MOUNT KLAPPAN COAL PROJECT
GEOLOGICAL REPORT
1983

Gulf

GULF CANADA RESOURCES INC.

COAL DIVISION

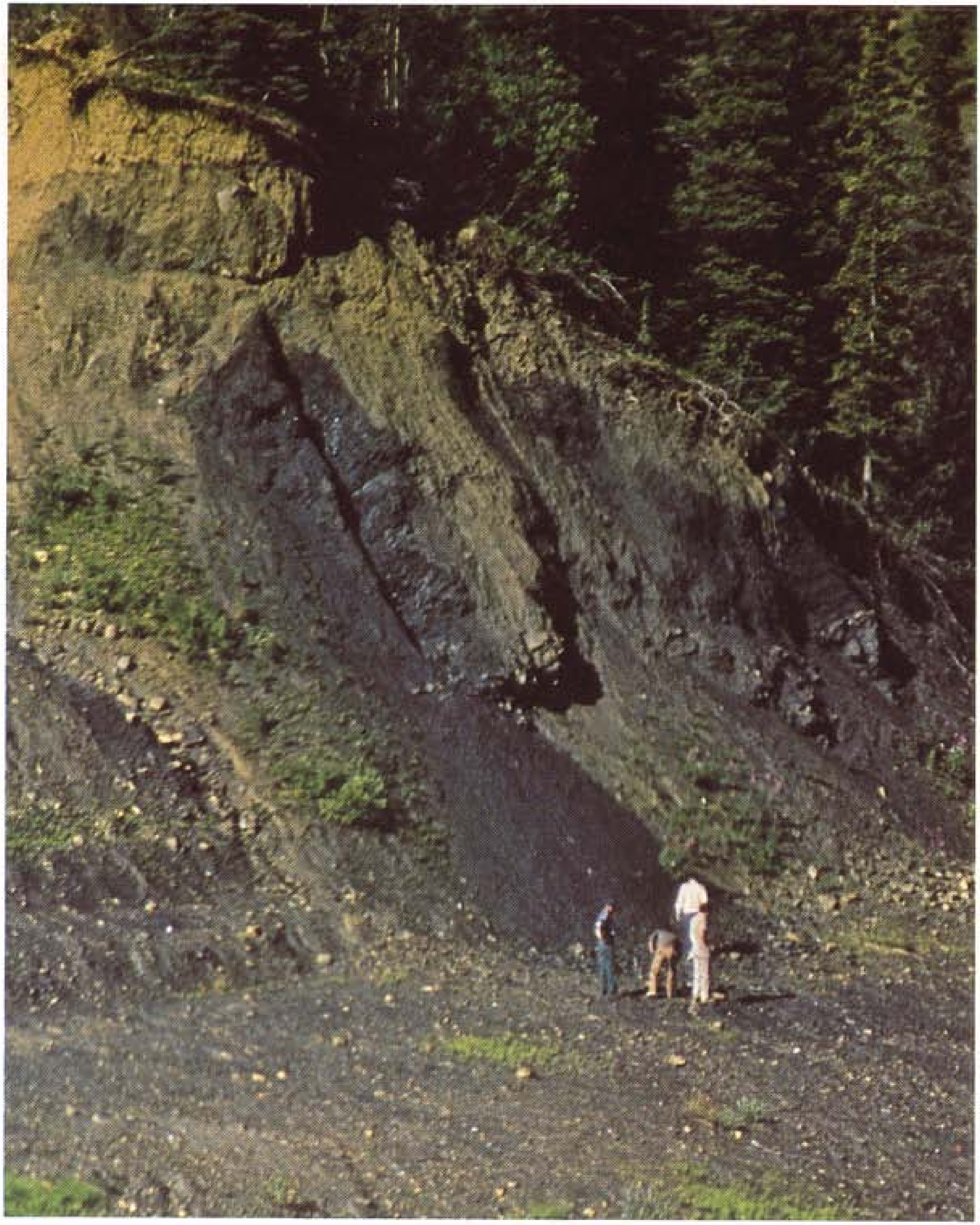
CONFIDENTIAL

MOUNT KLAPPAN

COAL PROJECT

GEOLOGICAL REPORT

1983



PREFACE

Gulf Canada Resources Inc. has recently completed its second major field exploration program on the Mount Klappan Coal Property, located in Northwest British Columbia.

The report which covers the period of March 1, 1983 to March 1, 1984, provides a current assessment of the geology, coal quality and resource potential of the Property based on the 1982 and 1983 field data. In addition, it covers the more detailed examination of one specific resource area containing surface mineable coal.

MOUNT KLAPPAN COAL PROPERTY

SUMMARY

1.0 SUMMARY

G.C.R.I.'s Mount Klappan Coal Property is composed of 145 Crown licences (38, 138 hectares) of land with an additional 44 Crown licences (12, 332 hectares) under application. The Property is located in the Bowser Basin of Northwest British Columbia some 180 miles (288 kilometres) north of Smithers, British Columbia.

Exploration during 1983 comprised three diamond drill holes totalling 603 metres; the excavation of 93 trenches, and the extraction of a 37 tonne bulk sample from an adit. In addition, the property was mapped at scales of 1:5 000 and 1:10 000.

The Mount Klappan Property covers sedimentary strata ranging from Middle - Upper Jurassic to Lower Cretaceous in age. Structurally, it consists of strata which is characterized by two phases of deformation. This has resulted in folds of the first phase trending NW-SE with minor thrusts. The second phase folding has resulted in generally broad, open NE to SW trending folds with relatively rare, flat lying thrusts expressed in several klippen fault structures.

The sediments are subdivided into three sequences which, in ascending order, are labelled the Klappan, Malloch and Rhondda Sequences. The Klappan Sequence, which is presently interpreted to comprise just over 950 metres of minor conglomerates, sandstones, claystones, siltstones and coal, is the main coal bearing unit.

The total resource potential of the property is calculated at 4 billion tonnes (rounded to the nearest billon tonnes) of which 967 million is classified as inferred and in excess of 3 billion tonnes as

speculative resources. The resources are contained in 16 seams ranging up to seven metres in thickness.

The coal, which is of anthracite rank, can be cleaned to simultaneously produce a variety of sized products, ranging in ash content from 5% ash premium coals to briquetting coals with ash contents of 25% or greater.

The anthracite products are characterized by low sulphur values (less than 1% and usually 0.5%) with only traces of chlorine and high calorific values. When crushed to pass 50 mm; 23% remains above 12 mm in size and 68% is greater than 1 mm in size.

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	19 000 N (East and West)	KPN83A08
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	15 000 N (East and West)	KPN83A09
	13 000 N (East and West)	KPN83A09
	11 000 N (East and West)	KPN83A09
	9 000 N (East and West)	KPN83A09
	7 000 N (East and West)	KPN83A09
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	1 000 S (East and West)	KPN83A10
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APPENDIX II
Maps and Cross-Sections
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Maps and Cross-Sections
1:5 000 and 1:10 000

		Drawing No.
1:5 000 Set	Geological Cross-Sections (2 kilometre spacing)	
	17 000 N (East)	KPN83E01
	15 000 N (East and West)	KPN83E02
	13 000 N (East and West)	KPN83E03
	11 000 N (East)	KPN83E04
	11 000 N (West)	KPN83E05
	9 000 N (East)	KPN83E06
	9 000 N (West)	KPN83E07
	7 000 N (East)	KPN83E08
	7 000 N (West)	KPN83E09
	5 000 N (East)*	KPN83E10
	5 000 N (West)	KPN83E11
	3 000 N (East)*	KPN83E12
	3 000 N (West)	KPN83E13
	1 000 N (East)*	KPN83E14
	1 000 N (West)	KPN83E15
	000 N (East)	KPN83E16
	000 N (West)	KPN83E17
	1 000 S (East)	KPN83E18
	1 000 S (West)	KPN83E19
	3 000 S (East)	KPN83E20
	3 000 S (West)	KPN83E21
	5 000 S (East)	KPN83E22
	5 000 S (West)	KPN83E23
	7 000 S (East)	KPN83E24
	7 000 S (West)	KPN83E25
	9 000 S (East)	KPN83E26
	9 000 S (West)	KPN83E27
	11 000 S (East)	KPN83E28
	11 000 S (West)	KPN83E29
	13 000 S (East)	KPN83E30
	13 000 S (West)	KPN83E31
	15 000 S (East and West)	KPN83E32
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* Not included in the 1983 report

APPENDIX II
Maps and Cross-Sections
1:5 000 and 1:10 000

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	Licences Under Application	
1:10 000 Set	**Geological Cross-Sections (2 kilometre Spacing)**	
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	19 000 N (East and West)	KPN83E39
	17 000 N (East and West)	KPN83E40
	15 000 N (East and West)	KPN83E41
	13 000 N (East and West)	KPN83E42
	11 000 S (East)	KPN83E43
	13 000 S (East	KPN83E44
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		Drawing No.
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	104 H/6 G	KPN83F01
	104 H/6 H,G	KPN83F02
	L12 M12, 104 H/6 A,H	KPN83F03
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	G10, 11 H10, 11	KPN83I04
	F12, 13 G12,13	KPN83I05
	F14, 15 G15	KPN83I06
	J14	KPN83107
1:10 000	Klappan Mountain Area Geology Map	
	H8, 9 I8, 9	KPN83J01
	I6, 7 J6, 7	KPN83J02
	G6, 7 H6, 7	KPN83J03
	F8, G8, 9	KPN83J04
1:10 000	Skeena Ellis Area Geology Map	
	I4, 5 J5, 104H/2J	KPN83K01
	G4, 5 H4, 5 104H/2J	KPN83K02
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	E6, 7 F6, 7	KPN83K06

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		Drawing No.
1:10 000	Geological Cross-Sections (2 kilometre Spacing)	
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	17 000 N (East and West)	KPN83L06
	15 000 N (East and West)	KPN83L07
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	5 000 N (West)	KPN83L09
	3 000 N (West)	KPN83L10
	1 000 N (West)	KPN83L10
	000 (East and West)	KPN83L11
	1 000 S (East and West)	KPN83L12
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	5 000 S (East and West)	KPN83L13
	7 000 S (East and West)	KPN83L13
	9 000 S (East and West)	KPN83L14
	11 000 S (East and West)	KPN83L14
	13 000 S (East and West)	KPN83L15
	15 000 S (East and West)	KPN83L15
	17 000 S (East and West)	KPN83L16
	19 000 S (East and West)	KPN83L16

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	Maps	
1:5 000	Lost-Fox Inferred Resource Area Geology Map	KPN83M01
1:5 000	Summit Inferred Resource Area Geology Map	
	Northern	KPN83M02
	Southern	KPN83M03
	Cross-Sections	
1:5 000	Lost-Fox Inferred Resource Area Geological Cross-Sections (500 metre spacing)	
	4 000 N (West)	KPN83N02
	3 500 N (West)	KPN83N03
	3 000 N (West)	KPN83N04
	2 500 N (West)	KPN83N05
	2 000 N (West)	KPN83N06
	1 500 N (West)	KPN83N07
	1 000 N (West)	KPN83N08
1:5 000	Summit Infereed Resource Area Geological Cross-Sections (500 metre spacing)	
		KPN83P01
	10 500 N	KPN83P02
	10 000 N	KPN83P03
	9 500 N	KPN83P04
	6 000 N	KPN83P06
	5 500 N	KPN83P07

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1:5 000 and 1:10 000

		Drawing No.
1:5 000 Set	Trench and Drill Hole Location	
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	Map E-5	KPN83T02
	Map E-6	KPN83T03
	Map E-7	KPN83T04
	Map F-4	KPN83T05
	Map F-5	KPN83T06
	Map F-6	KPN83T07
	Map F-7	KPN83T08
	Map F-8	KPN83T09
	Map F-12	KPN83T10
	Map F-13	KPN83T11
	Map F-14	KPN83T12
	Map G-4	KPN83T13
	Map G-5	KPN83T14
	Map G-6	KPN83T15
	Map G-7	KPN83T16
	Map G-8	KPN83T17
	Map G-9	KPN83T18
	Map G-10	KPN83T19
	Map G-11	KPN83T20
	Map G-12	KPN83T21
	Map G-13	KPN83T22
	Map G-14	KPN83T23
	Map G-15	KPN83T24
	Map H-4	KPN83T25
	Map H-5	KPN83T26
	Map H-6	KPN83T27
	Map H-7	KPN83T28
	Map H-8	KPN83T29
	Map H-9	KPN83T30
	Map H-10	KPN83T31
	Map H-11	KPN83T32
	Map H-12	KPN83T33
	Map H-13	KPN83T34
	Map H-14	KPN83T35
	map H-15	KPN83T36
	Map I-4	KPN83T37
	Map I-5	KPN83T38
	Map I-6	KPN83T39
	Map I-7	KPN83T40
	Map I-8	KPN83T41
	Map I-9	KPN83T42
	Map I-10	KPN83T43
	Map I-11	KPN83T44
	Map I-12	KPN83T45
	Map I-13	KPN83T46

APPENDIX III
Maps and Cross-Sections
1:5 000 and 1:10 000

		Drawing No.
1:5 000 Set	**Trench and Drill Hole Location**	
	Map I-14	KPN83T47
	Map I-15	KPN83T48
	Map J-5	KPN83T49
	Map J-6	KPN83T50
	Map J-7	KPN83T51
	Map J-8	KPN83T52
	Map J-9	KPN83T53
	Map J-10	KPN83T54
	Map J-11	KPN83T55
	Map J-12	KPN83T56
	Map J-13	KPN83T57
	Map J-14	KPN83T58
	Map K-7	KPN83T59
	Map K-8	KPN83T60
	Map K-9	KPN83T61
	Map K-10	KPN83T62
	Map K-11	KPN83T63
	Map K-12	KPN83T64
	Map L-10	KPN83T65
	Map L-11	KPN83T66
	Map L-12	KPN83T67
	Map M-11	KPN83T68
	Map M-12	KPN83T69
	Licences Under Application	
1:10 000 Set	**Trench and Drill Hole Location**	
	Map 104H/2 G,J	KPN83T70
	Map 104H/6 G	KPN83T71
	Map 104H/6H	KPN83T72
	Map 104H/6 B	KPN83T73
	Map 104H/6 A 104H/7 D	KPN83T74

WORK COMPLETED ON MT. KLAPPAN IN 1983

Adit 83-100	7152	BCTRC 83035	7144
DDH 83001	7152	BCTRC 83036	7143
DDH 83002	7150	BCTRC 83037	7161
DDH 83003	7426	BCTRC 83038	7160
WKD 83001	7152	BCTRC 83040	7160
WKD 83002	7152	BCTRC 83043	7161
WKD 83003	7152	BCTRC 83046	7158
WKD 83004	7152	KNTRC 83082	7428
WKD 83005	7152	KNTRC 83083	7428
WKD 83006	7152	KNTRC 83084	7429
SNTRC 83061	7426	KNTRC 83085	7429
SNTRC 83062	7426	KNTRC 83086	7429
SNTRC 83066	7426	KNTRC 83091	7154
SSTRC 83052	7426	KWTRC 83068	7521
SSTRC 83054	7426	KWTRC 83069	7519
SSTRC 83063	7426	KWTRC 83070	7519
LRTRC 83001	7152	KWTRC 83071	7519
LRTRC 83002	7152	KWTRC 83072	7521
LRTRC 83003	7145	KWTRC 83073	7488
LRTRC 83004	7145	KWTRC 83076	7518
LRTRC 83005	7145	KWTRC 83087	7523
LRTRC 83006	7145	KWTRC 83088	7523
LRTRC 83007	7145	KSTRC 83077	7517
LRTRC 83028	7151	MNTRC 83008	7135
LRTRC 83029	7151	MNTRC 83009	7135
LRTRC 83039	7170	MNTRC 83010	7135
LRTRC 83041	7169	MNTRC 83011	7140
LRTRC 83042	7151	MNTRC 83012	7140
LRTRC 83044	7169	MNTRC 83013	7140
LRTRC 83047	7152	MNTRC 83014	7135
LRTRC 83050	7152	MNTRC 83015	7130
LRTRC 83053	7151	MNTRC 83016	7129
LRTRC 83092	7152	MNTRC 83017	7130
LRTRC 83093	7152	MNTRC 83018	7129
BCTRC 83025	7161	MNTRC 83019	7129
BCTRC 83026	7161	MNTRC 83020	7130
BCTRC 83027	7143	MNTRC 83021	7134
BCTRC 83030	7144	MNTRC 83022	7130
BCTRC 83031	7144	MSTRC 83023	7130
BCTRC 83032	7144	MSTRC 83024	7130
BCTRC 83033	7144	KHTRC 83045	7139
BCTRC 83034	7144		

2.0 RECOMMENDATIONS

As a result of the data collected during the 1982 and 1983 exploration seasons, the following recommendations are made:

1) Further work should be undertaken to evaluate the resource potential of the areas underlain by Malloch sediments to determine if these licences shoud be retained or surrendered.

2) Based on the 1983 work, it is felt that further definition of the Malloch-Klappan contact will assist in the unravelling of the structure and stratigraphy of the Property.

3) The Lost-Fox area provides the best opportunity to intersect a complete or near complete section of the Klappan Sequence.

4) An increased comprehension of the structural domains occurring within the licence boundary could best be attained by studying Lost Ridge, the Summit and Little Klappan Areas where outcrop is good. In particular, attention should be directed to tracing the klippen structure identified in 1983.

3.0 INTRODUCTION

3.1 Location

The Mount Klappan coal licences are situated in Northwest British Columbia approximately 930 kilometres north of Vancouver, 530 kilometres northwest of Prince George and 336 kilometres northeast of Prince Rupert (Figure 3.1).

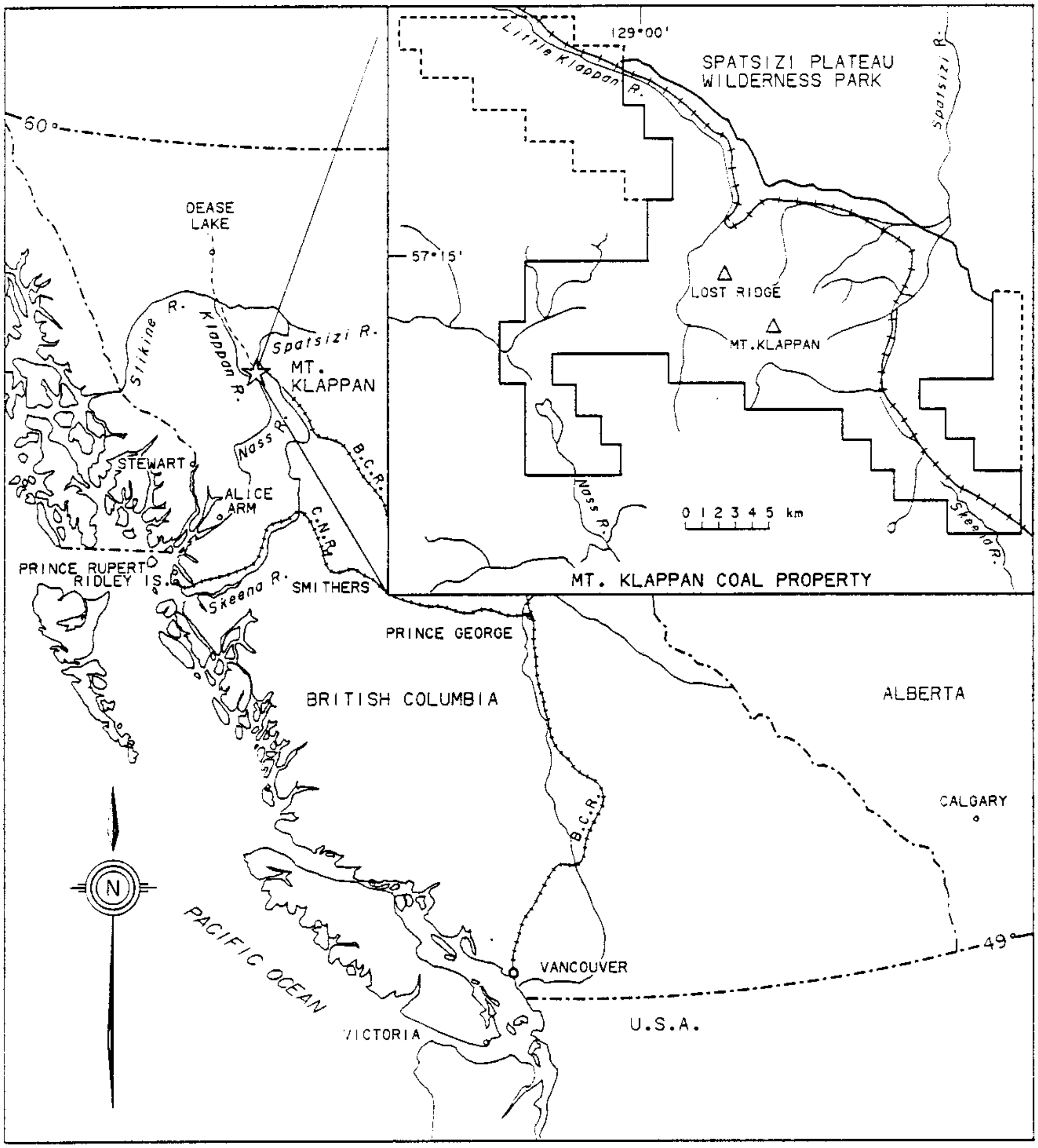
Geographically the coal licences are at the northern extremity of the Skeena Mountains between 57° 06' and 57° 23' north latitude, and 128° 37' to 129° 15' west longitude. The property covers the headwaters of the Klappan, Little Klappan, Spatsizi and Nass Rivers.

The nearest community to the Property is the Indian community of Iskut (population 500) located 100 kilometres to the northwest on the Stewart-Cassier Highway.

FIGURE 3.1

MT. KLAPPAN COAL PROPERTY

LOCATION MAP



——— MT. KLAPPAN LICENCE AREA - - - - - LICENCES UNDER APPLICATION	GULF CANADA RESOURCES INC. 09/01/84 Gulf

3.2 Access

The Property lies on the British Columbia Railway line between Dease Lake and Prince George. Although work on the line has ceased, steel was laid to within 80 kilometres of the licences. With the exception of a 24-kilometre stretch north of the Kluatantan River, the grade has been constructed from the end of steel through and past the Property to the Stikine River in the north (Figure 3.2).

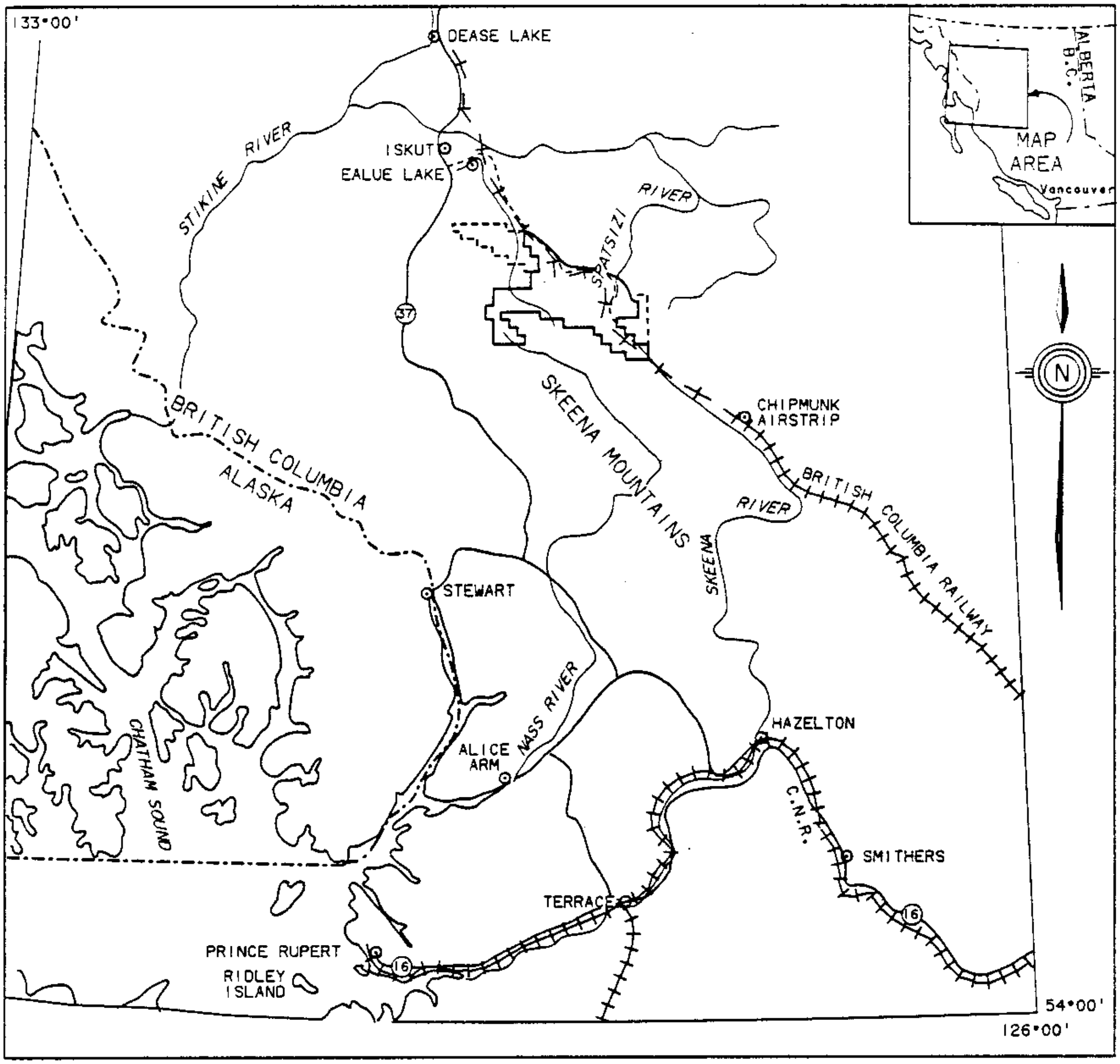
The absence of three bridges across the Klappan River, and Ealue and Tsetia Creeks, north of Mount Klappan, negated the use of the railway grade for access. However, as of March 1984, three bridges have been constructed and road access is now possible from Highway 37 along the Ealue Lake Road and hence down the railway grade.

During the 1983 program, access was by fixed wing and helicopter aircraft to the 1000-metre Summit airstrip.

FIGURE 3.2

MT. KLAPPAN COAL PROPERTY

PROPERTY ACCESS



———	ROAD ACCESS
- - - - -	SEASONAL ROAD ACCESS
+++++++	EXISTING RAILWAY
⊢ + +	PREPARED RAILBED
———	MT. KLAPPAN LICENCE AREA
- - - - -	LICENCES UNDER APPLICATION

0 20 40 60 80 km

GULF CANADA RESOURCES INC.
12/12/83

3.3 Property Description

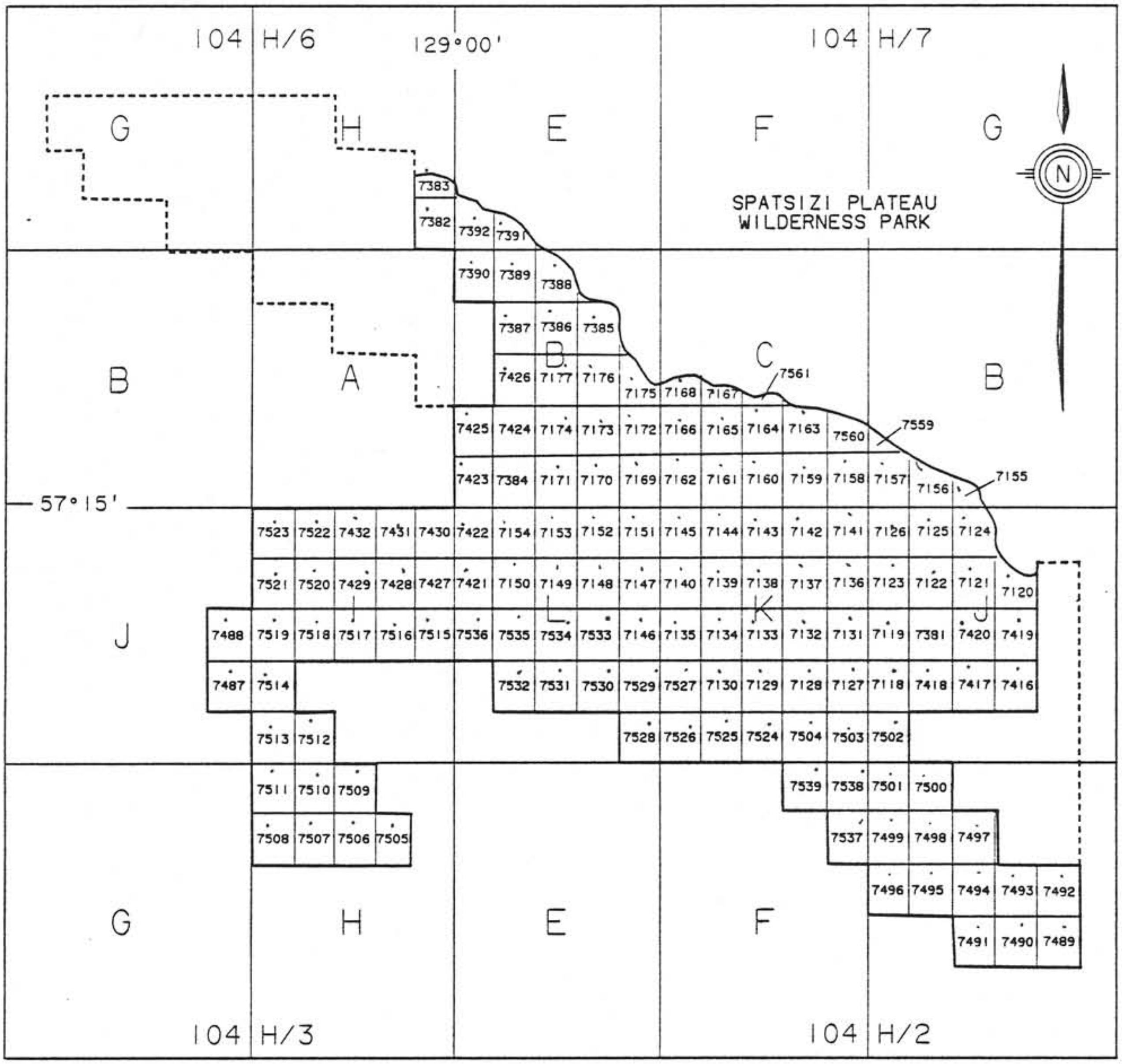
The Mount Klappan Coal Property comprises 145 coal licences (38,138 hectares) of land. The Property was acquired over three separate applications from 1981 to 1982 (Figure 3.3). A further 44 coal licences (12,332 hectares) were applied for following completion results of the 1982 program.

A re-definition of the northeastern boundary of the Property has occurred where Gulf re-applied to the Government of British Columbia, on November 16, 1982, for approximately 1000 hectares of land. The land was previously applied for, but not granted to Gulf Canada Resources Inc., due to the inaccurate positioning of the Spatsizi Plateau Wilderness Park's southwestern boundary.

FIGURE 3.3

MT. KLAPPAN COAL PROPERTY

LICENCES



LEGEND

——— LICENCE AREA

- - - - - - LICENCES UNDER APPLICATION

SCALE

1:238,095

0 1 2 3 4 5 km

GULF CANADA RESOURCES INC.
12/12/83

3.4 Ownership

Gulf Canada Resources Inc. wholly owns the coal licences and the coal licence applications.

3.5 Property Geography and Biophysical Environment

The Mount Klappan Coal Property is located near the headwaters of the Little Klappan, Klappan, Nass, Skeena, and Spatsizi Rivers (Figure 3.4). This area is within the northern extremity of the Skeena Mountains Physiographic Region. The regional physiography is of mountainous terrain and broad northwest to southeast trending river valleys of the Little Klappan, Klappan, Nass, and Skeena Rivers, and Didene Creek (Figure 3.4).

Elevations on the Property range from 1127 metres in the Spatsizi River Valley to over 2000 metres on Mount Klappan and the adjacent ridge tops.

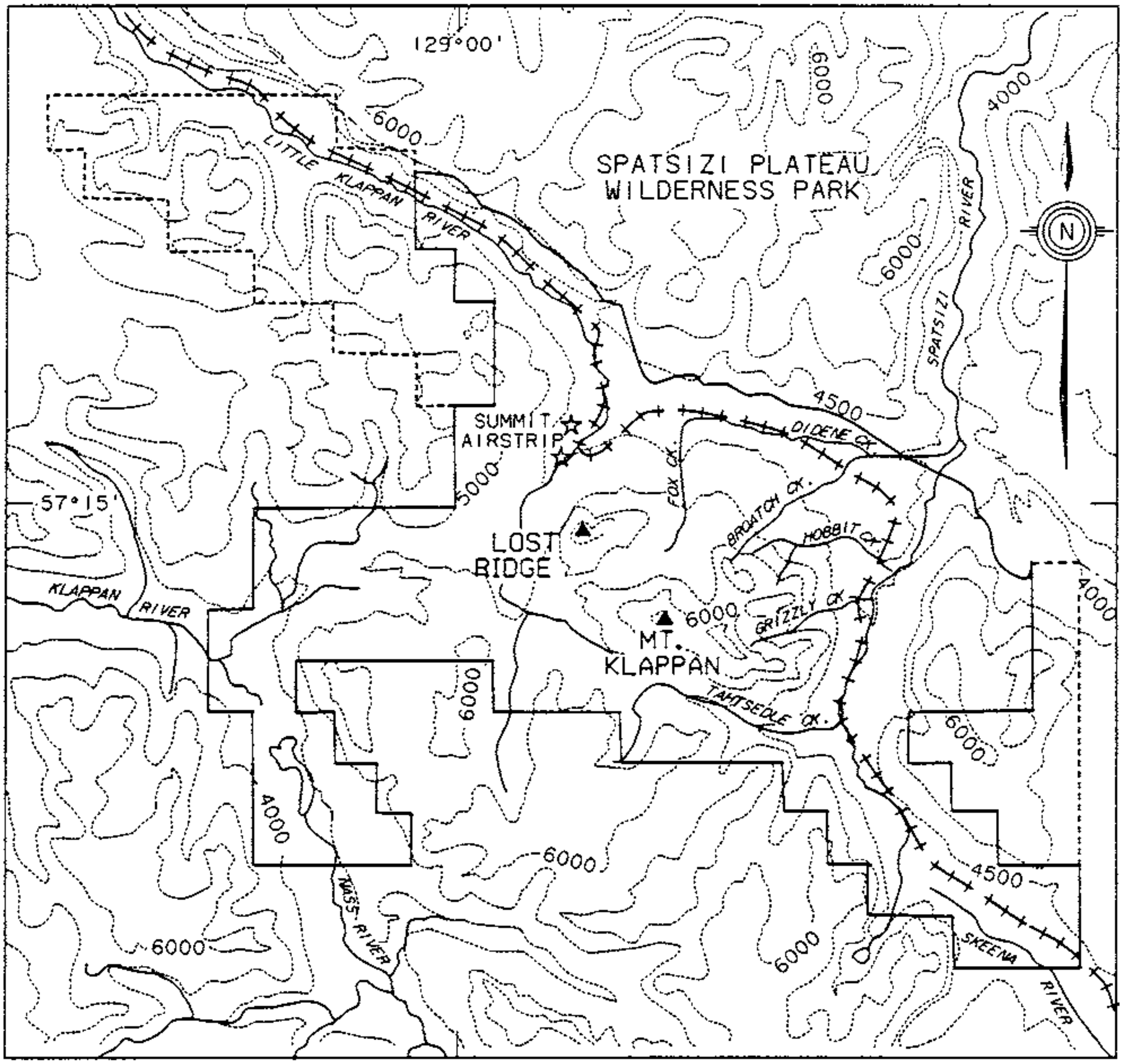
The climatic regime of the area is in the Northern and Central Plateau and Mountain Zone. Precipitation values average 300 to 400 mm per year with the mean daily temperatures comparable to Fort Nelson and Prince George. This information is derived from a weather station located on the northeastern edge of the Property which has been monitored monthly since its installation three years ago.

Tree line in the area is at approximately 1500 metres. Valley bottoms are partially covered with scattered coniferous forests, grasses, shrubs, meadows, and bogs. The higher elevations are characterized by alpine tundra.

FIGURE 3.4

MT. KLAPPAN COAL PROPERTY

PROPERTY GEOGRAPHY



LEGEND

++++ ++	PREPARED RAIL BED
-·-·-·-	PROVINCIAL PARK BOUNDARY
———	LICENCE AREA
------------	LICENCES UNDER APPLICATION
☆	CAMP LOCATIONS

SCALE

Ø 1 2 3 4 5km

GULF CANADA RESOURCES INC.
09/01/84

4.0 EXPLORATION HISTORY

4.1 Previous Exploration Work

V.H. Dupont made the first published description of coal in the Northern Bowser Basin in 1900 for the Canadian Department of Railways and Canals (Figure 4.1). In his report, he describes a coal outcrop near the confluence of Didene Creek and the Spatsizi River. This outcrop is now recognized as part of the Klappan coal occurrences.

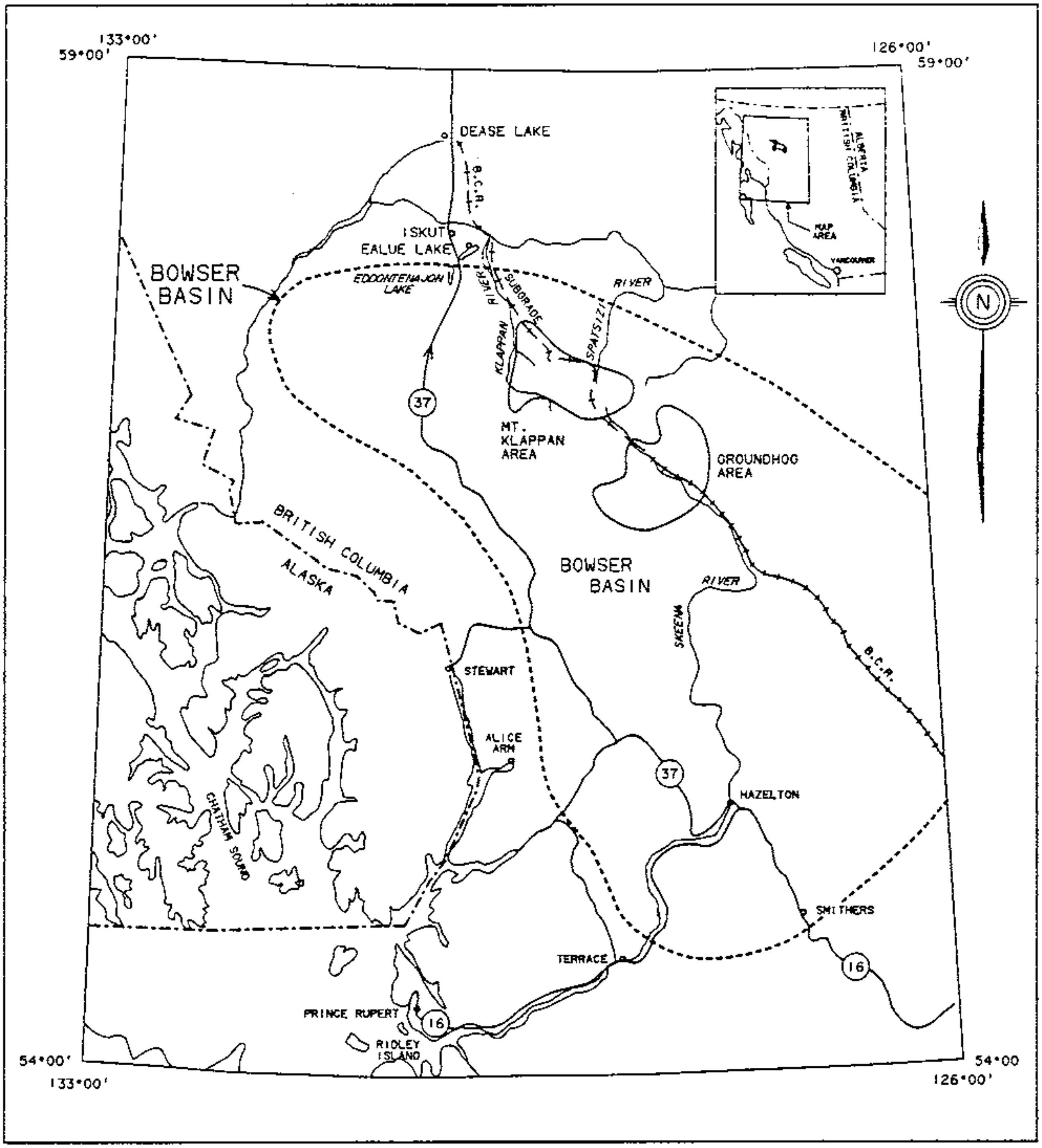
The Geological Survey of Canada has initiated five exploration programs into the area. The first, in 1911, was led by G.S. Malloch (Malloch, 1914) who undertook a geological evaluation of the Bowser Basin concentrating 55 miles to the south of Mount Klappan in the Groundhog Coal Measures. The second, in 1948, was led by Buckham and Latour (Buckham and Latour, 1950) which also concentrated in the Groundhog area. The third study in 1957 was called "Operation Stikine". The fourth and fifth programs, which broadly covered the Klappan Coal Measures, were led by Eisbacher in 1974 and in 1981. These studies resulted in some of the first stratigraphic and structural studies of the area. In addition, Eisbacher tried to broadly relate the depositional history of the Bowser Basin to the tectonic history of the area.

In 1979, Richards and Gilchrist from the B.C. Department of Mines published broad stratigraphic studies primarily in the

FIGURE 4.1

MT. KLAPPAN COAL PROPERTY

BOWSER BASIN



LEGEND	SCALE	
-------- BOWSER BASIN	0 20 40 MILES	GULF CANADA RESOURCES INC. 02/02/84

Groundhog area. However, they also included reference to the coal sequences of the Northern Bowser Basin.

Further interest in the Klappan coal occurrences during the late 1970's resulted in both Esso Minerals and Petrofina acquiring licences in the area. These licences were allowed to lapse in 1980 following minimal geological exploration of the area.

Initially, Gulf entered the Bowser Basin in 1979 concentrating in the Panorama-Groundhog Coal Measures. This was followed in 1981 by the acquisition of the Mount Klappan Property.

4.2 1981 Exploration Program

4.2.1 Methodology

The methodology of the 1981 program revolved around the mapping, trenching and sampling of exposed coal seams to determine their stratigraphic position; to construct a geological map; to delineate areas of potentially surface-mineable resources; and to select sites for a future drilling program.

4.2.2 Mapping

Mapping of Property was undertaken on Government 1:50 000 maps enlarged to 1:10 000 and 1:10 000 orthophotographs.

4.2.3 Trenching

Hand trenching, carried out under the supervision of a geologist, resulted in 24 trenches being dug. The objective of trenching was to fully expose those coal seams that were believed to exceed a minimum thickness of 0.5 metres.

4.2.4 Coal Quality

The Mount Klappan coal was shown to be an anthracite, based on reflectance measurements.

4.3 1982 Exploration Program

4.3.1 Methodology

Exploration on the Property for 1982 was carried out in two phases. Phase I, from June to July, was directed towards the mapping and trenching of the licences of the eastern mapping blocks. Phase II, from July to early September, concentrated on geologically mapping the western mapping blocks. Other studies included a structural and depositional environment assessment of the Property.

In addition, seven diamond drill holes were completed on the Property on sites defined by the first phase of work.

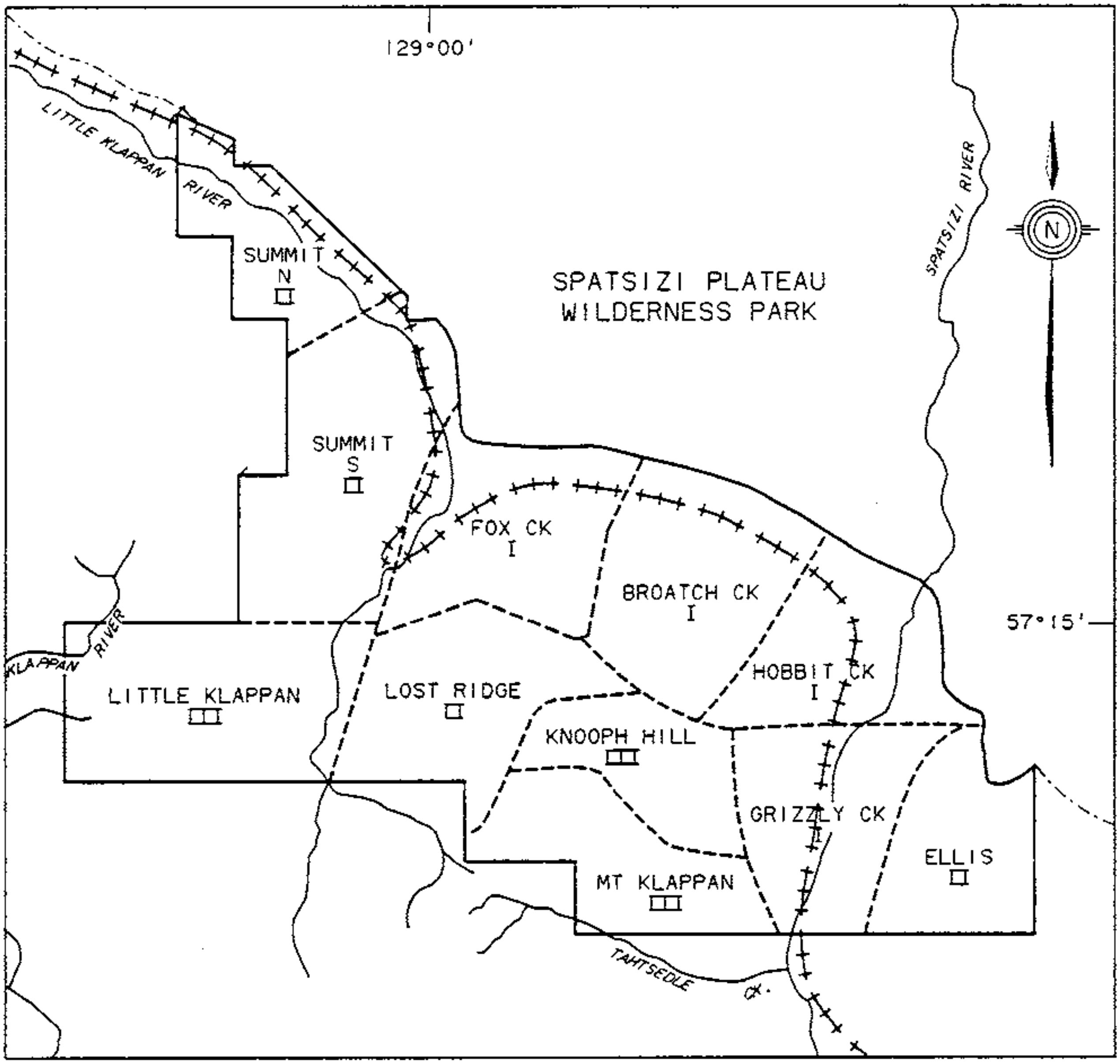
4.3.2 Mapping

The 1982 mapping program was accomplished at a scale of 1:10 000 and revolved around four two-man crews, consisting of a geologist and a geological assistant. Each crew was assigned specific mapping blocks out of a total of eleven blocks within the Property (Figure 4.2). All crews were supported by four-wheel drive trucks and a Hughes 500-D helicopter. The mapping method consisted of a modified plane table method in order to control traverse station positions. All traverses tied into known topographic points on one or more of the 213 control points. Control points included distinctive physiographic features, outcrop patterns, and

FIGURE 4.2

MT. KLAPPAN COAL PROPERTY

1982 EXPLORATION MAPPING AREAS



LEGEND

———	LICENCE AREA
+++ +++	PREPARED RAIL BED
—·—·—	PROVINCIAL PARK BOUNDARY
I	FIRST PRIORITY
II	SECOND PRIORITY
III	THIRD PRIORITY

SCALE

0 1 2 3 km

GULF CANADA RESOURCES INC.
09/01/84

lone trees or shrubs having the positions determined photogrammetrically and plotted on 1:10 000 map sheets.

In areas of good outcrop, sections were measured by mapping teams. They were then drafted to a scale of 1:200.

4.3.3 Trenching

All seams were trenched wherever spoil indicated the possibility of a seam in excess of 1 metre in true thickness. This resulted in 50 trenches being excavated by hand, logged and sampled by geologists during the 1982 program.

Trenches were described in detail and measured in true thickness. They were then surveyed in by chain and compass and plotted on the 1:10 000 base maps.

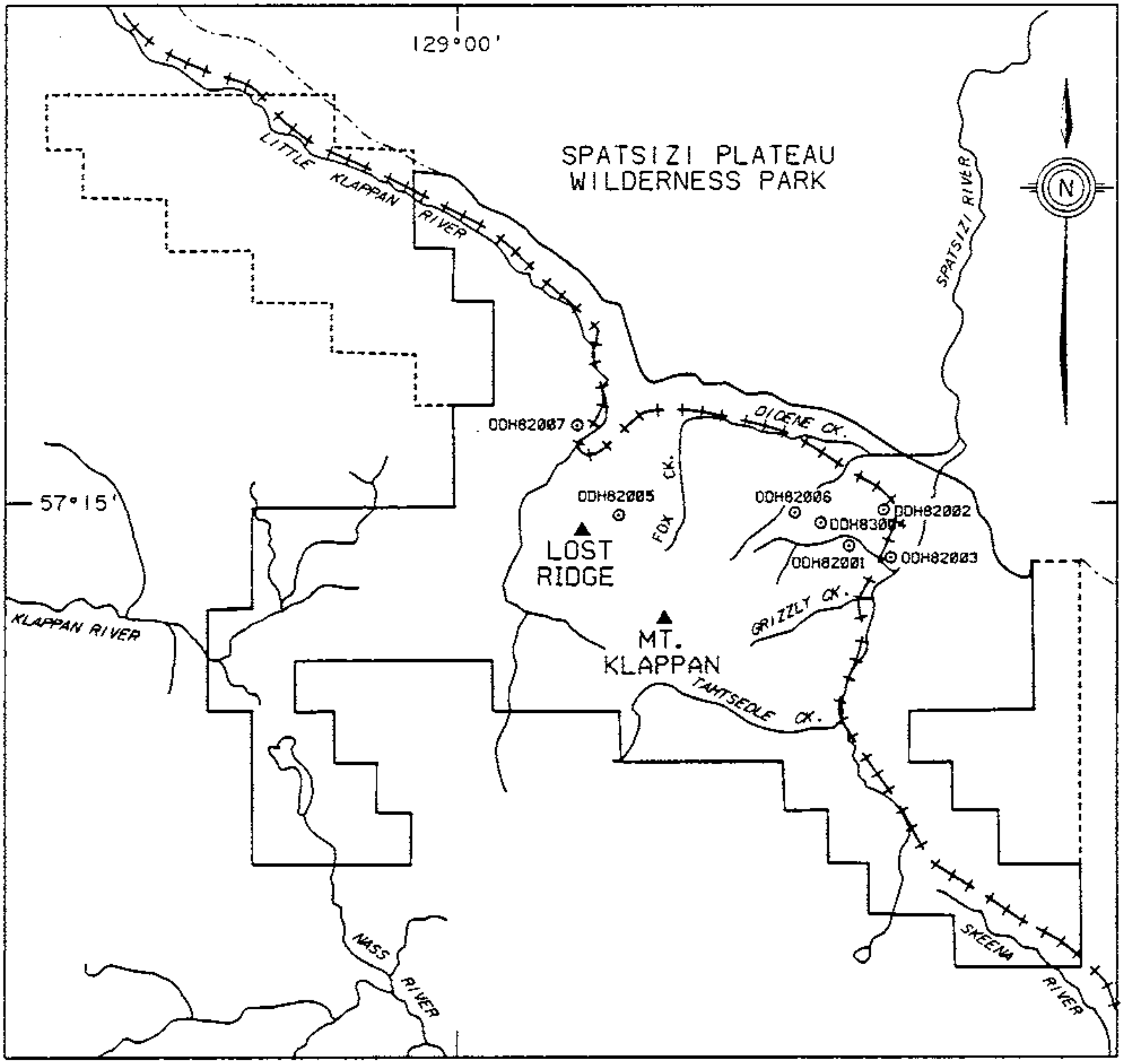
4.3.4 Diamond Drilling

The 1982 drilling program, totalling 1223 metres of drilling, consisted of 7 holes being drilled in a 33-day period (Figure 4.3 & Table 4.1). A Longyear Super 38 diamond drill was utilized since it was capable of being broken down for transportation by a Hughes 500-D helicopter from site to site. All drill holes were surveyed in by chain and compass and geophysically logged (except DDH82001) with a full suite of logs at a general scale of 1:200. Detailed logs were produced at a scale of 1:40 over the coal seams utilizing density, resistivity, gamma ray and caliper responses.

FIGURE 4.3

MT. KLAPPAN COAL PROPERTY

1982 DIAMOND DRILL HOLES



LEGEND

++++ ++++	PREPARED RAIL BED
— - — - —	PROVINCIAL PARK BOUNDARY
⊙	HQ DIAMOND DRILL HOLE - 1982
————	LICENCE AREA
------------	LICENCES UNDER APPLICATION

SCALE

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TABLE 4.1
GULF CANADA RESOURCES INC. - COAL DIVISION
15/NOV/82 PROJECT DATA SOURCE SUMMARY

DATA SOURCE	AREA	LOCATION NORTHING EASTING	ELEVATION (m)	LENGTH (m)	ANGLE	AZIMUTH	GEOPHYSICAL LOGS
KPNHCDDH82001	Hobbit Creek	N 6343645.00 E 514375.00	1400.00	124.10	90.0	0	Not logged
KPNHCDDH82002	Hobbit Creek	N 6345134.00 E 515445.00	1342.00	179.00	90.0	0	Open Hole
KPNHCDDH82003	Hobbit Creek	N 6343325.00 E 515540.00	1271.00	215.50	90.0	0	Open Hole
KPNBCDDH82004	Broatch Creek	N 6344510.00 E 513515.00	1470.00	157.60	60.0	40.0	Thru Rods
KPNLRDDH82005	Lost Ridge	N 6344340.00 E 506120.00	1815.00	243.60	60.0	55.0	Thru Rods
KPNBCDDH82006	Broatch Creek	N 6344865.00 E 512650.00	1489.00	173.00	60.0	345.0	Open Hole
KPNSSDDH82007	Summit South	N 6347475.00 E 504420.00	1315.00	130.20	70.0	5.0	Mostly Open Hole

4.3.5 Coal Quality

The results of the 1982 program again indicated that the Mount Klappan Property was underlain by anthracite that could be washed to produce a variety of product coals. A more detailed description is given in Section 4.4.2.

4.4 Results of Exploration 1982

4.4.1 Resources

The 1982 exploration program determined that the Mount Klappan Property has an exploration resource potential of 3 billion tonnes. Of this total, 890 million tonnes are classified as inferred, 1.2 billion tonnes as speculative. The remaining resource of over 1 billion tonnes is defined as a potential resource. The inferred resource is contained within the Hobbit-Broatch, Lost-Fox and Summit Resource areas which together cover only 15% of the Property. The Hobbit-Broatch area is the largest with 620 million tonnes, and is followed by the Lost-Fox area with 240 million tonnes. The Summit area is the smallest with 30 million tonnes.

4.4.2 Coal Quality

The Mount Klappan Property is underlain by anthracite which can be washed to produce a variety of product coals. These products range from low ash anthracites of 5-6% and 9-11% ash to briquetting coals with 20% ash. All products are low in sulphur with values ranging from 0.40% to 0.60%.

The premium coals can be washed to produce ash levels from 5-6% and having calorific values of 7,800 calories per gram (Appendix IV, Volumes III and IV).

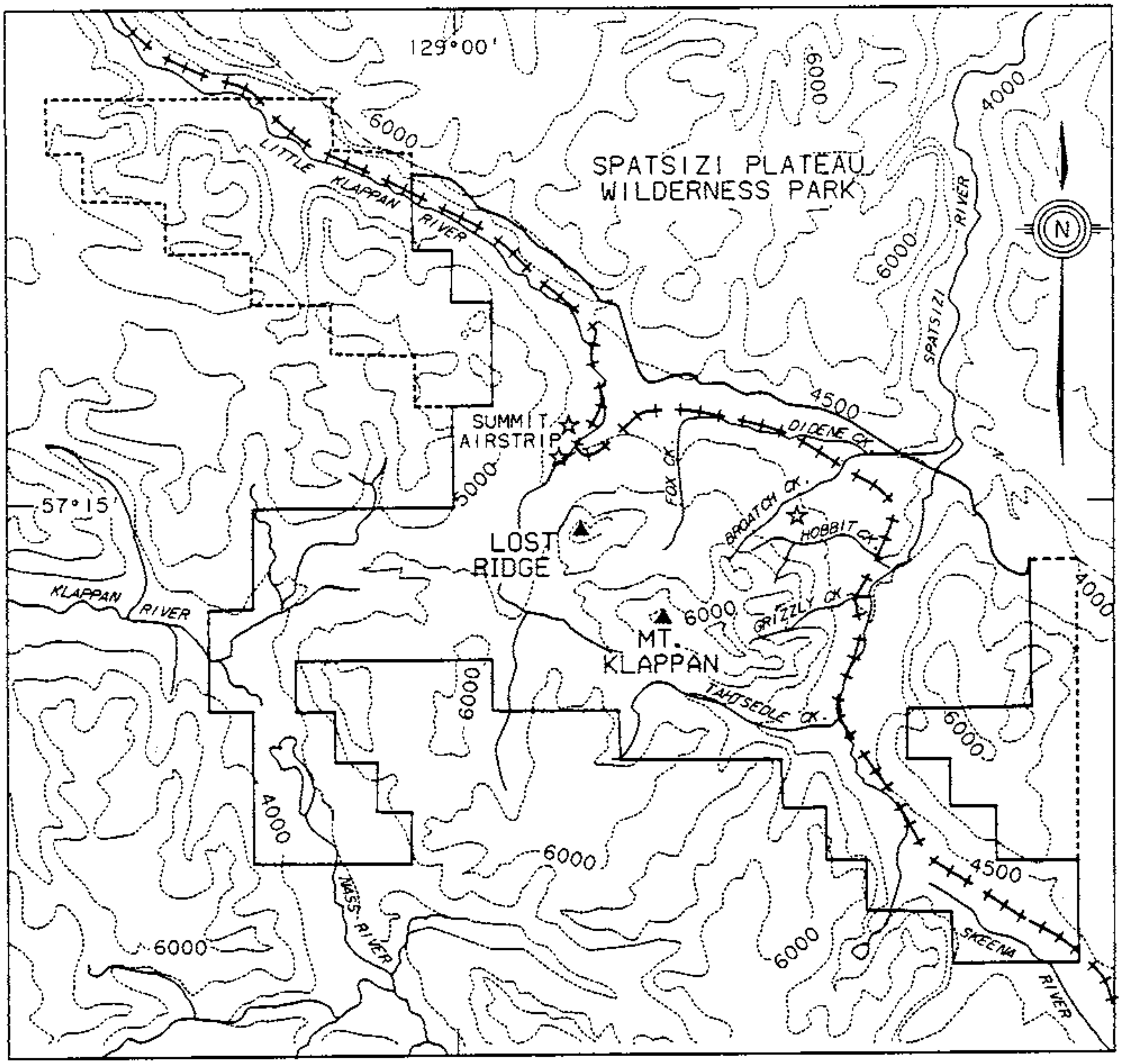
5.0 1983 EXPLORATION PROGRAM

The greatest portion of the 1983 program was directed towards the areas located outside of the Hobbit-Broatch area. This included the areas drained by Tahtsedle Creek, Grizzly Creek, and the Little Klappan, Klappan, Skeena, Spatsizi, and Nass Rivers (Figure 5.1). The greatest concentration of work was in the Lost-Fox area where one diamond hole, six Winkie holes and one adit were completed. The duration of the program was from May 1983 to March 1984, a total of 11 months. Of this period, mid-June to mid-October were spent in the field. The remaining five months were divided between field preparation, data compilation, evaluation, and report writing.

FIGURE 5.1

MT. KLAPPAN COAL PROPERTY

EXPLORATION INFRASTRUCTURE CAMP LOCATIONS



LEGEND

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- LICENCES UNDER APPLICATION
- ☆ CAMP LOCATIONS

SCALE

Ø 1 2 3 4 5km

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02/02/84

5.1 Program Objectives and Methodology

5.1.1 Objectives

The objectives of the 1983 exploration program were as follows:

1) To geologically map the Property in priority sequence at a 1:5 000 scale and 1:10 000 scale.

2) To define structures containing surface mineable coal other than in the Hobbit-Broatch Area.

3) To delineate the quality and size distribution of the Mt. Klappan coal.

5.1.2 Methodology

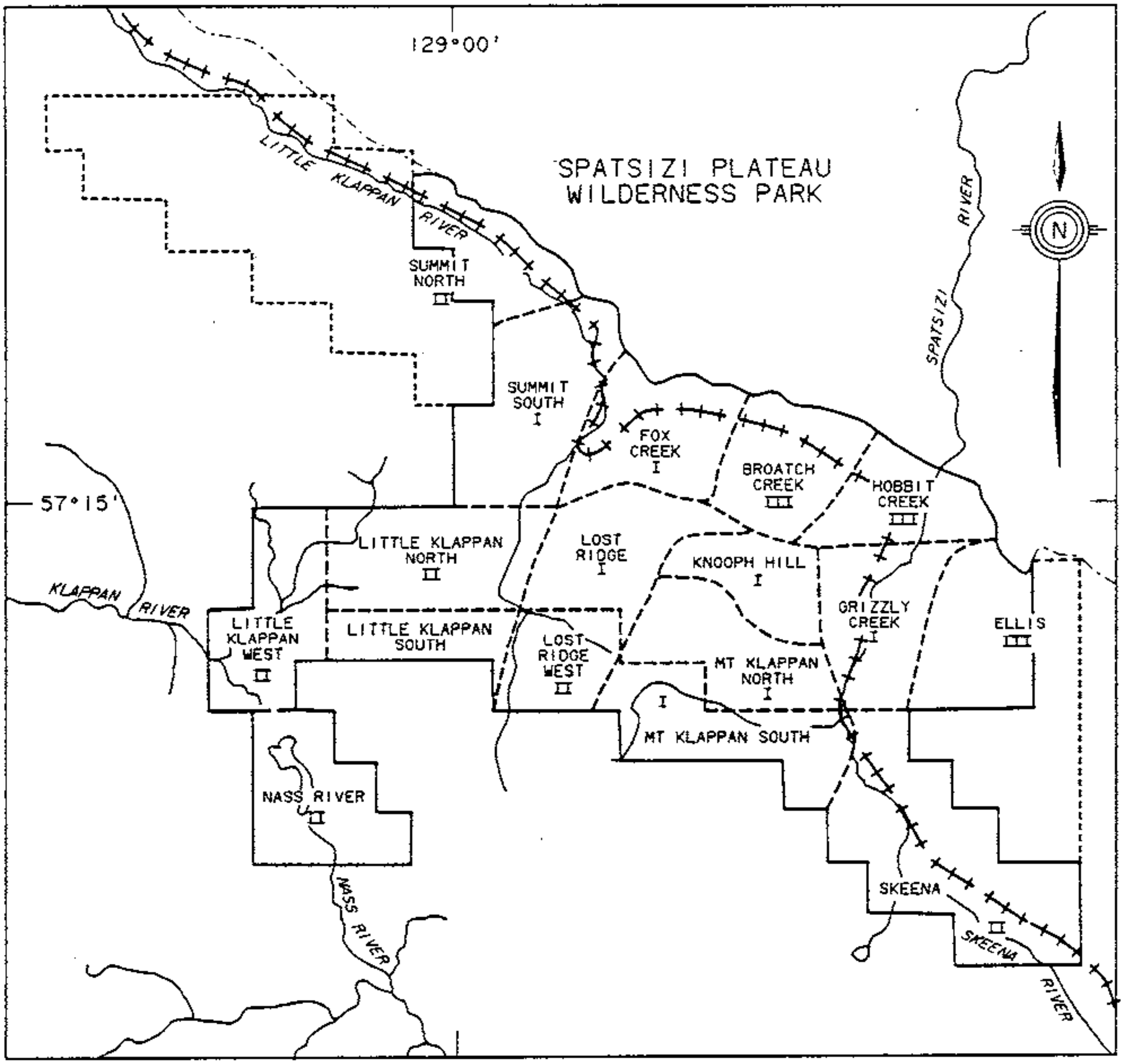
To accomplish the objectives outlined in Section 5.1.1, an exploration program was designed in the spring of 1983. This program consisted of detailed geological mapping, trenching, diamond drilling and the driving of one adit.

Objectives 1 and 2 were accomplished by dividing the Property into 5 five main segments consisting of 18 mapping blocks and subsequently mapping them in priority sequence (Figure 5.2). Objective 3 was accomplished by the driving of one adit in order to remove a 37-tonne bulk sample. The bulk sample was extracted from the I seam on Lost Ridge.

FIGURE 5.2

MT. KLAPPAN COAL PROPERTY

1983 EXPLORATION MAPPING AREAS



LEGEND

+++ +++	PREPARED RAIL BED
-·-·-·-	PROVINCIAL PARK BOUNDARY
———	LICENCE AREA
-------	LICENCES UNDER APPLICATION
I	FIRST PRIORITY
II	SECOND PRIORITY
III	THIRD PRIORITY

SCALE

0 1 2 3 km

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5.2 Cartography

The majority of the topographic maps used for geological interpretation were at 1:5 000 scale. These maps were produced from 1:30 000 aerial photographs taken in the fall of 1982. All diamond drill hole locations were based on chain and compass surveys from known points.

The remaining areas lacking 1:5 000 topographic map coverage were geologically mapped on specially prepared 1:10 000 scale maps having a contour interval of 100 feet.

5.3 Logistics

5.3.1 Field Camp

The 1983 field camp setup was completed by June 23 and was located on a previously cleared B.C.R. campsite. The exact location of the site was at the joining of the Little Klappan River and the B.C.R. sub-grade (UTM N6346900, E504360) (Figure 5.1). The camp consisted of 24 tents for personnel, office, cooking, eating, and storage facilities. In addition, one Chevrolet pickup truck was used throughout the duration of the program. The total exploration and support staff averaged from 15 to 25 people for the duration of the program.

All geological, camp equipment, truck, supplies and personnel were mobilized from Smithers to the Summit airstrip on the Mount Klappan Property. Transportation was provided by DHC-4 Dehavilland Caribou aircraft.

A second totally self-contained camp was established on the west end of the Summit airstrip to accommodate the diamond drilling crew, followed later by the adit crew. In total, it housed from five diamond drillers to 10 adit crew members and a cook.

The Gulf camp was demobilized in stages from August to October of 1983. The adit and drill camp were demobilized during late October of 1983.

5.3.2 Mapping and Drilling Support

The mapping and drilling programs were supported by a four-wheel drive truck and a Hughes 500-D helicopter. Road access to the eastern half of the Property was via the British Columbia Railway sub-grade with the remaining portions accessed by the Hughes 500-D helicopter.

5.4 Geological Mapping

The 1983 exploration program involved the detailed mapping of the Property at 1:5 000 and 1:10 000 scales (Geology Maps, Appendix II, Volume I). This was accomplished by dividing the Property into 5 segments comprising 18 mapping blocks with each block given a priority I to III. It was further sub-divided between four mapping teams with each mapping team consisting of one geologist and one geological assistant. All crews reached their traverse points by a Hughes 500-D helicopter or by truck. Mapping in the field was accomplished by a modified plane table method as described in Section 4.3.2.

The Priority I areas were mapped from June to the end of July. These blocks included Summit South, Lost-Fox, Knooph Hill, Grizzly Creek, and Mount Klappan North and South.

Priority II areas consisted of the following: Summit North, Little Klappan North, South and West; Nass River; and the Skeena blocks.

An unusually wet summer hampered mapping operations and, as a result, only one Priority III area, the Ellis block, was mapped.

Data obtained in the field from drill holes and trenches was entered into an on-site database system compatible with Gulf's in-house system. This information was then transferred to the main data base in the Calgary head office.

5.5 Trenching

Ninety-three (93) trenches were excavated by hand, logged and sampled during the 1983 exploration program. All seams within the mapping blocks were trenched wherever spoil indicated the possibility of a seam thickness greater than 1.0 metre in true thickness. Trenching crews consisted of a two-man team under the supervision of the geologist responsible for the mapping block.

The trenches averaged 0.8 metres in width, 1.0 metres in depth and 5.7 metres in length. In total, 338.99 metres of trenching was completed of which 100.95 metres were sampled. All trenched seams were measured in true thickness and described in detail. Locations of the trenches were surveyed in by the chain and compass method, and plotted on 1:5 000 and 1:10 000 base maps (Appendix III).

5.6 Diamond Drilling

A Longyear Super 38 diamond drill, capable of being broken down for transportation by a Hughes 500-D helicopter, was utilized for the drilling. The rig was mobilized to the Summit airstrip from Dease Lake in the Caribou aircraft and then airlifted by helicopter to the drill sites. The drill rig, which has a vertical depth capacity of over 360 metres, was adequate for the program requirements which did not exceed 300 metres in any one hole.

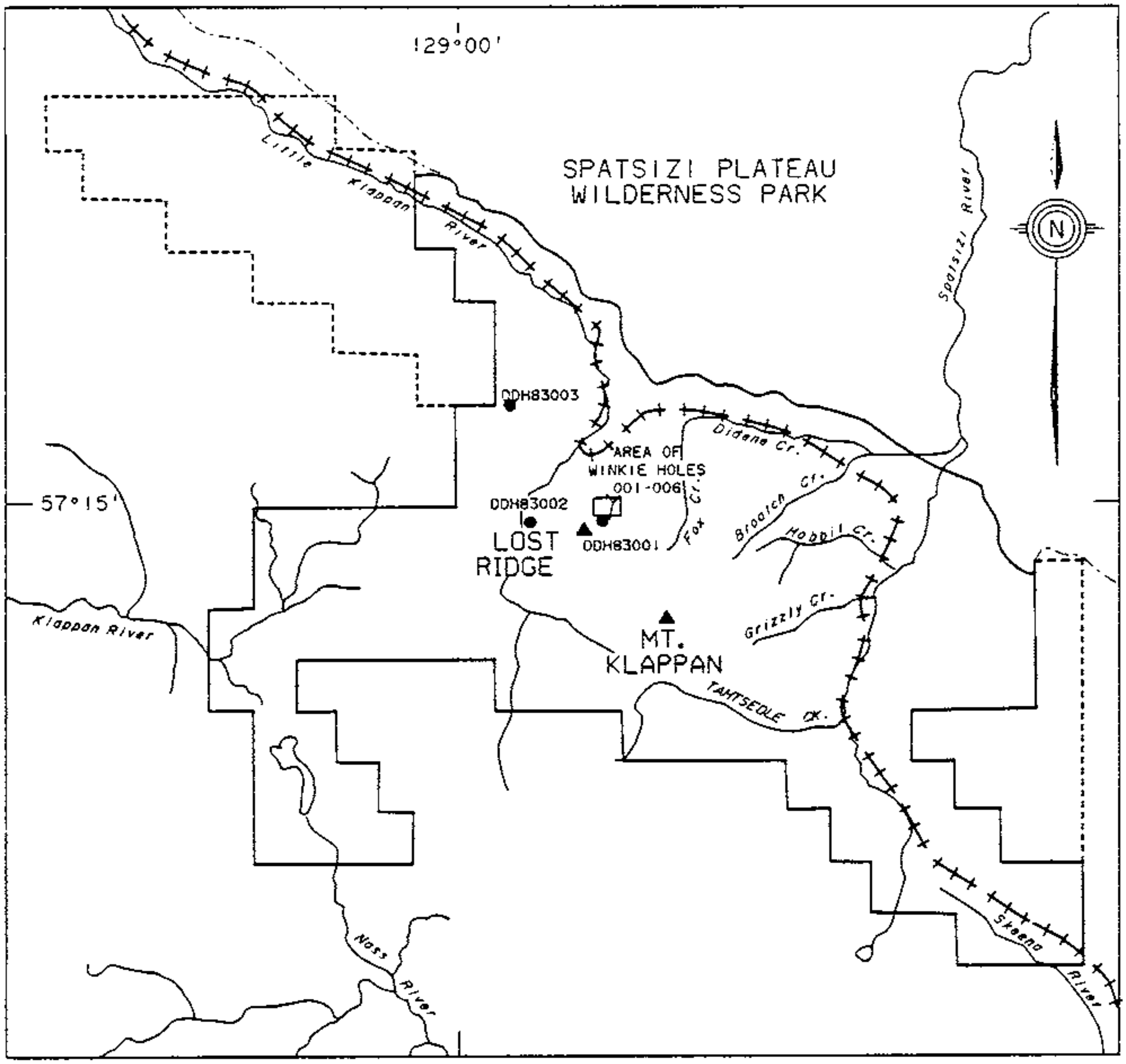
A total of 603.25 metres of drilling in 3 holes was completed in a 22-day period (Figure 5.3). The rig was operated on a two-shift, 24-hour-a-day basis with a driller and a helper on each shift. Table 5.1 summarizes the results of the program. All drill holes have been surveyed in by chain and compass, and appear on all appropriate geological maps and cross-sections (Appendix III and Appendix IV, Volumes I-III).

At the completion of the drilling program, the drill rig was airlifted to the Summit airstrip where it was prepared for winter storage.

FIGURE 5.3

MT. KLAPPAN COAL PROPERTY

1983 DRILL HOLES



LEGEND

┼┼┼ ┼┼	PREPARED RAIL BED
—·—·—·—	PROVINCIAL PARK BOUNDARY
●	HQ DIAMOND DRILL HOLE - 1983
□	AIX WINKIE HOLES - 1983 001-006
≻—	ADIT 1983
———	LICENCE AREA
- - - - - -	LICENCES UNDER APPLICATION

SCALE

0 1 2 3 4 5 km

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09/01/84

TABLE 5.1 DIAMOND HOLES
GULF CANADA RESOURCES INC. - COAL DIVISION
PROJECT DATA SOURCE SUMMARY

DATA SOURCE	AREA	LOCATION NORTHING EASTING	ELEVATION (m)	LENGTH (m)	ANGLE	AZIMUTH	GEOPHYSICAL LOGS
KPNLRDDH83001	Lost-Fox	N 6344261.00 E 505704.00	1841.00	299.40	90.0	0	Thru Rods
KPNLKDDH83002	Little Klappan	N 6342845.00 E 503090.00	1484.00	111.25	90.0	0	Open Hole
KPNSSDDH83003	Summit	N 6349585.00 E 501657.00	1825.00	192.60	60.0	230.0	Thru Rods

5.7 Winkie Drilling

A Winkie diamond drilling program was undertaken to precisely determine the location of the adit. In total, six Winkie holes were drilled in the vicinity of Lost Ridge for this purpose. Four of the six holes were spudded on top of Lost Ridge and two were situated on the overturned limb of the Lost Ridge Anticline (Appendix IV, Volumes I, II and III).

A total of 126.84 metres of drilling in the six holes were completed in a 20-day period. The rig was operated by a two-man crew, 10-12 hrs. per day, weather permitting. All drill holes were surveyed in by chain and compass (see Figure 5.3 and Table 5.2 for locations and a summary of the Winkie drilling).

At the completion of the drill program, the drill was airlifted to the Summit airstrip. From here, it was transported by a fixed-wing Beach 18 aircraft to Smithers, B.C.

It should be noted that although the Winkie drill completed its objective of determining continuity of the I seam, it has limited use in the area of geological coal exploration.

TABLE 5.2 WINKIE DIAMOND HOLES
GULF CANADA RESOURCES INC. - COAL DIVISION
PROJECT DATA SOURCE SUMMARY

DATA SOURCE	AREA	LOCATION NORTHING EASTING	ELEVATION (m)	LENGTH (m)	ANGLE	AZIMUTH	COMPLETION
KPNLRWKD83001	Lost Ridge	N 6344339.00 E 505758.00	1827.00	7.01	90.0	0	Lost Hole
KPNLRWKD83002	Lost Ridge	N 6344340.00 E 505758.00	1827.00	17.22	90.0	0	Completed
KPNLRWKD83003	Lost Ridge	N 6344324.00 E 505758.00	1832.00	21.00	90.0	0	Completed
KPNLRWKD83004	Lost Ridge	N 6344334.00 E 505816.00	1824.00	30.93	90.0	0	Completed
KPNLRWKD83005	Lost Ridge Overturned Limb	N 6344670.00 E 504620.00	1670.00	29.87	90.0	0	Lost Hole
KPNLRWKD83006	Lost Ridge Overturned Limb	N 6344675.00 E 504625.00	1675.00	19.81	70.0	205.0	Lost Hole

5.8 Geophysical Logging

All diamond drill holes were geophysically logged at a general scale of 1:200. Detailed logs were produced at a scale of 1:40 over the coal seams utilizing the density - resistivity, gamma ray and caliper responses. A digital geophysical logging system was employed with the information from probe readings being recorded directly onto magnetic tape. Paper prints of the logs were produced in the field to assist in core logging and correlation. Appendix IV, Volume II contains a complete set of geophysical logs.

The following is a list of the full suite of logs run during the program:

a) Gamma Ray
b) Neutron
c) Sidewall Density
d) Focused Beam Resistivity
e) Caliper
f) Direction Deviation

5.9 Drill Core Logging and Sampling

The drill core was logged and sampled by Gulf geologists who described the following parameters in detail: basic lithologies, fossil occurrences, sedimentary structures, stratigraphic marker beds, and any structural features such as larger scale folds and faults. The bedding to core angle (BCA), the angle between bedding and a line parallel to the core axis, was recorded for use in determining the true thickness of the strata intersected. The descriptive drill logs and a list of abbreviations used are found in Appendix IV, Volume II.

Coal core logging was based upon the percentage of the coal maceral vitrain (bright coal) contained within a measured unit of core, and upon any rock splits found contained within the coal. The following is a breakdown of the coal core description:

Bright	>80%	Vitrain	C-1
Bright Banded	60 - 80%	"	C-2
Dull/Bright	40 - 60%	"	C-3
Dull Banded	20 - 40%	"	C-4
Dull	<20%	"	C-5
Bone or Stone	0%	"	C-6

All coal core in excess of 0.5 metres apparent thickness, was sampled and sent to laboratories for detailed coal quality and washability tests. Samples were selected on the basis of geophysical log traces, cross-matched with the written log. Samples were taken in intervals small enough to assist in later sample compositing. Rock samples were taken of the main lithologies in each drill hole for further analysis. Whenever possible, the core was photographed prior to sampling.

Strip logs illustrating the core description as drilled and as corrected to true thickness were drafted at a scale of 1:200 (See Appendix IV, Volume II). A sample summary for each drill hole is also found in Appendix IV, Volume II. The core was stacked at the campsite and covered to protect it against rain and snow.

5.10 Drill Core and Trench Sample Analysis

All drill core coal samples were submitted for preliminary analysis to an independent laboratory. The coal samples were subjected to detailed washability studies from which a variety of product coals were produced. Each product coal then underwent extensive analytical testing (see Appendix IV, Volumes I and II).

5.11 Adit 83001

The adit drivage and bulk sampling program was undertaken during the months of September and October. Supervision was by G.C.R.I. Coal Division personnel and J. Perry of Coal-Ex Consulting Ltd.

Preliminary work to determine the adit site was undertaken during July by using a Winkie diamond drill rig. A total of six Winkie holes were drilled into the I seam to determine the best location for the adit.

The adit was driven into seam I on the northwesterly face of Lost Ridge approximately 232 metres from DDH82-005 and 136 metres from DDH83-001 (Figure 5.3). Access to the adit site is only by helicopter at this time. The coordinates and elevations for the portal are given below:

Adit 83-001		Location	Elevation
	UTM	N 6344350	1800 m
		E 5058555	

The adit construction and drivage was carried out by Target Tunneling Ltd. of Strathmore, Alberta.

Mobilization of the required adit equipment and personnel began on August 29th and was completed by September 1st. All equipment was mobilized from Calgary, Alberta and Smithers, B.C. to Dease Lake, B.C. From here, it was flown by fixed wing DHC 4 Dehavilland Caribou aircraft to the Summit Airstrip on the Mount Klappan Property.

Portal construction began on September 2nd and was completed by September 9th. Drivage of the adit was to a depth of 50 metres and was completed by October 14th. At this point, a 37-tonne sample was removed using 200-45 gallon steel drums which were airlifted to the Summit Airstrip. From there, it was flown by Beach 18 fixed wing aircraft to the Barrage, B.C., Airstrip located on Highway 37 west of the Klappan Property. At this point, the barrels were loaded onto trucks and shipped to Birtley Coal and Minerals Testing. For a more detailed description, see Appendix IV, Volume IV.

5.12 Data Management

During the 1983 field season, a HP 9816 computer was used in the field for budget purposes and for the storage of trench and drill hole data. This data was then transferred in Calgary to Gulf's Coal Data Base. All data stored to date in Calgary is on Gulf's AMDAHL V6 computer. The data stored includes all drill core descriptions, detailed records of each drill hole and trench, complete descriptions of all samples collected and all coal quality and washability data. The coal database utilizes the System 2000 database management system and Act 1 software to provide easy on-line data entry and screen retrieval of stored data.

5.13 Reclamation

The drilling program, undertaken with helicopter support, resulted in minor disturbance to the three diamond drill sites and six Winkie sites, as virtually no clearing of sub-alpine trees and shrubs was required for site preparation. All equipment and garbage has been removed from the sites. Coal seam hand trenches remain open for further inspection with back-filling to be undertaken at a later date.

The camp area utilized a pre-existing B.C.R. campsite. All camp equipment and most field equipment has been shipped to Smithers for winter storage, although some materials have been stored inside the B.C.R. communication trailers on the Property. All garbage has been removed from both campsites.

5.14 Special Projects

5.14.1 Depositional Environments

In early July and in mid-August, two sedimentologists from Gulf Canada's Geological Services Department visited the Mount Klappan Property for two weeks and one week, respectively. The purpose of their visit was to continue studies which would lead to a paleoenvironmental interpretation of the Mount Klappan Property. Outcrops and drill core were reviewed and sampled with special attention paid to sedimentary structures, fossil content and lithologic relationships. Samples were obtained for petrologic studies and for micro and macro fossil identification.

5.14.2 Regional Structure

Gulf has sponsored the first and second year's field work for a Ph.D thesis on the regional structure of the northern Bowser Basin. The Ph.D candidate, Ian Moffat, is working under the supervision of the Geology Department of the University of British Columbia.

5.15 Project Management and Contractors

The 1983 exploration program was managed by B. P. Flynn of Gulf Canada Resources Inc. Field operations were supervised by C. S. Williams and G. E. Seve, while the adit drivage was supervised by J. Perry of Coal-Ex Consulting Ltd., and J. Innis. Coal quality analysis results were interpreted by J. Innis with assistance from K. Fujita of Norwest Resource Consultants Ltd. Coal petrology studies were performed by D. E. Pearson & Associates Ltd.

The following additional professional and technical personnel contributed to the Mount Klappan Coal Project:

C. S. Williams	Project Geologist
G. E. Seve	Assistant Project Geologist
J. Innis	Senior Geologist
S. McKenzie	Geologist
K. Jenner	"
J. Elder	"
R. Maylor	Geological Assistant
S. Fawcett	" "
D. May	" "
C. Nogas	" "
H. Dameron	Helicopter Pilot
D. Zutter	" "
L. Scarbo	Geophysical Engineer
W. Hawthorne	Cook
O. Dodd	"

S. McClement	First Aid Attendant
B. Peterson	" " "
D. Durant	Field Accountants & Computer
P. Tsavalos	Operators

The following is a list of the service companies and suppliers used during the project:

Services

Canadian Marconi Co.	Calgary
West Can Electronics Services Ltd.	Calgary
Camday Leasing	Calgary
Trans-Provincial Airlines	Prince Rupert
M. R. Rentals	Smithers
Aero Expediting	Smithers
Hudson Bay Motel	Smithers
Glacier Helicopters	Smithers
Northern Thunderbird	Prince George
Highland Helicopters Ltd.	Smithers
Bulkley Valley Cleaners	Smithers
David E. Pearson & Associates Ltd.	Victoria
Cyclone Engineering Sales Ltd.	Edmonton
Canadian Freightways	Calgary
Central Mountain Air Services	Smithers
J. T. Thomas Diamond Drilling Ltd.	Smithers
Birtley Coal & Minerals Testing	Calgary
Commercial Testing	Golden, Colo.
Coors Spectrol-Chemical	Golden, Colo.
Target Tunnelling Ltd.	Strathmore
Teck Corporation	Vancouver

Suppliers

Economy Bookbindery Co. Ltd.	Calgary
Neville Crosby	Vancouver
Smithers Hardware	Smithers
Grove Rentals	Edmonton
Supervalue Stores	Smithers
Canadian Propane Gas & Oil	Smithers
Chevron Bulk Fuel & Services	Smithers
Alfar Industrial Supplies Ltd.	Smithers
Alpine Wiring & Plumbing Services	Smithers
Trac and Trail Equipment Ltd.	Smithers

Apollo Automotive Parts	Smithers
Dieterich Post (Alta.) Ltd.	Edmonton
Smithers Transport	Smithers
Smithers Lumber Yard Ltd.	Smithers
Bulkley Valley Wholesale Ltd.	Smithers
B. V. Freezer Meat Supply	Smithers
Shell Bulk Dealer	Smithers
O'Neill's Chevrolet Olds ltd.	Smithers
Park Ambulance	Calgary
Stikine Transport Ltd.	Smithers
Tenajon Motel	Eddontenajon
Northern Building Movers Ltd.	Smithers

6.0 GEOLOGY

6.1 Introduction

The 1983 program was designed to further define the resource base of the Lost-Fox Area as well as evaluate the potential for additional surface mineable deposits to occur on licences other than those comprising the Hobbit-Broatch and Lost-Fox Areas.

Additional drilling and interpretation of geologic data collected during detailed mapping of the Lost-Fox area, pointed to an overall thickness in excess of 900 metres for the Klappan Sequence. Further, the occurrence of coal over much of the section rendered the 1982 subdivision of the Klappan sediments, into an upper, middle and lower unit, somewhat meaningless. Hence in the 1983 report, differentiation of the Klappan Sequence is discontinued.

Exploration, while continuing to confirm the surface mineable resource base of the Lost-Fox Area, resulted in the discovery of two new areas; Summit in the north and Little Klappan in the west. While it is still too early to evaluate their true potential, the occurrence of seams in excess of 3 metres with head ashes in the high teens and low twenties, point to their being worthy of more detailed and concentrated effort.

6.2 Regional Geology

6.2.1 Geologic Setting

The coal measures of the Mount Klappan Property are contained within a series of sediments deposited in the Bowser Basin during middle Jurassic to early Cretaceous times. (Figure 6.1). The Bowser Basin conforms, in terms of its depositional setting, to the classical model of a "successor basin" (Eisbacher, 1974b, p. 274). The establishment of the Bowser Basin succeeded a period of eugeosynclinal marine volcanic activity and sedimentation. Uplift due to crustal collision from the west caused the basin to become at least partially enclosed and initiated a southwesterly progradation of coarse marine to non-marine deposits.

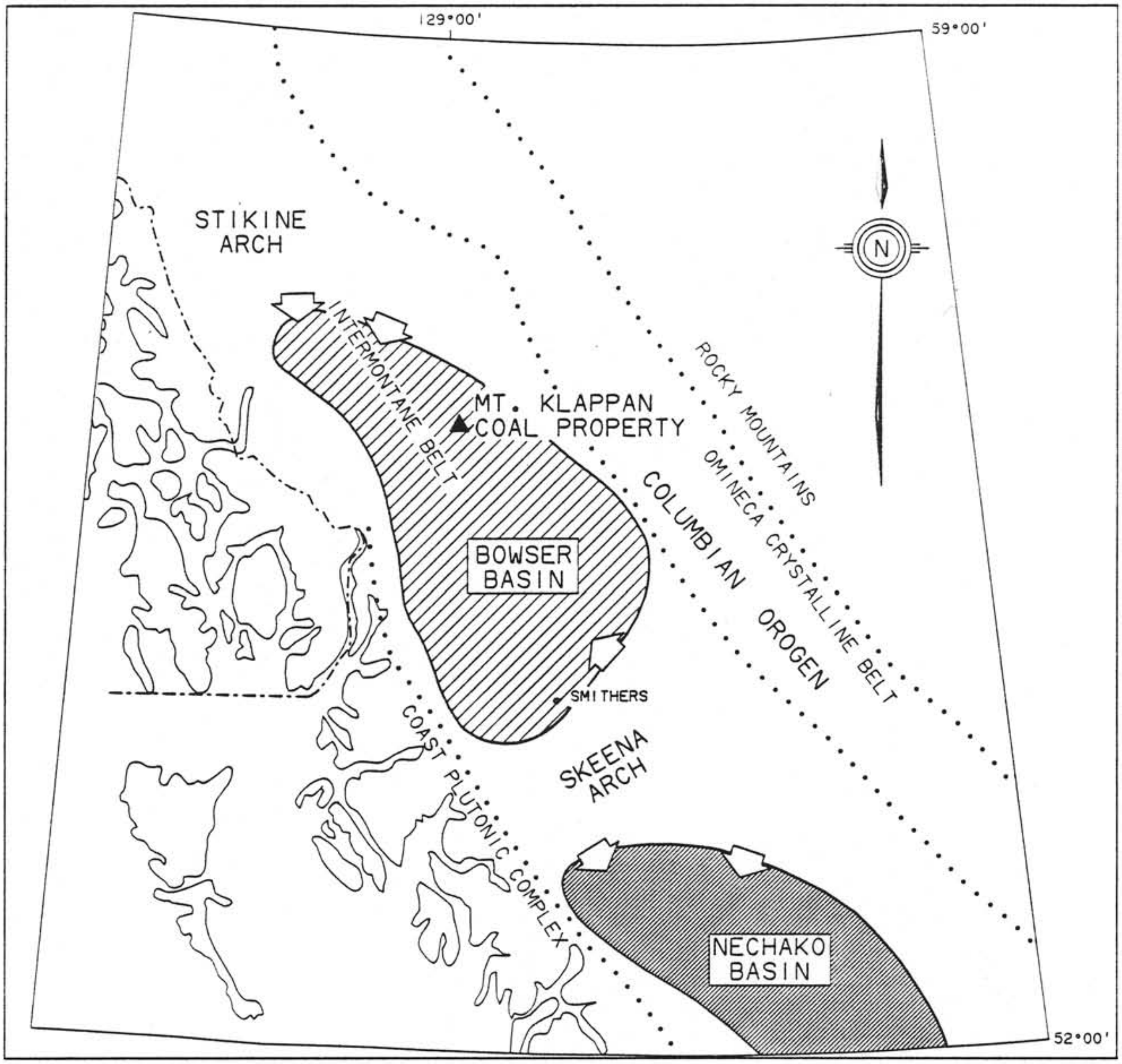
The Bowser Basin is bounded by the Stikine Arch to the north, in the area now occupied by the Stikine River; by the Skeena Arch to the south; and by the Columbia Orogen (Omineca Crystalline Belt) to the east (Figure 6.1). The western margin is thought to have been open to the sea at the time of Bowser sediment deposition. Paleocurrent measurements indicate a centripetal flow into the basin with material being drawn from the respective highlands to the north, south and east.

A progression through distal deltaic facies and turbidites, prodelta subsea fans, distal to proximal distributary

FIGURE 6.1

MT. KLAPPAN COAL PROPERTY

JURASSIC-CRETACEOUS BOWSER BASIN



LEGEND

BOWSER BASIN

NECHAKO BASIN

(AFTER TIPPER AND RICHARDS, 1976)

SCALE

0 100 200 km

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channels and finally to paralic coal swamps and alluvial fans is interpreted for the sedimentary environments of the Bowser Basin (Eisbacher, 1974b).

6.2.2 Regional Stratigraphy

In the southern portion, the assemblage contained within the Bowser Basin, has been subdivided into three groups by Tipper and Richards (1976). These groups, in ascending order are: the Early Jurassic to Middle Jurassic Hazelton Group; the Upper Jurassic Bowser Lake Group, and the Early Cretaceous Skeena Group. In the area discussed by Tipper and Richards (1976), the Skeena Group contains the major coal occurrences with some coal occurring at the top of the Bowser Lake Group.

In the Northern Bowser Basin, no such comprehensive work has been done, and the sedimentary package associated with the coal in the Klappan-Groundhog Area has been variously named: the Skeena Series (Malloch, 1914); Upper Hazelton (Buckham and Latour, 1950); Groundhog-Gunanoot (Eisbacher, 1974a), and has been dated as Lower Cretaceous (Malloch, 1914; Buckham and Latour, 1950) and Upper Jurassic to Lowest Cretaceous (Eisbacher, 1974a) (Table 6.1).

Gulf's geologists, until September 1982, adopted the name Skeena for the coal sequence of the Klappan-Groundhog Area because of the widespread use of this term in the southern part of the basin. At that time, lacking specific

TABLE 6.1

MT. KLAPPAN COAL PROPERTY

REGIONAL STRATIGRAPHY - TABLE OF FORMATIONS

AGE	SUBDIVISION OF AGE	GROUP	LITHOLOGY
TERTIARY	LOWER		QUARTZ PEBBLE CONGLOMERATE, TO PEBBLY SANDSTONE, SANDSTONE SUB QUARTZOSE FELDSPATHIC, DARK GREY TO REDDISH MUDSTONE, THIN COAL SEAMS, SHALE, AND ASH FALL TUFFS IN UPPER PORTION OF UNIT.
CRETACEOUS	UPPER		
	MIDDLE		
	LOWER	SKEENA	CHERT PEBBLE RICH;BROWN-GREY CONGLOMERATE, BLACK, BROWN, AND ORANGEY CLAYSTONE, SILICEOUS AND CLAYEY SANDSTONE, WITH SILTSTONE, CLAYSTONE AND COAL INTERBEDS. BASE OF UNIT DARK GREY TO BLACK TUFFS, TUFFACEOUS SANDSTONE AND CARBONACEOUS SHALE.
JURASSIC	UPPER	BOWSER BASIN	FELDSPATHIC TO QUARTZOSE SANDSTONE, DARK GREY TO BLACK SHALE, SILTSTONE, GREYWACKE, CHERT PEBBLE CONGLOMERATE AND MINOR COAL SEAMS.
	MIDDLE		
	LOWER	HAZELTON	REDDISH, PURPLE, GREY AND GREEN PYROCLASTIC AND FLOW VOLCANICS, WITH CALC-ALKALINE CHEMICAL AFFINITIES, REDDISH SANDSTONE, SILTSTONE, MUDSTONE, MINOR CONGLOMERATE, AND LIMESTONE AND THEIR TUFFACEOUS EQUIVALENTS.
TRIASSIC	UPPER	TAKLA	GREY-GREEN TO DARK GREEN FLOW AND PYROCLASTIC, BASALTIC AND ANDESITIC VOLCANIC ROCKS,PELITIC SEDIMENTARY ROCKS AND MINOR CARBONATE ROCKS.
	MIDDLE		

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fossil evidence to the contrary, Malloch's assignment of the name Skeena to the Lower Cretaceous was also accepted for the Klappan Area.

In the fall of 1982, micropaleontological evidence (Gulf Laboratory - personal communication) indicated a Jurassic to earliest Lower Cretaceous age for the Klappan sediments which would place these beds within the Bowser Lake Group as defined by Tipper and Richards (1976). Petrographic analyses further supported a possible Bowser Lake Group affiliation.

Additional fossil dating obtained by Gulf geologists in 1983, together with work undertaken by Moffat and Bustin, (in press) support an age of uppermost Middle Jurassic to early Late Jurassic. However, it should be noted that the fossil assemblage collected to date, reflects only the lower portion of the stratigraphic sequence contained within the Mount Klappan Property.

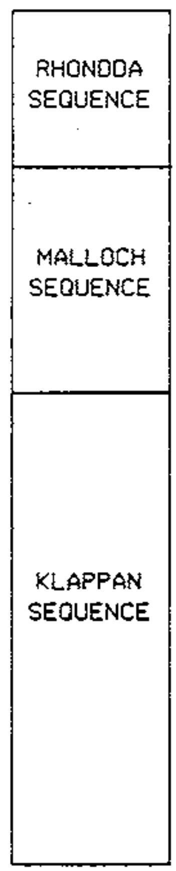
6.2.2.1 Klappan-Groundhog Area Stratigraphy

In the Klappan Area the Upper Jurassic to earliest Cretaceous sedimentary package is subdivided into three sequences, which in ascending order are, the Klappan, Malloch, and Rhondda Sequences, with the Klappan being the main coal-bearing unit (Figure 6.2). The subdivision is in many respects equivalent to the subdivision established in the Groundhog Area (Gulf

FIGURE 6.2

MT. KLAPPAN COAL PROPERTY

SCHEMATIC STRATIGRAPHIC COLUMN



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Canada Resources Inc. 1981 Panorama Geological Report). While the Malloch and Rhondda have been tentatively traced from the Klappan Area south to the Groundhog Area, correlation of the Klappan Sequence with the equivalent unit in the south is tenuous at best (Figure 6.3).

Although the Klappan and Groundhog Sequences may be found to be equivalent, differences in coal quality, thickness, and frequency, have resulted in the two units being treated separately at this time.

6.2.3 Structure

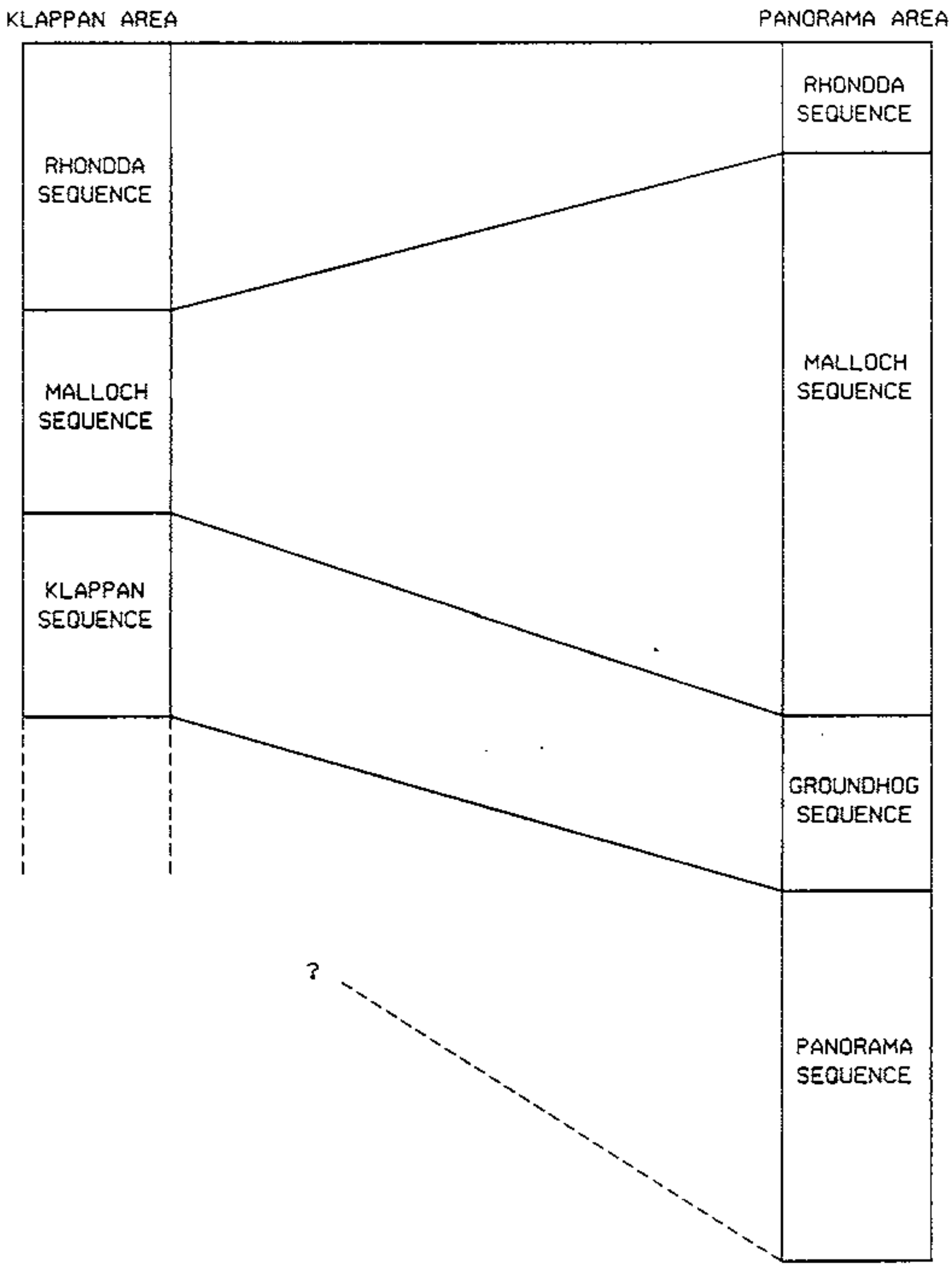
Structural deformation of Bowser Basin sediments resulted from intermittent tectonic stresses at the western cratonic margin from Cretaceous to recent time. The deformation caused an extensive, shallow decollement, recumbent folds, and local thrust faults extending a few kilometres along strike (Eisbacher, 1976).

The large scale forces resulting from collision of a remnant volcanic arc and cratonic margin subjected the area to northeast-southwest compression (F_1) creating the general structural trend of northwest-southeast. This trend is recognized in fold axial planes, cleavages, and thrust surfaces, which regionally tend to dip to the southwest.

FIGURE 6.3

MT. KLAPPAN COAL PROPERTY

KLAPPAN-GROUNDHOG STRATIGRAPHY



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Later positioning of the former volcanic arc terrain northwards along interlaced right lateral high angle faults (Eisbacher, 1981) may account for the later north-south compressional (F_2) event. This deformational event resulted in generally broad, open NE to SW trending folds with relatively rare, flat lying thrusts expressed in several Klippen fault structures.

The final deformational event which produced strike-slip and some dip-slip faulting may have resulted from a change in the rotational component of the western crustal block, terminating compression.

6.3 Property Geology

The Mount Klappan Property is underlain by the Klappan and Malloch Sequences and to a much lesser extent the Rhondda Sequence (Table 6.2). The Klappan Sequence is the main coal bearing unit, dominating the Property in overall areal extent. Malloch strata is found within the Klappan mountain massif and other highland areas located on the east, south and southwestern margins of the licence area. The Rhondda Sequence outcrops within a very small portion of the southern licence area, the remainder occurring further to the south of the Property.

Within the 1982 Mount Klappan Coal Project Geological Report, reference is made to marine strata lying below the Klappan Sequence. Since this Sequence was not identified on the Property in 1983, it was not included on the maps or cross-sections.

6.3.1 Klappan Sequence

The Klappan Sequence consists of sandstone, siltstone, mudstone, coal, and conglomerate. The coals range in thickness from a few centimetres up to 7.21 metres, representing the majority of the potentially economic coal on the Property.

Sandstones, varying in gain size from very fine grained to a grit, may exhibit ripple marks, planar tabular and trough cross- stratification, contain minor amounts of carbonate cement, and in many cases is found to contain

TABLE 6.2

MT. KLAPPAN COAL PROPERTY

TABLE OF FORMATIONS

JKr — **RHONDDA SEQUENCE**

MASSIVE TO THICK CONGLOMERATES AND GRITS INTERBEDDED WITH MINOR SILTSTONES AND SHALES.

JKm — **MALLOCH SEQUENCE**

INTERBEDDED CYCLIC SEQUENCES OF PREDOMINANTLY DARK GREY TO DARK BROWN WEATHERING SILTSTONES, ORANGE WEATHERING SILICEOUS NODULAR SILTSTONES AND CONGLOMERATES. UNIT SHOWS MARKED INCREASE IN ABUNDANCE OF SANDSTONES, MASSIVE CONGLOMERATES AND THIN COAL SEAMS TOWARDS THE BASE. COAL SEAMS AVERAGE 1.0 TO 2.0 METRES IN THICKNESS AND CONTAIN ABUNDANT ROCK SPLITS. SEQUENCE MAY CONTAIN PETRIFIED WOOD.

JKk — **KLAPPAN SEQUENCE**

SEQUENCE OF PREDOMINANTLY DARK GREY WEATHERING MUDSTONES AND SILTSTONES INTERBEDDED WITH FINE TO COARSE GRAINED SANDSTONES, OCCASIONAL THIN BEDDED CALCAREOUS ORANGE WEATHERING SILTSTONE NODULES, CONGLOMERATES AND ABUNDANT COAL SEAMS UP TO 5.7m THICK. UNIT GRADES DOWNWARDS INTO REPETITIVE SEQUENCE OF PREDOMINANTLY TABULAR BEDDED, MEDIUM TO COARSE GRAINED CONGLOMERATE SANDSTONES WHICH MAY DISPLAY TROUGH CROSS STRATIFICATION. INTERBEDDED SILTSTONES AND MUDSTONES OFTEN DISPLAYING LOW ANGLE CROSS LAMINATION. THICK COAL SEAMS MAY BE ASSOCIATED WITH THE MORE MASSIVE OF THE SANDSTONE BEDS. FOSSILS ASSOCIATED WITH THE FINE GRAINED SEDIMENTS INCLUDE SEVERAL SPECIES OF BIVALVES AS WELL AS RARE BELEMNITES AND AMMONITES.

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varying amounts of hematite. Petrographic analyses of the sandstones undertaken in 1982, indicate detrital chert as the dominant constituent with some quartz and minor feldspar, and virtually no muscovite. X-ray diffraction reveals ankerite (calcium, iron, magnesium and manganese carbonate ($CaCo_3$. (Mg, Fe, Mn) CO_3) as the predominant cement.

Interbedded siltstones and mudstones are generally dark grey to brown weathering, display low angle cross laminations, ripple marks, and occassional varved bedding. Orange weathering siltstone or chert nodules have been found in these sediments. These finer grained units also have been found to contain several species of pelecypods, as well as rare belemnites and ammonites. Chert pebble conglomerates occurring within the Mount Klappan Property may locally exceed 15 metres in thickness, and are often found as a cliff forming unit. The conglomerate beds generally exhibit sharp bases and grade laterally and vertically into sandstone. The total thickness of the Klappan Sequence is presently interpreted to be in the order of 900 metres.

A sequence of massive to thick bedded, grey weathering sandstones observed below Lost Ridge to the north and again in the Summit South Area, may be a possible marker bed within the Klappan Sequence. Further work is necessary to define this sandstone unit before divisions within the Klappan Sequence can be made.

6.3.1.1 Coal Seam Development

The Klappan Sequence is interpreted to contain up to 16 seams over a 900-950 metre interval (Table 6.3). Statistical information on the 16 seams is derived from drill hole and trench information from the eastern, central, and northern portions of the Property. The seams are labelled in ascending order: A to P (Figures 6.4 and 6.5), ranging in average thickness from a minimum of 0.43 metres to a maximum average thickness of 7.21 metres (Table 6.3).

The cumulative average thickness of all the seams combined is greatest within the Lost-Fox area at 53.62 metres (Figure 6.4). To the southeast within the Hobbit-Broatch area a cumulative average of 22.08 metres is obtained, while to the north, the Summit Area has an aggregate thickness of 15.49 metres. The average interseam thickness also increases towards the Lost-Fox Area at 62 metres. The Hobbit-Broatch Area has the smallest interseam thickness of 15 metres, increasing to 50.9 metres within the Summit Area.

On the western side of the Property seams found within the Klappan Sequence vary in thickness from 0.86 metres to 3.96 with a cumulative average thickness of 18.9 metres. The coal bearing potential for much of the covered ground between the Little

Table 6.3
COAL SEAM THICKNESS SUMMARY

SEAM	HOBBIT-BROATCH AREA DDH 82001*	DDH 82002	DDH 82003	DDH 82004	DDH 82006	Average (m)	LOST-FOX AREA DDH 82005	DDH 83001	Trenched	Adit	Average (m)	SUMMIT AREA DDH 82007	DDH 83003	Average (m)
P									2.66		2.66			
O									2.47		2.47			
N									2.54		2.54			
M									5.63		5.63			
L							2.24				2.24			
K	3.45		2.52			2.99	5.75				5.75			
J	0.93		2.33			1.63	5.16				5.16			
I	6.97		4.32			5.65	4.98	5.54		5.01, 4.82	5.09			
H	1.73		2.57		2.01	2.10		5.58			4.58			
G	2.77	‡4.03	4.22	2.88	2.45	3.27		7.21+			7.21		4.92+	4.92
F		0.35	2.17	0.04	0.16	0.68		4.82			4.82			
E		3.16	+2.14	0.75	0.63	1.67		1.32			1.32		2.66+	2.66
D		0.53		0.35	0.59	0.49						3.91		3.91
C		0.67			0.19	0.43			1.33		1.33	2.71		2.71
B					1.50	1.50			1.88		1.88	1.29		1.29
A					1.67	1.67			0.94		0.94			
Aggregate						22.08					53.62			15.49
Aggregate of Seams greater than 0.5 m						21.16								

* Net Thicknesses exclude core loss

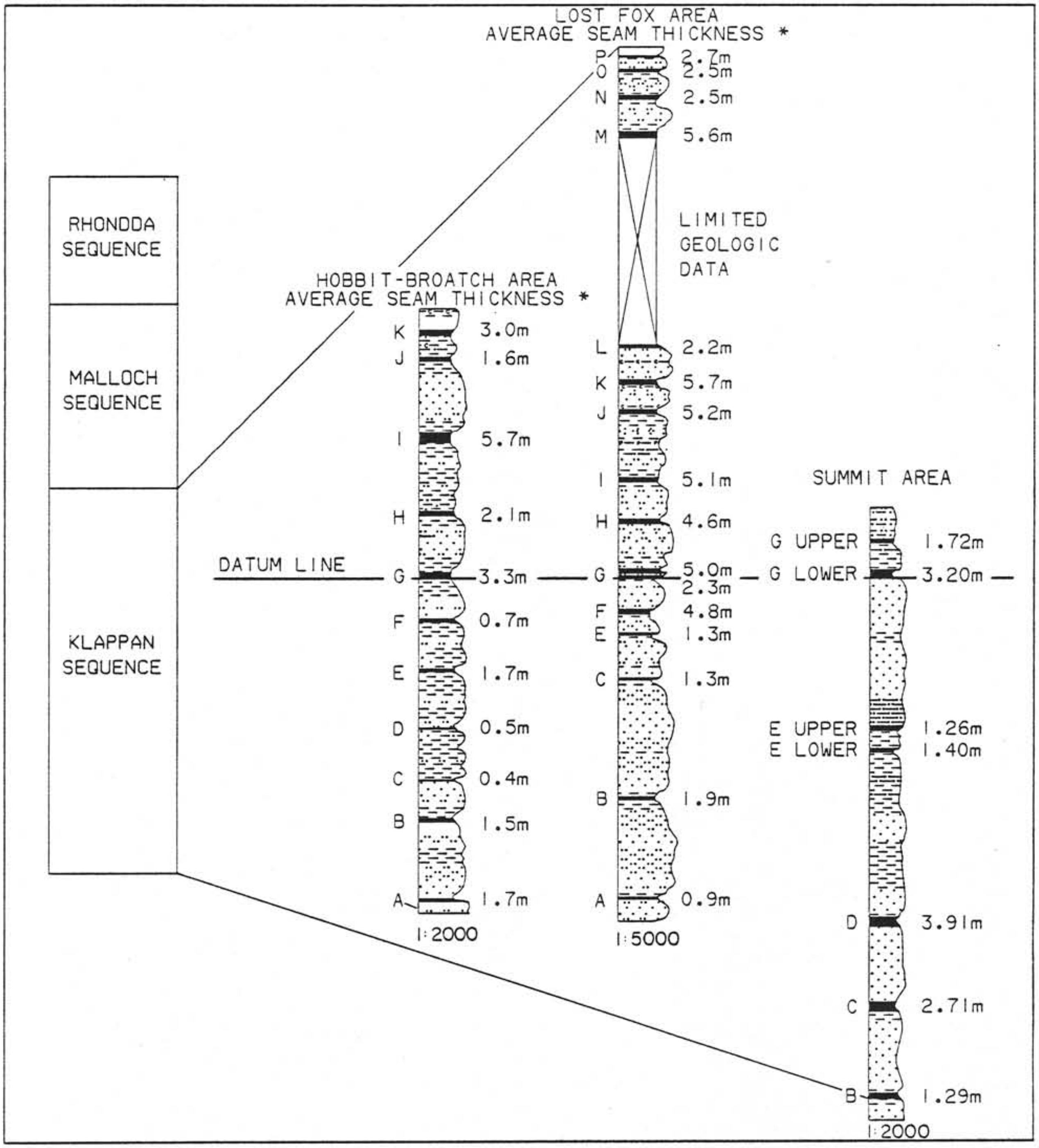
\+ Includes upper and lower portions

‡ Upper seam only

FIGURE 6.4

MT. KLAPPAN COAL PROPERTY

KLAPPAN SEQUENCE



* INCLUDES SEAMS <0.5m

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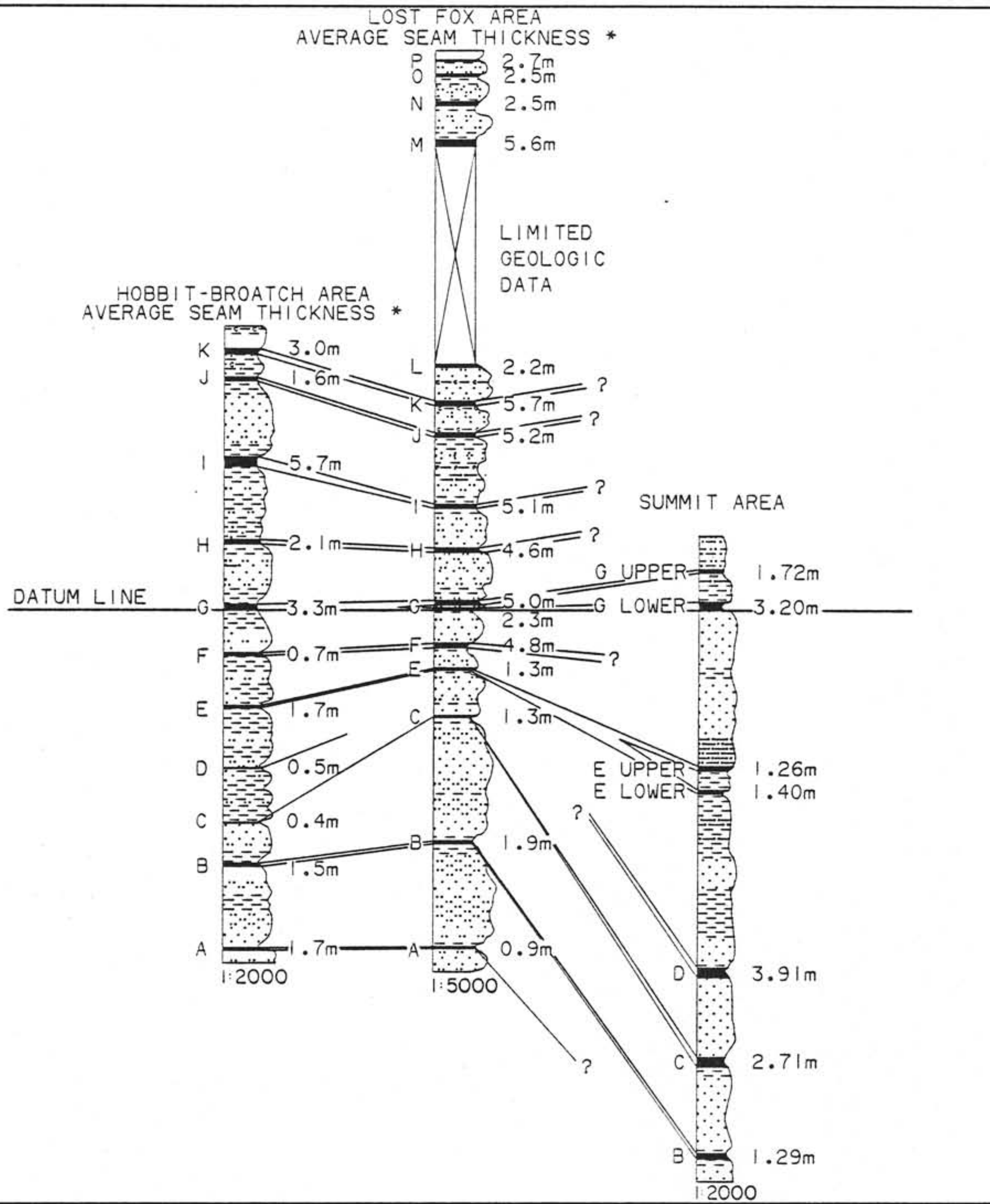
FIGURE 6.5

MT. KLAPPAN COAL PROPERTY

DISTRIBUTION OF COAL SEAM



* INCLUDES SEAMS <0.5m

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Klappan-Nass River Area and the Lost-Fox Area is considered high.

6.3.2 Malloch Sequence

The majority of this sequence is comprised of interbedded siltstone and mudstone, thick bedded to massive conglomerates, sandstone, and coal. The upper portion of the Malloch is predominantly dark grey weathering siltstones and mudstones, interbedded with sandstone and occassional conglomerate beds. These units may contain orange weathering siliceous nodules. The abundance of sandstone, conglomerates, and minor coal seams increases towards the base of the sequence.

In the Klappan Mountain Area, seam thicknesses vary between 0.33 and 2.50 metres, with a cumulative average of 13.77 metres, over a 350 metre section. These seams are contained within the lower portion of the Malloch Sequence and are thinner, and less numerous than those contained within the Klappan Sequence. Again a proportion of the Skeena Ellis Area is underlain by Malloch sediments; however, coal spoil has been located adjacent to areas interpreted to be within the main coal bearing Klappan Sequence. Petrified wood fragments have been found in several areas underlain by the Malloch and these sediments are thought to be of a more terrestrial nature than those of the Klappan Sequence. The thickness of the Malloch Sequence is approximately 800 metres.

6.3.3 Rhondda Sequence

The Rhondda Sequence overlies the Malloch Sequence and is comprised of massive chert pebble conglomerates, grits, and conglomeratic sandstones. Occasional thin beds of siltstone and mudstone are found associated with coal seams in the order of a few centimetres thick. The thickness of the Rhondda Sequence has not, as yet, been determined.

6.3.4 Environment of Deposition

Information gathered to date by Gulf geologists and sedimentologists, indicates that interdeltaic beach-barrier island, deltaic and alluvial plain deposits (Rowe, unpub. rep. 1983) comprise the main coal bearing Klappan Sequence. Overlying the Klappan Sequence, the Malloch Sequence is dominated by fluvial and lacustrine depositional features, while within the uppermost sequence, the Rhondda, alluvial influences are dominant. Underlying the coal bearing sequence are strata contained within a marginal marine-to-marine facies.

The large scale depositional setting is interpreted to be that of a restricted basin, indicated by sediment source direction from the northeast, east, and southeast. Further work is necessary to delineate the paleoshoreline, and subsequent resource target areas.

6.3.5 Structure

The Klappan Area is dominated structurally by a synclinorium-anticlinorium pair trending northwest-southeast. The axis of the Mt. Beirnes Synclinorium (Richards and Gilchrist, 1979) is defined by the massive conglomerates of the Rhondda Sequence situated to the south of the Property near Mt. Gunanoot. The western reaches of this synclinorium can be traced into the central portion of the Little Klappan-Nass River Area of the Property.

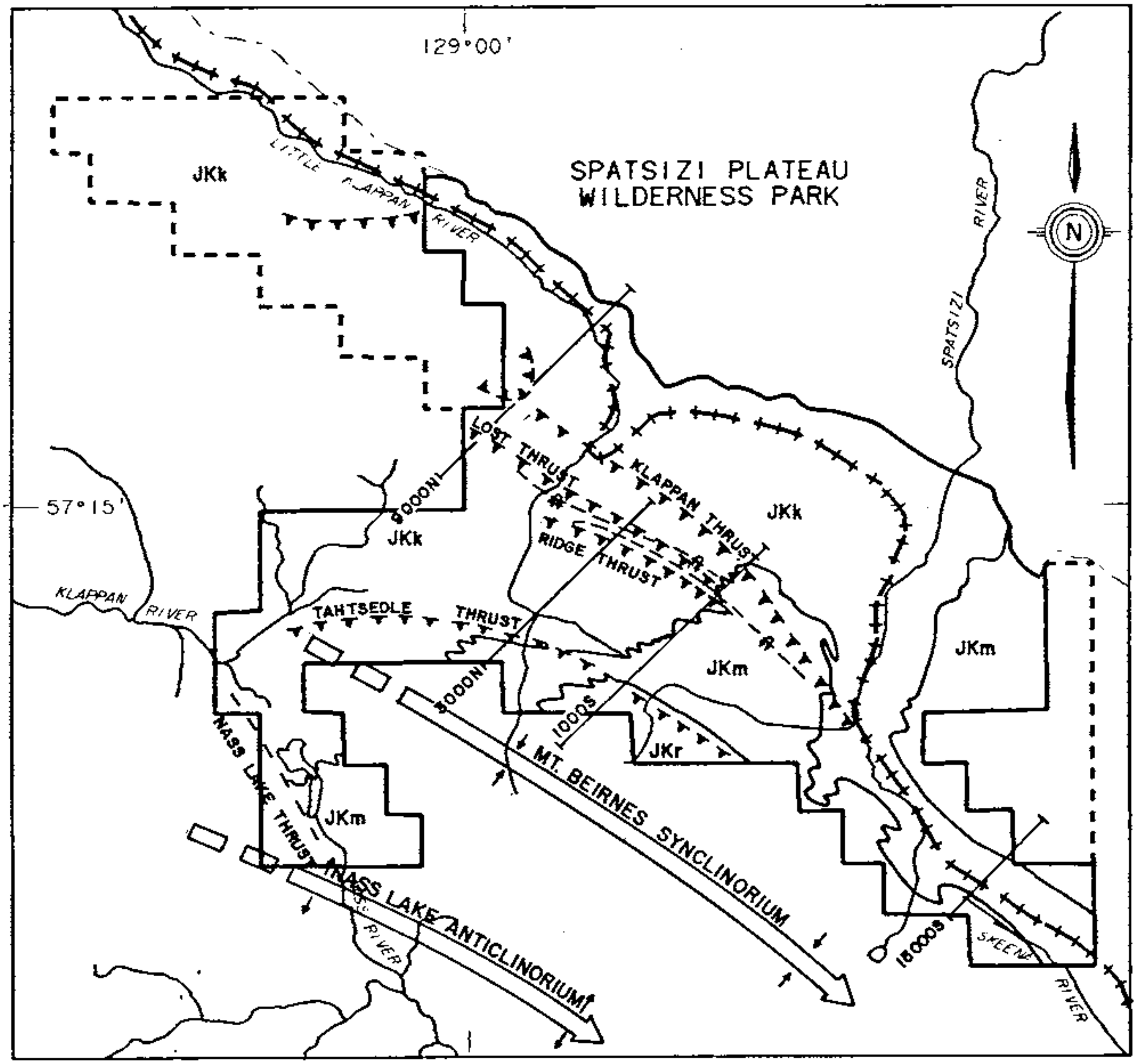
The Nass River Anticlinorium (Moffat and Bustin, in press) is situated to the south of Mt. Gunanoot and crosses the south end of the Little Klappan-Nass River Area. The less competent, finer grained strata of the Malloch and Klappan Sequences exhibit varying structural complexity. The folds within these units are upright to overturned to the northeast on the eastern limb of the synclinorium and overturned towards the southwest on the western limb. Fold vergence swings back again to the northeast on the western limb of the anticlinorium.

The bulk of the Property covers the eastern limb of the Synclinorium (Figures 6.6, 6.7A & 6.7B). The area has been subjected to two phases of deformation (Bustin and Moffat, 1983), (Mount Klappan Coal Project Geological Report 1982), both phases postdating the youngest sediments within the Property.

FIGURE 6.6

MT. KLAPPAN COAL PROPERTY

1983 SCHEMATIC GEOLOGY MAP



LEGEND

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- LICENCES UNDER APPLICATION
- JKr RHONDDA SEQUENCE
- JKm MALLOCH SEQUENCE
- JKk KLAPPAN SEQUENCE

SCALE

0 1 2 3km

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09/01/84

FILE NAME I205,57183I024019.LOC

RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001 — DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 — 1/4 — 1/2 MILE

0 — 500 — 1000 METERS

FIGURE 6.7A

MOUNT KLAPPAN COAL PROPERTY

MT. KLAPPAN - SKEENA ELLIS AREA

GEOLOGICAL CROSS SECTIONS

15000 & 1000 S.E. & (WEST)

15/03/84

RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

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Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.7B

MOUNT KLAPPAN COAL PROPERTY

LOST RIDGE - SUMMIT AREA

GEOLOGICAL CROSS SECTIONS

9000 & 3000 N.E. & (WEST)

Gulf

15/03/84

The original compressional event, resulted in the development of first phase folds (F_1) trending in a northwest to southeast direction. Geometry of these folds range from broad and upright, to overturned megascopic Z folds with axial planes inclined as much as 45° to the northeast.

Faulting related to the first phase of deformation includes thrust and extension faults. The Klappan Thrust is the major fault within the Property extending from the Tahtsedle Creek-Spatsizi River confluence, northward through the Lost-Fox Area into the Summit Area where it is interpreted to die out. Displacement of this southwest dipping fault, though variable, is estimated to be approximately 100 metres.

Several other thrust faults occur within the Property, namely, the Lost and Ridge Faults within the Lost-Fox Area and the Tahtsedle Fault traced along the southern edge of the Property. Both the Lost and Ridge Faults have limited dip slip displacements estimated to approach a maximum of 50 and 150 metres, respectively. Traceable strike length does not exceed 7.5 kilometres for either the Lost or Ridge Thrust Faults. The Tahtsedle Thrust Fault is extensive in strike length approaching 11 kilometres and exhibits an increase in displacement from a few tens of metres in the southeast to a maximum of 500 metres in the Nass River Area.

Extension or tear faults have also been associated with this first phase of folding. Several have been noted in the Klappan Mountain and Hobbit-Broatch Areas. They are thought to have limited strike slip displacement in the order of several hundred metres.

A second stage of deformation, phase II folds, (F_2) resulted in the formation of broad open folds trending in a northeast-southwest direction. The imprint of these folds on the first phase folds is seen as a series of plunge changes approaching maximum values of between 45° north to 21° south.

Low angle to flat lying thrust faults are also associated with this compressional event. Faults of this nature in the Summit Area, are thought to have formed several klippen; however, the amount of displacement has not been determined.

In a direct comparison of the first and second phases of deformation, the second phase appears to be the weaker of the two. The second stage folds are broad and open in comparison to the first stage and exhibit a much greater wavelength and smaller amplitude.

6.4 Detailed Geology

6.4.1 Introduction

The 1983 mapping program divided the Property into five main segments comprising 18 mapping blocks. These five segments are the Lost-Fox Area, the Summit Area, the Klappan Mountain Area, the Little Klappan-Nass River Area, and the Skeena-Ellis Area (Figure 6.8). A more detailed description of each follows.

6.4.2 Lost-Fox Area

The Lost-Fox area extends roughly east and south past Fox Creek; north to the Property boundary and west to the Little Klappan River (Figure 6.9).

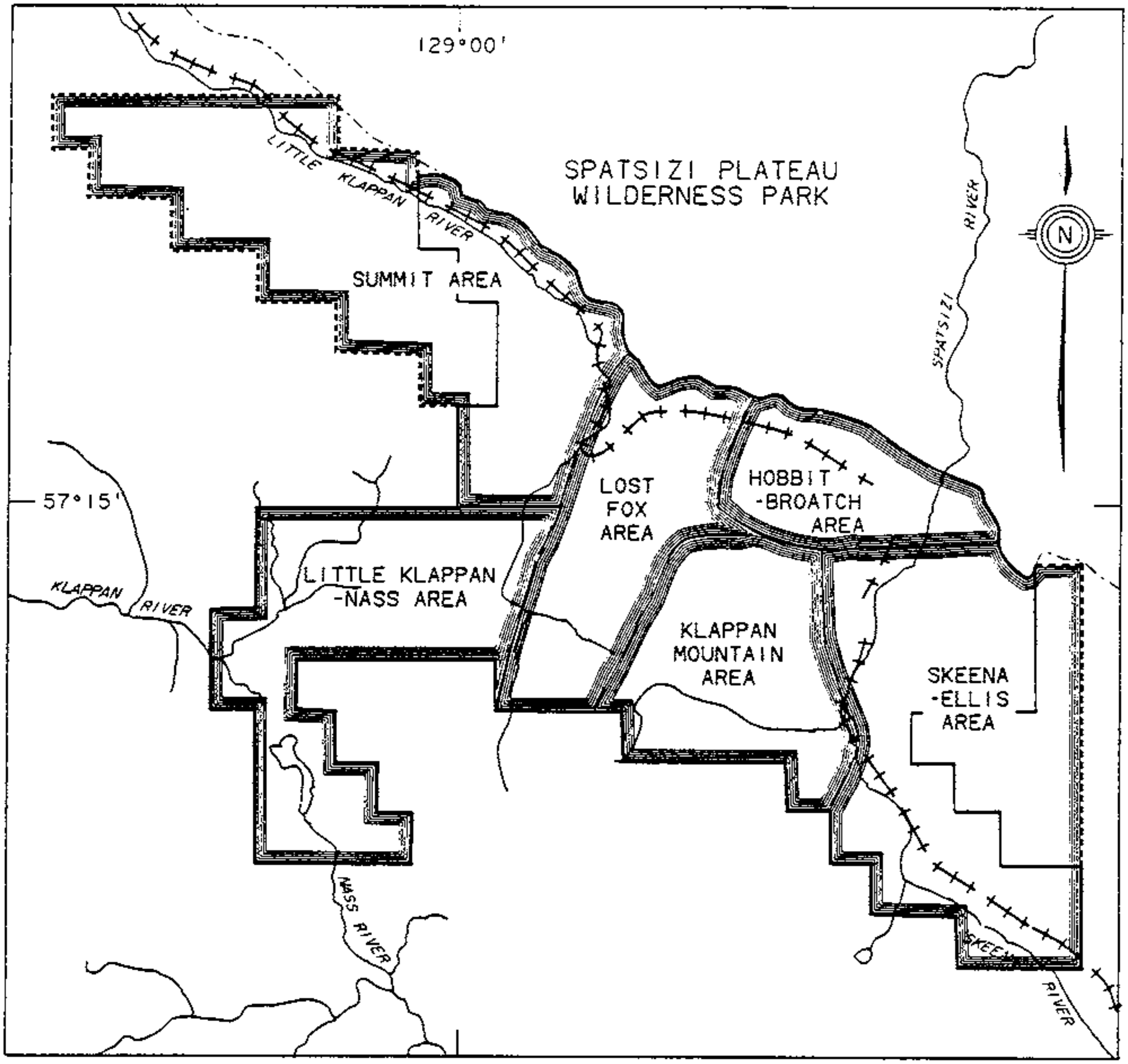
Strata within the Lost-Fox Area consists largely of the Klappan coal bearing Sequence. However, the southeastern corner of the area is believed to lie within the Malloch Sequence. This is based on the change in lithologies in the vicinity of Fox Creek. As a result of this interpretation, the Malloch contact has been pushed down the southeast side of Lost Ridge from its position in 1982.

Sediments of the Lost-Fox Area are interpreted to range from marginal marine to marine in character. Evidence for this is seen in core samples from DDH82005 and DDH83001. In total, two diamond drill holes intersected

FIGURE 6.8

MT. KLAPPAN COAL PROPERTY

1983 AREAS OF DETAILED GEOLOGY



LEGEND

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- LICENCES UNDER APPLICATION

SCALE

0 1 2 3 km

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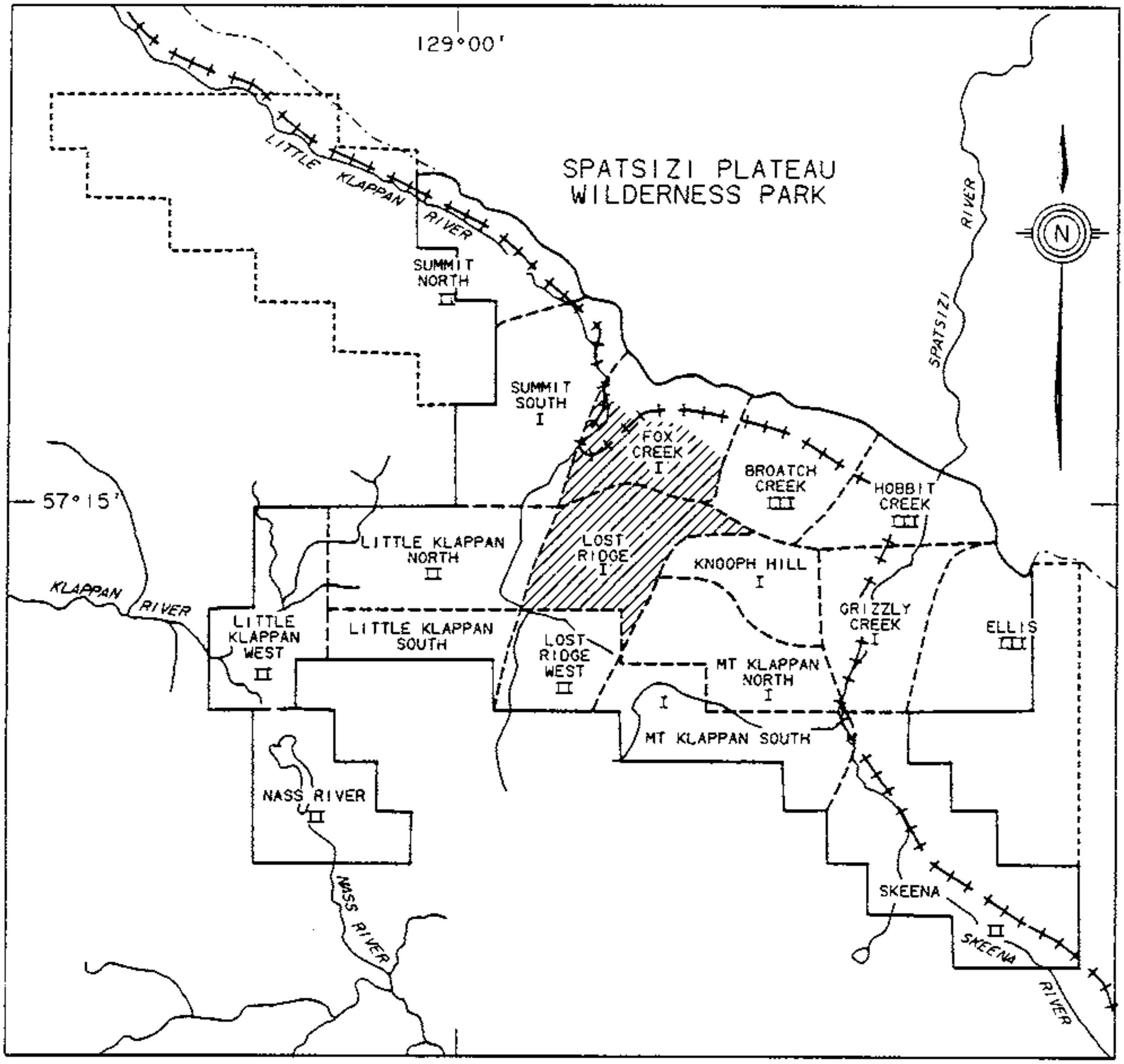
FIGURE 6.9

MT. KLAPPAN COAL PROPERTY

LOST FOX AREA 1983 MAPPING AREA



LEGEND

┼┼┼ ┼┼┼	PREPARED RAIL BED
-·-·-·-·-	PROVINCIAL PARK BOUNDARY
———	LICENCE AREA
------------	LICENCES UNDER APPLICATION
I	FIRST PRIORITY
II	SECOND PRIORITY
III	THIRD PRIORITY

SCALE

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09/01/84

seams E through L with seam I being the common correlatable seam.

DDH82005 intersected what are interpreted to be marginal marine deposits as indicated by thinly bedded sequences of siltstones and sandstones containing thick coal seams and plant fossils.

Drill hole DDH83001 intersected some of the marginal marine deposits seen in DDH82005 and more marine sediments near the bottom of the hole. These marine sediments consist of conglomeratic siltstones and sandstones, dark mudstones, with an increasing abundance of worm borrows and shell fragments. This lower marine unit is believed to be correlatable to similar sediments to the north within the Summit South Area.

6.4.2.1 Coal Seam Development

The 1982 and 1983 diamond drilling programs have proved the existence of seams E through L (Table 6.4). Seams A to C, exposed on the western end of Lost Ridge and seams M to P, outcropping along Fox Creek, have been hand trenched. Seams A to P comprise a total seam thickness of 53.62 metres over an interval of 979.0 metres. Coal seam thicknesses vary from 0.94 metres to 7.21 metres with an average thickness of 3.57 metres (Figure 6.10). Although seam D has been extrapolated from DDH82007, into the

Table 6.4

SUMMARY OF LOST-FOX AREA DRILLED SEAM INTERSECTIONS

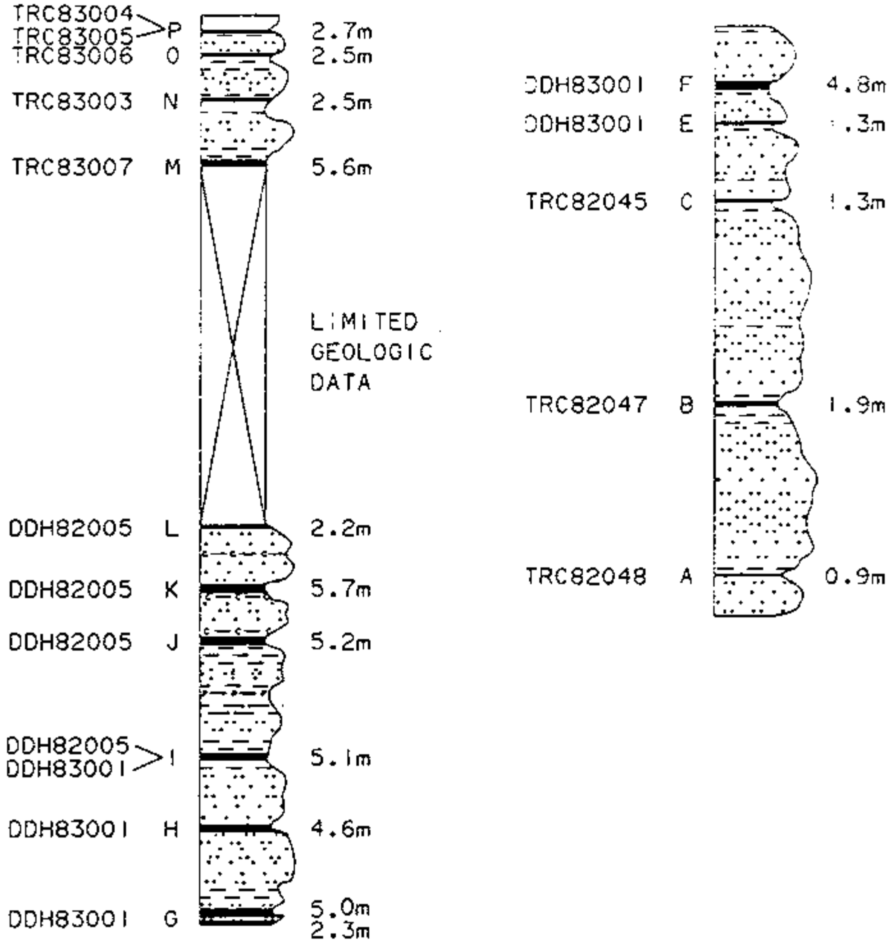
Drill Hole	Seam	Drilled Internal (m)	Seam True Thickness (m)	Interseam True Thickness (m)	Coal (m)/ Coal & Rock (m)
82005	L	236.14-238.92	2.24		1.43/2.24
				34.11	
	K	186.89-193.81	5.75		2.75/5.75
				22.26	
	J	148.09-154.34	5.16		3.99/5.16
				69.72	
	I	54.02-60.30	4.98		4.26/4.98
83001	I	26.90-32.68	5.54		4.97/5.54
				40.34	
	H	74.73-79.38	4.58		3.87/4.58
				51.47	
	G up	133.42-137.43	3.98		3.66/4.95
				0.78	
		138.22-139.19	0.97		
				3.12	
	G lo	142.45-144.75	2.26		1.23/2.26
				35.11	
	F	180.62-186.01	4.82		3.89/4.82
				23.61	
	E	209.60-210.00	1.32		1.32/1.32

FIGURE 6.10

MT. KLAPPAN COAL PROPERTY

LOST-FOX AREA COAL SEAM DISTRIBUTION

AVERAGE SEAM THICKNESS *



* INCLUDES SEAM INTERSECTIONS >0.5m

SCALE: 1:5000

GULF CANADA RESOURCES INC.
06/03/84

northern extreme of the Lost-Fox Area, it was excluded from the aggregate coal thickness, as it was not trenched or intersected by drill holes within the Lost Ridge Area.

Excellent exposure on the north face of Lost Ridge reveals the continuity of the seams, especially seam I which can be traced along structure for 1300 metres. An adit driven through the upright portion of this seam and DDH82005 and DDH83001 which both intersected seam I have provided an average seam thickness of 5.09 metres. Six Winkie drill holes intersected the seam with only 3 of the Winkie holes coring the total seam. Seams E through H, which are not as well exposed on the ridge face were trenched in some localities and intersected by DDH83001.

Stratigraphically above seam L are the Fox Creek seams M through P. These seams appear to be duller in hand specimen and to contain more rock partings than the Lost Ridge seams. The change in character of the coal may be partially due to the proximity of this part of the Klappan Sequence to the Malloch contact.

6.4.2.2 Structure

Structurally, the Lost-Fox Area is characterized by the northwest-southeast trending Lost Ridge Anticline and Lost Ridge Syncline. The plunge on both structures is to the southeast and varies from 30° on the lower north face to 8° on the ridge crest and to as high as 21° in Fox Creek (Figures 6.11 & 6.12 A-C).

The Lost Ridge Anticline is overturned as much as 45° to the northeast. The southwest limb, which plunges more steeply than the topography resulting in a gain of stratigraphic section, forms a dip slope down the back of the ridge. After partially forming another syncline this limb is truncated to the southwest by the Ridge Thrust (formerly the Klappan Thrust - Mount Klappan Coal Project Geological Report 1982), striking northwest and dipping 60° at surface through the ridge crest. As the Thrust traces through Fox Creek, the surface dip is 47° shallowing at depth. The lower seams of the Klappan Sequence on the western end of Lost Ridge have been thrust over the upper seams with a displacement of 150 metres at the top of the ridge narrowing to 110 metres at Fox Creek. Of note, is the change in strike and dip of the Ridge Thrust from the 1982 interpretation. The trace of Thrust has moved northeastward on the southwest slope of Lost Ridge resulting in a steeper dip on the Thrust at surface.

FIGURE 6.11

MT. KLAPPAN COAL PROPERTY

LOST - FOX AREA GEOLOGY

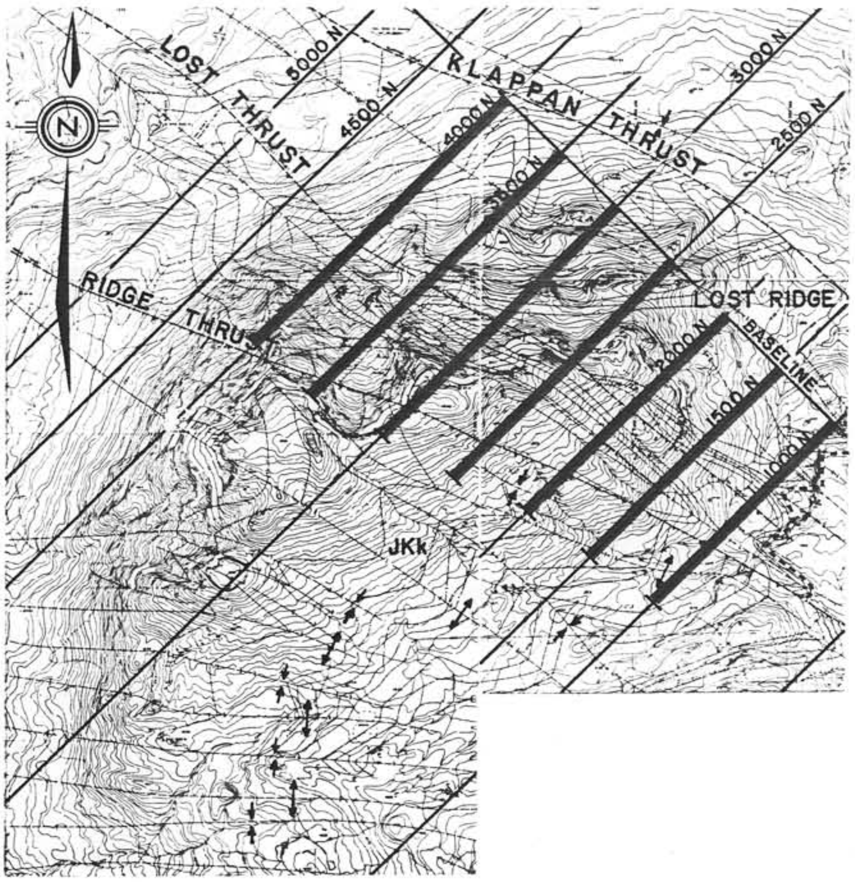


TABLE OF FORMATIONS	GEOLOGICAL SYMBOLS
JKr - RHONDDA SEQUENCE CONGL., GRITS, SHALES	LICENCE BOUNDARY
JKm - MALLOCH SEQUENCE INTRBD, SILTSTONES, CONGL, THIN COAL	GEOLOGICAL CONTACT(APPROX.,INFER)
JKk - KLAPPAN SEQUENCE MDST.,SDST., COAL SEAMS	COAL SEAM(OUTCROP INFER)
	ANTICLINE(DEFINED,APPROX.)
	SYNCLINE(DEFINED,APPROX.)
	THRUST FAULT(DEFINED,APPROX.,INFER)

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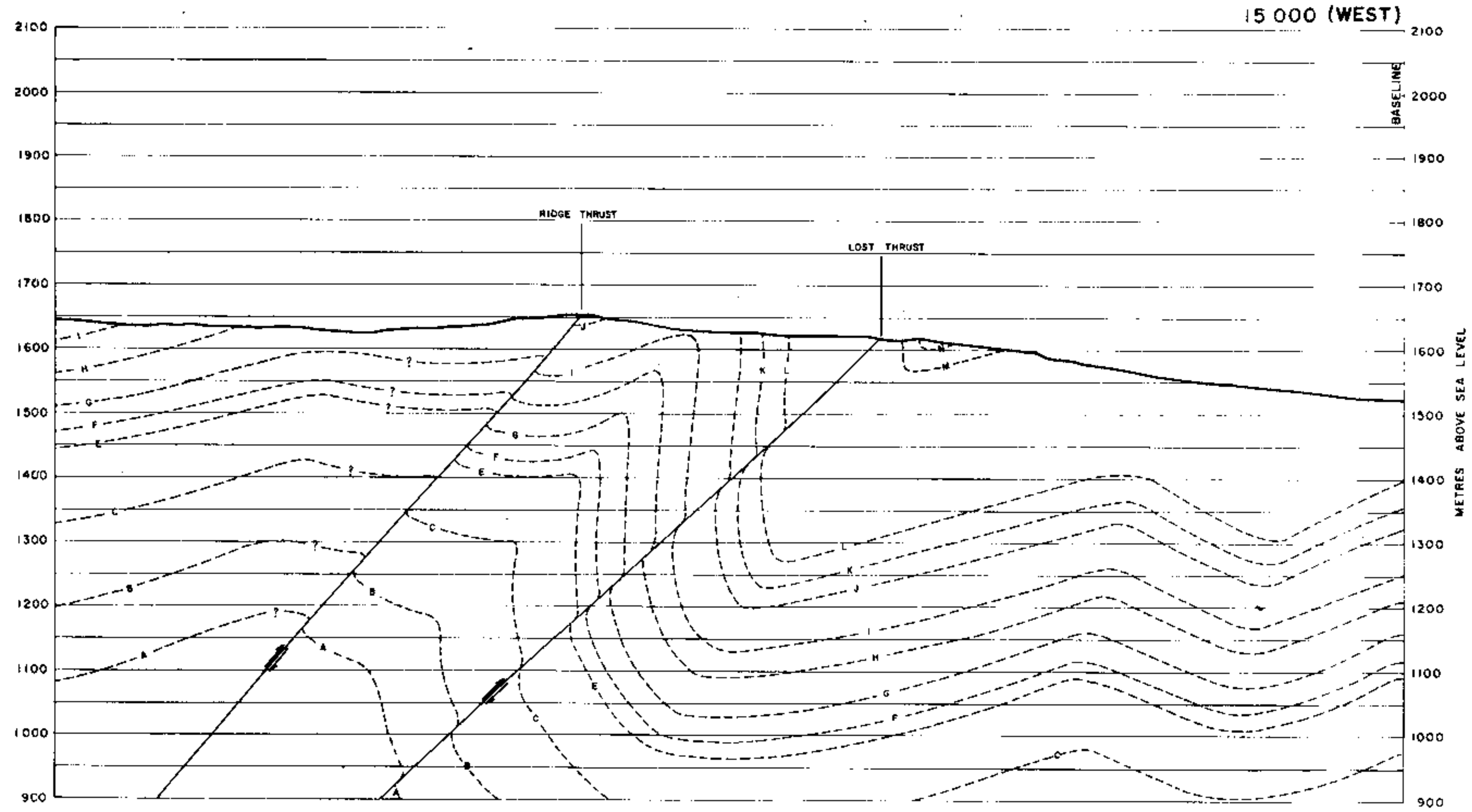
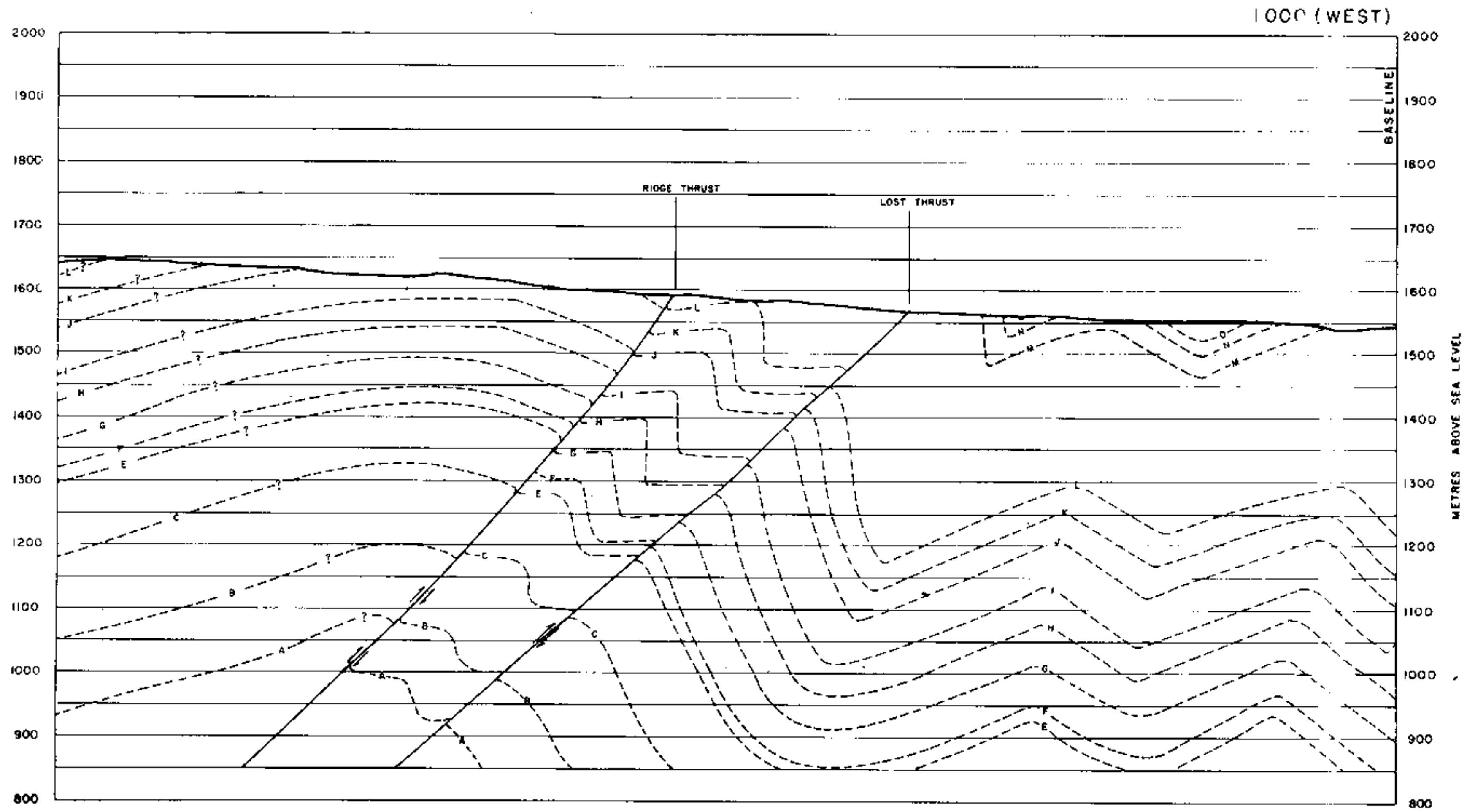




RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001 — DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 — 1/4 — 1/2 MILE

0 — 500 — 1000 METERS

FIGURE 6.12A

MOUNT KLAPPAN COAL PROPERTY

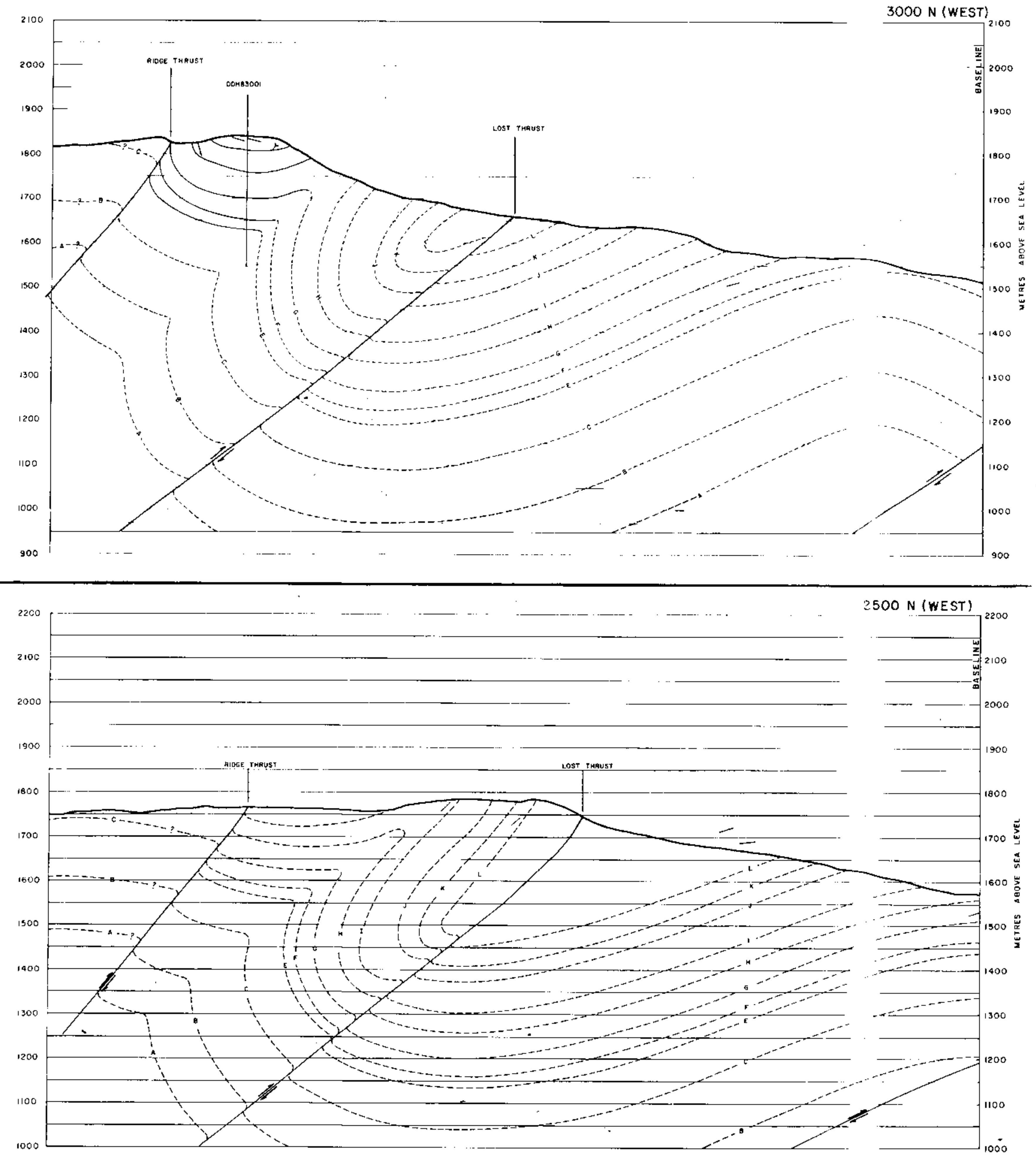
LOST - FOX AREA

GEOLOGICAL CROSS SECTIONS

15000 & 1000 (WEST)

Gulf

15/03/84



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Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.12B

MOUNT KLAPPAN COAL PROPERTY

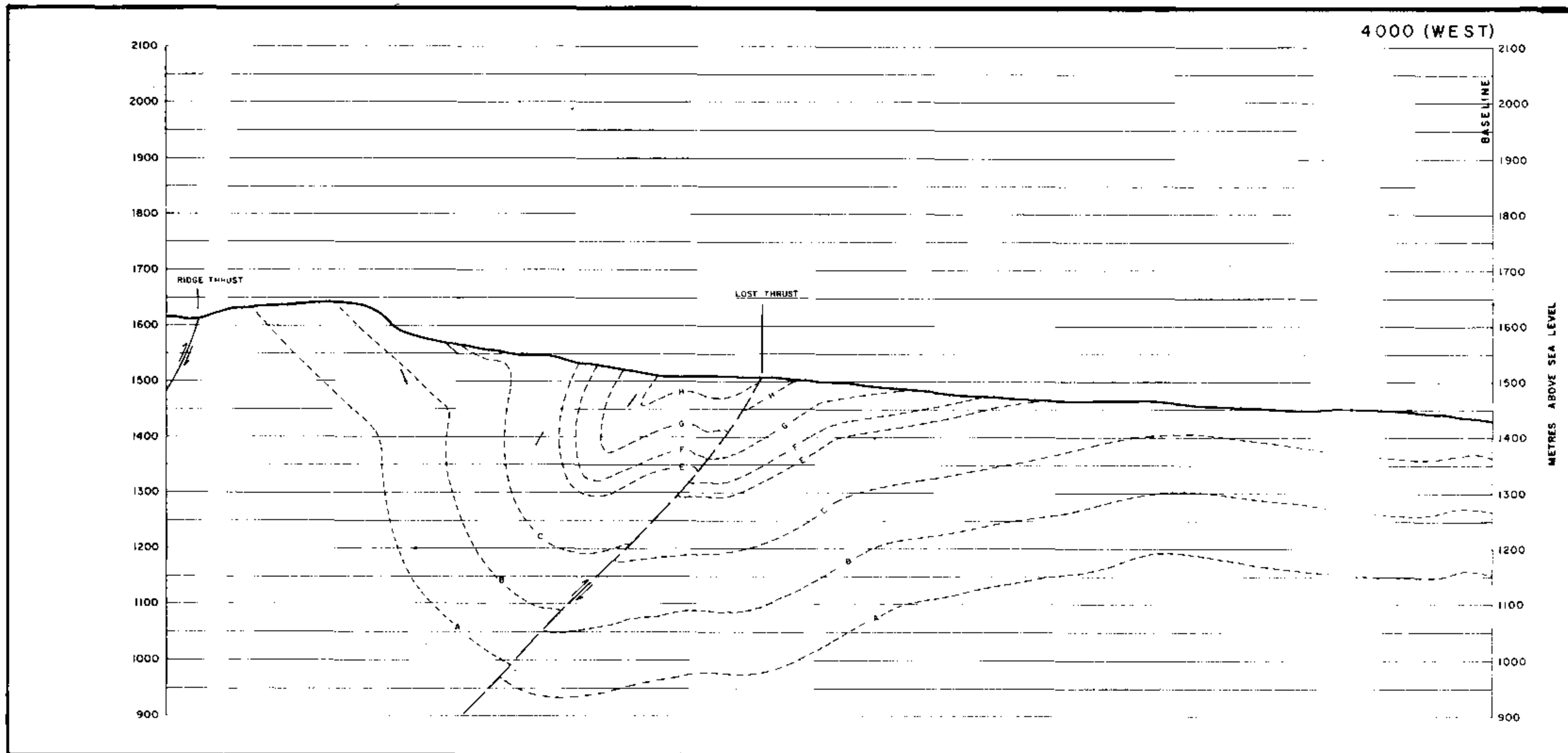
LOST - FOX AREA

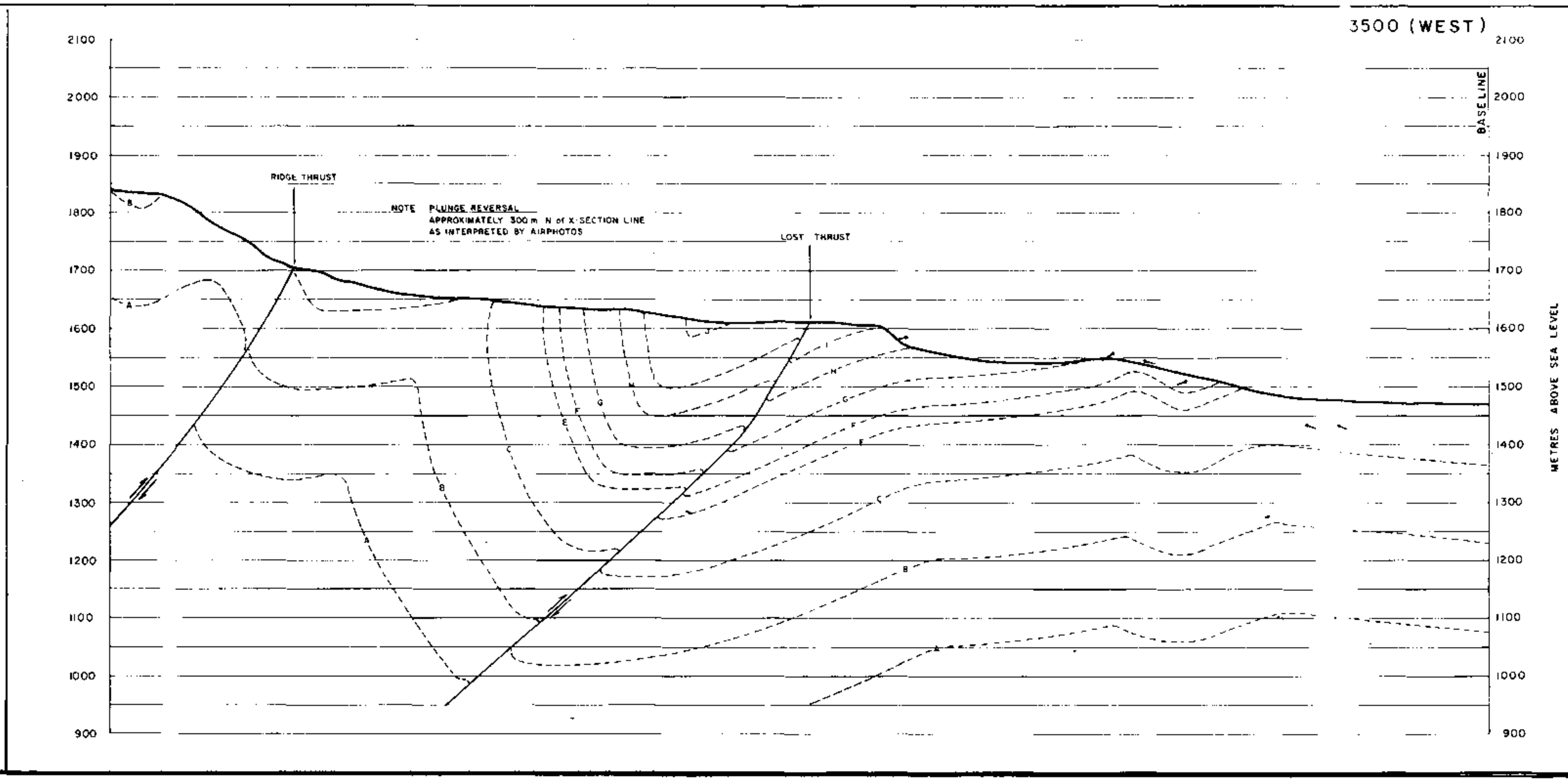
GEOLOGICAL CROSS SECTIONS

3000 & 2500 N (WEST)

15/03/84

Gulf





RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.12C

MOUNT KLAPPAN COAL PROPERTY

LOST - FOX AREA

GEOLOGICAL CROSS SECTIONS

4000 & 3500 (WEST)

15/03/84

Gulf

Northeast of the Lost Ridge Anticline, the Lost Ridge Syncline plunges eastward into Fox Creek and extends northward to the base of the Summit South Area. The northeast limb of the fold dips gently to the southwest before reaching Fox Creek where fold styles are tighter with smaller wavelengths. The axis of the Syncline is crosscut by the northwest striking Lost Thrust. Maximum dip slip displacement along the Thrust is 55 metres at the top of Lost Ridge narrowing to 20 metres before it eventually dies out south of Fox Creek. Both the Ridge and Lost Thrusts are believed to be a result of the F_1 stage of deformation.

The most northern and most extensive fault through the Lost-Fox area is the Klappan Thrust. It strikes northwest with a dip slip displacement of 100 metres in the east part of the area and is interpreted to die out within the Summit South area.

Several small normal faults with displacement of 10 to 20 metres exist on the eastern face of Lost Ridge as possible post-tectonic relaxation features.

The previously mentioned NW-SE folds are characteristic of the Lost-Fox area but a second deformational phase (F_2) of NE-SW trending folds dominate the lower north face of Lost Ridge.

Infrequent cleavage-bedding intersections, broad fold styles and wavelengths of 500 to 600 metres, all suggest that this second phase of deformation was less intense than the primary phase. The plunge reversals resulting from the two intersecting fold patterns have not been observed on the southern or eastern areas of Lost Ridge due to the lack of outcrop exposure. If, with further exploration, a reversal is documented off the eastern end of Lost Ridge, the 950 metres of Klappan Sequence sediments would be reduced.

6.4.3 Summit Area

The Summit Area, which includes the Summit South and Summit North mapping areas, comprises the northern part of the Mount Klappan Property (Figure 6.13).

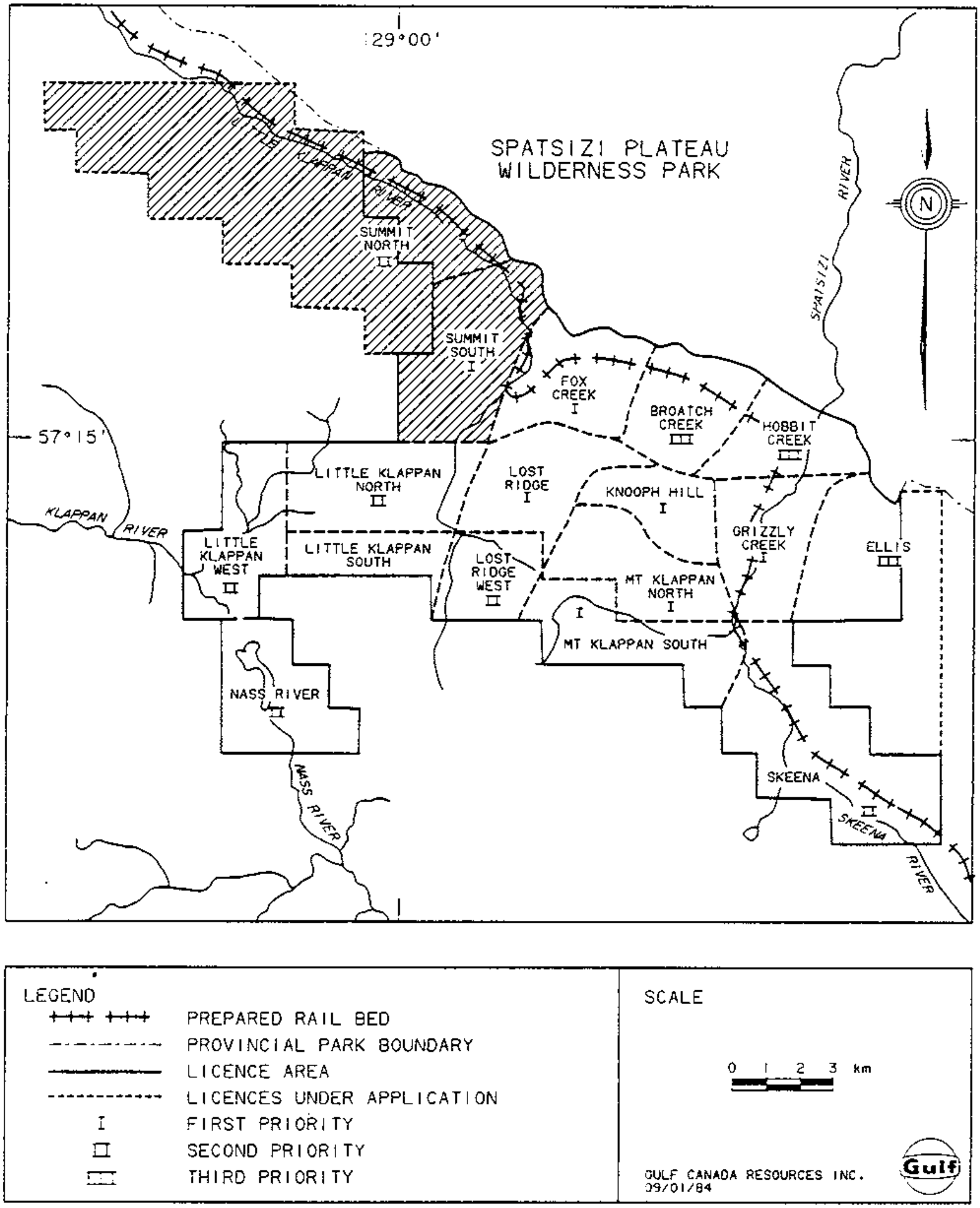
The strata exposed in this area belong to the lower portion of the main coal bearing section of the Klappan Sequence. They are believed to be stratigraphically equivalent to the lower part of the Klappan Sequence exposed in the Lost-Fox area to the south.

In general, the sediments of the Summit area are more marine in character than their southern stratigraphic equivalents in the Lost-Fox Area (Rowe, 1983). This conclusion is based on the following observations:

FIGURE 6.13

MT. KLAPPAN COAL PROPERTY

SUMMIT AREA 1983 MAPPING AREA



1) A higher proportion (relative to the Lost-Fox Area) of marine sediments (micro-paleontology).

2) The occurrence in several localities and stratigraphic levels of marine fossil indicators i.e. Belemnites and pelecypod assemblages (Stelck, Personal Comm).

A total of 27 trenches were excavated and two diamond holes drilled in conjunction with detailed field mapping.

6.4.3.1 Coal Seam Development

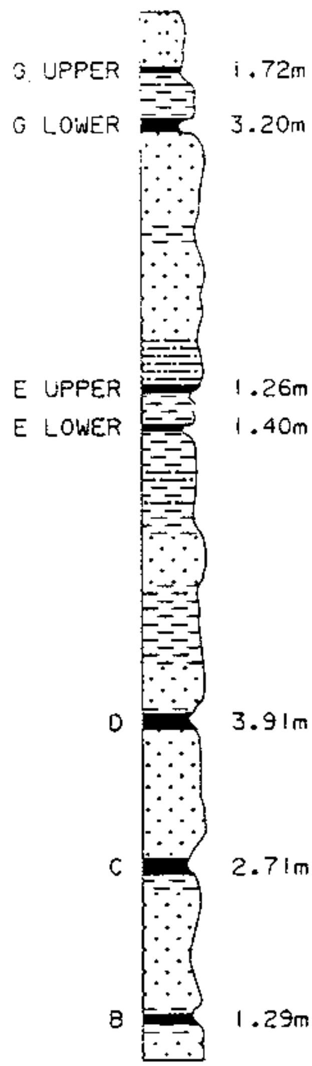
The three coal seams, B, C, and D that were intersected in DDH82007 have a total true thickness of 7.91 metres. Maximum and minimum thicknesses are 3.91 metres and 1.29 metres respectively with an average thickness of 2.64 metres. The average interseam thickness is 35.4 metres (Figure 6.14).

The four coal seams, E upper, E lower, G upper and G lower, intersected in DDH83003, have a total thickness of 7.58 metres. The maximium and minimum thicknesses of the coal seams are 3.20 metres and 1.26 metres respectively with an average of 1.90 metres. The interseam thickness separating E lower from G upper is interpreted to be 77.10 metres (Table 6.5).

FIGURE 6.14

MT. KLAPPAN COAL PROPERTY

SUMMIT AREA COAL SEAM DISTRIBUTION



SCALE: 1:2000

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20/02/84

Table 6.5

Summary of Summit Area Drilled Seam Intersections

Drill Hole	Seam	Drilled Interval (m)	Seam True Thickness (m)	Interseam True Thickness (m)	Coal (m)/ Coal + Rock (m)
82007	D	19.19-23.10	3.91		2.31/3.91
				33.85	
	C	57.14-59.85	2.71		1.95/2.71
				36.55	
	B	96.56-97.85	1.29		0.80/1.29
83003	G Upper	40.30-42.05	1.72		1.05/1.72
				2.71	
	G Lower	44.80-48.00	3.20		1.93/3.20
				77.10	
	E Upper	126.95-128.24	1.26		1.06/1.26
				9.15	
	E Lower	137.68-139.10	1.40		1.09/1.40

6.4.3.2 Structure

The strata of the Summit Area have undergone two phases of deformation similar to the rest of the Klappan Property (Figures 6.15 and 6.16 A-D).

The first folding episode (F_1) resulted in northwest-southeast trending folds which range from tight to overturned anticline syncline pairs. Faulting associated with the F_1 folds resulted in mainly thrust and tear faults with the thrust faults attaining attitudes up to 70° from horizontal.

The second folding episode (F_2) resulted in east-west trending folds which are mainly broad open folds ranging in attitudes from 20°N to 27°S. This phase of deformation imparted significant plunge angles on the F_1 folds. Faulting associated with the F_2 folds formed mainly low angle (less than 20° from horizontal) thrust faults which result in the formation of at least one klippe in the Summit area.

FIGURE 6.15

MT. KLAPPAN COAL PROPERTY

SUMMIT AREA GEOLOGY

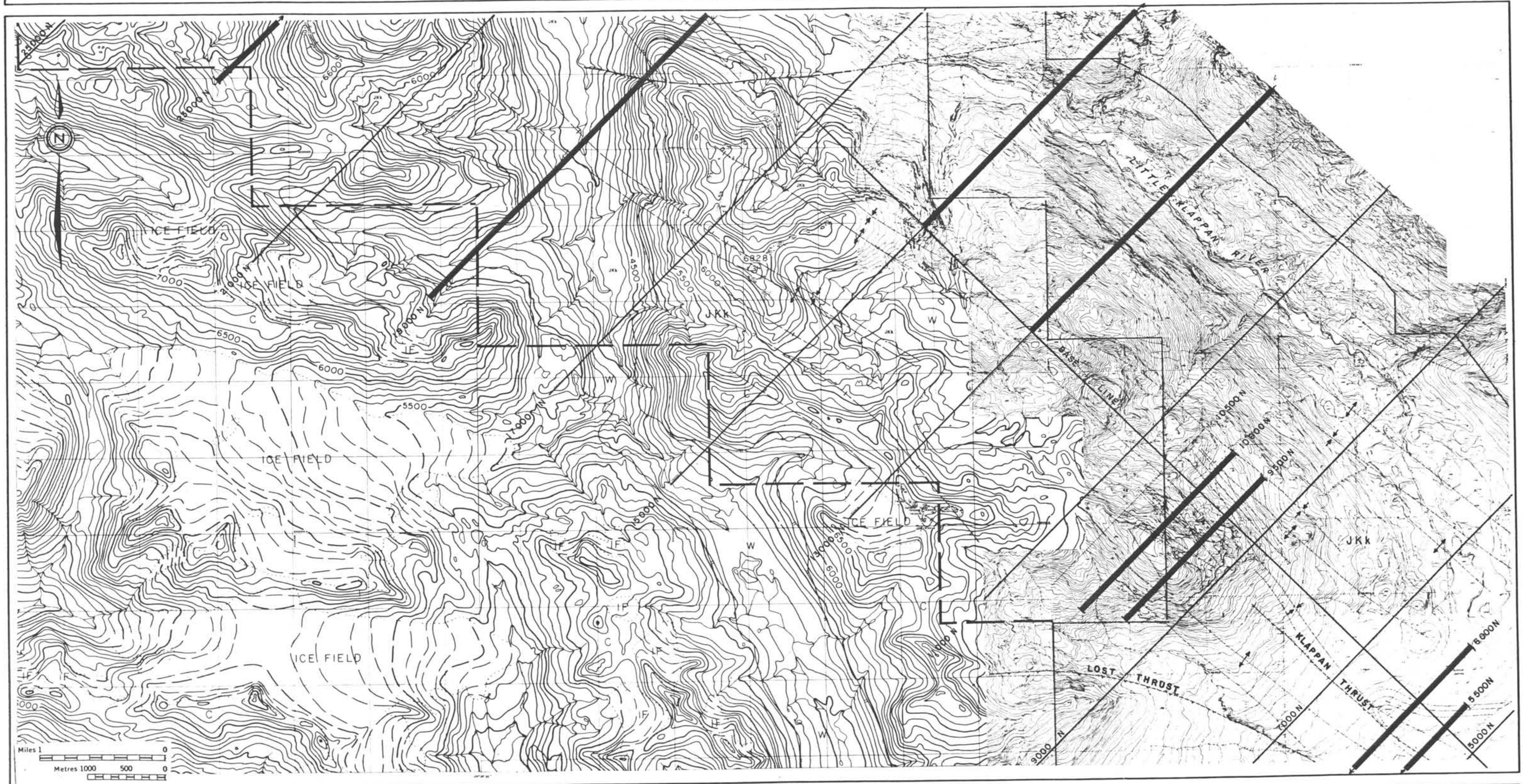

TABLE OF FORMATIONS

JKr - RHONDDA SEQUENCE
CONGL., GRITS, SHALES

JKm - MALLOCH SEQUENCE
INTRBD, SILTSTONES, CONGL, THIN COAL

JKk - KLAPPAN SEQUENCE
MDST., SDST., COAL SEAMS

GEOLOGICAL SYMBOLS

LICENCE BOUNDARY
GEOLOGICAL CONTACT(APPROX.,INFER)
COAL SEAM(OUTCROP INFER)
ANTICLINE(DEFINED,APPROX.)
SYNCLINE(DEFINED,APPROX.)
THRUST FAULT(DEFINED,APPROX.,INFER)

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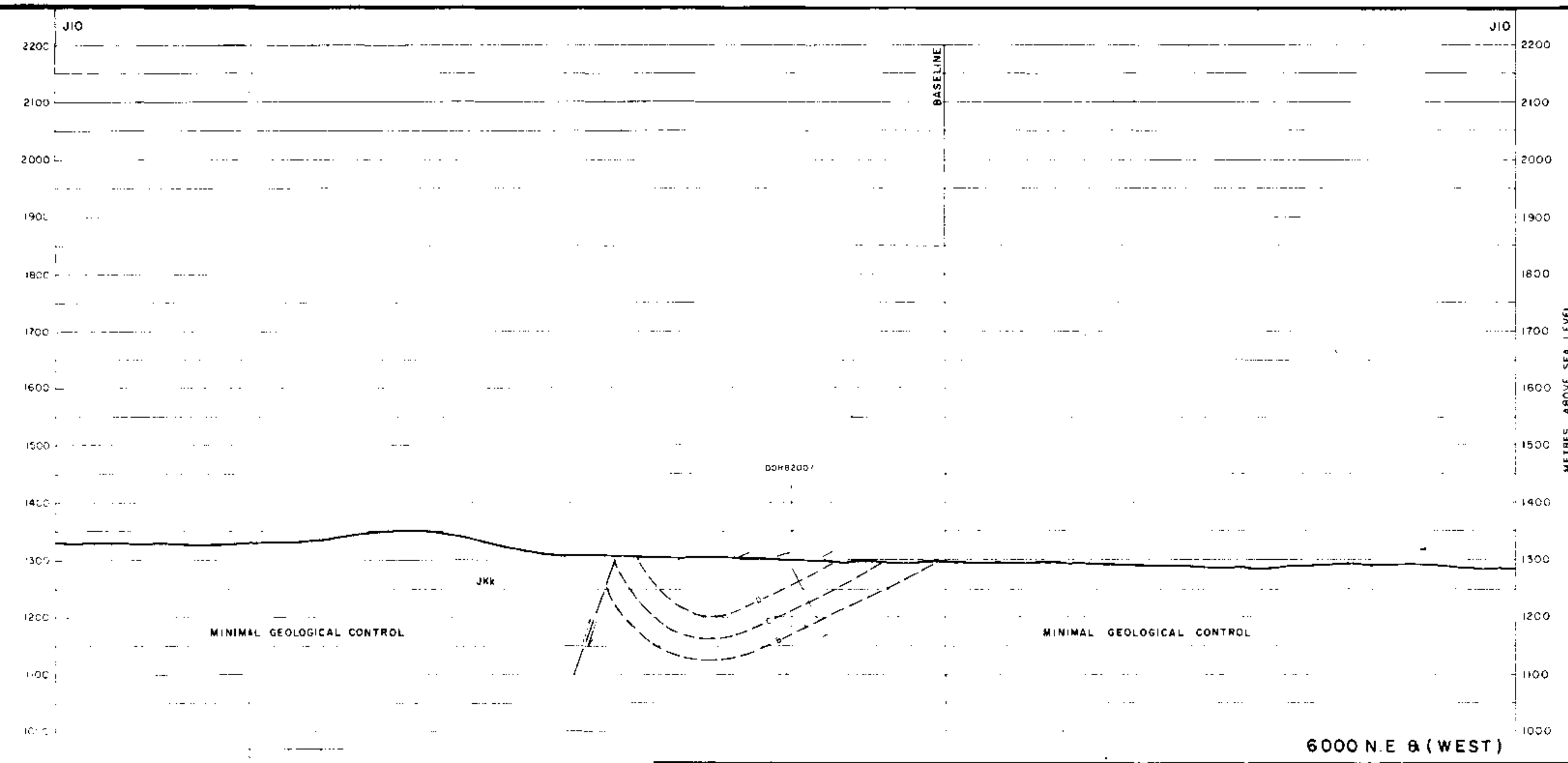
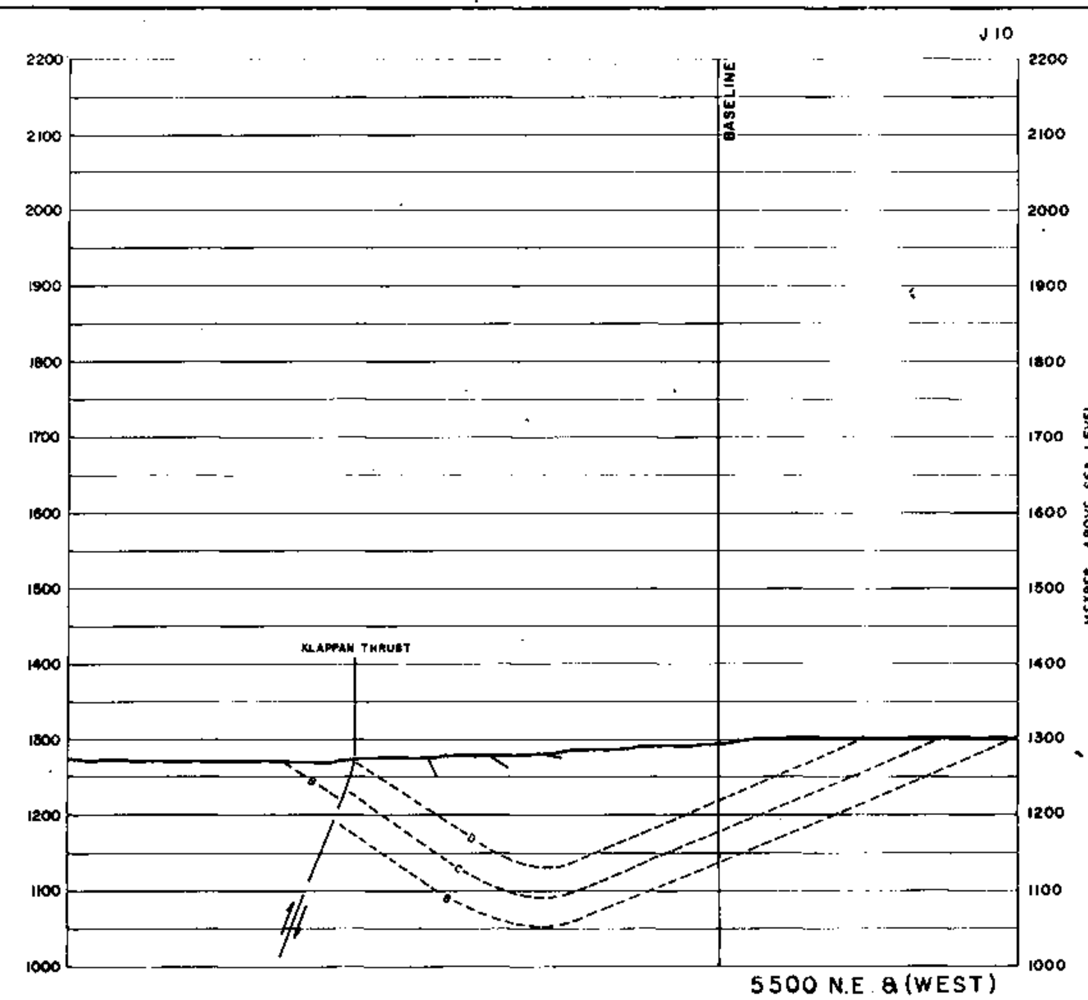
16/03/84





RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

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Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.16A

MOUNT KLAPPAN COAL PROPERTY

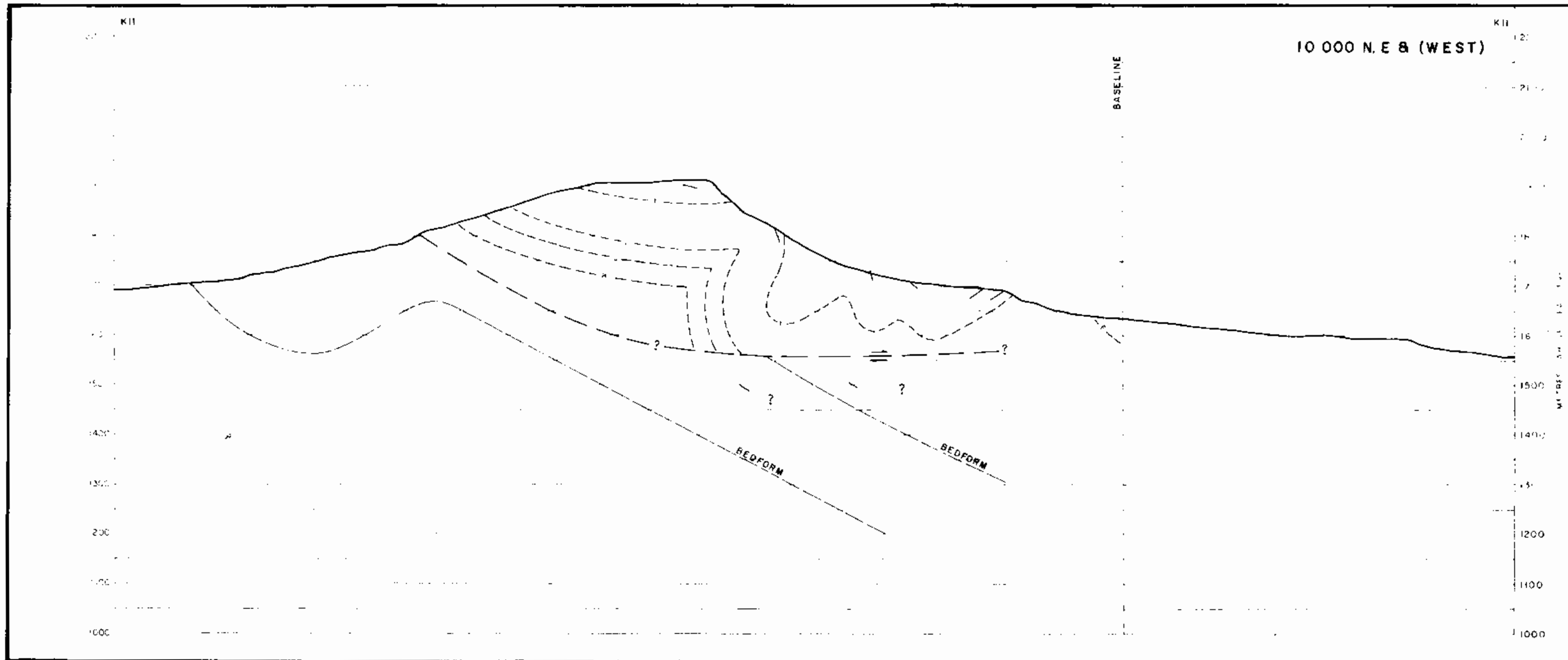
SUMMIT AREA

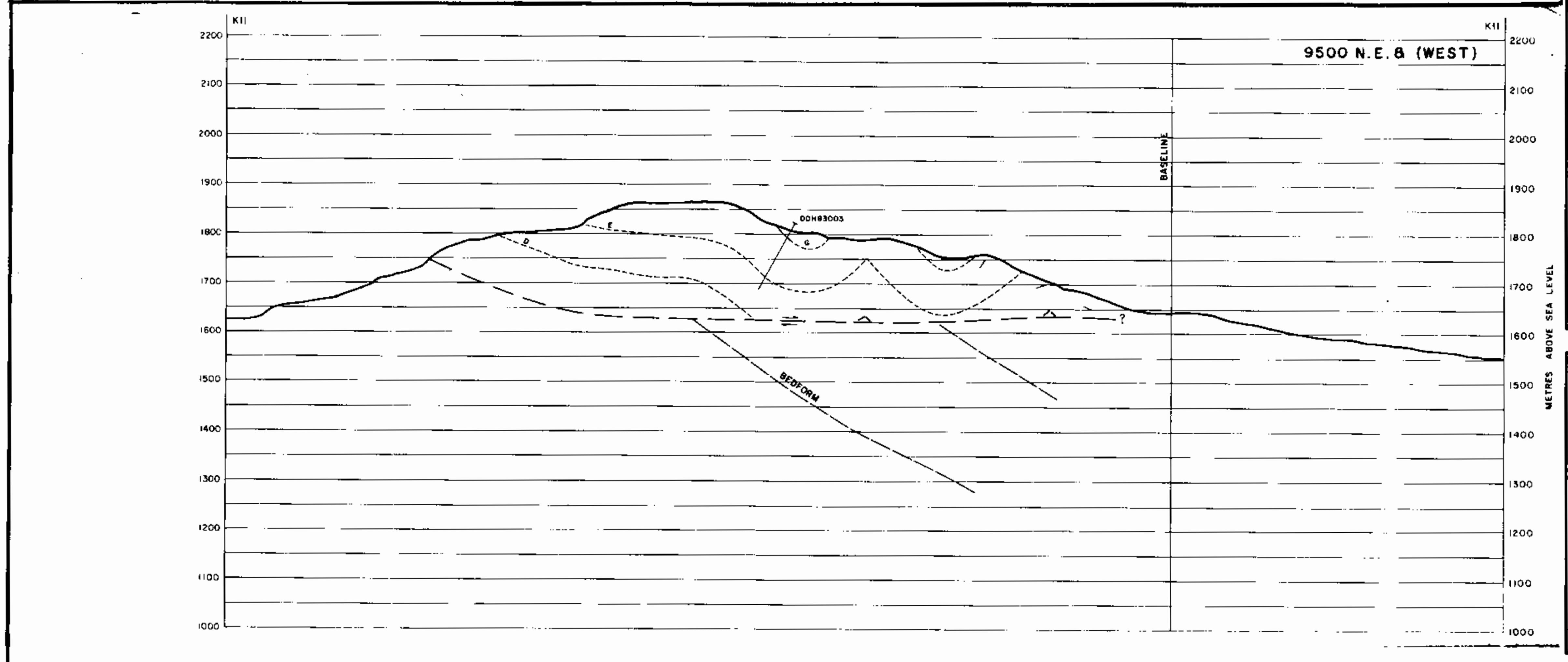
GEOLOGICAL CROSS SECTIONS

6000 & 5500 N.E. & (WEST)

Gulf

15/03/84





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Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.16B

MOUNT KLAPPAN COAL PROPERTY

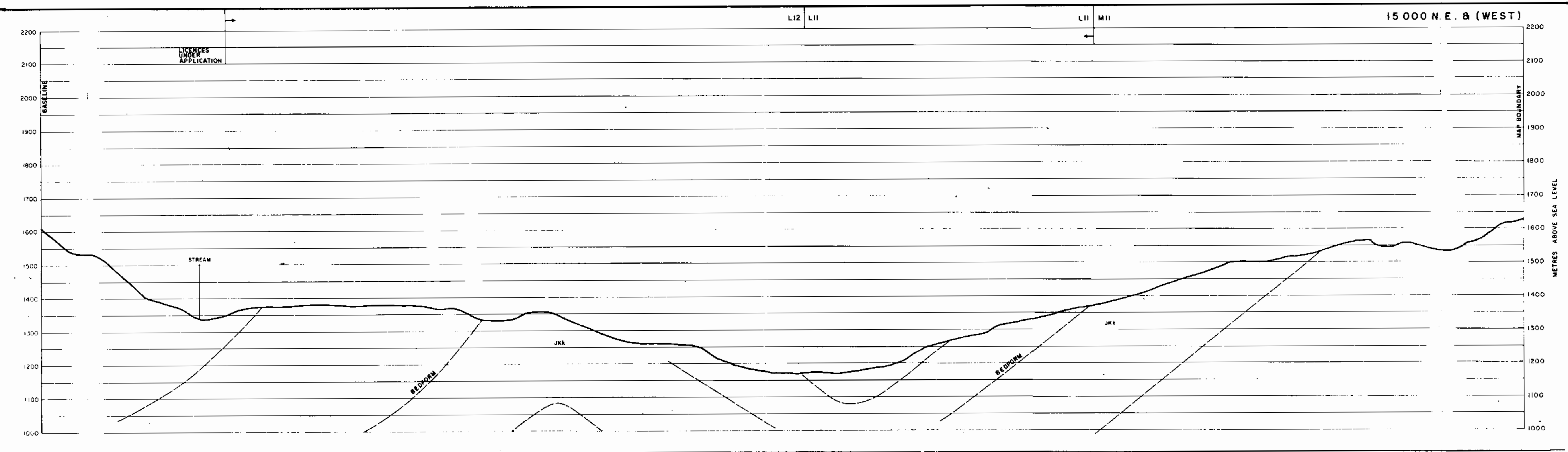
SUMMIT AREA

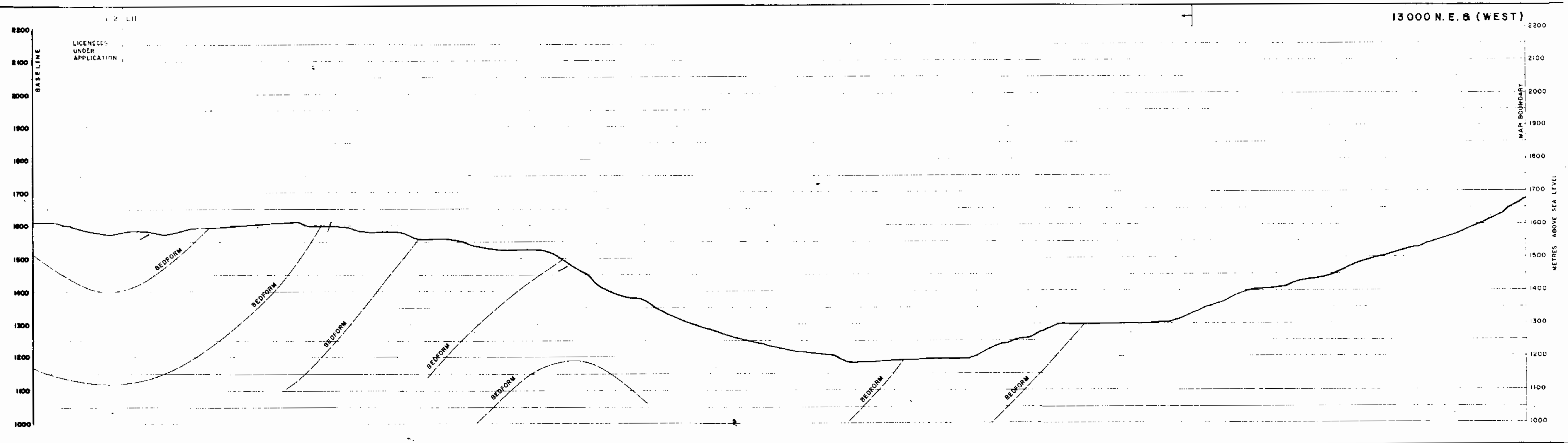
GEOLOGICAL CROSS SECTIONS

10000 & 9500 N.E. 8 (WEST)

Gulf

15/03/84





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Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.16C

MOUNT KLAPPAN COAL PROPERTY

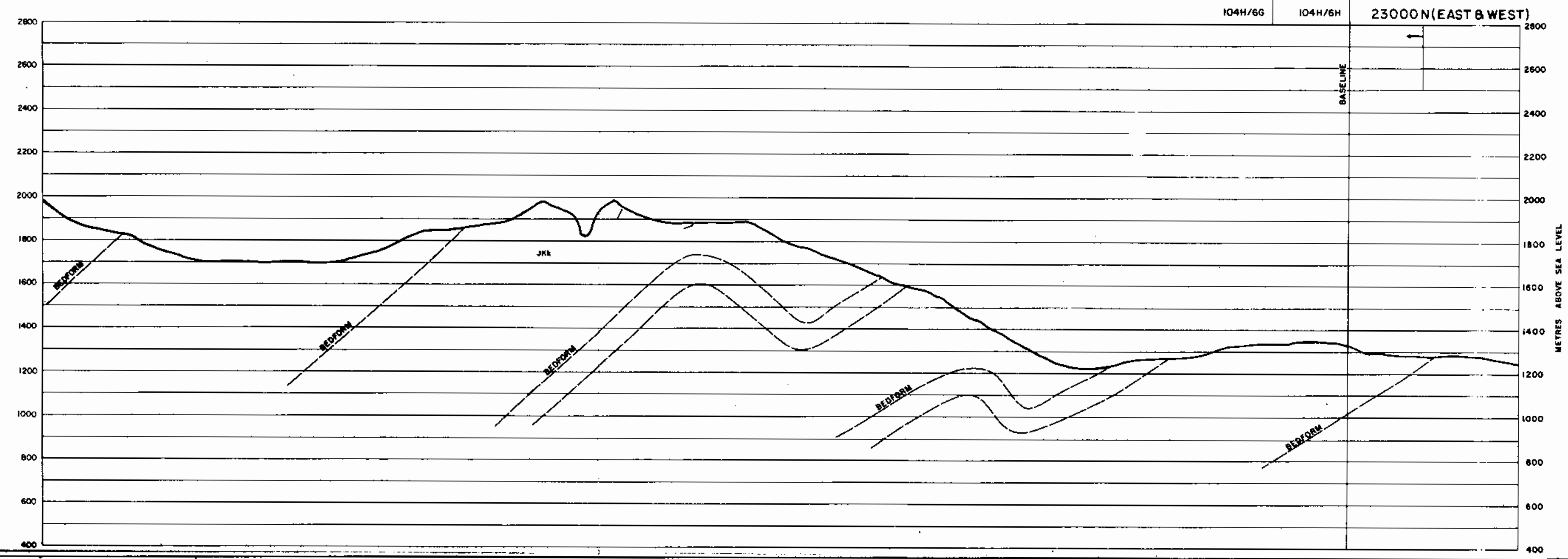
SUMMIT AREA

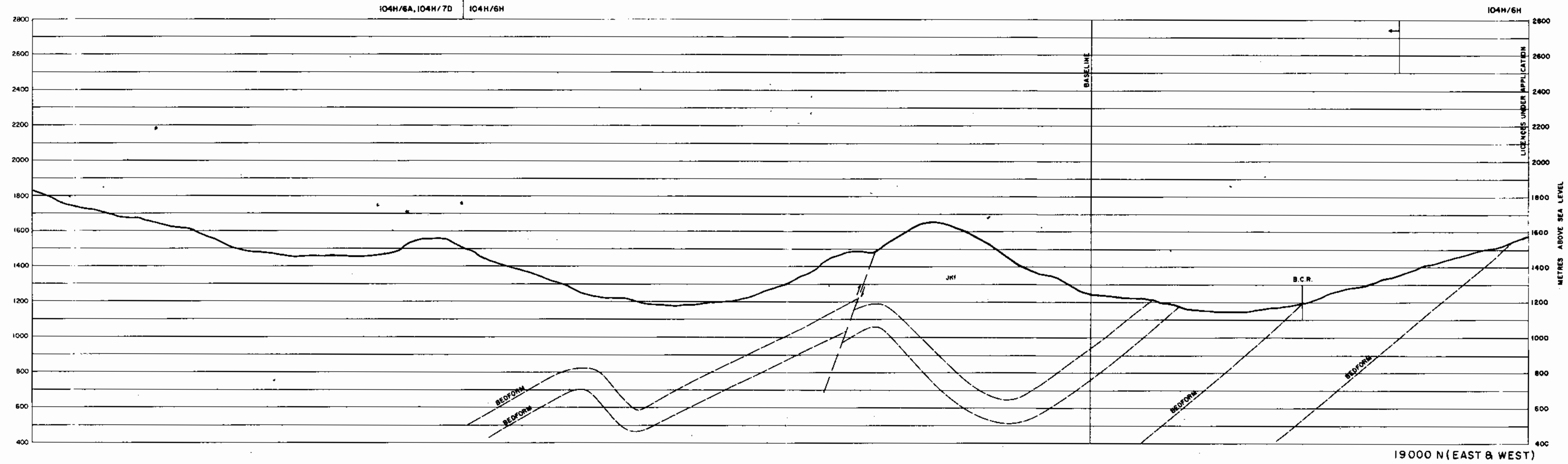
GEOLOGICAL CROSS SECTIONS

15000 & 13000 N (EAST & WEST)

Gulf

15/03/84





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JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 — 1/2 — 1 MILE

0 — 1000 — 2000 METERS

FIGURE 6.16D

MOUNT KLAPPAN COAL PROPERTY

SUMMIT AREA

GEOLOGICAL CROSS SECTIONS

23000 & 19000 N (EAST & WEST)

Gulf

15/03/84

6.4.4 Klappan Mountain Area

The Klappan Mountain Area comprises the south-central portion of the Property from the southern licence boundary to Fox Creek in the north. The western limit of the area is marked by the highland separating the headwaters of the Little Klappan River and that of Tahtsedle Creek, while to the east, the foot of Knooph Hill and eastern extensions of Grizzly Ridge and Cincies Ridge provide the boundary (Figure 6.17). A total of 18 trenches have been excavated.

The Klappan Mountain Area is underlain, in order of abundance, by the Malloch and Klappan Sequences and to a very small part by the sediments of the Rhondda Sequence.

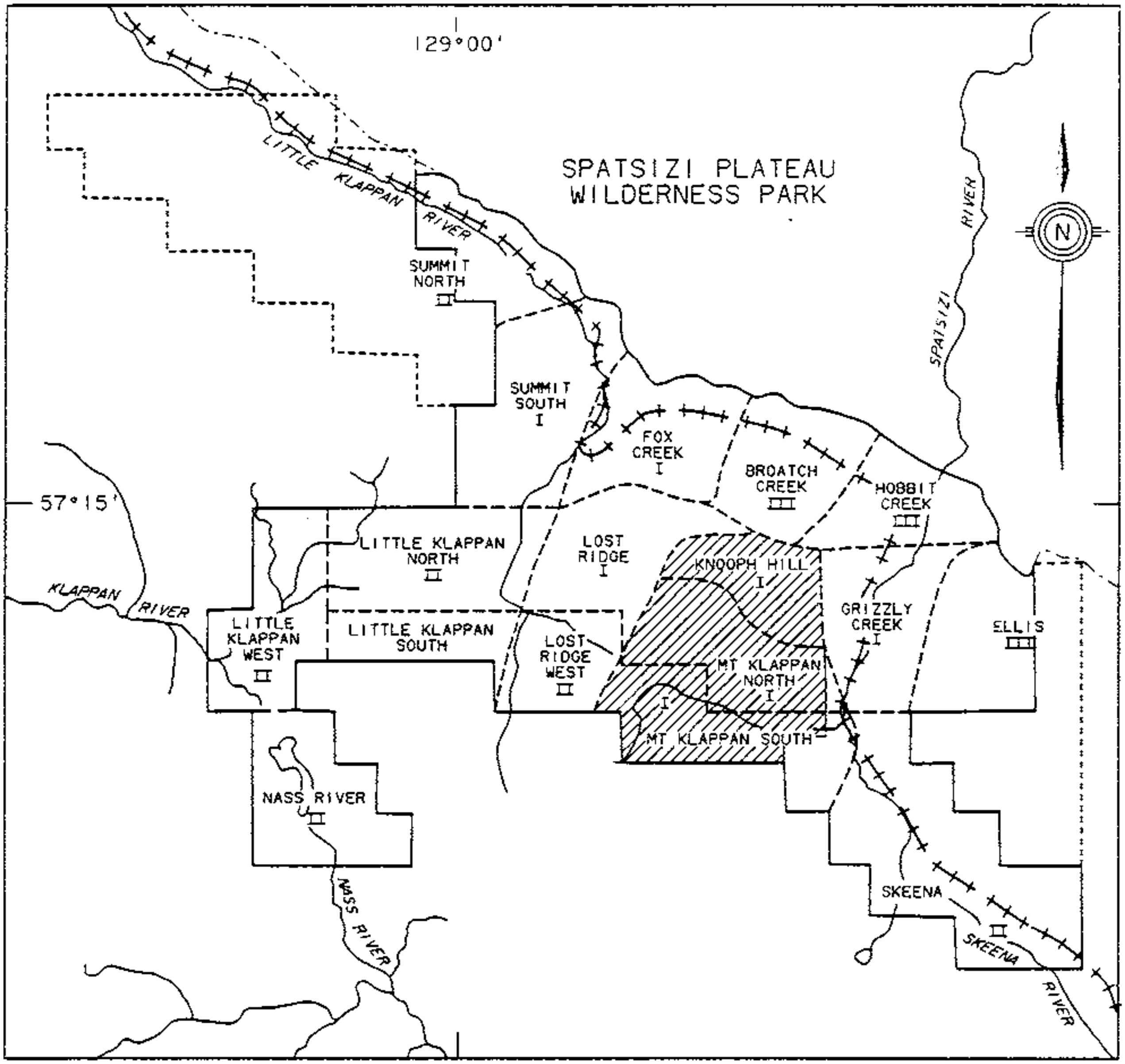
6.4.4.1 Coal Seam Development

Within the Malloch Sequence 11 seams have been trenched giving a cumulative average thickness of 13.77 metres. These seams are contained within a stratigraphic interval 350 metres thick. The seams vary from a minimum average thickness of 0.33 metres to a maximum average of 2.50 metres. The average seam thickness (including seams less than 0.5 metres) is 1.25 metres. Interseam thickness varies from 15 to 87 metres. Many trenches have not been included in this correlation, as the structural and stratigraphic information is as yet inconclusive in several areas. Furthermore, numerous exposures of coal spoil are

FIGURE 6.17

MT. KLAPPAN COAL PROPERTY

KLAPPAN MOUNTAIN AREA 1983 MAPPING AREA



LEGEND

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- LICENCES UNDER APPLICATION
- I FIRST PRIORITY
- II SECOND PRIORITY
- III THIRD PRIORITY

SCALE

0 1 2 3 km

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09/01/84

scheduled for trenching. The trenched seams are expected to increase the number of correlatable coal seams within the area (Figure 6.18).

6.4.4.2 Structure

The Klappan Mountain Area is dominated by northwest-southeast trending first phase folds, predominantly upright and open in nature. Several folds in the Tahtsedle Creek area and one on the north face of Mount Klappan are overturned to the northeast. Folds vary in wavelength from 200 to 1000 metres averaging 500 metres, with amplitudes reaching 300 metres, but commonly are 150 metres.

The second phase folds, which are seen as plunge changes within the primary folds, are broad and open, reversing north to south dip direction on average every 900 metres with values of between 18° north and 16° south.

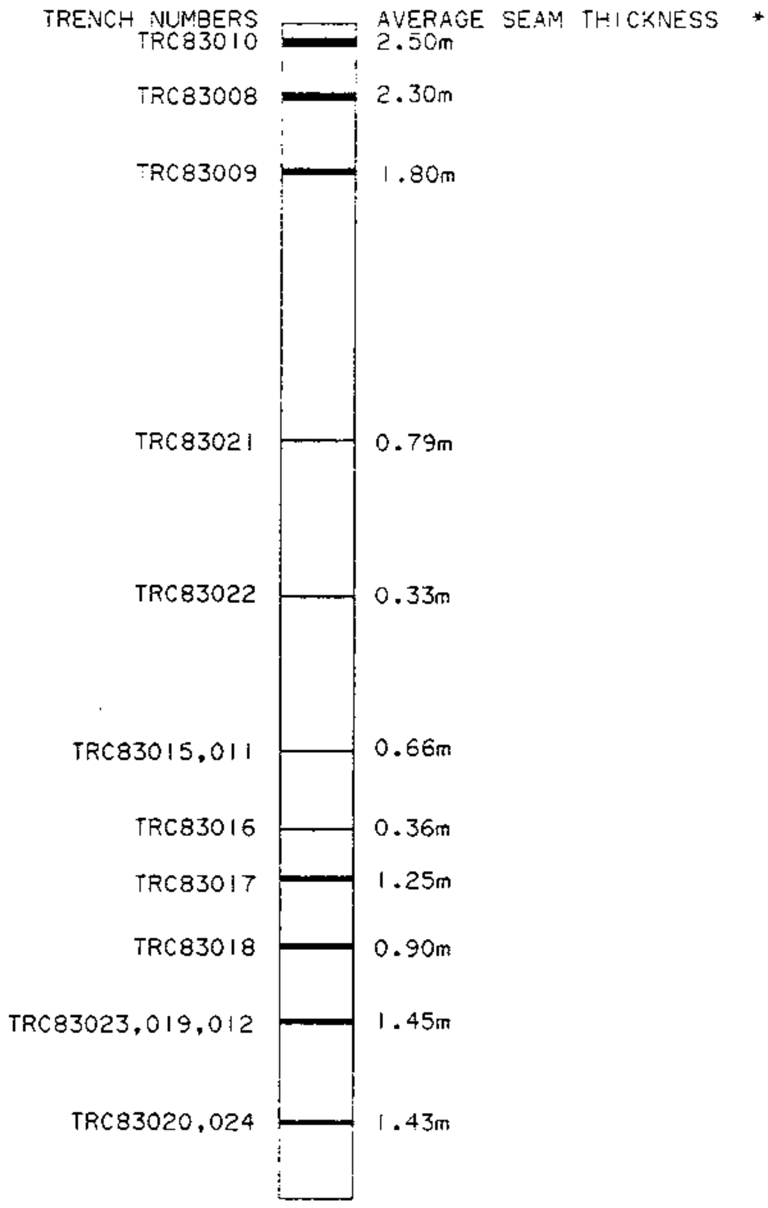
Two southwest dipping Thrust Faults have been noted in the area, namely, the Klappan and Tahtsedle Thrust Faults. Both of the faults have limited dip slip displacement in the order of 100 metres or less. It is suspected there are several other Thrust Faults of minor displacement within the area.

On the north face of Mount Klappan, two extensional faults have been mapped. Both faults

FIGURE 6.18

MT. KLAPPAN COAL PROPERTY

KLAPPAN MOUNTAIN AREA COAL SEAM DISTRIBUTION



NOTE: * INCLUDES SEAMS <0.5m

SCALE: 1:2500

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09/03/84

strike northeast-southwest and have strike-slip displacement of approximately 100 metres, the dip slip component is not known at this time. Several normal faults, a few tens of metres in displacement and of limited extent, were also noted (Figures 6.19 and 6.20).

6.4.5 Little Klappan-Nass River Area

The Little Klappan-Nass River Area occupies the southwest part of the Property extending east to Lost Ridge, north to Summit South and southwest past Nass Lake (Figure 6.21).

Most of the area is underlain by the Klappan Sequence with the Malloch Sequence outcropping along the higher ridges to the south and southwest.

The mapping area contains both marine and marginal marine sediments. Mudstone and siltstone sequences hosting bivalves, intersected by DDH83002, and coal seams trenched along the Little Klappan River are considered marine. Southward at higher elevations in the Nass River Area, plant fossils and coal seams (less than 0.5 metres thick) within siltstone and sandstone sequences, indicate marginal marine deposits. West of the Property, outcrop near the Nass River Glacier appears to be more marine (S. M. Rowe, 1983).

FIGURE 6.19

MT. KLAPPAN COAL PROPERTY

KLAPPAN MOUNTAIN AREA GEOLOGY

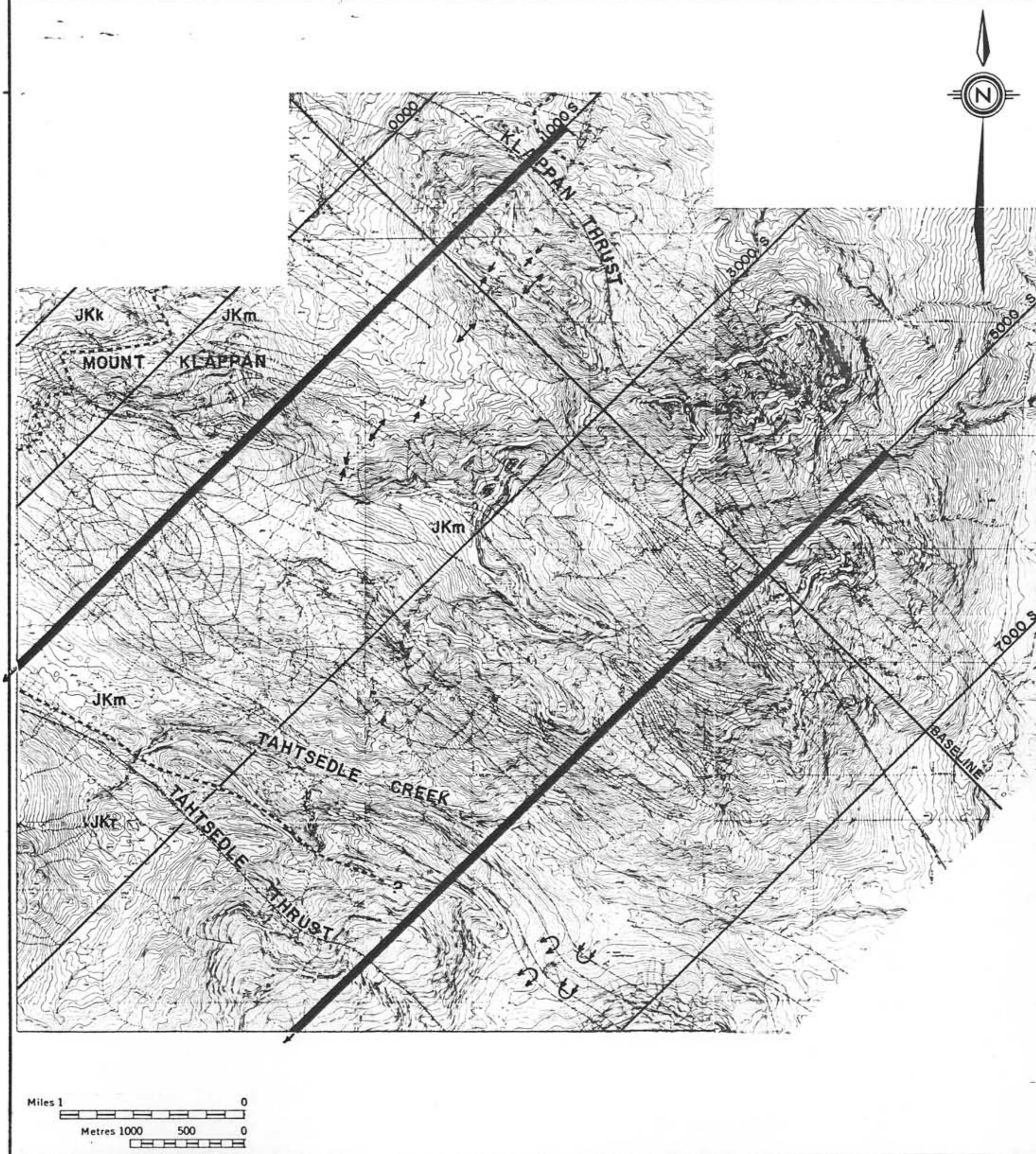


TABLE OF FORMATIONS	GEOLOGICAL SYMBOLS
JKr - RHONDDA SEQUENCE CONGL., GRITS, SHALES JKm - MALLOCH SEQUENCE INTRBD, SILTSTONES, CONGL, THIN COAL JKk - KLAPPAN SEQUENCE MDST., SDST., COAL SEAMS	LICENCE BOUNDARY GEOLOGICAL CONTACT(APPROX., INFER) COAL SEAM(OUTCROP INFER) ANTICLINE(DEFINED, APPROX.) SYNCLINE(DEFINED, APPROX.) THRUST FAULT(DEFINED, APPROX., INFER) GULF CANADA RESOURCES INC. 16/03/84

RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.20

MOUNT KLAPPAN COAL PROPERTY

KLAPPAN MOUNTAIN AREA

GEOLOGICAL CROSS SECTIONS

5000 & 1000 S.E. 8 (WEST)

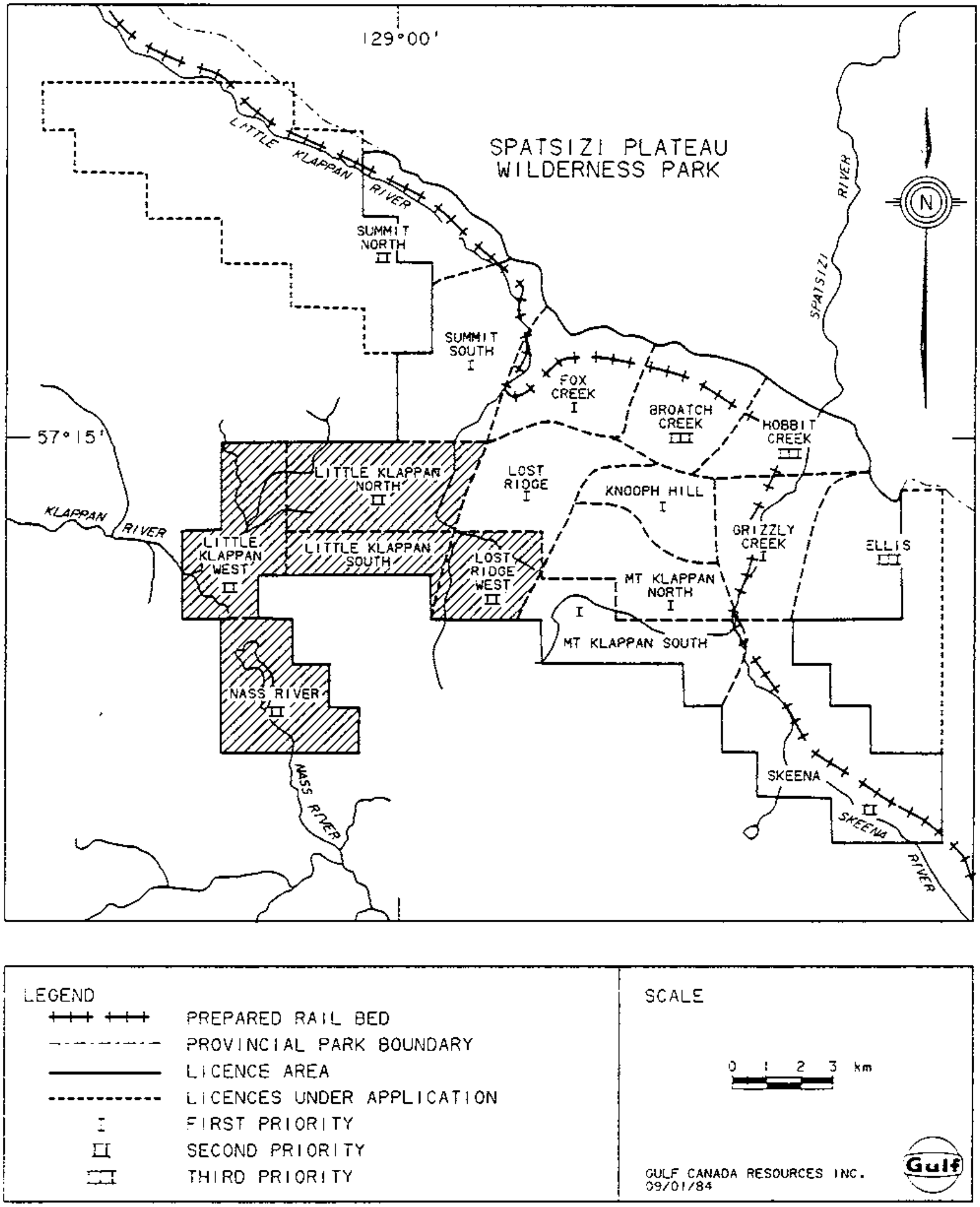
Gulf

15/03/84

FIGURE 6.21

MT. KLAPPAN COAL PROPERTY

LITTLE KLAPPAN - NASS AREA 1983 MAPPING AREA



6.4.5.1 Coal Seam Development

Nine coal seams have been defined by coal quality and trench log correlation of the trenches excavated in the Little Klappan-Nass River Area. Due to the lack of drill hole data, interseam thicknesses were obtained from cross-sections. The coal seams total 18.9 metres over a minimum interval of 670 metres with seam thicknesses varying from 0.86 metres to 3.96 metres (Figure 6.22). The average thickness is 2.1 metres. Four additional seams that were trenched were not used in the coal seam statistics as the distance of projection to the cross-section would have produced inaccurate interseam thicknesses.

Of note is the Tahtsedle Thrust which cross cuts the coal bearing section. The displacement along this thrust has been approximated and further work to ascertain the displacement may result in a change of the thickness of the coal bearing section.

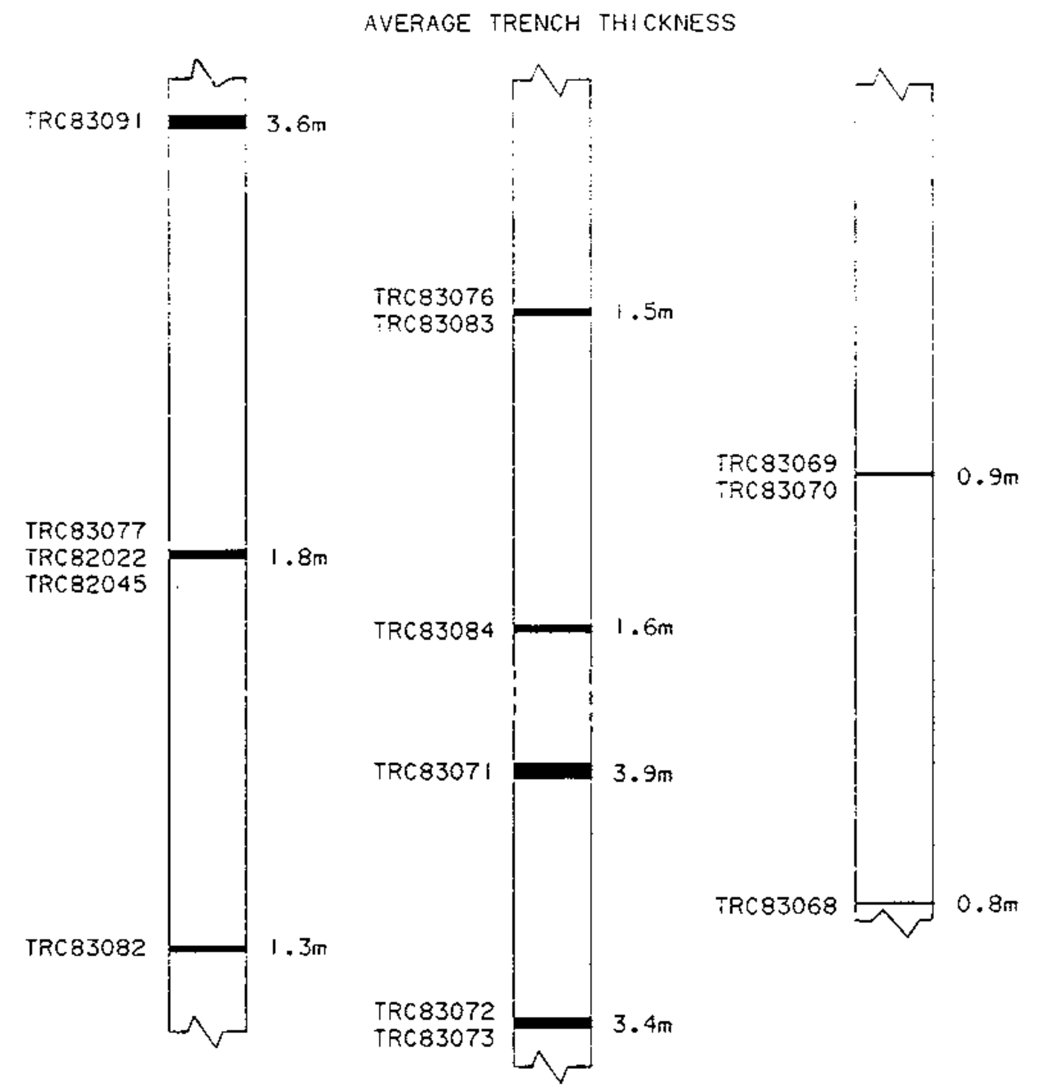
6.4.5.2 Structure

The Little Klappan-Nass River Area is structurally dominated by the Mount Beirnes Synclinorium. Northeast of Nass Lake, the syncline plunges to the southwest at 14° with limbs dipping up to 60°. West of the synclinal core, tight folds are overturned to the southwest while eastward the folds

FIGURE 6.22

MT. KLAPPAN COAL PROPERTY

LITTLE KLAPPAN-NASS AREA COAL SEAM DISTRIBUTION



* SEAM CORRELATION AND POSITION IN STRATIGRAPHIC SEQUENCE DETERMINED FROM COAL QUALITY DATA AND CROSS SECTIONS RESPECTIVELY. SEAM THICKNESS BASED ON TRENCH DATA.

SCALE: 1:2000

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are overtuned to the northeast (Bustin and Moffat, 1983).

Two deformational phases are evident throughout the area. Broad F_1 folds dominate the structure with wavelengths ranging from 400 to 700 metres and amplitudes of 250 metres. Tighter F_1 fold styles exist on a smaller scale. Along the Little Klappan River these folds are upright to overturned to the northeast trending at 110° and plunging 11° southwest. Wavelengths vary from 250 to 400 metres with amplitudes of 50 to 100 metres. Similar F_1 folds exist westward, north of Nass Lake. Second phase folds have been documented where northwest trending F_1 folds plunge 20° southeast then reverse plunge to 10° northwest.

The Tahtsedle Thrust is the major Thrust Fault across the area. It has been mapped south of Mount Klappan and traced, through air photo interpretation, to just east of Nass Lake. Striking WNW and dipping at approximately 40° at surface, the Thrust truncates northwest trending folds to the south and places them over eastwest trending folds to the north. The truncation of these two fold trends may be a result of either a scissoring effect during thrusting or a large-scale dipslip displacement. A maximum of 500 metres dip slip displacement, narrowing to 100 metres displacement, has been interpreted for the Tahtsedle Thrust. To the west, this Thrust is untraceable. The Nass Lake Thrust, existing west of the Nass River, was delineated through air photo interpretation (Figures 6.23 and 6.24).

Due to thick tree cover and the limited extent of mapping, much of the structure in the western part of the mapping area was determined through air photo interpretation. Further exploration will provide better seam correlation and support the possible existence of plunge reversals suggested in air photos.

6.4.6 Skeena-Ellis Area

The Skeena-Ellis Area occupies the southeastern and eastern portions of the Mount Klappan Property (Figure 6.25). The licence boundary confines the area on its northern, southern, and eastern extremities. The western limits are defined by the Hobbit-Broatch resource area, the eastern limit of Cincies Ridge and the licence boundary on the west side of the Skeena River Valley.

The area is underlain by both the Malloch and Klappan Sequences dominating the uplands and valleys of the Skeena and Spatsizi Rivers, respectively.

6.4.6.1 Coal Seam Development

To date, only limited prospective exploration mapping has been conducted in this region. This has

FIGURE 6.23

MT. KLAPPAN COAL PROPERTY

LITTLE KLAPPAN - NASS AREA GEOLOGY

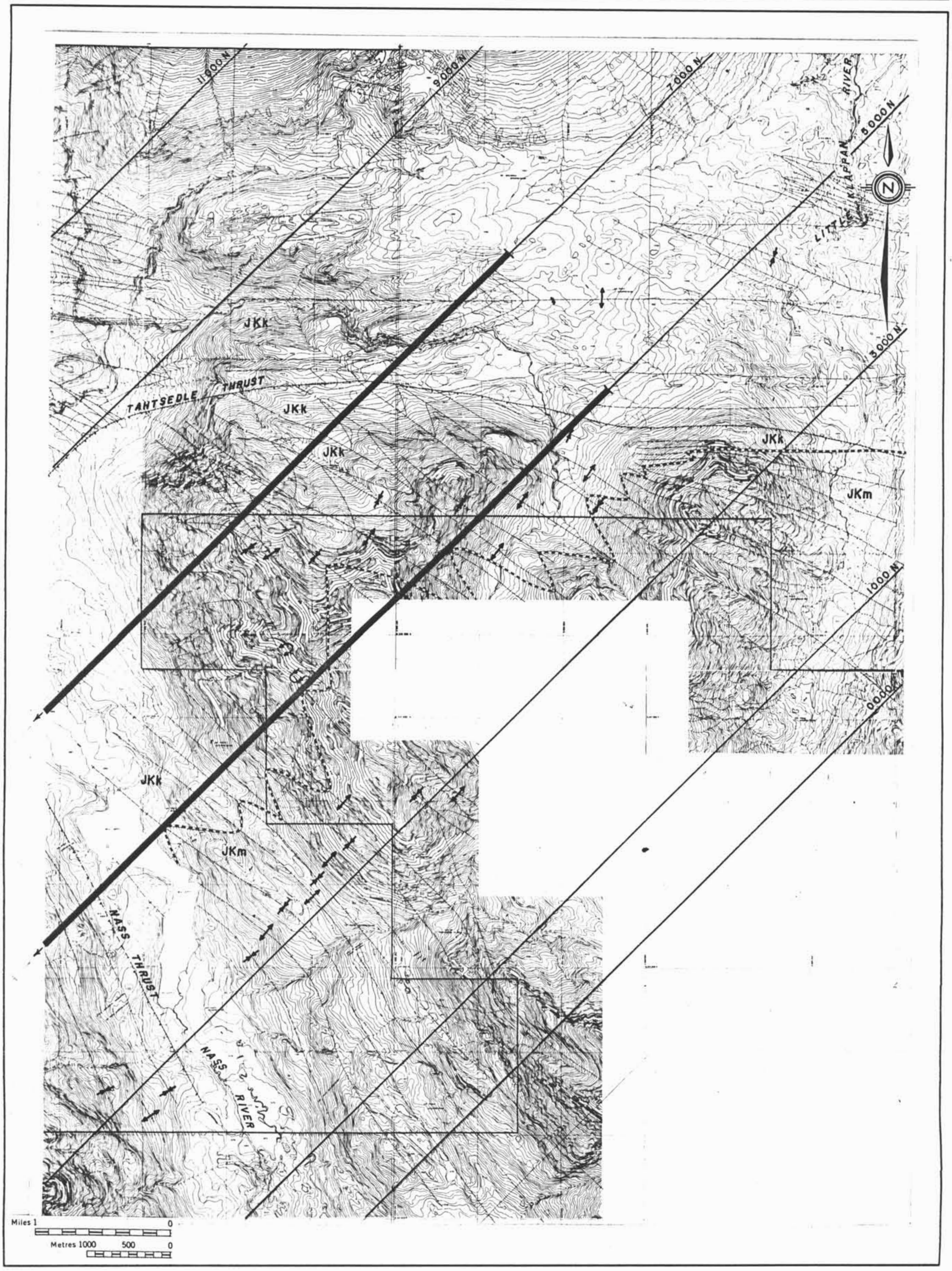


TABLE OF FORMATIONS

JKr - RHONDDA SEQUENCE
CONGL., GRITS, SHALES

JKm - MALLOCH SEQUENCE
INTRBD, SILTSTONES, CONGL, THIN COAL

JKk - KLAPPAN SEQUENCE
MDST., SDST., COAL SEAMS

GEOLOGICAL SYMBOLS

LICENCE BOUNDARY
GEOLOGICAL CONTACT(APPROX.,INFER)
COAL SEAM(OUTCROP INFER)
ANTICLINE(DEFINED,APPROX.)
SYNCLINE(DEFINED,APPROX.)
THRUST FAULT(DEFINED,APPROX.,INFER)

GULF CANADA RESOURCES INC.
16/03/84

RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

LICENCE BOUNDARY

COAL SEAM TRACE (OUTCROP, INFERRED)

GEOLOGICAL CONTACT (APPROX., INFERRED)

FAULT TRACE (DEFINED, APPROX., INFERRED)

DDH 83001

DIAMOND DRILL HOLE WITH ATTITUDE CONTROL

0 1/4 1/2 MILE

0 500 1000 METERS

FIGURE 6.24

MOUNT KLAPPAN COAL PROPERTY

LITTLE KLAPPAN - NASS AREA

GEOLOGICAL CROSS SECTIONS

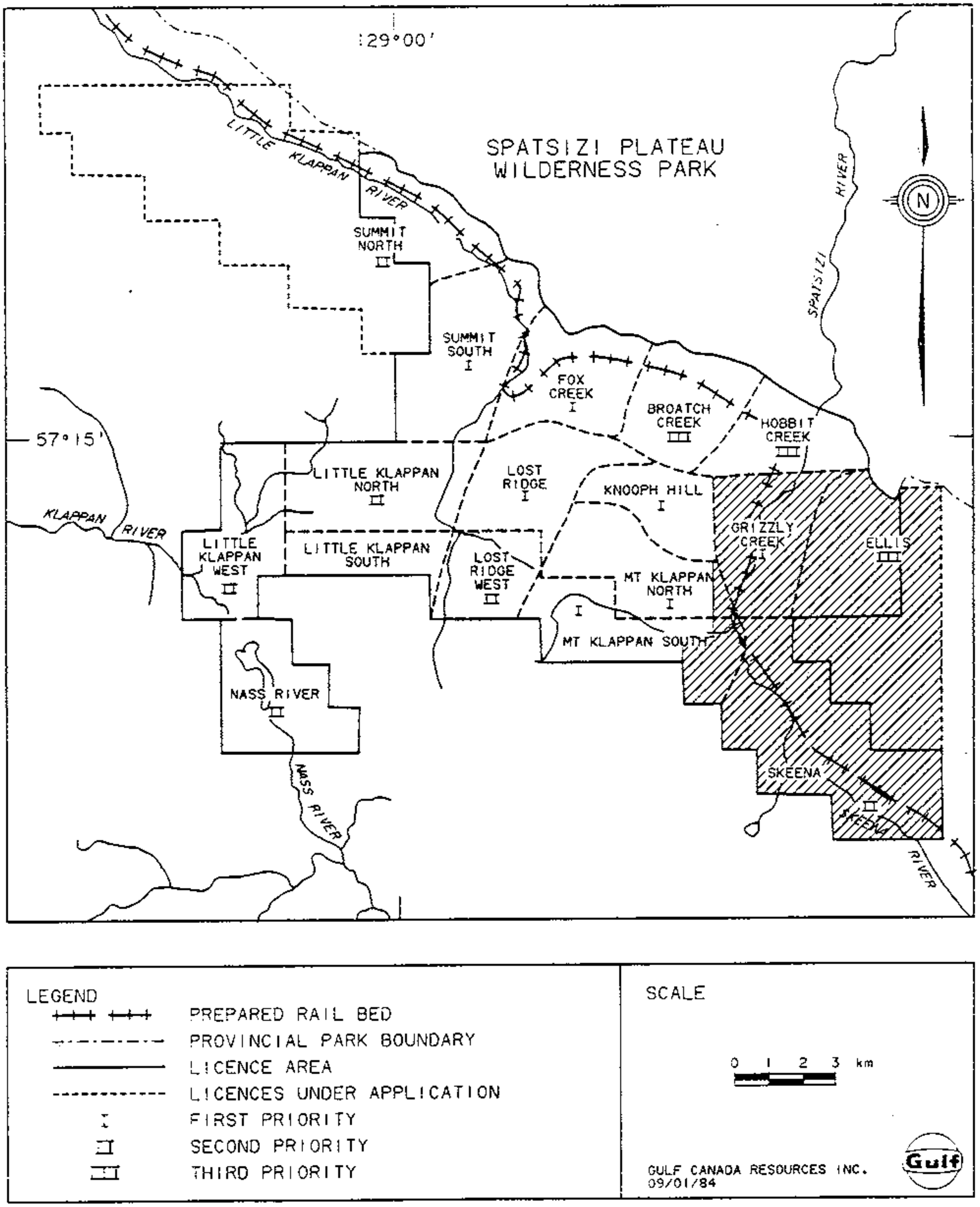
7 000 & 5 000 N. (WEST)

15/03/84

FIGURE 6.25

MT. KLAPPAN COAL PROPERTY

SKEENA - ELLIS AREA 1983 MAPPING AREA



resulted in the location of numerous coal showings but no trenching or drilling has been implemented. It is apparent that significant coal does exist in both the Klappan and Malloch Sequences and definition of this resource, however, awaits further work.

6.4.6.2 Structure

Reconnaissance mapping of the Skeena-Ellis Area has indicated the presence of the two phases of folding recognized across the Mount Klappan Property. The first phase folds are dominant and are seen to be upright and open; wavelength is in the order of 300 metres and amplitudes range from 400 to less than 50 metres. Plunge reversals are much more subdued in the Skeena-Ellis area with maximum values approaching 12° in either a northwest or southeast direction.

Of note is the difference in structural style across the Skeena River Valley. The highlands to the west are dominated by the Beirnes Synclinorium and exhibit very broad open folds that tighten and increase in frequency and complexity towards the valley floor. The east side of the Skeena River Valley does not reflect this same gradation in structural complexity. One possible explanation is the competancy of the different stratigraphic units to withstand deformation (Bustin and Moffat, 1983). The west side of the valley, just off the licences, is capped by the massive and resistant beds of the

Rhondda Sequences which are absent to the east of the Skeena River (Figures 6.26 & 6.27).

Faulting in the Skeena-Ellis area is expected to occur as in the rest of the Property; however, only two faults have been recognized to date. The Klappan Thrust Fault cuts across Cincies Ridge southward into the valley of the Skeena River where it is covered by recent fluvial sediments. Displacement is interpreted to remain at approximately 100 metres across this fault. On the north end of Ellis Ridge, a normal fault is found with a displacement in the order of 40 metres. This southwest-northeast trending fault can be traced for only a short distance as it crosses Ellis Ridge.

FIGURE 6.26

MT. KLAPPAN COAL PROPERTY

SKEENA - ELLIS AREA GEOLOGY

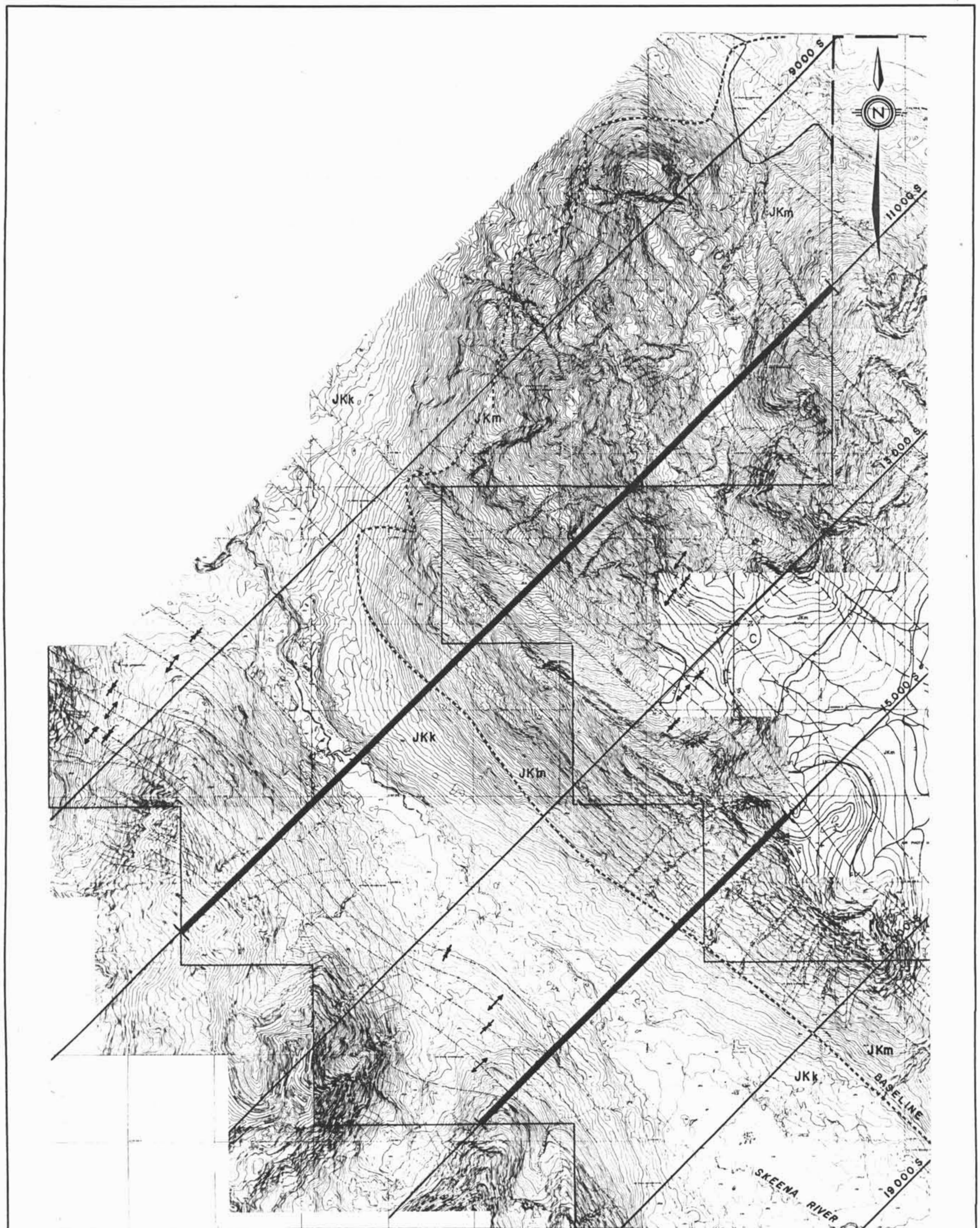


TABLE OF FORMATIONS

JKr - RHONDDA SEQUENCE
CONGL., GRITS, SHALES

JKm - MALLOCH SEQUENCE
INTRBD, SILTSTONES, CONGL, THIN COAL

JKk - KLAPPAN SEQUENCE
MDST., SDST., COAL SEAMS

GEOLOGICAL SYMBOLS

- LICENCE BOUNDARY
- GEOLOGICAL CONTACT(APPROX.,INFER)
- COAL SEAM(OUTCROP INFER)
- ANTICLINE(DEFINED,APPROX.)
- SYNCLINE(DEFINED,APPROX.)
- THRUST FAULT(DEFINED,APPROX.,INFER)

GULF CANADA RESOURCES INC.
16/03/84

RHONDDA SEQUENCE

JKr Massive to thick conglomerates and grits interbedded with minor siltstones and shales.

MALLOCH SEQUENCE

JKm Interbedded cyclic sequences of predominantly dark grey to dark brown weathering siltstones, orange weathering siliceous nodular siltstones and conglomerates. Unit shows marked increase in abundance of sandstones, massive conglomerates and thin coal seams towards the base. Coal seams average 1.0 to 2.0 metres in thickness and contain abundant rock splits. Sequence may contain petrified wood.

KLAPPAN SEQUENCE

JKk Sequence of predominantly dark grey weathering mudstones and siltstones interbedded with fine to coarse grained sandstones, occasional thin bedded calcareous orange weathering siltstone nodules, conglomerates, and abundant coal seams up to 5.7 m thick. Unit grades downwards into repetitive sequence of predominantly tabular bedded, medium to coarse grained conglomeratic sandstones which may display trough cross stratification. Interbedded siltstones and mudstones often displaying low angle cross lamination. Thick coal seams may be associated with the more massive of the sandstone beds. Fossils associated with the fine grained sediments include several species of bivalves as well as rare belemnites and ammonites.

Legend

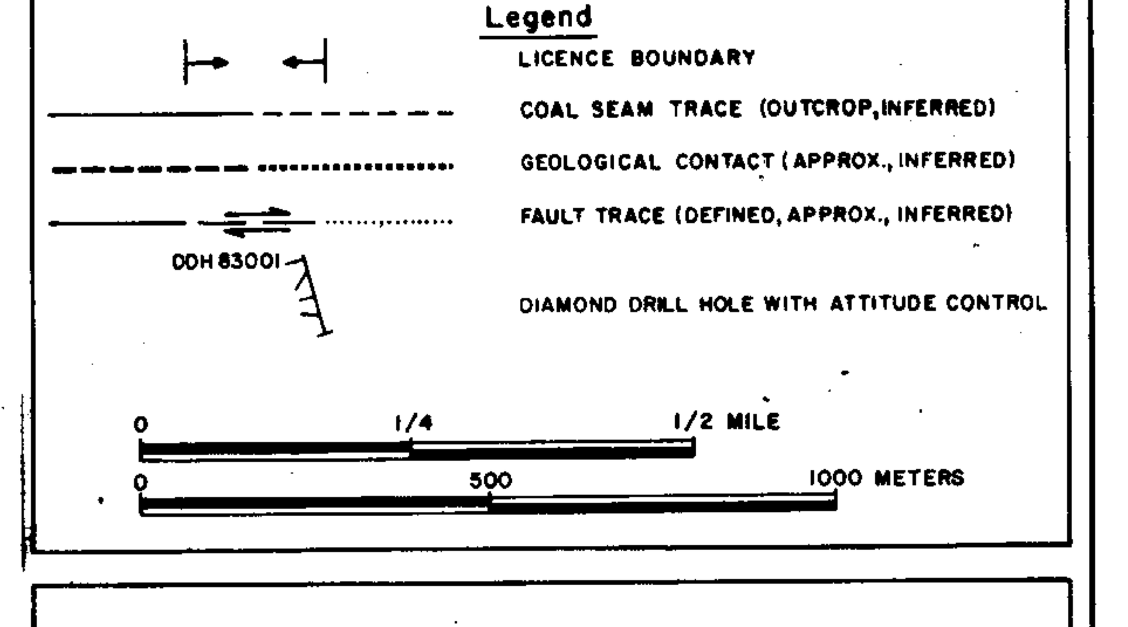


FIGURE 6.27

MOUNT KLAPPAN COAL PROPERTY

SKEENA - ELLIS AREA

GEOLOGICAL CROSS SECTIONS

15000 & 11000 S.E. 8 (WEST)

15/03/84

7.0 RESOURCES

7.1 Summary

The Klappan Sequence, underlying the Mount Klappan Property, is estimated to have an exploration resource potential of 4 billion tonnes (rounded down to the nearest billion) of anthracite coal. Of this amount, 967 million tonnes is classified as an inferred resource, and 3 billion tonnes is the speculative resource.

Resources	Billion Tonnes
Inferred	967
Speculative	3388
Total Resource	4355

7.2 Inferred Resource Area

The insitu inferred resources are contained within 4 areas (Figure 7.1). The Hobbit-Broatch Area, delineated in the 1981 and 1982 exploration programs, was not worked on and remains at 620 million tonnes inferred resource. Continued work in the Lost-Fox Area increased inferred resources from 240 to 330 million tonnes. The Summit Area has an additional inferred resource area within its boundary; however, additional geological information acquired during the 1983 exploration season reduced the inferred resources from 30 to 17 million tonnes.

Resource Area	Million Tonnes
Hobbit-Broatch	620
Lost-Fox	330
Summit	17
	967

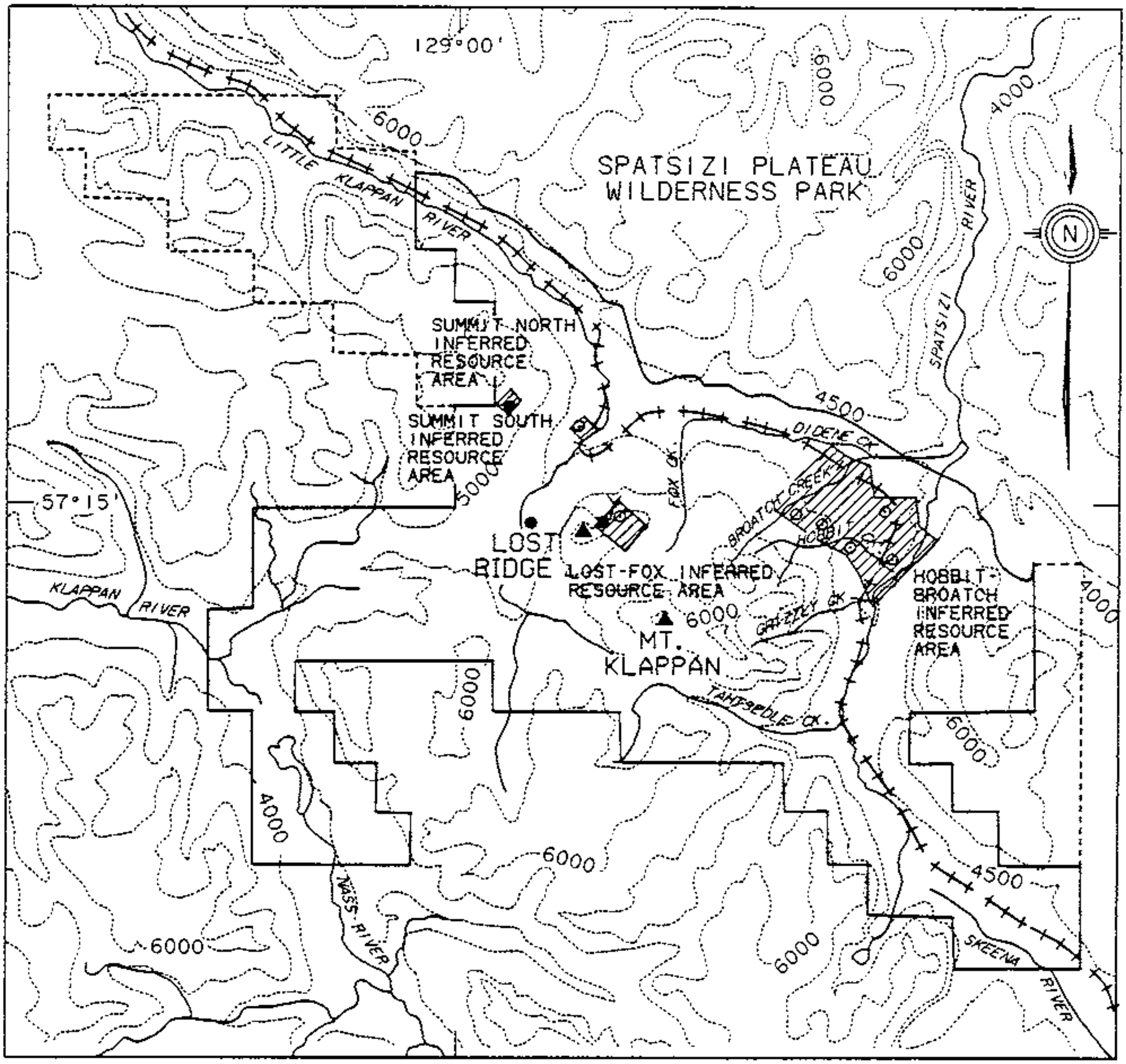
7.2.1 Hobbit-Broatch Resource Area

The Hobbit-Broatch Area was not examined during the 1983 program. The inferred resource of 620 million tonnes (Table 7.1) and resource area outline (Figure 7.1) remain as

FIGURE 7.1

MT. KLAPPAN COAL PROPERTY

INFERRED RESOURCE AREAS



LEGEND:

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- LICENCES UNDER APPLICATION
- INFERRED RESOURCE AREAS

SCALE:

0 1 2 3 4 5km

GULF CANADA RESOURCES INC.
07/03/84

Table 7.1

INFERRED RESOURCE AREA SUMMARY

RESULTING TOTAL SEAM TONNAGE (million tonnes)

SEAM	HOBBIT-BROATCH AREA	LOST-FOX AREA	SUMMIT AREA	TOTAL
O		0.325		0.325
N		1.04		1.04
M		4.69		4.69
L		11.69		11.69
K	67.94	33.18		101.12
J	32.81	32.60		65.41
I	162.26	42.55		204.81
H	63.47	42.28		105.75
G	106.21	48.60 22.19	0.53 0.99	178.52
F	18.18	46.62		64.80
E	57.02	12.50	2.36 2.63	74.51
D			4.75	4.75
C		12.41	3.79	16.20
B	52.60	14.29	2.27	69.16
A	59.55	5.27		64.82
Total	620.04	330.23	17.33	967.60

per the 1982 Mount Klappan Geological Report.

7.2.2 Lost-Fox Resource Area

The Lost-Fox Resource Area occupies the eastern half of Lost Ridge extending east to the baseline, west to the Ridge Thrust, south to Fox Creek and north to the extent of outcrop control (Figure 7.1). This Area consists of approximately 330 million tonnes of inferred coal resources within a 6.0 square kilometre area (Table 7.1).

7.2.3 Summit Resource Areas

The Summit resource areas have been arbitrarily defined as being within one kilometre strike direction and within one kilometre dip direction from a geological control point. Geological boundaries, described in Section 6.4.3, further restrict the size of the Summit Resource Areas. Only lack of data limits the continuation of the Resource Areas in all directions other than subcrop direction. In the Southern Summit Resource Area, an inferred resource of 10.8 million tonnes occurring in seams B, C, and D was calculated from an aggregate seam thickness of 7.91 metres (Table 6.5). In the Northern Summit Resource area, an additional inferred resource of 6.37 million tonnes occurring in seams E lower, E upper, G lower, and G upper was calculated using an aggregate seam thickness of 7.58 metres (Table 6.5). The total inferred resource identified thus far in the Summit Area is 17.3 million tonnes (Table 7.1).

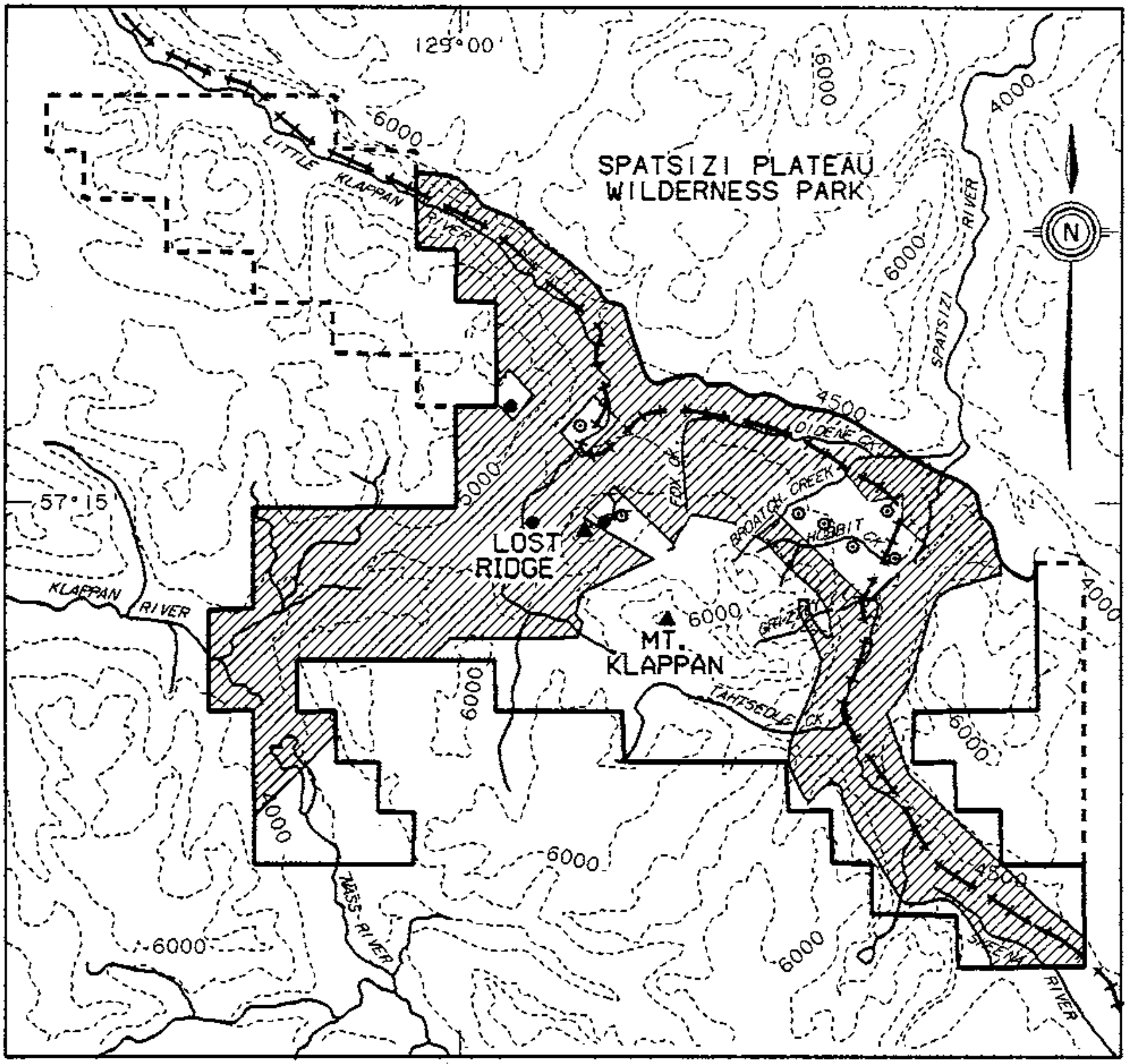
7.3 Speculative Resource Area

The speculative resource of 3.388 billion tonnes is calculated to underlie an area of approximately 235 square kilometres within the Mount Klappan Property. Five mapping areas, which include the Skeena-Ellis, Lost-Fox, Little Klappan-Nass, Summit, and Hobbit-Broatch (Figure 7.2) were measured and the area underlain by the Klappan Sequence determined. A proporation of the Klappan Sequence aggregate coal thickness was utilized to obtain the resources for these areas (Table 7.2).

FIGURE 7.2

MT. KLAPPAN COAL PROPERTY

1983 SPECULATIVE RESOURCE AREAS



LEGEND:

+++ ++	PREPARED RAIL BED
— - — - —	PROVINCIAL PARK BOUNDARY
———	LICENCE AREA
- - - - -	LICENCES UNDER APPLICATION
//////	SPECULATIVE RESOURCE AREAS

SCALE:

0 1 2 3 4 5km

GULF CANADA RESOURCES INC.
07/03/84

Table 7.2

SPECULATIVE RESOURCE AREA SUMMARY

Mapping Area	Planimetric Area Average (cm^2)	Correct-tion Factor(%)	Speculative Resource Area (km^2)	Proportion Aggregate Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes Tonnes (million)	Total Property Speculative Resource
Skeena-Ellis	211	.2461	51.93	8.47	1.70	747.70	
Lost Fox	151	.2461	37.16	8.47	1.70	535.08	
Little-Klappan Nass	294	.2461	72.35	8.47	1.70	1041.82	
Summit	172	.2461	42.33	8.47	1.70	609.50	
Hobbit-Broatch	128	.2461	31.50	8.47	1.70	453.58	
							3387.68

7.4 Total Property Resources

The total resource potential of the Property has been calculated to be 4.355 billion tonnes of anthracite. The figure was derived by summing the inferred and speculative resources.

7.5 Procedures and Parameters

The Property is subdivided into five resource areas based on confidence in stratigraphy, structure, coal seam distribution, and coal thickness. Four of the areas are defined as containing inferred resources, and the remainder as containing speculative resources.

All 1983 inferred resources were calculated by the cross-section method at a spacing of 500 metres to a total depth of 650 metres.

Seam thickness, seam length, section width, and specific gravity constituted the basic data for all resource calculations according to the following formula:

Metric Tonnes Coal = Thickness x Length x Width x Specific Gravity

These parameters were applied in a similar manner for all cross-section resource tonnage calculations.

The seam thicknesses used were true thickness values. Where a coal zone contained two distinct seams, the thicknesses were summed. Parameters for inferred resource calculations in the Hobbit-Broatch Area are unchanged and can be referred to in the Mount Klappan Coal Project - Geological Report 1982.

Within the Lost-Fox Area, seam thicknesses are based upon drill hole intersections and trench values. Where two or more values per seam were obtained, the thicknesses were averaged. The Summit Area seam thicknesses are based on drill hole intersections only.

Individual seam lengths in the Lost-Fox, and Summit Areas were measured to a maximum depth of 650 metres. The individual seam thickness applied to this seam length resulted in the calculated coal area related to individual cross-sections.

The area of influence of each cross-section used to determine coal volume in inferred resource areas, was defined as the distance between the midpoints of adjacent cross-sections. The sections were spaced 500 metres apart in all inferred resource areas.

A planimetric area approach was utilized to determine the speculative resources within the Mount Klappan Property (Figure 7.2). Included were the Skeena-Ellis, Lost-Fox, Little Klappan-Nass, Summit, and Hobbit-Broatch Areas. The outcrop area of the Klappan Sequence within each of these areas was measured by planimeter and coal tonnages derived by using a portion of the aggregate coal thickness found within the Lost-Fox Area of 53.62 metres. This porportionate thickness of 8.47 metres was derived from an average of 150 of the 950 metres of the Klappan Sequence interpreted to underlie these areas. Inferred resource areas were removed from any area determinations.

A specific gravity of 1.70 g/cc for insitu coal was used throughout all resource calculations to determine coal tonnage. This figure was derived from average specific gravity determinations on drill core samples.

8.0 COAL QUALITY

8.1 SUMMARY

The 1983 Mount Klappan exploration program produced additional coal quality information on the Lost-Fox and Summit Resource Areas. DDH83-001 provides data on seams E, F, G, H and a second intersection of I to the resource indicated in seams I, J, K and L by DDH82-005. The overall average raw coal quality for the Lost-Fox Area has not changed through the addition of these seams and the potential for generation of low sulphur, low ash premium products is preserved and even improved.

Simulated clean coal analysis for all seams in DDH83-001 provide average quality for 5% ash and 10% ash products in the Lost-Fox Area. Seams E through I produce an average 22.6% laboratory yield of 5.0% ash coal with a gross calorific value of 7940 cal/gm (a.d.b.) and 0.6% sulphur. A 31.8% yield of 24.0% ash briquetting material with a gross calorific value of 5760 cal/gm (a.d.b.), (5910 cal/gm (d.b.)) can be derived from 5% ash product reject.

As an alternative, a 34.1% laboratory yield of 9.2% ash premium coal can be produced from the same seams. This product has a gross calorific value of 7390 cal/gm (a.d.b.) and a sulphur level of 0.6%. Reject from the production of this coal can be cleaned to yield 6.9% briquetting coal at 23.3% ash and 6010 cal/gm (6100 cal/gm (d.b.) gross calorific value.

TABLE 8.1

COAL QUALITY SUMMARY TABLE

	RAW		Lost-Fox	
	Lost-Fox	Summit	5% Ash	10% Ash
Yield	-	-	22.6	34.1
Proximate Analysis				
Residual Moisture	1.8	1.5	0.8	1.4
Ash	35.8	56.0	5.0	9.2
Volatile Matter	8.0	6.8	5.8	6.9
Fixed Carbon	54.4	35.7	88.4	82.5
Net Calorific Value (cal/gm)	4790	2970	7810	7260
Gross Calorific Value (cal/gm)	4900	3040	7940	7390
Hardgrove Grindability Index	48	62	35	36
Chlorine (%)	0.06	0.05	-	-
Carbon Dioxide (%)	3.4	4.8	0.1	0.2
Total Sulphur	0.5	0.6	0.6	0.6
Ultimate Analysis				
Carbon	56.3	37.6	88.5	82.8
Hydrogen	1.9	1.4	2.6	2.5
Nitrogen	0.6	0.3	0.9	0.9
Oxygen	3.1	2.6	1.6	2.6
Sulphur	0.5	0.6	0.6	0.6
Ash Composition				
SiO_2	54.5	57.5	51.0	56.3
Al_2O_3	20.9	18.8	26.5	23.0
Fe_2O_3	7.8	5.7	4.9	5.3
CaO	4.2	2.7	2.5	2.6
MgO	3.2	2.5	1.4	1.9
TiO_2	0.6	0.5	1.6	1.3
Na_2O	1.1	1.4	1.4	1.3
K_2O	1.0	1.3	0.8	1.1
SO_3	2.3	1.5	0.6	0.9
P_2O_5	0.9	0.6	2.2	1.5
Ash Fusion (Oxidizing Atmosphere °C)				
Initial Temp.	1260	1250	1240	1255
Softening Temp.	1325	1305	1400	1390
Hemispherical Temp.	1355	1335	1430	1415
Fluid Temp.	1390	1365	1450	1440

Table 8.2

MT. KLAPPAN BULK SAMPLE

Size Distribution of Total
Sample Crushed to 50 mm

SIZE FRACTION (mm)	WT%	CUMULATIVE WT%
50 x 25	14.00	14.00
25 x 12	9.40	23.40
12 x 6	11.20	34.60
6 x 1	33.60	68.20
1 x 0.5	11.90	80.10
0.5 x 0.15	12.20	92.30
0.15 x 0	7.70	100.00

The Hardgrove Grindability Index for both products is in the range of 35 to 36. The size distribution of raw coal from which sized products may be generated can be approximated by the analysis of the bulk sample from seam I. Of the total sample reduced to less than 50 mm, 23.4% is above 12 mm in size and 68.2% is above 1 mm.

In the Summit Resource Area, DDH83-003 intersects three seam intervals which have a relatively high head ash, but can with cleaning make a modest contribution of 10% ash product (8.5% laboratory yield).

The trench data reported in Section 8.4 is not included in average quality calculations for the resource areas, but is discussed in terms of its implications for future exploration.

The bulk sampling program is described in detail in Appendix IV, Volume IV.

8.2 PROCEDURES AND PARAMETERS

8.2.1 Introduction

The 1983 Mount Klappan exploration program provided three sources of data for discussion of the coal quality on the property.

An adit was driven in a well defined seam of known quality specifically to obtain a large sample for analytical investigations.

Hand trenches were dug wherever coal spoil was encountered in any abundance. If good definition of the stratigraphy, roof and floor of the seam could be gained through digging then a representative sample was taken to contribute to the body of data on property wide coal distribution and quality.

Three diamond drill holes were bored at various points on the property to further stratigraphic and resource interpretation. The seams cored in these holes were fully analyzed to provide detailed quality data to accompany resource calculations.

Because of the complexity of the adit bulk sample analytical program and the detail in which the findings are discussed, a separate volume (Appendix IV) is devoted to it.

The objectives and observations arising from the trenching and drilling programs are discussed here.

8.2.2 Trenching Program

8.2.2.1 Objectives

The objectives of the 1983 trenching program were as follows:

1) To provide an ongoing contribution to the data base on the distribution and thickness of outcropping seams.
2) To guide exploration into new areas through tracing of favourable analyses of trench sampled coal.
3) To contribute to the accumulated data on regional trends of quality and coal petrographic parameters.

8.2.2.2 Methodology

The procedures for siting, orienting and excavating trenches are described in Section 5.5. Upon completion, not all trenches had sufficient thickness or a high enough coal: rock ratio to warrant sampling. In addition ground conditions sometimes made it impossible to make a full transect of the seam, the trench resulting stopping short of the roof or floor or both. In these cases representative samples again could not be taken.

The sampling technique was guided by the internal stratigraphy of the seam. Normally, a fairly homogeneous seam would be cut by a single continuous channel. If substantial partings or changes in coal character were encountered in the trench, then several smaller samples would be taken with sampled intervals conforming to stratigraphic controls. Note was taken of the portion of the seam represented by each sample so that analytical results could be later compared and combined meaningfully.

8.2.2.3 Analytical Procedures

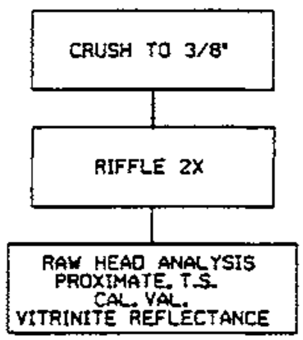
The analytical program for all 54 trench samples is illustrated in Figure 8.1. All analysis except vitrinite reflectance was carried out by Cyclone Engineering Sales Ltd. of Edmonton, Alberta. Subsamples for reflectance determination were prepared by Cyclone and shipped to the Commercial Testing and Engineering Co. office in Golden, Colorado. Trench samples were analyzed on a raw basis only, all washability and simulated product studies were conducted on the diamond drill core samples.

FIGURE 8.1

MT. KLAPPAN COAL PROPERTY

1983

ANALYTICAL FLOW SHEET FOR TRENCH SAMPLES



8.2.3 Diamond Drilling Program

8.2.3.1 Objectives

The objectives of the 1983 Mount Klappan diamond drilling program were as follows:

1) To intersect and sample new seams in an established resource area (DDH 83-001 in the Lost-Fox area).
2) To sample new seams in an attempt to broaden the established resource (DDH83-003 in the Summit South Block).
3) To provide washability and simulated product analysis data for the additional seams and to allow updating of the quality information on the resource contained within key areas.

8.2.3.2 Methodology

Diamond drill hole coal seam samples, logged in detail and sampled by increments, (see Appendix IV) were subjected to a full program of analytical tests and float sink studies, outlined in Figures 8.2 and 8.3).

FIGURE 8.2

MT. KLAPPAN COAL PROPERTY

1983

DIAMOND DRILL CORE COAL TESTING PROGRAM

PART 1

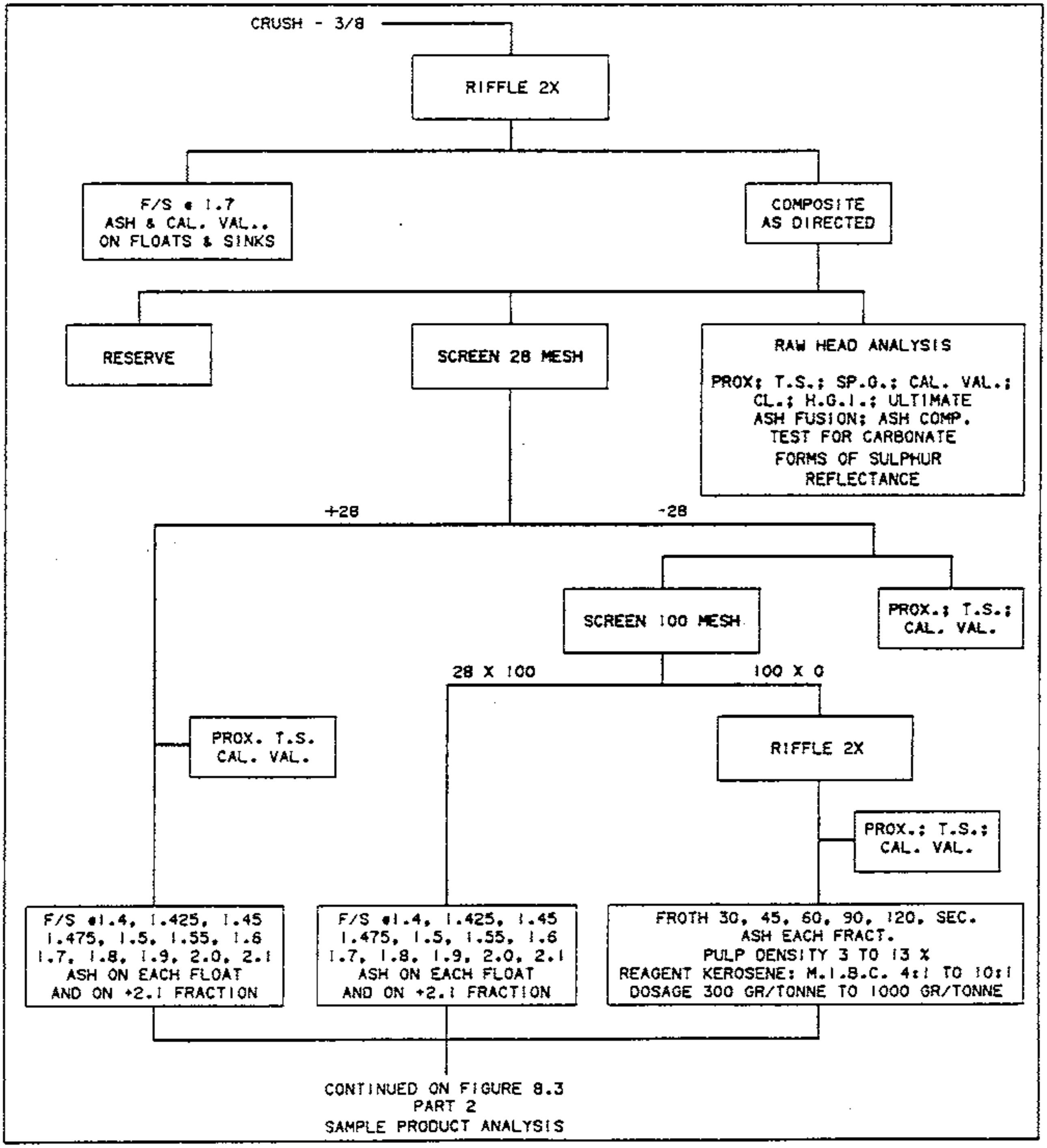


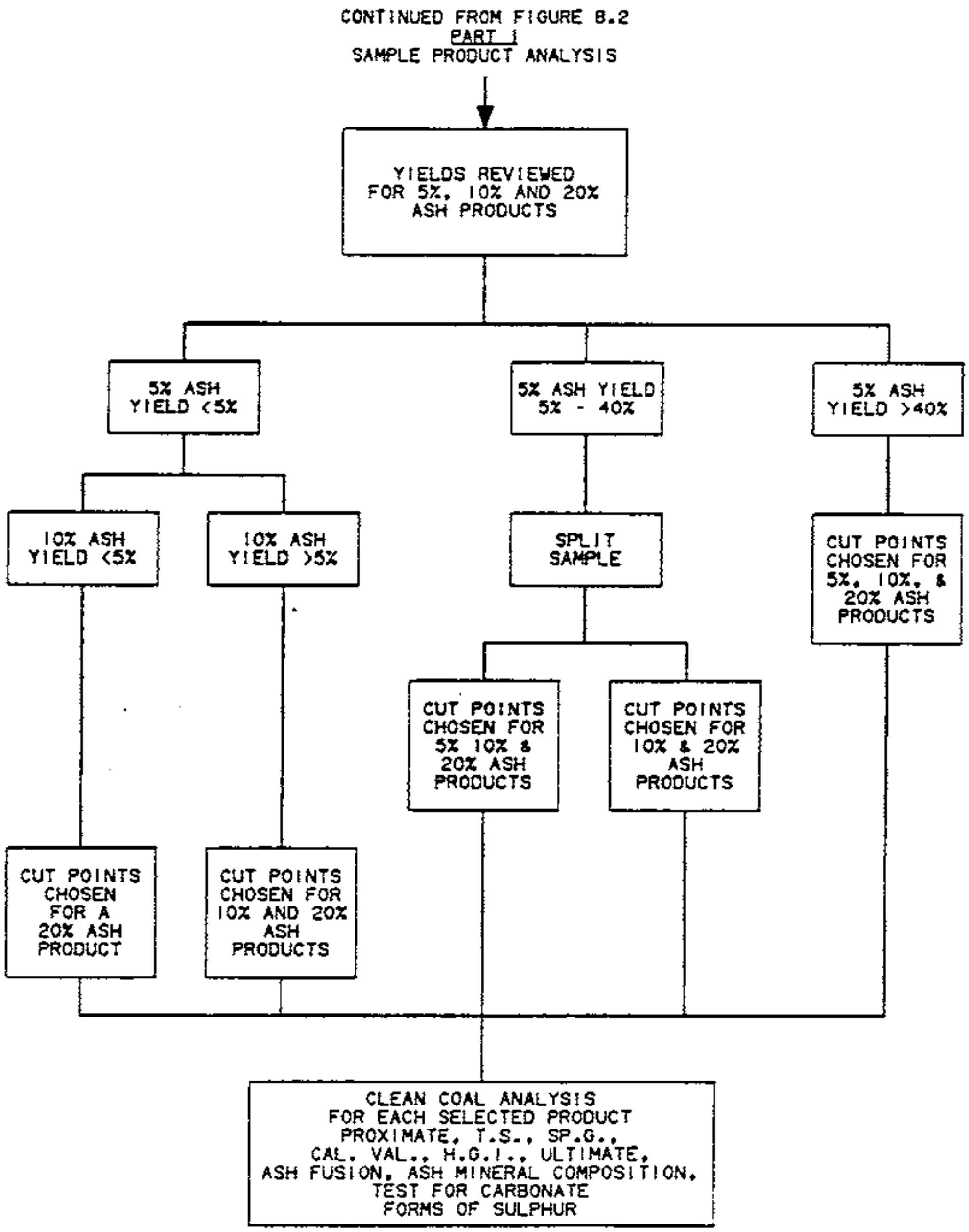
FIGURE 8.3

MT. KLAPPAN COAL PROPERTY

1983

DIAMOND DRILL CORE COAL TESTING PROGRAM

PART 2



The 1983 Mt. Klappan diamond drilling program involved three holes but the two seam intersections in DDH 83-002 were not sufficiently thick (less than 0.4 m) to warrant sampling and analysis.

All chemical and rheological analyses were done by Cyclone Engineering Sales Ltd. of Edmonton, Alberta, as per the flow sheet.

Vitrinite reflectance determinations were done at Commerical Testing and Engineering of Golden, Colorado.

8.2.3.3 Analytical Procedures

The flow sheet is divided into four main portions:

1) Compositing
2) Size Analysis
3) Detailed Washability Studies
4) Product Analysis

8.2.3.3.1 Compositing

Compositing of the incremental samples from each seam was guided by float-sink testing of a small portion of each sample to determine the yield and ash characteristics of the increment (Appendix

IV). Based on data available from 1981 and 1982 coal quality assessments a specific gravity of 1.7 was chosen for this initial float-sink test.

8.2.3.3.2 Size Analysis

Once composited, a portion of each composite sample was crushed to 3/8 inch (10.0 mm) and then screened on 28 mesh (0.6 mm) and 100 mesh (0.15 mm) screens. A detailed analysis of some larger size fractions is included in the bulk sample analysis report (Appendix IV).

8.2.3.3.3 Float Sink Data

A total of 10 specific gravity fractions between 1.40 and 2.10 S.G. were separated out of the +28 and 28 x 100 mesh size fractions of each composite sample. The specific gravities of flotation were 0.05 S.G. apart between 1.4 and 1.55 S.G. and 0.10 S.G. apart from 1.60 S.G. upwards.

The 100 x 0 fraction underwent froth flotation for periods of 30, 45, 60, 90 and 120 seconds.

Yield, ash and calorific value determinations done on each specific gravity fraction were used to group the seams according to their ability to product premium (5 + 10% ash) and briquetting quality (25% ash) products.

Certain cut-offs were applied in deciding whether a seam was capable of producing 5% or 10% ash (see Figure 8.3). In cases where marginal production of 5% ash was possible, samples were split (where sample quantity was sufficiently large) so that the potential of both 5% and 10% ash products could be assessed. A middlings product of about 26% ash was analyzed after extraction of the premium product wherever practical.

8.2.3.3.4 Product Analysis

The clean coal and raw coal and middlings products were subjected to extensive analytical tests, which included proximate analysis, ultimate analysis, total sulphur, forms of sulphur, calorific value, chlorine and carbon dioxide determinations, Hardgrove Grindability and ash characteristics. Some of these analyses were not possible for some seams due to limited availability of sample.

Calorific values for 1982 quality reported for comparison have been calculated from a linear regression generated using ash values and measured gross calorific values from all washability, product and raw analyses conducted to date for Mt. Klappan coal. The formula derived is:

Calorific Value (MJ/kg) = 34.989 - (Ash % x 0.411)

The regression was calculated using figures on an air-dried basis and can be used as a general correlation for all Mt. Klappan coal.

Net Calorific values are calculated using the formula:

Net C.V. (Btu) = Gross C.V. (Btu) - 10.30 x (Total Hydrogen % x 9).

8.3 Coal Rank

The Mount Klappan coal is anthracite. The mean maximum reflectance of vitrinite in oil ranges up to 4.87% and the dry mineral matter free (d.m.m.f.) volatile matter content of the purest washed coal available on the property, (2-5% ash), is 6% or less. A fuel ratio of 15, obtained by dividing the fixed carbon content by the volatile matter, is calculated for the same low ash coal.

Anthracite coal is characterized as having a mean maximum reflectance in excess of 2.5%, a d.m.m.f. volatile matter content of between 2% and 8% (A.S.T.M.) and a fuel ratio in excess of 9 (Japan Industrial Standards Association - J.I.S.).

A unique feature of the Mount Klappan anthracite is the presence of carbonate in the ash and partings within the seam. During tests to determine volatile matter content, the carbonates in the ash produce from less than 1% to 5% carbon dioxide, which is reported as a part of the total volatile matter. It should be noted that in coals with carbon dioxide contents in excess of 1%, the apparent value of volatile content will be inflated beyond the levels actually contributed by the coal. This will occur predominantly in coals with higher ash levels. The volatile matter content of premium low and medium ash coals with carbon dioxide contents below 1% will be representative.

8.4 Coal Quality - Trenching Program

8.4.1 Proximate, Sulphur and Calorific Value

As all coal derived from trench samples is weathered, analysis of these samples will not be indicative of the true character of the coal. Proximate analyses are generally useful only in that an indication of ash level is provided. Due to the extended oxidation of outcropping coal, moisture levels and frequently also volatile contents are artificially elevated. The volatiles are affected because the ash material is so saturated with moisture that not all moisture can be driven out of hydrated ash minerals at the low temperature used in residual moisture determination. The remaining moisture reports as water vapour to the volatile component. A fuller discussion of this phenomenon is given in the volume on bulk sample analysis (Appendix IV).

As these samples are from a number of different seams distributed over a wide area it is not surprising that ash levels vary from 12% to almost 65%. Most ash levels are depressed below true levels for the coal in unoxidized state because of the raised moisture and volatile contents. Moisture levels are no lower than 2% and peak at almost 16%, averaging around 6%. Volatiles range between 4.3% and 26.5% and average 14%.

Sulphur levels appear to be not much affected by the oxidation levels inherent in trench samples and average around 0.4%, much the same as for drill core. The odd trench with an exceptionally high sulphur value likely contains some locally concentrated pyrite.

Calorific values vary inversely with ash level though these, too, are somewhat lower than would be found in drill core samples with comparable ash levels, again, because of the raised moisture levels in trench samples. The calorific value corresponding to the trench with the lowest ash level (12.2% in TRC83-072), is 6880 cal/gm (gross).

For trench sample analysis, proximate (chiefly ash) and calorific value measurements (sulphur levels being equal) point to two prospective areas for further investigation. These are, in order of potential, Little Klappan West, and Summit North.

In the Little Klappen West mapping block, trench 83-072 intersects a seam with a thickness of 3.51 m (12.2% ash, 6880 cal/gm (gross) as above). Other seams of interest are in trench 83-073 (3.36 m thick, ash of 17.0% and calorific value of 6370 cal/gm (gross)), and trench 83-076 (1.54 m in thickness, with an ash of 17.5%, and a calorific value of 5090 cal/gm (gross) at a moisture level of 8.5% (5560 cal/gm on a dry basis). The seam intersected by trench 83-087 also has a fairly low ash (19.5%) but is only 0.8 m thick where intersected.

Seams trenched in the Summit North block have a slightly high ash, but are thicker. Trench 83-066 has a thickness of 7.02 m with an ash of 21.4% and a gross calorific value of 3780 cal/gm at 14.9% moisture (4450 cal/gr d.b.). Several other seams of reasonable thickness have intervals with head ash levels in the range of 25-30%. The seams as a whole have quality as follows: 83-051, 1.22 m, 28.8% ash; 83-055, 2.74 m, 37.2% ash; 83-056, 2.32 m, 40.1% ash; and 83-058, 5.7 m thick, 29.6% ash. The ash levels will be higher, but calorific values will probably also be higher for these coals analyzed in unoxidized form.

Several trenches in Malloch coal located in the Mount Klappan North block, have some intervals with head ash between 11% and 30%, but all are 0.5 m in thickness or less.

8.4.2 Petrographic Analyses

A vitrinite reflectance determination was done on each trench sample largely to add to data already collected on regional reflectance variance within the Property. A few of the samples were so oxidized that an insufficient number of unweathered grains were available for a meaningful interpretation. For slightly less weathered samples, a number of relatively unoxidized vitrinite grains were specifically selected in order to provide for a sample. This practice has a tendency to bias the reading towards a higher mean, but in severely oxidized samples, this is desirable. Even so, some values for Ro max. were reduced to 2.20%. On the other hand, some less oxidized samples returned Ro max. values as high as 4.87%.

The dispersion of values supports previous and current stratigraphic interpretations. The highest Ro max. values, and therefore the lowest stratigraphic horizons, occur largely in Little Klappan West, Lost Ridge and Summit South. Most of the lowest Ro max. values are from coals in the Malloch of the Mount Klappan North block. Intermediate stratigraphic levels appear to underlie the Knooph Hill, Broatch Creek, Little Klappan North, Little Klappan South, Summit North and Mount Klappan South blocks.

8.5 Coal Quality-Diamond Drilling Program

8.5.1 Raw Coal

The two diamond drill holes for which 1983 coal quality data is available, DDH83-001 and DDH83-003, are located in the Lost-Fox and Summit South resource areas, respectively. DDH83-001 is relatively close to DDH82-005 and is therefore considered to contribute to the same resource area. A comparison of average raw coal quality for 1982 and 1983 is provided in Tables 8.3, 8.4 and 8.5. Although DDH83-003 and DDH82-007 are both in the same mapping block, the distance between them requires that, at present, they be considered separately. Only DDH83-003 is discussed in this report (see Table 8.6); the 1982 Mount Klappan Geological Report contains a treatment of DDH82-007.

In the Lost-Fox resource area, DDH82-005 penetrates seams I, J, K and L, while DDH83-001 intersects E, F, G, H and I. In the scenario under review in the 1982 report, certain of the seam intervals of DDH82-005 were not included in product discussions, because they did not meet the criteria then applied. For the purposes of this discussion, all seam intervals in both holes are included. In the average quality table for the two holes taken together (Table 8.5), an average quality for the two intersections of seam I was calculated before it was combined with the other seams. This was done to avoid biassing the average by including seam I twice.

TABLE 8.3

MT. KLAPPAN DDH 83-001
AVERAGE RAW COAL QUALITY

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
84%	11%	5%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.9	-
Ash	33.8	34.5
Volatile Matter	7.0	7.1
Fixed Carbon	57.3	58.4
Total Sulphur	0.5	0.5
Combustible Sulphur	0.0	-
Chlorine	0.06	-
Carbon Dioxide	2.4	-
HGI	49	-
Net Calorific Value (cal/g)	4980	5090
Gross Calorific Value (cal/g)	5090	5190
Ultimate Analysis		
Carbon	58.2	59.3
Hydrogen	2.0	2.0
Nitrogen	0.6	0.6
Oxygen	3.0	3.1

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1260	1330	1360	1395
Reducing	1185	1280	1315	1360

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
57.9	19.7	6.6	2.7	2.5

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.6	1.2	1.0	2.1	0.6

SiO_2/Al_2O_3 Ratio: 2.94

Silica %: 83.09

Fouling Factor: 0.22

Base/Acid Ratio: 0.18

Dolomite %: 37.37

TABLE 8.4

MT. KLAPPAN DDH 82-005
AVERAGE RAW COAL QUALITY

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
84%	10%	6%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	2.0	-
Ash	34.2	34.9
Volatile Matter	9.3	9.5
Fixed Carbon	54.5	55.6
Total Sulphur	0.4	0.4
Combustible Sulphur	0.0	-
Chlorine	0.05	-
Carbon Dioxide	4.0	-
HGI	44	-
Net Calorific Value (cal/g)	4900	5010
Gross Calorific Value (cal/g)	5010	5110
Ultimate Analysis		
Carbon	57.9	59.1
Hydrogen	1.9	1.9
Nitrogen	0.7	0.7
Oxygen	2.9	3.0

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1255	1325	1355	1390
Reducing	1205	1265	1290	1345

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
50.2	23.2	9.3	5.8	3.9

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.5	1.0	1.0	2.6	1.3

SiO_2/Al_2O_3 Ratio: 2.17

Silica %: 72.57

Fouling Factor: 0.28

Base/Acid Ratio: 0.28

Dolomite %: 45.93

TABLE 8.5

LOST-FOX RESOURCE AREA
AVERAGE RAW COAL QUALITY

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
84%	11%	5%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.8	-
Ash	35.8	36.5
Volatile Matter	8.0	8.1
Fixed Carbon	54.4	55.4
Total Sulphur	0.5	0.5
Combustible Sulphur	0.0	-
Chlorine	0.06	-
Carbon Dioxide	3.4	-
HGI	48	-
Net Calorific Value (cal/g)	4790	4890
Gross Calorific Value (cal/g)	4900	4990
Ultimate Analysis		
Carbon	56.3	57.3
Hydrogen	1.9	1.9
Nitrogen	0.6	0.6
Oxygen	3.1	3.2

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1260	1325	1355	1390
Reducing	1200	1275	1305	1355

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
54.5	20.9	7.8	4.2	3.2

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.6	1.1	1.0	2.3	0.9

SiO_2/Al_2O_3 Ratio: 2.60

Silica %: 78.27

Fouling Factor: 0.25

Base/Acid Ratio: 0.23

Dolomite %: 42.43

TABLE 8.6

MT. KLAPPAN DDH 83-003
AVERAGE RAW COAL QUALITY

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
87%	9%	4%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.5	-
Ash	56.0	56.9
Volatile Matter	6.8	6.9
Fixed Carbon	35.7	36.2
Total Sulphur	0.6	0.6
Combustible Sulphur	0.0	-
Chlorine	0.05	-
Carbon Dioxide	4.8	-
HGI	62	-
Net Calorific Value (cal/g)	2960	3020
Gross Calorific Value (cal/g)	3040	3090
Ultimate Analysis		
Carbon	37.6	38.2
Hydrogen	1.4	1.4
Nitrogen	0.3	0.3
Oxygen	2.6	2.6

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1250	1305	1335	1365
Reducing	1200	1255	1290	1335

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
57.5	18.8	5.7	2.7	2.5

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.5	1.4	1.3	1.5	0.6

SiO_2/Al_2O_3 Ratio: 3.06

Base/Acid Ratio: 0.18

Silica %: 84.08

Dolomite %: 38.04

Fouling Factor: 0.25

8.5.1.1 Proximate Analysis

8.5.1.1.1 Moisture

Moisture levels average between 1.5 and 2.0% on a raw basis in both the Lost-Fox and Summit South resource areas. In the Lost-Fox area, DDH83-001 and DDH82-005 have similar average moisture levels of 1.9% and 2.0%, respectively. In both these holes, seam I, being relatively thick and with a high moisture value, tends to raise the overall average. The elevated moisture level is likely because seam I is the highest seam in both holes and therefore most exposed to oxidation. For the total Lost-Fox resource area average, the influence of seam I is reduced as only one intersection is included with almost twice the number of deeper, dryer seams. The average moisture level for the Lost-Fox area is 1.8%.

All seams in DDH83-003 have typical moisture levels and the average, without the influence of seam I, is 1.5%.

8.5.1.1.2 Ash

The average ash level in the Lost-Fox resource area has changed very little from 1982 figures. Figures are 33.8% in DDH83-001, 34.2% in DDH82-005, and 35.8% overall. Again, the higher overall figure is because the relatively low ash seam I is averaged with only 3 other seams in 82-005, and seven other higher ash seams in 82-005 and 83-001. The lower average ash in 83-001 relative to 83-005, is due to the inclusion of low ash intervals in the central section of seam H (16.7% ash over 1.6 m) and in seam E (17.4% ash over 1.32 m).

All seam intersections in DDH83-003 are quite high in ash, close to the average of 56%.

8.5.1.1.3 Volatile Matter

The average volatile content indicated for DDH83-001 is much more representative than that for DDH82-005; 7.0% compared with 9.3%. This is largely because the average for DDH82-005 includes three high ash intervals (J middle, L lower and L upper, all between 43.6% and 60.2% ash), with unusually high contents of carbonate. The CO_2 content produced from these three intervals is around 7.5% for the first two, and almost 28% for the latter. In turn, the volatile content for these intervals is raised to 13%, 14% and 31.3%, respectively, due to the presence of the carbonate. Most other seam intersections have relatively normal volatile matter contents between 7% and 8%. The overall average for the Lost-Fox area is 8.0% (a.d.b.).

Despite the high ash of the DDH83-003 intervals, the volatile content is not unduly affected by external interference. The average volatile content is 6.8%.

8.5.1.1.4 Fixed Carbon

Fixed carbon levels have remained fairly consistent between 1982 and 1983. For DDH83-001, the average content is 57.3%, slightly higher than for DDH82-005 (54.5%), because a greater number of slightly thicker lower ash intervals are included. Overall, the average fixed carbon content is reduced to (54.4%), once again, because the positive effect of seam I is diluted by a larger number of higher ash seams.

Due to high ash levels, the fixed carbon content through 83-003 averages only 35.7%.

8.5.1.2 Total Sulphur and Chlorine

All seams in the Lost-Fox resource area have "normal" sulphur levels, at or below 0.5%. The average level for DDH83-001 at 0.5% is higher than the average for DDH82-005 (0.4%) and raises the overall average to 0.5%.

In the Summit South area, as represented by 83-003, sulphur levels, on average, are higher (0.6%) influenced by a pyrite zone in seam E lower (raising sulphur levels here to 1.2%).

Chlorine levels are uniformly low in all seams in both areas. Averages are 0.06% for DDH83-001, 0.05% for DDH82-005, 0.06% for the Lost-Fox area and 0.05% for DDH83-003.

8.5.1.3 Calorific Value

The calorific value of raw coal is closely related to the ash content. Levels in DDH83-001 are slightly higher (at 5090 cal/gm (gross), than in

DDH82-005 (5010 cal/gm (gross)), as would be expected in comparing the two ash levels. The overall average gross calorific value is 4900 cal/gm.

Because of the very high ash levels for all seams in DDH83-003, the average gross calorific value amounts to only 3040 cal/gm.

8.5.1.4 Hardgrove Grindability Index

A constant relationship has been noted in Mount Klappan coals between high ash levels and correspondingly high values for H.G.I. The coal itself, under most circumstances, is quite hard and the progressive inclusion of more ash material tends to raise the H.G.I. This effect seems to influence DDH83-001 more strongly than DDH82-005. Several higher ash intervals of substantial thickness, chiefly in seam G, have H.G.I.'s in the 50's and 60's, raising the average for DDH83-001 to 49 compared with 44 for DDH82-005. The average for the Lost-Fox area is 48.

In the DDH83-003, the high ash levels result in an average H.G.I. of 62.

8.5.1.5 Ultimate Analysis

There is really no substantial difference in ultimate composition between 1982 and 1983 results. Hydrogen levels are marginally lower in DDH82-005 than DDH83-001, because the average for 82-005 includes the previously discussed seam L upper interval. Here the source of the very large volatile content also creates an apparent imbalance in ultimate components with 19.1% oxygen and only 0.7% hydrogen. The overall composition of 56.3% carbon, 1.9% hydrogen, 0.6% nitrogen, and 3.1% oxygen for the Lost-Fox area, closely reflects the analyses for both 83-001 and 82-005.

The high ash level of the 83-003 seams reduces both carbon and hydrogen levels as these are both, for the most part, elements of the combustible portion of the coal. Ultimate analysis indicates a content of 37.6% carbon, 1.4% hydrogen, 0.3% nitrogen, and 2.6% oxygen.

8.5.1.6 Ash Fusion Temperatures

There is no difference in ash fusion temperatures between 83-001 and 82-005. For these, and for the overall average, temperatures in an oxidizing atmosphere are 1260°C for initial deformation and 1390°C for fluidity ± 5°C. In a reducing atmosphere, temperatures range between 1185°C and 1360°C.

For DDH83-003, the temperatures are extremely comparable to the Lost-Fox area temperatures. They are 1250°C to 1365°C (initial to fluid) in an oxidizing atmosphere, and 1200°C to 1335°C in a reducing atmosphere.

8.5.1.7 Ash Mineral Composition

Despite the extreme similarity in ash fusion temperatures between 83-001 and 82-005, there are distinct differences in ash mineral composition. These differences, however, have a tendency to offset each other in terms of their effect on ash fusibility. DDH83-001 has a slightly higher silicon content and a slightly lower alumina content than 82-005. This would tend to lower the relative fusion temperatures of 83-001 because of its greater amount of excess silica. The contents of iron, calcium and magnesium are much higher in the seams of 82-005 than in 83-001, causing a higher base to acid ratio (Fe_2O_3 + (CaO + MgO + Na_2O + K_2O : SiO_2 + Al_2O_3 + TiO_2) which counteracts the effect of the silica/alumina balance. The overall average for the Lost-Fox area has intermediate amounts of all three oxides and the equilibrium between the opposing tendencies is maintained.

Coincidentally, the ash mineral composition of 83-003 is almost identical to that of 83-001, which accounts for the correspondence in ash fusion temperatures.

8.5.2 5% Ash Product

8.5.2.1 Yield

As illustrated in Figure 8.3, all seams were reviewed in terms of their potential to produce a 5% ash product. If examination of washability data (Appendix IV) indicated that a yield for a seam interval greater than 5% could be achieved, then a simulated product analysis was carried out for that interval.

Following this procedure, it was found that none of the seams in 83-003 could produce any significant quantity of 5% ash product. However, all but one (G lower) of the seam intervals in DDH83-001 were capable of some 5% ash coal production. Seam I, as a whole, yielded 39.2%, 5% ash coal by laboratory measurement. A laboratory yield of 20.6% was realized for seam H, 11.3% for seam G upper, 15.0% for seam F and 22.0% for seam E.

The coal quality of this 5% ash product is presented in contrast to that achieved in the 1982 Mount Klappan analysis program (see Tables 8.7 and 8.8). The difference in emphasis between the two

TABLE 8.7

MT. KLAPPAN DDH 83-001
AVERAGE 5% COAL PRODUCT

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
97%	3%	Discarded

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	0.8	-
Ash	5.0	5.0
Volatile Matter	5.8	5.8
Fixed Carbon	88.4	89.2
Total Sulphur	0.6	0.6
Combustible Sulphur	0.4	-
Chlorine	0.06	-
Carbon Dioxide	0.1	-
HGI	35	-
Net Calorific Value (cal/g)	7800	7870
Gross Calorific Value (cal/g)	7940	8000
Ultimate Analysis		
Carbon	88.5	89.2
Hydrogen	2.6	2.6
Nitrogen	0.9	0.9
Oxygen	1.6	1.7

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1240	1400	1430	1450
Reducing	1215	1320	1380	1425

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
51.0	26.5	4.9	2.5	1.4

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
1.6	1.4	0.8	0.6	2.2

SiO_2/Al_2O_3 Ratio: 1.92

Silica %: 85.28

Fouling Factor: 0.20

Base/Acid Ratio: 0.14

Dolomite %: 35.45

TABLE 8.8

MT. KLAPPAN DDH 82-005
AVERAGE 5% COAL PRODUCT

SIZE ANALYSIS:*

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
92%	8%	Discarded

*crushed to 10.0 mm (3/8")

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	0.5	-
Ash	5.0	5.0
Volatile Matter	5.2	5.2
Fixed Carbon	89.3	89.8
Total Sulphur	0.4	0.4
Combustible Sulphur	0.4	-
Chlorine	0.07	-
Carbon Dioxide	0.2	-
HGI	33	-
Net Calorific Value (cal/g)	7800	7850
Gross Calorific Value (cal/g)	7950	8000
Ultimate Analysis		
Carbon	89.4	89.9
Hydrogen	2.8	2.8
Nitrogen	1.2	1.2
Oxygen	0.7	0.7

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1230	1435	1475	1500
Reducing	1230	1425	1460	1500

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
49.1	30.5	2.7	3.7	0.4

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
1.2	1.2	0.8	0.9	3.8

SiO_2/Al_2O_3 Ratio: 1.61

Silica %: 87.84

Fouling Factor: 0.13

Base/Acid Ratio: 0.11

Dolomite %: 46.59

programs (1982 and 1983) is that while in 1982 the possibility of maximizing the 5% ash yield of a single seam (I lower) was reviewed, in 1983 the alternative approach of gleaning at least some 5% ash product wherever possible was undertaken. A notable consistency in most aspects of quality analysis is apparent.

8.5.2.2 Proximate Analysis

The Proximate analysis of the average 5% ash product from 83-001 is very little changed from that of the 1982 low ash coal. The 5% ash coal from DDH83-001 is drawn from a number of seams with a relatively high raw ash level, while in 1982, production was from a selected interval with a very low head ash. The difference in the character of the ash accounts for the slightly higher moisture level in DDH83-001. Although both coals have been cleaned to the same ash level, the source and type of the ash is different in each case.

The target of 5.0% ash was well achieved in both cases.

As with moisture, the volatile level in 83-001 is slightly elevated because of the variability in ash. While seam I lower from 82-005 was chosen as an ideal case, some intervals contributing to the average 83-001, 5% ash resource are marginal.

Due to the relatively higher moisture and volatile contents, the fixed carbon level in 83-001 is 88.4% compared with 89.3% in 82-005.

8.5.2.3 Total Sulphur, Chlorine and Carbon Dioxide

All these parameters are quite low in the average quality for 5% ash coal from DDH83-001. Chlorine levels cannot be measured directly from the products as excess chlorine absorbed from the heavy liquids used in float/sinking interferes with the true reading. The value expected here is an average of measurements from raw coal. The inclusion of several seams in 83-001 appears to improve the levels of chlorine and carbon dioxide relative to 82-005. The sulphur level, however, is slightly higher. DDH83-001 contains an average 0.6% sulphur, 0.06% chlorine (in raw) and 0.1% carbon dioxide compared with 0.4% sulphur, 0.07% chlorine (in raw) and 0.2% carbon dioxide in DDH82-005 (seam I lower).

8.5.2.4 Calorific Value

The gross calorific value measured for the low ash resource for 83-001 (7940 cal/gm) is virtually identical to that measured in 1982 (7950 cal/gm).

8.5.2.5 Hardgrove Grindability Index

The H.G.I. also is very little changed though the value for 83-001 (35) reflects the inclusion of some seams containing slightly softer material (The H.G.I. for 82-005 seam I lower is 33).

8.5.2.6 Ultimate Analysis

Two things can be noted about the ultimate analysis of the 83-001 low ash product. The nitrogen level has been reduced through the inclusion of more seams (0.9% compared with 1.2%) and the oxygen level has been influenced by the contribution of high head ash coal. At 1.6% oxygen compared with 0.7%, a greater content of oxidized material, coal or ash, is demonstrated. The other components are very comparable in their proportions; carbon is 88.5% and hydrogen 2.6% for 83-001, carbon is 89.4% and hydrogen 2.8% for 82-005.

8.5.2.7 Ash Fusion Temperatures

Ash fusion temperatures for average 83-001, 5% ash coal range from 1240°C to 1450°C (initial to fluid, oxidizing atmosphere) and 1215°C to 1425°C (initial to fluid, reducing atmosphere). These temperatures are slightly lower and with a narrower span than those for 82-005 seam I lower (1230°C to

1500°C in both atmospheres). Contribution from a variety of seams results in an ash of somewhat different composition and character.

8.5.2.8 Ash Mineral Composition

Although the ratios between various ash minerals favor high fusion temperatures for the average low ash product of 83-001, the difference from the ratios for 82-005 accounts for the difference in ash fusion temperatures. While the base to acid ratio is quite low for 83-001 and the silica:alumina ratio less than 2, both ratios are even lower for 82-005 (seam I lower). The average ash of 83-001 seams, with an iron content greater than the sum of its calcium and magnesium contents, is characterized as "bituminous type" while the 82-005 seam I lower ash exemplifies the reverse condition and is termed "lignitic type". This character difference further accounts for the lower fusion temperature of 83-001 ash. Overall, the silica content of 83-001 is slightly higher than for 82-005 and the alumina content is slightly lower. Iron, magnesium and titanium contents are higher and calcium and phosphorous contents are lower. The presence of an marginally higher amount of sodium in 83-001 in conjunction with the difference in ash type makes the average 5% ash product less ideal in terms of fouling potential than that which can be produced for seam I lower exclusively.

8.5.3 10% Ash Product

8.5.3.1 Yield

After production of a 5% ash product, the potential of each seam to produce an additional 10% ash product was assessed. No intervals were capable of producing a minimal yield (5% or more) of 10% ash additional product so the target for secondary production for all intervals was set to a briquetting ash level (around 25%). The 10% ash products discussed here were produced as alternatives to 5% ash and simulated clean coal analyses were done to provide flexibility of choice in designing scenarios for maximized exploitation of the Lost-Fox resource potential.

All seam intervals in both 83-001 and 83-003 were capable of producing at least some medium (10%) ash product. The yields in 83-001 were 57.8% for

TABLE 8.9

MT. KLAPPAN DDH 83-001
AVERAGE 10% COAL PRODUCT

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
98%	2%	Discarded

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.4	-
Ash	9.2	9.3
Volatile Matter	6.9	7.0
Fixed Carbon	82.5	83.7
Total Sulphur	0.6	0.6
Combustible Sulphur	0.2	-
Chlorine	0.06	-
Carbon Dioxide	0.2	-
HGI	36	-
Net Calorific Value (cal/g)	7250	7360
Gross Calorific Value (cal/g)	7390	7490
Ultimate Analysis		
Carbon	82.8	84.0
Hydrogen	2.5	2.5
Nitrogen	0.9	0.9
Oxygen	2.6	2.7

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1255	1390	1415	1440
Reducing	1200	1345	1380	1415

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
56.3	23.0	5.3	2.6	1.9

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
1.3	1.3	1.1	0.9	1.5

SiO_2/Al_2O_3 Ratio: 2.45

Base/Acid Ratio: 0.15

Silica %: 85.17

Dolomite %: 36.89

Fouling Factor: 0.20

TABLE 8.10

MT. KLAPPAN DDH 82-005
AVERAGE 10% COAL PRODUCT

SIZE ANALYSIS: *

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
89%	11%	Discarded

*crushed to 10.0 mm (3/8")

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	0.7	-
Ash	9.8	9.9
Volatile Matter	6.1	6.1
Fixed Carbon	83.4	84.0
Total Sulphur	0.4	0.4
Combustible Sulphur	0.4	-
Chlorine	0.04	-
Carbon Dioxide	0.3	-
HGI	38	-
Net Calorific Value (cal/g)	7310	7360
Gross Calorific Value (cal/g)	7450	7500
Ultimate Analysis		
Carbon	83.6	84.2
Hydrogen	2.7	2.7
Nitrogen	1.0	1.0
Oxygen	1.8	1.8

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1235	1375	1390	1410
Reducing	1230	1370	1385	1400

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
54.9	23.9	3.9	4.3	1.0

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
1.0	1.2	0.8	1.0	3.2

SiO_2/Al_2O_3 Ratio: 2.30

Silica %: 85.65

Fouling Factor: 0.17

Base/Acid Ratio: 0.14

Dolomite %: 47.32

TABLE 8.11

MT. KLAPPAN DDH 83-003
AVERAGE 10% COAL PRODUCT

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
97%	3%	Discarded

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	0.7	-
Ash	9.3	9.4
Volatile Matter	5.6	5.6
Fixed Carbon	84.4	85.0
Total Sulphur	0.6	0.6
Combustible Sulphur	0.1	-
Chlorine	0.05	-
Carbon Dioxide	0.3	-
HGI	37	-
Net Calorific Value (cal/g)	7390	7440
Gross Calorific Value (cal/g)	7520	7570
Ultimate Analysis		
Carbon	84.3	84.9
Hydrogen	2.5	2.5
Nitrogen	0.9	0.9
Oxygen	1.7	1.7

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1220	1315	1340	1375
Reducing	1155	1240	1280	1315

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
52.3	25.0	6.9	2.8	2.6

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
2.3	1.2	1.4	1.2	1.4

SiO_2/Al_2O_3 Ratio: 2.09

Base/Acid Ratio: 0.19

Silica %: 80.96

Dolomite %: 36.24

Fouling Factor: 0.23

seam I, 39.2% for seam H, 13.3% for seam G, 26.2% for seam F, and 44.3% for seam E. Yields were considerably lower for DDH83-003 at 8.0% for seam G lower, 8.3% for seam E upper, and 9.9% for seam E lower (seam E upper and lower are separated by a substantial rock split and must be considered separately).

The intervals from 82-005 from which a 10% ash simulated product was extracted were again selected for their ability to produce a maximum yield. As with the 5% ash product, the strategy for product analysis in 83-001 (and 83-003) was changed in order to evaluate product quality as derived from all possible seams. The seam intervals involved from 82-005 were I upper, J lower, J upper and L middle.

8.5.3.2 Proximate Analysis

The dissimilarity between the proximate analyses of 83-001 and 82-005, 10% ash seam intervals (mostly in moisture and volatiles), can be explained by citing the difference in contributing ash constituents. Residual moisture levels and volatiles are both higher in 83-001 (1.4% and 6.9% compared with 0.7% and 6.1%). The average yield of 10% ash product from 82-005 intervals was 62.3% compared with the much lower yields derived from 83-001 seams. As the cleaning character differed, so does the character of the ash included in the medium ash products from each source, and so, in turn, does the amount of moisture retained in the ash and released in both the residual moisture and volatile determinations.

Ash levels are comparable at 9.2% for 83-001 and 9.8% for 82-005 and, due to the variation in the other proximate components, the fixed carbon levels also vary (82.5% for 83-001 and 83.4% for 82-005).

The washability of the coals from 83-003 is different yet again and so the proximate analysis shows distinct characteristics. While the average cut points for 83-001, 10% ash products were 1.68 S.G. for the 10 mm x 0.6 mm fraction and 1.79 S.G. for the 0.6 mm x 0.15 mm fraction, lower separation gravities of 1.57 and 1.65, respectively, were required to generate even the small yields attainable from 83-003 seam intervals. The ash components carried with the coal in each case were therefore not the same and influenced the proximate analysis (moisture and volatiles) in different ways. The ash levels of DDH83-001 and 83-003 are similar (9.2% and 9.3%) but the moisture and volatile levels for 83-003 are 0.7% and 5.6% (compared with 1.4% and 6.9% for 83-001). The fixed carbon content of 83-003 is 84.4% and for 83-001 is 82.5%).

8.5.3.3 Total Sulphur, Chlorine and Carbon Dioxide

Sulphur, chlorine and carbon dioxide levels are all quite similar for 10% ash products. In the Lost-Fox Area there is a slight increase in sulphur and chlorine between 1982 and 1983, as the number of seams involved increases. The relative carbon dioxide content, however, decreases. Values for 83-003 are in very much the same range. For 83-001, the sulphur content is 0.6%, chlorine is 0.06% and carbon dioxide 0.2%. The values are 0.4%, 0.04% and 0.3% for 82-005, and 0.6%, 0.05% and 0.3% for 83-003.

8.5.3.4 Calorific Value

The higher moisture level reduces the available heat content from 83-001. Gross calorific value is 7390 cal/gm compared with 7450 cal/gm for 82-005. DDH83-003 has a lower ash content than 82-005 (9.3% and 9.8%, respectively) at the same moisture level and therefore has a relatively enhanced gross calorific value of 7520 cal/gm.

8.5.3.5 Hardgrove Grindability Index

The average H.G.I. for all seams in both the Lost-Fox and Summit South resource areas is very similar. Values are 36 for 83-001, 37 for 83-003 and 38 for 82-005.

8.5.3.6 Ultimate Analysis

The oxygen level of the 10% ash products from 83-001 is elevated relative to the other 10% ash products under consideration. This is a companion effect to the interference with moisture and volatile measurements described previously. It does not illustrate a coal characteristic so much as indicate a feature of the ash carried with the coal. The oxygen value for 83-001 is 2.6% as opposed to 1.8% for 82-005 and 1.7% for 83-003. For the same data sets, carbon levels are 82.8%, 83.6% and 84.3%, hydrogen contents are 2.5%, 2.7% and 2.5%, and nitrogen values are 0.9%, 1.0% and 0.9%.

8.5.3.7 Ash Fusion Temperatures

The differences in ash character suggested by proximate and ultimate analyses do not appear in the ash fusion temperatures, which at 1255°C to 1440°C (initial to fluid, oxidizing atmosphere) for 83-001 are not significantly different from those for 82-005 (1235°C to 1410°C, under the same conditions). For 83-003, the temperatures are somewhat lower (1220°C to 1375°C, also oxidizing atmosphere).

8.5.3.8 Ash Mineral Composition

The differences in ash mentioned above do, however, appear in the ash mineral analyses. The ash from 10% ash product coal of 83-001, is comparable to 82-005 in most respects, with the exception of having a higher iron and magnesium and a lower sodium and phosphorous content. These small variations determine

that the 83-001 ash is "bituminous type" and the 82-005 ash is "lignitic type". The base/acid ratios for the two Lost-Fox holes are approximately equal, accounting for the similarity in fusion temperatures. The ratio for 83-003 is a little higher, however, and the fusion temperatures are a little lower.

8.5.4 Briquetting Coal Product

Simulated briquetting coal products were generated from the seams in 83-001 and 83-003 through processing of the sinks after premium coal extraction. These "middlings" were cleaned from the reject of both 5% ash and 10% ash products. The analytical results of the middlings from 5% ash reject of DDM83-001 cannot be combined with the middlings from 10% ash reject, because the two premium coals were examined as alternatives to one another (See Tables 8.12 to 8.14). Though all middlings were cleaned to the same target ash, and have similar characteristics, the reject from the two

TABLE 8.12

MT. KLAPPAN DDH 83-001
AVERAGE BRIQUETTING PRODUCT (AFTER 5% ASH PRODUCTION)

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
89%	1%	10%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	2.5	-
Ash	24.0	24.6
Volatile Matter	9.4	9.6
Fixed Carbon	64.1	65.8
Total Sulphur	0.5	0.5
Combustible Sulphur	0.1	-
Chlorine	-	-
Carbon Dioxide	0.8	-
HGI	47	-
Net Calorific Value (cal/g)	5640	5800
Gross Calorific Value (cal/g)	5760	5910
Ultimate Analysis		
Carbon	65.0	66.7
Hydrogen	2.0	2.1
Nitrogen	0.7	0.7
Oxygen	5.3	5.4

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1255	1370	1395	1420
Reducing	1205	1320	1370	1405

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
59.4	20.2	6.0	3.2	3.0

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.5	1.1	1.0	1.0	1.1

SiO_2/Al_2O_3 Ratio: 2.95

Base/Acid Ratio: 0.18

Silica %: 83.01

Dolomite %: 43.22

Fouling Factor: 0.20

TABLE 8.13

MT. KLAPPAN DDH 83-001
AVERAGE BRIQUETTING PRODUCT (AFTER 10% ASH PRODUCTION)

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
90%	Negligible	10%

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.5	-
Ash	23.3	23.7
Volatile Matter	7.8	7.9
Fixed Carbon	67.4	68.4
Total Sulphur	0.6	0.6
Combustible Sulphur	0.3	-
Chlorine	-	-
Carbon Dioxide	0.9	-
HGI	46	-
Net Calorific Value (cal/g)	5890	5990
Gross Calorific Value (cal/g)	6010	6100
Ultimate Analysis		
Carbon	67.6	68.6
Hydrogen	2.1	2.1
Nitrogen	0.7	0.7
Oxygen	4.2	4.3

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1240	1380	1405	1440
Reducing	1190	1340	1385	1405

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
61.9	19.7	6.1	2.1	2.3

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
0.8	1.0	1.0	0.8	0.6

SiO_2/Al_2O_3 Ratio: 3.15

Silica %: 85.64

Fouling Factor: 0.15

Base/Acid Ratio: 0.15

Dolomite %: 34.87

TABLE 8.14

MT. KLAPPAN DDH 83-003
AVERAGE BRIQUETTING PRODUCT (AFTER 10% ASH PRODUCTION)

SIZE ANALYSIS:

+0.6 mm	0.6mm - 0.15mm	0.15mm - 0
99%	1%	Negligible

	Air Dry	Dry Basis
Proximate Analysis		
Residual Moisture	1.6	-
Ash	23.5	23.9
Volatile Matter	7.4	7.5
Fixed Carbon	67.5	68.6
Total Sulphur	0.9	0.9
Combustible Sulphur	0.5	-
Chlorine	-	-
Carbon Dioxide	0.9	-
HGI	43	-
Net Calorific Value (cal/g)	5880	5990
Gross Calorific Value (cal/g)	5990	6090
Ultimate Analysis		
Carbon	67.6	68.7
Hydrogen	1.9	1.9
Nitrogen	0.7	0.7
Oxygen	3.8	3.9

Ash Fusion:

°C	Initial	Softening	Hemispherical	Fluid
Oxidizing	1185	1295	1325	1370
Reducing	1160	1255	1295	1340

Ash Analysis:

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
60.9	20.8	5.3	3.3	2.6

TiO_2	Na_2O	K_2O	SO_3	P_2O_5
1.1	1.3	1.3	1.0	1.2

SiO_2/Al_2O_3 Ratio: 2.93

Silica %: 84.44

Fouling Factor: 0.22

Base/Acid Ratio: 0.17

Dolomite %: 43.14

alternative cases must here be considered separately, also as alternative possibilites. For 83-003, only middlings cleaned from reject of 10% ash premium product are discussed as no 5% ash product was attainable.

8.5.4.1 Yield

The washability of Mount Klappan anthracite in general is such that the cut point that must be used to clean a 5% ash product is very distinct. There is a very narrow range of specific gravities between the point at which no coal will float, and the point where the cumulative ash of all float is 5%. The slope of the washability curve is maintained between 5% and 10% ash, such that in most cases the yields for 10% ash products by seam (see Section 8.5.3.1) are almost exactly twice the yields for 5% ash coal (see Section 8.5.2.1). Above approximately 10% ash, however, the increase in cumulative ash level over the same range of specific gravities is much reduced. Because of this character of washability, the yield of middlings product after 5% ash production is much greater than that after 10% ash production. The yield of 5% middlings from seam I is 30.1% while the yield of 10% middlings is 3.4% (for I upper only). The respective yields for seam H are 39.8% and 9.1%, for seam G are 18.3% (G upper only) and 8.8%, for seam F are 33.6% and 3.3%, and for seam E are 44.6%

and 11.8%. The target ash of the secondary briquetting product was set at 26%.

For 83-003, the yields of middlings after 10% ash product are much the same as for 83-001, at 5.4% for seam G lower, 10.9% for seam E upper, and 19.5% for E lower.

8.5.4.2 Proximate Analysis

As the ash level of the briquetting product is high relative to the premium products, so generally are the moisture values. Moisture levels are at 1.5% for the middlings after 10% ash product in both 83-001 and 83-003 but are at 2.5% for the middlings after 5% ash product from 83-001. It appears that the ash material that retains moisture well (as discussed previously) comes out with the product coal in approximately the 1.60 S.G. to 1.80 S.G. range. The effect is seen in the 10% ash product coal, which has a higher moisture level than the 5% ash product from the same source. It is also seen in that the reject from 5% ash product, which includes the extra ash that makes up the 10% ash product, also has a higher moisture content than the reject from 10% ash production. Above the cut point for 10% ash product, the ash material seems to have less moisture retention capacity than between the cut points for 5% ash and for 10% ash.

The volatiles are also affected by the peculiar character of the ash in this S.G. range. For the middlings after 10% ash production, the volatile content is 7.8% for 83-001 and 7.4% for 83-003. For the middlings after 5% ash product, the average volatile content of 83-001 is 9.4%.

The ash values for briquetting coal are generally lower than the target at 24.0% (83-001 after 5%), 23.3% (83-001 after 10%) and 23.5% (83-003). Although the cut points chosen from washability results were designed to give a higher ash (26%), in practical application the ash of the premium products after cleaning was slightly low (see previous sections) and as a result, the middlings product ash is also low.

Fixed carbon levels are quite consistent except where affected by inflated moisture and volatile values: 67.4% for 83-001 after 10% ash production; 64.1% for 83-001 after 5% ash production; and 67.5% for 83-003 after 10% ash production.

8.5.4.3 Total Sulphur, Chlorine and Carbon Dioxide

Sulphur levels are approximately consistent with what is seen on a raw basis and are still quite low. The value for 83-001 after 5% is 0.5%, with 0.6% for 83-001 after 10% and 0.9% for 83-003. The average is raised in 83-003 by an unusually high value of 1.3% in the E upper interval. In this particular instance, the high content of sulphur is not a function of pyrite concentration.

Chlorine measurements are not available for any middlings product because of the interference of the heavy liquids used in flotation. Because of the two-stage processing involved in generating the briquetting products, it is not reasonable to quote raw values as being representative.

Carbon dioxide content has risen with the ash level in the middlings products and is fairly uniform at 0.8% for 83-001 after 5%, 0.9% for 83-001 after 10% and 0.9% for 83-003. These levels of carbon dioxide, no doubt, contribute somewhat to raised volatile matter readings, but other effects must be involved, as described above, since the carbon dioxide levels are constant through the middlings products while the volatiles vary.

8.5.4.4 Calorific Value

Calorific values largely reflect ash levels, but are also affected by moisture. The briquetting coal from 83-001 after 5% ash production, with its high moisture level, is 5760 cal/gm (gross) compared with 6010 cal/gm for 83-001 after 10% ash and 5990 cal/gm for 83-003.

8.5.4.5 Hardgrove Grindability Index

There is minimal variation in H.G.I. through all briquetting coal analyses. The figures are slightly higher than for the premium products, reflecting the higher ash levels. The H.G.I. for 83-001 after 5% is 47, for 83-001 after 10% is 46, and for 83-003 after 10% is 43.

8.5.4.6 Ultimate Analysis

The link between raised oxygen levels and inflated moisture and volatile values described briefly in the 10% ash product section (see Section 8.5.3.6), is also in evidence here. Oxidation type effects, chiefly the concentration of water and other products of oxidation processes through the breakdown of both coal and its contained ash minerals, are observable in proximate analyses through changes in moisture and volatiles, and in ultimate analyses through increases in oxygen, and in some cases, decreases in hydrogen. The oxygen levels in 83-001 after 5% ash production, with its high moisture and volatile content, is 5.3% compared with 4.2% in 83-001 after 10%, and 3.8% in 83-003. There is not much variation in hydrogen values: 2.0%, 2.1% and 1.9%, respectively, or in nitrogen value, all averaging 0.7%. The carbon value for 83-001 after 5% is proportionally smaller where the oxygen and ash levels are higher, 65.-% compared with 67.6% for both 83-001 after 10% and 83-003.

8.5.4.7 Ash Fusion Temperatures

Ash fusion temperatures support the contention that there are some differences in ash character between the rejects after 5% ash production and after 10% ash production from the same coals in the Lost-Fox area. There also appear to be differences in the ash between rejects after 10% ash production in the Lost-Fox area and in the Summit South area. In an oxidizing atmosphere, temperatures range from 1240°C to 1440°C (initial to fluid) for 83-001 after 10%, from 1255°C to 1420°C for 83-001 after 5%, and for 1185°C to 1370°C for 83-003. Very much the same pattern is followed by fusion temperatures in a reducing atmosphere. The explanation for this declining trend lies in the ash mineral analyses.

8.5.4.8 Ash Mineral Composition

A number of different mineral constituents seem to follow the trend established by ash fusion temperatures from 83-001 after 10% through 83-001 after 5%, to 83-003. Silica, magnesium and titanium values fluctuate randomly over a fairly narrow range, but alumina, calcium, sodium, potassium, sulphur trioxide and phosphorous values all rise steadily from sample to sample. Iron values describe the opposite trend. The result of these shifts is that while 83-001 after 10% ash production has a decidedly "bituminous type" ash, the ash of 83-001 after 5% ash is marginally lignitic and the ash of 83-003 slightly more so. The base to acid ratio increases over the span between the same samples, accounting for the reduction in fusion temperatures. By examination of average ash mineral composition, there appears to be no reason why the fusion temperatures for 83-003 should be significantly lower than for 83-001 after 5% ash production. This appears to be a case where the low fusion temperatures for a single seam (E upper) have affected the average in a way that the ash mineral values have not. The variations in percentage of certain minerals is smaller than the effect that such variation has on the fusion temperatures.

9.0 LIST OF REFERENCES

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APPENDIX A

STATEMENT OF QUALIFICATIONS

STATEMENT OF QUALIFICATIONS

BRIAN P. FLYNN

This is to certify that I obtained my Bachelor of Science Degree in Geology at The University of Natal, South Africa in 1971.

Since Graduation I spent one year in base metal exploration in Sourth Africa and in excess of seven years in coal exploration in Western Canada. Of this period, five and three quarter years have been in the Coal Division of Gulf Canada Resources Inc., during which time I have been responsible for the planning and supervision of evaluation programs involving diamond and rotary drilling, as well the design of regional exploration programs in Western Canada and the Arctic. At the present time, I hold the position of Co-ordinator Coal Projects.

STATEMENT OF QUALIFICATIONS

CHARLES S. WILLIAMS

This is to certify that I obtained my Diploma of Petroleum Geology from the Southern Alberta Institute of Technology in 1976 and my Bachelor's Degree in Earth Sciences from Chadron State College, Chadron, Nebraska in 1980.

My geological experience has been gained during exploration mapping and drilling programs in Alberta and British Columbia. Since receiving my Diploma of Petroleum Geology, I have spent 9 years in coal exploration in Western Canada. During the first three years I was with Dension Mines Ltd. while the fourth year was spent with Crows Nest Resources. My fifth, sixth, and seventh years (summer and full time) were employed with Norwest Resource Consultants Ltd. during which I worked on mapping and drilling programs for Gulf Canada Resources and Suncor. Since November 1981 I have been employed by the Coal Division of Gulf Canada Resources Inc.

STATEMENT OF QUALIFICATIONS

GLENN E. SEVE

This is to certify that I obtained my Bachelor of Science Degree in Geology at The University of Alberta in 1979.

I have gained my geological experience through coal property evaluations and exploration mapping and drilling programs situated in Alberta and British Columbia. I have been employed as a Geologist with the Coal Division of Gulf Canada Resources Inc. since 1979.

STATEMENT OF QUALIFICATIONS

JOHN W. INNIS

This is to certify that I obtained my Bachelor of Science Degree in Geological Science at Queen's University in 1977, and a Master of Science Degree in Geology at the University of Western Ontario in 1980.

My geological experience includes involvement in mineral exploration and mapping programs in Newfoundland, Saskatchewan and British Columbia for three summers, and latterly six summers in coal exploration in northeastern and north-central British Columbia. I have been employed as a Geologist in the Coal Division of Gulf Canada Resources Inc. since 1980 and have participated in the evaluation of Gulf's Panorama and Mount Klappan properties.

STATEMENT OF QUALIFICATIONS

F. SCOTT MCKENZIE

This is certify that I obtained my Bachelor of Science Degree in Earth Sciences at the University of Waterloo in 1982.

My geological experience includes involvement in mineral, petroleum and coal exploration in the Northwest Territories, Ontario, Alberta and British Columbia. I have been employed as a Geologist with Gulf Canada Resources Incorporated since my graduation in May, 1982.

MOUNT KLAPPAN COAL PROPERTY

APPENDIX B

LEGAL DESCRIPTION AND LISTING OF LICENCES

MT. KLAPPAN COAL PROJECT LICENCES - 1983

LICENCE NUMBER	DATE ISSUED	HECTARES	SERIES	BLOCK
7118	Sept. 1/81	281	104-H-2	J
7119	"	281	"	"
7120	"	32	"	"
7121	"	224	"	"
7122	Dec. 31/83	281		"
7123	"	281	"	"
7124	Sept. 1/81	98	"	"
7125	Dec. 31/83	281	"	"
7126	"	281	"	"
7127	Sept. 1/81	281	104-H-2	K
7128	"	281	"	"
7129	"	281	"	"
7130	"	281	"	"
7131	"	281	"	"
7132	"	281	"	"
7133	"	281	"	"
7134	"	281	"	"
7135	"	281	"	"
7136	Dec. 31/83	281	"	"
7137	Sept. 1/81	281	"	"
7138	"	281	"	"
7139	"	281	"	"
7140	Dec. 31/83	281	"	"
7141	"	281	"	"
7142	"	281	"	"
7143	"	281	"	"
7144	"	281	"	"
7145	"	281	"	"
7146	Sept. 1/81	281	104-H-2	L
7147	Dec. 31/83	281	"	"
7148	Sept. 1/81	281	"	"
7149	"	281	"	"
7150	"	281	"	"
7151	Dec. 31/83	281	"	"
7152	"	281	"	"
7153	Sept. 1/81	281	"	"
7154	"	281	"	"
7155	Sept. 1/81	61	104-H-7	B
7156	"	167	"	"
7157	"	265	"	"
7158	Dec. 31/83	281	104-H-7	C
7159	"	281	"	"
7160	"	281	"	"

MT. KLAPPAN COAL PROJECT LICENCES - 1983
(cont'd)

LICENCE NUMBER	DATE ISSUED	HECTARES	SERIES	BLOCK
7161	Dec. 31/83	281	104-H-7	C
7162	"	281	"	"
7163	"	257	"	"
7164	"	280	"	"
7165	"	280	"	"
7166	"	280	"	"
7167	Sept. 1/81	75	"	"
7168	"	142	"	"
7169	Dec. 31/83	281	104-H-7	D
7170	"	281	"	"
7171	"	281	"	"
7172	"	280	"	"
7173	"	280	"	"
7174	"	280	"	"
7175	Sept. 1/81	94	"	"
7176	Dec. 31/83	277	"	"
7177	Sept. 1/81	280	"	"
7381	Mar. 18/82	281	104-H-2	J
7382	"	280	104-H-6	H
7383	"	108	"	"
7384	"	281	104-H-7	D
7385	"	204	"	"
7386	"	280	"	"
7387	"	280	"	"
7388	"	172	"	"
7389	"	275	"	"
7390	"	280	"	"
7391	"	115	104-H-7	E
7392	"	260	"	"
7416	Mar.15/83	281	104-H-2	J
7417	"	281	"	"
7418	"	281	"	"
7419	"	278	"	"
7420	"	281	"	"
7421	"	281	104-H-2	L
7422	"	281	"	"

MT. KLAPPAN COAL PROJECT LICENCES - 1983
(cont'd)

LICENCE NUMBER	DATE ISSUED	HECTARES	SERIES	BLOCK
7423	"	281	104-H-7	D
7424	"	280	"	"
7425	"	280	"	"
7426	"	280	"	"
7427	"	281	104-H-3	I
7428	"	281	"	"
7429	"	281	"	"
7430	"	281	"	"
7431	"	281	"	"
7432	"	281		
7487	Oct. 21/82	281	104-H-3	J
7488	"	281	"	"
7489	"	282	104-H-2	G
7490	"	282	"	"
7491	"	282	"	"
7492	"	282	"	"
7493	"	282	"	"
7494	"	282	"	"
7495	"	282	"	"
7496	"	282	"	"
7497	"	281	"	"
7498	"	281	"	"
7499	"	281	"	"
7500	"	281	"	"
7501	"	281	"	"
7502	"	281	104-H-2	J
7503	"	281	104-H-3	K
7504	"	281	"	"
7505	"	281	104-H-3	H
7506	"	281	"	"
7507	"	281	"	"
7508	"	281	"	"
7509	"	281	"	"
7510	"	281	"	"
7511	"	281	"	"

MT. KLAPPAN COAL PROJECT LICENCES - 1983
(cont'd)

LICENCE NUMBER	DATE ISSUED	HECTARES	SERIES	BLOCK
7512	"	281	104-H-3	I
7513	"	281	"	"
7514	"	281	"	"
7515	"	281	"	"
7516	"	281	"	"
7517	"	281	"	"
7518	"	281	"	"
7519	"	281	"	"
7520	"	281	"	"
7521	"	281	"	"
7522	"	281	"	"
7523	"	281	"	"
7524	"	281	104-H-2	K
7525	"	281	"	"
7526	"	281	"	"
7527	"	281	"	"
7528	"	281	104-H-2	L
7529	"	281	"	"
7530	"	281	"	"
7531	"	281	"	"
7532	"	281	"	"
7533	"	281	"	"
7534	"	281	"	"
7535	"	281	"	"
7536	"	281	"	"
7537	"	281	104-H-2	F
7538	"	281	"	"
7539	Oct. 21/82	281	"	"
7559	Jun. 30/83	22		
7560	"	153		
7561	"	21		
		38,138		

Under application:

44	Mar. 14/83	12,332	104-H-2 J,G 104-H-6 A,B,G,H 104-H-7 D

STATEMENT OF QUALIFICATIONS

KIMBERLEY A. JENNER

This is to certify that I have obtained my Bachelor of Science Degree in Geology from Dalhousie University in 1982.

My geological experience has been gained through mineral and coal exploration in the Altantic Provinces, Quebec and British Columbia. I have been employed as a Geologist with the Coal Division of Gulf Canada Resources Incorporated since my graduation in May, 1982.

MOUNT KLAPPAN COAL PROPERTY

APPENDIX C

CARTOGRAPHIC PROCEDURES

CARTOGRAPHIC PROCEDURES

A set of 17 1:10 000 scale map sheets covering the Mount Klappan Anthracite Property was compiled from existing federal air photo coverage in May, 1982, by Western Photogrammetry of Edmonton. In August, 1982, McElhanney Surveying and Engineering Ltd. of Vancouver and Western Photogrammetry were contracted to provide a new set of air photographs and prepare a 1:5 000 scale map set. The photography was completed on September 15, 1982, and the preparation of a map set consisting of 64 1:5 5000 map sheets was completed on January 17, 1983.

Western Photogrammetry

17007 - 107 Avenue
Edmonton, Alberta T5S 1G3
Telephone (403) 483-7722
Telex 037-2537

1982 04 14

OUR FILE NO. Q 566

Gulf Canada Resources Inc.
9th Floor
401 - 9th Avenue, S.W.
CALGARY, Alberta
T2P 2H7

Attention: Mr. John Innis
Coal Division

Dear Sir:

Re: MOUNT KLAPPEN PROPERTY - TOPOGRAPHIC MAPPING

Following our discussions with Mr. Brian Flynn of your company we are pleased to submit our proposal and cost estimates to undertake mapping on this property.

The attached plan shows the limits of the area to be mapped. Also shown are the flight lines of existing Federal Government 1:60000 scale aerial photography, which would be used. We have researched the availability of existing ground control in the area. This is obtainable from B.C. Government, trig control division. A total of twelve stations are established and they range from 2nd to 4th order horizontally and fourth order vertically. We propose to supplement this with additional vertical values obtained from the 1:50000 map sheets - 104 H 2, 3, 6 & 7 covering the area. All coordinates will be based upon the U.T.M. grid system and Geodetic Datum. In addition we have contacted B.C. Rail to confirm that data is available on the railroad bed (to Dease Lake). This would enable us to incorporate this data onto our mapping. Any coordinates supplied through this source would be used to increase the control network.

.../2

The resultant accuracy of mapping is not expected to be to the standards and general specifications of the Canadian Association of Aerial Surveyors. We understand that for the purposes of this mapping that this use of existing control is acceptable. Subsequently, the main areas of concern would be re-flown and mapped at a larger scale using new ground control as required.

The mapping to be produced now would be at a scale of 1:10000 with 10.0 metre contours interval. The final sheets would be supplied on a cronar positive from scribed negatives produced from the pencil manuscripts. This would result in a high quality reproducible product rather than the cheaper pencil manuscript. The final sheet layout is understood to be required on a system based upon the coal licences. At the time of plotting, we also understand that a number of field check point (± 200) are to be selected by your department. These points would be plotted onto the pencil manuscripts for later use by field staff.

Costs

a) To obtain all existing field control data and undertake aerial triangulation of 27 overlaps from 1:60000 scale photography. $1930.00

b) To compile topographic mapping in pencil manuscripts at a scale of 1:10000 showing 10.0 metre contours. 27.5¢ per hectare.

c) To produce reproducible cronar positive map sheets from b) 24¢ per hectare.

The area outlined is calculated to measure 24300 hectares and our unit prices would apply to the area actually mapped.

All mapping would be carried out in our Edmonton offices. Our facilities being the largest photogrammetric operation in Western Canada. We have successfully undertaken numerous mapping projects over the past twelve years for clients in the mining industry, with special emphasis on the coal mining area.

These clients include:

Baroid Canada Ltd.
Canadian Island Creek Coals Ltd.
Cardinal River Coals Ltd.
Dentherm Resources Ltd.
Esso Resources Ltd.
Luscar Ltd.
Manalta Coal Ltd.
McIntyre Mines Ltd.
PreCambrian Shield Resources
Suncor Inc.
Syncrude Ltd.
Union Oil Co. Canada Ltd.

.../3

McElhanney Surveying
& Engineering Ltd

200 - 1166 Alberni Street, Vancouver, B.C.
Canada V6E 1A5 (604) 683-8521
Telex 04-51474 Cable SURVENG

McElhanney

18 August, 1982

Our Ref.# 37005-0

Gulf Canada Resources Inc.,
P.O. Box 130,
Calgary, Alberta

Attention: Mr. Brian Flynn

RE: Mt. Klappan Aerial Photography

With reference to our recent telephone conversation we would like to thank you for authorizing us to provide you with 2 extra lines of 1:30,000 black and white aerial photography.

We understand that you require 2 additional flight lines to the south of the area we had originally proposed to fly. In addition, you would like us to extend the flight lines approximately 2 miles to the west of the original designated area. Please see the enclosed map showing complete photo coverage of the revised area.

Fee Schedule

1) For the provision of 2 additional flight lines for a total of 52 line miles as described above, the firm lump sum amount of ....$1,150.00 plus applicable tax.

2) The original contract prints for the 1:30,000 black and white aerial photography was the firm lump sum of ....$5,590.00 plus applicable tax.

3) For the provision of 2 rolls of target material, the firm lump sum amount of ....$ 500.00 plus applicable tax.

The new total for the complete job is ....$7,240.00 plus applicable tax.

L DIVISION

.../2

We understand that all targets have been set out and we are awaiting for the weather situation to improve before flying. We will contact you as soon as the area has been flown.

During our last conversation you mentioned that you would require field survey crews to tie in the photo control targets. We do have field crews working in the vicinity of your project area and it would be advantageous to transfer them to your site within the next week or two. Please contact us and let us know when the surveyors will be required.

We appreciate the opportunity of offering our services to you and look forward to a successful completion of this assignment.

Yours very truly,

McELHANNEY SURVEYING & ENGINEERING LTD.,

L. Hume

Lloyd J. Hume, C.E.T.
Business Development Representative

LJH:leo
Encl.

Western Photogrammetry

17007 - 107 Avenue
Edmonton, Alberta T5S 1G3
Telephone (403) 483-7722
Telex 037-2537

MK 2750-3 F-

Klappan - Maps-Surveys

RECEIVED
Gulf Canada Resources Inc.
DEC 16 1982
COAL DIVISION

1982 12 15

OUR FILE NO. Q 694

Gulf Canada Resources Inc.
Coal Division, 9th Floor East
401 - 9th Avenue, S.W.
CALGARY, Alberta
T2P 2H7

Received
Gulf Canada Resources Inc.
JAN 6 1983
CALGARY
Coal Division
FILE

ATTENTION: Mr. B. P. Flynn, Supervisor
Regional Exploration

Dear Sirs:

Re: MOUNT KLAPPAN, TOPOGRAPHIC MAPPING - 1:5000

In response to your invitation, this will confirm the details of our proposal and the cost breakdown to produce mapping and enlargements at a scale of 1:5000 of the areas that you requested.

The areas of interest are:

1) The original 33000 hectares, mapped at 1:10000 with 10.0 metre contours by Western Photogrammetry earlier this year and

2) The new area to the south and west, approximately 27480 hectares. This area is that shown on copy of figure 1.4 (Mt. Klappan Coal Property) as transmitted to us by telecopier. In addition to the area shaded on this plan, an additional 1 km strip is to be included around the perimeter. This strip amount to 8480 hectares. The new area of 22000 hectares is reduced by 3000 ha to 19000 ha; by the mapping already produced in original area.

.../2

Your requirements call for:

a) The addition of 5.0 metre contours interpolated by photogrammetric plotting from the 1967 1:60000 aerial photography of the original area at 1:10000 scale, the scribing and subsequent enlargement of this area to 1:5000 scale. This would involve the production of an estimated total of 40 final map sheets.

b) The plotting of new area at 1:10000 scale, with 10.0 metre contours and 5.0 metre interpolated contours from same 1:60000 aerial photography. This would entail the acquisition of new photos from N.A.P.L. in Ottawa and ground control data from B.C. Government to cover the southerly portions of this area.

This plotting would then be scribed and enlarged to 1:5000 scale, as in a) above. An estimated total of 36 final sheets would be involved in this area.

c) The location of the British Columbia Railway track bed would be plotted from the 1:30,000 scale aerial photography obtained by Gulf Resources in September 1982. This would be added to the final map sheets.

The accuracy of the 5.0 metre interpolated contours would be equal to the 10.0 metre contours. This is normally given as one half of the given contour interval i.e. ± 5.0 metres. Spot heights are similarly guaranteed to one quarter of the contour interval, ± 2.5 metres. Both of these figures being for ground not obscurred by tree or vegetation cover. These accuracy standards are those supplied by the General Specifications of the Canadian Association of Aerial Surveyors. The relative accuracies between contours and spot heights at any given local area of mapping would be better than these absolute accuracies.

<u>Costs</u>

1)

a)	To plot 5.0 metre contours at 1:10000 scale of original area (33,000 ha)	$ 5,600.00
b)	To draft 5.0 metre contours at 1:10000 scale	$ 5,000.00
c)	Photographic enlargement of 1:10000 to 1:5000 Negatives	$ 1,500.00

d)	Registration and masking of final 1:5000 Negative sheets	$ 2,100.00
e)	Production of final mylar positives 1:5000 approximately 40 sheets	$ 1,800.00
	Sub Total 1)	$16,000.00

2)

a)	Aerotriangulation, adjustment and compilation of new area (27480 ha) at scale 1:10000 with 10.0 metre contours	$ 7,500.00
b)	Drafting of 1:10000 / 10.0 metre contours	$ 6,500.00
	Sub Total 2)	$14,000.00

3)

a)	Compilation of 5.0 metre contours of new area.	$ 4,600.00
b)	Drafting of 5.0 metre contour of new area	$ 4,400.00
c)	Photographic reproduction and enlargement to 1:5000 scale	$ 1,500.00
d)	Registration and masking of 1:5000 negatives	$ 1,800.00
e)	Production of final mylar positives 1:5000 approximately 36 sheets	$ 1,600.00
	Sub Total 3)	$13,900.00

4)

Plotting of B.C.R. rail bed from 1982 1:30000 aerial photography and drafting onto final sheets. $ 1,100.00

Any changes to boundaries and area noted will be adjusted up or downward proportionally to figures supplied here.

Total Items 1, 2, 3 & 4 $45,000.00

the uma group

Delivery

In response to your request we anticipate that progressive deliveries of final sheets will commence in mid January 1983 with final delivery being around the end of January.

We will be pleased to arrange for the scheduling of the delivery of initial priority area sheets as indicated by you, following further discussions between us.

We trust that this proposal and cost breakdown meets your requirements and we request that you should contact the undersigned if there are any questions arising from it.

We greatly appreciate this opportunity to offer our organization's services to your company at this time. We look forward to co-operating with you on this project.

Yours truly,

WESTERN PHOTOGRAMMETRY

J. R. Symonds
MAPPING MANAGER

JRS/mck

the uma group

Sedimentology of the Mt. Klappan Area, B.C.

S.M. Rowe
December, 1983
Geological Services

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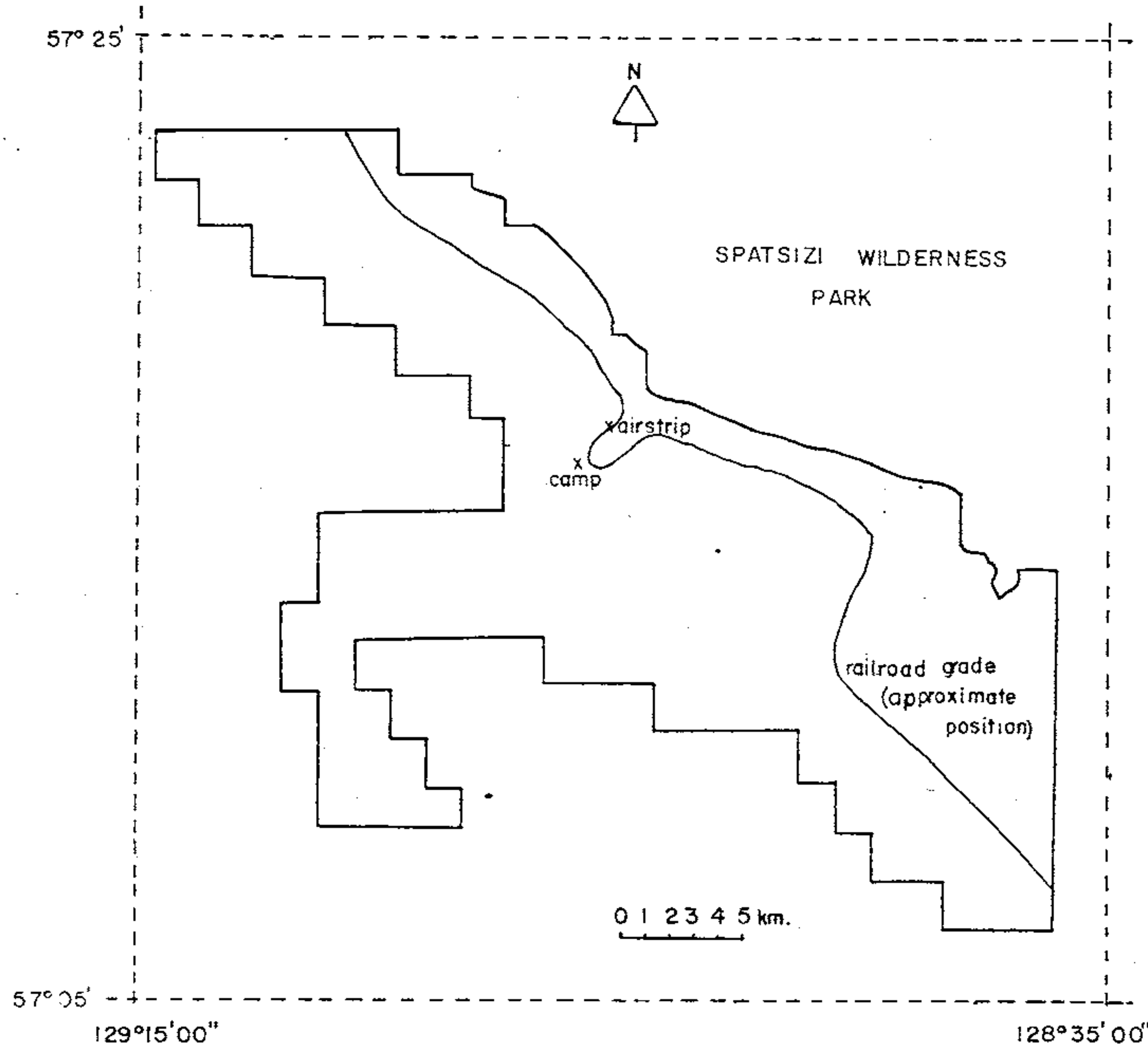


FIGURE 1: Location map.

I. INTRODUCTION

This project was carried out on request of the Coal department to further assess the paleo-environment and sedimentology of the Mt. Klappan area in northern British Columbia.

The Mt. Klappan area lies roughly between 128°30'->129°15' and 57°10'->57°20' being bordered to the north by the Spatsizi Wilderness Park, with the abandoned CPR railroad grade lying within the study area boundaries (see figure 1).

This project is a continuation of the brief assessment done in August, 1982, trying to further unravel the structural complexity of the area in order to determine the true stratigraphy. A total of four weeks were spent in the field examining outcrops, as well as reexamining the cores drilled in 1982. The new core, drilled in the 1983 summer season, was also examined.

However, due to inclement weather, not all outcrops and areas intended for viewing were reached, especially in late August when low clouds and snow obscured much of the high ground to the north of the camp in the Summit area.

In this report, a tentative correlation of the stratigraphy in the area will be made as well as attempting to relate the cores to the outcrop sections observed. Although exposures are abundant, they are mostly strike sections rather than showing a complete vertical section (throughout the area), omitting their relationship to underlying strata.

Therefore the relationships between certain outcrops are still largely speculative.

Recommendations will also be made for further studies, possible drill locations and general exploration trends.

II. STRUCTURE

The structure of the area was dealt with in detail by the coal department and they should be consulted for any specifics concerning the structure. However, to understand the overall stratigraphy of the area, a good understanding of the basic structural setting is necessary. Basically the area appears to be a WNW to SSE trending anticline and syncline, superimposed upon this is a series of E-W trending folds (see figure 2). Along with these two dominant fold directions numerous minor small scale folds and faults are present throughout the entire area (see figure 2). This tends to complicate the stratigraphy greatly, making correlation between individual outcrops very difficult. For example, there is a lack of outcrop between Didene Creek and Hobbit Creek, subsequently it can only be inferred what is happening there. The most logical assumption is that they would be stratigraphic equivalents. This is an area that needs much more work done.

Major facies changes are also likely to occur throughout the area. Extensive drilling appears to be needed to obtain sufficient structural data.

East - West trending folds

Minor fault showing displacement.

Figure 2: General Structure of Mt. Klappan Area

III. SEDIMENTOLOGY & PETROLOGY

The various rock units of the area were described in last years report (Mt. Klappan coal property, November 1982) but a few new units have been added. From stratigraphic highest to lowest the total sequence is:

A. Non Marine Units

1. Conglomerates (.1m to 16m thick)
2. Pink cross bedded sandstones (.5m to 20m thick)
3. Interbedded, partially varved sandstone, siltstone, shale and marl unit (3m to 10m thick, may be repeated)

B. Transitional Units

4. Coal unit (coal layers are found in several other units as well) (each being .2m to 3m thick)
5. Argillaceous sandstone unit (sandstone with red specks)(10m to 20m thick)

C. Marine Units

6. Interbedded sandstone, siltstone and shale units usually with chert banding (5m to 50m thick)
7. Shale unit (lower contact unknown but where observed 10m to 30m thick)

The complex structure of the Mt. Klappan area makes it difficult to determine total thickness of the stratigraphic sequence. From data collected to date, it appears the sequence is about 150m to 300m in total thickness. This thickness is taken from approximately the top of the conglomerate on Mt. Klappan to the shales (base not defined yet), of the Summit area.

1. The Conglomerates

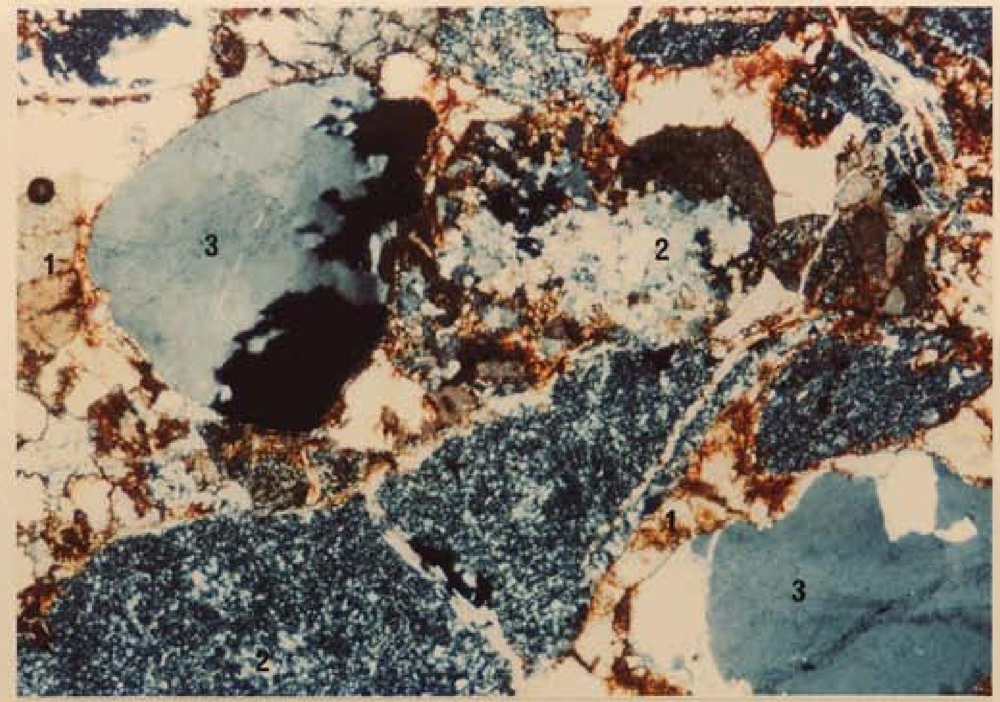
The conglomerates of the Mt. Klappan area, although widespread, appear to be more confined to the upper non-marine sections, although in a few localities they come very close to the marine areas such as in Spatsizi Park where large bivalve shells were found at the base of the conglomerates.

The conglomerates of the Mt. Klappan area make up a major cliff forming unit. Conglomerates found on Mt. Klappan are 16 m at their thickest and a single 1 cm pebble layer at their thinnest (as a lag in the base of a sandstone channel). The conglomerate lies conformably on the sandstone unit in places while cutting it in other places such as upper Fox Creek where the conglomerates cut into a sandy shale.

The conglomerate appears massive in most localities but on intensive examination, large scale high angle cross bedding was observed. These cross beds were rarely visible due to their large scale.

Most conglomerate outcrops displayed a very sharp base and a slightly gradational top. It appears that numerous cycles make up the conglomerate as a whole. An overall fining upward trend was noticed.

The conglomerate is a coarse grained chert conglomerate with a clast-supported sand matrix. A later stage of carbonate cementation was noted in all conglomerates, (see figure 3). Grain size ranges from 3 mm to 10 cm with the average pebble size being 1 cm.



Thin section of conglomerate showing abundant Carbonate Cement(1), Chert(2), Quartz(3). 6.3x

Large conglomerate with underlying sandstone unit, sharp lower contact on Conglomerate

Figure 3: Conglomerate Unit

In outcrop the conglomerates weather to a dull grey and are prone to be covered by a dark lichen growth, which obscures the nature of the rock in places.

The conglomerate is found in several localities within the study area, as well as in the surrounding mountains to the south and south east. The conglomerate by the railroad grade (see figure 4 for outcrop locations) may be a totally separate conglomerate but is probably time equivalent. In the area of Mt. Gunanoot numerous cycles of conglomerates are present and appear to be stratigraphically higher than those of Mt. Klappan.

Much of the Mt. Klappan region has been documented as deltaic (Eisbacher, 1974). The large conglomerate channels appear to be largely fluvial to deltaic. Possibly they represent a large tidal channel with a fairly extensive braided stream system associated with it (as seen in the cross bedded sandstones that are lateral equivalents to the conglomerates (see figure 5). As you approach Lost Ridge a more deltaic environment (coal swamps, marine forams) is encountered. In the other direction, to the south, the conglomerates take on a more fluvial appearance with associated varved lacustrine deposists and non-marine microfossils.

To the south and south east of the area, where conglomerates are more widespread, they possibly represent alluvial plain to alluvial fan deposits.

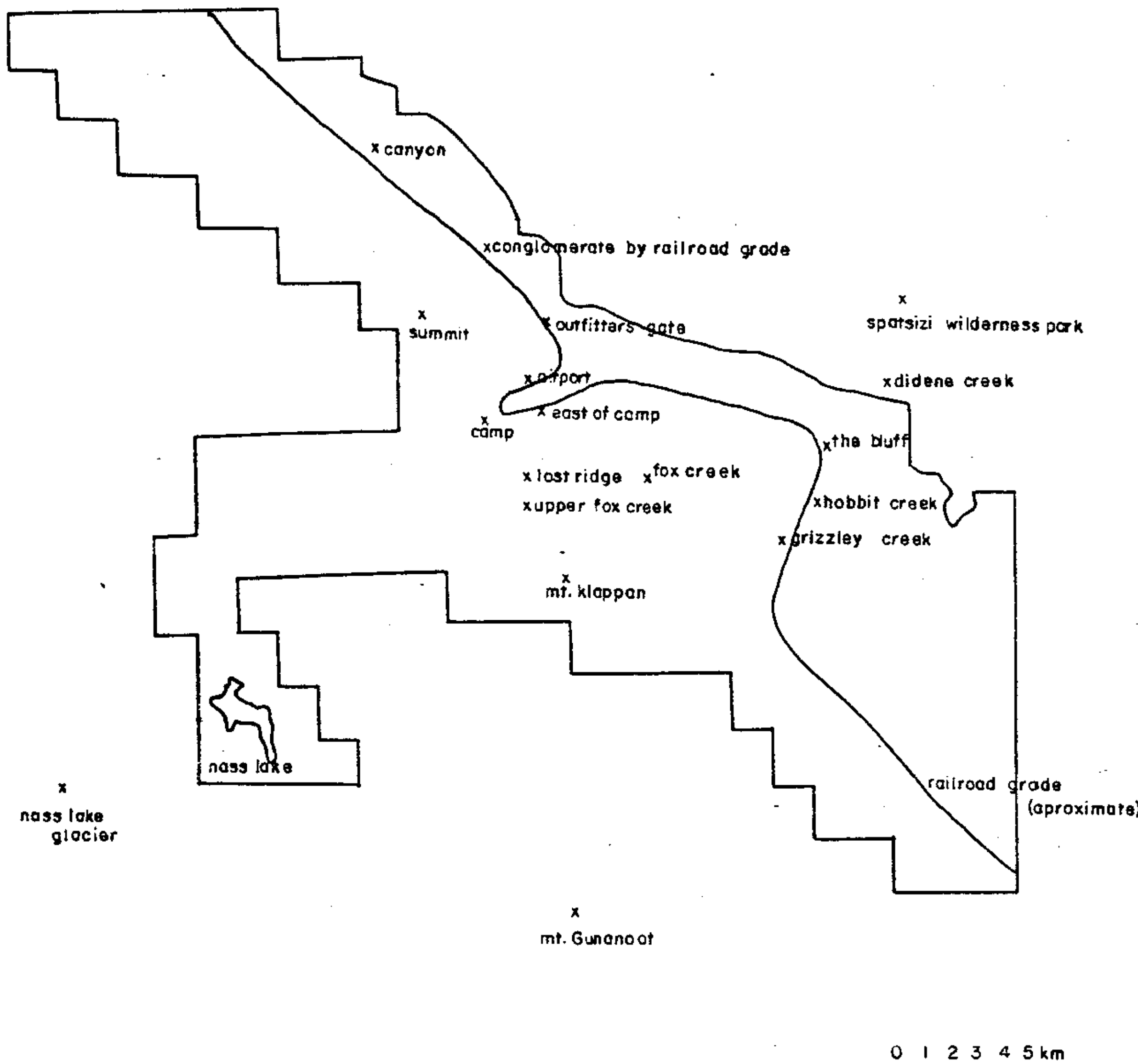


FIGURE 4 : Outcrop location map

Two conglomerate channels separated by high angle
cross bedded sandstones, most containing pebble lags.

Cross bedded pink sandstones. Tops are to the left.

Figure 5: Channeling on Mt. Klappan

2. Pink, Cross Bedded Sandstones

Like the conglomerates, these sandstones also appear to be associated with the more non-marine portion of the area. In particular they are associated with the conglomerate channels on Mt. Klappan (see figure 5). They are of lesser vertical extent than the conglomerates being from .5m to 20m (average about 3m). They appear to be discontinuous over the area which indicates that they may be a part of a large meandering river or deltaic channel system.

The pink sandstone weathers a pale greyish-pink colour and has a slightly sucrosic texture. It is very equigranular, with equal portions of chert and quartz. It appears to be the same as the matrix for the conglomerate with minor carbonate cementation. The average grain size is less than 1 mm (see figure 6).

3. Interbedded and Varved Sandstone, Siltstone, Shale and Marl unit.

This unit is also characteristic of the more non-marine intervals of the area with the best example being at the top of Mt. Klappan by the small lake (see figure 7). Here the sediments are distinctly varved with numerous associated ripples and an occasional marl bed. This would indicate local shallow lacustrine conditions. These sediments appear to be very cyclic in nature, not only on the scale of the varves (1mm to 3cm) but also on a larger scale (several meters) as observed on Mt. Gunanoot where these sediments occur at regular intervals along with the conglomerate and sandstone units (see figure 7).

Pink sandstone unit thin section showing Carbonate Cement(1), Chert(2), Quartz(3) 6.3x

High angle X beds of the pink sandstone

Figure 6: Pink sandstone unit

Cyclical sequences on Mt. Gunanoot. These units also contain a cliff forming conglomerate(1).

Top of Mt. Klappan cyclical nature of sediments. More noticeable on a smaller scale.

Figure 7: Interbedded and varved sandstone, siltstone, shale and marl unit.

This section has been determined to be non-marine from paleontology.

4. Coal Unit

The coal unit as described previously (Mt. Klappan coal Property, 1982) contains a high grade anthracite with thicknesses from several centimeters to several meters. No further work was done this year on the coal units, but it appears these coals were formed mainly in interdeltaic marginal marine swamps. Minor coal forming also took place in lacustrine conditions.

5. Argillaceous Sandstone Unit

This unit has been described in the previous report. The argillacious sandstone unit was found to be fairly widespread throughout the area and was interpreted to represent a marginal marine, deltaic system. A variety of these sands were noted throughout the area such as the possible deltaic tidal channels at the bluff. The sandstones appear to be sourced from different directions, but they all seem to be marginal marine to deltaic in appearence. They average 10 - 20m in thickness. These sandstones have high heamatite content, and pebble lags are usually found along the base of the channels. Similar sandstones are found east of camp, at the airstrip, at the outfitters gate and at the the top of the canyon to the north on the railroad grade (see figure 4 for outcrop locations). That is not to say these are all the same sands but they do most likely represent similar conditions and similar source areas over a period of time.

6. Interbedded Sandstone, Siltstone and Shale Units, usually with Limy, Chert Banding

This unit was determined by paleontology to be marginal marine to marine. The best example is seen at Hobbit Creek. Here it occurs as well formed turbidites representing a prodeltaic facies. This particular area has unusually large limy chert nodules (see figure 8). The unit is also found at the north end of the canyon and to a certain extent on Lost Ridge. Overall these beds are very rhythmic in nature on about a 30 - 50 cm scale and continue over as much as a 50 meter interval. Similar units are found by the Nass River Glacier (see figure 9) but may represent possibly slightly deeper water conditions. No extensive palynology work or paleontology work has been done on this area so the depositional conditions are very tentative.

7. Shale Unit

Shale is found everywhere and in every unit but it is most pervasive in the deeper marine units (as determined by paleontology). The shales are very dark and appear to lack extensive bioturbation. Belemnites are found in this unit, indicating good open marine conditions. The marine shales are dominant in the Summit area as well as in holes 831 near its base, 833, and 827. They were also found in the Spatsizi Wilderness Park (see figure 10).

Interbedded prodeltaic turbidites; note large cherty growths(1): Hobbit Creek

Interbedded marine shales at north end of canyon.

Figure 8: Interbedded sandstones, siltstones, and shale unit.

Figure 9: Nass River Glacier

Burrowing is rare throughout. Here it appears to have undergone soft sediment deformation.

Belemnites found at top of a small sandy zone in the shale.

Figure 10: Shale Unit

IV. STRATIGRAPHIC CORRELATIONS AND PALEOGEOGRAPHY

As mentioned previously, stratigraphic correlations are very difficult because of the complex structure in the area. Another factor is the lack of core. With the sparse core available, the tendency has been to ignore structure in it. There is no reason to believe that the core has not been folded and faulted, in the same way as surrounding rocks. Folding or faulting through a shale is not likely to be observed in core but none-the-less would be present. Many faults in outcrop are only inferred as well. Others do display displacement of the more competent beds (see figure 11).

Basically the area appears to represent a regressive cycle from marine to non-marine. There also appears to be a facies change from mainly marine conditions in the north to mainly non-marine conditions in the south. The thinning of the conglomerates towards the north west, minor paleocurrent directions, and marine conditions to the north, point to a southeasterly to easterly direction for the source area. However, a few paleocurrent directions (McKenzie pers com.) appear to be coming from the north, indicating the basin has a limited extent to the north of the Summit area. This apparent conflicting evidence or varying transport directions can be explained by a rather restricted basin (see figure 12). This basin could either be cut off from the main marine source or actually be open to the main marine influence to the west. Either way it would not change the position of the basin in the Mt. Klappan area. The dominance of marine conditons to the north is the main reasons for the basin being to the north, but definitely more work is needed to verify this completely. To the north in the Summit Area, as well as in a

Fault with noticeable displacement.

Two faults with not so noticeable displacement.
Could be 5 cm or 5 m displacement.

Figure 11: Minor fault displacement

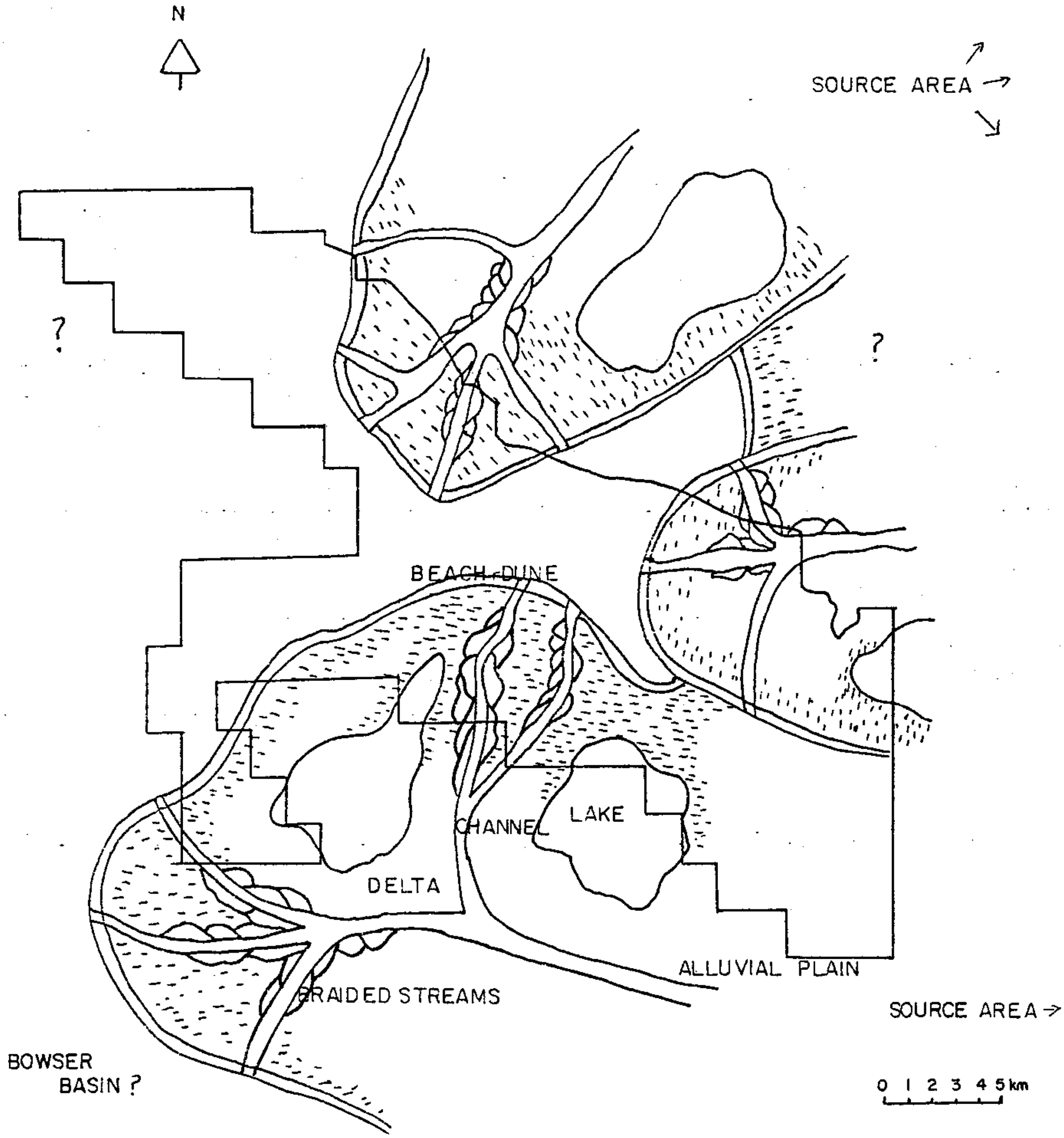


FIGURE 12: Depositional model. Deltas are not time equivalents, they overlap

similar stratigraphic locality in the Spatsizi Wilderness Park, marine belemnites were found. Belemnites were also found in cores drilled in similar levels such as in holes 833,832,831.

As you move south, and possibly slightly higher stratigraphically, you encounter the more marginal marine deposits of Didene Creek (oyster reefs), the bluff (tidal channels), and Hobbit Creek (prodelta turbidites). Lost Ridge would also come into this category but it is uncertain whether it is stratigraphically equivalent to Hobbit Creek or not; more core data are needed. The oyster reefs definitely indicate marginal marine, salt to brackish water conditions. Also several paleontology samples taken from the Hobbit Creek area indicate brackish conditions.

Even further to the south, Mt. Gunnanoot and surrounding areas display a distinct fluvial and lacustrine influence. The numerous conglomerates appear to be mainly deltaic (to the north) and fluvial (to the south) in the Mt. Klappan area but could be alluvial plain even further to the southeast.

The general trend therefore appears to be going from marine sediments to the north through transitional sediments in the middle to non-marine sediments in the southern part of the study area.

Figure 12 depicts a delta model. These deltas could be from the same source or could be from different locations on the alluvial plain. They do overlap however, such as the delta at Hobbit Creek which appears to overlie the main coal seam. This seam according to this model could extend quite a ways north under the overlying delta.

Outcrop near the Nass River Glacier to the southwest appears to be more marine. This may be due to a connection to the west with the Bowser basin (see figure 12).

Considering the number of facies changes in the area, correlation of the core is extremely difficult. A volcanic pebble horizon (see figure 13) was noticed in several holes. The cores were then correlated on the assumption that this layer was widespread enough in the area to be the same event in time. More coring is needed to determine if this volcanic layer is a valid marker.

To date this layer has not been found in outcrop. Volcanic ash layers were noted in core as well as in outcrop but none appear reliable enough to constitute a marker horizon. For a tentative correlation of the core, see figure 14.

Figure 13: Volcanic pebble marker horizon

V. DISCUSSION

The sediments at Mt. Klappan seem to be very similar in age and appearance to the southern Alberta and British Columbia Nikanassin Formation/Kootenay Group and overlying Cadomin Formation (see figure 15).

In Alberta/British Columbia the Nikanassin/Kootenay comprises an interstratified sequence of medium to dark grey to yellowish-brown weathering siltstone, sandstone, mudstone, shale and minor thin seams of coal which ranges in thickness from 53 m to 488 m (Gibson 1978). This sequence has been determined to be interdeltaic beach-barrier island, deltaic and alluvial plain to the south in the Kootenay and more typically delta plain to the north in the corresponding Nikanassin Formation (Gibson, 1983) (see figure 16).

These units are overlain unconformably by sandstone and conglomerate of the Cadomin Formation of the Blairmore Group which varies from alluvial deposits near the Foothills Front Ranges to mainly fluvial towards the west (Gibson, 1978).

The Kootenay Group is broken into 3 distinct formations: the Morrissey Formation, the Mist Mountain Formation, (formerly called the coal bearing member) and at the top the Elk Formation (Gibson, 1983).

The Morrisey Formation is a cliff forming sequence separating the Kootenay from the underlying marine shale "Passage beds" of the Fernie Formation. The Morrissey Formation consists of dark grey to black mudstones and shales and limonitic siltstones and sandstones with local channels containing pebble lags (Ollerenshaw 1977), and a fine to coarse

Period	Epoch	Eisbacher, 1974c NORTHERN BOWSER BASIN	Tipper & Richards, 1975 SOUTHERN BOWSER BASIN	Richards & Gillchrist, 1979 NORTHERN GROUNDHOG COALFIELD	Bustin & Moffat, 1983 GROUNDHOG COALFIELD	Gibson 1983 ALBERTA BRITISH COLUMBIA	This Paper Rowe, 1983 MT. KLAPPAN
CRETACEOUS	Upper	Sustut Sifton Assemblage	Sustut Group	Sustut Group		Alberta Group	
CRETACEOUS	Lower	Bowser Assemblage: Jenkins Creek Facies; Gunanoot Groundhog Facies	Skeena Group	Gunanoot Assemblage	Groundhog Group: Devils Claw Unit; McEvoy Unit	Blairmore Gr.: Crowsnest Fm.; Cadomin Fm. Kootenay Gr.: Elk Fm.	Non Marine
JURASSIC	Upper	Bowser Assemblage: Duti River Slamgeesh Facies	Bowser Lake Group	Gunanoot Assemblage	Groundhog Group: Currier; Prudential	Kootenay Gr.: Mist Mountain Fm.; Morrissey Fm.	Transition Zone; Marine Clastics
JURASSIC	Middle	Takla Hazelton Assemblage	Hazelton Group		Jackson Unit	Fernie Fm.	Marine Shale
JURASSIC	Lower	Takla Hazelton Assemblage	Hazelton Group			Fernie Fm.	Marine Shale
TRIASSIC	Upper		Takla Group				
TRIASSIC	Middle						

Figure 15: Nomenclature of the Mt. Klappan area, and its relationship to the Bowser Basin and Kootenay Group.

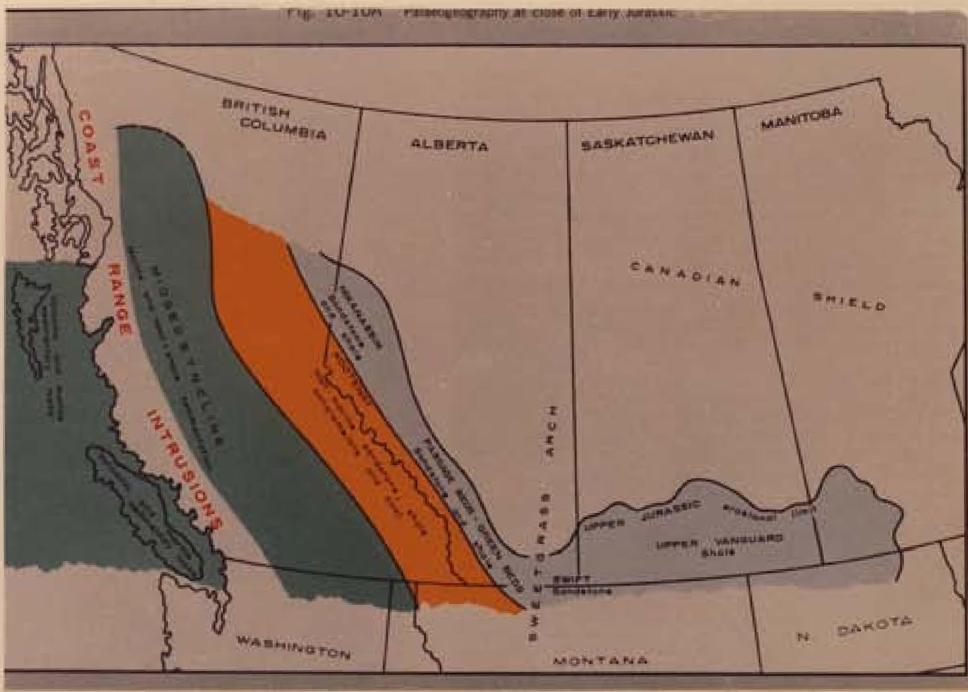


Figure 16: Showing the beginnings of the Fernie formation before the Nevadan Orogeny uplift mountains to the West.
(after A.S.P.G. Geological History of Western Canada)

grained quartzose sandstone prone to a light grey weathering. This has been interpreted as being offshore "prodelta" and strandline deposits of a highly constructive, wave-dominated delta system (Gibson, 1983).

There is a similar sequence of rocks found at Mt. Klappan in the Summit area and near the very north of the railroad grade (see figure 17). Here the stratigraphically lower shales contain belemnites indicating good marine conditions similar to the "Passage beds" of the Fernie Formation. Above this are a sequence of interlayered greasy black shales, argillaceous siltstones, and limonitic to cherty siltstones which are cut into at the top by a cliff forming interbedded siltstone and cherty sandstone. Some minor coal is present in the interlayered sequence of black shales and argillaceous siltstones. This outcrop at the far northern end of the railroad grade is most likely stratigraphically equivalent to the outcrops at the outfitters gate, the airstrip and the outcrop just east of camp on the rail grade. All indications point to these outcrops as being marginal marine (paleontology data), having formed parts of a littoral environment, possibly a wave-dominanted deltaic system similar to that interpreted by Gibson.

The next unit, the Mist Mountain Formation, formerly called the coal bearing member, is a grey to grey-brown, interbedded carbonaceous-argillaceous sandstone, siltstone, mudstone, shale with numerous seams of bituminous coal. Minor conglomerates and conglomeratic sandstones are documented in places as well (Gibson 1977). This has been interpreted to be interdeltaic beach-barrier island, deltaic and alluvial plain deposits

North end of canyon, interlayered shales, siltstones and limonitic to cherty siltstones (weathered orange)

Dark marine shales of the Summit area containing belemnites.

Figure 17: Marine Sequence

(Gibson 1976B). The Mist Mountain formation represents mainly a transition zone from marine to non-marine. Mt. Klappan's similar sequence of rocks comprises all the major coal-bearing sequences such as Hobbit creek and Lost Ridge. Possible stratigraphic equivalents are also Didene Creek and the Bluff by the road. Hobbit Creek appears to be a prodeltaic turbidite sequence. The deltaic sequence appears to be overlying an older coal sequence which is probably more indicative of shoreline conditions (see figure 12). Structurally it is very hard to distinguish whether the outcrops at the Bluff and Didene Creek are above or below Hobbit Creek. Didene Creek and the Bluff by the road appears to contain numerous channels near the top of the section (possibly tidal deltaic channels). Paleontology indicates marine to brackish conditions.

Hobbit Creek coals were buried rapidly by the turbidites of a prodeltaic sequence due to a minor transgression. From Hobbit Creek, stratigraphically upwards, continental siltstone are encountered. They contain leaf impressions and a few tree stumps ranging from .4 m to 3 m in diameter.

The final unit of the Kootenay Group is the Elk Formation. The Elk Formation is a series of conglomerates which grade laterally into coarse grained sandstones and siltstones or into a cyclical succession of sandstones, siltstone, and shales (Gibson, 1977). This is generally a cliff-forming sequence and also contains sporadic thin seams of coal. In several localities (eg. Mt. Allan, Alberta) the coal seam was referred to as a "Needle Coal" being composed of up to 15 cm of a compacted mass of coniferous needles. This would suggest a much more continental origin of the sediments such as the more prominent parts of alluvial plains and the distal portions off alluvial fans (Gibson 1983). Mt. Klappan's similar sequence would be at Mt. Klappan itself. Mt. Klappan is composed of large cliff-forming conglomerates which laterally become sandstone to siltstones (see figure 15). Minor coal seams as well as tree stumps and leaf impressions are found near the top of Mt. Klappan. This sequence appears to be fluvial in nature (paleontology results) and most likely continues over to the lower portions of Mt. Gunanoot, as well as some upper sections of the Spatsizi Wilderness Park. Towards the park however the sediments appear to change to a more marine facies as indicated by belemnites and clams found in outcrop.

Overlying the Elk Formation, erosionally in most places, is the conglomeratic sandstone of the Cadomin Formation of the Blairmore Group. In some localities, however, the Elk Formation is overlain abruptly and possibly conformably by the fine to coarse clastics of the Pocaterra Member of the Blairmore Group.

As, so far, little work has been done to the south of the Mt. Klappan area, it is hard to tell if a similar situation exists here too.

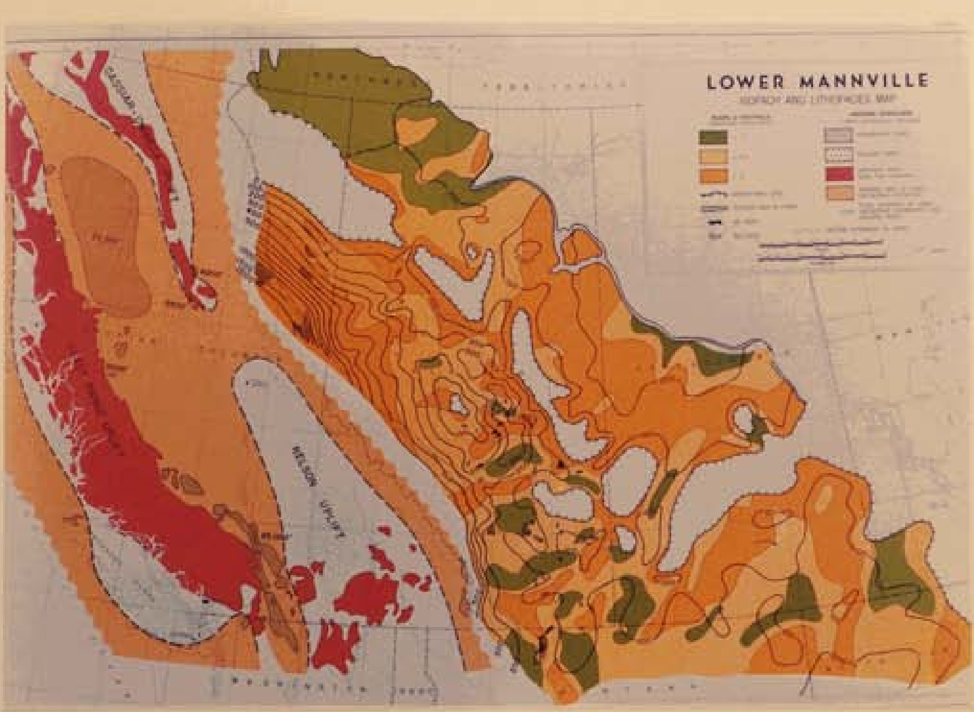
Most likely the conglomerates on top of Mt. Gunanoot and surrounding peaks are similar in origin and characteristics to the Cadomin conglomerates which, depending on their distance from the source, are alluvial to fluvial deposits.

Because of Mt. Klappans' many similarities to the Kootenay Group, it is suggested that very similar conditions existed both on the east and west side of the Nelson uplift. Further to the north is the Caissiar Omineca uplift which joins the Nelson uplift in the Early Cretaceous (see figure 18). Depending on Mt. Klappans' proximity to the source, going outward (west to north west) from the mountains you would encounter first alluvial deposits, with associated fluvial deposits then deltaic and finally marine (see figure 19). This is very similar to the situation on the east side of the mountains.

VI. CONCLUSIONS AND RECOMMENDATIONS

In conclusion it is thought that the marine basin is to the north of the area not to the south as previously assumed, making the basin independent of the Bowser Basin. However, the possibility of the two being joined to the west should not be disregarded but for the purposes of correlation in the area they should be considered as two separate basins.

This concept of the basin to the north gives room for much more exploration potential on the east, north and possibly the south margins of the basin (see figure 20).



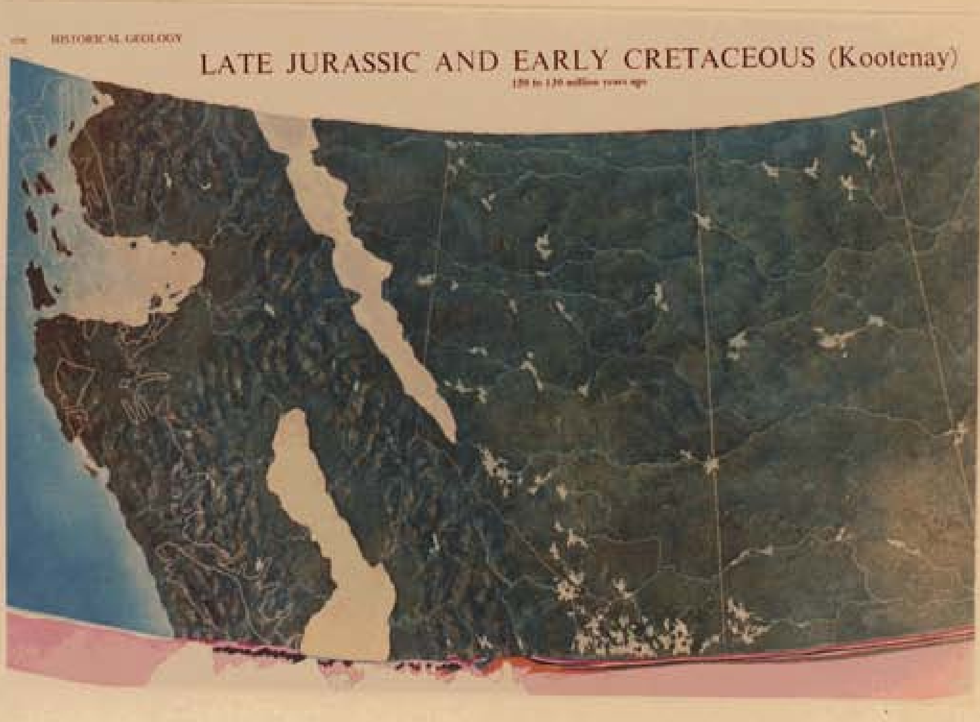


Figure 18: Late Jurassic, Early Cretaceous Paleogeography.
Note discrepancy in positions of the basin at this time.
The upper photo has it open to the Pacific while the lower photo is restricted to the interior.
(After ASPG Geological History of Western Canada and Samuel J. Nelson, The Face of Time.)

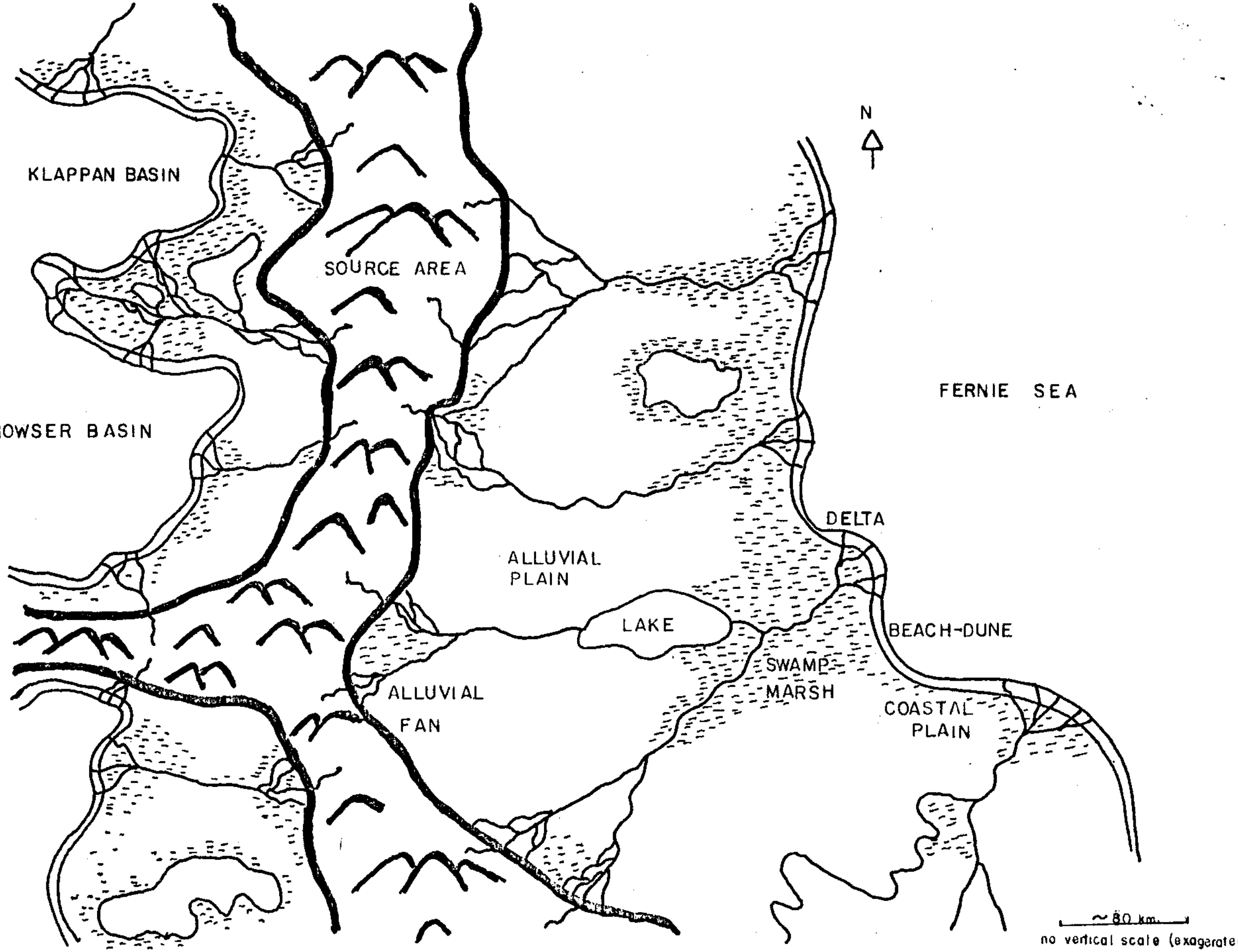


FIGURE 19 : Schematic paleogeographic map illustrating environments of deposition of Kootenay Group (after Gibson, 83), and possible environment of deposition of the Mt. Klappan area.

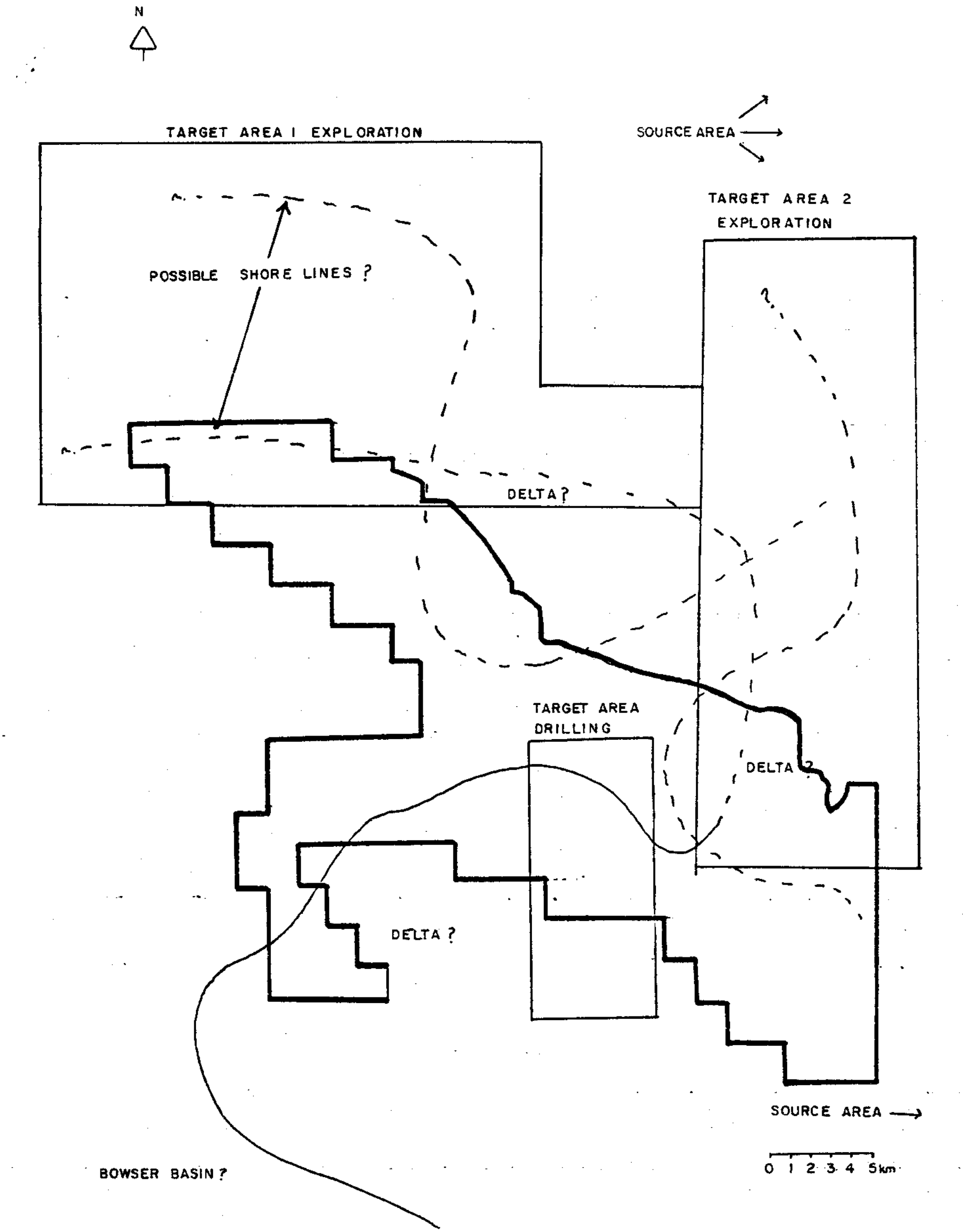


FIGURE 20: TARGET AREAS

In comparing the Mt. Klappan area to the Kootenay Group, it is not meant to compare exact events in geological history but to emphasize the vast similarities of deposition at a similar time span. The Kootenay Group spans the entire Rocky Mountain Front with the type of irregularities expected in any terrain, such as numerous individual alluvial fans, and numerous deltas. But overall, similar conditions existed at similar times. Therefore, it is a logical assumption that similar events also took place on the other side of the uplift at approximately the same time. So even if the two basins are separated by the Nelson and Omineca-Cassiar uplift, similar sediments should be deposited to the east as would be to the west. The much better understood Kootenay Group is considered a viable model for the Bowser basin as well as for the Mt. Klappan region but on a much smaller scale.

Much more work is needed to pinpoint the exact shorelines. To do this the gross structure of the area has to be better known so you can correlate one outcrop to another.

Coring must be done on a much more intensive scale. The correlations of the cores at present are somewhat dubious. There is a lot of distance between the present ten holes with too much structural folding in between to expect easy correlation on a large scale. More cores would also help determine more of the environmental aspects of the coal, giving a three dimensional picture of the area. Fox creek in particular needs to be tied into the area as to whether it is above or below or equivalent to Lost Ridge.

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1800m
82005 1815m
83001 1841m
83003 1825m
1800m
seam i
structural repeating in 83003
83002 1484m
82004 1470m
82006 1489m
82001 1400m
82002 1342m
BLUFF
82003 1271m
82007 1315m
facies change
facies change
holes 82005 and 83001 cannot be correlated due to the scale of the map. see below for their stratigraphic relationship. 82005 is inverted.
sandstone
interbedded sandstone siltstone & shale
coal
shale
V volcanic pebbles, possible marker horizon
40m
30m
20m
10m
0m
VS
hs-exagerated.
FIGURE 14: Core Correlation Mt. Klappan B.C.
Lost Ridge
Schematic Stratigraphic Drillhole Locations Disreguarding Minor Folding Within The Units
no scale
GULF CANADA RESOURCES INC.
MT. KLAPPAN B.C.
CORE CORRELATION
BY: S.M. ROWE
DATE: JANUARY 1984

MOUNT KLAPPAN COAL PROPERTY

APPENDIX E

RESOURCE DATA & CALCULATIONS

INFERRED RESOURCE CALCULATIONS

INFERRED RESOURCE AREA SUMMARY

RESULTING TOTAL SEAM TONNAGE (million tonnes)

SEAM	HOBBIT-BROATCH AREA	LOST-FOX AREA	SUMMIT AREA	TOTAL
O		0.325		0.325
N		1.04		1.04
M		4.69		4.69
L		11.69		11.69
K	67.94	33.18		101.12
J	32.81	32.60		65.41
I	162.26	42.55		204.81
H	63.47	42.28		105.75
G	106.21	48.60	0.53	178.52
		22.19	0.99	
F	18.18	46.62		64.80
E	57.02	12.50	2.36	74.51
			2.63	
D			4.75	4.75
C		12.41	3.79	16.20
B	52.60	14.29	2.27	69.16
A	59.55	5.27		64.82
Total	620.04	330.23	17.33	967.60

Summary

Hobbit-Broatch Resource Area

Seam		Resulting Total Seam Tonnage (million tonnes)
K		67.94
J		32.81
I		162,26
H		63.47
G		106.21
F		18.18
E		57.02
D		
C		
B		52.60
A		59.55
	TOTAL	620.04

Hobbit-Broatch Resource Figure

Summary
Calculation of Inferred Resources
in the Hobbit-Broatch Resource Area

Section	Resulting Total Seam Tonnage (million tonnes)
500 S	10.27
1000 S	28.52
1500 S	59.55
2000 S	61.15
2500 S	45.43
3000 S	61.70
3500 S	66.22
4000 S	82.41
4500 S	70.66
5000 S	70.28
5500 S	63.85
TOTAL	620.04

Hobbit-Broatch Resource Figure

SECTION 500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K					
J					
I					
H	0.110	.500	2.12	1.70	0.20
G	0.395	.500	3.32	1.70	1.11
F					
E	0.885	.500	1.66	1.70	1.25
D					
C					
B	2.200	.500	1.50	1.70	2.81
A	3.455	.500	1.67	1.70	4.90
				TOTAL	10.27

SECTION 1000 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	0.235	.500	3.13	1.70	0.63
J	0.310	.500	1.41	1.70	0.37
I	0.690	.500	6.07	1.70	3.56
H	1.255	.500	2.12	1.70	2.26
G	2.020	.500	3.32	1.70	5.70
F					
E	3.275	.500	1.66	1.70	4.62
D					
C					
B	4.060	.500	1.50	1.70	5.18
A	4.370	.500	1.67	1.70	6.20
				TOTAL	28.52

SECTION 1500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.570	.500	3.13	1.70	6.84
J	2.700	.500	1.41	1.70	3.24
I	3.220	.500	6.07	1.70	16.61
H	3.605	.500	2.12	1.70	6.50
G	3.820	.500	3.32	1.70	10.78
F					
E	3.850	.500	1.66	1.70	5.43
D					
C					
B	3.810	.500	1.50	1.70	4.86
A	3.725	.500	1.67	1.70	5.29
				TOTAL	59.55

SECTION 2000 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.770	.500	3.13	1.70	7.37
J	2.860	.500	1.41	1.70	3.43
I	3.130	.500	6.07	1.70	16.15
H	3.645	.500	2.12	1.70	6.57
G	3.790	.500	3.32	1.70	10.70
F					
E	4.075	.500	1.66	1.70	5.75
D					
C					
B	4.145	.500	1.50	1.70	5.28
A	4.155	.500	1.67	1.70	5.90
				TOTAL	61.15

SECTION 2500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	1.520	.500	3.13	1.70	4.04
J	1.700	.500	1.41	1.70	2.04
I	2.065	.500	6.07	1.70	10.65
H	2.620	.500	2.12	1.70	4.72
G	3.110	.500	3.32	1.70	8.78
F					
E	3.575	.500	1.66	1.70	5.04
D					
C					
B	3.720	.500	1.50	1.70	4.74
A	3.820	.500	1.67	1.70	5.42
				TOTAL	45.43

SECTION 3000 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.615	.500	3.13	1.70	6.96
J	2.775	.500	1.41	1.70	3.33
I	3.210	.500	6.07	1.70	16.56
H	3.545	.500	2.12	1.70	6.39
G	3.715	.500	3.32	1.70	10.48
F	3.815	.500	0.87	1.70	2.82
E	3.870	.500	1.66	1.70	5.46
D					
C					
B	3.740	.500	1.50	1.70	4.77
A	3.475	.500	1.67	1.70	4.93
				TOTAL	61.70

SECTION 3500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.065	.500	3.13	1.70	8.15
J	3.230	.500	1.41	1.70	3.87
I	3.735	.500	6.07	1.70	19.27
H	3.865	.500	2.12	1.70	6.96
G	3.885	.500	3.32	1.70	10.96
F	3.845	.500	0.87	1.70	2.84
E	3.845	.500	1.66	1.70	5.43
D					
C					
B	3.540	.500	1.50	1.70	3.98
A	3.350	.500	1.67	1.70	4.76
				TOTAL	66.22

SECTION 4000 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.900	.500	3.13	1.70	10.38
J	4.195	.500	1.41	1.70	5.03
I	4.460	.500	6.07	1.70	23.01
H	4.805	.500	2.12	1.70	8.66
G	4.720	.500	3.32	1.70	13.32
F	4.715	.500	0.87	1.70	3.49
E	4.720	.500	1.66	1.70	6.66
D					
C					
B	4.530	.500	1.50	1.70	5.78
A	4.285	.500	1.67	1.70	6.08
				TOTAL	82.41

SECTION 4500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.500	.500	3.13	1.70	9.31
J	3.660	.500	1.41	1.70	4.39
I	3.950	.500	6.07	1.70	20.38
H	3.925	.500	2.12	1.70	7.07
G	3.945	.500	3.32	1.70	11.13
F	3.840	.500	0.87	1.70	2.84
E	3.965	.500	1.66	1.70	5.59
D					
C					
B	3.895	.500	1.50	1.70	4.97
A	3.510	.500	1.67	1.70	4.98
				TOTAL	70.66

SECTION 5000 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	3.335	.500	3.13	1.70	8.87
J	3.570	.500	1.41	1.70	4.28
I	3.725	.500	6.07	1.70	19.22
H	4.120	.500	2.12	1.70	7.42
G	4.125	.500	3.32	1.70	11.64
F	3.990	.500	0.87	1.70	2.95
E	4.030	.500	1.66	1.70	5.69
D					
C					
B	3.795	.500	1.50	1.70	4.84
A	3.780	.500	1.67	1.70	5.37
				TOTAL	70.28

SECTION 5500 S

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
K	2.025	.500	3.13	1.70	5.39
J	2.360	.500	1.41	1.70	2.83
I	3.265	.500	6.07	1.70	16.85
H	3.730	.500	2.12	1.70	6.72
G	4.115	.500	3.32	1.70	11.61
F	4.385	.500	0.87	1.70	3.24
E	4.320	.500	1.66	1.70	6.10
D					
C					
B	4.230	.500	1.50	1.70	5.39
A	4.030	.500	1.67	1.70	5.72
				TOTAL	63.85

SUMMARY

LOST-FOX RESOURCE AREA

Seam		Resulting Total Seam Tonnage (million tonnes)
O		.325
N		1.04
M		4.69
L		11.69
K		33.18
J		32.60
I		42.55
H		42.28
G up		48.60
G lo		22.19
F		46.62
E		12.50
C		12.41
B		14.29
A		5.27
	TOTAL	330.23

SUMMARY

CALCULATION OF INFERRED RESOURCES
IN THE LOST-FOX RESOURCE AREA

Section		Resulting Total Seam Tonnage (million tonnes)
1000 N		52.03
1500 N		56.64
2000 N		62.19
2500 N		61.54
3000 N		49.08
3500 N		28.50
4000 N		20.25
	TOTAL	330.23

SECTION 1000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
O	.155	.500	2.47	1.70	.325
N	.350	.500	2.54	1.70	.756
M	.650	.500	5.63	1.70	3.11
L	1.55	.500	2.24	1.70	2.95
K	1.58	.500	5.75	1.70	7.72
J	1.62	.500	5.16	1.70	7.11
I	1.68	.500	5.09	1.70	7.27
H	1.72	.500	4.58	1.70	6.70
G up	1.62	.500	4.95	1.70	6.82
G lo	1.62	.500	2.26	1.70	3.11
F	1.06	.500	4.82	1.70	4.34
E	.760	.500	1.32	1.70	.853
C	.400	.500	1.33	1.70	.452
B	.265	.500	1.88	1.70	.424
A	.115	.500	.94	1.70	.092
				TOTAL	52.03

SECTION 1500 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
N	.055	.500	2.54	1.70	.188
M	.195	.500	5.63	1.70	.933
L	1.35	.500	2.24	1.70	2.57
K	1.46	.500	5.75	1.70	7.14
J	1.56	.500	5.16	1.70	6.84
I	1.89	.500	5.09	1.70	8.18
H	1.90	.500	4.58	1.70	7.40
G up	1.90	.500	4.95	1.70	7.99
G lo	1.90	.500	2.26	1.70	3.65
F	1.89	.500	4.82	1.70	7.74
E	1.69	.500	1.32	1.70	1.90
C	1.14	.500	1.33	1.70	1.29
B	.390	.500	1.88	1.70	.623
A	.250	.500	.94	1.70	.200
				TOTAL	56.64

SECTION 2000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
N	.045	.500	2.54	1.70	.097
M	.135	.500	5.63	1.70	.646
L	1.59	.500	2.24	1.70	3.03
K	1.74	.500	5.75	1.70	8.50
J	1.80	.500	5.16	1.70	7.89
I	2.23	.500	5.09	1.70	9.65
H	2.22	.500	4.58	1.70	8.64
G up	2.05	.500	4.95	1.70	8.63
G lo	2.05	.500	2.26	1.70	3.94
F	1.75	.500	4.82	1.70	7.17
E	1.54	.500	1.32	1.70	1.73
C	1.09	.500	1.33	1.70	1.23
B	.550	.500	1.88	1.70	.879
A	.200	.500	.94	1.70	.160
				TOTAL	62.19

SECTION 2500 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L	1.17	.500	2.24	1.70	2.23
K	1.33	.500	5.75	1.70	6.50
J	1.50	.500	5.16	1.70	6.58
I	2.13	.500	5.09	1.70	9.22
H	2.32	.500	4.58	1.70	9.03
G up	2.16	.500	4.95	1.70	9.09
G lo	2.16	.500	2.26	1.70	4.15
F	2.13	.500	4.82	1.70	8.73
E	2.14	.500	1.32	1.70	2.40
C	1.50	.500	1.33	1.70	1.70
B	1.03	.500	1.88	1.70	1.65
A	1.03	.500	.94	1.70	.264
				TOTAL	61.54

SECTION 3000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
L	.480	.500	2.24	1.70	.914
K	.680	.500	5.75	1.70	3.32
J	.855	.500	5.16	1.70	3.75
I	1.35	.500	5.09	1.70	5.84
H	1.62	.500	4.58	1.70	6.31
G up	1.93	.500	4.95	1.70	8.12
G lo	1.93	.500	2.26	1.70	3.71
F	2.09	.500	4.82	1.70	8.56
E	2.31	.500	1.32	1.70	2.59
C	2.16	.500	1.33	1.70	2.44
B	1.64	.500	1.88	1.70	2.62
A	1.13	.500	.94	1.70	.903
				TOTAL	49.08

SECTION 3500 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
J	.855	.500	5.16	1.70	.430
I	1.35	.500	5.09	1.70	2.39
H	1.62	.500	4.58	1.70	2.71
G up	1.93	.500	4.95	1.70	4.71
G lo	1.93	.500	2.26	1.70	2.15
F	2.09	.500	4.82	1.70	5.94
E	2.31	.500	1.32	1.70	1.73
C	2.16	.500	1.33	1.70	2.81
B	1.64	.500	1.88	1.70	1.52
				TOTAL	28.50

SECTION 4000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
H	.383	.500		1.70	1.49
G up	.770	.500		1.70	3.24
G lo	.770	.500		1.70	1.48
F	1.01	.500		1.70	4.14
E	1.16	.500		1.70	1.30
C	2.20	.500		1.70	2.49
B	2.49	.500		1.70	3.98
A	2.66	.500		1.70	2.13
				TOTAL	20.25

SUMMARY

SUMMIT RESOURCE AREAS

SEAM		RESULTING TOTAL Seam Tonnage (million tonnes)
G Upper		0.53
G Lower		0.99
E Upper		2.36
E Lower		2.63
D		4.75
C		3.79
B		2.77
	Total	17.33

SUMMARY

CALCULATION OF INFERRED RESOURCES

IN THE SUMMIT RESOURCE AREAS

Section	Total Seam Resulting Tonnage (Million Tonnes)
5000 N	1.90
5500 N	5.52
6000 N	3.39
9500 N	4.38
10000 N	2.14
	TOTAL 17.33

SUMMIT RESOURCE FIGURE

SECTION 5000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
D	1.900	.080	3.91	1.70	1.01
C	1.520	.080	2.71	1.70	0.56
B	1.900	.080	1.29	1.70	0.33
				TOTAL	1.90

SECTION 5500 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
D	0.725	0.500	3.91	1.70	2.41
C	0.850	0.500	2.71	1.70	1.96
B	1.050	0.500	1.29	1.70	1.15
				TOTAL	5.52

SECTION 6000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
D	0.400	0.500	3.91	1.70	1.33
C	0.550	0.500	2.71	1.70	1.27
B	0.720	0.500	1.29	1.70	0.79
				TOTAL	3.39

SECTION 9500 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
G Upper	0.290	0.630	1.72	1.70	0.53
G Lower	0.290	0.630	3.20	1.70	0.99
E Upper	1.000	0.630	1.26	1.70	1.35
E Lower	1.000	0.630	1.40	1.70	1.50
				TOTAL	4.38

SECTION 10000 N

Seam	Seam Length (km)	Width of Influence (km)	Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes (million)
G Upper					
G Lower					
E Upper	0.910	0.520	1.26	1.70	1.01
E Lower	0.910	0.520	1.40	1.70	1.13
				TOTAL	2.14

SPECULATIVE RESOURCE CALCULATIONS

SPECULATIVE RESOURCE AREA SUMMARY

Mapping Area	Planimetric Area Average (cm^2)	Correct-tion Factor(%)	Speculative Resource Area (km^2)	Proportion Aggregate Seam Thickness (m)	Specific Gravity (g/cc)	Tonnes Tonnes (million)	Total Property Speculative Resource
Skeena-Ellis	211	.2461	51.93	8.47	1.70	747.70	
Lost Fox	151	.2461	37.16	8.47	1.70	535.08	
Little-Klappan Nass	294	.2461	72.35	8.47	1.70	1041.82	
Summit	172	.2461	42.33	8.47	1.70	609.50	
Hobbit-Broatch	128	.2461	31.50	8.47	1.70	453.58	
							3387.68