MOUNT KLAPPAN COAL PROJECT
SUMMIT - NASS AREA
GEOLOGICAL REPORT
1985

GEOLOGICAL REPORT

706

GULF CANADA LIMITED
COAL DIVISION

GULF CANADA LIMITED

Mount Klappan Coal Project Geological Report

Summit-Nass Area

1985

Coal Project Licence Number

7118 to 7177

7381 to 7392

7416 to 7432

7487 to 7539

7559 to 7561

7714 to 7757

8032 to 8053

Cassiar Land District

NTS Map Number 104 H

Latitude Between 57° 06' and 57° 23'

Longitude Between 128° 37' and 129° 15'

Gulf Canda Limited

January, 1986

PREFACE

The 1985 Summit-Nass Geological Report combines current and previous exploration work to provide an assessment of the geology, coal quality and resource potential of the Summit-Nass Area.

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Appendix I

Coal Trench Data and Coal Quality Data

Measured Section Data

1:50 000 Maps

	Drawing No.
1985 Coal Trench Data and Coal Quality Data	
Data Source Summaries	
Coal Seam Details	
Descriptive Logs	
Head Analyses	
Reflectance Data	
1:50 000 1981 - 1985 1984 Trench Location Map	KPN 85007.
1985 Measured Section Data (13 in total)	
Data Source Summaries	
Stratigraphic Logs	
Descriptive Logs	
1:50 000 1981 - 1984 Measured Section Location Map	KPN85005
1:50 000 Maps	
1985 Geology Map	KPN85001
1985 Coal Resource Map	KPN85002
1985 Coal Licence Map	KPN85003

APPENDIX I

Coal Trench Data and Coal Quality Data

Measured Section Data

1:50 000 Maps

cont'd

	Drawing No.
1985 Fossil Location Map	KPN85004
1985 Measured Section Location Map	KPN85005
1985 Traverse Location Map	KPN85006
1985 Trench Location Map	KPN85007

APPENDIX II

Geology Maps and Cross-Sections

	Drawing No.
Summit Area	
1:5 000 Maps	
J-10	KPN85SA-01
J-11	KPN85SA-02
J-12	KPN85SA-03
K-9	KPN85SA-04
K-10	KPN85SA-05
K-11	KPN85SA-06
K-12	KPN85SA-07
L-10	KPN85SA-08
L-11	KPN85SA-09
L-12	KPN85SA-10
M-11	KPN85SA-11
M-12	KPN85SA-12
1:10 000 Maps	
104 H/6 A, 104 H/7 D	KPN85SA-13
104 H/6 B	KPN85SA-14
104 H/6 H	KPN85SA-15

APPENDIX II
cont'd

	Drawing No.
1:5 000 Cross-Sections	
13 000 NE + W	KPN85SA-16
11 000 NE + W	KPN85SA-17
10 500 NE + W	KPN85SA-18
10 000 NE + W	KPN85SA-19
9 500 NE + W	KPN85SA-20
9 000 NE + W	KPN85SA-21
7 000 NE + W	KPN85SA-22
6 000 NE + W	KPN85SA-23
5 500 NE + W	KPN85SA-24
1:10 000 Cross-Sections	
17 000 NE + W	KPN85SA-25
15 000 NE + W	KPN85SA-26
13 000 NE + W	KPN85SA-27
11 000 NW	KPN85SA-28
Nass Area	
1:5 000 Maps	
F12	KPN85NA-01
F13	KPN85NA-02

APPENDIX II
cont'd

	Drawing No.
F14	KPN85NA-03
G10	KPN85NA-04
G11	KPN85NA-05
G12	KPN85NA-06
G13	KPN85NA-07
G14	KPN85NA-08
G15	KPN85NA-09
H10	KPN85NA-10
H11	KPN85NA-11
H12	KPN85NA-12
H13	KPN85NA-13
H14	KPN85NA-14
H15	KPN85NA-15
I11	KPN85NA-16
I12	KPN85NA-17
I13	KPN85NA-18
I14	KPN85NA-19
I15	KPN85NA-20
J13	KPN85NA-21
J14	KPN85NA-22

1:10 000 Maps

104 H/3 G	KPN85NA-23
104 H/3 J	KPN85NA-24

APPENDIX II

cont'd

	Drawing No.
1:5 000 Cross-Sections	
11 000 NW	KPN85NA-25
9 000 NW	KPN85NA-26
7 000 NW	KPN85NA-27
5 000 NW	KPN85NA-28
3 000 NW	KPN85NA-29
1 000 NW	KPN85NA-30
1 000 SW	KPN85NA-31
1:10 000 Cross-Sections	
17 000 NW	KPN85NA-32
15 000 NW	KPN85NA-33
13 000 NW	KPN85NA-34
11 000 NW	KPN85NA-35
9 000 NW	KPN85NA-36

1.0 SUMMARY

The Gulf Canada Limited Mount Klappan property is composed of 211 crown licences, comprising 56 194 hectares of land. It is located in the Bowser Basin of northwestern British Columbia approximately 150 kilometres northeast of Stewart.

In 1984 the Mount Klappan property was divided into three areas to facilitate exploration activities and logistics. Those areas included the Hobbit-Broatch Area, the Lost-Fox Area and the Summit-Nass-Skeena Area. During the 1985 field program exploration was carried out only on the Lost-Fox Area and the Summit-Nass Area, the latter to which this report pertains.

Combined exploration activity on the Mount Klappan property during 1985 comprised mining of over 135 000 tonnes of raw coal from a test pit, drilling 34 diamond drill holes, for 6 146 metres, and excavating 45 trenches. In addition, the property was mapped at scales of 1:2 500, 1:5 000 and 1:10 000 and new airphoto coverage at a scale of 1:8 000 was produced for the Lost-Fox and Hobbit-Broatch Areas.

Sedimentary rocks of the Mount Klappan property range in age from Upper Jurassic to Lower Cretaceous and are subdivided into four sequences which, in ascending order, are the Spatsizi, Klappan, Malloch and Rhondda. The Klappan Sequence is the main coal-bearing unit and is interpreted as being up to 900 metres thick. In the Summit-Nass Area the Spatsizi, Klappan and Malloch sequences are exposed with the Klappan Sequence occupying the largest area.

Structurally the sedimentary rocks within the property have undergone two distinct episodes of deformation resulting in northwest-southeast trending phase one folds and east-west trending second phase folds. Thrusting is associated with both compressional events, however strike-slip and high angle normal faults are interpreted to be the result of a later extensional event.

The Mount Klappan property contains a total in-situ measured resource of 64.4 million tonnes from 20 potentially mineable coal seams ranging, locally, up to 6.75 metres in thickness.

Additional resources at lesser levels of confidence indicate a total property resource potential of 6 154.9 million tonnes. The Summit-Nass Area contributes 3 960.8 million tonnes, of largely speculative resource to the total potential (Table 1.1).

Table 1.1
Coal Resource Summary
(MT)

	Mount Klappan Property	Summit-Nass Area
Measured	64.4	--
Indicated	75.2	--
Inferred	491.0	35.8
Speculative	5 524.3	3 960.8
Total	6 154.9	3 996.6

2.0 RECOMMENDATIONS

Based on the compilation and interpretation of exploration data from the Summit-Nass Area the following recommendations are proposed:

1. Initate a mechanical trenching program in southern Summit to facilitate seam correlations from exposures in the valley north of Marshall-Layton Ridge to coal seams in Summit South.

2. Continue delineation of the Klappan coal-bearing sequence through detailed mapping and stratigraphy in central and northwestern Nass.

3. Relinquish licences 8049, 8050, 8051, 8052, 8053 which are interpreted as lying within the middle to upper Spatsizi Sequence and which do not contain exposed coal seams.

3.0 INTRODUCTION

3.1 Mount Klappan Coal Project

3.1.1 Location

The Mount Klappan coal licences are situated in northwest British Columbia approximately 930 kilometres north of Vancouver, 150 kilometres northeast of Stewart and 530 kilometres northwest of Prince George (Figure 3.1).

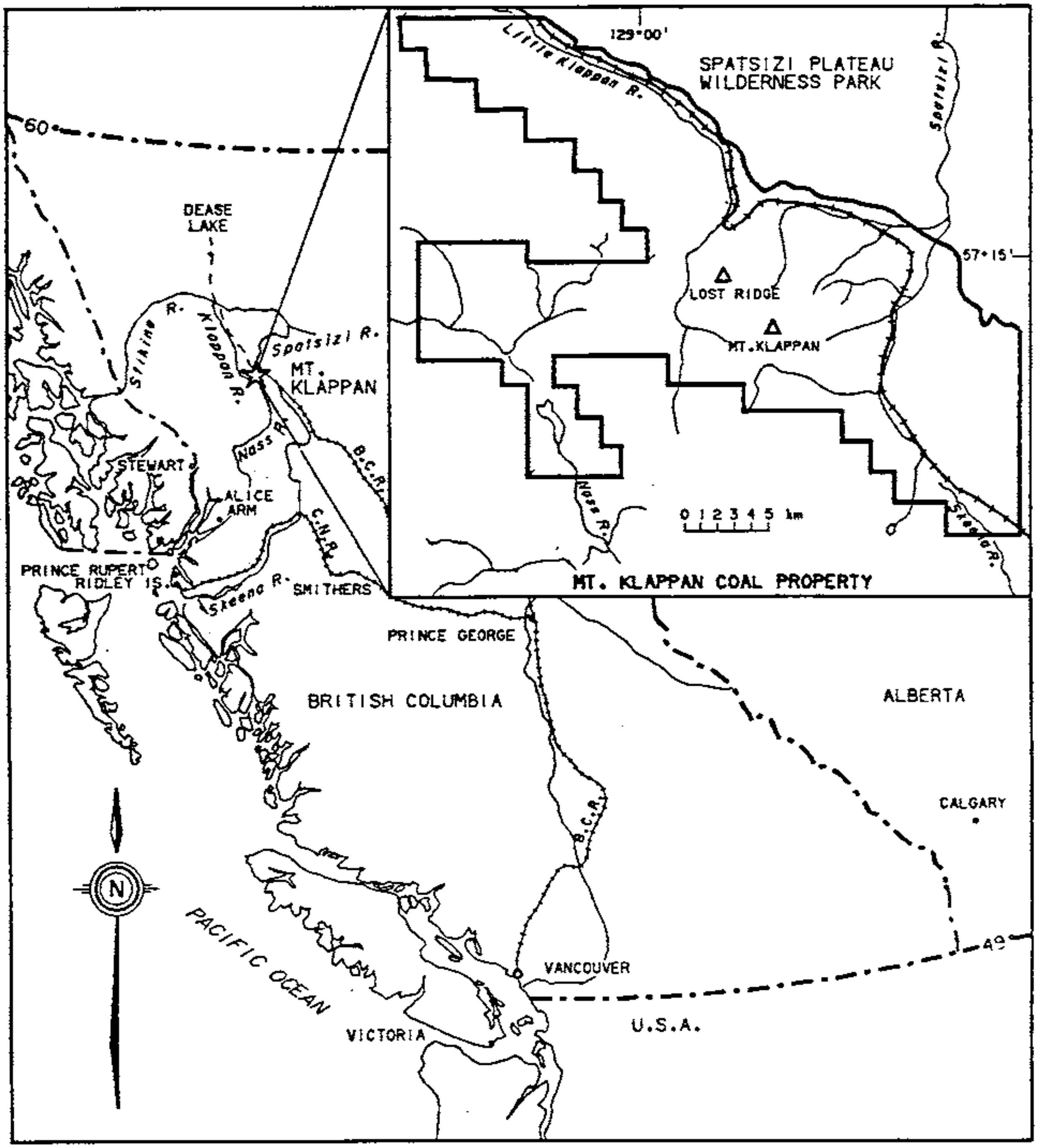
Geographically the coal licences are at the northern extremity of the Skeena Mountains between 57° 06' and 57° 23' north latitude, and 128° 37' and 129° 15' west longitude, and cover the headwaters of the Klappan, Little Klappan, Spatsizi and Nass Rivers.

Iskut (population 500) is the nearest community to the property located 100 kilometres to the northwest on the Stewart-Cassier Highway (Hwy 37).

3.1.2 Access

The Mount Klappan property straddles the partially completed British Columbia Railway line between Prince George and Dease Lake (Figure 3.2). Prior to cessation of work on the construction of the line, steel was laid to within 80 kilometres south of the property. With the exception of a 24 kilometre stretch north of the Kluatantan River, the railway

FIGURE 3.1
MOUNT KLAPPAN COAL PROPERTY
LOCATION MAP



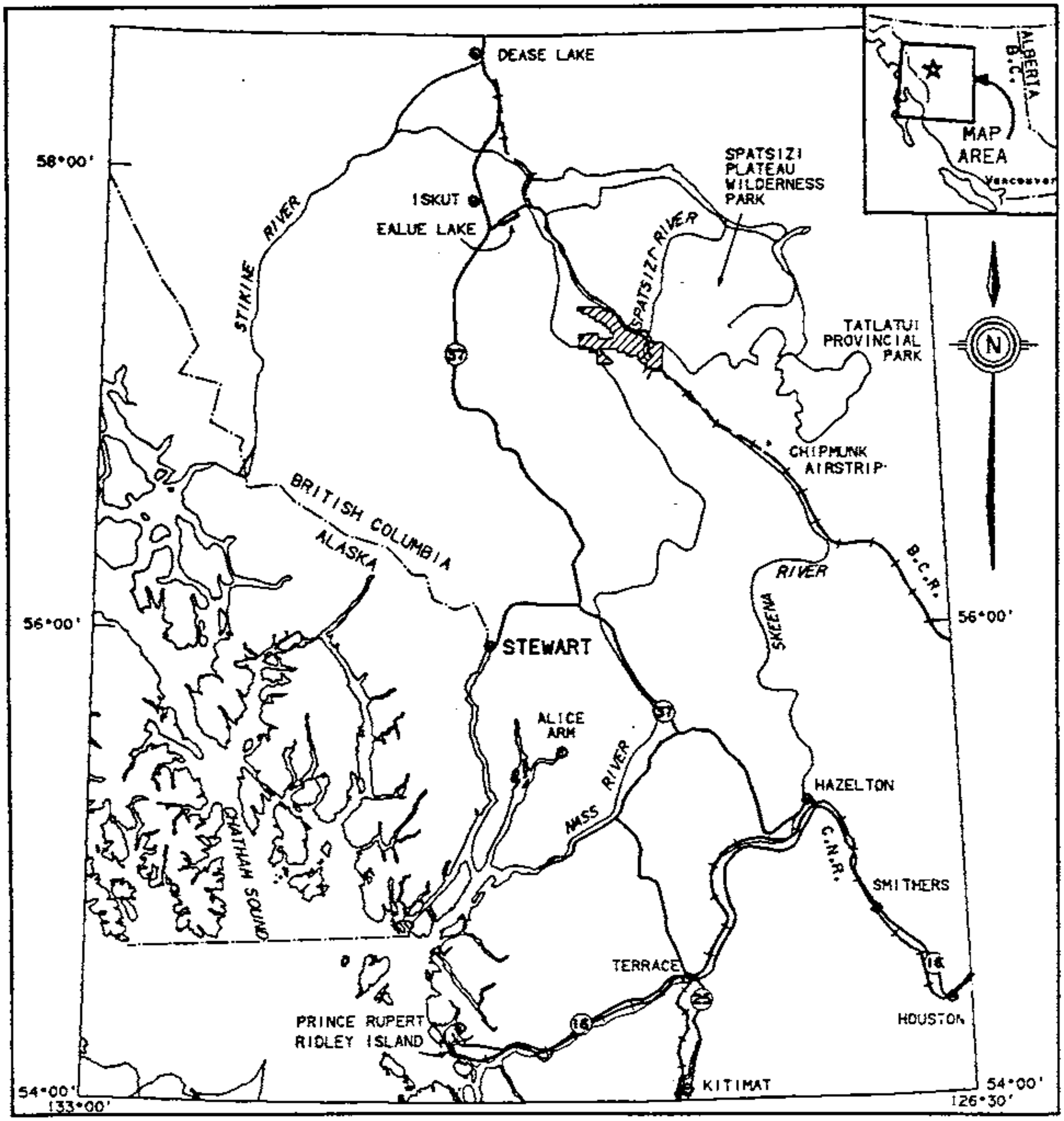
MT. KLAPPAN LICENCE AREA

GULF CANADA RESOURCES INC.
10/01/85

FIGURE 3.2

MOUNT KLAPPAN COAL PROPERTY

PROPERTY ACCESS



LEGEND

- ROAD ACCESS
- EXISTING RAILWAY
- EXISTING RAILWAY SUBGRADE
- MT. KLAPPAN LICENCE AREA

SCALE

0 20 40 60 80 100 km

GULF CANADA RESOURCES INC.
12/02/85

Gulf

DSO:[205,57]BSD'''025.LOC

subgrade was constructed through and beyond the property to the Stikine River just south of Dease Lake.

Road access to the property from Highway 37, via Ealue Lake Road, is provided along the British Columbia Railway subgrade. Three bridges were constructed along the subgrade early in 1984 to permit surface access to the property. Road distances from Terrace and Stewart to the property are 575 kilometres and 426 kilometres respectively.

Fixed wing aircraft provide access by air and use the 1000 metre Summit Airstrip located along the railway subgrade in the central region of the property.

3.1.3 Property Description

The Mount Klappan property comprises 211 coal licences totalling 56 194 hectares of land (Appendix B; Figure 3.3). The property was acquired in five separate applications from 1981 to 1985.

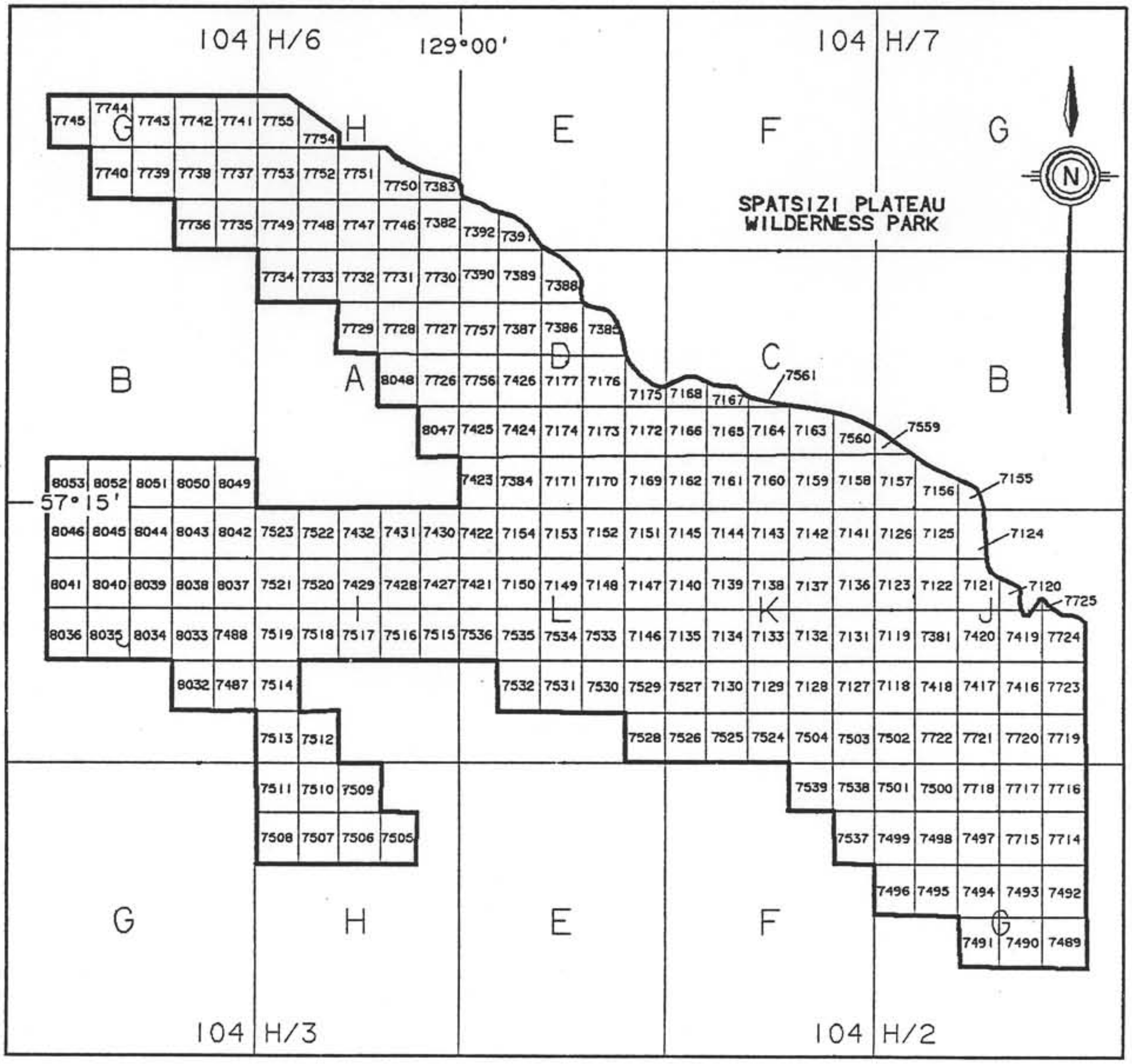
3.1.4 Ownership

Gulf wholly owns the coal licences comprising the Mount Klappan property.

3.1.5 Geography and Biophysical Environment

The Mount Klappan property is located at the headwaters of the Little Klappan, Klappan, Nass, Skeena, and

FIGURE 3.3
MOUNT KLAPPAN COAL PROPERTY
LICENCES



LEGEND

LICENCE AREA

7386 LICENCE NUMBER

SCALE

0 1 2 3 4 5 km

GULF CANADA RESOURCES INC.
APRIL, 1985

FILE NAME [205,57]831024020.LOC

Spatsizi Rivers (Figure 3.1). This area is within the northern extremity of the Skeena Mountains physiographic region. The regional physiography is of mountainous terrain with broad northwest to southeast trending valleys of the aforementioned rivers.

Elevations on the property range from 991 metres in the Klappan 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 mean daily temperatures comparable to Fort Nelson and Prince George. This information is derived from weather stations located on the northeastern edge of the property which have been monitored monthly since their 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.

3.2 Summit-Nass Area

3.2.1 Location

The Mount Klappan property has been divided into five project blocks to facilitate exploration expansion and subsequent logistics. The Summit-Nass Area encompasses the northwestern and southwestern quadrants of the Mount Klappan property (Figure 3.4).

The Summit Area is cut by the Little Klappan River to the northeast and extends to the southwest into a series of ridges. The Nass Area has a common northeast boundary with Summit south while its western and southern borders are bounded by several small ice fields. Drainage valleys of the Klappan and Nass Rivers occupy a large portion of the Nass Area.

3.2.2 Access

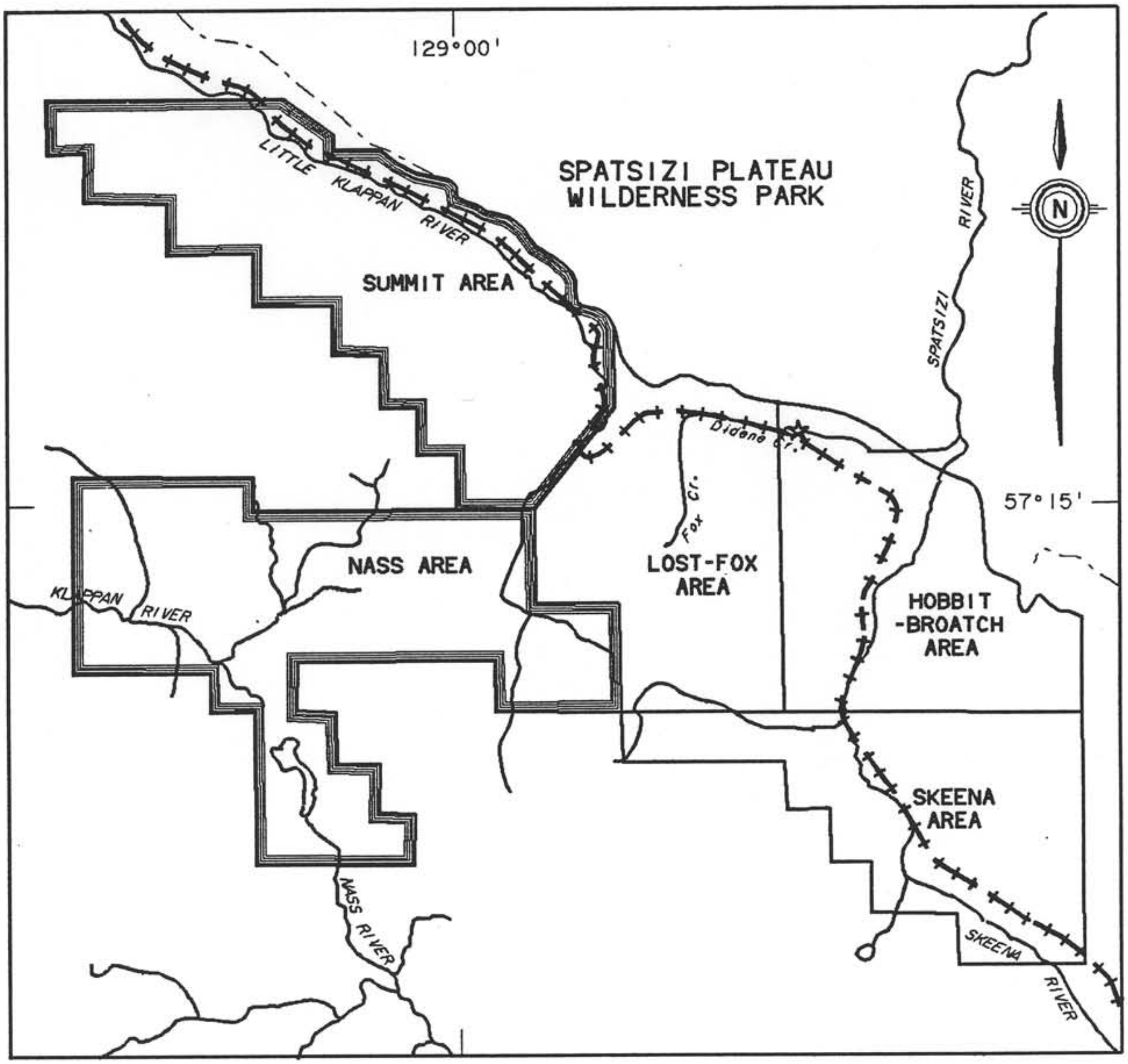
The low lying portions of the Summit Area are accessible by truck along the British Columbia Railway subgrade. Exploration at higher elevations of Summit and to all parts of the Nass Area require helicopter support from the Didene Creek base camp.

3.2.3 Area Description

The Summit-Nass Area covers 30 440.5 hectares and includes 112 of the 211 licences comprising the Mount Klappan Coal Project (Appendix B). Of the 54 licences (totaling 14 142.5 hectares) of the Summit block, two licences, 7171 and 7173, are divided in the southwest corner between the Summit-Nass Area and the Lost-Fox Area. The Nass block contains 58 coal licences equalling 16 298.0 hectares.

FIGURE 3.4

MOUNT KLAPPAN COAL PROPERTY
SUMMIT - NASS
1985 EXPLORATION AREAS



LEGEND

- PREPARED RAIL BED
- PROVINCIAL PARK BOUNDARY
- LICENCE AREA
- DIDENE CREEK CAMP

SCALE

0 1 2 3 km

GULF CANADA RESOURCES INC.
10/12/84

FILE NAME [205,57]841165013.LOC

3.2.4 Biophysical Environment

The regional physiography of the Summit-Nass Area is one of mountainous terrain and broad northwest to southeast trending valleys.

Vegetation is variable with alpine tundra characterizing higher elevations above treeline and thick coniferous forests, shrubs, meadows and bogs occupying valley floors. Elevations range from 1 036 metres in the Nass Valley to over 2 100 metres in the Summit Area.

The headwaters of the Little Klappan, Klappan and Nass Rivers all occur within the Summit-Nass licence boundary. These rivers are generally broad and meandering forming sporadic deep gorges only when cutting through steep terrain.

Heavy precipitation and ground fog occurred on 7 percent of the field days. Portions of the Summit and northern Nass Areas, depending on weather conditions, may remain snow covered year around. Several small ice fields are located just beyond the western property boundary in Summit and the northern property boundary in Nass.

4.0 EXPLORATION HISTORY

4.1 Mount Klappan Property

4.1.1 Exploration Prior to Gulf's Acquisition

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 6.1). 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 programs resulted in some of the first stratigraphic and structural studies of the area. In addition, Eisbacher tried to 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 stratigraphic studies primarily in the 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 on the Panorama-Groundhog Coal Measures. This was followed in 1981 by the acquisition of the Mount Klappan property.

4.1.2 Summary of Exploration 1981-1984

Prior to 1985, Gulf undertook six separate exploration programs on the Mount Klappan property. The exploration included geological mapping, hand trenching, mechanical trenching, diamond drilling, rotary drilling and adit driveage, as summarized in Table 4.1. The results of these exploration activities have been documented in six separate reports:

Mount Klappan Coal Project - Geological Report	1981
Mount Klappan Coal Project - Geological Report	1982
Mount Klappan Coal Project - Geological Report	1983
Mount Klappan Coal Project - Lost-Fox Area	1984
Mount Klappan Coal Project - Hobbit-Broatch Area	1984
Mount Klappan Coal Project - Summit-Nass-Skeena Area	1984

Table 4.1

MOUNT KLAPPAN COAL PROJECT
EXPLORATION SUMMARY 1981 TO 1984

	1981	1982	1983	1984	Total
Adits					
Number	--	--	1	--	1
Tonnes	--	--	39.2	--	39.2
Diamond Drill Holes					
Number (HQ)	--	7	3	8	18
Total Metres	--	1 223	603	1 507	3 333
Number (AIX)	--	--	6	--	6
Total Metres	--	--	126	--	126
Rotary Drill Holes					
Number	--	--	--	17	17
Total Metres	--	--	--	897	897
Hand Trenching					
Number	24	51	93	95	263
Total Metres	89	289	527	416	1 321
Mechanical Trenches					
Number	--	--	--	128	128
Total Metres	--	--	--	1 041	1 041
Measured Sections					
Number	--	--	--	13	13
Total Metres	--	--	--	2 736	2 736
Geological Mapping					
Scales	1:10 000	1:10 000	1: 5 000 1:10 000	1: 2 500 1: 5 000 1:10 000	

4.2 Summit-Nass Area

4.2.1 Summary of Exploration 1981-1984

Exploration work in the Summit-Nass Area commenced in 1981 and has continued annually, during summer field seasons, until the present. The programs consisted of air photo interpretation, geologic mapping, hand trenching and diamond drilling (Table 4.2).

Table 4.2

SUMMIT-NASS AREA EXPLORATION SUMMARY 1981-1984

Summit Area

	1981	1982	1983	1984	Total
Hand Trenches					
Number	2	2	26	18	48
Length (m)	12.9	25.4	188.7	90.10	317.10
Diamond Dril Holes					
Number		1	1	--	2
Length (m)		192.6	130.2	--	322.8

Nass Area

	1981	1982	1983	1984	Total
Hand Trenches					
Number	--	2	16	13	31
Length (m)	--	8.5	56.0	45.5	110.0

5.0 1985 EXPLORATION PROGRAM

5.1 Program Objectives

The objectives of the 1985 exploration program for the Summit-Nass Area were:

1. To refine geological mapping of the Summit-Nass Area at scales of 1:5 000 and 1:10 000 for further delineation of coal-bearing strata.

2. To concentrate on structural mapping and hand trenching programs in potential resources areas.

3. To further define the stratigraphy through detailed examination of collected species of flora and fauna macrofossils.

5.2 Summary of Exploration

5.2.1 Mount Klappan Coal Project

In five years of exploration programs on the Mount Klappan property, Gulf has advanced through regional investigations to seam tracing, drilling, and adit driveage (Table 5.1). While new areas are constantly being investigated, exploration is focussed on those areas which have immediate economic interest.

Table 5.1

MOUNT KLAPPAN COAL PROJECT
EXPLORATION SUMMARY 1981 TO 1985

	1981	1982	1983	1984	1985	Total
Adits						
Number	--	--	1	--	--	1
Tonnes	--	--	39.2	--	--	39.2
Diamond Drill Holes						
Number (HQ)	--	7	3	8	34	52
Total Metres	--	1223	603	1507	6146	9479
Number (AIX)	--	--	6	--	--	6
Total Metres	--	--	126	--	--	126
Rotary Drill Holes						
Number	--	--	--	17	6	23
Total Metres	--	--	--	897	620	1517
Mechanical Trenches (Seam Tracing)						
Number	--	--	--	128	--	128
Total Metres	--	--	--	1041	--	1041
Hand Trenches						
Number	24	51	93	95	45	308
Total Metres	89	289	527	416	178	1499
Measured Sections						
Number	--	--	--	13	19	31
Total Metres	--	--	--	2736	3347	6083
Geological Mapping						
Scales	1:10 000	1:10 000	1:5 000 1:10 000	1:2 500 1:5 000 1:10 000	1:2 500 1:5 000 1:10 000	

gations to seam tracing, drilling, and adit driveage (Table 5.1). While new areas are constantly being investigated, exploration is being focus on those areas which have immediate economic interest.

Both a winter and summer program were run during this past year. The winter program resulted in the completion of 15 diamond and 6 rotary drill holes in the Lost-Fox Area. A winter exploration road, about 8.0 kilometres in length, was constructed in late 1984 from the British Columbia Railway subgrade up the backside of Lost Ridge to provide truck and cat access to the central Lost-Fox Area. The Didene Creek Camp provided lodging and working space for up to 50 Gulf and support personnel during the program. Geological as well as drilling and support crews were transported to their work stations from camp via 4 x 4 vehicles. Drill equipment was skidded from site to site using either a D-6 or a D-8 Caterpillar and the rig was serviced by four-wheel-drive vehicles.

The summer program included geological mapping of the Lost-Fox, Summit and Nass Areas, initiation of a detailed core study, and drilling 19 diamond drill holes. Extraction of trial cargoes from the Lost-Fox Area was undertaken during the autumn, and at the time of writing, operations associated with this are ongoing.

The winter access road was upgraded to a year round haul road for the excavation program. This road provided easy access to the central Lost-Fox Area. Geological, To accommodate the expanded activities on the property, the Didene Creek Camp was enlarged to provide lodging and working space for up to 150 Gulf and support personnel.

The British Columbia Railway subgrade provided good access through the property, joining with Highway 37 via the Ealue Lake Road (Figure 3.2). A four-wheel-drive Emergency Transportation Vehicle was on standby at all times for use in a medical emergency.

Commercial as well as charter fixed wing aircraft linked the Summit Airstrip on the property to major centres and provided convenient air transportation for personnel and cargo throughout the exploration program.

5.2.2 Summit-Nass Area

Exploration of the Summit-Nass Area began on July 15, 1985 and was completed August 28, 1985. A summary of the Summit-Nass exploration activities is outlined in Table 5.2.

The 1985 Summit-Nass report contains geologic interpretations based on all exploration information collected to date.

5.3 Cartography

Topographic maps used in this exploration program are at 1:5 000 and 1:10 000 scales. The 1:5 000 metric maps were pre-

Table 5.2

SUMMIT-NASS AREA EXPLORTION SUMMARY

1985

	1985	1981-1985 Total
Diamond Drill Holes (HQ)		
Number	--	2
Total Metres	--	322.8
Hand Trenches		
*Number	12	91
Total Metres	47.5	474.6
Measured Sections		
Number	5	13
Total Metres	1294	2662

*Includes trenches that have been relogged.

pared from 1:30 000 British Columbia Government air photos flown prior to subgrade construction. For the areas of northwestern Summit and western Nass where 1:5 000 map coverage did not exist 1:50 000 imperial Government topographic maps were blown up to 1:10 000 scale.

5.4 Geologic Mapping

Reconnaissance and detailed geological mapping were carried out at scales of 1:5 000 and 1:10 000. The Summit-Nass Area was mapped on a priority basis commencing with Summit south, northern Nass, intermediate and peripheral areas; the latter was mapped on 1:50 000 government air photos and plotted on 1:50 000 imperial topographic maps.

Three crews consisting of a geologist and a geological assistant were responsible for the areas. Transportation of crews to the field was provided by helicopter and in some instances by truck.

5.5 Trenching

Twelve trenches comprising a total thickness of 47.5 metres were excavated in the Summit-Nass Area. Coal exposures in excess of 0.5 metres were logged at true thickness and sampled during daily traverses.

Tables 6.7 and 6.9 summarize 1981-1985 trench information. A more detailed description of coal trench data is contained in Appendix I.

5.6 Data Management

Throughout the 1985 exploration program, an HP 9816 microcomputer was utilized for cost accounting and budget control. During the field season it also served as an on site data storage system which facilitated the uploading of outcrop, trench, drill hole coal quality and washability data onto Gulf's mainframe Coal Data Base, set up on an AMDAHL V8 computer, in Calgary. System 2000 data base management and Act 1 software provided data entry, retrieval and manipulation of stored data on the mainframe computer.

5.7 Reclamation

The Summit-Nass exploration program produced very minor environmental disturbances. Most hand excavated trenches were backfilled.

Construction of the trailer camp on a site south of Didene Creek was fully permitted.

5.8 Additional Studies

Several studies have been undertaken in previous years on the Mount Klappan property including regional structural analyses, microscopic conglomerate correlations and paleoenvironmental interpretations. In addition, samples have been collected during previous exploration programs specifically for petrography and paleontology studies. Macrofossil flora and fauna indentification, distribution and correlation has provided a detailed property stratigraphy guideline for future exploration programs. Results of the paleontology study are outlined in Section 6.3 of the Geological Report. A petrographic interpretation of the sediments is contained in Section 6.4.4.

5.9 Project Management and Contractors

The 1985 exploration program was co-ordinated by V. Duford of Gulf Canada Limited. Field operations in the Summit-Nass Area were supervised by K. Jenner with assistance from S. MacLeod. Coal quality analyses were performed by Loring Laboratories and interpreted by J. Innis. D.E. Pearson and Associates Limited conducted coal petrology studies. The report was written by K. Jenner and S. MacLeod.

The following personnel contributed to the Summit-Nass exploration program.

V. Duford	Co-ordinator, Coal Geology
K. Jenner	Geologist
S. MacLeod	Geologist
K. Foellmer	Geologist
B. Buhay	Geologist
L. Stewart	Geological Assistant
K. Hunter	Geological Assistant
A. Ledda	Geological Assistant
K. Groves	Geological Assistant
J. Lemon	Geological Assistant

A. Sali	Administrator
T. Sampietro	Camp Manager
C. Earle	Field Accountant
S. Lee	Computer Operator
C. Ireland	Secretary
G. Gillik	Helicopter Pilot
C. Archibald	First Aid Attendant
R. Bonang	Cook

The following companies provided services and/or supplies to the Summit-Nass exploration program.

Canadian Freightways Ltd.	Calgary, Alberta
Central Mountain Air Services Ltd.	Smithers, B.C.
D.E. Pearson & Associates Ltd.	Calgary, Alberta
Kenn Borek Air	Calgary, Alberta
Loring Laboratories	Calgary, Alberta
Nevill Crobsy Inc.	Vancouver, B.C.
Northern Mountain Helicopters Inc.	Prince George, B.C.
Northmount camp Services (1975) Ltd.	Vancouver, B.C.

Pacific Western Airlines	Vancouver, B.C.
Starr Industries Ltd.	Fort St. John
Terrace Totem Ford	Terrace, B.C.
Trans-Provincial Airways	Terrace, B.C.
Westcan Electronic Services Ltd.	Calgary, Alberta

6.0 GEOLOGY

6.1 Introduction

Geological mapping and hand trenching activities were undertaken in the Summit, Nass and Lost-Fox areas of the Mount Klappan property during the 1985 exploration program. In addition, rotary drilling, diamond drilling and trial cargo operations proceeded on the Lost-Fox Area. The results of this exploration program combined with previous years' work provided the basis for geological interpretations presented in this report.

The Mount Klappan property is underlain by uppermost Jurassic to Lower Cretaceous strata which consist of marine to non-marine sediments deposited in the Bowser Basin of northcentral British Columbia. The strata have been subjected, regionally, to two successive non-coaxial phases of deformation, F_1 and F_2, which resulted in folding and faulting trending in NW-SE (F_1) and E-W (F_2) directions. (See 1:50 000 Regional Geology Map located in Appendix I).

The coal seams of the Mount Klappan property occur primarily in the Klappan Sequence; in addition, some minor seams have been trenched in the Spatsizi and Malloch Sequences. Coal seams up to 6.75 metres in thickness exist in the Lost-Fox Area and are usually found to be laterally continuous over broad areas although some seams thin locally.

6.2 Basinal Geologic Setting

The coal measures of the Mount Klappan property are contained within sediments ranging in age from uppermost Jurassic to Lower Cretaceous. These sediments were deposited in the Bowser Basin, a successor basin to the volcanogenic Hazelton Trough (Tipper and Richards 1976). The Bowser Basin is bounded to the north and south by the Stikine and Skeena Arches respectively, and to the east by the Columbia Orogen (Omineca Crystalline Belt). The western margin is thought to have been open to the sea at the time of Bowser sediment deposition (Figure 6.1).

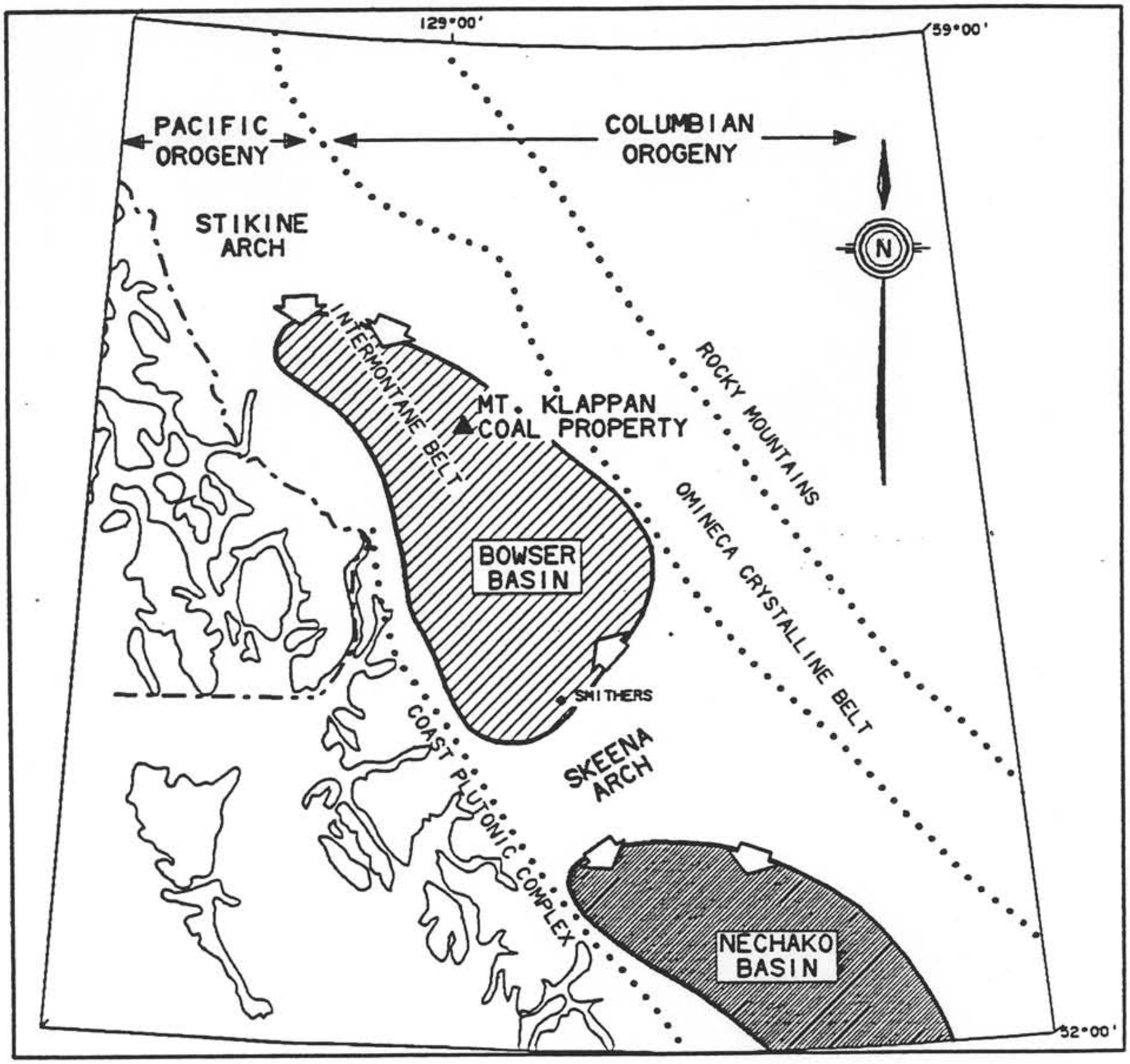
The formation and development of the Bowser Basin was controlled by the "collision and subsequent isostatic uplift of several crustal blocks' in the Cordilleron Orogen of western Canada" (Eisbacher, 1981). These crustal blocks include the Stikine Terrane (volcanic arc complex) which directly underlies the Bowser sediments, the Atlin Terrane (remnant oceanic crust) and the Omineca Crystalline Belt (western margin of the North American Craton).

During the Middle Jurassic, the Skeena Arch was uplifted and the subsidence of the Stikine Terrane divided the Hazelton Trough into the Bowser Basin to the north and the Nechako Basin to the south. Uplift of the Atlin Terrane to the north and northeast of the Bowser Basin, coupled with continued subsidence of the Stikine Terrane and collision and suturing of both these terranes with the

FIGURE 6.1

MOUNT 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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Gulf

Omineca Crystalline Belt (Eisbacher, 1981) resulted in a progradation of non-marine over marine sediments within the basin.

Paleocurrent measurements indicate a centripetal flow into the Bowser Basin from highlands to the north, northeast, and south.

Bowser Basin sediment source rocks originate within the Atlin Terrane (high chert; low volcanic content) for the north and northeastern margins of the Basin, and from the remnant volcanic arc assemblage of the Stikine Terrane, (high volcanic; low chert content) for the southern portion of the Basin. Sediments from the Lower Cretaceous (youngest marine succession of the Bowser Basin) through to the Paleocene are found only on the eastern, and in part, the southern margins of the Basin.

Geologic studies in the southern and northern Bowser Basin sediments have resulted in several reports and descriptions of the sedimentary package associated with the Mount Klappan Area. These studies are summarized in Table 6.1.

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

TABLE 6.1

MOUNT KLAPPAN COAL PROPERTY

REGIONAL STRATIGRAPHY - TABLE OF FORMATIONS

		MALLOCH, 1914	*BUCKHAM & LATOUR, 1950*	*SOUTHER & ARMSTRONG, 1966*	*EISBACHER, 1974c*	*TIPPER & RICHARDS, 1976*	*RICHARDS & GILCHRIST, 1979*	*BUSTIN & MOFFAT, 1983*
		SOUTHERN GROUNDHOG COALFIELD	GROUNDHOG COALFIELD	NORTHERN BRITISH COLUMBIA	NORTHERN BOWSER BASIN	SOUTHERN BOWSER	SOUTHERN GROUNDHOG COALFIELD	GROUNDHOG COALFIELD
CRETACEOUS	UPPER			SUSTUT-SIFTON ASSEMBLAGE	SUSTUT-SIFTON ASSEMBLAGE	SUSTUT GROUP		
CRETACEOUS	LOWER	SKEENA SERIES	HAZELTON GROUP: UPPER PART	BOWSER ASSEMBLAGE	BOWSER ASSEMBLAGE: JENKINS CREEK FACIES; GUNANOOT-GROUNDHOG FACIES	SKEENA GROUP	GUNANOOT ASSEMBLAGE	DEVILS CLAW UNIT; McEVOY UNIT
JURASSIC	UPPER	HAZELTON GROUP	HAZELTON GROUP: LOWER PART	BOWSER ASSEMBLAGE	BOWSER ASSEMBLAGE: DUTI RIVER SLAMGEESH FACIES	BOWSER LAKE GROUP	GUNANOOT ASSEMBLAGE	CURRIER / PRUDENTIAL; JACKSON UNIT
JURASSIC	MIDDLE			TAKLA-HAZELTON ASSEMBLAGE	TAKLA-HAZELTON ASSEMBLAGE	HAZELTON GROUP		
JURASSIC	LOWER			TAKLA-HAZELTON ASSEMBLAGE	TAKLA-HAZELTON ASSEMBLAGE			
TRIASSIC	UPPER					TAKLA GROUP		
TRIASSIC	MIDDLE							

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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.

Later position 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 deformation event resulted in generally broad, open NE to SW trending folds with relatively rare, flat lying thrusts expressed in 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 Mount Klappan Coal Project Geology

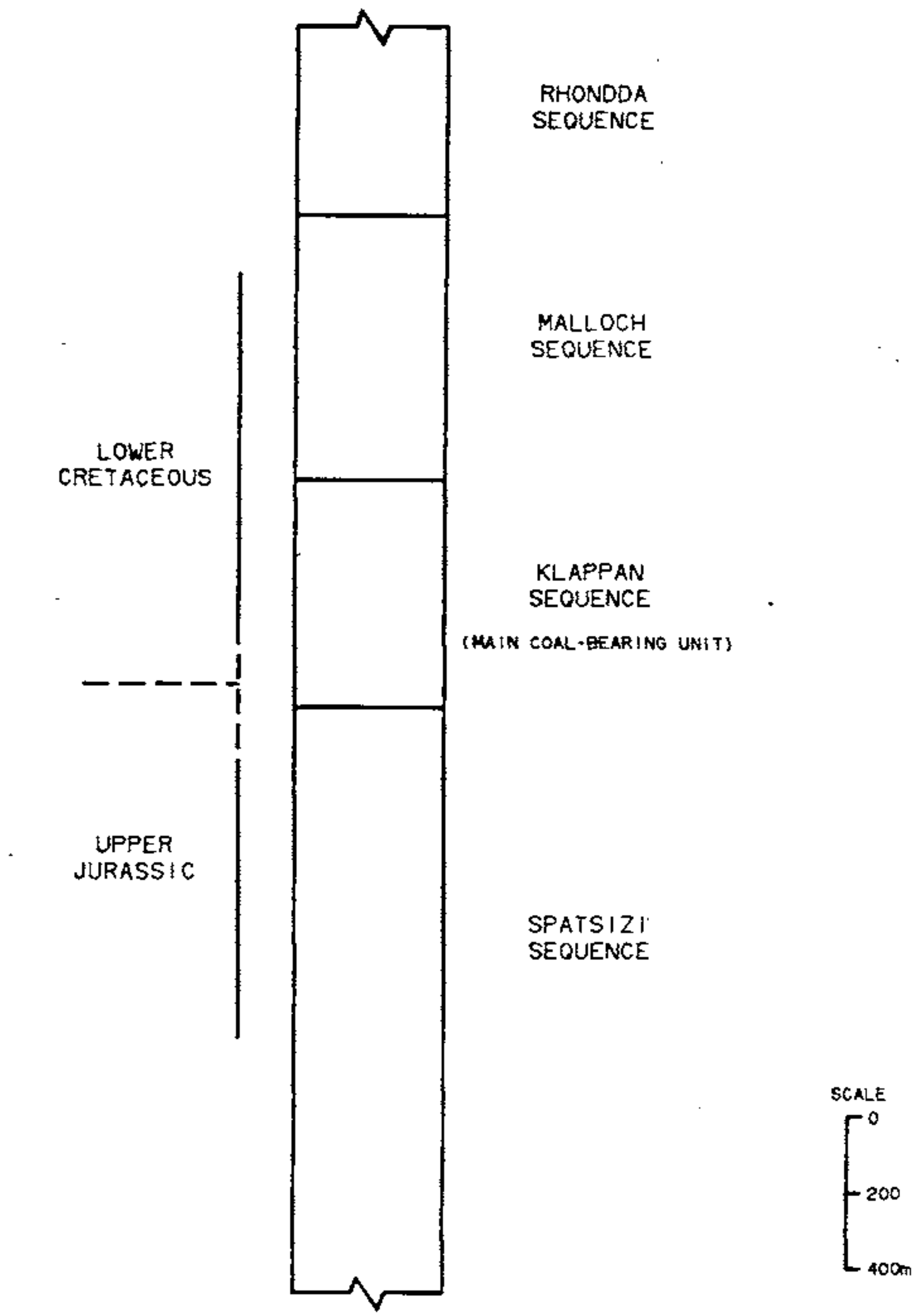
6.3.1 Stratigraphy

Based on collected species of plant macrofossils and fauna, the sediments underlying the Mount Klappan property range from uppermost Jurassic to Lower Cretaceous in age (Section 6.3.2). This sedimentary package has been subdivided into four sequences which, in ascending order, are the Spatsizi, Klappan, Malloch and Rhondda sequences (Figure 6.2). These conformable sequences occur within approximately 3 000 metres of section and represent a gradual marine

FIGURE 6.2

MOUNT KLAPPAN COAL PROPERTY

SCHEMATIC STRATIGRAPHIC COLUMN



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regression. Table 6.2 briefly outlines the sedimentological characteristics observed within each sequence.

6.3.1.1 Spatsizi Sequence

The Spatsizi Sequence is the lowest stratigraphic unit within the Mount Klappan property. Approximately 600 metres of this section have been measured and although the base has not been observed the stratigraphic thickness is estimated to be in excess of 1 200 metres. Interbedded mudstones, siltstones and sandstones are found throughout the sequence while thin coal seams and massive conglomerates exist within the upper portion. The overall trend is a coarsening upward sequence with marine conditions evident throughout and increasing coastal environment influences toward the upper transitional contact with the Klappan Sequence.

Exposures of the Spatsizi Sequence are located in the western and northern Summit Area and in the northern Nass Area of the Mount Klappan property.

6.3.1.2 Klappan Sequence

The Klappan Sequence, the main coal-bearing unit, conformably overlies the Spatsizi Sequence and occurs over the majority of the property. It represents a transition from marine conditions, at the

TABLE 6.2

MOUNT KLAPPAN COAL PROPERTY

TABLE OF FORMATIONS

Kr **RHONDDA SEQUENCE**

SEQUENCE OF THICK CHERT PEBBLE CONGLOMERATES AND MINOR GRITTY SANDSTONES INTERBEDDED WITH AN INCREASING NUMBER OF SILTSTONES AND MUDSTONES TOWARDS THE BASAL CONTACT. LARGE SCALE TROUGH AND TABULAR CROSS BEDS ARE COMMON. SIX SPECIES OF PLANT FOSSILS INCREASE IN ABUNDANCE TOWARDS THE BASE OF THE SEQUENCE.

Km **MALLOCH SEQUENCE**

THICK INTERBEDS OF MUDSTONES, ARGILLACEOUS SILTSTONES, FINE GRAINED SANDSTONES AND THIN INTERBEDS OF ORANGE WEATHERING NODULAR SILTSTONES. MANY CONGLOMERATE BEDS DISPLAY LARGE SCALE CROSS BEDDING AND TEND TO BE LATERALLY DISCONTINUOUS. THICK CLEAN SANDSTONE BEDS AND THIN COAL SEAMS INCREASE IN ABUNDANCE TOWARDS THE BASAL GRADATIONAL CONTACT. TWENTY SPECIES OF PLANT FOSSILS EXIST WITHIN THE SEQUENCE. BIVALVES ARE RARE.

JKk **KLAPPAN SEQUENCE (MAIN COAL-BEARING UNIT)**

FINE TO COARSE GRAINED SANDSTONES INTERBEDDED WITH MUDSTONES, SILTSTONES, OCCASIONAL THIN BANDS OF ORANGE WEATHERING CALCAREOUS SILTSTONES, CONGLOMERATES AND ABUNDANT COAL SEAMS. CONGLOMERATE BEDS GRADE LATERALLY INTO SANDSTONE. SANDSTONES OFTEN DISPLAY TABULAR OR TROUGH CROSS BEDDING. RHYTHMITES OCCUR IN THE MIDDLE OF THE SEQUENCE. TWENTY-THREE SPECIES OF BIVALVES AND TWENTY-TWO SPECIES OF PLANTS OCCUR THROUGHOUT. PETRIFIED WOOD AND RARE COQUINA MAY BE PRESENT TOWARDS THE UPPER CONTACT.

Js **SPATSIZI SEQUENCE**

PREDOMINANTLY A MARINE SEQUENCE OF INTERBEDDED MUDSTONES, SILTSTONES, SANDSTONES AND CONGLOMERATES. CARBONACEOUS MUDSTONES, THIN COAL SEAMS AND CHERT PEBBLE CONGLOMERATES ARE MORE ABUNDANT IN THE UPPER PART OF THE SEQUENCE. NINETEEN SPECIES OF BIVALVES ARE PRESENT. BELEMNITES ARE RARE. PLANT DEBRIS MAY OCCUR NEAR THE UPPER GRADATIONAL CONTACT.

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base of the unit, to more coastal influenced sediments toward the top. The stratigraphy consists of cyclic packages of interbedded fine to coarse-grained sandstones, siltstones, mudstones, laterally discontinuous conglomerates and abundant coal seams. At least 25 coal seams with individual thicknesses up to 6.75 metres exist within the Klappan Sequence. The sequence is interpreted to attain a thickness of up to 900 metres.

6.3.1.3 Malloch Sequence

The Malloch Sequence conformably overlies the Klappan Sequence and outcrops in the central, western and southeastern areas of the property. The strata consist of interbedded argillaceous sandstone, siltstone and mudstone with the development of thin coal seams toward the base of the sequence. Chert pebble conglomerates are laterally discontinuous. Approximately 700 metres of Malloch Sequence is exposed within the Mount Klappan property.

6.3.1.4 Rhondda Sequence

The Rhondda Sequence is the highest stratigraphic package on the Mount Klappan property and has a gradational and conformable contact with the underlying Malloch Sequence. Outcropping Rhondda Sequence strata is restricted to the southeast of the property in the Skeena Area. Lithologically this unit consists of thick, laterally extensive chert pebble conglomerates. Thin interbeds of sandstones, siltstones and mudstones increase in thickness toward the bottom of the sequence. The top of the Rhondda has not been observed but approximately 500 metres of exposed section exists within the Klappan property. It is interpreted that the Rhondda Sequence represents a prograding alluvial fan system over a transitional coastal-marine environment.

6.3.2 Plant Macrofossil and Fossil Fauna Distribution

During the 1984 and 1985 field seasons a minimum of 476 specimens of fossil flora and fauna were collected from 235 sites on the Mount Klappan property during routine traverses and the drill core logging program. Forty-seven species of fossil fauna and nineteen species of plant macrofossils were collected, described and identified with the purpose of aiding in stratigraphic delineation and correlation, age determination and paleoenvironmental interpretations. The 1985 Fossil Location Map in Appendix I documents all collection sites.

6.3.3 Fossil Distribution and Paleoenvironmental Implications

6.3.3.1 Spatsizi Sequence

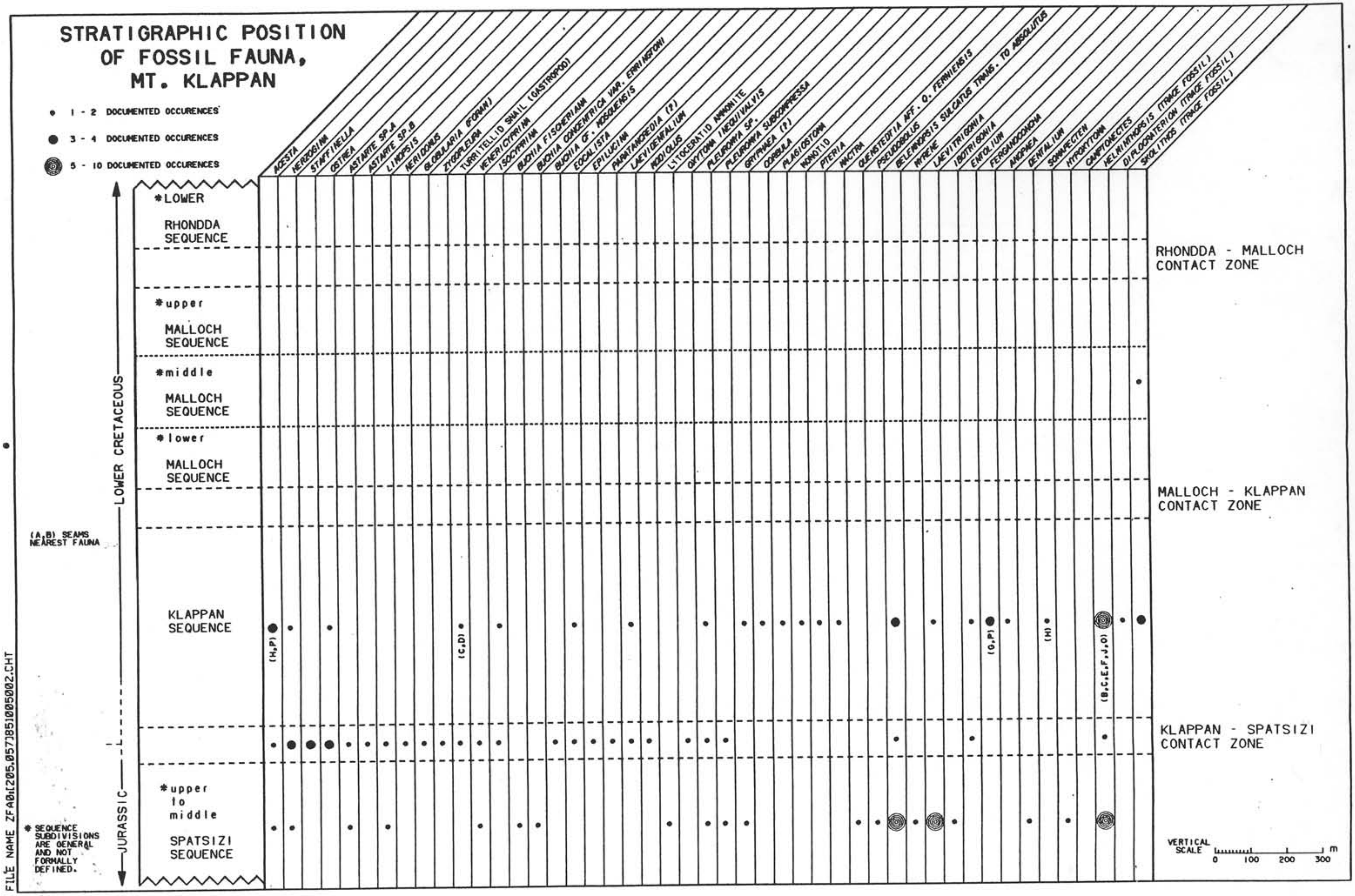
Marine bivalves, particularly Laevitrigonia, Ostrea, Staffinella and Herzogina, exist with belemnites (Belemnopsis sulcatus), and foraminifera (Globularia) in the predominantly marine Spatsizi Sequence (Table 6.3). No plant fossils are found except at the upper contact zone where conditions are interpreted to have been transitional between marine and terrestrial. Abundant fresh and brackish water and marine bivalves, trace fossils (Helminthopsis, Diplocraterion, and Scolithos), turritellid snails, minor plant macrofossils and belemnites are found in close proximity in this zone.

The conglomerate near the top of the sequence was formed in environments not conducive to preservation, therefore this portion of the strata is relatively barren.

A complete listing of fossils, their geographic locations and stratigraphic position may be found in Appendix E.

6.3.3.2 Klappan Sequence

All but three of the species found on the property are represented in the Klappan Sequence but in lesser numbers than in the lower Malloch Sequence (Table 6.4). Below seams E and F the diversity and total population of plant fossils decreases and increases for bivalves and belemnites. Marine forams (Globularia) and brackish water bivalves (Modiolus and Ostrea) are also present. This fossil distribution,



STRATIGRAPHIC POSITION OF FOSSIL FAUNA, MT. KLAPPAN
1 - 2 DOCUMENTED OCCURENCES
3 - 4 DOCUMENTED OCCURENCES
5 - 10 DOCUMENTED OCCURENCES
ACESTA
HERZOGINA
STAFFINELLA
OSTREA
ASTARTE SP.A
ASTARTE SP.B
LIMOPSIS
NERIDOMUS
GLOBULARIA (FORAM)
ZYGOPLEURA
TURRITELLID SNAIL (GASTROPOD)
VENERICYPRINA
ISOCYPRINA
BUCHIA FISCHERIANA
BUCHIA CONCENTRICA VAR. ERRINGTONI
BUCHIA CF. MOSQUENSIS
EOCALLISTA
EPILUCINA
PARATANCREDIA (?)
LAEVIDENTALIUM
MODIOLUS
LYTOCERATID AMMONITE
OXYTOMA INEQUIVALVIS
PLEUROMYA SP.
PLEUROMYA SUBCOMPRESSA
GRYPHAEA (?)
CORBULA
PLAGIOSTOMA
MONOTID
PTERIA
MACTRA
QUENSTEDTIA AFF. Q. FERNIENSIS
PSEUDOBOLUS
BELEMNOPSIS SULCATUS TRANS. TO ABSOLUTUS
MYREAE
LAEVITRIGONIA
IBOTRIGONIA
ENTOLIUM
FERGANOCONCHA
ANOPAEA
DENTALIUM
SOMAPECTEN
HYPOXYTOMA
CAMPTONECTES
HELMINTHOPSIS (TRACE FOSSIL)
DIPLOCRATERION (TRACE FOSSIL)
SKOLITHOS (TRACE FOSSIL)
LOWER CRETACEOUS
JURASSIC
*LOWER RHONDDA SEQUENCE
*upper MALLOCH SEQUENCE
*middle MALLOCH SEQUENCE
*lower MALLOCH SEQUENCE
KLAPPAN SEQUENCE
*upper to middle SPATSIZI SEQUENCE
RHONDDA - MALLOCH CONTACT ZONE
MALLOCH - KLAPPAN CONTACT ZONE
KLAPPAN - SPATSIZI CONTACT ZONE
(A,B) SEAMS NEAREST FAUNA
(H,P)
(C,D)
(O,P)
(H)
(B,C,E,F,J,O)
* SEQUENCE SUBDIVISIONS ARE GENERAL AND NOT FORMALLY DEFINED.
VERTICAL SCALE
0
100
200
300
m
FILE NAME ZFA0:[205,057]8510050002.CHT

TABLE 6.3

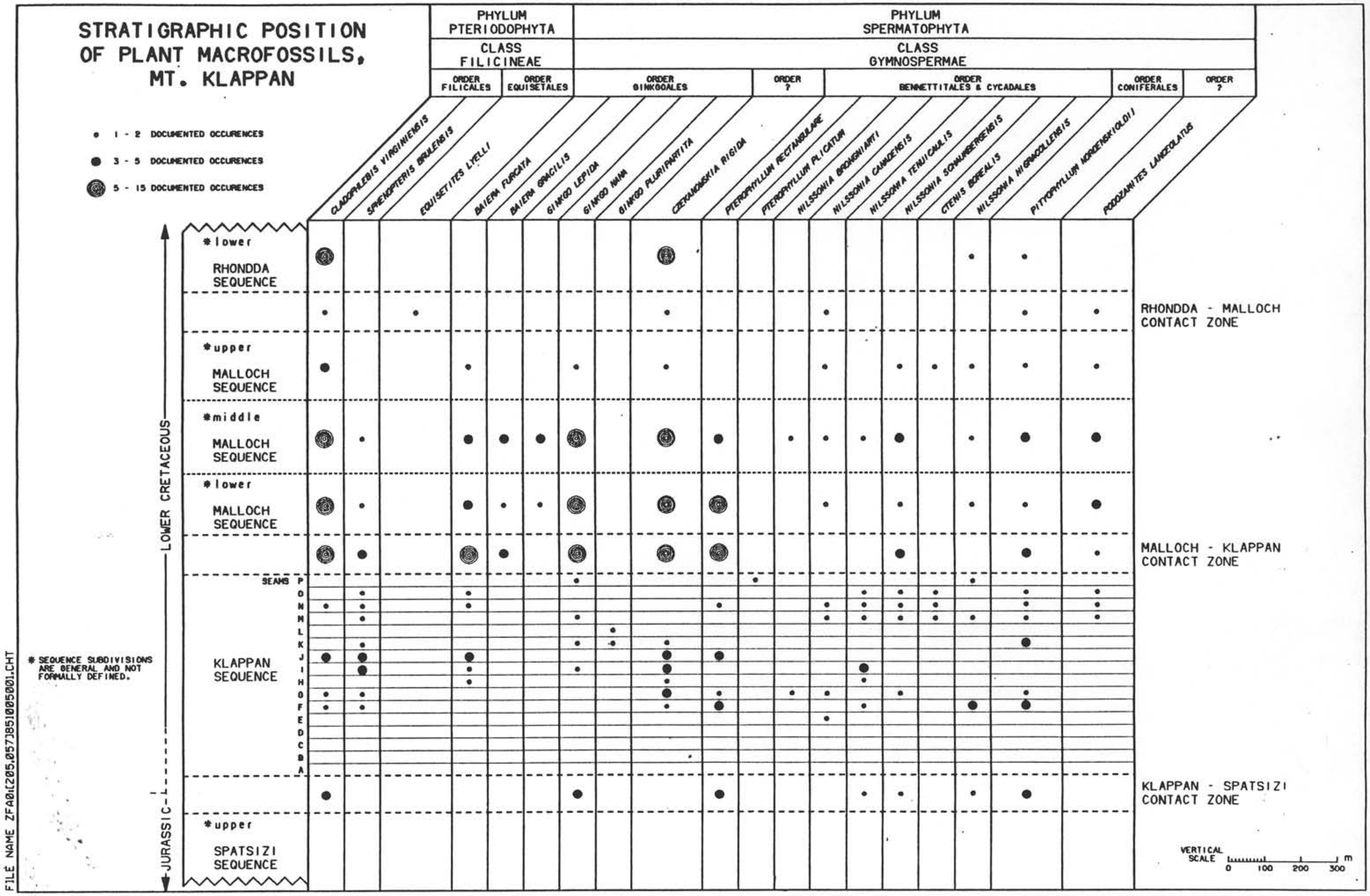

STRATIGRAPHIC POSITION OF PLANT MACROFOSSILS, MT. KLAPPAN
• 1 - 2 DOCUMENTED OCCURENCES
● 3 - 5 DOCUMENTED OCCURENCES
◉ 5 - 15 DOCUMENTED OCCURENCES
PHYLUM PTERIODOPHYTA
CLASS FILICINEAE
ORDER FILICALES
ORDER EQUISETALES
PHYLUM SPERMATOPHYTA
CLASS GYMNOSPERMAE
ORDER GINKGOALES
ORDER ?
ORDER BENNETTITALES & CYCADALES
ORDER CONIFERALES
ORDER ?
CLADOPHLEBIS VIRGINIENSIS
SPHENOPTERIS BRULENSIS
EQUISETITES LYELLI
BAIERA FURCATA
BAIERA GRACILIS
GINKGO LEPIDA
GINKGO NANA
GINKGO PLURIPARTITA
CZEKANOWSKIA RIGIDA
PTEROPHYLLUM RECTANGULARE
PTEROPHYLLUM PLICATUM
NILSSONIA BRONGNIARTI
NILSSONIA CANADENSIS
NILSSONIA TENUICAULIS
NILSSONIA SCHAUMBERGENSIS
CTENIS BOREALIS
NILSSONIA NIGRACOLLENSIS
PITYOPHYLLUM NORDENSKIOLDII
PODOZAMITES LANCEOLATUS
LOWER CRETACEOUS
JURASSIC
*lower RHONDDA SEQUENCE
RHONDDA - MALLOCH CONTACT ZONE
*upper MALLOCH SEQUENCE
*middle MALLOCH SEQUENCE
*lower MALLOCH SEQUENCE
MALLOCH - KLAPPAN CONTACT ZONE
SEAMS P O N M L K J I H G F E D C B A
KLAPPAN SEQUENCE
KLAPPAN - SPATSIZI CONTACT ZONE
*upper SPATSIZI SEQUENCE
* SEQUENCE SUBDIVISIONS ARE GENERAL AND NOT FORMALLY DEFINED.
VERTICAL SCALE
0 100 200 300 m
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TABLE 6.4

together with such sedimentary structures as wave ripples in clean, thick bedded sandstones, suggests a partly coastal marine influence near the base of the Klappan Sequence.

The coal-bearing strata above seams E and F appear to have been deposited in and adjacent to swamps in a fluvio-deltaic environment. Root mottling and burrowing (ie Helminthopsis) indicate non-transported, indigenous vegetation and shallow water with minimal wave or current influence such as may be found in a poorly drained swamp. The plant population is of a high diversity, has relatively large populations and is well preserved in the anaerobic and reducing conditions of standing water.

Near the channels, in well drained swamps, the sediments are coarser, thicker bedded and cross-bedded. These discontinuous swamps would be expected to have a smaller and less diverse plant population, which would be more fragmentary in nature. Preservation would be poorer due to the loss of organic material in oxidizing conditions. The variation in the diversity and preservation of the plant population found within the Klappan Sequence supports this environmental interpretation.

6.3.3.3 Malloch Sequence

The Malloch Sequence typically has a high

The Malloch Sequence typically has a high diversity of plants but they are fragmentary in nature and few in numbers. The diversity and numbers are higher in the lower Malloch and they peak at the Malloch Klappan contact zone. The most dominant species are Cladophlebis virginiensis, Baiera furcata, Ginkgo nana, Czekanowskia rigida and Pterophyllum rectangulare. No bivalves or other fauna are documented. Fossil and sedimentological evidence (Section 6.3.3) suggest that the sequence was the result of distal portions of alluvial fans prograding over a delta plain. Conglomerate dominated depositional environments such as alluvial fans result in reworking and non-preservation of plants near the top of the Malloch Sequence. The lower energy delta plain environment, interpreted for sediments nearer the Malloch-Klappan contact zone, is more conducive to a higher plant diversity and better preservation. Marine fauna are absent in the Malloch Sequence.

6.3.3.4 Rhondda Sequence

The Rhondda Sequence contains minor quantities of Cladophlebis virginiensis, Czekanowskia rigida, Nilssonia nigracollensis and the conifer Pityophyllum nordenskioldii. The low diversity and numbers and the fragmentary nature of the plants is probably due to reworking and non-preservation in high energy depositional environments such as alluvial fans.

The Malloch-Rhondda contact zone contains an additional four species. The broad-leafed conifer, Podozamites lanceolatus, the conifer Pityophyllum nordenskioldii, Nilssonia canadensis and Equisetites lyelli are all present in minor quantities.

Only Equisetites lyelli is unique to this zone but this may be due to its low population compared to other flora. The increase in plant species as a whole, in this zone, is reflected in the change of the depositional environment interpreted for sediments near the base of the Rhondda where there is an increase in siltstone, channelling and thin carbonaceous bands. The plants are less fragmentary in nature and are found predominantly in the nodular, orange-weathered, laminated siltstone, mudstone units and in the roof and floor of thin coal and carbonaceous mudstone bands.

6.3.4 Age Implication of Fossil Distribution

Nineteen species of plant macrofossils, documented predominantly in the Klappan and Malloch sequences indicate that the Cretaceous boundary should be placed within, or in close proximity to, the Klappan-Spatsizi contact zone (Figure 6.2). This 100 to 300 metre section is loosely defined as a zone with stratigraphic characteristics and fossil contents which are transitional in nature between the marine conditions of the Spatsizi Sequence and the predominantly fluvio-deltaic conditions of the Klappan Sequence. Marine bivalves, gastropods and belemnites are found in close proximity to terrestrial plant fossils in this zone.

Five of the nineteen plant macrofossils contained within the stratigraphic package are not definitively Lower Cretaceous in age and may be confused with Jurassic counterparts when examined macroscopically. These include the gymnosperms Czekanowskia rigida, Baiera furcata, Nilssonia nigracollensis, Podozamites lanceolatus, and Ctenis borealis. Single species collections are rare, however, and floristic comparisons with other western Canadian formations with similar collections (Table 6.5) suggest that the Klappan Sequence is predominantly Lower Cretaceous in age. The Kootenay and Blairmore Formations of Lower Cretaceous (Necomian/Barremian-Albian) age contain 14 of the 19 species from Mount Klappan.

6.3.5 Limitations to Use of Fossils as Index Fossils

Fossil collections from the 1984 and 1985 field seasons have demonstrated a few key trends which, in combination with lithological patterns, aid in the delineation of stratigraphic boundaries. These fossil trends are documented in Table 6.6.

In general, the Spatsizi Sequence is the only Mount Klappan strata characterized by the presence of Lytoceratid ammonites, a relative abundance of belemnites and marine

AGES OF MT. KLAPPAN PLANT MACROFOSSILS IN OTHER WESTERN CANADIAN FORMATIONS

• 1 - 2 DOCUMENTED OCCURENCES

● 3 - 4 DOCUMENTED OCCURENCES

◎ 5 OR MORE DOCUMENTED OCCURENCES

(BASED ON DATA FROM BELL, 1956)

* PARTIAL SPECIES LISTS ARE GIVEN FOR ALL FORMATIONS. ONLY THOSE SPECIES COMMON TO BOTH MT. KLAPPAN AND OTHER FORMATIONS ARE INCLUDED.

			KLAPPAN - MALLOCH - RHONDDA SEQUENCE PLANT MACROFOSSILS																		
		FORMATIONS	CLADOPHLEBIS VIRGINIENSIS	SPHENOPTERIS BRULENSIS	EQUISETITES LYELLI	BAIERA FURCATA	BAIERA GRACILIS	GINKGO LEPIDA	GINKGO NANA	GINKGO PLURIPARTITA	CZEKANOWSKIA RIGIDA	PTEROPHYLLUM RECTANGULARE	PTEROPHYLLUM PLICATUM	NILSSONIA BRONGNIARTI	NILSSONIA CANADENSIS	NILSSONIA TENUICAULIS	NILSSONIA SCHAUMBERGENSIS	CTENIS BOREALIS	NILSSONIA NIGRACOLLENSIS	PITYOPHYLLUM NORDENSKIOLDII	PODOZAMITES LANCEOLATUS
LOWER CRETACEOUS	ALBIAN	BLAIRMORE FM (UPPER FLORA)	●	•																	? •
		PASAYTEN GP	◎													? •					
		KINGSVALE GP												•							
		CROWSNEST FM																			
		COMMOTION FM																			
	APTIAN	BLAIRMORE GP (LOWER FLORA)	◎	•	•				•	◎					•					●	•
		LUSCAR FM	◎	•	●					◎		◎	•		•					◎	◎
		BULLHEAD GP (GETHING FM)	●				•	•		•		◎	•		●					●	◎
		USLIKA FM	●																		
		HAZELTON GP (SKEENA BEDS)					•		•	•		•			•					•	
		JACKASS MOUNTAIN GP	●									•									
		SPENCE BRIDGE GP																			
	NEOCOMIAN - BARREMIAN	KOOTENAY FM	◎		◎	•	•	●	◎	●	◎				•		◎	◎	•	◎	◎
		NIKANASSIN FM			•	?			•	●	●								●	•	•
		HAZELTON GP (HAZELTON AREA)	◎		◎	•			◎		◎			•			•		•	◎	•
		HAZELTON GP (GROUNDHOG AREA)	◎						•	•						•	●		◎		•
		TANTALUS FM	•											•		•				•	

TABLES INDICATES A LOWER CRETACEOUS AGE FOR COAL-BEARING STRATA OF MT. KLAPPAN BY FLORISTIC COMPARISONS WITH OTHER WESTERN CANADIAN LOWER CRETACEOUS FORMATIONS WITH SIMILAR COLLECTIONS.

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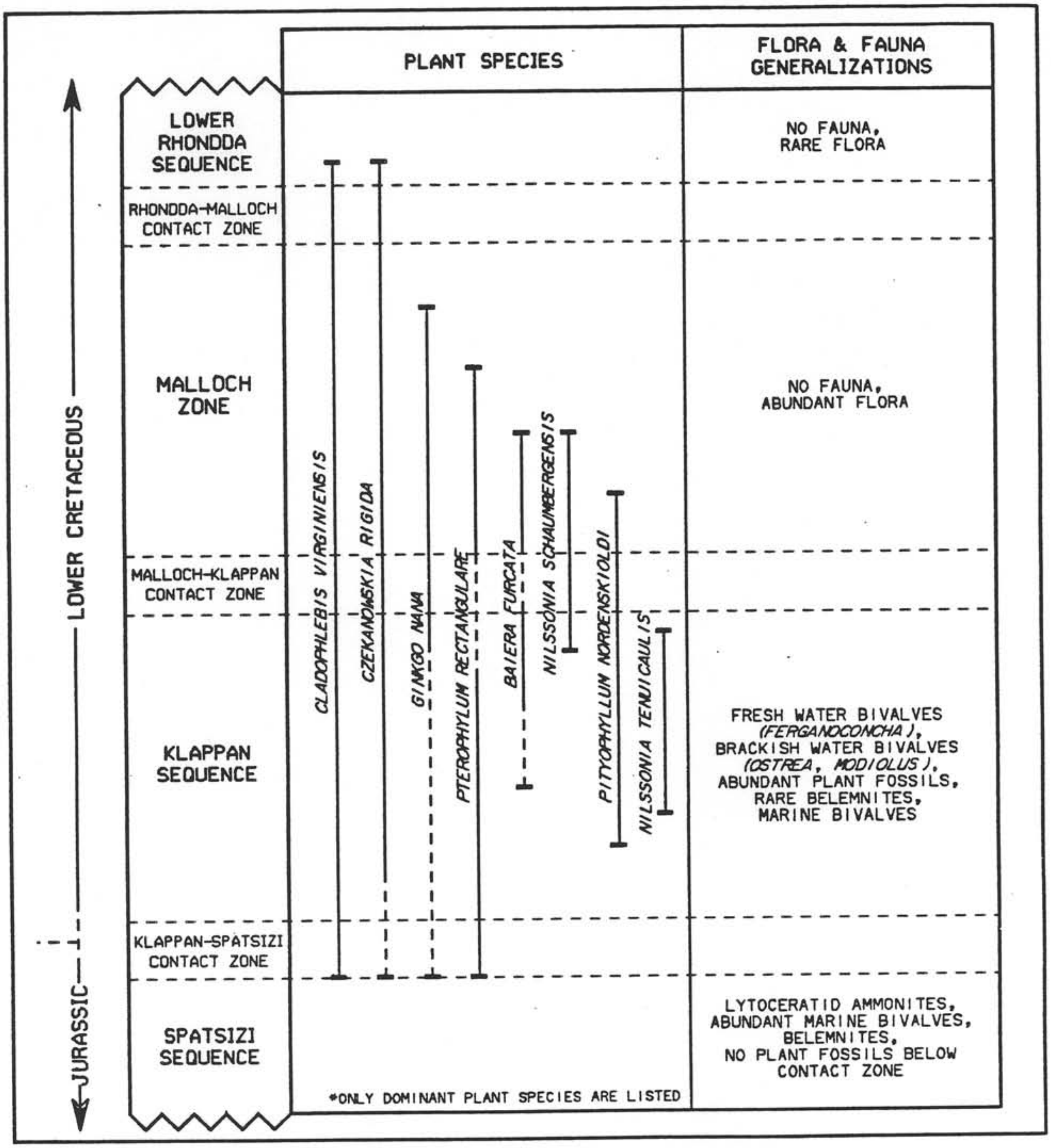
TABLE 6.5

TABLE 6.6

MOUNT KLAPPAN COAL PROPERTY

GENERAL TRENDS OF FOSSIL DISTRIBUTION



VERTICAL SCALE 0 100 200 300 m

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bivalves and an absence of plant fossils. The Klappan Sequence, including the contact zone, contains the only fresh water bivalves (Ferganoconcha) and brackish water bivalves such as Ostrea and Modiolus. The Malloch Sequence contains no bivalves or other fauna, to date, but has a high diversity and population of plant fossils particularly in the middle and lower portions. The Rhondda Sequence is distinctive in its general lack of flora and fauna.

Many of the species, documented at Mount Klappan in specific horizons, span the entire Lower Cretaceous period in other western Canadian coal-bearing formations. This suggests that the presence or absence of fossils within the strata is controlled largely by depositional environments rather than strictly by age. For this reason, single species documented at a limited number of locations should not be considered as indicative of a specific age, given the present control.

6.3.6 Structure

Deformation of sediments within the Mount Klappan property is the result of two phases of non-coaxial stress which postdate sediment deposition. The dominant structural features are the Beirnes Synclinorium and the Nass River Anticlinorium, both of which trend northwest - southeast. These major folds and associated structures were formed during the first deformational phase, F_1. On the Klappan property the synclinorium axis can be observed in the competent Rhondda strata as a broad, open, upright feature. Folds to the east of the synclinorium have axes which dip westward while folds west of the snyclinorium have easterly dipping axes. A single anticlinorium axis cannot be observed. Instead the exposed anticlinorium lies within less competent Malloch strata where folds are inconsistently upright and overturned.

Pervasive F_1 cleavage is well developed in all fine grained lithologies. It has been observed as both axial plane divergent and convergent cleavage and trends at 135 degrees.

Only minor southwest dipping thrusts with displacements of tens of metres are associated with the first deformational event.

The second deformational phase, F_2, primarily produced low amplitude, long wavelength folds trending northeast - southwest. Very localized tight, overturned fold styles of F_2 generation have also been observed. The overprinting of second stage folds onto the original deformational phase is seen as a series of plunge reversals averaging from 8 to 10 degrees to the northwest and southeast.

F_2 generation cleavage can be seen in most fine grained lithologies. It fans both outward and inward with respect to the axial plane of the fold with varying trends from 30 to 110 degres.

Several north - south trending, high angle normal faults with displacements of one to thirty metres are attributed to a structural event which occurred later than those previously described. Large fracture zones trending east - west are also believed to be part of this younger event.

6.4 Summit-Nass Area Geology

6.4.1 Introduction

The structure and stratigraphy observed in the Summit and Nass Areas only differs slightly from that described in the 1984 report. Detailed structural studies completed in Summit identified folds where two thrust faults were originally placed. Similarly, ground work and air photo interpretation resulted in the introduction of folds where the Nass thrust once existed. Lastly, strata west of Nass Lake which were previously interpreted as Spatsizi sediments are now considered to be Malloch Sequence sediments, based on numerous plant species identification.

At least 1 500 metres of combined Spatsizi, Klappan and Malloch Sequence stratigraphy is exposed in the Summit-Nass Area ranging from upper Jurassic to Lower Cretaceous in age. This section represents a marine regression with small sporadic transgressions documented throughout the package.

6.4.2 Summit Area

6.4.2.1 Spatsizi Sequence

Four hundred and fifty metres of upper Spatsizi

Sequence sediments outcrop along the western property boundary of the Summit Area. It is presently interpreted that Spatsizi strata may exist in Summit North but detailed stratigrapic work is needed to confirm this.

Lithologically the section consists predominantly of 10 to 30 metre coarsening upward cycles of laminated dark grey mudstones and thinly bedded to laminated medium grey siltstones capped by fine-grained, grey sandstones. Each cycle is gradational ending with a sharp upper contact. Sandstone units often display low angle cross-bedding and where they are thinly bedded with siltstones they are usually burrowed. Small sandstone channels are laterally discontinuous and contain rip-up clasts and scour surfaces at their base. Bivalve hash is common. Coal and carbonaceous zones are absent.

Spatsizi Sequence sediments form the lowest package of a marine regression which continued through to Lower Cretaceous time.

6.4.2.2 Klappan Sequence

Coal-bearing Klappan Sequence sediments occupy most of the Summit Area reaching a thickness of 500 to 600 metres. The sequence has been subdivided into three informal units on the basis of coal thickness and quality, fossil content and, to a lesser extent, lithotypes. Boundaries between units are subjective and transitional.

The lowermost 150 metres of Klappan Sequence strata contains thin coal seams tentatively correlated with the lowermost seams of Lost Ridge. A sedimentologically similar package exposed north of Layton Ridge may also be equivalent lower Klappan Sequence strata.

Deposition of these sediments in a marginal marine environment is supported by the presence of gastropods, belemnites, an abundance of marine bivalves, and a general lack of in-situ plant fossils. Intertonguing of marine and non-marine fluvial strata has produced a well developed transitional sedimentary package between Klappan and underlying Spatsizi Sequence sediments.

Lithologically this lower unit is characterized by grey to black, thinly intercalated mudstones and siltstones with lesser amounts of tan to grey weathering, medium to fine-grained sandstones. Lenticular, discontinuous chert pebble and granule conglomerates up to four metres in thickness exist locally. Thin, dirty coal seams are present in association with fine-grained sediments.

Sandy packages commonly contain ripple cross-bedding and, where graded transitions into finer lithologies exist, bioturbation and worm burrows are frequent. Coarsening up cycles are present but not well defined.

Plant fossil remains are rare and poorly preserved but numerous bivalves species are present. Indentified species are of marine, fresh and brackish water origin.

The middle 200 to 250 metres of the Klappan Sequence grades upward from underlying strata and is distinguished from the latter by the presence of thick continuous coal seams. Exposures of this unit are found on Marshall-Layton Ridge and Summit South, the predominant areas of focus in the Summit Area.

The sediments are interpreted to have been deposited in a terrestrial fluvial environment with a moderate marine deltaic influence. Fluvial interaction produced thinly interbedded, often ripple laminated, brown to dark grey or orange weathering siltstone, mudstone and fine-grained sandstone sequences interrupted by massive to thickly bedded, medium-grained sandstone beds up to 20 metres in thickness. The fine-grained sequences frequently exhibit colour banding weathering patterns resulting in a "tiger-striped" appearance. Such a pattern is best exhibited in the vicinity of TRC85001.

Sandstones often display medium to large scale, tabular and trough cross-bedding, pebble lags and basal scouring in small coarsening and fining upward sequences. These features are well illustrated in measured section OTC84009.

The numerous coal seams are frequently capped and underlain by thick bedded, medium-grained sandstones.

Thirteen plant species associated primarily with fine-grained lithotypes, are not as common as in the overlying unit although they are of a great diversity. Ferns are the best represented plant group with Nilssonia tenuicaulis, one of the few fossils consistently associated with roof rock sandstones, being widespread in Summit North and South. A similar diversity of bivalves exists in this unit, with single collections yielding five or more species. Rare belemnites are limited to the lower unit and the trace fossil Helminthopsis is common.

The upper 200 to 300 metres of the Klappan Sequence is a dominantly recessive package lacking coal. This barren zone is exposed in the northern part of Layton Ridge. It consists of red, brown or black weathering mudstones, interrupted by thick bedded orange weathering fine-grained sandstones and medium -grained grey to brown sandstones. The fines, which occur in 5 to 15 metre fining upward packages, comprise approximately 75 percent of the strata.

A correlation between central and southern Summit is tenuous due to the lack of geological data. A 200 metre section of medium grained sandstones and lenticular conglomerates interbedded with orange-brown weathering siltstones is characteristic of central Summit. Thin, poor quality coal and carbonaceous mudstone bands are associated with the fine grained sediments which comprises 70 percent of the strata.

The Klappan Sequence is thought to be thickest in the central Summit Area. In southeastern Summit, where coal seams are well developed and laterally continuous, relatively barren upper Klappan Sequence strata have been eroded reducing the overall stratigraphic thickness of the coal- bearing package.

6.4.2.3 Coal Seam Development

6.4.2.3.1 Klappan Sequence

The Summit South area, and to a lesser extent, Marshall Ridge and Layton Ridge continue to be of greatest interest in the Summit Area. Summit South offers favourable structural conditions and thick, laterally extensive coal seams. Marshall and Layton Ridges expose abundant, thick seams of high quality coal but structural complexity and erosion makes continuity of seams problematic.

In total 57 hand trenches have been excavated to date, 10 in the 1985 field season (Table 6.7). They have delineated 4 seams of 6.08 metres total thickness on Layton Ridge and a cumulative interseam thickness of approximately 100 metres. This package dips consistently at 15 to 20 degrees to the south - southeast, but has not been traced laterally due to erosion and an existing glacier. A further two seams, 4.37 and 3.15 metres in thickness, exposed in trenches TRC85002 and TRC83075, respectively, exist in the Marshall - Layton Valley northwest of Summit South. Each seam is of a high coal quality and a low ash content. These seams have been tentatively correlated with seams G (4.9 metres total thickness) and F (2.15 metres thick) both intersected in DDH83003. The continuity of each seam has been traced by spoil showings for a minimum distance of 500 metres within the Marshall/Layton Valley and each is believed to extend into Summit South. These seams are interpreted to be separated from the 4 seams of Layton Ridge by a maximum interseam of approximately 75 metres. Two diamond drill holes, DDH83003 and DDH82007, both drilled in the Summit South area, intersected a total of 7 seams in addition to the 4 seams exposed in outcrop in the Marshall/Layton area (Figure 6.3).

Table 6.7

SUMMIT AREA TRENCH SUMMARY

Year	Trench	C/C + R (m)	Sequence
1981	81007	3.98/4.97	Klappan
	81008	3.07/4.45	Klappan
1982	82035	3.29/3.48	Klappan
	82039	6.36/7.72	Klappan
1983	83048*	6.60/7.00	Klappan
	83049	0.87/1.37	Klappan
	83051	1.36/1.47	Klappan
	83052	3.50/3.50; 4.83/5.20	Klappan
	83054	1.71/1.91	Klappan
	83055	2.32/2.74	Klappan
	83056	1.92/2.32	Klappan
	83057	1.93/2.54	Klappan
	83058	5.33/5.68	Klappan
	83059	0.91/1.13; 1.89/2.27	Klappan
	83060	7.68/9.24; 0.90/0.90	Klappan
	83061	1.40/1.90	Klappan
	83062	1.79/1.89	Klappan
	83063	0.00/4.20	Klappan
	83064	0.50/0.70	Klappan
	83065	0.08/0.08	Klappan
	83066	6.18/7.02	Klappan
	83067	1.10/1.81	Klappan
	83074	1.53/2.95	Klappan

*retrenched (85003) therefore not included in average coal seam thickness

Table 6.7
Cont'd

SUMMIT AREA TRENCH SUMMARY

Year	Trench	C/C + R (m)	Sequence
1983 (cont'd)	83075	3.15/3.25	Klappan
	83078	0.60/0.60	Klappan
	83079	0.70/0.70	Klappan
	83080	0.50/0.50	Klappan
	83081	0.80/0.80	Klappan
	83089	0.15/0.15	Klappan
	83090	3.75/4.85	Klappan
1984	84001	0.80/0.80	Klappan
	84002	0.75.0.75	Klappan
	84008	0.54/0.80	Klappan
	84009	0.48/0.48	Klappan
	84013	0.72/1.55	Klappan
	84016	0.59/2.13	Klappan
	84017	0.85/0.86	Klappan
	84020	1.53/2.91	Klappan
	84021	0.82/0.97	Klappan
	84022	2.55/2.65	Klappan
	84023	1.20/1.44	Klappan
	84024	0.75/0.75	Klappan
	84025	0.89/1.72	Klappan
	84026	1.63/1.83	Klappan
	84027	2.69/3.32	Klappan
	84028	0.75/1.58	Klappan
	84029	2.52/2.88	Klappan
	84030	0.32/0.43	Klappan

Table 6.7
Cont'd

SUMMIT AREA TRENCH SUMMARY

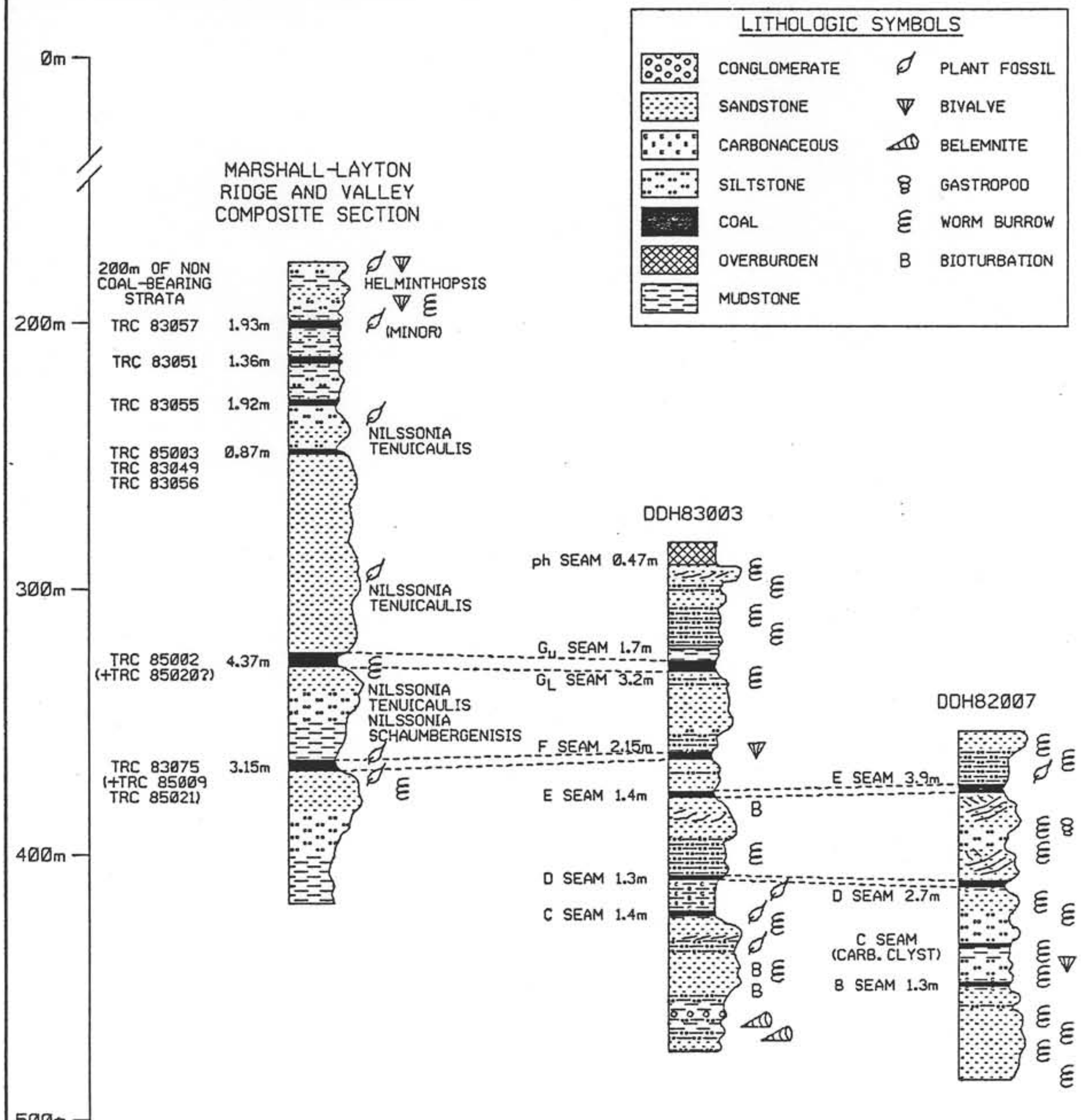
Year	Trench	C/C + R (m)	Sequence
1985	85001	1.22/2.27	Klappan
	85002	4.37/4.37	Klappan
	85003+	0.72/0.72	Klappan
	85005	1.06/1.23	Klappan
	85009	1.44/2.47	Klappan
	85011	2.44/3.00	Klappan
	85012	1.87/2.52	Klappan
	85019	1.30/1.50	Klappan
	85020	1.30/1.06	Klappan
	85021	1.39/1.63	Klappan

+relogged trench 83048

FIGURE 6.3

MOUNT KLAPPAN COAL PROPERTY

SUMMIT AREA COAL-BEARING SECTION
MARSHALL-LAYTON RIDGE AND SUMMIT SOUTH



* NEW DDH83003 AND DDH82007 CORRELATION SUBJECT TO CONFIRMATION BY DETAILED CORE STUDY IN 1986.

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Diamond drill hole DDH83003 intersected 6 seams with a total true thickness of 10.42 metres and a total interseam thickness of 116.28 metres. Seams tentatively correlated with Ph, G upper, G lower, F, E, D and C were intersected including 2 seams interpreted from coal loss.

Diamond drill hole DDH82007 intersected four seams tentatively designated as seams E, D, C and B of Lost Ridge (Table 6.8). They have a total true thickness of 8.36 metres and a total interseam of 70.11 metres. The nomenclature changes introduced since the 1984 field season are subject to confirmation by a detailed core study in 1986.

The stratigraphic position of the two shallow seams exposed in Repeater Valley in trenches TRC84076 and TRC83060 has not yet been determined. Very poor outcrop exposure makes a strict stratigraphic correlation between these seams and those intersected in DDH83003 tenuous. The favourable structural conditions of the 3.32 metre seam (for TRC83060) emphasizes the need for further seam tracing, and hand trenching in 1986.

Table 6.8

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
82007	E	19.19 - 23.10	3.91		2.13/3.91
				33.85	
	D	57.14 - 59.85	2.71		1.95/2.71
				21.41	
	C	81.26 - 81.71	0.45		Coal Loss
				14.85	
	B	96.56 - 97.85	1.29		0.80/1.29
83003	ph	In casing	0.47		0.97/0.47*
				27.34	
	Gu	40.30 - 42.05	1.72		1.05/1.72
				2.71	
	Gl	44.80 - 48.00	3.20		1.93/3.20
				32.59	
	F	80.59 - 82.74	2.15		Coal Loss
				4.20	
	E	86.94 - 87.16	0.22		Coal Loss
				39.79	
	D	126.95 - 128.24	1.26		1.06/1.26
				9.15	
	C	137.68 - 139.10	1.40		1.09/1.40

* Spudded into seam, coal unconsolidated and represents a minimum thickness.
** Seam designations are subject to confirmation by detailed core study.

6.4.2.4 Structure

Summit Area strata have been folded, and to a minor extent, faulted during at least two distinct phases of non-coaxial compression resulting in fold patterns tending northwest-southeast (F_1) and northeast - southwest (F_2). This pattern is also recognizable on a regional scale throughout the Mount Klappan property. Pronounced east - west trends, interpreted as being unrelated to F_1 and F_2 deformational events, are locally distinct.

An equal area plot of poles to bedding planes in the Summit Area demonstrates three prominent fold directions (Figure 6.4). The scatter of points (n = 696) does not allow graphical determination of F_1 or F_2 average plunges but Figures 6.5 clearly exhibits a shallow plunge, 2 to 5 degrees for the east - west trending fold direction.

Regional F_1 folds are typically upright to overturned to the north with a shallow southeasterly plunge of 5 to 6 degrees. Axial planes commonly dip steeply to moderately to the southwest with northern fold limbs generally steeper than southern limbs. In incompetent lithologies, where fold styles are tighter and of higher amplitudes, plunges may locally steepen to 28 degrees.

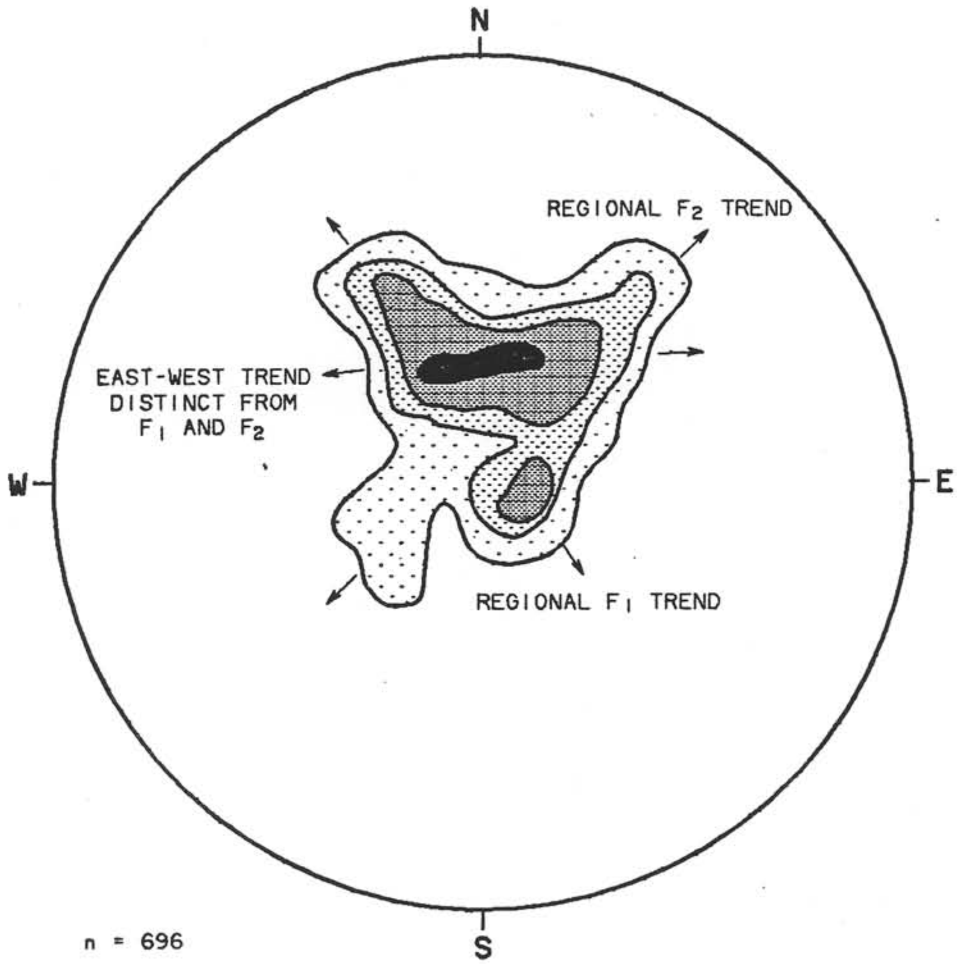
Second phase folds which typically trend

FIGURE 6.4

MOUNT KLAPPAN COAL PROPERTY

1985 SUMMIT AREA - KLAPPAN SEQUENCE

EQUAL AREA PLOT OF POLES TO BEDDING PLANES



[black]	5 - 6%	(34 - 41 MEASUREMENTS)
[dense shading]	4 - 5%	(26 - 34)
[dotted]	3 - 4%	(20 - 26)
[sparse dots]	2 - 3%	(14 - 20)
[blank]	0 - 2%	(0 - 14)

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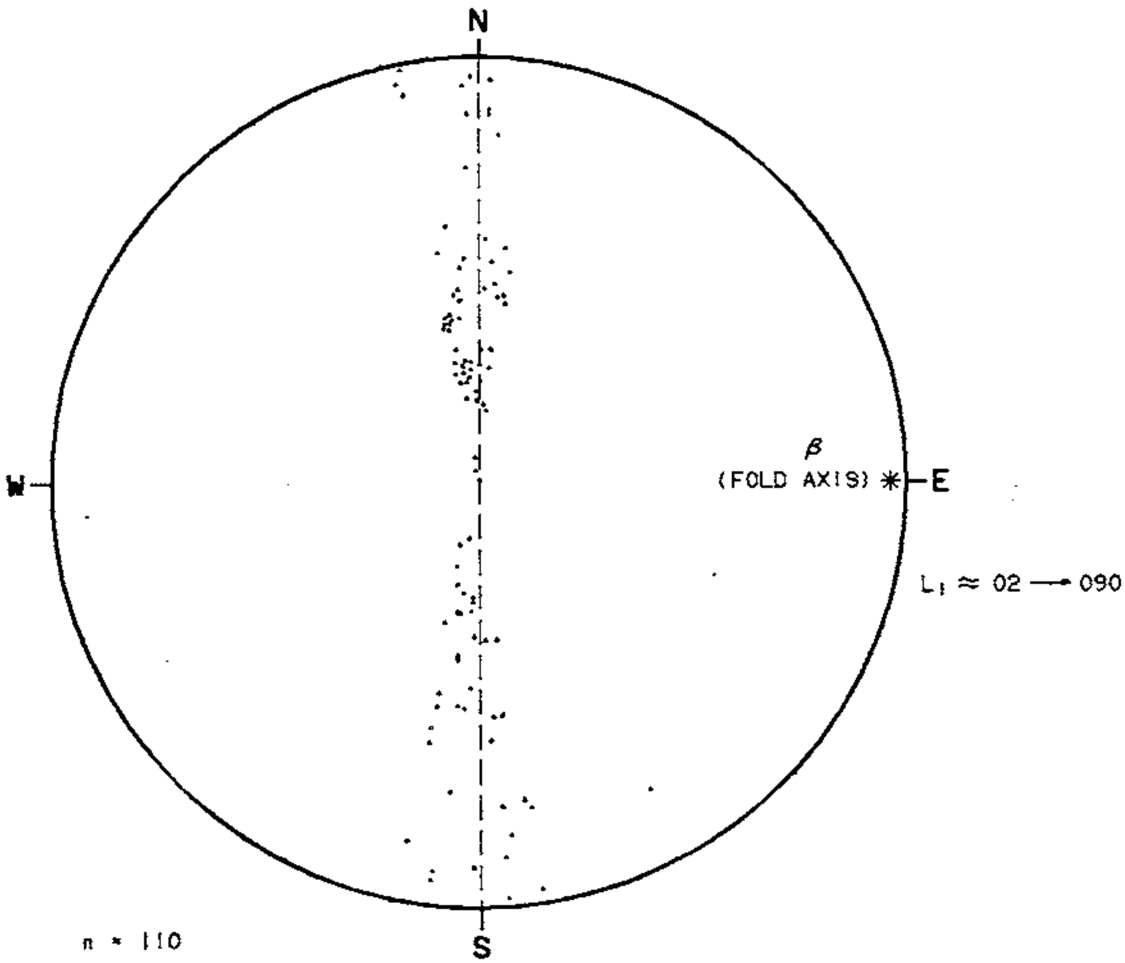
FIGURE 6.5

MOUNT KLAPPAN COAL PROPERTY

1985 SUMMIT AREA - KLAPPAN SEQUENCE
S-POLE PLOT OF EAST-WEST TRENDS



· POLE TO BEDDING PLANE

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northeast - southwest are of limited extent throughout most of the Summit region, but are significant locally at the east end of Marshall Ridge and in Summit South, southwest of DDH83003. Plunges appear to be shallower than those measured on F_1 structures, although this observation may be biased by the competency of the strata in which they are contained. Axial planes are commonly moderately to steeply dipping.

Small scale localized faulting associated with F_1 or F_2 compressional events is of minimal significance. Dextral strike-slip and normal faults with displacements of less than 10 metres have been observed.

Thrust faulting is believed to be of a smaller scale than previously interpreted. The thrust fault originally located west of Marshall Ridge and extending through Repeater Valley has been reinterpreted as a syncline trending 103 degrees and plunging 20 degrees to the southeast. Well developed axial planar cleavage which fans from near vertical in the core to 15 degrees on the limbs supports this interpretation.

The low angle thrust fault in Summit South has been reinterpreted as a broad anticline west of TRC83060, although outcrop exposure is very poor. Where this thrust trace falls between TRC83052, TRC83054, and TRC85011, recently collected data suggests that a series of tightly folded, overturned, northwest and southeast plunging anticlines of F_1 generation exist. Axial planes dip southeast with fold vergence to the northeast.

A shallowly south dipping thrust has been observed on Repeater Ridge with an inferred displacement of tens of metres. Tightly hinged drag folds with axes parallel to the direction of movement of the thrust sheet, and amplitudes between 30 and 60 metres, exist immediately above and below the shear plane.

6.4.3 Nass Area

6.4.3.1 Spatsizi Sequence

The Spatsizi Sequence is the lowest stratigraphic mapped unit of the Mount Klappan property. The base of the sequence has not been observed in the study area but the strata are interpreted to reach a thickness of 900 metres.

Lithologically the sequence consists of thinly laminated, dark grey mudstones interbedded with tan weathering siltstones, thin to thick bedded, fine-grained, grey sandstones and massive, chert pebble conglomerates which become well developed in Spatsizi Park in the middle to upper portion of the sequence. Poorly developed, thin coal seams exist at the very top of the unit. An overall coarsening upward trend is recognized with individual 75 metre cycles grading from basal mudstone to sandstone and conglomerate, the latter displaying sharp upper contacts. Sandstones and siltstones are predominant in the middle of the Spatsizi Sequence and generally lack primary sedimentary structures; small channel sands and current ripples are common higher in the sequence. Mudstones usually contain bivalve horizons but rarely host belemnites. Plants and wood fragments exist only at the top of the Spatsizi Sequence in close proximity to carbonaceous zones and coal seams.

The Spatsizi Sequence is interpreted to represent a marine regression ranging from marine influenced sedimentation to deposition resulting from coastal processes. Consequently, a transitional zone of at least 200 metres, between marine and terrestrial depositional environments joins the Spatsizi and overlying Klappan Sequences.

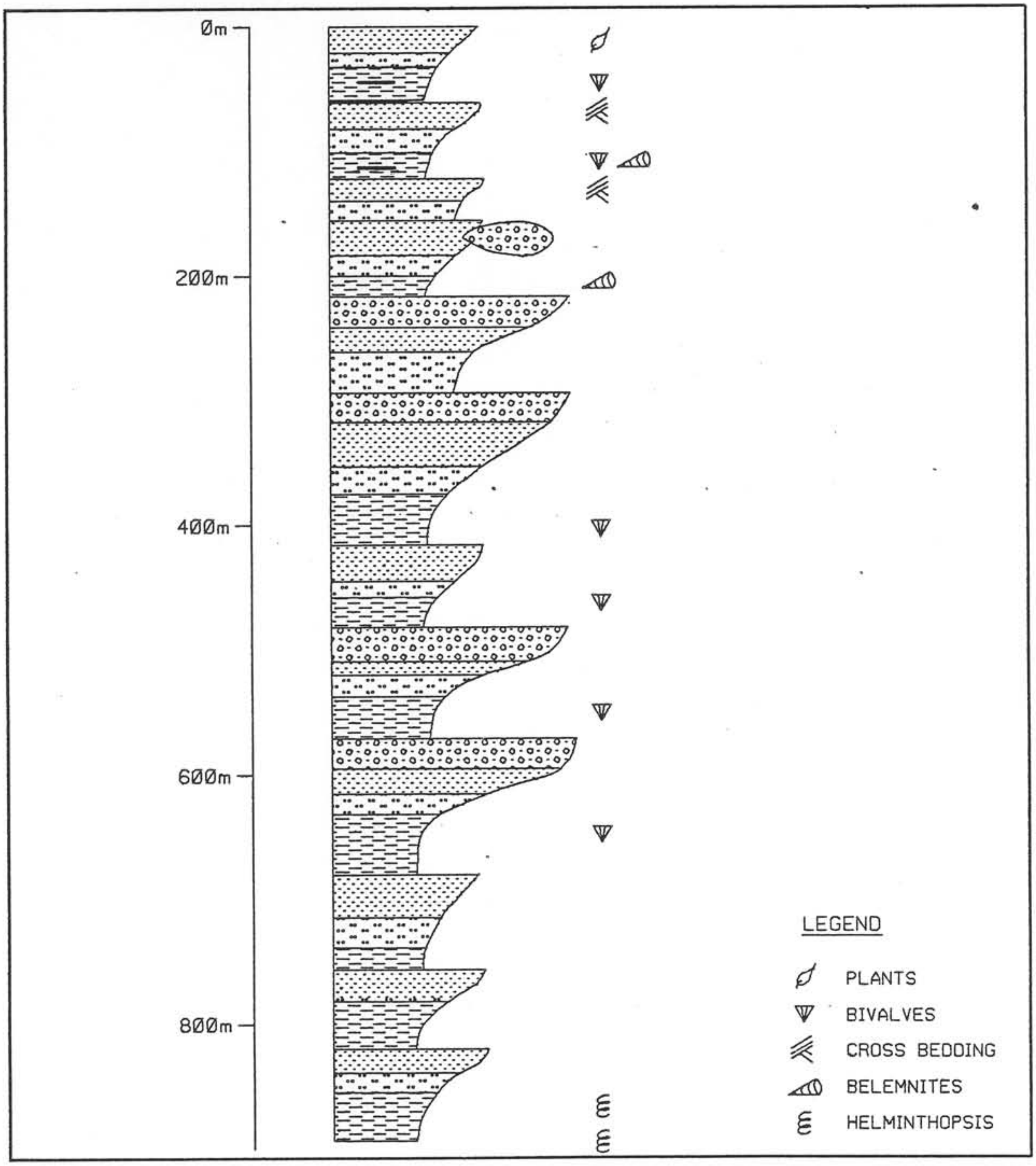
The collection of Belemnopsis sulcatus, Laevitriognia, Herzogina and Staffinella and the absence of plant macrofossils indicates an upper Jurassic age for the Spatsizi Sequence.

A vertical distribution of Spatsizi Sequence sediments is shown in Figure 6.6. These sediments are well exposed in the northwestern corner of the Nass Area along Glacier Ridge and Kay Ridge.

FIGURE 6.6

MOUNT KLAPPAN COAL PROPERTY

NASS AREA SIMPLIFIED COMPOSITE STRATIGRAPHIC COLUMN
SPATSIZI SEQUENCE



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6.4.3.2 Klappan Sequence

The Klappan Sequence is the main coal-bearing unit of the Mount Klappan property. In the Nass region the coal-bearing strata outcrop in the valleys of the Klappan River, Nass Lake, and lower Helm Creek. The lack of exposure in these vegetated areas prevents section measurements but a stratigraphic thickness of up to 400 metres is expected. Midway within the transitional zone joining the Spatsizi and Klappan Sequences lies the base of the Klappan Sequence. A conformable and gradational upper contact into overlying Malloch strata is also observed.

Lithologically Klappan Sequence sediments consist of small fining upward cycles of laterally discontinuous chert pebble conglomerates, thin bedded, medium grey siltstones, laminated dark grey mudstones and coal. Bivalves and burrows occur sporadically in the basal mudstones; belemnites are rare. In the middle of the sequence coal seams are well developed and plant macrofossils, rootlets and wood fragments are prevalent. Sandstones display undulatory current ripples and small scale channeling.

Klappan Sequence sediments are interpreted to represent lowermost alluvial fan or coastal plain deposits with marine influences. The marine regression observed in the Spatsizi Sequence continued through Klappan and Malloch Sequence time. Thick coal seams in the middle of the Klappan Sequence maintain the same cyclicity throughout the package but become thinner and more carbonaceous higher in the sequence. Sediments are moderately sandier and the unit is void of bivalves.

Distinctive, medium-grained, light grey weathering sandstones, associated with coal, occur intermittently from the Nass Valley to Lost Ridge; a probable result of similar environmental processes effective during deposition. For this reason Klappan strata in the Nass Area are interpreted to be laterally equivalent to the lower coal-bearing sediments of the Klappan Sequence on Lost Ridge.

Based on collections of fossil fauna and plant macrofossils the Klappan Sequence spans upper most Jurassic and Lower Cretaceous time.

6.4.4.3 Malloch Sequence

The Malloch Sequence gradationally and conformably overlies the Klappan Sequence. It has limited distribution in the study area but 800 metres of Malloch section are exposed on the ridges just east and west of Nass Lake.

Malloch Sequence sediments are comprised of 3 to 15 metre fining upward cycles of laterally discontinuous chert pebble conglomerates grading up into fine-grained, thin to thick bedded, grey sandstones and dark grey, laminated to thin bedded siltstones. Bright orange weathering siltstones, some of which are calcareous, are distributed throughout the sequence. Dark grey, laminated mudstones form the top of most cycles grading into coal, lower in the Malloch and becoming siltier up section. Sandy and interlayered silty units, up to 15 metres thick, become silt dominated at the top of the cycle, in the basal Malloch, and sandier higher in the sequence. Lateral facies changes over 500 metres from coarser to finer sediments are common.

Channel sandstones and conglomerates exist throughout the Malloch Sequence. They are laterally discontinuous over 20 to 200 metres and often display planar and trough cross-beds, scour surfaces, graded bedding and pebble lags. Transported woody fragments are commonly found randomly orientated in these ancient channels. Conglomerates form the widest channels which become more prevalent up section. Excellent exposures of obliquely stacked channels can be observed on Rhondda Ridge and Maritime Mountain. The upper Malloch contact is placed beneath the first laterally continuous conglomerate in excess of ten metres.

It is interpreted that the Malloch Sequence represents deposition of the middle to distal portion of an alluvial fan complex reworked by river systems.

Landward transgression observed in the lower sequences continued through Malloch time marked by sporadic regressions allowing for the development of coaly zones in the middle Malloch. A vertical distribution of the Malloch Sequence is shown in Figure 6.7.

Plant macrofossils are abundant throughout the Malloch, the most common including Cladophlebis viginiensis, Ginkgo nana and Czekanowskia rigida. Based on these and other species the Malloch Sequence spans Lower Cretaceous time.

6.4.3.4 Coal Seam Development

6.4.3.4.1 Spatsizi Sequence

Thin coal seams, usually less than one metre, exist only at the very top of the Spatsizi Sequence. The one trench excavated in this lower sequence, TRC84004 retrenched at TRC85010, contains dirty coal with a coal to coal + rock ratio of 3.15/4.47 metres. Because of the predominantly marine character of the Spatsizi sediments the coals observed in this sequence are not expected to be of economic importance.

6.4.3.4.2 Klappan Sequence

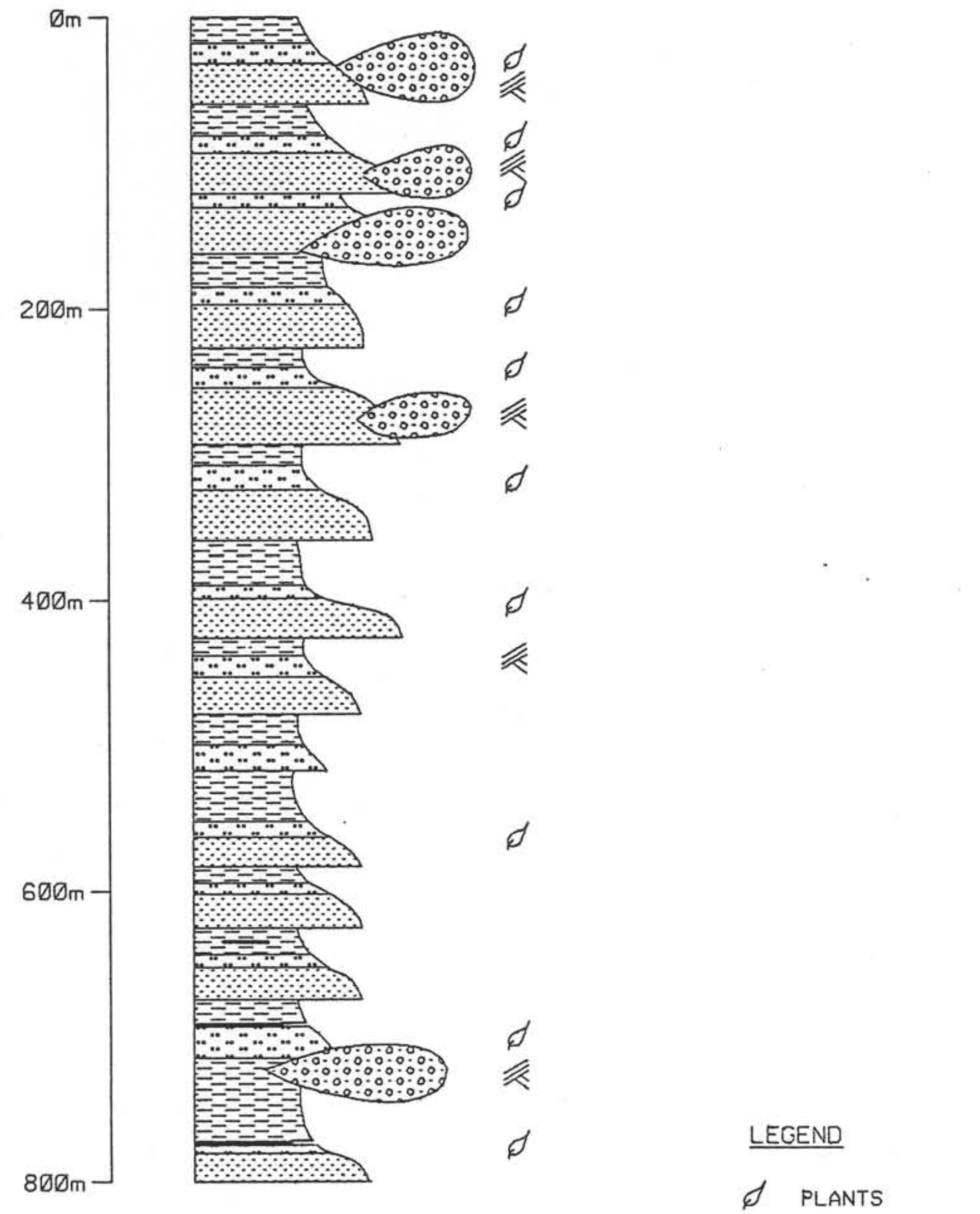
Within the Nass region a total of

FIGURE 6.7

MOUNT KLAPPAN COAL PROPERTY

NASS AREA SIMPLIFIED COMPOSITE STRATIGRAPHIC COLUMN

MALLOCH SEQUENCE



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twenty-four trenches have been excavated in the Klappan Sequences ranging from 0.80 to 3.96 metres in thickness (Table 6.9). The average thickness of all of the seams is 1.9 metres.

The lower coal-bearing section outcropping predominantly along Helm Creek is interpreted to extend westward surrounding the Klappan River and southward underlying Nass Lake (see 1985 Geology Map, Appendix I).

Due to the lack of outcrop and drill hole information individual seam correlations are tenous, but based on the stratigraphy the sediments are interpreted to be laterally equivalent to the lower coal-bearing Klappan Sequence of the Lost Ridge.

6.4.3.4.3 Malloch Sequence

Five trenches have been excavated in the Malloch Sequence and not exceed two metres in thickness (Table 6.9). In the Nass Area seams only occur in the basal Malloch and are generally thinner and less frequent than those in the underlying Klappan Sequence. To date a seam correlation has not been development.

Table 6.9

NASS AREA TRENCH SUMMARY

Year	Trench	C/C + R (m)	Sequence
1982	82021	3.26/3.57	Klappan
	82022	1.13/2.60	Klappan
1983	83068	0.63/0.86	Klappan
	83069	0.91/0.91	Klappan
	83070	0.67/0.95	Klappan
	83071	3.62/3.96	Klappan
	83072	3.13/3.51	Klappan
	83073	3.01/3.36	Klappan
	83076	1.20/1.54	Malloch
	83077	1.32/1.48	Malloch
	83082	1.00/1.27	Klappan
	83083	1.13/1.50	Klappan
	83084	0.90/1.59	Klappan
	83085	0.80/0.90	Klappan
	83086	1.51/1.96	Klappan
	83087	0.70/0.80	Klappan
	83088	1.15/1.50	Klappan
	83091'	3.26/3.57	Klappan
1984	84003	1.50/1.50	Malloch
	84004	0.74/1.39	Spatsizi
	84005*	2.58/2.95	Klappan
	84006	1.31/1.46	Klappan
	84007	0.90/0.90	Klappan

Table 6.9
Cont'd

NASS AREA TRENCH SUMMARY

Year	Trench	C/C + R (m)	Sequence
1984	84010	1.05/1.05	Malloch
(cont'd)	84011	3.36/3.74	Klappan
	84012	1.00/1.00	Klappan
	84014	1.95/2.16	Klappan
	84015	1.55/1.70	Klappan
	84018	1.10/1.68	Klappan
	84031+	0.95/1.09; 0.97/1.00	Klappan
	84032°	1.55/1.82	Klappan
1985	85010-	3.15/4.47	Spatsizi
	85018	0.73/0.93	Klappan

' retrench of 82021

* retrench of 83073

+ retrench of 83071

° retrench of 82072

- retrench of 84004

6.4.3.5 Structure

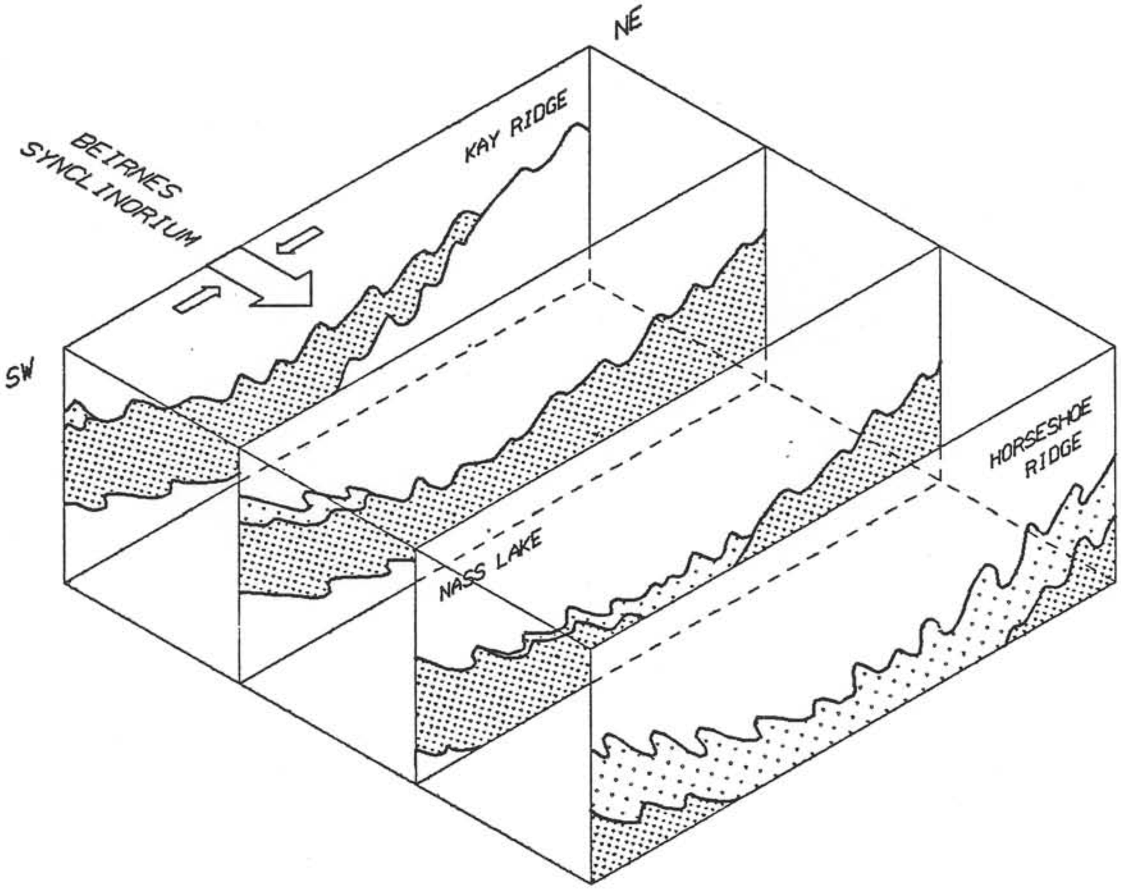
Structural deformation within the Nass Area is the result of two phases of non-coaxial stress. The dominant structural features resulting from the first deformational phase (F_1) are the Beirnes Synclinorium and, outside the western property boundary, the Nass River anticlinorium. The synclinorium is easily identified on Beirnes Ridge as a shallow dish trending northeast - southwest within competent upper Malloch and lower Rhondda strata. The southerly plunge of the structure exposes lower Spatsizi sediments to the north and Rhondda Sequence strata to the south. East of the synclinorium axis folds verge northeast with generally long shallowly dipping southwest limbs and short northeast limbs. West of the axis folds display a southwesterly vergence. See Figure 6.8. In the area surrounding the synclinal axis fold styles vary but tend to be upright.

The anticlinorium axis is not as easily seen due to the incompetency of the Malloch strata in which it is exposed. Similarily a single axis of the synclinorium disappears within Malloch sediments and a zone of upright to overturned folds verging both east and west can be recognized. This style is particularly noticeable on Caribou Ridge. Farther away from the axis fold amplitudes increase and hinges tend to be higher. In locations where Klappan strata

FIGURE 6.8

MOUNT KLAPPAN COAL PROPERTY

NASS AREA GEOLOGICAL SCHEMATIC



MALLOCH SEQUENCE	NO SCALE IMPLIED
KLAPPAN SEQUENCE	
SPATSIZI SEQUENCE	

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are exposed fold wavelengths are larger and amplitudes smaller than those observed in Malloch strata. The primary structural trend is 130 degrees with plunges ranging from 14 degrees northwest to 10 degrees southeast. Locally plunges can be very steep.

Thrusting, related to the first deformational event, is of minor importance. Two thrust faults have been recognized in the Malloch Sequence, on the western and southern boundaries of the Nass Area, each dipping southwest and each with displacements of tens of metres.

Primary cleavage is well developed throughout the Nass Area, particularly in fine grained lithologies. It commonly occurs in an axial plane convergent or divergent pattern and trends at 130 degrees.

The second deformational event, F_2, produced broad, open fold styles which can be identified as plunge reversals on primary folds. Axial trends vary from 90 to 110 degrees and have been traced for a maximum of 300 metres.

Strike slip faults trending from 10 degrees to 40 degrees east are believed to be associated with either the second deformational phase or a later structural event. Lateral translation of sediments up to 75 metres is common. On a smaller scale strike slip faults, with 10 to 30 metres displacement, outcrop southeast of the major faults complicating the correlation of several local coal trenches. Lastly, small high angle normal faults with displacements of less than 1 metre to 10 metres are found throughout the study area.

F_2 cleavage is evident in many localities but is better developed within siltstones and mudstones. It is axial plane convergent and divergent and parallels axial traces which vary from 10 to 110 degrees.

6.4.4 Summit-Nass Area Sandstone Petrology

6.4.5.1 Introduction

During the 1983 and 1984 field seasons sandstones and siltstones, predominantly within the Klappan Sequence, were sampled from outcrop. Thin sections were analyzed for composition, textural relationships and diagenetic features with the purpose of determining the applicability of sandstone petrology in the lateral correlation of stratigraphy.

6.4.4.2 Primary Mineralogy

The primary mineralogy of the majority of the samples is remarkably similar, with major changes in petrology being related to diagenetic features.

Sandstones are primarily chert or feldspathic litharenites characterized by the presence of chert, plagioclase, potassium feldspar and volcanic and sedimentary rock fragments. Minor quantities of muscovite or biotite and opaque minerals such as detrital hematite may be present. Various amounts of organic matter are present in sands in close proximity to coal seams.

6.4.4.3 Textural Features

The sandstones studied display a great variation in texture. Most samples are immature to submature with poor sorting and a high degree of grain angularity. Textural inversions, in which angular quartz and feldspars coexist with well rounded chert grains, in otherwise immature sandstones, are common. These inversions suggest that the cherts have been rounded in a previous sedimentary cycle.

6.4.4.4 Sandstone Diagenesis

Diagenetic features include megaquartz growth from SiO_2 matrices, chert recrystallization to megaquartz, sericitization of feldspars, dolomitization, calcite and siderite cementation and the formation of authogenic chlorite and hematite. In general, there appears to be an enrichment of carbonates close to mudstone contacts. Of the samples studied, thinly interbedded sequences of mudstones and sandstones or siltstones are commonly highly calcified suggesting the importance of mud as a supply of ions for cementation. Nass River fine-grained, chert arenites are particularly well calcified in thinly bedded middle Malloch strata.

6.4.4.5 Application of Petrology

Textural relationships, diagenetic features and primary mineralogy do not change systematically with depth for the small population of samples. Malloch and Klappan sediments from various Summit-Nass Area locations have similar primary mineralogy and alteration features. It is not possible to determine the stratigraphic position of a given sample strictly on the basis of sandstone petrology, although correlation on the basis of specific localized diagenetic features may be useful.

7.0 RESOURCES

7.1 Mount Klappan Coal Project

7.1.1 Summary

The in-situ, largely speculative level of coal resources of the Mount Klappan Coal Project total 6.1 billion tonnes in seams greater than 0.5 metres in thickness to a maximum depth of 500 metres below surface. Of this total potential, 64.4 million tonnes are defined as being measured resources. The following table summarizes the resource contributions from each area of the property as well as the representation by resource category. The 1:50 000 Coal Resource Map (Appendix I) presents the distribution of resources over the Mount Klappan property.

Table 7.1
MOUNT KLAPPAN COAL PROJECT
COAL RESOURCES (MT)

	Category			
Area	**Measured**	**Indicated**	**Inferred**	**Speculative**
Lost-Fox	52.3	50.7	86.1	717.9
Hobbit-Broatch	12.1	24.5	369.1	613.3
Summit	--	--	35.8	2 254.0
Nass	--	--	--	1 706.8
Skeena	--	--	--	232.3
Total	64.4	75.2	491.0	5 524.3

Total Coal Resource Potential: 6 154.9

The coal seams of interest are contained within the strata of the Klappan Sequence. Coal measures of the Malloch and Spatsizi Sequences are not presently considered to be of economic importance and therefore, were not included in resource calculations.

The parameters within which the coal resources were classified and the procedures utilized in resource calculations are outlined in Section 7.3.3.

7.2 Summit-Nass Area

7.2.1 Summary

The majority of the 3 996.6 billion tonnes of coal resource in the Summit-Nass Area is at the speculative level (Table 7.2). At the inferred level, 35.8 million tonnes of resource lies within the southern part of Summit in three separate resource areas.

Two inferred resource areas are based on diamond drill hole seam intersections (DDH82007 and DDH83003) which have been tentatively designated as Klappan Sequence seams E to B and Ph to C respecively. A third inferred resource area is based on three hand trenches (TRC84026, TRC84027 and TRC83060B) which expose two seams situated in a shallow, near-surface bowl in close proximity to DDH83003 (Table 7.3). No overlap was included between these two adjacent resource areas due to the lack of outcrop control and the uncertainty of the stratigraphic position of the seams exposed in the trenches.

Table 7.2
SUMMIT-NASS AREA
COAL RESOURCES
(in million tonnes)

	Measured	Indicated	Inferred	Speculative
Summit Area	-	-	35.8	2 254.0
Nass Area	-	-	--	1 706.8
Total	-	-	35.8	3 960.8

7.3 Procedures and Parameters

7.3.1 Introduction

In-situ coal resources are defined as in place coal (coal and partings) contained in seams occuring within specified limits of thickness and depth from surface. Resources are further defined through classification into "measured", "indicated", "inferred", and "speculative" categories based on the existence and relative spacing of coal seam exploration data.

The procedures for the resource calculations include standard methods utlizing geological cross-sections and maps as described in Section 7.3.2.

The Energy Mines and Resources Report ER79-9: Coal Resources and Reserves of Canada outlines guidelines for coal

Table 7.3
SUMMIT AREA INFERRED RESOURCE DATA POINTS

Data Source	Seam	Drilled Interval (m)	True Thickness (m)	Interseam True Thickness (m)	Coal (m) Coal + Rock (m)
DDH82007	E	19.19 - 23.10	3.91		2.31/3.91
				33.85	
	D	57.14 - 59.85	2.71		1.95/2.71
				21.41	
	C	81.26 - 81.71	0.45		Coal Loss
				14.85	
	B	96.56 - 97.85	1.29		0.80/1.29
DDH83003	ph	in casing	0.47*		0.47/0.47*
				27.84	
	Gu	40.30 - 42.05	1.72		1.05/1.72
				2.71	
	Gl	44.80 - 48.00	3.20		1.93/3.20
				32.59	
	F	80.59 - 82.74	2.15		Coal Loss
				4.20	
	E	86.94 - 87.16	0.22		Coal Loss
				39.79	
	D	126.95 - 128.24	1.26		1.06/1.26
				9.15	
	C	137.68 - 139.10	1.40		1.09/1.40

*Spudded into seam, unconsolidated therefore minimum thickness; average thickness in surface exposures is 0.50 m

Data Source	Seam	Drilled Interval (m)	True Thickness (m)	Interseam True Thickness (m)	Coal (m) Coal + Rock (m)
TRC84026	?		1.83+		1.63/1.83
TRC84027	?		3.32++		2.69/3.32
TRC83060	?		6.93		5.76/6.93
				1.35	
			0.68		0.68/0.68

+structurally thichened seam conservatized by 25 percent
++same seam; minimum seam thickness

resource calculations in the Cordilleran Region. These EMR parameters were modified for use in the Mount Klappan Coal Project as outlined in Section 7.3.2.

The parameters utilized for the 1985 Mount Klappan Coal Project are described in Section 7.3.3.

7.3.2 Procedures

A distribution of valid data points for each seam was established through diamond drill hole intersections and trenches. Based on maximum allowable data point spacing resources were calculated for a specific category.

Measured and indicated resource figures are derived from polygons constructed horizontally around valid data points within the resource area. To date, in the Summit Area, only inferred resources have been established due to the existence of just one data point in the resource area. In this case a horizontal circle was drawn around the data point and projected perpendicularly onto the cross-sections(s) intersecting the circles area of influence. The seam length was then measured within these limits.

In the Summit Area single diamond hole data points exist for each seam in two of the three resource areas. The third resource area is comprised of two seams based on three correlatable hand trenches. All areas have been assigned a one kilometre radius of influence.

The third dimension required for coal volume calculation after seam thickness and length have been determined is "strike length" or "influence" of the seam. This measurement usually equals the cross-section spacing if it is less than or equal to the required data point spacing for the resource category under consideration. Where a seam projects to the surface within the influence boundary the influence is measured to the point of outcrop.

To calculate coal tonnage in all categories a weight average of Mount Klappan coal quality data provided a specific gravity of 1.68 tonnes per cubic metre.

The resource calculation procedure is summarized by the following equation:

Tonnes of Coal =

Seam Thickness x Seam Length x Influence x Specific Gravity

(m) (m) (m) (mt/m^3)

Speculative resources were calculated using a sligthly different procedure. The areal extent, on the 1:50 000 Regional Geology Map (Appendix I), of the Klappan Sequence outside areas of a higher resource confidence was planimetered. The representative seam thickness applied to this area was 25 percent of the average total aggregate coal thickness from the Lost-Fox (50.21 metres) and Hobbit-Broatch (26.40 metres) Areas. This figure appears to be a reasonable estimate of the thickness of the coal-bearing section within the speculative resource area.

The previously determined specific gravity of 1.68 tonnes per cubic metre was used in the following equation summarizing speculative resource calculations.

$$\text{Tonnes of Coal} = \underset{(m^2)}{\text{Planimetered Area}} \times \underset{(m)}{9.58} \times \underset{(mt/m^3)}{1.68}$$

7.3.3 Parameters

Resource parameters described below were used throughout the property, however due to data point density only inferred and speculative resources apply directly to the Summit-Nass Area. The classification scheme is illustrated in Figure 7.1.

Seams with thicknesses greater than 0.5 metres were projected to a maximum depth of 500 metres for resource calculations.

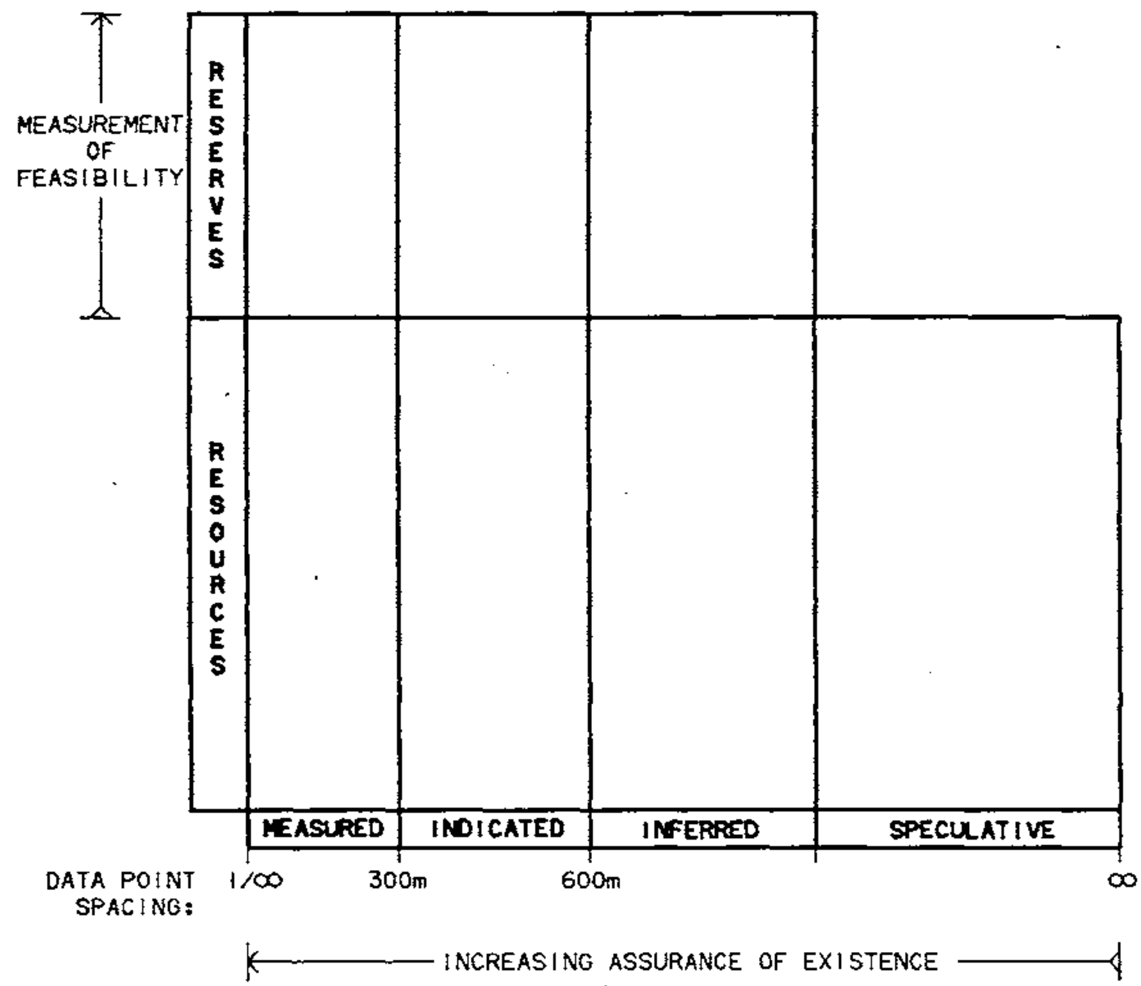
7.3.3.1 Measured Resources

Measured resources include those resources delineated through establishment of exploration data points and therefore reported with confidence as to the character and continuity of the coal seams. The maximum distance between data points, which may include adits, drill holes, trenches and outcrops, is 300 metres.

FIGURE 7.1

MOUNT KLAPPAN COAL PROPERTY

1985 RESOURCE CLASSIFICATION SCHEME



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7.3.3.2 Indicated Resources

Indicated resources include resources which are delineatd using established data points as well as reasonable geological projections. The maximum distance between data points is 600 metres.

7.3.3.3 Inferred Resources

Inferred resources include resources which are delineated utilizing regional geological data points which aid in the prediction of coal seam continuity. Report ER79-9 does not state a data point spacing for this category. For the purposes of standardization for the 1985 Mount Klappan Coal Project resource calculations, a maximum data point spacing of 2000 metres was used for the inferred level. The inferred resource summary for the Summit Area is given in Table 7.4.

Inferred resources within the Summit-Nass Resource Areas were based on seams containing 60 percent coal. Where a coal zone contained two distinct seams, thicknesses were summed.

7.3.3.4 Speculative Resources

Speculative Resources include those resources calculated from a few scattered coal occurrences in areas of little or no geologic data where the

Table 7.4
INFERRED RESOURCE DATA SUMMARY TABLE
(Seam Tonnage in Million Tonnes)

DDH82007 Resource Area

Section	5500N	6000N	Total (per seam)
Seam			
E	1.18	1.64	2.82
D	1.09	1.64	2.73
B	0.76	0.88	1.64
Total (per section)	3.03	4.16	7.31

Total Inferred Resource for DDH82007 Resource Area: **7.19 mt**

DDH83003 Resource Area

Section	9000N	95000N	10 000N	10 500N	Total (per seam)
Seam					
Ph	0.06	0.05	0.17	--	0.28
G	2.66	2.91	1.45	--	7.02
F	1.51	1.65	1.64	0.49	5.29
D	0.93	1.60	1.11	0.65	4.29
C	1.07	1.83	1.28	0.82	5.00
Total (per section)	6.23	8.04	5.65	1.96	21.88

Total Inferred Resource for DDH83003 Resource Area: **21.88 mt**

TRC84026-TRC84027-TRC83060 Resource Area

Section	9500N	10 000N	10 500N	Total (per trench)
TRC84026-TRC84027	--	1.95	0.67	2.62
TRC83060B	2.30	1.79	--	4.09
Total (per section)	2.30	3.74	0.67	6.71

Total Inferred Resource for TRC84026-TRC84027-TRC83060B Resource Area: **6.71 mt**

Summit Area Total Inferred Resource: **35.78 mt** coal-bearing sequence is interpreted to exist. There is no maximum spacing in this category.

7.4 Discussion

A comparison of 1984 and 1985 Summit Area resource figures shows a 10 percent drop in tonnage for the latter period. Several factors have contributed to this decline, all of which can be attributed to the geological reinterpretation of Summit South, based on additional detailed work completed during the 1985 exploration program. Most significantly the low angle thrust sheet, previously interpreted as lying within the resource area, introduced the correlation of two thick coal seams across the shear plane. Measurements obtained in this area the following year resulted in the replacement of the thrust with a syncline bringing the seams to the surface and making them uncorrelatable with seams 500 metres westward. The existing structural gap between these coal exposures, which caused the reduction of inferred resources, can be closed with future refinement of the Summit South geology.

8.0 COAL QUALITY

8.1 Summary

The 1985 coal quality program for the Summit-Nass Area consisted of proximate, gross calorific and sulphur analyses for ten hand trenches. Vitrinite reflectance determinations were performed on 8 of these samples (Table 8.1).

Coal quality analyses were performed by Loring Laboratories. D.E. Pearson and Associates Limited conducted coal petrology studies.

8.2 Procedures and Parameters

Accessible coal exposures greater than 0.5 metres in true thickness were trenched, logged in detail and channel sampled during the course of the routine traverse. Sample intervals were chosen from the descriptive log and reflected changes in the character of the coal seam. Substantial partings and obvious differences in coal composition were sampled individually to enable tracing of these variations throughout the seam.

Appendix I contains all of the coal quality data for the 1985 trenches.

8.3 Summit Area

Ten trenches were excavated in central Summit and Summit South to further define existing resource potential. Six seams were analysed for proximate, gross calorific and sulphur values; all of these seams underwent vitrinite reflectance studies (Table 8.2).

Table 8.1

SUMMIT-NASS AREA

TRENCH AVERAGE

COAL QUALITY SUMMARY

1985

	Nass	Summit
No. of trenches analysed	2	6
No. of analyses	2	6
Proximate analysis		
Residual Moisture (%)	5.6	7.96
Ash (%)	26.38	21.78
Volatile Matter (%)	11.98*	19.01*
Fixed Carbon (%)	56.03	53.29
Total Sulphur (%)	0.37	0.39
Gross Calorific Value (cal/gm)	20.97	49.31
Vitrinite Reflectance	4.2 *	3.3 *

* The volatile matter contents are very high due to the highly oxidized nature of the samples. Vitrinite reflectance confirms that these seams are actually of anthracite rank.

Table 8.2

SUMMIT-NASS AREA

ASH AND REFLECTANCE SUMMARY

1985

Area	Location	Ash (%)	Reflectance	Sequence
Summit	TRC85001	--	--	Klappan
	TRC85002	9.47	3.17	Klappan
	TRC85003	--	--	Klappan
	TRC85009	24.32	3.18	Klappan
	TRC85011	21.20	3.19	Klappan
	TRC85012	19.75	3.48	Klappan
	TRC85019	20.09	3.53	Klappan
	TRC85020	23.56	3.28	Klappan
Nass	TRC85010	44.91	3.80	Spatsizi
	TRC85018	7.85	4.60	Klappan

The head ash levels of Summit samples range from 19.75 to 24.32 percent with a 21.78 percent average. These ash values are artificially depressed and cannot be considered to represent the true ash content of unoxidized coal. They should not be compared with analyses of coal from drill core. One biased grab sample of high vitrain coal from part of a seam, yielded an ash of 9.47 percent but was not included in ash content averaging.

Reflectance values vary within the Summit Area but are contained within the range of 3.17 to 3.53 percent. They have been used in conjunction with macrofossil identifications and existing drill hole information as a general indicator of the stratigraphic position of coal seams. When compared with additional reflectance values from throughout the property, Summit data indicates that the seams trenched during the 1985 exploration program may lie within the middle to lower portion of the Klappan Sequence.

8.4 Nass Area

Two seams excavated in the Nass Area were analysed for proximate, gross calorific, sulphur and reflectance values (Table 8.1).

Large differences in coal composition exist between the two trenches. Coal sampled from TRC85010, which is interpreted to lie within the marine Spatsizi Sequence, is dirtier and yields a higher head ash and lower gross calorific value than TRC85018 of the Klappan Sequence.

Relectance values have not been used as a stratigraphic indicator for coal seams in the Nass Area due to the small population of values from both the Spatsizi and Malloch Sequences (refer to Appendix III Volume II of the 1984 Summit-Nass-Skeena Geological Report). Until more data is collected the normal range of reflectance values for each of these sequences can not be reliably determined.

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APPENDIX A

STATEMENT OF QUALIFICATIONS

STATEMENT OF QUALIFICATIONS

VIRGINIA L. DUFORD

P.GEOL.

This is to certify that I obtained a Bachelor of Science Degree in Geology and Chemistry at the University of Western Ontario in 1979.

My geological experience has included mineral exploration in Quebec and Ontario, and coal, oil, and gas exploration in the western provinces of Canada. I have been employed as a Geologist in the Coal Division of Gulf Canada Limited since October, 1981.

STATEMENT OF QUALIFICATIONS

KIMBERLEY A. JENNER

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

My geological experience, in chronological order, includes sedimentological studies on the Bay of Fundy, base mineral exploration in northern Nova Scotia, southern Quebec, New Brunswick and western Newfoundland, and presently coal exploration in the Bowser Basin in northwestern British Columbia.

I have been employed as a geologist with the Coal Division of Gulf Canada Limited since May 1982.

STATEMENT OF QUALIFICATIONS

SHARON MACLEOD

This is to certify that I obtained my Bachelor of Science Degree in Geology from the University of Calgary in 1985.

I have gained my geological experience through field mapping of uranium and coal in the Northwest Territories and southwest and northwest British Columbia, and by involvement in the structural analysis of the Trail Pluton and Castlegar Gneiss fault zone. I have participated in paleontological studies and coal property evaluation of Gulf's Mount Klappan leases for the past two field seasons.

APPENDIX B

LEGAL DESCRIPTION OF LICENCES

Appendix B

MOUNT KLAPPAN COAL PROJECT LICENCES
1985

Summit Area

Licence	Effective Date	Hectares	Series	Block
7171*	Dec. 31/82	140.5	104-H-7	D
7173*	Dec. 31/82	140.0	104-H-7	D
7174	Dec. 31/82	280.0	104-H-7	D
7176	Dec. 31/82	277.0	104-H-7	D
7177	Sept. 1/81	280.0	104-H-7	D
7382	Mar. 15/82	280.0	104-H-6	H
7383	Mar. 15/82	108.0	104-H-6	H
7384	Mar. 15/82	281.0	104-H-7	D
7385	Mar. 15/82	204.0	104-H-7	D
7386	Mar. 15/82	280.0	104-H-7	D
7387	Mar. 15/82	280.0	104-H-7	D
7388	Mar. 15/82	172.0	104-H-7	D
7389	Mar. 15/82	275.0	104-H-7	D
7390	Mar. 15/82	280.0	104-H-7	D
7391	Mar. 15/82	115.0	104-H-7	E
7392	Mar. 15/82	260.0	104-H-7	E
7423	Mar. 15/83	281.0	104-H-7	D
7424	Mar. 15/83	280.0	104-H-7	D
7425	Mar. 15/83	280.0	104-H-7	D
7426	Mar. 15/83	280.0	104-H-7	D
7726	Jan. 10/84	280.0	104-H-6	A
7727	Jan. 10/84	280.0	104-H-6	A
7728	Jan. 10/84	280.0	104-H-6	A
7729	Jan. 10/84	280.0	104-H-6	A
7730	Jan. 10/84	280.0	104-H-6	A

Summit Area (cont'd)

Licence	Effective Date	Hectares	Series	Block
7731	Jan. 10/84	280.0	104-H-6	A
7732	Jan. 10/84	280.0	104-H-6	A
7733	Jan. 10/84	280.0	104-H-6	A
7734	Jan. 10/84	280.0	104-H-6	A
7735	Jan. 10/84	280.0	104-H-6	G
7736	Jan. 10/84	280.0	104-H-6	G
7737	Jan. 10/84	280.0	104-H-6	G
7738	Jan. 10/84	280.0	104-H-6	G
7739	Jan. 10/84	280.0	104-H-6	G
7740	Jan. 10/84	280.0	104-H-6	G
7741	Jan. 10/84	280.0	104-H-6	G
7742	Jan. 10/84	280.0	104-H-6	G
7743	Jan. 10/84	280.0	104-H-6	G
7744	Jan. 10/84	280.0	104-H-6	G
7745	Jan. 10/84	280.0	104-H-6	G
7746	Jan. 10/84	280.0	104-H-6	H
7747	Jan. 10/84	280.0	104-H-6	H
7748	Jan. 10/84	280.0	104-H-6	H
7749	Jan. 10/84	280.0	104-H-6	H
7750	Jan. 10/84	261.0	104-H-6	H
7751	Jan. 10/84	280.0	104-H-6	H
7752	Jan. 10/84	280.0	104-H-6	H
7753	Jan. 10/84	280.0	104-H-6	H
7754	Jan. 10/84	154.0	104-H-6	H
7755	Jan. 10/84	274.0	104-H-6	H
7756	Jan. 10/84	280.0	104-H-6	D
7757	Jan. 10/84	280.0	104-H-6	D
8047	Mar. 29/85	280.0	104-H-6	A
8048	Mar. 29/85	280.0	104-H-6	A

* Licence split between Summit-Nass-Skeena and Lost-Fox Areas.

Summit Area Total Hectares = 14 142.5

Nass Area Licence	Effective Date	Hectares	Series	Block
7150	Sept. 1/81	281	104-H-2	L
7154	Sept. 1/81	281	104-H-2	L
7421	Mar. 15/83	281	104-H-2	L
7422	Mar. 15/83	281	104-H-2	L
7427	Mar. 15/83	281	104-H-3	I
7428	Mar. 15/83	281	104-H-3	I
7429	Mar. 15/83	281	104-H-3	I
7430	Mar. 15/83	281	104-H-3	I
7431	Mar. 15/83	281	104-H-3	I
7432	Mar. 15/83	281	104-H-3	I
7487	Oct. 21/82	281	104-H-3	J
7488	Oct. 21/82	281	104-H-3	J
7505	Oct. 21/82	281	104-H-3	H
7506	Oct. 21/82	281	104-H-3	H
7507	Oct. 21/82	281	104-H-3	H
7508	Oct. 21/82	281	104-H-3	H
7509	Oct. 21/82	281	104-H-3	H
7510	Oct. 21/82	281	104-H-3	H
7511	Oct. 21/82	281	104-H-3	H
7512	Oct. 21/82	281	104-H-3	I
7513	Oct. 21/82	281	104-H-3	I
7514	Oct. 21/82	281	104-H-3	I
7515	Oct. 21/82	281	104-H-3	I
7516	Oct. 21/82	281	104-H-3	I
7517	Oct. 21/82	281	104-H-3	I
7518	Oct. 21/82	281	104-H-3	I
7519	Oct. 21/82	281	104-H-3	I
7520	Oct. 21/82	281	104-H-3	I

Nass Area (cont'd)

Licence	Effective Date	Hectares	Series	Block
7521	Oct. 21/82	281	104-H-3	I
7522	Oct. 21/82	281	104-H-3	I
7523	Oct. 21/82	281	104-H-3	I
7530	Oct. 21/82	281	104-H-2	L
7531	Oct. 21/82	281	104-H-2	L
7532	Oct. 21/82	281	104-H-2	L
7533	Oct. 21/82	281	104-H-2	L
7534	Oct. 21/82	281	104-H-2	L
7535	Oct. 21/82	281	104-H-2	L
7536	Oct. 21/82	281	104-H-2	L
8032	Mar. 29/85	281	104-H-3	J
8033	Mar. 29/85	281	104-H-3	J
8034	Mar. 29/85	281	104-H-3	J
8035	Mar. 29/85	281	104-H-3	J
8036	Mar. 29/85	281	104-H-3	J
8037	Mar. 29/85	281	104-H-3	J
8038	Mar. 29/85	281	104-H-3	J
8039	Mar. 29/85	281	104-H-3	J
8040	Mar. 29/85	281	104-H-3	J
8041	Mar. 29/85	281	104-H-3	J
8042	Mar. 29/85	281	104-H-3	J
8043	Mar. 29/85	281	104-H-3	J
8044	Mar. 29/85	281	104-H-3	J
8045	Mar. 29/85	281	104-H-3	J
8046	Mar. 29/85	281	104-H-3	J
8049	Mar. 29/85	281	104-H-6	B
8050	Mar. 29/85	281	104-H-6	B
8051	Mar. 29/85	281	104-H-6	B
8052	Mar. 29/85	281	104-H-6	B
8053	Mar. 29/85	281	104-H-6	B

Nass Area Total Hectares = 16 298.0

Summit-Nass Area Total Hectares = 30 440.5

Hobbit-Broatch Area

Licence	Effective Date	Hectares	Series	Block
7118	Sept. 1/81	281	104-H-2	J
7119	Sept. 1/81	281	104-H-2	J
7120	Sept. 1/81	32	104-H-2	J
7121	Sept. 1/81	224	104-H-2	J
7122	Dec. 31/82	281	104-H-2	J
7123	Dec. 31/82	281	104-H-2	J
7124	Sept. 1/81	98	104-H-2	J
7125	Dec. 31/82	281	104-H-2	J
7126	Dec. 31/82	281	104-H-2	J
7127	Sept. 1/81	281	104-H-2	K
7128	Sept. 1/81	281	104-H-2	K
7131	Sept. 1/81	281	104-H-2	K
7132	Sept. 1/81	281	104-H-2	K
7136	Dec. 31/82	281	104-H-2	K
7137	Sept. 1/84	281	104-H-2	K
7141	Dec. 31/82	281	104-H-2	K
7142	Dec. 31/82	281	104-H-2	K
7155	Sept. 1/81	61	104-H-7	B
7156	Sept. 1/81	167	104-H-7	B
7157	Sept. 1/81	265	104-H-7	B
7158	Dec. 31/82	281	104-H-7	C
7159	Dec. 31/82	281	104-H-7	C
7163	Dec. 31/82	257	104-H-7	C
7381	Mar. 18/82	281	104-H-2	J
7416	Mar. 15/83	281	104-H-2	J
7417	Mar. 15/83	281	104-H-2	J
7418	Mar. 15/83	281	104-H-2	J
7419	Mar. 15/83	278	104-H-2	J
7420	Mar. 15/83	281	104-H-2	J
7559	June 30/83	22	104-H-7	B

Hobbit-Broatch Area (cont'd)

Licence	Effective Date	Hectares	Series	Block
7560	June 30/83	153	104-H-7	C
7723	Jan. 10/84	281	104-H-2	J
7724	Jan. 10/84	250	104-H-2	J
7725	Jan. 10/84	7	104-H-2	J

Hobbit-Broatch Area Total Hectares = 7 996.0

Lost-Fox Area

Licence	Effective Date	Hectares	Series	Block
7129	Sept. 1/81	281	104-H-2	K
7130	Sept. 1/81	281	104-H-2	K
7133	Sept. 1/81	281	104-H-2	K
7134	Sept. 1/81	281	104-H-2	K
7135	Sept. 1/81	281	104-H-2	K
7138	Sept. 1/81	281	104-H-2	K
7139	Sept. 1/81	281	104-H-2	K
7140	Dec. 31/82	281	104-H-2	K
7143	Dec. 31/82	281	104-H-2	K
7144	Dec. 31/82	281	104-H-2	K
7145	Dec. 31/82	281	104-H-2	K
7146	Sept. 1/81	281	104-H-2	L
7147	Dec. 31/82	281	104-H-2	L
7148	Sept. 1/81	281	104-H-2	L
7149	Sept. 1/81	281	104-H-2	L
7151	Dec. 31/82	281	104-H-2	L
7152	Dec. 31/82	281	104-H-2	L
7153	Sept. 1/81	281	104-H-2	L
7160	Dec. 31/82	281	104-H-7	C
7161	Dec. 31/82	281	104-H-7	C
7162	Dec. 31/82	281	104-H-7	C
7164	Dec. 31/82	280	104-H-7	C
7165	Dec. 31/82	280	104-H-7	C
7166	Dec. 31/82	280	104-H-7	C
7167	Sept. 1/81	75	104-H-7	C
7168	Sept. 1/81	142	104-H-7	C
7169	Dec. 31/82	281	104-H-7	D
7170	Dec. 31/82	281	104-H-7	D
7171*	Dec. 31/82	140.5	104-H-7	D

Lost-Fox Area (cont'd)

Licence	Effective Date	Hectares	Series	Block
7172	Dec. 31/82	280	104-H-7	D
7173*	Dec. 31/82	140	104-H-7	D
7175	Sept. 1/81	94	104-H-7	D
7527	Oct. 21/82	281	104-H-2	K
7529	Oct. 21/82	281	104-H-2	L
7561	June 30/83	21	104-H-7	C

* Licence split between Lost-Fox and Summit-Nass-Skeena Areas

Lost-Fox Area Total Hectares = 8 757.5

Skeena Area

Licence	Effective Date	Hectares	Series	Block
7489	Oct. 21/82	282	104-H-2	G
7490	Oct. 21/82	282	104-H-2	G
7491	Oct. 21/82	282	104-H-2	G
7492	Oct. 21/82	282	104-H-2	G
7493	Oct. 21/82	282	104-H-2	G
7494	Oct. 21/82	282	104-H-2	G
7495	Oct. 21/82	282	104-H-2	G
7496	Oct. 21/82	282	104-H-2	G
7497	Oct. 21/82	281	104-H-2	G
7498	Oct. 21/82	281	104-H-2	G
7499	Oct. 21/82	281	104-H-2	G
7500	Oct. 21/82	281	104-H-2	G
7501	Oct. 21/82	281	104-H-2	G
7502	Oct. 21/82	281	104-H-2	J
7503	Oct. 21/82	281	104-H-3	K
7504	Oct. 21/82	281	104-H-3	K
7524	Oct. 21/82	281	104-H-2	K
7525	Oct. 21/82	281	104-H-2	K
7526	Oct. 21/82	281	104-H-2	K
7528	Oct. 21/82	281	104-H-2	L
7537	Oct. 21/82	281	104-H-2	F
7538	Oct. 21/82	281	104-H-2	F
7539	Oct. 21/82	281	104-H-2	F
7714	Jan. 10/84	281	104-H-2	G
7715	Jan. 10/84	281	104-H-2	G
7716	Jan. 10/84	281	104-H-2	G
7717	Jan. 10/84	281	104-H-2	G
7718	Jan. 10/84	281	104-H-2	G
7719	Jan. 10/84	281	104-H-2	G

Skeena Area (cont'd)

Licence	Effective Date	Hectares	Series	Block
7720	Jan. 10/84	281	104-H-2	G
7721	Jan. 10/84	281	104-H-2	G
7722	Jan. 10/84	281	104-H-2	G

Skeena Area Total Hectares = 9 000.0

APPENDIX C

DISTRIBUTION OF WORK BY LICENCE

APPENDIX C
DISTRIBUTION OF WORK BY LICENCE
1985

TRENCH NUMBER	LICENCE NUMBER
KPNSSTRC85001	7426
KPNSNTRC85002	7757
KPNSNTRC85003	8048
KPNSNTRC85005	8047
KPNSNTRC85009	7728
KPNNRTRC85010	8043
KPNSSTRC85011	7426
KPNSSTRC85012	7426
KPNNRTRC85018	7534
KPNSNTRC85019	7726
KPNSNTRC85020	7728
KPNSNTRC85021	7727

APPENDIX D

RESOURCE DATA AND CALCULATIONS

SUMMIT AREA

INFERRED RESOURCES

SUMMIT SOUTH INFERRED RESOURCE DATA

DDH83003 RESOURCE AREA

Seam	Section	Seam Thickness	Seam Length	Influence	Specific Gravity	Million Tonnes
Ph	9000N	0.50	145	460	1.68	0.06
G		4.92	700	460	1.68	2.66
F		2.15	910	460	1.68	1.51
D		1.26	950	460	1.68	0.93
C		1.40	990	460	1.68	1.07

Total inferred resource this section: 6.23mt

Ph	9500N	0.50	125	500	1.68	0.05
G		4.92	705	500	1.68	2.91
F		2.15	915	500	1.68	1.65
D		1.26	1510	500	1.68	1.60
C		1.40	1560	500	1.68	1.83

Total inferred resource this section: 8.04mt

Ph	10000N	0.50	400	500	1.68	0.17
G		4.92	350	500	1.68	1.45
F		2.15	910	500	1.68	1.64
D		1.26	1050	500	1.68	1.11
C		1.40	1090	500	1.68	1.28

Total inferred resource this section: 5.65mt

F	10500N	2.15	400	340	1.68	0.49
D		1.26	900	340	1.68	0.65
C		1.40	1025	340	1.68	0.82

Total inferred resource this section: 1.96mt

DDH82007 RESOURCE AREA

E	6000N	3.91	500	500	1.68	1.64
D		2.71	720	500	1.68	1.64
B		1.29	810	500	1.68	0.88

Total inferred resource this section: 4.16mt

E	5500N	3.91	360	500	1.68	1.18
D		2.71	480	500	1.68	1.09
B		1.29	700	500	1.68	0.76

Total inferred resource this section: 3.03mt

TRC84026-TRC84027-TRC83060 RESOURCE AREA

TRC84026	10000N	3.32	700	500	1.68	1.95
TRC84027	10500N	3.32	240	500	1.68	0.67
TRC83060B	9500N	7.61	360	500	1.68	2.30
	10000N	7.61	280	500	1.68	1.79

Total inferred resource this area: 6.71mt

SUMMIT AREA TOTAL INFERRED RESOURCE: 35.78mt

SUMMIT-NASS AREA

SPECULATIVE RESOURCES

SUMMIT-NASS AREA SPECULATIVE RESOURCE DATA

SUMMIT AREA

Area	Planimetered Surface Area (m^2)	Aggregate Seam Thickness (m)	Specific Gravity (t/m^3)	Coal Tonnage (MT)
Summit	142270000	9.58	1.68	2 289.8
Nass	106050000	9.58	1.68	1 706.8
Total	248320000	9.58	1.68	3 996.6

APPENDIX E

LISTING OF FOSSILS

LIST OF FAUNA MACROFOSSILS FROM MOUNT KLAPPAN
1984 - 1985

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (Stelck)	COMMENTS
GD8400310A	Summit North	Lowermost Klappan Sequence [upper Spatsizi Sequence(?)]	Herzogina sp., Staffinella sp; Ostrea sp; Astarte sp. A., Astarte sp. B., Limopsis sp., Neridomus sp., Globularia sp.*, Zygopleura, turritellid snail, Camptonectes, (?) ammonite (unidentified)	Marine Association *Foraminifera
GD8400310B	Summit North	Lowermost Klappan Sequence [upper Spatsizi Sequence (?)]	Herzogina sp., Staffinella sp., belemnite (unidentified)	Marine Association
GD8400411	Summit North	Lowermost Klappan [upper Spatsizi Sequence (?)]	Staffinella sp.	Same beds as GD840310B, Same species as GD8400310A,B
GD8400506	Summit North	Lowermost Klappan [upper Spatsizi Sequence (?)]	Isocyprina trans. to Venericyprina Ostrea sp., Entolium (?), Modiolus Staffinella sp., Herzogina	Similar association as GD8400310A
GD8400510	Summit North	Lowermost Klappan - [upper Spatsizi Sequence (?)]	Modiolus sp; Ostrea sp.	Brackish water (possibly estuarial) association
GD840913	W.Nass - new leases	Spatsizi Sequence (possibly Klappan Sequence)	Buchia sp. cf. B. mosquensis, Entolium sp. Eocalista sp., Epilucina sp.	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (Stelck)	COMMENTS
GD8423060A (or OTC8405)	Spatsizi Park	Uppermost Spatsizi Sequence	Paratancredia (?), Laevidentalium, Astarte sp., Glycimerid indet., Staffinella sp., turritellid gastropod	Similar association as SM84009
GD842407	Summit NW-just off property	Spatsizi Sequence	Acesta (?) sp. A., Hypoxytoma sp., Buchia concentrica var. erringtoni	Similar association as SM8400401 and KJ8400806
GD842420B	Summit NW-just off property	Spatsizi Sequence	Acesta sp. B	
GD842422	Summit NW-just off property	Spatsizi Sequence	Fragment of Lytoceratid ammonite	
SM830101A, B	Repeater Ridge	Spatsizi-Klappan Boundary Region	Oxytoma inequivaluis, Camptonectes sp., Pleuromya sp., Pleuromya subcompressa	Shallow marine association showing very little hint of lessening of salinity
SM831819A	Summit North	Lower Klappan Sequence (?)	Acesta, Entolium sp., Ostrea Gryphaea?), Corbula	
SM831819B	Summit North	Lower Klappan Sequence (?)	Plagiostoma, Monotid, Pteria sp., Mactra (?)	
SR5	Spatsizi Park east; same ridge as SR6	Spatsizi Sequence	Pleuromya sp., Quenstedtia aff. Q. ferniensis, Pseudobolus, Belemnopsis sulcatus trans. to absolutus	Same belemnite species as GD8400118

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (Stelck)	COMMENTS
SR6	Spatsizi Park east side; same ridge as SR5 and SR7	Spatsizi Sequence	Venericyprina, Pleuromya, Astarte, Ostrea?, or Gryphaea, Limopsis, Myrene	Reduced salinity
SR7	Spatsizi Park east side; same ridge as SR5 and SR6	Spatsizi Sequence	Laevitrigonia sp. C, Laevitrigonia sp. A aff. L. gibbosa, Ibotrigonia sp. B, Herzogina sp., Buchia fischeriana, Lucinid indet., Ostrea(?), Astarte(?)	Herzogina sp. same as GD840310A,B
JT8400511F	Between Knooph Hill and Mt. Klappan	Uppermost coal-bearing Klappan Sequence	Ferganoconcha	Fresh water
TRC8360	Summit South	Middle Klappan Sequence	Eocallista sp. cf. E. regularis	
GD84001-18	Spatsizi Park	Upper Spatsizi Sequence	Belemnopsis sp. cf. B. sulcata	Same as SR5
GD84001-18	Spatsizi Park	Upper Spatsizi Sequence	Laevitrigonia sp. A aff. L. gibbosa, Hypoxytoma	Same as SR7
ES840403	NE Nass	Lower Klappan Sequence	Anopaea, Isocyprina sp.	
OTC8405A (or GD8423)	Spatsizi Park	Upper Spatsizi	Astarte sp., Dentalium sp., Limopsis sp.	
GS840702	NE of Didene Creek	Middle Klappan Sequence	Ferganoconcha sp.	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (Stelck)	COMMENTS
KJ8400806	Lost Ridge-E end	Klappan Sequence in vicinity of P seam	*Acesta* (?) sp. B	
DDH84004	Hobbit-Broatch	Mid Klappan Sequence between Seams F and H	*Ferganoconcha* sp.	
SM8400401	Summit North W. end near BCR, above "G seam"	Lower-middle Klappan Sequence	*Somapecten* sp., *Acesta* sp. A	Same as GD842407 and KJ840406
SM840916	Summit North	Lower-middle Klappan; lower than SM840401	*Pleuromya* sp., *Laevitrigonia* sp. cf. A aff. *L. gibbosa*, *Laevidentalium* sp., *Herzogina*	*Laevitrigonia* species same as SR7; *Herzogina* species same as GD8400310A
SM8401006	Nass just N of new leases	Spatsizi Sequence	*Laevitrigonia* sp. A. aff. *L. gibbosa*	Same as SR7 and SM8400916
SR4	--	--	*Laevitrigonia* sp. A. aff. *L. gibbosa*	Same as SR7 and SM8400916

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM0515106	Summit North; Layton Ridge	Lower-middle Klappan Sequence	Ostrea (?)	
SM851206	Horseshoe Ck.; Nass	Klappan Sequence	Bivalves - 3-5 species, unidentified	
SM852304	Summit North; Marshall Ridge N. Face	Middle-lower Klappan Sequence	Bivalves, unidentified	
KG850205	Summit South	Middle Klappan Sequence	Bivalves, unidentified	
SM852402	Summit North; Valley N of Layton Ridge	Middle-lower Klappan Sequence	Helminthopsis	Trace fossil
SM852301	Summit North; Marshall Ridge	Middle-lower Klappan Sequence	Helminthopsis, Scolithos	Trace fossils
SM8530	Summit South	Middle-lower Klappan Sequence	Helminthopsis	Trace fossil
SM863101-04	Dante Creek, Summit South	Lower Klappan Sequence	Bivalves (unidentified), horizontal worm burrow	
OTC84003	Summit North; Marshall Ridge	Middle-lower Klappan Sequence	Belemnopsis	Cross-section only of belemnite

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM8532106	Summit North; Layton ridge	Middle-lower Klappan Sequence	Vertical and angular burrows (unidentified), bivalves (unidentified)	
KJ85011-2	Just W of Spatsizi River	Spatsizi - Klappan Boundary area	*Helminthopsis*	Trace fossil
KF8521	Ridge W of Helm Creek	Klappan - Spatsizi Boundary area	*Belemnopsis*, bivalves (unidentified)	
KF852301-09	W Nass, north of Klappan River	Spatsizi Sequence	Bivalves; unidentified	
KJ85007-1 (OTC8508)	Spatsizi Park	Upper Spatsizi Sequence	Bivalves; unidentified	
KJ85010-3	Spatsizi Park W of Butler Creek	Uppermost Spatsizi-Lower Klappan Sequence	Bivalves; unidentified	Occurs with plant hash
KJ85021-2	Summit North	Uppermost Spatsizi - lower Klappan Sequence	*Ostrea*, *Staffinella*, other unidentified bivalves	
KJ85016-1	Above Helm Creek in NW Nass	Klappan Sequence	*Belemnopsis*	Belemnite
KJ85015-1	Kay Ridge; Just N of Nass licences	Upper Spatsizi - lower Klappan Sequence	*Helminthopsis*, bivalves (unidentified)	Occurs with minor coalified plant material

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
KJ85010-2 (OTC85009)	Spatsizi Park; Ridge W of Butler Creek	Uppermost Spatsizi - lower Klappan Sequence	Belemnopsis	Belemnite
KJ85003-1 (OTC85003)	Spatsizi Park	Spatsizi Sequence	Helminthopsis	Trace fossil
KJ85003-2	Spatsizi Park	Spatsizi Sequence	Helminthopsis	Trace fossil
SM852303	Summit North	Middle - lower Klappan Sequence	Belemnopsis	Belemnite
SM852304	Summit North	Middle - lower Klappan Sequence	Bivalves, unidentified	
GD840118	Spatsizi Park	Spatsizi Sequence	Belemnopsis	Belemnite
GD840508	Summit North	Klappan (?) Sequence	Bivalves, unidentified	
GD840907	NW Nass, N of Klappan River	Klappan (?) Sequence	Bivalves, unidentified	
GD840924	NW Nass, N of Klappan River	Klappan (?) Sequence	Diplocraterion, Skolithos	Trace fossils
GD841108	Skeena Area	Malloch Sequence	Bivalves, unidentified	
GD841704	Skeena Area	Malloch Sequence	Skolithos burrow	Trace fossil

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
GS840702	Didene Creek	Middle (?) Klappan Sequence	Bivalves, unidentified	
SM842701	Summit North just N of Layton Ridge	Lower-middle Klappan Sequence	Bivalves, unidentified	
OTC8401	Summit North	Middle-lower Klappan Sequence	Bivalves, unidentified	
OTC8405	Spatsizi Park	Spatsizi-Klappan Boundary region	Belemnopsis, bivalves (un-identified)	Belemnite
KJ840806	Lost Ridge	Middle Klappan Sequence	Bivalves, unidentified	
SM841116	W. Nass	Klappan Sequence	Bivalves, unidentified	

LIST OF PLANT MACROFOSSILS FROM MOUNT KLAPPAN
1984 - 1985

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
DDH84006	Lost Ridge top box 50, 116 m from top	Zone I in middle Klappan Sequence - between I seam and bentonite	*Sphenopteris brulensis*, *Nilssonia* cf. *tenuicaulis*	
DDH84005	Lost Ridge box 16, 32-33m from top	Below G ph and above Gu seam in mid Klappan Sequence	*Czekanowskia* cf. *rigida*	
SM85001	Mt. Klappan	Malloch Sequence about 300 m from contact	*Cladophlebis virginiensis martiniana*, *Ginkgo nana*, *Nilssonia* sp., *Pityophyllum nordenskioldii*	same location as SR1
SM85002	Lost Ridge W end	Klappan Sequence above seam F	*Nilssonia* cf. *tenuicaulis*, *Pityophyllum nordenskioldii*, *Czekanowskia* cf. *rigida*, *Pterophyllum rectangulare* *Nilssonia nigracollensis*	
OTC85001	Lost Ridge hogbacks	Klappan Sequence below seam J	*Czekanowskia* cf. *rigida*, *Pterophyllum rectangulare*, *Baiera* cf. *furcata*, *Cladophlebis virginiensis*	
SM8500201 (OTC 85002)	Lost Ridge	Klappan Sequence between seams I & J	*Sphenopteris brulensis*, *Nilssonia* sp., *Czekanowskia* cf. *rigida*	

*See accompanying map KPN85004 for fossil locations.

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM8500303	Lost Ridge W end	Below I seam in middle Klappan Sequence	Nilssonia sp. A., Baiera cf. furcata, Czekanowskia cf. rigida	
SM8500401 (OTC85004)	Knooph Hill top	Malloch within 200 - 300 m (true thickness) of Klappan content	Nilssonia sp., Cladophlebis virginiensis, Czekanowskia cf. rigida, Ginkgo nana, Pityophyllum nordenskioldii, Pterophyllum rectangulare	
SM85005 (OTC85005)	Knooph Hill front face, E end	Malloch Sequence (?)	Unidentified species (cf. Podozamites), Cladophlebis virginiensis, Czekanowskia cf. rigida, Ginkgo, cf. lepida, Pterophyllum rectangulare, Nilssonia schaumbergensis, Baiera cf. furcata	
SM850901	Knooph Hill beds correlat-eable with OTC 85004	Malloch Sequence	Czekanowskia cf. rigida*, Pterophyllum rectangulare*, Cladophlebis virginiensis**, Nilssonia schaumbergensis*, Pityophyllum nordenskioldii	*Abundant **Just downsection
SM850906	Broatch Creek before anti-cline closest to Knooph Hill; above coal	Lower Malloch Sequence	Ginkgo nana, Baiera cf. furcata, Pterophyllum rectangulare, Cladophlebis virginiensis	
SM85011	Horseshoe Ridge	Middle Malloch Sequence	Baiera, cf. furcata, Nilssonia, nigracollensis*, Czekanowskia cf. rigida, Cladophlebis virginiensis martiniana	*Very abundant; Nilssonia nigracollensis abundance decreases and Cladophlebis virginiensis increases down section
SM850903	Knooph Hill beds laterally equivalent to OTC85005	Lower-middle Malloch Sequence	Cladophlebis virginiensis, Czekanowskia cf. rigida, Pterophyllum rectangulare	All abundant

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM8505 (OTC85005)	Knooph Hill just below OTC85004	Mid-lower Malloch Sequence	Cladophlebis virginiensis,* Czekanowskia cf. rigida* Podozamites*, Ginkgo cf. lepida,* Pterophyllum rectangulare, Nilssonia schaumbergensis	*Abundant throughout, particularily C cf. rigida
SM850904	Broatch Creek just down-section from OTC85005	Lower Malloch Sequence	Podozamites cf. lanceolatus, Czekanowskia cf. rigida Cladophlebis virginiensis	
SM851001	Broatch Creek about 230 m down creek	Lowermost Malloch Sequence	Ginkgo nana*, Baiera furcata	*Abundant
SM851002	Broatch Creek ESE of hog-backs on E side of creek	Lower Malloch Sequence	Ginkgo nana, Baiera furcata, Czekanowskia cf. rigida	
SM851004	Broatch Creek just down-section from SM851002	Lower Malloch Sequence	Nilssonia canadensis, Czekanowskia cf. rigida, Podozamites cf. lanceolatus, Pterophyllum rectangulare	
SM851101	Tahtsedle Ck. area near Horseshoe Ridge	Lower-middle Malloch Sequence	Czekanowskia cf. rigida, Ginkgo nana	Both abundant
SM851102	Tahtsedle Ck. just down-section from last location	Lower-middle Malloch Sequence	Czekanowskia cf. rigida, Ginkgo nana, Nilssonia nigracollensis	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM851103	Tahtsedle Ck. Horseshoe Ridge area	Lower-middle Malloch Sequence down section from SM851102	Baiera gracilis, Cladophlebis virginiensis, Nilssonia nigracollensis, Czekanowskia cf. rigida	Decrease in mudstone and siltstone downsection and plants associated with them; Cladophlebis virginiensis becomes one of a few species found in abundance
SM851304 (TRC85018)	Horseshoe Ck. Tahtsedle Ck. area	Klappan Sequence	Nilssonia tenuicaulis	
SM8515	Summit North Marshall Ridge	Lower-middle Klappan Sequence	Cladophlebis virginiensis*, Nilssonia canadensis*, Pityophyllum nordenskioldii	*Minor
SM851601 SM851608	Summit North Layton Ridge	Middle Klappan Sequence - underlying TRC83049	Nilssonia tenuicaulis	overall very few plant fossils in this portion of the middle Klappan Sequence - abundant bivalves (unidentified) present
SM851806	Lost Ridge Haul Road South of Survey Pt 2971	Middle Klappan Sequence near coaster zone	Ginkgo nana	
SM851903	Lost Ridge Haul Road just above TRC85029	Middle Klappan Sequence near G seam	Czekanowskia cf. rigida, Nilssonia schaumbergensis, Pityophyllum nordenskioldii	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM852403	Summit North; valley below facing BCR	Middle-lower Klappan Sequence	Czekanowskia cf. rigida, Pityophyllum nordenskioldii	
SM852404	Summit North Valley below facing BCR	Middle-lower Klappan Sequence	Ginkgo nana (?)	Very large
SM852407	Summit North Valley below facing BCR	Middle-lower Klappan Sequence	Nilssonia tenuicaulis, Nilssonia schaumbergensis	
SM8527	Summit South N of DDH82002	Middle-lower Klappan Sequence	Nilssonia tenuicaulis	
SM852803	Summit South Tiger striped unit overlying coal in TRC 83052	Middle-lower Klappan Sequence	Nilssonia schaumbergensis, Czekanowskia cf. rigida, Nilssonia tenuicaulis	
SM8532	Repeater Ridge Summit North	Lowermost Klappan Sequence	Nilssonia tenuicaulis, Nilssonia schaumbergensis, Cladophlebis virginiensis	Occurs with abundant bivalves (unidentified) and Helminthopsis
SM8533 (OTC85018)	SW Nass, Ripple Creek	Upper Klappan - Lower Malloch Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis fisheri*, Sphenopteris cf. brulensis, Pterophyllum rectangulare, Baiera gracilis	*Minor - latter 5 species minor and exist only at bottom of section

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
OTC85014	Lost Ridge	Upper Klappan Sequence - probably around O seam	Sphenopteris cf. brulensis, Nilssonia schaumbergensis*, Nilssonia tenuicaulis+, Pityophyllum nordenskioldii*, Baiera furcata, Podozamites cf. lanceolatus, Ctenis borealis	*Abundant +Very abundant also associated with 2 beds of bivalves and Helminthopsis
SM85340307	SW Nass-outside of licences	Lower Rhondda Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis	Overall very few plants; C. cf. rigida increases downsection
SM842905A, D SM842906	Summit South	Middle Klappan Sequence	Ginkgo nana, Cladophlebis virginiensis martiniana, Cladophlebis virginiensis acuta Nilssonia sp.	
SD840107	--	--	Cladophlebis virginiensis	
SD840202	Tahtsedle Ck. area	Middle Malloch Sequence	Nilssonia nigracollensis	
SD840301	--	--	Cladophlebis virginiensis	
SD841001	--	--	Nilssonia sp., Nilssonia brongniarti, Czekanowskia cf. rigida	
SM843202A SM843202E	Summit North	Lower-middle Klappan Sequence	Nilssonia sp. Nilssonia brongniarti	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM840916	S Nass Area	Malloch Sequence	Czekanowskia cf. rigida, Podozamites cf. lanceolatus	
SM842703	Summit North just W of Marshall and Layton Ridges	Lower-middle Klappan Sequence	Cladophlebis virginiensis	
SM853301	SW Nass-off leases; Ripple Creek	Upper Klappan - lower Malloch Sequence	Czekanowskia cf. rigida	
SM853302	SW Nass-off leases; Ripple Creek	Upper Klappan - lower Malloch Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis	
SM853303	SW Nass-off leases; Ripple Creek	Upper Klappan - lower Malloch Sequence	Czekanowskia cf. rigida, Sphenopteris cf. brulensis, Cladophlebis virginiensis, Baiera cf. gracilis, Nilssonia schaumbergensis, Pterophyllum rectangulare	
SM853402	SW Nass-off leases	Lower Rhondda Sequence	Czekanowskia cf. rigida	Minor
SM853404	SW Nass-off leases	Lower Rhondda Sequence	Cladophlebis virginiensis	Minor
SM853407	SW Nass-off leases	Lower Rhondda Sequence	Czekanowskia cf. rigida	
SM851304	Tahtsedle Ck. area, Horseshoe Creek	Klappan Sequence	Nilssonia tenuicaulis	
SM850501	Knooph Hill; cirque N face	Lower Malloch Sequence	Cladophlebis virginiensis, Czekanowskia cf. rigida, Podozamites cf. lanceolatus, Ginkgo cf. lepida, Pterophyllum rectangulare	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM850514	Knooph Hill - cirque N face	Lower Malloch Sequence	Cladophlebis virginiensis, Czekanowskia cf. rigida	
SM850519	Knooph Hill - cirque N face	Lower Malloch Sequence	Cladophlebis virginiensis, Czekanowskia cf. rigida	
SM850522	Knooph Hill - cirque N face	Lower Malloch Sequence	Nilssonia schaumbergensis	
SM850901	Broatch Creek	Lower Malloch-upper Klappan Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis, Pityophyllum nordenskioldii	All abundant
SM850902 SM850903	Broatch Creek	Lower Malloch-upper Klappan Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis Nilssonia schaumbergensis	
SM850904	Broatch Creek	Lower Malloch-upper Klappan Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis, Pterophyllum rectangulare, Podozamites cf. lanceolatus	
SM850905	Broatch Creek	Lower Malloch-upper Klappan Sequence	Ginkgo nana, Baiera furcata	
SM851001	Broatch Creek	Lower Malloch-upper Klappan Sequence	Ginkgo nana, Baiera furcata	
SM851002	Broatch Creek	Lower Malloch-upper Klappan Sequence	Ginkgo nana, Baiera furcata Czekanowskia cf. rigida	
SM851003	Broatch Creek	Lower Malloch-upper Klappan Sequence	Ginkgo nana, Baiera furcata Czekanowskia cf. rigida	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
SM851004	Broatch Creek	Lower Malloch-upper Klappan Sequence	*Nilssonia canadensis*, *Czekanowskia* cf. *rigida*, *Podozamites* cf. *lanceolatus*, *Pterophyllum rectangulare*	
SM851005	Broatch Creek	Lower Malloch-upper Klappan Sequence	*Ginkgo nana*, *Baiera* cf. *furcata*	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
JT85A	Lost Ridge - front E slope	Upper Klappan Sequence around M seam	Pityophyllum nordenskioldii, Nilssonia canadensis, Nilssonia nigracollensis, Ginkgo nana, Sphenopteris cf. brulensis, Podozamites cf. lanceolatus, Nilssonia schaumbergensis, Nilssonia tenuicaulis, Pterophyllum rectangulare	Occurs with abundant bivalves (unidentified)
JT85001	Lost Ridge	Klappan Sequence around seam N	Cladophlebis virginiensis fisheri	
JT8502 (July 2)	Lost Ridge DDH85003	Klappan Sequence overlying K seam by 10-20m	Pityophyllum nordenskioldii, Nilssonia sp., Czekanowskia cf. rigida, Ginkgo nana, Sphenopteris cf. brulensis	
JT85B	Lost Ridge Middle-west end	Klappan Sequence just below G seam	Sphenopteris cf. brulensis, Cladophlebis virginiensis, Nilssonia canadensis, Pterophyllum rectangulare, Pityophyllum nordenskioldii	
JT8507	Lost Ridge near Sc19	Klappan Sequence near J seam	Sphenopteris cf. brulensis, Pterophyllum rectangulare	
JT843605A,C	Mt. Klappan	Klappan Sequence	Nilssonia tenuicaulis, Cladophlebis virginiensis	
JT850511F	Knooph Hill	Klappan Sequence	Nilssonia tennuicaulis	
JT84LRA JT84LRB	Lost Ridge	Klappan Sequence	Nilssonia schaumbergensis Nilssonia brongniarti	
JT842501	Lost Ridge	Klappan Sequence	Ginkgo nana	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
JT844004	Lost Ridge	Middle Klappan Sequence	*Baiera* sp.	
MB85001	Lost Ridge E side	Klappan Sequence between seams K and M	*Ginkgo pluripartita*	
MB85001	Lost Ridge E side	Klappan Sequence slightly above N seam	*Nilssonia* sp.	
BL8401	N of Grizzly Creek	Malloch Sequence	*Ctenis borealis*	
KJ85013-2	Beirnes Ridge	Middle-lower Malloch Sequence	*Nilssonia nigracollensis*, *Ctenis borealis*, *Czekanowskia* cf. *rigida*, *Nilssonia schaumbergensis*, *Cladophlebis virginiensis fisheri*, *Baiera furcata*, *Sphenopteris* cf. *brulensis*	
KJ85026-1	Caribou Ridge	Middle-upper Malloch Sequence	*Czekanowskia* cf. *rigida*, *Podozamites* cf. *lanceolatus*, *Cladophlebis virginiensis martiniana*, *Cladophlebis virginiensis acuta*, *Pityophyllum nordenskioldii*	
KJ85027-1	Ridge W of Nass Lake	Middle-upper Malloch Sequence	*Czekanowskia* cf. *rigida*, *Pityophyllum nordenskioldii*, *Cladophlebis virginiensis acuta*, *Ginkgo nana*, *Cladophlebis virginiensis martiniana*, **Nilssonia canadensis*	*Very large
KJ841403	Knooph Hill	Lower Malloch Sequence	*Cladophlebis virginiensis*, *Sphenopteris brulensis*	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
KJ85028-1 (OTC85017)	Rhondda Ridge SW Nass-off leases	Uppermost Malloch Sequence - lower Rhondda	*Nilssonia canadensis*, *Pityophyllum nordenskioldii*, ***Podozamites* cf. *lanceolatus*; **Czekanowskia* cf. *rigida*, *Equisetites lyelli* stem, *Cladophlebis virginiensis martiniana*	*Very abundant **increases downsection
KJ85025-1	Maritime Mountain	Malloch Sequence	*Czekanowskia* cf. *rigida*	
KJ85025-3	Maritime Mountain	Malloch Sequence	*Cladophlebis virginiensis*	
KJ85014-1	Caribou Ridge	Lower Malloch Sequence Close to Klappan Contact	*Sphenopteris* cf. *brulensis*	
KJ85007-2	Spatsizi Park	Spatsizi-Klappan Boundary Area	*Nilssonia* sp., *Pityophyllum nordenskioldii*	
KJ85011-3 (OTC85010)	Just W of Spatsizi River	Spatsizi-Klappan Boundary Area	*Pityophyllum nordenskioldii*, *Nilssonia nigracollensis*, *Ginkgo nana*	
KJ85009-1	Spatsizi Park; ridge E of Butler Creek	Spatsizi-Klappan Boundary Area	*Pterophyllum rectangulare*	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
KJ85014-1	Caribou Ridge	Mid-lower Malloch Sequence	Czekanowskia cf. rigida	
KJT2404-G	E end of Lost Ridge	Klappan Sequence	Coniopteri (?), Ptilophyllum articum (?)	
KJ85029-1	Ski Ridge SW Nass	Middle-lower Malloch Sequence	Czekanowskia cf. rigida	
KJ85029-2	Ski Ridge SW Nass	Middle-lower Malloch Sequence	Czekanowskia cf. rigida	
KJ85029-3	Ski Ridge SW Nass	Middle-lower Malloch Sequence	Czekanowskia cf. rigida, Podozamites cf. lanceolatus, Cladophlebis virginiensis	
KJ85029-4	Ski Ridge SW Nass	Middle-lower Malloch Sequence	Czekanowskia cf. rigida, Pityophyllum nrdenskioldii Cladophlebis virginiensis	
KJ85029-5	Ski Ridge SW Nass	Middle-lower Malloch Sequence	Ginkgo nana	
KJ85029-6	Ski Ridge SW Ridge	Middle-lower Malloch Sequence	Podozamites cf. lanceolatus	
KJ85026-3	E Nass-W of Horseshoe Ridge	Malloch Sequence	Czekanowskia cf. rigida, Podozamites cf. lanceolatus	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
KJ85026-4	E Nass-W of Horseshoe Ridge	Malloch Sequence	Cladophlebis virginiensis martiniana	
KJ85062-5	E Nass-W of Horseshoe Ridge	Malloch Sequence	Cladophlebis virginiensis acuta, Pityophyllum nordenskioldii, Czekanowskia cf. rigida, Pterophyllum rectangulare	
KJ85027-5	W Nass, outside of leases	Malloch Sequence	Czekanowskia cf. rigida, Cladophlebis virginiensis, Nilssonia canadensis, Pityophyllum nordenskioldii	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
LS850210-11	S Nass Area outside of leases	Middle (?) Malloch Sequence	*Cladophlebis virginiensis martiniana*, *Czekanowskia* cf. *rigida*, *Podozamites* cf. *lanceolatus*	Minor
LS840110	SE Nass Area just W of Nass Lake, outside of lease boundary	Middle Malloch Sequence	*Czekanowskia* cf. *rigida*, *Nilssonia brongniarti*, *Podozamites* cf. *lanceolatus*, *Pityophyllum* cf. *nordenskioldii*, *Pterophyllum rectangluare*, *Cladophlebis virgeniensis fisheri*, *Cladophlebis virginiensis acuta*, *Nilssonia tenuicaulis*	
LS840107	S Nass Area just S of lease boundary	Middle Malloch Sequence	*Cladophlebis virginiensis*, *Ginkgo nana*	
LS850210	S Nass Area just S of lease boundary	Malloch Sequence	*Cladophlebis virginiensis martiniana*	
LS850211	S Nass Area just S of lease boundary	Malloch Sequence	*Czekanowskia* cf. *rigida*, *Podozamites* cf. *lanceolatus*	
BB850502	W Nass, outside of leases	Malloch Sequence	*Czekanowskia* cf. *rigida*	
BB850504	W Nass, outside of leases	Malloch Sequence	*Podozamites* cf. *lanceolatus*, *Czekanowskia* cf. *rigida*	
GD8413B12/13	Ellis Ridge	Malloch Sequence	*Cladophlebis virginiensis fisheri*, *Czekanowskia* cf. *rigida*	
GD840202	Spatsizi Park	Spatsizi-Klappan Boundary Zone	*Cladophlebis virginiensis martiniana*	
D842201-09	Horsehoe Ridge Area	Malloch Sequence	*Cladophlebis virginiensis*	

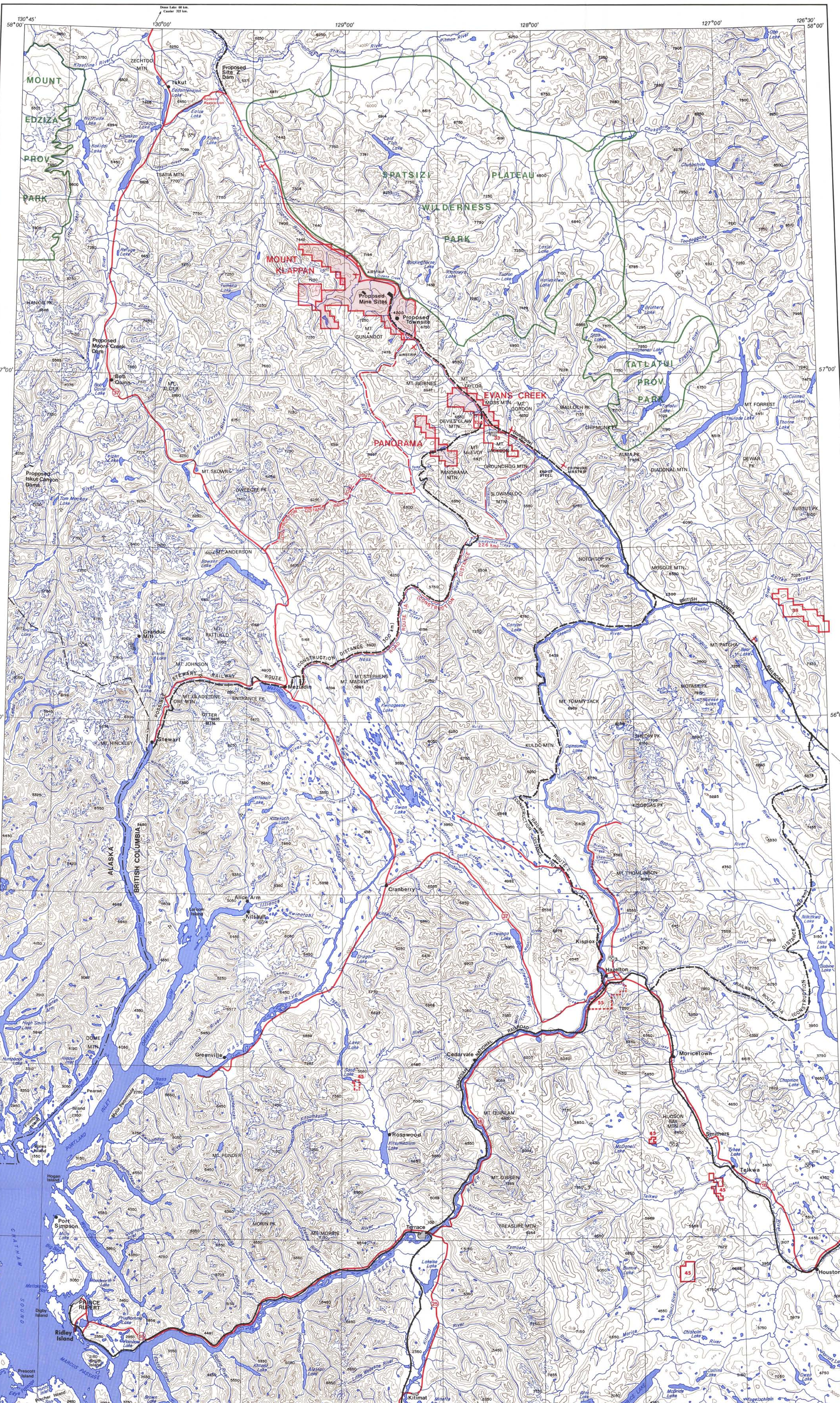
SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
GD841914	Skeena, just W of lease boundary	Rhondda Sequence	Czekanowskia cf. rigida	
GD841919	Skeena, just W of lease boundary	Rhondda Sequence	Nilssonia nigracollensis, Cladophlebsis virginiensis Pityophyllum nordenskioldii	
GD841925	Skeena, just W of lease boundary	Rhondda Sequence	Cladophlebis virginiensis	
GD841007	Nass	Klappan Sequence	Cladophlebis virginiensis	
GD841615	Nass	Klappan Sequence	Ginkgo nana	
GD840712	Close to Ellis Ridge	Malloch Sequence	Pityophyllum nordenskioldii	
GD8413/12A	Ellis Ridge Area	Malloch Sequence	Ginkgo nana	
GD842309	Spatsizi Park	Spatsizi-Klappan boundary zone	Ginkgo nana	
ES840101	W Nass-Klappan River Area	Klappan Sequence	Nilssonia nigracollensis	
ES840214	W Nass-just off leases	Malloch Sequence	Czekanowskia cf. rigida	
ES840215	W Nass-just off leases	Malloch Sequence	Ctenis borealis	
ES840201	W Nass-just off leases	Malloch Sequence	Cladophlebis virginiensis fisheri	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
ES840301	Ridge E of Nass Lake	Upper Klappan-close to Malloch boundary	Nilssonia nigracollensis	
ES840403	Nass	Klappan Sequence	Cladophlebis virginiensis	
ES841110 ES841102	N. Nass, just N of new leases	Klappan (?) Sequence	Pityophyllum nordenskioldii Baiera furcata, Ginkgo nana	
ES841701 ES841702 ES841703 ES841704 ES841706	Horseshoe Ridge-E Nass	Middle Malloch Sequence	Ginkgo nana Nilssonia canadensis, Ginkgo nana Nilssonia nigracollensis Czekanowskia cf. rigida Nilssonia nigracollensis Nilssonia nigracollensis	
ES841601 ES841602 ES841603	W Nass, just S of lease boundary	Malloch Sequence	Cladophlebis virginiensis martiniana, Ginkgo nana Cladophlebis virginiensis acuta Cladophlebis virginiensis acuta	
ES842103	E Nass, N of Horseshoe Ridge	Klappan Sequence	Ginkgo nana	
ES842501	E Nass, N of Horseshoe Ridge	Klappan Sequence	Cladophlebis virginiensis fisheri, Pterophyllum rectangulare	
ES842701	E Nass, N of Horseshoe Ridge	Klappan Sequence	Nilssonia nigracollensis	

SPECIMEN NUMBER	LOCATION	STRATIGRAPHIC POSITION	IDENTIFICATION (MacLeod)	COMMENTS
ES84270203	E Nass, N of Horseshoe Ridge	Klappan Sequence	Nilssonia brongniarti, Pterophyllum rectangulare	
SF840214	Horseshoe Ridge	Malloch Sequence	Pterophyllum rectangulare, Baiera cf. furcata, Czekanowskia cf. rigida	
SF840215	Nass Area		Ctenis borealis	
SR2	Mt. Klappan	Malloch Sequence	Nilssonia canadensis, Pitophyllum nordenskioldii, Pterophyllum rectangulare	
SF8403	Mt. Klappan	Malloch Sequence	Ctenis borealis	

APPENDIX F

1:500 000 NORTHWESTERN BRITISH COLUMBIA MAP



Produced jointly by GULF CANADA DRAFTING DEPT. and HARDY ASSOC. (1978) LTD., MAPPING SECTION.

Revised to June, 1984

LEGEND

- Highway
- Road, possible
- Road, alternate
- Railway
- Possible Railway Route
- Proposed Dam Site
- Proposed Pits, Mt. Klappan property
- Proposed Townsite, Mt. Klappan property
- Boundary, Park or Reserve
- Boundary, International
- Spot Elevation (feet above sea level) · 6750
- Contours (1000 Foot Interval) 2000
- Mine (see separate list) 4
- Prospect
- City, Town

COAL PROPERTIES

- GULF CANADA RESOURCES INC.
- 33 SUNCOR INC.
- 134 GROUNDHOG COAL LTD.
- 45 SHELL CANADA RESOURCES LTD.
- 55 D. GROOT LOGGING LTD.
- COAL LICENCES UNDER APPLICATION

MINES

1 DOME MOUNTAIN — Ag, Pb, Zn
2 DUTHIE — Ag, Pb, Zn, Au, Cd, Cu
3 SILVER STANDARD — Ag, Pb, Zn, Au, Cu
4 KITSAULT — Mo
5 SCOTTIE GOLD — Au, Ag
6 GRANDUC — Cu, Ag, Au
7 BAKER – Au, Ag

GULF CANADA RESOURCES INC.

NORTHWEST BRITISH COLUMBIA

SCALE 1: 500,000

Kilometres 10 5 0 10 20 30 40 50 Kilometres
Miles 5 0 10 20 30 Miles

REFERENCE NOTE

Mines: from The Northwest Region — B.C. Regional Economic Study, 1982.

Prospects: from Kitimat-Stikine Regional District — 1:500,000 Regional Resource Map, 1981.

Base Map: from Dept. of Energy, Mines and Resources, Surveys and Mapping Branch, current N.T.S. series maps.

KEY MAP

706

GR - MT. KLAPPAN 85A
SUMMIT - NASS AREA
CONFIDENTIAL
REFLECTANCE DATA
FROM APPENDIX I
(COAL TRENCH DATA AND COAL QUALITY DATA)

~~CONFIDENTIAL~~

706

1985 SUMMIT

AREA TRENCHES

~~CONFIDENTIAL~~

GULF CANADA RESOURCES LIMITED
Sample 8001

BASIC STATISTICS

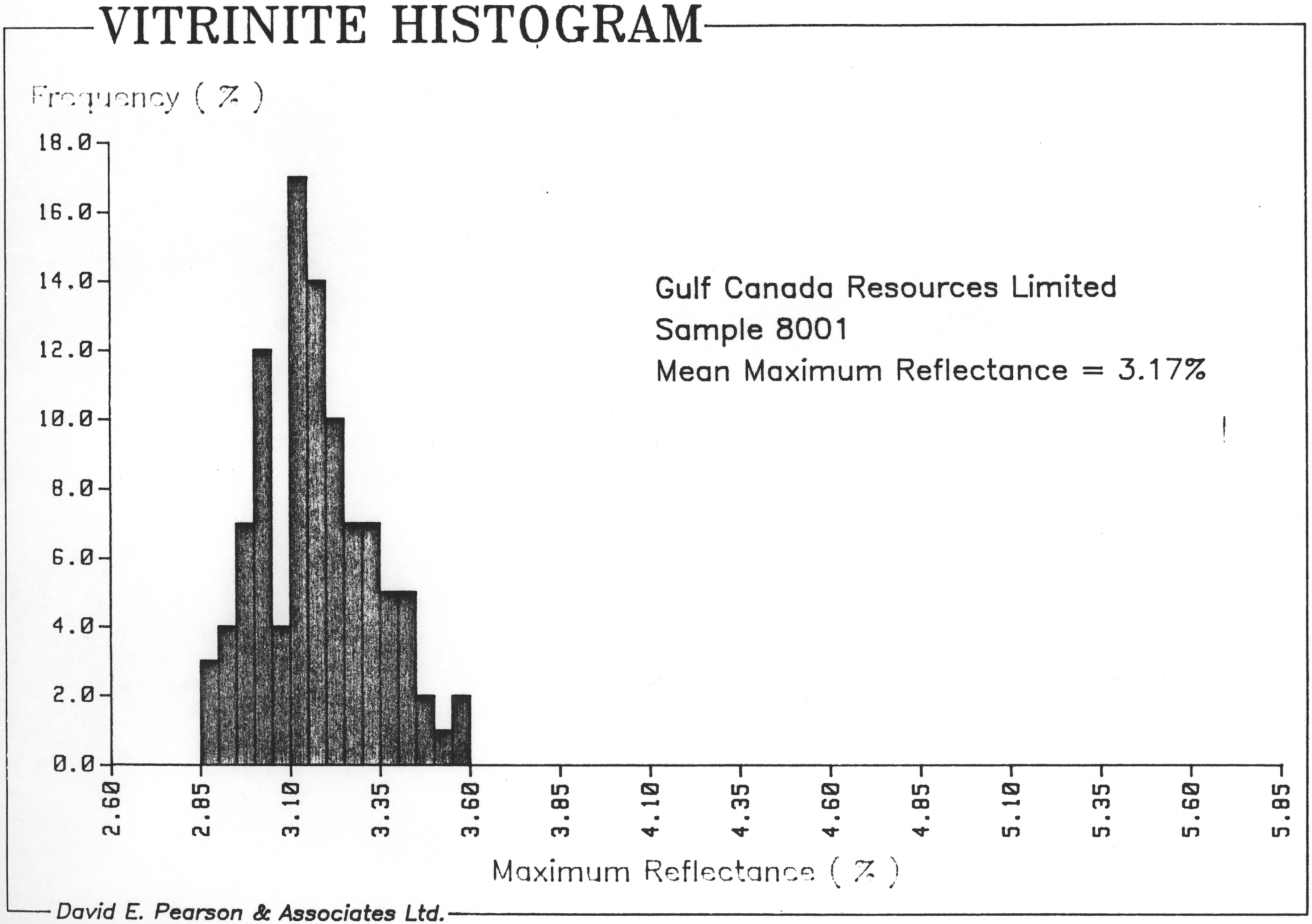
Number of Observations...........................	100
Mean Maximum Reflectance (Romax)...%	3.17
Standard Error of the Mean......................	.02
Coefficient of Variation..........................%	5.07
Variance..	.0258
Standard Deviation...................................	.1607
Skewness..	.3157
Kurtosis..	2.6404

CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
6	2.85	3	3.00
7	2.90	4	4.00
8	2.95	7	7.00
9	3.00	12	12.00
10	3.05	4	4.00
11	3.10	17	17.00
12	3.15	14	14.00
13	3.20	10	10.00
14	3.25	7	7.00
15	3.30	7	7.00
16	3.35	5	5.00
17	3.40	5	5.00
18	3.45	2	2.00
19	3.50	1	1.00
20	3.55	2	2.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V28	3.00
V29	11.00
V30	16.00
V31	31.00
V32	17.00
V33	12.00
V34	7.00
V35	3.00


VITRINITE HISTOGRAM
Frequency (%)
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2.60
2.85
3.10
3.35
3.60
3.85
4.10
4.35
4.60
4.85
5.10
5.35
5.60
5.85
Maximum Reflectance (%)
Gulf Canada Resources Limited
Sample 8001
Mean Maximum Reflectance = 3.17%
David E. Pearson & Associates Ltd.

GULF CANADA LIMITED
Sample #5962

BASIC STATISTICS

Number of Observations	100
Mean Maximum Reflectance (Romax)...%	3.18
Standard Error of the Mean	.01
Coefficient of Variation...%	3.97
Variance	.0159
Standard Deviation	.1263
Skewness	-.0296
Kurtosis	2.7269

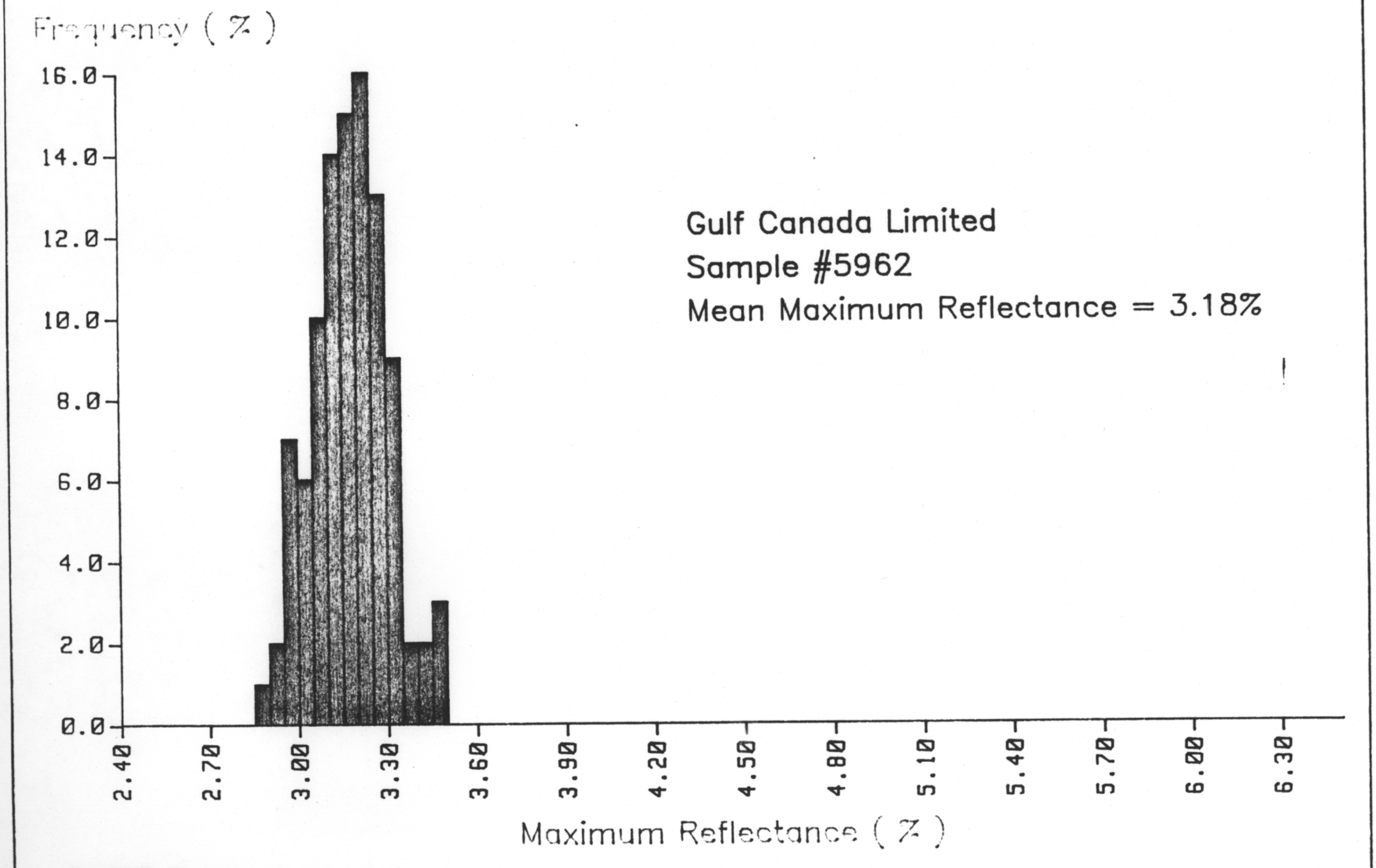
CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
10	2.85	1	1.00
11	2.90	2	2.00
12	2.95	7	7.00
13	3.00	6	6.00
14	3.05	10	10.00
15	3.10	14	14.00
16	3.15	15	15.00
17	3.20	16	16.00
18	3.25	13	13.00
19	3.30	9	9.00
20	3.35	2	2.00
21	3.40	2	2.00
22	3.45	3	3.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V28	1.00
V29	9.00
V30	16.00
V31	29.00
V32	29.00
V33	11.00
V34	5.00

VITRINITE HISTOGRAM



David E. Pearson & Associates Ltd.

GULF CANADA RESOURCES LIMITED
Sample 5965

BASIC STATISTICS

Number of Observations	100
Mean Maximum Reflectance (Romax)...%	3.19
Standard Error of the Mean	.02
Coefficient of Variation...%	6.52
Variance	.0432
Standard Deviation	.2079
Skewness	.0979
Kurtosis	2.0705

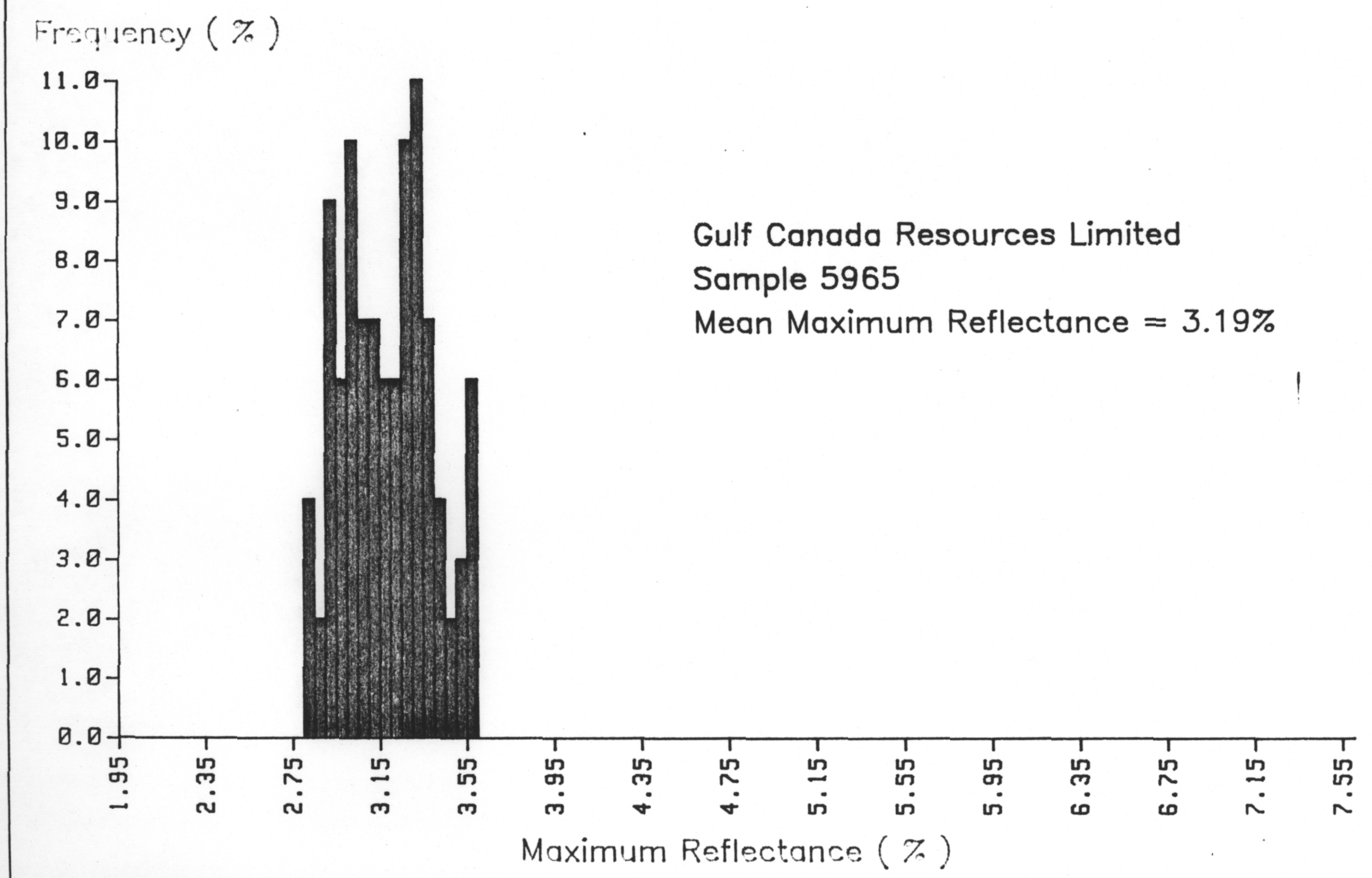
CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
18	2.80	4	4.00
19	2.85	2	2.00
20	2.90	9	9.00
21	2.95	6	6.00
22	3.00	10	10.00
23	3.05	7	7.00
24	3.10	7	7.00
25	3.15	6	6.00
26	3.20	6	6.00
27	3.25	10	10.00
28	3.30	11	11.00
29	3.35	7	7.00
30	3.40	4	4.00
31	3.45	2	2.00
32	3.50	3	3.00
33	3.55	6	6.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V28	6.00
V29	15.00
V30	17.00
V31	13.00
V32	16.00
V33	18.00
V34	6.00
V35	9.00

VITRINITE HISTOGRAM



David E. Pearson & Associates Ltd.

GULF CANADA RESOURCES LIMITED
Sample 5964

BASIC STATISTICS

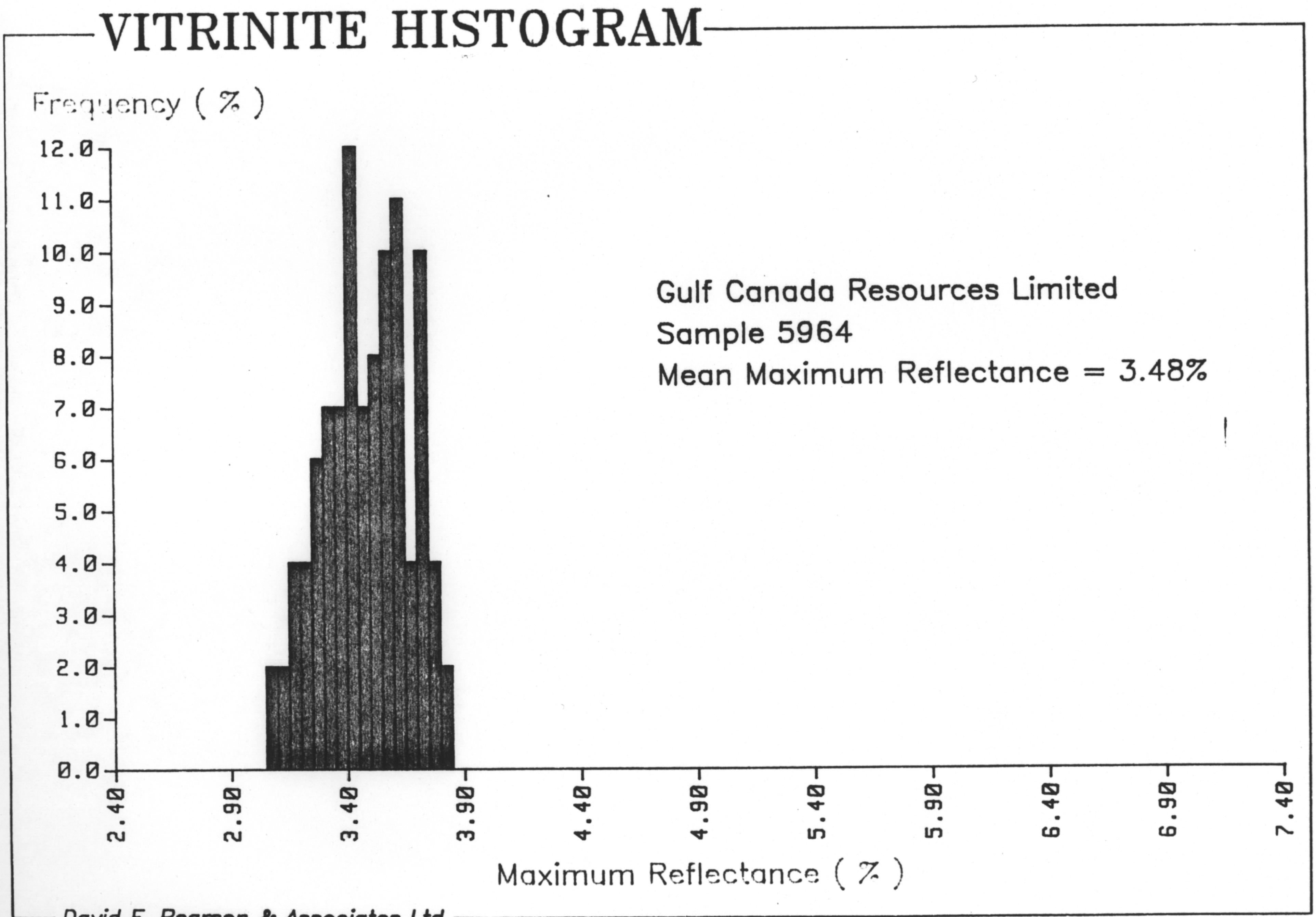
Number of Observations	100
Mean Maximum Reflectance (Romax)...%	3.48
Standard Error of the Mean	.02
Coefficient of Variation...%	5.35
Variance	.0347
Standard Deviation	.1863
Skewness	-.2355
Kurtosis	2.3281

CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
14	3.05	2	2.00
15	3.10	2	2.00
16	3.15	4	4.00
17	3.20	4	4.00
18	3.25	6	6.00
19	3.30	7	7.00
20	3.35	7	7.00
21	3.40	12	12.00
22	3.45	7	7.00
23	3.50	8	8.00
24	3.55	10	10.00
25	3.60	11	11.00
26	3.65	4	4.00
27	3.70	10	10.00
28	3.75	4	4.00
29	3.80	2	2.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V30	2.00
V31	6.00
V32	10.00
V33	14.00
V34	19.00
V35	18.00
V36	15.00
V37	14.00
V38	2.00


VITRINITE HISTOGRAM
Frequency (%)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
2.40
2.90
3.40
3.90
4.40
4.90
5.40
5.90
6.40
6.90
7.40
Maximum Reflectance (%)
Gulf Canada Resources Limited
Sample 5964
Mean Maximum Reflectance = 3.48%
David E. Pearson & Associates Ltd.

GULF CANADA RESOURCES LIMITED
Sample 5963

BASIC STATISTICS

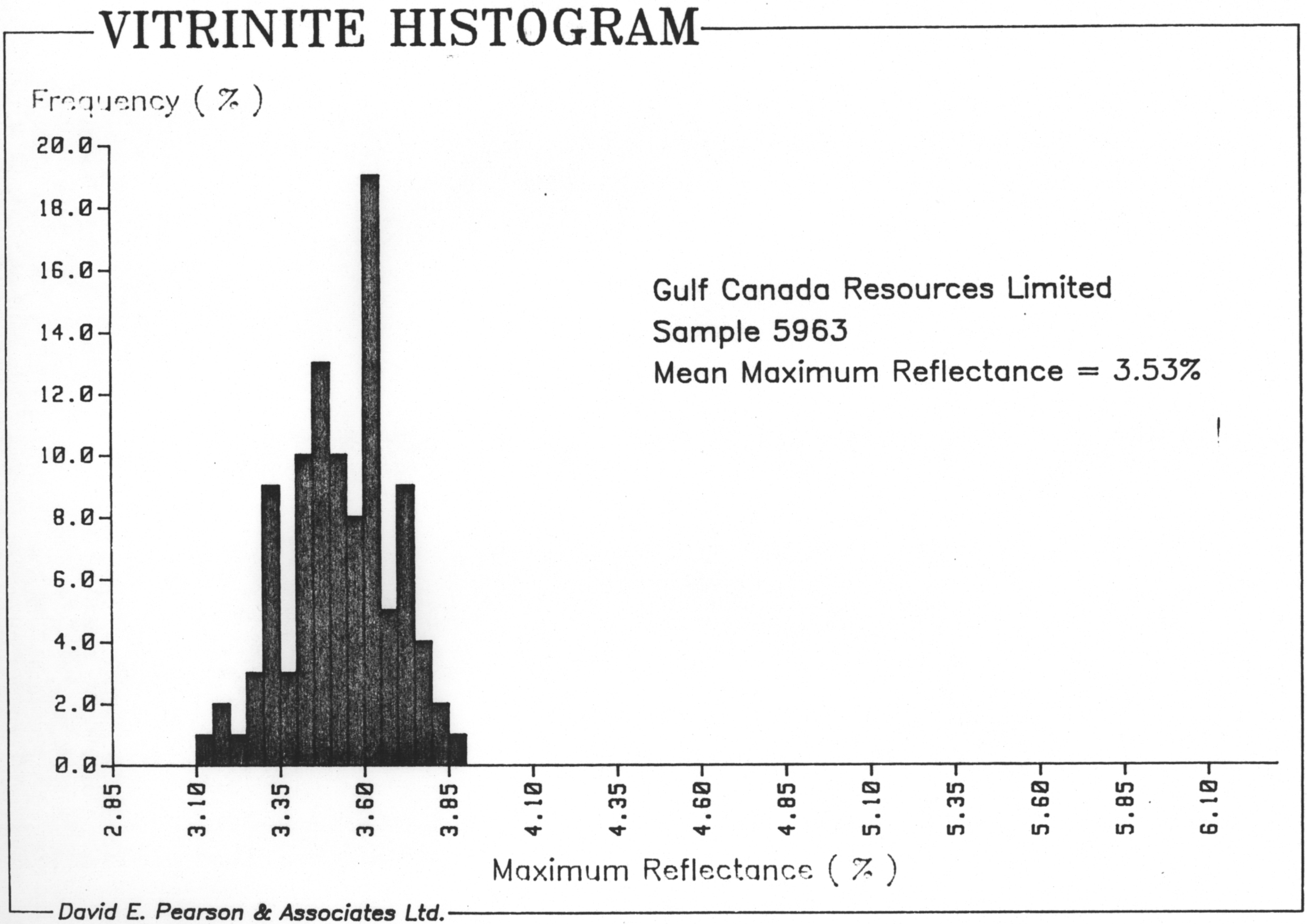
Number of Observations	100
Mean Maximum Reflectance (Romax)...%	3.53
Standard Error of the Mean	.02
Coefficient of Variation...%	4.49
Variance	.0250
Standard Deviation	.1582
Skewness	-.2872
Kurtosis	2.6753

CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
6	3.10	1	1.00
7	3.15	2	2.00
8	3.20	1	1.00
9	3.25	3	3.00
10	3.30	9	9.00
11	3.35	3	3.00
12	3.40	10	10.00
13	3.45	13	13.00
14	3.50	10	10.00
15	3.55	8	8.00
16	3.60	19	19.00
17	3.65	5	5.00
18	3.70	9	9.00
19	3.75	4	4.00
20	3.80	2	2.00
21	3.85	1	1.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V31	3.00
V32	4.00
V33	12.00
V34	23.00
V35	18.00
V36	24.00
V37	13.00
V38	3.00



VITRINITE HISTOGRAM
Frequency (%)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Gulf Canada Resources Limited
Sample 5963
Mean Maximum Reflectance = 3.53%
2.85
3.10
3.35
3.60
3.85
4.10
4.35
4.60
4.85
5.10
5.35
5.60
5.85
6.10
Maximum Reflectance (%)
David E. Pearson & Associates Ltd.

GULF CANADA LIMITED
Sample #5960

BASIC STATISTICS

Number of Observations..........................	100
Mean Maximum Reflectance (Romax)...%	3.28
Standard Error of the Mean......................	.02
Coefficient of Variation..........................%	5.65
Variance..	.0344
Standard Deviation..................................	.1854
Skewness..	-.1424
Kurtosis..	2.3042

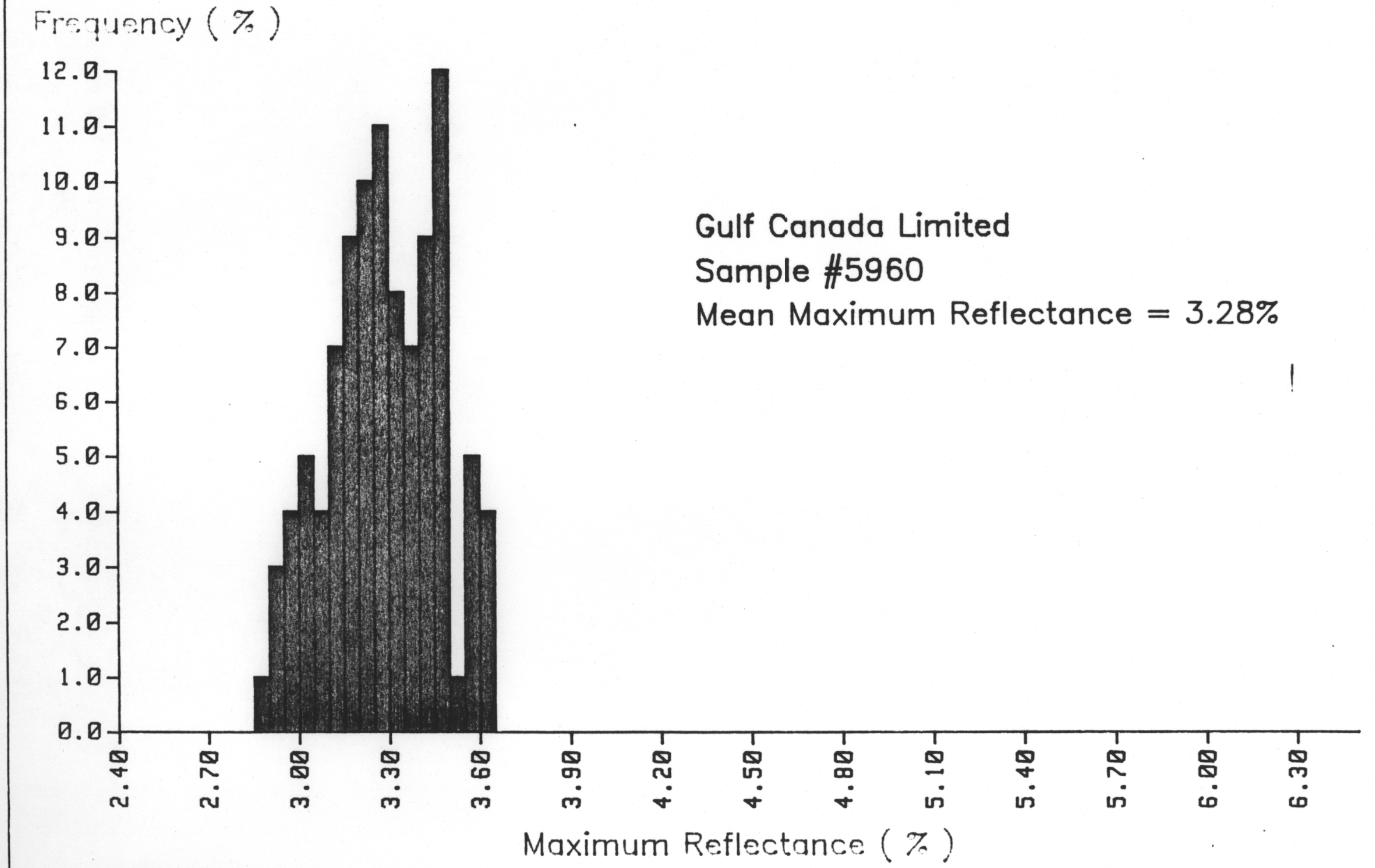
CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
10	2.85	1	1.00
11	2.90	3	3.00
12	2.95	4	4.00
13	3.00	5	5.00
14	3.05	4	4.00
15	3.10	7	7.00
16	3.15	9	9.00
17	3.20	10	10.00
18	3.25	11	11.00
19	3.30	8	8.00
20	3.35	7	7.00
21	3.40	9	9.00
22	3.45	12	12.00
23	3.50	1	1.00
24	3.55	5	5.00
25	3.60	4	4.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V28	1.00
V29	7.00
V30	9.00
V31	16.00
V32	21.00
V33	15.00
V34	21.00
V35	6.00
V36	4.00

VITRINITE HISTOGRAM



David E. Pearson & Associates Ltd.

1985 NASS AREA

TRENCHES

GULF CANADA LIMITED
Sample #5957-5959

BASIC STATISTICS

Number of Observations	100
Mean Maximum Reflectance (Romax)...%	3.80
Standard Error of the Mean	.03
Coefficient of Variation...%	6.67
Variance	.0645
Standard Deviation	.2539
Skewness	.1990
Kurtosis	2.3384

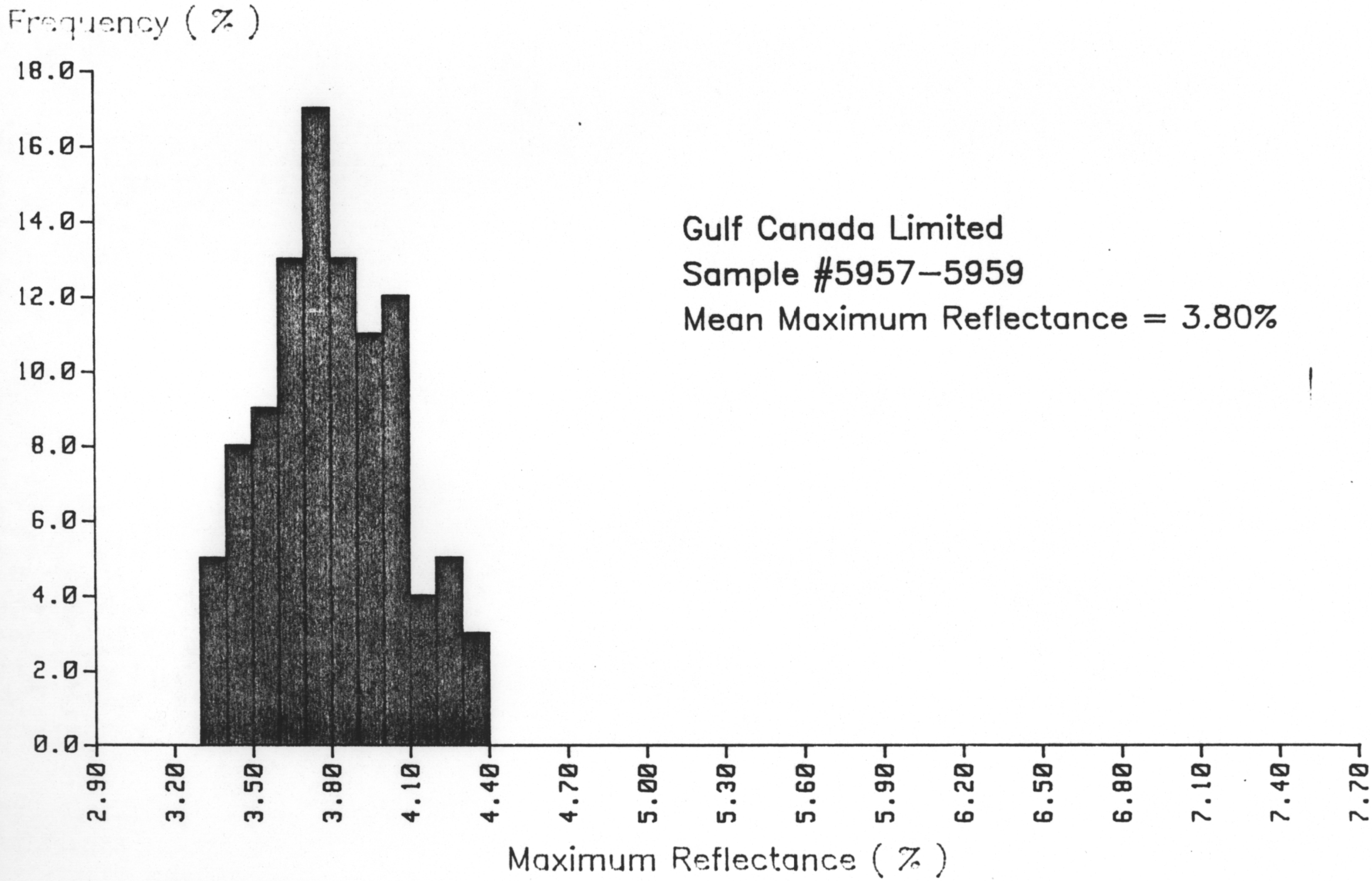
CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
5	3.30	5	5.00
6	3.40	8	8.00
7	3.50	9	9.00
8	3.60	13	13.00
9	3.70	17	17.00
10	3.80	13	13.00
11	3.90	11	11.00
12	4.00	12	12.00
13	4.10	4	4.00
14	4.20	5	5.00
15	4.30	3	3.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V33	5.00
V34	8.00
V35	9.00
V36	13.00
V37	17.00
V38	13.00
V39	11.00
V40	12.00
V41	4.00
V42	5.00
V43	3.00

VITRINITE HISTOGRAM



David E. Pearson & Associates Ltd.

GULF CANADA RESOURCES LIMITED
Sample 8052

BASIC STATISTICS

Number of Observations	100
Mean Maximum Reflectance (Romax)...%	4.60
Standard Error of the Mean	.02
Coefficient of Variation...%	4.13
Variance	.0361
Standard Deviation	.1900
Skewness	.0919
Kurtosis	2.4254

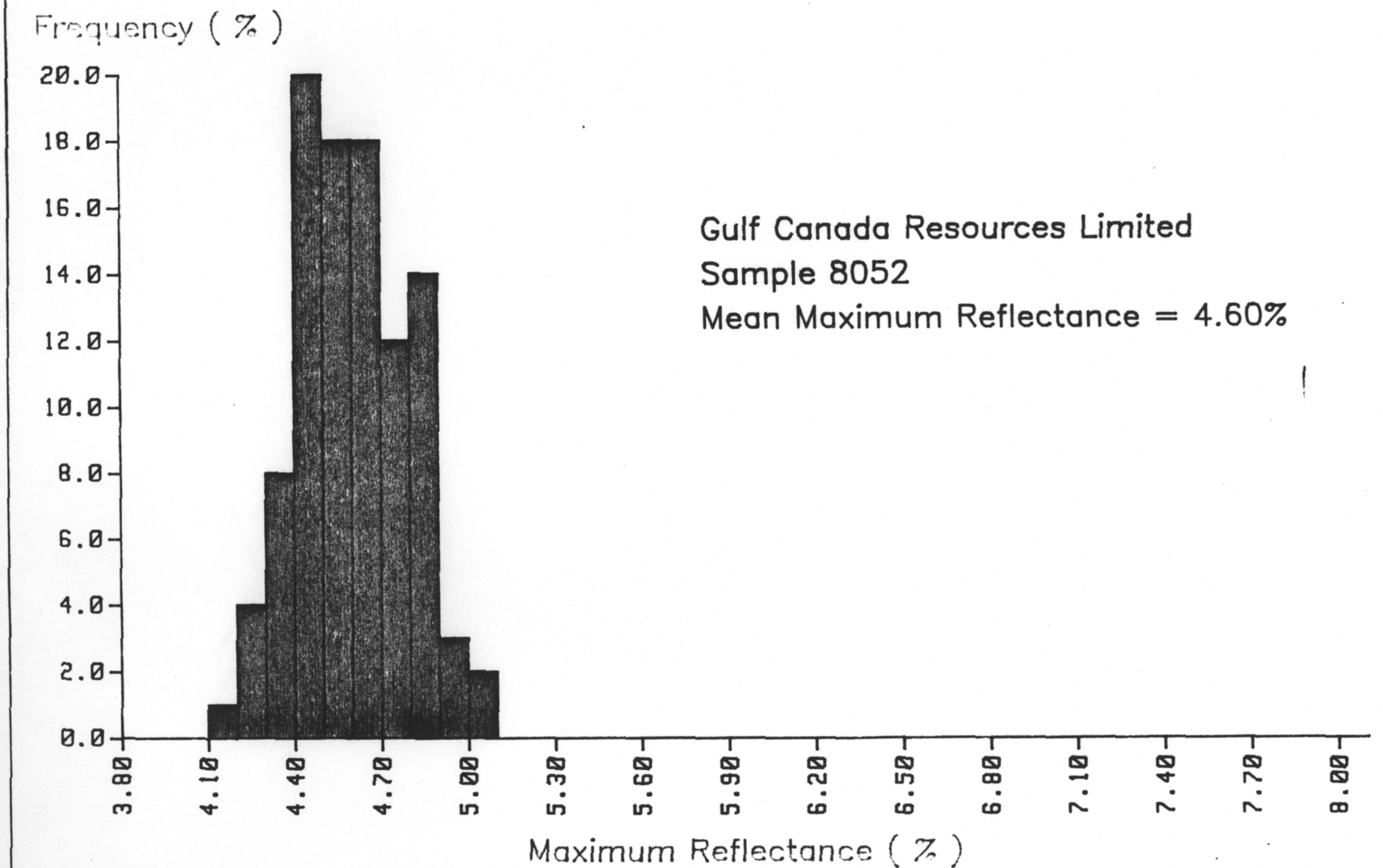
CELL STATISTICS

Cell Number	Lower Limit	Number of Observations	Frequency (%)
4	4.10	1	1.00
5	4.20	4	4.00
6	4.30	8	8.00
7	4.40	20	20.00
8	4.50	18	18.00
9	4.60	18	18.00
10	4.70	12	12.00
11	4.80	14	14.00
12	4.90	3	3.00
13	5.00	2	2.00

VITRINITE TYPE DISTRIBUTION

Vitrinite Type	Frequency (%)
V41	1.00
V42	4.00
V43	8.00
V44	20.00
V45	18.00
V46	18.00
V47	12.00
V48	14.00
V49	3.00
V50	2.00

VITRINITE HISTOGRAM



David E. Pearson & Associates Ltd.