	12782	13.66	db
		8.11	93.35				dmmf
	Rank:	Semi-anthracite					
B19	48.3	9.0	42.7	0.29	5605		db
Comp B17, B18,B19	29.3	8.2	62.5	0.39	9526	31.86	db
		12.03	91.72				
	Rank:	Semi-anthracite					

28 November 1979
79[illegible]

CLIENT: ESSO MINERALS CANADA

SAMPLE: MT. KLAPPAN OUTCROP CHANNEL SAMPLES

OUTCROP W29 - HOBBIT #1

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4125 W1	11.2	1.6	8.8	7.9	81.7	0.51	13031	adb
		12.6	7.8	7.0	72.6	0.45	11572	arb
			8.9	8.0	83.1	0.52	13243	db
4126 W2	7.1	1.9	21.4	7.2	69.5	0.53	11140	adb
		8.9	19.9	6.7	64.5	0.49	10349	arb
			21.8	7.3	70.9	0.54	11356	db
4127 W3	7.2	2.2	20.0	6.0	71.8	0.43	11480	adb
		9.2	18.6	5.7	66.5	0.40	10653	arb
			20.4	6.1	73.5	0.44	11738	db
4128 W4	7.4	1.1	17.6	8.4	72.9	0.49	11809	adb
		8.4	16.3	7.8	67.5	0.45	10935	arb
			17.8	8.5	73.7	0.50	11940	db
4129 W5	5.4	1.6	40.2	7.0	51.2	0.33	7954	adb
		6.9	38.0	6.6	48.5	0.31	7524	arb
			40.9	7.1	52.0	0.34	8083	db
4130 W6	15.3	3.2	27.2	15.0	54.6	0.52	9148	adb
		18.0	23.0	12.7	46.3	0.44	7748	arb
			28.1	15.5	56.4	0.54	9450	db
4131 W7	7.8	1.6	34.3	6.9	57.2	0.40	9098	adb
		9.3	31.6	6.4	52.7	0.37	8388	arb
			34.9	7.0	58.1	0.41	9246	db
4152 W28	5.2	1.9	24.8	7.8	65.5	0.49	10474	adb
		7.0	23.5	7.4	62.1	0.46	9929	arb
			25.3	8.0	66.7	0.50	10677	db
4253	RM.%	ASH%	VOL%	FC.%	S.%	B.T.U.	S.G.	
COMPOSITE OF W1, W2	1.8	18.6	7.0	72.6	0.48	11650	1.52	adb
W3 & W4		18.9	7.1	74.0	0.49	11864	-	db
4252 COMPOSITE	RM.%	ASH%	VOL%	FC.%	S.%	B.T.U.		
OF	2.3	31.7	9.8	56.2	0.42	9106		adb
W6 & W7		32.4	10.0	57.6	0.43	9320		db

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OUTCROP W31 - HOBBIT #2

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4138	10.8	2.7	13.7	14.2	69.4	0.66	11174	adb
W14		13.2	12.2	12.7	61.9	0.59	9967	arb
			14.1	14.6	71.3	0.68	11484	db
4139	12.3	2.5	23.1	12.9	61.5	0.60	9924	adb
W15		14.5	20.3	11.3	53.9	0.53	8703	arb
			23.7	13.2	63.1	0.62	10178	db
4140	8.5	2.0	22.0	9.4	66.6	0.67	10636	adb
W16		10.3	20.1	8.6	61.0	0.61	9732	arb
			22.4	9.6	68.0	0.68	10853	db
4141	8.9	1.7	28.2	7.4	62.7	0.67	9974	adb
W17		10.4	25.7	6.7	57.2	0.61	9086	arb
			28.7	7.5	63.8	0.68	10146	db
4151	6.2	1.7	24.3	9.6	64.4	0.53	10299	adb
W27		7.8	22.8	9.0	60.4	0.50	9660	arb
			24.7	9.8	65.5	0.54	10477	db

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OUTCROP W32a - HOBBIT #3

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4132	11.5	3.1	20.8	15.9	60.2	0.47	9966	adb
W8		14.2	18.4	14.1	53.3	0.42	8820	arb
			21.5	16.4	62.1	0.49	10285	db
4133	8.8	2.9	16.1	12.7	68.3		10903	adb
W9		11.4	14.7	11.6	62.3	0.44	9944	arb
			16.6	13.1	70.3	0.49	11229	db
4134	11.9	2.9	24.2	13.6	59.3	0.41	9452	adb
W10		14.5	21.3	12.0	52.2	0.36	8327	arb
			24.9	14.0	61.1	0.42	9734	db
4135	12.3	2.7	10.3	15.1	71.9	0.53	11689	adb
W11		14.7	9.0	13.2	63.1	0.46	10251	arb
			10.6	15.5	73.9	0.54	12013	db
4136	11.9	2.5	6.7	14.1	76.7	0.64	12511	adb
W12		14.1	5.9	12.4	67.6	0.56	11022	arb
			6.9	14.5	78.6	0.66	12832	db
4137	13.6	2.2	19.2	12.5	66.1	0.54	11006	adb
W13		15.5	16.6	10.8	57.1	0.47	9509	arb
			19.6	12.8	67.6	0.55	11254	db
4150	7.4	4.0	15.2	14.0	66.8	0.50	10805	adb
W26		11.1	14.1	13.0	61.8	0.46	10005	arb
			15.8	14.6	69.6	0.52	11255	db

4255	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.		
COMPOSITE OF W8,W9,	2.9	15.9	14.2	67.0	0.51	10856		adb
W10,W11,W12		16.4	14.6	69.0	0.53	11180		db

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OUTCROP W34 - HOBBIT #4

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4142 W18	10.9	2.9	13.9	11.6	71.6	0.55	11555	adb
		13.5	12.4	10.3	63.8	0.49	10296	arb
			14.3	11.9	73.8	0.57	11900	db
4143 W19	12.5	1.8	18.2	11.5	68.5	0.58	11186	adb
		14.1	15.9	10.1	59.9	0.51	9788	arb
			18.5	11.7	69.8	0.59	11391	db
4144 W20	14.2	2.5	16.1	13.3	68.1	0.62	11029	adb
		16.3	13.8	11.4	58.5	0.53	9463	arb
			16.5	13.6	69.9	0.64	11312	db
4145 W21	14.6	2.1	11.8	14.0	72.1	0.60	11852	adb
		16.4	10.1	12.0	61.5	0.51	10122	arb
			12.1	14.3	73.6	0.61	12106	db
4146 W22	10.0	1.6	16.1	10.1	72.2	0.55	11587	adb
		11.4	14.5	9.1	65.0	0.50	10428	arb
			16.4	10.3	73.3	0.56	11775	db
4147 W23	16.9	2.5	20.5	14.6	62.4	0.56	10371	adb
		19.0	17.0	12.1	51.9	0.47	8618	arb
			21.0	15.0	64.0	0.57	10637	db
4148 W24	15.7	2.0	39.1	12.2	46.7	0.42	7418	adb
		17.4	33.0	10.3	39.3	0.35	6253	arb
			39.9	12.4	47.7	0.43	7569	db
4149 W25	13.6	2.3	20.0	13.1	64.6	0.61	10579	adb
		15.6	17.3	11.3	55.8	0.53	9140	arb
			20.5	13.4	66.1	0.62	10828	db
4256	RM.%	ASH%	VOL%	FC.%	S.%	B.T.U.	S.G.	adb
COMPOSITE OF W18,W19	2.6	15.9	12.4	69.1	0.58	11310	1.53	adb
W20,W21,W22,W23		16.3	12.7	71.0	0.60	11612	-	db

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OUTCROP W37 - HOBBIT A

LAB. NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4153	5.5	2.1	51.2	6.2	40.5	0.36	-	adb
W29		7.5	48.4	5.9	38.2	0.34	-	arb
			52.3	6.3	41.4	0.37	-	db
4154	9.5	1.3	16.2	9.8	72.7	0.55	11790	adb
W30		10.7	14.7	8.9	65.7	0.50	10670	arb
			16.4	9.9	73.7	0.56	11945	db
4155	12.7	1.9	83.0	10.8	4.3	0.11	-	adb
W31		14.4	72.5	9.4	3.7	0.10	-	arb
			84.6	11.0	8.1	0.11	-	db
4156	8.7	0.9	22.9	11.1	65.1	0.58	10888	adb
W32		9.5	20.9	10.1	59.5	0.53	9941	arb
			23.1	11.2	65.7	0.59	10987	db
4157	12.7	1.7	57.7	7.5	33.1	0.39	-	adb
W33		14.2	50.4	6.5	28.9	0.34	-	arb
			58.7	7.6	33.7	0.40	-	db
4158	6.9	1.4	15.0	7.2	76.4	0.75	12423	adb
W34		8.2	14.0	6.7	68.1	0.70	11566	arb
			15.2	7.3	77.5	0.76	12599	db
4159	8.0	1.0	17.6	10.5	70.9	0.55	12079	adb
W35		8.9	16.2	9.7	65.2	0.51	11113	arb
			17.8	10.6	71.6	0.56	12201	db
4160	8.7	0.9	44.2	9.6	45.3	0.38	7678	adb
W36		9.5	40.4	8.8	41.3	0.35	7010	arb
			44.6	9.7	45.7	0.38	7748	db
4161	8.8	1.1	27.5	7.7	63.7	0.58	10267	adb
W37		9.8	25.1	7.0	58.1	0.53	9364	arb
			27.8	7.8	64.4	0.59	10381	db

LAB. NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	
4257 COMPOSITE OF W30, W31,W32,W33,W34,W35	1.6	34.1	9.1	55.2	0.50	8704	adb
		34.7	9.2	56.1	0.51	8846	db

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OUTCROP W36 - HOBBIT B

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4120	11.4	2.5	13.1	12.6	71.8	0.51	11667	adb
B32		13.6	11.6	11.2	63.6	0.45	10337	arb
			13.4	12.9	73.7	0.52	11966	db
4121	14.1	3.0	8.2	13.3	75.5	0.57	12500	adb
B33		16.7	7.0	11.4	64.9	0.49	10738	arb
			8.5	13.7	77.8	0.59	12887	db

LAB. NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	S.G.	
4258 COMPOSITE OF B32 & B33	2.7	11.2	13.1	73.0	0.53	12044	1.50	adb
		11.5	13.5	75.0	0.54	12378	-	db

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OUTCROP W216 - CINCIE #1

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	S.G.	
4162 W38	13.9	4.0	28.8	18.4	48.8	0.42	8095	1.70	adb
		17.3	24.8	15.8	42.1	0.36	6970	-	arb
			30.0	19.2	50.8	0.43	8432	-	db

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OUTCROP W49

LAB.NO.	ADM%	MOIST.	ASH%	VM.%	FC.%	S.%	B.T.U.	
4115	8.9	6.2	28.8	9.9	55.1	0.55	8861	adb
B27		14.5	26.2	9.0	50.3	0.50	8072	arb
			30.7	10.6	58.7	0.59	9447	db

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SAMPLE: MT. KLAPPAN OUTCROP CHANNEL SAMPLES

OUTCROP W51 - FOX #1

LAB.NO.	ADM%	MOIST.	ASH%	VM.%	FC.%	S.%	B.T.U.	
4116	9.9	1.9	25.4	8.3	64.4	1.09	10386	adb
B28		11.6	22.9	7.5	58.0	0.98	9358	arb
			25.9	8.5	65.6	1.11	10587	db
4117	11.5	1.5	29.3	7.7	61.5	0.69	9973	adb
B29		12.8	25.9	6.8	54.5	0.61	8826	arb
			29.7	7.8	62.5	0.70	10125	db
4118	10.1	1.1	39.6	4.9	54.4	0.56	8128	adb
B30		11.1	35.6	4.4	48.9	0.50	7307	arb
			40.0	5.0	55.0	0.57	8218	db
4119	8.5	2.5	34.9	7.1	55.5	0.76	8768	adb
B31		10.8	31.9	6.5	50.8	0.70	8023	arb
			35.8	7.3	56.9	0.78	8993	db

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OUTCROP B202 - KLAPPAN #1

LAB.NO.	ADM%	MOIST.	ASH%	VM.%	FC.%	S.%	B.T.U	
4122 B34	5.0	2.5	19.2	6.4	71.9	0.47	10820	adb
		7.4	18.2	6.1	68.3	0.45	10279	arb
			19.7	6.6	73.7	0.48	11097	db
4123 B35	3.4	3.1	20.0	5.0	71.9	0.46	10989	adb
		6.4	19.3	4.8	69.5	0.44	10615	arb
			20.6	5.2	74.2	0.47	11341	db
4124 B36	4.4	2.1	19.9	5.9	72.1	0.43	10879	adb
		6.4	19.0	5.6.	69.0	0.41	10400	arb
			20.3	6.0	73.7	0.44	11112	db

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OUTCROP W166 EAST - GRIZZLEY #1

LAB.NO.	ADM%	MOIST.	ASH%	VOL.%	FC.%	S.%	B.T.U.	
4163 V1	8.5	1.5	76.3	6.0	16.2	0.18	-	adb
		9.9	69.8	5.5	14.8	0.16	-	arb
			77.5	6.1	16.4	0.18	-	db
4164 V2	8.8	1.9	52.5	10.4	35.2	0.29	-	adb
		10.5	47.9	9.5	32.1	0.26	-	arb
			53.5	10.6	35.9	0.30	-	db
4165 V3	10.3	1.2	40.4	9.1	49.3	0.46	7996	adb
		11.4	36.2	8.2	44.2	0.41	7172	arb
			40.9	9.2	49.9	0.47	8093	db
4166 V4	9.5	2.1	23.8	10.9	63.2	0.50	10717	adb
		11.4	21.5	9.9	57.2	0.45	9699	arb
			24.3	11.1	64.6	0.51	10947	db
4167 V5	9.3	1.9	37.6	10.0	50.5	0.50	8115	adb
		11.0	34.1	9.1	45.8	0.45	7360	arb
			38.3	10.2	51.5	0.51	8272	db

LAB.NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	
4259 COMPOSITE OF V3&V4	2.0	31.0	9.8	57.2	0.48	9492	adb
		31.6	10.0	58.4	0.49	9686	db

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SAMPLE: MT. KLAPPAN OUTCROP CHANNEL SAMPLES

OUTCROP W166 WEST - GRIZZLEY #2

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4168 V6	9.8	2.4	11.5	15.0	71.1	0.64	11884	adb
		12.0	10.4	13.5	64.1	0.58	10719	arb
			11.8	15.4	72.8	0.66	12176	db
4169 V7	13.2	2.2	66.8	7.8	23.2	0.51	-	adb
		15.1	58.0	6.8	20.1	0.44	-	arb
			68.3	8.0	23.7	0.52	-	db
4170 V8	12.4	1.7	20.2	9.5	68.6	0.48	11226	adb
		13.9	17.7	8.3	60.1	0.42	9834	arb
			20.5	9.7	69.8	0.49	11420	db
4171 V9	12.0	1.5	15.2	10.1	73.2	0.63	12078	adb
		13.3	13.4	8.9	64.4	0.55	10629	arb
			15.4	10.3	74.3	0.64	12262	db

LAB.NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	
4206 COMPOSITE OF V8&V9	1.6	16.8	9.7	71.9	0.59	11863	adb
		17.1	9.9	73.0	0.60	12056	db

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OUTCROP B30 - GRIZZLEY #3

LAB.NO.	ADM%	MOIST.	ASH%	VM.%	FC.%	S.%	B.T.U.	
4133	13.0	1.7	11.6	8.5	78.2	0.56	12645	adb
B26		14.5	10.1	7.4	68.0	0.49	11001	arb
			11.8	8.6	79.6	0.57	12864	db
4114	9.2	1.0	18.8	6.9	73.3	0.58	12018	adb
B26A		10.1	17.1	6.3	66.5	0.53	10912	arb
			19.0	7.0	74.0	0.59	12139	db

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SAMPLE: MT. KLAPPAN OUTCROP CHANNEL SAMPLES
OUTCROP B111 - LOST RIDGE #1

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4096	12.8	4.1	14.0	12.3	69.6	0.53	11201	adb
B9		16.4	12.2	10.7	60.7	0.46	9767	arb
			14.6	12.8	72.6	0.55	11680	db
4097	10.8	4.1	10.6	11.9	73.4	0.52	11755	adb
B10		14.5	9.5	10.6	65.4	0.46	10485	arb
			11.1	12.4	76.5	0.54	12258	db
4098	15.0	2.1	18.3	11.4	68.2	0.38	10796	adb
B11		16.0	15.6	9.7	58.7	0.32	9177	arb
			18.7	11.6	69.7	0.39	11028	db
4099	10.5	3.0	15.3	11.7	70.0	0.47	11564	adb
B12		13.2	13.7	10.5	62.6	0.42	10350	arb
			15.8	12.1	72.1	0.48	11992	db
4100	7.2	4.5	8.7	9.1	77.7	0.53	12447	adb
B13		11.4	8.1	8.4	72.1	0.49	11551	arb
			9.1	9.5	81.4	0.55	13034	db
4101	6.6	4.3	4.7	7.4	83.6	0.45	13060	adb
B14		10.6	4.4	6.9	78.1	0.42	12198	arb
			4.9	7.7	87.4	0.47	13647	db
4102	12.5	6.9	7.6	13.7	71.8	0.46	11545	adb
B15		18.5	6.7	12.0	62.8	0.40	10102	arb
			8.2	14.7	77.1	0.49	12401	db

LAB.NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	S.G.	
4261 COMPOSITE OF B9,B10	4.1	11.0	10.7	74.2	0.51	11848	1.53	adb
B11,B12,B13,B14,B15		11.5	11.2	77.3	0.53	12355	-	db

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OUTCROP B108 - LOST RIDGE #1A

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4107	8.9	2.2	5.6	5.8	86.4	0.65	13700	adb
B20		10.9	5.1	5.3	78.7	0.59	12481	arb
			5.7	5.9	88.4	0.66	14008	db
4108	8.3	2.2	13.8	5.8	78.2	0.49	12349	adb
B21		10.3	12.7	5.3	71.7	0.45	11407	arb
			14.1	5.9	80.0	0.50	12719	db
4109	10.6	2.5	16.8	6.4	74.3	0.44	11917	adb
B22		12.8	15.0	5.7	66.5	0.39	10654	arb
			17.2	6.6	76.2	0.45	12223	db
4110	7.5	2.4	20.9	7.6	69.1	0.53	11228	adb
B23		9.7	19.3	7.0	64.0	0.49	10386	arb
			21.4	7.8	70.8	0.54	11504	db
4111	7.7	2.6	20.8	5.8	70.8	0.47	11336	adb
B24		10.1	19.2	5.4	65.3	0.43	10463	arb
			21.4	6.0	72.6	0.48	11639	db
4112	10.5	1.8	16.6	6.6	75.0	0.54	11971	adb
B25		12.1	14.9	5.9	67.1	0.48	10714	arb
			16.9	6.7	76.4	0.55	12190	db

LAB.NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	
4262 COMPOSITE OF B21,B22, B23, B24 & B25	2.2	18.0	6.1	73.7	0.49	11755	adb
		18.4	6.2	75.4	0.50	12019	db

Birtley Coal
& Minerals Testing

29 November 1979

CLIENT: ESSO MINERALS CANADA LIMITED

SAMPLE: MT. KLAPPAN OUTCROP CHANNEL SAMPLES

OUTCROP B218 - LOST RIDGE #2

LAB.NO.	ADM%	MOIST.	ASH%	VOL%	FC.%	S.%	B.T.U.	
4103	7.6	5.0	33.4	6.5	55.1	0.49	8595	adb
B16		12.2	30.9	6.0	50.9	0.45	7942	arb
			35.2	6.8	58.0	0.52	9047	db
4104	14.0	3.0	21.1	9.0	66.9	0.49	10681	adb
B17		16.6	18.1	7.7	57.6	0.42	9186	arb
			21.8	9.3	68.9	0.51	11011	db
4105	9.5	2.7	12.1	6.8	78.4	0.48	12437	adb
B18		11.9	11.0	6.2	70.9	0.43	11255	arb
			12.4	7.0	80.6	0.49	12782	db
4106	14.9	3.1	46.8	8.7	41.4	0.28	5431	adb
B19		17.5	39.8	7.4	35.3	0.24	4622	arb
			48.3	9.0	42.7	0.29	5605	db

LAB.NO.	RM.%	ASH%	VM.%	FC.%	S.%	B.T.U.	S.G.	
4263 COMPOSITE OF B17, B18, & B19	3.0	28.4	8.0	60.6	0.38	9240	1.68	adb
		29.3	8.2	62.5	0.39	9526	-	db

Birtley Coal
& Minerals Testing

GR - MTN KLAPPAN 79(3)A.

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C W 36

SEAM NAME HOBBIT #B

LOCATION UTM EASTING 514400 NORTHING 6343770

FORMATION BOWSER LAKE GROUP

ELEVATION 4500 FT.; 1370m

COMMENTS GOOD OBSERVATION CONDITIONS. COAL IS FRESH.

POSSIBLY CORRELATED TO HOBBIT #2

ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG ____ OUTCROP X

GEOLOGIST J.C. BROATCH

DATE AUG. 14/79

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
	cm		?		COAL							
B32	0		COAL	70		? 30						VERY MINOR IRON STAINING ON SURFACE
			LOW ANGLE THRUST FAULT. DISPLACEMENT OF ABOUT 5cm. RUSTY STAIN.									
	50											
	95		SILTSTONE, 1cm PARTING.									
B33	100		COAL	90								VERY MINOR IRON STAINING ON SURFACE. SILTY & WEATHERED.
	150											
	165		1cm SOFT MUD PARTING.									
	175		SHALE									MEDIUM GREY, SILTY 2m THICK.
	200											

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD **NTS LOCATION** 104 H/2 **DRILL HOLE OR OUTCROP NUMBER** O/C B 111

SEAM NAME LOST RIDGE # I **LOCATION** UTM EASTING 505650 NORTHING 6344390

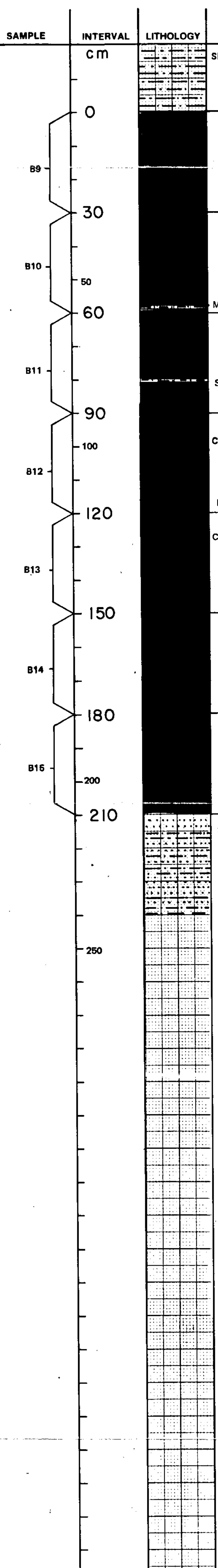
FORMATION BOWSER LAKE GROUP **ELEVATION** 5900 FT.; 1800m

COMMENTS COAL MAY NOT BE FRESH, GROUND FROZEN BELOW 0.8m.

ORIGIN OF LOG: CORE — **CHIP SAMPLES** — **GEOPHYSICAL LOG** – **OUTCROP** X

GEOLOGIST J.C. BROATCH **DATE** AUG. 8/79

DESCRIPTION



	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
SILTSTONE		COAL							FISSILE 5m THICK.
COAL	95								– RUBBLEY WEATHERED COAL. – NO PARTING.
COAL									– RUBBLEY VITRAIN.
MUD & SILTSTONE (1cm)									
COAL SILTSTONE 1cm									
COAL HARD CHUNKS	100								RUBBLEY VITRAIN. HARD COAL CHUNKS.
COAL	100								
COAL	100								
COAL	100								
SANDSTONE & SILTSTONE									SANDSTONE (80%) AND SILTSTONE (20%); BLOCKY, 4m THICK. THE COAL HAS RARE PEACOCK LUSTRE AND POSSIBLE MINOR PYRITE MINERALIZATION.

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ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C W 37

SEAM NAME HOBBIT # A

LOCATION UTM EASTING 514240 NORTHING 6343670

FORMATION BOWSER LAKE GROUP

ELEVATION 4540 FT.; 1380m

COMMENTS FAIR OBSERVATION CONDITIONS, IN SHADOW ON A SUNNY DAY. COAL IS HARD AND NOT HEAVILY WEATHERED. PROBABLY CORRELATED TO HOBBIT #3 & #4.

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

GEOLOGIST P.M. WATERS

DATE AUG. 12/78

DESCRIPTION

SAMPLE	INTERVAL cm		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
		SANDSTONE & SHALE		COAL			INTERBEDDED SHALEY SANDSTONE AND SILTY SHALE, MODERATELY HARD, 3m+ THICK.
W29	0	SHALE & COAL	40	0	0	60	– TRACE OF WHITE MINERAL ON CLEATS. – INTERBEDDED COALY SHALE AND COAL.
W30	15	COAL	40	60	0	0	– CUT BY FAULTS, ½cm GOUGE. – COAL MODERATELY HARD. 2mm OF RUSTY QUARTZ VEINS SPLAYING OFF FAULT.
W31	50	CLAY					GREY BROWN, SANDY.
W32	60	COAL	20	70	0	10	– CUT BY SOME FAULTS AS ABOVE. COAL IS VERY HARD – TRACE OF BOTRYOIDAL CALCITE ON CLEATS. – TRACE OF QUARTZ VEINS SPLAYING OFF FAULTS. – TRACE OF PEACOCK BLUE IRON STAINING. SHALE IS HARD 2 TO 3cm PARTINGS.
W33	150	SHALE	5	15	0	80	– RUSTY COAL. – SHALE BROWN, MODERATELY HARD.
W34	160	COAL	15	75	0	10	– EXTREMELY HARD COAL. – VERY HEAVY RUST STAIN ON CLEATS. AND BEDDING SURFACES. – ½mm BOTRYOIDAL CALCITE ON CLEATS. SHALE IS 1 TO 2cm THICK.
W35	230	COAL	5	80	0	15	FAULT PLANE ? COAL IS HARD TO VERY HARD IN SHALY SECTIONS. SHALE IS 1 TO 15cm THICK.
W36	340	COAL & SHALE	0	50 ?	0	50 ?	INTERBEDDED COAL AND SHALE, BROWN, MODERATLY SOFT TO HARD. – BEDDING IS DOWN TO A FEW mm. THICK. NO MINERALIZATION.
	435	SHALE					FAULT. BROWN GREY, MODERATELY SOFT, 4m+ THICK. VITRAIN HAD OCCASIONAL BIRDSEYE CLEAT. FAULTS – 2 TO 5mm. COAL FAULT GOUGE. 0 TO 15cm STRATIGRAPHIC THROW. SPACING 2m, EXTENSIONAL. – TRACE OF QUARTZ VEIN ON FAULT, FORMING TWO CONJUGATE SETS.

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ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C W–34

SEAM NAME HOBBIT #4

LOCATION UTM EASTING 514940 NORTHING 6343650

FORMATION BOWSER LAKE GROUP

ELEVATION 4340 FT.; 1320m

COMMENTS FAIR OBSERVATION CONDITIONS IN SHADOW OF BRIGHT SUN, OUTCROP IS WEATHERED AND SLUFFED. PROBABLY CORRELATED TO HOBBIT #3 & #A.

ORIGIN OF LOG: CORE ____ CHIP SAMPLES ____

GEOPHYSICAL LOG – **OUTCROP** X

GEOLOGIST P.M. WATERS **DATE** AUG. 10/79

DESCRIPTION

SAMPLE	INTERVAL (cm)		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
		SANDSTONE & SILTSTONE		COAL			INTERBEDDED FINE GRAINED SANDSTONE AND SILTSTONE, MODERATLY HARD TO MODERATLY SOFT. 4m+ THICK.
W18	0–65	COAL	30	65	0	5	– OCCASIONAL SMALL FRACTURES AND ZONES OF GOUGE. TRACE OF IRON STAIN ON SOME CLEATS. SHALE IS IN 1 TO 3cm PARTINGS.
W19	65–128	COAL	20	70	0	10	OCCASIONAL SMALL FAULT. GOUGE ZONE (1cm). TRACE OF IRON STAINING ON CLEATS. SHALE IS IN 1 TO 2cm PARTINGS.
	128–132	SHALE					BROWN, CLAYEY.
W20	132–170	COAL	20	70	0	10	AS ABOVE.
W21	170–215	COAL	5	95	0	0	BEDDING IS IRREGULAR. COAL IS BROKEN INTO BLOCKS (FAULT ZONE ?). ABUNDANT IRON STAINING ON CLEATS.
W22	215–260	COAL	15	80	0	5	CUT BY ONE IRON STAINING FAULT. TRACE OF IRON STAINING ON CLEATS. SHALE IS IN 1 TO 2cm PARTINGS.
W23	260–300	COAL	10	80	0	10	SHALE IS AS 1cm PARTING. COAL IS FINELY BROKEN (FAULT BRECCIA ?) IRON STAINING ON CLEATS.
W24	300–360	COAL & SHALE	10	10	0	80	TRANSITION ZONE – SHALEY COAL AND COALY SHALE. TRACE OF IRON STAIN ON CLEATS.
	360–	SHALE					BROWN, COALY, FOSSILIFEROUS, MODERATLY HARD. – THE SEAM HAS SMALL FAULTS AND FRACTURES THROUGHOUT IT. IT IS ON THE NOSE OF AN ANTICLINE LINE AND MAY BE PODDED.

W25

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(LS)

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD NTS LOCATION 104 H/2 DRILL HOLE OR OUTCROP NUMBER O/C W 29

SEAM NAME HOBBIT #1 LOCATION UTM EASTING 515720 NORTHING 6342990

FORMATION BOWSER LAKE GROUP ELEVATION 4020 FT.; 1230m

COMMENTS FAIR OBSERVATION CONDITIONS. OVERCAST DAY. COAL EXPOSED BY B.C. RAILWAY. COAL IS NOT VERY WEATHERED. POSSIBLY CORRELATED TO HOBBIT #3, 4, A.

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

GEOLOGIST P.M. WATERS DATE AUG. 5/79

DESCRIPTION

	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
TILL		COAL			
FAULT WITH 5 TO 10cm OF CLAY AND COAL GOUGE.					POSSIBLY ICE THRUST FAULT IRON STAIN ON CLEAT.
COAL	0	100	0	0	
COALY CLAY					– BLACK, VERY SOFT, CARBONACEOUS, HARD.
COAL	30	60	0	10	COAL IS CONTORTED AND BROKEN, POWDERY IN PLACES. THICKNESS COULD BE WRONG AS THERE IS NO CONSISTENT BEDDING. TRACE OF IRON STAIN ON CLEAT.
COAL	50	45	0	5	BEDDING IS REGULAR, COAL QUITE FRIABLE WITH SOME HARD LAYERS. TRACE OF IRON STAIN ON CLEATS.
3cm OF VERY HARD BLACK NON COAL LAYERS.					
COAL	10	85	0	5	IRON STAIN ON CLEATS. BEDDING IS CONTORTED.
COAL	30	70	0	0	IRON STAIN ON CLEATS. MINOR CALCITE VEINING. BEDDING IS REGULAR, NOT BROKEN.
COALY SHALE	10	20	0	70	MAINLY BROWN CLAY AND CARBONACEOUS SHALE. TRACE OF IRON STAIN ON THE CLEAT. MINOR WHITE MINERAL ON THE CLEATS.
COAL	30	50	0	20	– ABUNDANT IRON STAIN ON THE CLEATS. – CALCITE VEINS. BEDDING IS REGULAR.
COAL	20	70	0	10	TRACE OF IRON STAIN ON THE CLEATS. ABUNDANT WHITE MINERAL. BEDDING IS REGULAR.
CLAY					– BROWN, VERY SOFT.
SHALE					– SILTY, VERY HARD AND BRITTLE. 3m+ THICK. ALL UNITS SHOW SLIGHTLY CONTORTED BEDS. ANY UNIT THAT HAS CONTORTED BEDDING IN THE DESCRIPTION IS ALSO FINELY BROKEN IN PLACES. VITRAIN TENDS TO POWDER EASILY, SO PERCENTAGES MAY BE UNDERESTIMATED. SOFT CLAY PARTINGS BECOME LIGHTER TOWARDS BOTTOM.

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COALFIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C W-31

SEAM NAME HOBBIT # 2

LOCATION UTM EASTING - 515380 NORTHING - 6343280

FORMATION BOWSER LAKE GROUP

ELEVATION 4260 FT.; 1300 m

COMMENTS GOOD OBSERVATION CONDITIONS. OBLIQUE BRIGHT SUN. COAL EXPOSED IN 1976 IN A QUARRY FOR THE B.C. RAILWAY ROAD BED % VITRAIN MAYBE UNDERESTIMATED BECAUSE THE COAL IS BADLY BROKEN. POSSIBLY CORRELATED TO HOBBIT # B.

ORIGIN OF LOG: CORE ___ CHIP SAMPLES ___

GEOPHYSICAL LOG — OUTCROP X

GEOLOGIST P.M. WATERS

DATE AUG. 8/79

DESCRIPTION

INTERVAL (cm)		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
	SHALE		COAL			BROWN AND BLACK, CARBONACEOUS, MINOR 3cm BANDS OF COAL, SHALE IS SOFT, COAL IS HARD, 1m+ THICK.
0	COAL	10	85	0	5	OCCASIONAL BED IS IRON STAINED
45			FAULT	2cm	COAL GAUGE	
	COAL	0	100	0	0	BROKEN BY FRACTURES AT 5 TO 10cm SPACING SHEARING COMMON. BEDDING IS CONTORTED.
95	COAL	85	0	0	15	BROKEN BY FRACTURES AT 10 TO 20cm SPACING.
155			FAULT, 1cm COAL BRECCIA, APPROX. 30cm STRATIGRAPHIC THROW.			
	COAL	95	0	0	5	BROKEN BY OCCASIONAL FRACTURES.
250	SHALE & COAL & SANDSTONE					INTERBEDDED BROWN CLAYEY SHALE; COAL; AND POORLY CONSOLIDATED SANDSTONE; SOFT, 1m+ THICK.

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GR - MTN KLAPPAN 79(3)A

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD
NTS LOCATION 104 H/2
DRILL HOLE OR OUTCROP NUMBER O/C W-32a
SEAM NAME HOBBIT #3
LOCATION UTM EASTING – 515060 NORTHING – 6343470
FORMATION BOWSER LAKE GROUP
ELEVATION 4300 FT., 1310m
COMMENTS GOOD OBSERVATION CONDITIONS. BRIGHT DIRECT SUN. COAL IS SOMEWHAT OXIDIZED, PROBABLY CORRELATED TO HOBBIT #4 & #A.
ORIGIN OF LOG: **CORE** ____ **CHIP SAMPLES** ____
GEOPHYSICAL LOG – **OUTCROP** X
GEOLOGIST P.M. WATERS **DATE** AUG. 8/79

DESCRIPTION

	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
SHALE & COAL		COAL			INTERBEDDED GREY SHALE AND 3cm COAL LENSES, SHALE IS SOFT, COAL IS FRIABLE, 1m+ THICK.
COAL	0	100	0	0	FINELY BROKEN, 2mm CLEAT SPACING. OCCASIONALY 1cm LAYER WITH HEAVY IRON STAINING.
COAL	0	100	0	0	SIMULAR TO UNIT ABOVE, BUT 1cm CLEAT SPACING. NO MINERALIZATION.
COAL	5	80	0	15	OCCASIONAL 1cm LAYER WITH HEAVY IRON STAINING. 15% SHALE AS 1 TO 2cm THICK PARTINGS. CLEAT SPACING 1cm.
COAL	5	90	0	5	- TRACES OF IRON STAINS ON OCCASIONAL CLEATS. CLEAT SPACING VARIES FROM 3mm TO 10mm.
COAL	5	95	0	0	CLEAT SPACING VARIES FROM 1mm TO 3cm.
COAL	0	70	0	30	GRADATIONAL UNIT. NO MINERALIZATION. 1cm QUARTZ VEIN.
SHALE					BLACK TO BROWNISH BLACK, FOSSILIFEROUS, MODERATLY HARD, 4m+ THICK.

% VITRAIN MAY BE UNDER ESTIMATED, BECAUSE FINELY BROKEN COAL APPEARS ATTRITAL RATHER THAN VITRAINOUS.

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ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD **NTS LOCATION** 104 H/2 **DRILL HOLE OR OUTCROP NUMBER** O/C W-166

SEAM NAME GRIZZLY #2 **LOCATION** UTM EASTING 511780 NORTHING 6341280

FORMATION BOWSER LAKE GROUP **ELEVATION** 6400 FT.; 1950m

COMMENTS GOOD OBSERVATION CONDITIONS, SUNNY AND WARM.

ORIGIN OF LOG: **CORE** -- **CHIP SAMPLES** -- **GEOPHYSICAL LOG** – **OUTCROP** X

GEOLOGIST B.D. VINCENT **DATE** AUG. 11/79

DESCRIPTION

SAMPLE	INTERVAL cm	LITHOLOGY	% VITRAIN	% ATTRITAL COAL	% FUSAIN	% SHALE	
		COVERED					POSSIBLY MEDIUM GREY SILTSTONE.
V6	0	COAL	HIGH				– POWDERY HIGH IN VITRAIN.
V7	18	SHALE					LENSEY, SOFT TO HARD.
V8	34	COAL	HIGH				– POWDERY, HIGH IN VITRAIN.
V9	80	COAL	HIGH				– POWDERY, HIGH IN VITRAIN.
	145	MUDSTONE					BROWN GREY, SOFT TO HARD.

* COAL IS FROZEN AT DEPTH OF 1.0- 1.5m BELOW THE SURFACE OF THE SCREE SLOPE. POWDERED NATURE OF COAL LIKELY DUE TO FREEZE-THAW ACTION.

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GR- MTN KLAPPAN 79(3)A

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD
NTS LOCATION 104 H/2
DRILL HOLE OR OUTCROP NUMBER O/C W-216
SEAM NAME CINCIE #1
LOCATION UTM EASTING -513640 NORTHING -6340140
FORMATION BOWSER LAKE GROUP
ELEVATION 5260 FT.; 1600m
COMMENTS GOOD OBSERVATION CONDITIONS, DIRECT BRIGHT SUN. OUTCROP IS WEATHERED TO COARSE POWDERED ½cm BLOCKS BUT BEDDING WELL PRESERVED.
ORIGIN OF LOG: CORE ___ CHIP SAMPLES ___
GEOPHYSICAL LOG ___ **OUTCROP** X
GEOLOGIST P.M. WATERS
DATE AUG. 14/79

DESCRIPTION

	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
SHALE		COAL							GREY FOSSILIFEROUS BECOMING CARBONACEOUS TOWARD COAL; MODERATELY HARD, 0.5 m THICK.
COAL	10	60	0	30					– DIFFICULT TO ESTIMATE % OF COMPONENTS – SOME REGULAR AND IRREGULAR 1cm BANDS OF RUSTY COAL, POSSIBLY LIESEGANG RINGS.
SHALE									DARK GREY CARBONACEOUS; MODERATELY SOFT, 1cm THICK

L10

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GR - MTN. KLAPPAN 79(3)A

ESSO MINERALS CANADA — COAL DEPARTMENT

GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C B–218

SEAM NAME LOST RIDGE #2

LOCATION UTM EASTING 504340 NORTHING 6343340

FORMATION BOWSER LAKE GROUP

ELEVATION 5600 FT.; 1710m

COMMENTS COAL MODERATELY FRESH.

ORIGIN OF LOG: CORE – CHIP SAMPLES –

GEOPHYSICAL LOG – OUTCROP X

GEOLOGIST J.C. BROATCH DATE AUG. 7/79

DESCRIPTION

	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
SILTSTONE		COAL							RECESSIVE, PEBBLY 20m+ THICK
									50% COAL, 50% MUDSTONE OR SILTSTONE.
COAL	30 ?	70 ?							ANTHRACITE ? – VERY RUSTY, HARD. POSSIBLY 5% MUDSTONE.
MUDSTONE & SILTSTONE									– QUARTZ RICH (5%), RECESSIVE.
COAL		100 ?							
COAL		100 ?							MAY CONTAIN UP TO 15% WEATHERED COALY SOIL.
COAL	2cm MUDSTONE	100 ?							
SHALE									RECESSIVE, IMPERVIOUS. ALL COAL SHOWS RUST STAINING IN BANDS ALONG CLEATS.

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GR- MTN KLAPPAN 79(3)A

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C W 51

SEAM NAME FOX #1

LOCATION UTM EASTING 508190 NORTHING 6343830

FORMATION BOWSER LAKE GROUP

ELEVATION 5020 FT.; 1530m

COMMENTS COAL NOT FRESH AT THE TOP, OKAY AT THE BOTTOM.

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

GEOLOGIST J.C. BROATCH

DATE AUG. 12/79

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE						
	cm		SHALE		COAL								SHALEY, RECESSIVE 2m+ THICK.
	0		COAL	90									MUDSTONE PARTINGS HAVE DISCONTINUOUS IRON STAINING.
B28			SHALE	1cm									
	50		SHALE	LENSE	1cm								
B31	65 100		SHALE & SILTSTONE & COAL	20									INTERBEDDED MUDSTONE, SILTSTONE, AND COAL. ABUNDANT IRON STAINING AND SULFUR.
B29	115 150		COAL										RARE MUDSTONE LENSES. – IRON STAIN.
	185		SHALE										– COALY MUDFLAKES.
B30	195 200		COAL	607									COALY MUDSTONE IN FLAKES.
	225 250		SHALE										SILTY, MODERATELY RECESSIVE

GR - MTN - KLAPPAN 79(3)A

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY: MT. KLAPPAN GROUNDHOG COAL FIELD
NTS LOCATION: 104 H/2
DRILL HOLE OR OUTCROP NUMBER: O/C W 166
SEAM NAME: GRIZZLY #1
LOCATION: UTM EASTING 511880 NORTHING 6341310
FORMATION: BOWSER LAKE GROUP
ELEVATION: 6320 FT.; 1930m
COMMENTS: GOOD OBSERVATION CONDITIONS SUNNY AND CALM.
ORIGIN OF LOG: CORE – CHIP SAMPLES
GEOPHYSICAL LOG
OUTCROP X
GEOLOGIST: B.D. VINCENT
DATE: AUG. 11/79

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY		% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
	cm		SILTSTONE		COAL							MEDIUM GREY, HARD BUT VERY FRACTURED 0.5m THICK GRADATIONAL LOWER CONTACT.
V1	0		COAL									SHALEY COAL. – SHARP LOWER CONTACT.
V2	22		MUDSTONE									MUDSTONE – SHARP LOWER CONTACT.
V3	31		COAL	HIGH								– COAL COULD NOT TELL PROPORTIONS OF CONSTITUENTS – HIGH VITRAIN. HIGHLY FRACTURED. NO MINERALIZATION.
V4	110		COAL	60		40						– HIGHLY FRACTURED. NO MINERALIZATION. SHARP LOWER CONTACT.
V5	154		COAL & SHALE									COAL AND CARBONACEOUS MUDSTONE.
	170		SILTSTONE									DARK GREY. VERY FOSSIFEROUS BANDS, HARD AND SPLINTERY, 1.5m THICK.

GR- MTN. KLAPPAN 79(3)A

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD

NTS LOCATION 104 H/2

DRILL HOLE OR OUTCROP NUMBER O/C B–30

SEAM NAME GRIZZLY #3

LOCATION UTM EASTING 512110 NORTHING 6341070

FORMATION BOWSER LAKE GROUP

ELEVATION 4400 FT.; 1340m

COMMENTS FAIR TO GOOD OBSERVATION CONDITIONS.

ORIGIN OF LOG: **CORE** – **CHIP SAMPLES** – **GEOPHYSICAL LOG** – **OUTCROP** X

GEOLOGIST J.C. BROATCH **DATE** AUG. 10/79

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE	
	cm	SILTSTONE		COAL			RECESSIVE.
	0	SHALE & COAL	30			70	SOFT MUDSTONE AND COALY SILTSTONE OR MUDSTONE IRON STAINED.
B26	65	COAL	80				SULFUR? VITRAIN WITH SILTSTONE/ COAL BOULDERS. IRON STAINING ON CLEATS.
		SILTSTONE 1cm					
	175	MUD					SOFT.
B26A	185	COAL	100				ABUNDANT SULFUR ODOUR. IRON STAINING ON CLEATS.
	260	SANDSTONE & SHALE					VERY RESISTANT, APPROXIMATELY 27m THICK.

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GR- MTN KLAPPAN 79(3)A

ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KAPPLAN GROUNDHOG COAL FIELD
NTS LOCATION 104 H/2
DRILL HOLE OR OUTCROP NUMBER O/C 9 -202
SEAM NAME KLAPPAN #1
LOCATION UTM EASTING 502590 NORTHING 6343060
FORMATION BOWSER LAKE GROUP
ELEVATION 4600 FT.; 1400m
COMMENTS FAIR OBSERVATION CONDITIONS. - ROOTS PARTING APPROXIMATELY VERTICAL SEAM.
ORIGIN OF LOG: CORE -- CHIP SAMPLES -- GEOPHYSICAL LOG ____ OUTCROP X
GEOLOGIST J.C. BORATCH
DATE AUG. 14/79

DESCRIPTION

SAMPLE	INTERVAL	LITHOLOGY	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
	cm	SILTSTONE		COAL							SHEARED, RUBBLY; MODERATELY RESISTANT, 5m THICK.
B34	0 50	COAL	80								– BEDDING SLIGHTLY CONTORTED, DIRTY, BROKEN. VERY MINOR IRON STAINING ON CLEATS.
	70	SHALE									SILTY, SOFT.
B35	85 100	COAL		80?							IRON STAINING ABUNDANT ON CLEATS.
	115	SILTSTONE									VERY HARD
	120 150	COAL		80?							IRON STAINING ABUNDANT ON CLEATS.
	165	SHALE									COALY, SOFT.
B36	190 200 250 300	COAL	65			35					INTERBEDDED COAL (65%) AND MUDSTONE (35%) MINOR IRON STAINING ON CLEATS.
	330	SHALE & COAL									COAL (20%) AND MUDSTONE, RUSTY QUARTZ VEINING.
	350 400	SANDSTONE									BLOCKY, RESISTANT, APPROXIMATELY 10m THICK.

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ESSO MINERALS CANADA — COAL DEPARTMENT
GRAPHIC COAL SEAM LOG

PROPERTY MT. KLAPPAN GROUNDHOG COAL FIELD
NTS LOCATION 104 H/2
DRILL HOLE OR OUTCROP NUMBER O/C B 108
SEAM NAME LOST RIDGE #1A
LOCATION UTM EASTING – 505670 NORTHING 6344650
FORMATION BOWSER LAKE GROUP
ELEVATION 5520 FT.; 1680m
COMMENTS TRENCH INCOMPLETE. 2m OVERBURDEN, SLUMPING.
ORIGIN OF LOG: CORE — CHIP SAMPLES — GEOPHYSICAL LOG ____ OUTCROP X
GEOLOGIST J.C. BROATCH
DATE AUG. 9/79

DESCRIPTION

	% VITRAIN	% ATTRITAL	% FUSAIN	% SHALE					
SANDSTONE		COAL							RESISTANT, BLOCKY, 10m OR LESS THICK.
COAL	90+								POSSIBLE MINOR IRON STAINING. 2cm PARTINGS.
COAL	90+								IRON STAINING.
SHALE									SILTY.
COAL	90+								3cm RUSTY LENS.
COAL	90+								IRON STAINING. PERMAFROST.
MUD PARTING 2cm THICK									
COAL	90+								IRON STAINING. PERMAFROST.
COAL	90+								BOTTOM 10cm WEATHERED. IRON STAINING.
SHALE & SILTSTONE & SANDSTONE									FISSILE, MODERATELY RESISTANT, APPROXIMATELY 30m THICK. MINOR PEACOCK LUSTRE ON CLEATS ALL THROUGH THE COAL.

M1

NOTE:

TIGHT OVERTURNED LIMBS OF FOLDS MAY BECOME THRUST FAULTS UP OR DOWN SECTION

CONVERSLY THRUST FAULTS MAY DIE OUT INTO TIGHT OVERTURNED LIMBS

ALMOST ALL THE SMALL SCALE FOLDING AND FAULTING CANNOT BE SHOWN BECAUSE THE OUTCROP SPACING IS TOO LARGE

FAULTS OTHER THAN THRUST FAULTS ARE ASSUMED TO BE VERTICAL WITH A DISPLACEMENT TOO SMALL TO BE SHOWN ON THIS SCALE

THE STRUCTURE IS NOT AS GENERALIZED ON THE RIDGES AS IN THE VALLEYS BECAUSE OF BETTER EXPOSURE AT HIGHER ELEVATIONS

LEGEND

COAL SEAMS	PROBABLE	━━━
	POSSIBLE	— — —
	ERODED	········
MEASURED BEDDING ATTITUDE		\
BEDDING	PROBABLE	⁄
	POSSIBLE	⁄ ⁄
	ERODED	⋰
THRUST FAULT	OBSERVED	↖
	ASSUMED	╲ ╲
FAULT	OBSERVED	≀
	ASSUMED	≀ ≀

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MOUNT KLAPPAN - GROUNDHOG COAL FIELD
STRUCTURAL CROSS - SECTIONS
SCALE 1:10,000 —— NO VERTICAL EXAGERATION
AUG. 1979
FIGURE 6
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MOUNT KLAPPAN – GROUNDHOG COAL FIELD
GEOLOGICAL MAP

EAST HALF
FIGURE 5b

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COAL DEPARTMENT

MOUNT KLAPPAN - GROUNDHOG COAL FIELD
GEOLOGICAL MAP

WEST HALF
FIGURE 5a

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