PR-Onionlake 80 (1)A

"Onion Lake Coal Exploration
1980"
Shell Canada Resources Ltd.
by Dennis E. Bell
March 31, 1981 N.T.S. 98I10W
C.L.# 4220-4223, 4749

564

PR- Onion Lake 80 (1) A

OPEN FILE

ONION LAKE

COAL EXPLORATION

-1980-

Coal Licences 4220 - 4223 Inclusive and 4749 (5 total)

Peace River Land District Northeast British Columbia

National Topographic Series 93 I/10 W (Wapiti Lake)

Latitude and Longitude: 54 degrees, 44 minutes north
120 degrees, 48 minutes west

Owner: Shell Canada Resources Limited

Operator: Crows Nest Resources Limited

Consultant and Author: Dennis E. Bell, P. Geol.(Alberta)
Max Air Exploration Limited
P.O. Box 878
Jasper, Alberta, TOE 1EO

Field Work: June 9th through August 29th, 1980

Submission Date: March 31, 1981

CNRL Coal Land Disposition Map HC-18B

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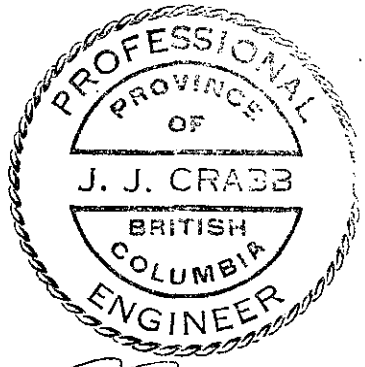
PROFESSIONAL VERIFICATION OF REPORT

Entitled: Onion Lake Coal Exploration, 1980
Peace River Land District
Northeast British Columbia
B.C. Coal Licences 4220-4223 Inclusive and 4749 (5 total)

Mr. Dennis E. Bell carried out the 1980 geological field program on the Onion Lake, northeast British Columbia coal licences held by Shell Canada Resources Limited and operated by Crows Nest Resources Limited.

Dennis E. Bell, B.Sc., graduated in Geology from Dalhousie University in 1965. Since 1968 he has specialized in basic field mapping, structural interpretation, and exploration supervision in the coking coal belt of British Columbia and Alberta. He has worked on projects similar to this property for this Company and for such major coal companies as Manalta Coal Ltd., Luscar Ltd., Fording Coal Ltd., and Petro-Canada. Mr. Bell is registered as a Professional Geologist in the Association of Professional Engineers, Geologists, and Geophysicists of Alberta.

I consider the aforementioned geologist to be well qualified to have undertaken the responsibilities he was assigned for this project. I am satisfied that the attached report dated March 31, 1981, has been competently prepared and justly represents the information obtained from this project.



J. J. Crabb, P. Eng.

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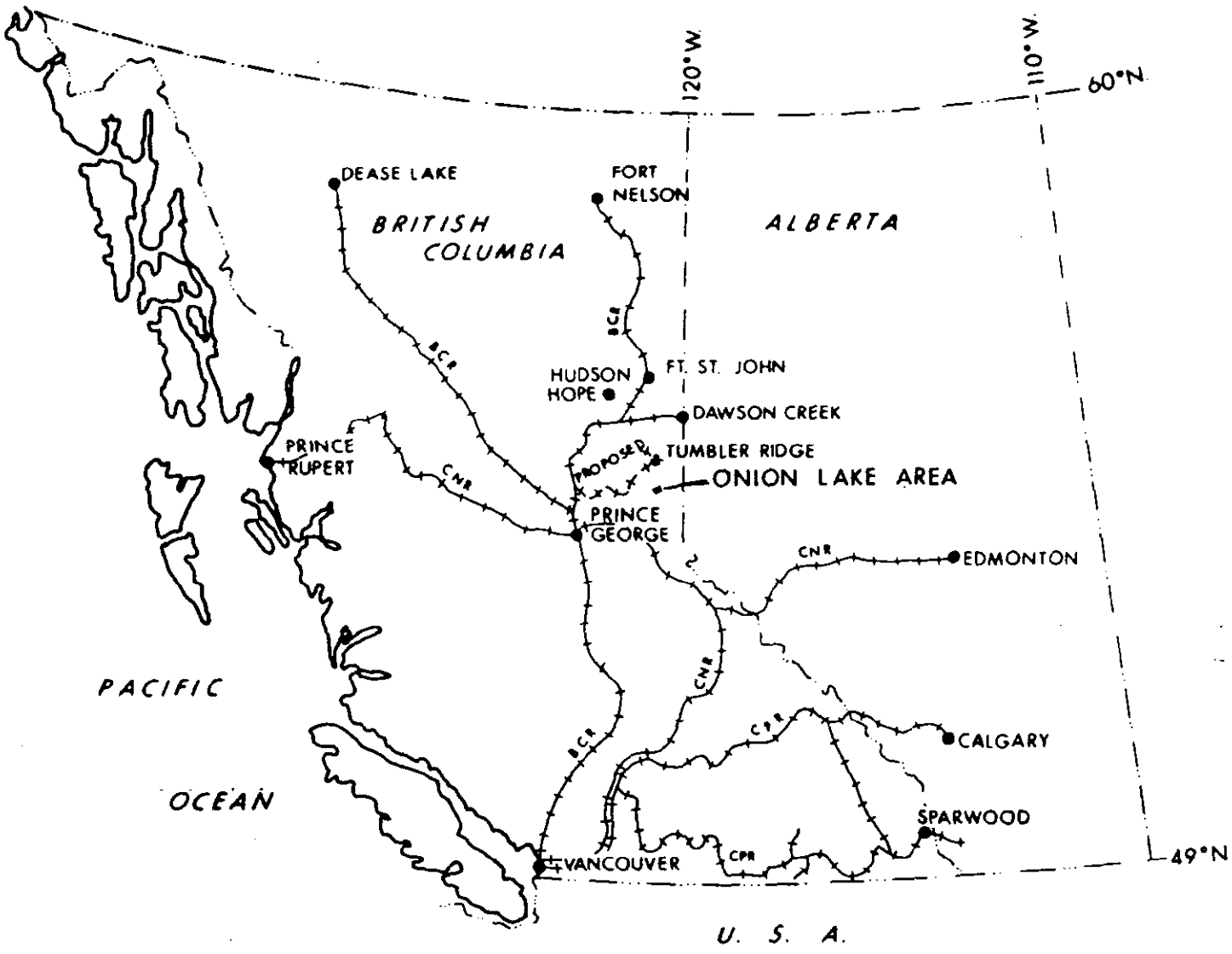


Crows Nest Resources Limited

EXPLORATION

ONION LAKE

N.E B.C

LOCATION MAP

FIGURE 1

AUTHOR A WHITE	SCALE	ENCLOSURE No
DATE 81 03 05	REVISED	DRAWING No AA-542
To Accompany		

1.0 SUMMARY

During the field season of 1980, Crows Nest Resources Limited conducted a surface detail geological mapping program over a 7 km x 3 km stretch of the coking coal belt of northeastern British Columbia. The area is called Onion Lake after the lake of the same name situated 1 km southward. Cost of the project was approximately $39,000.

Two mapping pairs, led by Dennis Bell, consultant, and Alan White, geologist, Crows Nest Resources, spent 15 days in the area, mapping on a base of 1:5,000. As the region has not yet been mapped on a 1:50,000 scale by the Geological Survey of Canada, the particular objective was to define and map the two known coal-containing formations - the Gething and the Commotion - as they may (or may not) exist under the five licences composing the property.

The Onion Lake area is bordered on the north and south by older McIntyre Mines-Canadian Superior Exploration licences operated by Petro-Canada, and on the east by licences held outright by Petro-Canada. To the west (and forming the western edge of the property) is one of the Paleozoic non-coal front-range Rocky Mountains (Bone Mountain).

1.0 (continued)

Mapping shows that approximately one-third of the licence area (the western third) is underlain by the non-coal Paleozoic mountain, but the remainder appears to contain both of the coal formations. Outcrop exposure is relatively poor, but there is enough to show that while there is a normal formational sequence at the eastern edge of the property which dips west under the mountain as the west flank of the Wapiti Anticline, the sequence is folded and contorted within 1 km of the major front-range thrust separating the coal sequence from the carbonate mountain.

The area is still wilderness, and it exists mostly near or above the treeline zone. No trails enter the area. The work was helicopter-supported from the Kinuseo Creek-Duke Mountain (Monkman) Petro-Canada camp 17 km to the northeast, where the crew stayed as guests.

Three contiguous 1:5,000 geologic map sheets have been prepared. A grid on paper has been established, based on stereographic analysis of the uncontorted northeastern half of the area. A structural cross-section has been prepared, using this grid. These maps and this section form the foundation of this report.

With 1980's basic detail mapping program completed, Crows Nest is presently (March, 1981) planning a first helicopter-supported diamond drill hole for the 1981 season. Further detail mapping on the 1:5,000 scale by two mapping pairs is also planned.

2.0 INTRODUCTION

2.1 Coal Land Tenure

Five licences (4220-4223 Incl. and 4749) compose Group 242, 1425 hectares. The project is named after Onion Lake, situated 1 km south.

The following table entitled "B.C. Coal Licences Tenure Standing, Onion Lake" gives details of tenure.

TABLE NO. 1

CROWS NEST RESOURCES LIMITED EXPLORATION — **B.C. COAL LICENCES TENURE STANDING** — **BLOCK:** ONION LAKE — **GROUP:** # 242 — **PROJECT:** ONION LAKE — **YEAR:** 1980 — **DATE:** MARCH 5, 1981

PROJECT NAME	PROJECT LICS. TOTAL NO.	PROJECT AREA TOTAL AC/HA	BLOCK NAME	BLOCK LIC. TOTAL NO.	BLOCK AREA TOTAL AC/HA	GROUP NO.	GROUP LICS. TOTAL NO.	GROUP AREA TOTAL AC/HA	GROUP YEAR	LICENCE NO.	LEGAL DESCRIPTION	LICENCE AREA TOTAL AC/HA	ACQ/ADM YEAR	ACQ/ADM FEES $	RENTALS ANNUAL $	RENTALS TOTAL TO NEXT ANN. $10^3	REQ. WORK EXPIRED $10^3	REQ. WORK CURRENT LIC. YEAR	REQ. WORK CURRENT $	PRE-PAID YEAR	PRE-PAID $	ANNIVERSARY DATE	BUDGET CURRENT YEAR AFE	BUDGET $10^3	EXP TOTAL $10^3	POTL SHELL CLASS	COMMITMENTS J.V. OTHER THAN B.C. GOV. DESCRIPTION	REMARKS
ONION LAKE	5	1425	ONION LAKE	5	1425	242	5	1425	1		NTS 93-I-10 BLK		78-79	50	7,125	20	24	2&3	17,813	1	22,830	DEC. 31	A151 M		65	Y		ONE LAND MAPSHEET
										4220	UNITS 25,26,35,36	300	78	10	1,500	4.5	6	3	3,750	1	4,806	DEC. 31	A151 M		15.3	Y		WORK DONE
										4221	27,28,37,38	300	78	10	1,500	4.5	6	3	3,750	1	4,806	DEC. 31	A151 M		15.3	Y		SINCE LAST ANNIVERSARY
										4222	47,48,58	225	78	10	1,125	3.4	4.5	3	2,813	1	3,606	DEC. 31	A151 M		11.5	Y		IS NOT INCLUDED
										4223	49,50,59,60	300	78	10	1,500	4.5	6	3	3,750	1	4,806	DEC. 31	A151 M		15.3	Y		
										4749	5, 6,15,16	300	79	10	1,500	3	1.5	2	3,750	1	4,806	DEC. 31	A151 M		7.8	Y		
																									39,143			1980
																									8,438			1978-1979

GENERAL REMARKS: FILL NECESSARY LINES AND COLUMNS ONLY, COAL DEVELOPMENT POTENTIAL IS "Y" (PRIME) UNLESS OTHERWISE STATED. LICENCES HELD BY SHELL CANADA RESOURCES LTD.- CNRL IS THE OPERATOR.

TABLE NO. 1

C0015

2.2 Location, Geogaphy, and Physiography

Onion Lake is a more or less rectangular area measuring approximately 7 km by 3 km and oriented southeast-northwest.

Some location descriptions are:

1) Situated on the lower northeast slopes of Bone Mountain, 2270 m, one of the front-range Rockies of northeastern British Columbia.
2) Centered about latitude 54 degrees, 44 minutes north, longitude 120 degrees, 48 minutes west.
3) 140 km west-southwest from Grande Prairie, Alberta.
4) 155 km east-northeast from Prince George, British Columbia.
5) 45 km south-southeast from the proposed townsite of Tumbler Ridge.

Relief in the coal formation part of the licences varies from 1300 m to 1830 m; the majority of the area tends towards the top of this range.

The area, as befits its position on the northeast flank of a front-range Rocky, is rugged and sometimes heavily forested. Much of the higher ground is barren alpine, supporting only lichens and moss. Bone Mountain supports an active sheep range, and any mining plan would have to take this into account.

2.2 (continued)

There is a treeline zone supporting alpine meadow and alpine fir below the barren ground. This is followed by often swampy, often sharply-gullied forest down and northeast to the base of the coal section. Lower yet the forest cover is more patchy. Onion Creek, draining Onion Lake, winds through the southeast corner of the licences, and supports an alluvial-flats environment.

Much of the upper-elevation barren and meadow zone ground is mantled by glacial outwash tills and small moraine-like sand and gravel deposits. This has confused aerial photographic interpretation and left a large amount of ground with no outcrop exposure.

2.3 Access

This 1980 field mapping by two pairs was done from helicopter. There are no trails into the area, although a seismic line running from the Duke block to the east across Onion Creek ends approximately 1 km downslope towards the center of the Onion Valley on the south bank of Gorge Creek (see 1:5,000 map Q22).

Road building to the area from Kinuseo Creek, 12 km to the north, would be difficult, as Onion Creek itself contains a long canyon along this stretch. To avoid this, road access would have to cross Feller's Creek, which also does not have gentle banks. In addition there is a rise of 300 m to 500 m involved.

The Kinuseo Creek Valley, part of the Murray River drainage, contains all-weather 40 kph gravel road access. The Monkman Pass coal camp of Petro-Canada, servicing the Duke coal area, is situated 13 km northeast of the area. The mapping crew stayed as guests in this camp, keeping helicopter time to five minutes either way.

The camp is serviced from Grande Prairie, 158 km northeast down the Redwillow River in Alberta. The turnoff from the Grande Prairie - Dawson Creek highway is 37 km west of Grande Prairie at Beaverlodge, Alberta. The drive is approximately 2-1/2 hours in dry weather.

2.4 Environment

Onion Lake is relatively high, cold, and windy compared to the average ground covering the coal belt in this part of northeast British Columbia. Petro-Canada finds that June 15th is the earliest starting date for post-breakup work. As Onion Lake is higher and right on the front of the mountains, such work should be delayed to July 1st in any year. Snow covers the most prospective ground until late May. 1980's work ended with the descent of the snow line to 1450 m on August 24th.

Bone Mountain supports a large and active sheep range. It also supports a large grizzly population, frequently seen by the staff and pilots of other minerals crews in the area throughout the 1980 season.

3.0 WORK DONE

3.1 Summary of Previous Work

Previous work on Onion Lake consists of two geologic studies; there has been no drilling or other equipment work by any company in the area.

The first item of geologic work is the 1:50,000 regional geologic map (CNRL No. HJ-21A - see enclosures) from company stock. It shows essentially the same information as is on the 1:50,000 Index and Compilation Map included with this report.

The second geologic work is Georgia Hoffman's 1979 "Onion Lake Coal Property" report, also on company file. It describes field mapping of a reconnaissance nature, somewhat fleshing out the 1:50,000 regional map, but includes no work at a smaller scale. The scope did not involve detail mapping leading to drill site selection or structural delineation.

It is notable that the Geological Survey of Canada has not mapped this stretch of northeastern British Columbia on a scale as small as 1:50,000; therefore both reconnaissance and detail mapping necessarily had to start at a more basic level than is usual where a G.S.C. base is available. The delineation and selection of mappable units had to be (and was) first accomplished.

3.2 Scope and Objective of 1980 Exploration

With 1:50,000 reconnaissance mapping in hand, the 1980 Onion Lake geologic mapping program was intended to provide detail mapping on a 1:5,000 scale. The immediate objective was to do sufficient ground work to identify the best possible site for a single diamond drill hole in 1981.

In addition, such mapping was intended to outline the structural setting, the lithologic nature of the rock units, and the most prospective parts of the licences from a mining point of view.

3.3 Work Done in 1980

With the help of average weather, a good base camp, and the experience carried into the area from the other parts of the coal belt nearby by the mapping crew, the program was a success. The worst problem encountered was a relative lack of outcrop. There was enough exposure, however, to be able to pick several suitable spots within the licences from which to penetrate the known most prospective section.

3.4 Costs of Work Done in 1980

Detailed costs of the 1980 Onion Lake geologic program are contained in the Application to Extend Term of Licence on the following two pages.

Total cost of the 1980 program is calculated to be $39,143.

Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

APPLICATION TO EXTEND TERM OF LICENCE

I, Bolton Agnew (Name) agent for Shell Canada Resources Ltd. (Name)

P.O. Box 100 (Address) (Address)

Calgary, Alberta, T2P 2H5

Valid FMC No. 187621

hereby apply to the Minister to extend the term of Coal Licence(s) No(s). 4220 to 4223 Incl. and 4749; Five Licences, Group #242 in the Peace River Land District - 1425 hectares for a further period of one year.

2. Property name Onion Lake, N.E. B.C.

3. I am allowing the following Coal Licence(s) No(s). to forfeit None

4. I have performed, or caused to be performed, during the period June 1 to December 31, 19 80, work to the value of at least $ 39,143 on the location of coal licence(s) as follows:

CATEGORY OF WORK	Licence(s) No(s).	Apportioned Cost
Geological mapping	4220 - 4223 Incl. & 4749	$ 38,743
Surveys: Geophysical		
Geochemical		
Other		
Road construction		
Surface work		
Underground work		
Drilling		
Logging, sampling, and testing		
Reclamation		
Other work (specify)		
Off-property costs		To Date 400

5. I wish to apply $ 39,143 of this value of work on Coal Licence(s) No(s). 4220 - 4223 Incl. & 4749, Group #242

6. I wish to pay cash in lieu of work in the amount of $ on Coal Licence(s) No(s).

7. The work performed on the location(s) is detailed in the attached report entitled Onion Lake Coal Property - Geological Report 1980 will be submitted in ninety days.

1980.12.22 (Date) (Signature)

Land Supervisor (Position)

(FORMS AND REPORT TO BE SUBMITTED IN DUPLICATE)

CATEGORY OF WORK

GEOLOGICAL MAPPING Yes ☒ No ☐

		Area (Hectares)	Scale	Duration
Reconnaissance				
Detail:	Surface			
	Underground	1700	1:5,000	$38,743
*Other (specify)				
			Total Cost	$ $38,743

GEOPHYSICAL/GEOCHEMICAL SURVEYS Yes ☐ No ☒

Method
Grid
Topographic
*Other (specify)

Total Cost $

ROAD CONSTRUCTION Yes ☐ No ☒

Length Width
On Licence(s) No(s).
Access to

Total Cost $

SURFACE WORK Yes ☐ No ☒

	Length	Width	Depth	Cost
Trenching				
Seam Tracing				
Crosscutting				
*Other (specify)				
			Total Cost	$

UNDERGROUND WORK Yes ☐ No ☒

	No. of Adits	Maximum Length	No. of Holes	Total Metres	Cost
Test Adits					
*Other workings					
				Total Cost	$

DRILLING Yes ☐ No ☒

		Hole Size	No. of Holes	Total Metres	Cost
Core:	Diamond				
	Wireline				
Rotary:	Conventional				
	Reverse circulation				
*Other (specify)					
Contractor					
Where is the core stored?					
				Total Cost	$

LOGGING, SAMPLING AND TESTING Yes ☐ No ☒

Lithology:	Drill samples	☐	Core samples	☐	Bulk samples	☐
Logs:	Gamma-neutron	☐	Density	☐		
*Other (specify)						
Testing:	Proximity analysis	☐	FSI	☐	Washability	☐
	Carbonization	☐	Petrographic	☐	Plasticity	☐
*Other (specify)						

OTHER WORK (specify details) Cost

Total Cost	$
On-property costs	$38,743
Off-property costs	400
Total Expenditures	$39,143

1980.12.22
(Date)

(Signature)

Manager - Accounting, CNRL
(Position)

*A full explanation of other work is to be included.

4.0 GEOLOGY

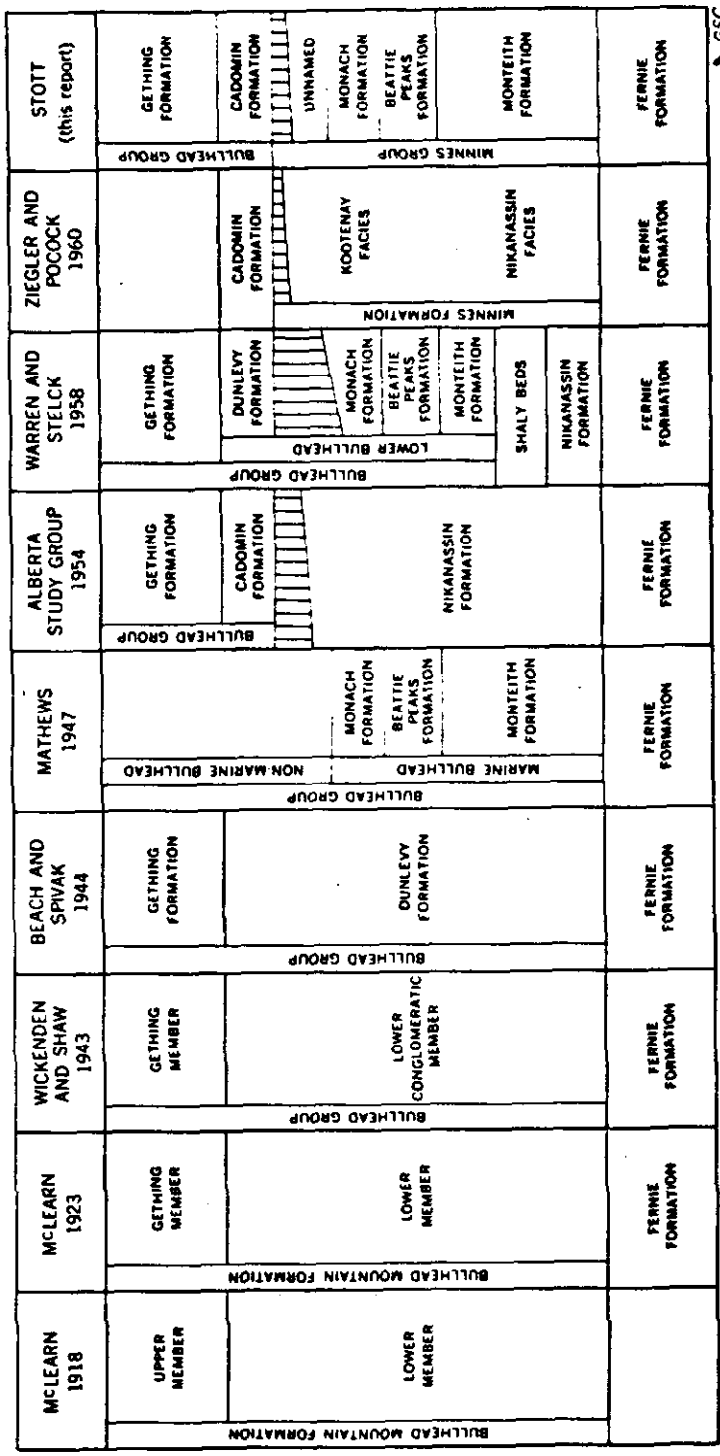
4.1 Regional Geology

A problem encountered in planning exploration on the Secus Mountain, Onion Lake, and Five Cabin Creek properties was that there existed no Geological Survey of Canada detail 1:50,000 geologic maps covering that portion of the coking coal belt in northeastern British Columbia. The G.S.C. has done detail work to the northwest up the belt, as have other coal exploration companies, but distance and facies changes have confused identification of mappable units in this region.

The generally accepted nomenclature is that of the Survey's Stott (Bulletin 152, 1968) dividing the section of interest into the Bullhead and Minnes Groups, with further subidivisions into formations and members. This is as reproduced on the two following pages in formational diagrams of both groups.

The Petro-Canada staff has fit its intensive Duke Mountain drilling into this nomenclature and also used it for its six drill holes of previous years in the Secus Mountain area.

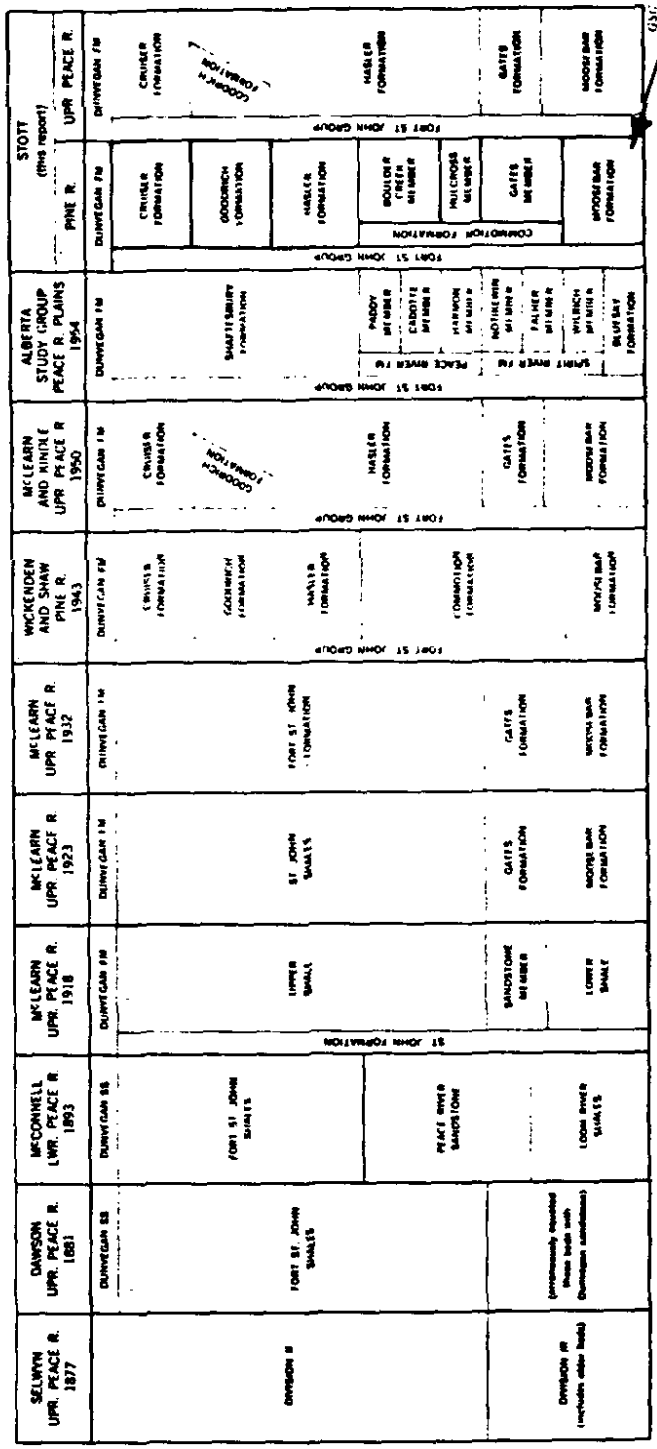
FORMATIONAL DIAGRAM
LOWER CRETACEOUS SERIES
BULLHEAD & MINNES GROUP



This nomenclature (Stott, Geological Survey of Canada Bulletin 152) is used in this report and on all maps and sections.

FIG. 2

FORMATIONAL DIAGRAM
UPPER/LOWER CRETACEOUS SERIES
FORT ST. JOHN GROUP



This Pine River nomenclature (Stott, Geological Survey of Canada Bulletin 152) is used in this report and on all maps and sections.

FIG. 3

Nomenclature of Fort St. John Group

4.1 (continued)

The 1980 Crows Nest mapping crew decided to continue this nomenclature, to fit in with the work of G.S.C. and Petro-Canada as Crows Nest and Petro-Canada may continue to exchange some parts of their information in the future. The Secus Mountain area in particular is one logical mining area, but it is divided into intertwined fashion between the two companies.

The 1980 mapping crew divided the total section yet further into units mappable through all three Crows Nest properties and throughout the Petro-Canada licences (including the Duke Mountain Block). Should Petro-Canada institute a detailed mapping program on any of its properties in this region of northeast British Columbia (it has not done so in the past, including within the Duke Mountain block), continuity between the companies exploring and developing in the same belt can be maintained.

The Onion Lake and Secus Mountain 1:50,000 compilation maps (enclosures) and 1:25,000 compilation maps were constructed by overlaying the 1:5,000 grids on the topography, and placing the formations and members as measured on these grids from the 1:5,000 maps and sections.

4.2 Stratigraphy

Minnes, Bullhead, and lower Fort St. John Group strata in the region stretching from Secus Mountain through Onion Lake and Five Cabin Creek contain an unusually high proportion of conglomerate. Identification and mappability of the two target units, the Gething Formation in the Bullhead Group and the Gates Member of the Commotion Formation of the Fort St. John Group, has been hindered by the vastly increased footages of conglomerate they contain, compared to the remainder of the better-studied part of the coal belt to the northwest (which also contains the type section for the nomenclature).

In fact, not only the Gates and Gething contain many thick conglomerates, but the Minnes, Cadomin, and Boulder Creek also contain unusually thick units of conglomerate. This character is unique to this part of the coal belt, and Stott treats it with some attention in his 1968 bulletin.

The most noticeable conglomerate thicknesses have been centered around Mt. Belcourt, one of the four foothills in the Secus area. To the northwest, at Onion Lake and Five Cabin Creek, the total mass of conglomerate is less and it has less effect on the mappability of the standard nomenclature, but the number of conglomerate occurrences remains high.

4.2 (continued)

Secus Mountain itself, situated right next to Mt. Belcourt, has a long, striking west slope composed of dip-slope units of conglomerates, deeply incised by small canyons and gorges, all of it basically exposed and barren. The general concept and question of how to divide and follow the conglomerates has thus become known in the local mapping trade as "the Secus Mountain conglomerates."

The effect of the conglomerates has been to defeat identification of the standard formations and members, to the point that over the years various crews making quick geological examinations with the idea of locating drill sites to prospect the Gething and Gates ended up often by drilling a completely wrong formation.

The problem is mostly centered along the part of the belt containing Five Cabin Creek, Onion Lake, and Secus Mountain, which are all located along the innermost line of inner foothills. Those properties situated along the outer side of the inner foothills (i.e. the Duke Mountain Block of Petro-Canada, as well as the Belcourt and Saxon properties of Denison Mines) on the east flank of the Wapiti Anticline have less conglomerate.

4.2 (continued)

The Geological Survey maintains an active interest in "the Secus Mountain Conglomerates", and the crew was visited for one day by one of their geologists (D. Gibson), who wished to see the division of the units by the crew.

Since the mapping was completed and the 1:5,000 maps and structural cross-sections finished in November of 1980, the logs (drill core and geophysical) of the six Petro-Canadian holes at Secus Mountain have been acquired by Crows Nest. The positions and altitudes of the holes have never been surveyed (this will be done in 1981), but the author can see that they fit the sections closely, and therefore the basic interpretation and conception of the stratigraphy are valid.

4.2.1 The Stratigraphic Section

As it appeared that an academic style of mapping by the Geological Survey and reconnaissance-level mapping by coal company geologists had not in the past produced a workable division of units in the stratigraphic section, Crows Nest Resources' 1980 crew decided instead, as it was the first crew on the west side of the Wapiti Anticline to do detail mapping, to use a different approach.

The concept was to concentrate instead on building up a structural framework containing the whole of the sequence from Minnes up through Boulder Creek, and while so doing to attempt to divide the total section into smaller and smaller units, eventually sandwiching possible coal horizons into smaller and smaller spaces.

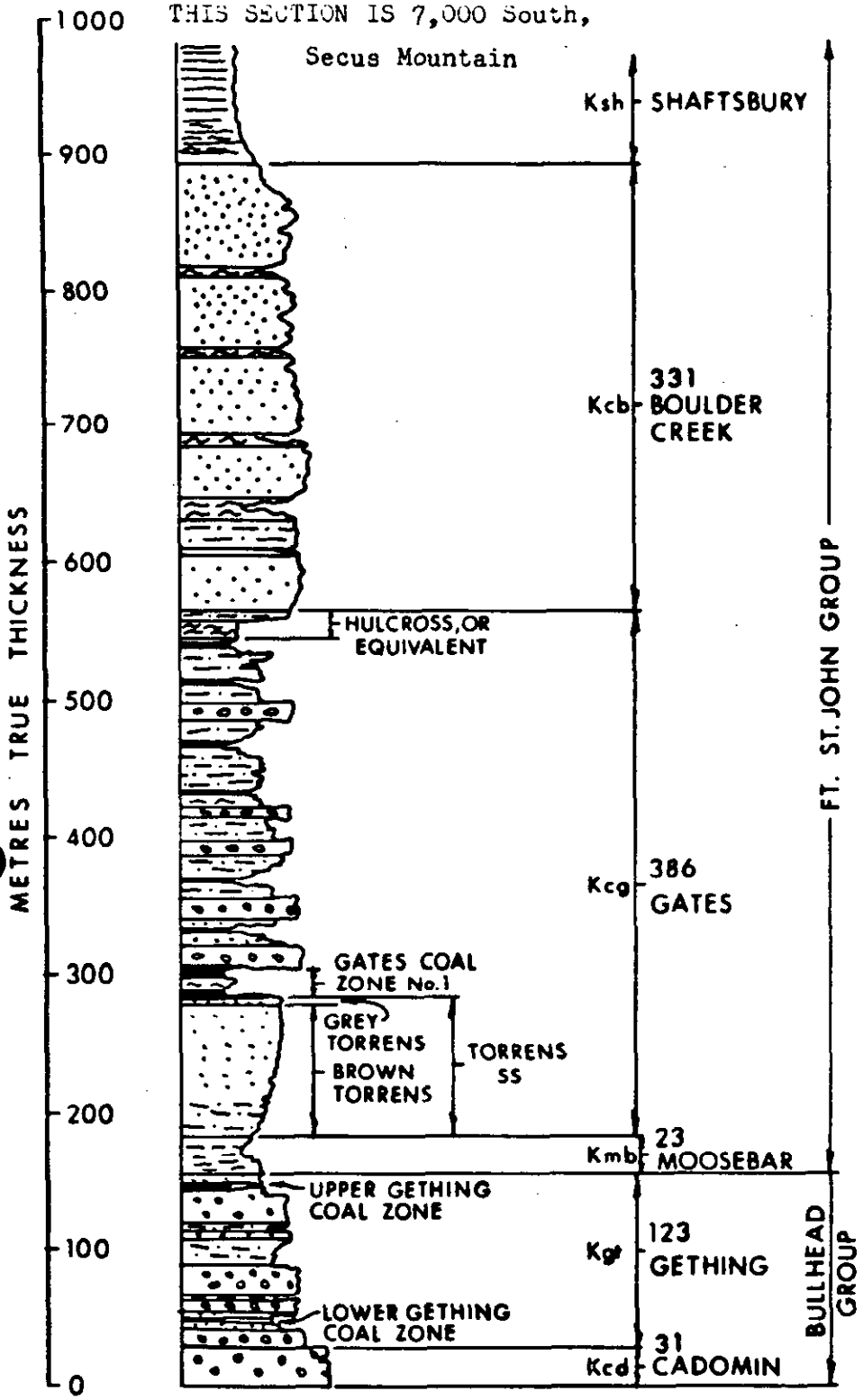
This entailed leaving aside most notions of academic interest, (such as paleoenvironments and unconformities), and also leaving aside the notion that particular coal beds should be followed. As coal beds are usually recessive and unexposed, the problem came to be to find identifiable units close by in the section.

4.2.1 (continued)

The mapping was thus carried out from the point of view of the most basic principle: if enough exposures are looked at, and each exposure is compared to all others on the most fundamental geological points such as grain size, bedding characteristics, and so on, then eventually it would be possible to follow certain (and also probably prominent) units close to the coal horizons and so locate drill sites no matter what the discussions on the formal nomenclature would have to say concerning the identify and origin of the units. In other words, the whole problem could be by-passed.

Being able to separate and follow the prominent units in the total stratigraphic section became, then, essentially the study of "the Secus Mountain Conglomerates". The stratigraphic descriptions following the next couple of pages of the stratigraphic section are oriented to this question.

The two pages of stratigraphic section are meant to be used by the reader for six different locations: four within the Secus Mountain area, and one each at Onion and Five Cabin Creek. The nomenclature remains the same, but the reader must substitute the appropriate thickness for each location from the table. The sketch presented is for the 7,000 South structural cross-section on the west slope of Secus Mountain itself.



Marine : shales, siltstones, some minor sandstone and pebbles ; recessive.

Non-marine : sandstones, minor conglomerates, siltstones, mudstones, sometimes coaly, relatively prominent

Marine shale

Sandstones, conglomerates, siltstones, mudstones, coal. Neither prominent nor recessive.

Sandstone ; particularly prominent and distinctive ; transitional marine to non-marine environment.

Grey marine shale ; very recessive

Non-marine sandstones and conglomerates, minor siltstones, mudstones, coal ; often prominent.

Non-marine massive conglomerates, minor coarse sandstones ; extremely prominent

— COAL
— SHALE
— SANDSTONE
— CONGLOMERATES
— SANDSTONE, SILTSTONE MUDSTONE INTERBEDDED

Crows Nest Resources Limited
EXPLORATION
N.E. BRITISH COLUMBIA
FIG. 10
STRATIGRAPHIC SECTION

AUTHOR D.E. UELL	SCALE 1:10 000	ENCLOSURE No.
DATE 81 03	REVISED	DRAWING No. AA-534

UNIT		Kcd	Kgt	Kmb	Kcg	Kbc	Torrens ss*	TOTALS
SECUS MOUNTAIN	7,000 S	31	123	23	386	331	50	894
	000 N/S	77	104	23	396	204	51	804
	4,000 N	SAXON THRUST PLATE: T = Top Plate (Dumb Goat); B = Bottom Plate (Whatley)						
		T / B	T / B	T / B	T / B	T / B	T / B	T / B
		152 / 165	260 / 184	23 / 23	435 / -	77 / -	43 / 79	947 / -
	9,000 N	96	58	23	362	61	64	600
ONION LAKE		36	100	30	Top Missing	Missing	Gray 6.5 Brown 166	-
FIVE CABIN CREEK								

TABLE NO. 2

* NOTE: Torrens sandstone figures include Transition Beds

4.2.2 Stratigraphic Descriptions

4.2.2.1 Minnes Group

The Minnes Group is the term used for any section stratigraphically beneath the Cadomin Formation, the base of the overlying Bullhead Group. Minnes strata throughout this portion of northeastern British Columbia have not been mapped in detail, and the group is undivided.

The Minnes Group is composed of a sequence of both marine and non-marine sediments; often coal or coaly beds occur, but they are rarely thicker than one or two meters, and seem to have little extent laterally.

The nature of the Minnes section immediately beneath the Cadomin at any particular location is often different from the last. At Onion Lake there are massive, thick conglomerates beneath the Cadomin; along the 30 km of Secus it varies from conglomerates to interbedded sandstones, siltstones, and shales, with coal often showing up.

4.2.2.2 Cadomin Formation

The 1980 Crows Nest Resources crew used a definition of the Cadomin somewhat different than that used by both past coal company workers and the Geological Survey. It was found that by restricting the name to a particular conglomerate within the overall succession, it was possible to divide the question of "the Secus Mountain Conglomerates" into Minnes conglomerates, Cadomin conglomerates, and Gething conglomerates.

The problem has been that if the geologist includes all thick massive conglomerates in the Cadomin, he will have almost no Gething before the Moosebar is encountered. Georgia Hoffman, in her 1979 "Onion Lake Coal Property", states that "the Cadomin is ... unusually thick ... in the Onion Lake area". Also, in regard to the Cadomin-Gething part of the problem, she states "mapping problems ... indicate that a more consistent unit for this area is the Bullhead Group as a whole". The trouble is that if all conglomerates are called Cadomin, then there is very little left to call Gething, and the Gething is what is supposed to be drilled as it contains coal.

4.2.2.2 (continued)

Crows Nest Resources' crew restricts the name Cadomin to a unit mostly conglomeratic which stands apart in a set of fundamental mapping characteristics from all other conglomerates within the Minnes-Bullhead-Fort St. John succession. The conglomerate must be light-gray weathering, ring hard to the pick, be so tough that the rock breaks off through the pebbles, cobbles, and boulders, rather than around them, and must always form the basic backbone for the whole succession (Minnes to Boulder Creek) in the topography and structure.

In addition, it must contain particular shades of rosey pink, a jade-like green, and a particular smooth, light gray in the constituents. Cadomin sandstones contain these particular colours, within the sand grain sizes. This character of the Cadomin is the same, in the author's view, as he has seen in the Cadomin from the Alberta town of Cadomin north through the coking coal belt as far as the Peace River. It is very like the Cadomin anywhere through the Luscar and McIntyre Mines properties.

4.2.2.2 (continued)

All section below this unit, including conglomerates, is called Minnes. The conglomerates tend to be less tough, browner in overall aspect, slightly less topographically prominent, and they do not ever contain the pink and green constituents.

The top of the Cadomin is taken at that centimeter where the tough, light-gray, massive conglomerate or sandstone gives way to something softer and browner; it may be a conglomerate or a sandstone, but it will be much browner, pebbles and cobbles can be more easily extracted, and the pick hits with a thud.

4.2.2.3 Gething Formation

In addition to colour and hardness, Gething conglomerates bear another relation to the Cadomin beds beneath: whatever the average largest constituent size in the Cadomin, the Gething will have similarly large sizes, but always slightly smaller. For example, if the Gething has boulders to 20 cm in length, expect 25 cm in the Cadomin beneath.

Up to half of the Gething at any point along the length of the region can be expected to be conglomerate, occuring in one or more massive, prominent units. Gething cliffs can often be followed for several kilometers at a time.

It would appear that in the stretch covering Five Cabin Creek all the way southeast through Secus, there may be expected to be only two coal zones - an upper and a lower - within the Gething. The crew did not find any place where it seemed there could be room for more than that, and each of these zones probably contains no more than a meter or two each. (The lately-acquired Petro-Canada drill logs from Secus are now known to bear this out.)

The Gething is thus judged to be less prospective at this point, and therefore the first drilling on these properties by Crows Nest Resources will be aimed at the Gates Member of the Commotion, lying some distance above.

4.2.2.4 Moosebar Formation

The Moosebar Formation is notable mostly because of its very characteristic recessive effect on the topography. It is thicker in the Sukunka area to the northwest, is thinning southwards towards Onion Lake, where it is 30 m, and is thinnest in the Secus area. At Secus the crew used 23 m for the Moosebar in constructing the cross-sections, as the actual marine beds in two complete exposures (complete exposures of the Moosebar are almost unheard of, and warrant special examination anytime) were that thickness. The exposure measured at Onion Lake (in The Gorge) is the only other complete exposure known in the region.

Coal crews through the years have followed "the Moosebar recession" in the topography, and through Crows Nest Resources licences the effect remains.

4.2.2.5 Commotion Formation

The Commotion Formation is divisible into a coal-bearing Gates Member, a marine Hulcross Member overlying the Gates, and then the Boulder Creek Member, an often-coaly sandstone unit.

4.2.2.5 (continued)

The Hulcross was found to be almost non-identifiable in the Secus area (it was found near the peak of Mt. Belcourt). A section this high has not been identified in the Onion Lake area, but it is thick at Five Cabin Creek and thickens northwestward.

Mapping was generally stopped in the base of the Boulder Creek, as there is no prospective coal known above the Gates.

4.2.2.5.1 Gates Member, Commotion Formation

The Gates Member is perhaps the most consistent in thickness of all the units between Secus Mountain area and Onion Lake; the range appears to be 362 to 435 m. It is composed of alternating sequences of conglomerates, sandstones, siltstones, mudstones, and coal beds. As a general rule the coal seams, while remaining numerous, get uninterestingly thinner towards the top of the member. Individual conglomerate units, while massive and often prominent, are thinner and more well-bedded than Gething and Cadomin conglomerates. The constituents remain the same, but at smaller diameters. The crew found that it could not distinguish between Gates conglomerates individually, but it could generally differentiate them from Gething conglomerates.

4.2.2.5.1.1 Torrens Submember, Gates Member, Commotion Formation

The Torrens Submember consists of an extremely distinctive sandstone occurring at the bottom of the Gates. It is the most prominent unit in the succession besides the Cadomin. Typically, the top five or ten meters of Torrens may be folowed for kilometers at a stretch. The upper unit within the Torrens is a hard gray sandstone, which overlies and is always thinner than the underlying softer brown main part of the unit. The brown sandstones have an extremely distinctive weathering which etches out a particular cross-bedding. The sequence from Moosebar through the Torrens and into the coal above is very reminiscent of the Weary Ridge - Moose Mountain - coal member sequence in southeast British Columbia.

The combination of distinctive topography, distinctive outcrop and distinctive colouring make the Torrens an ideal marker.

4.2.2.5.1.2 Transition Beds, Gates Member, Commotion Formation

The Transition Beds are both part real outcrop and part a notion of conception. The name is applied by the crew to those beds which are "transitional" or "passage" from the marine Moosebar into the terrestial cross-bedded Torrens sandstones above.

They are composed of very evenly-bedded siltstones and very fine sandstones, which grade upwards into the Torrens. The cross-bedding and increased grain sizes appear imperceptibly. Nothing else in the sequence is as evenly bedded.

This unit is quite recessive, and always forms the gentler ground where the Moosebar is rising up to the Torrens prominence above. It is not included in the Moosebar as that name is reserved for the striking moosebar topographic recession.

4.2.2.5.1.3 Gates Coal Zone No. 1, Gates Member, Commotion Formation

Mapping (and the logs of the Petro-Canada holes) shows that the thickest coal in the Gates may be found in the 20 to 30 meters above the Torrens Sandstone. In places the coal lies directly on top of it. Sometimes there is one thick bed (estimated at 14 m at one ridge on Mt. Belcourt); more often there are two or more thinner beds.

No further seam or zone designations have been made above this lowermost No. 1 Zone, as in the 1980 season the crew did not conduct more than a few traverses to describe the Gates to that level of detail. This can be done as drilling and future work progresses. Any drilling will be placed to end in the Torrens, and so the seams above the No. 1 Zone can be catalogued at the same time.

4.2.2.5.1.4 First Gates Conglomerate, Gates Member, Commotion Formation

Very often there is a somewhat prominent Gates conglomerate forming a massive unit above the Coal Zone No. 1. It is often mappable through a kilometer at a time, and forms a convenient top to the recessive coal zone. It has been mapped where appropriate.

4.2.2.5.2 Boulder Creek Member, Commotion Formation

The Boulder Creek is a prominent sandstone unit above the Gates. The contact (where the Hulcross is not present) is drawn at the beginning of hard, generally gray-weathering, massive, often pebbly sandstone.

The Boulder Creek can often also be followed through many kilometers, and forms the cap on the mapping. Only once was its top mapped, although often it can be seen from the air to be giving away to Shaftesbury shales.

4.3 Geological Structure

The Crows Nest Resources-operated areas in the Five Cabin Creek-Onion Lake-Secus Mountain region of northeastern British Columbia were licenced because of their possibility of containing considerable mileage of the two known prospective formations, the Gething and the Commotion.

The region is approximately 90 km in length. To cover this distance in 64 days of field season, counting all time lost to mobilization and demobilization, weather in a northern Rocky Mountain climate, and incidental losses, the two mapping pairs decided to take a structural approach to the mapping, treating the belt as a whole. This meant acquring actual, measured thickness on the formations and their parts individually. In this manner, drilling with reasonable expectations of being at about the right sites could be planned for the future with no extra effort - the proper positions would become revealed.

Efforts were concentrated in the beginning at traverses across the formations, from Minnes up to Boulder Creek. As the units became clearer, they were extended longitudinally. In this fashion, by chain-measuring selected good exposures across the sequence, and then rapidly following their longitudinal extensions in the topography, the thicknesses for the formations and their parts as expressed in the cross-sections became apparent.

4.3 (continued)

There is a natural rhythm apparent in the thickening and thinning of the formations along the belt.

In the latter part of the season, efforts were directed at refining the sections in the lower part of the Gates, so that the excellent Torrens marker can be used as a guide for the Gates Coal Zone No. 1 immediately above it.

4.3.1 Structural Setting

The problem in mapping on the Onion Lake licences is lack of good outcrop exposure. This is partly due to a glacial mantle, partly due to topography, and partly due to its northeasterly-facing direction (which results in heavy forest and deep overburden).

The basic approach was to box in, volumetrically, the area that could contain coal, whittling down that which is unknown. The thrust limiting the succession along the southwestern long side was mapped in to 200 m horizontal accuracy. The Cadomin and Torrens along the northeastern long side were mapped by chain at selected locations. Where any outcrop was found in the mostly-covered ground elsewhere, it was located as accurately as possible (usually to within 10 m) and examined very carefully. The sequence continues northwest and southeast out of the licences into Petro-Canada licences, and so these property lines define the section at either end of the property.

It is judged at this time that, while continued detail traversing is of course desirable, most of the major features that will be found have been found.

4.3.1 (continued)

In general, there is indeed room for a considerable amount of Gates to be present. This may be seen on the cross-section. Also, however, there appears to be a system of faulted folds almost completely hidden from view. This is due to the close proximity of the Rockies' front-range thrust, which experience shows causes contorted folding northeast of it within 1 km all through this belt of northeastern British Columbia. The hidden part of Onion Lake is about that width.

Maping the thrust position showed that the fault is bevelling the available Commotion section so that there is much more room at the south end of the property than the north. This would mean that the fold axes in the 1 km distorted zone should be converging with the fault to the north (rather than south). From the several partially exposed folds found within the zone, this indeed appears to be the case.

The first drill hole has been planned to penetrate the undisturbed Gates section (hopefully it is undisturbed) along the northeastern long side of the property. If seams of mineable thickness are found, then continued work may be planned with a better idea of the section.

4.3.2 Stereographic Analysis

137 bedding attitudes (strikes and dips) were plotted by computer in scatter and pole plot contour diagrams.

46 of these were run as a separate set entitled ONWA - Onion Wapiti Anticline. These were taken on the regularly-dipping west flank of the Wapiti Anticline, but not from within the mostly-hidden disturbed zone which forms the bulk of the property. The computed average attitude is a strike of 320 degrees and a dip of 44 degrees southwest.

This average strike is used as the baseline for the grid, and the average dip direction is used as the cross-section's strike. A structural framework for future drilling and mapping is now in place.

The remaining 91 attitudes were run as WEON, or West Onion, so that a stereoplot of these attitudes would be available as work progresses.

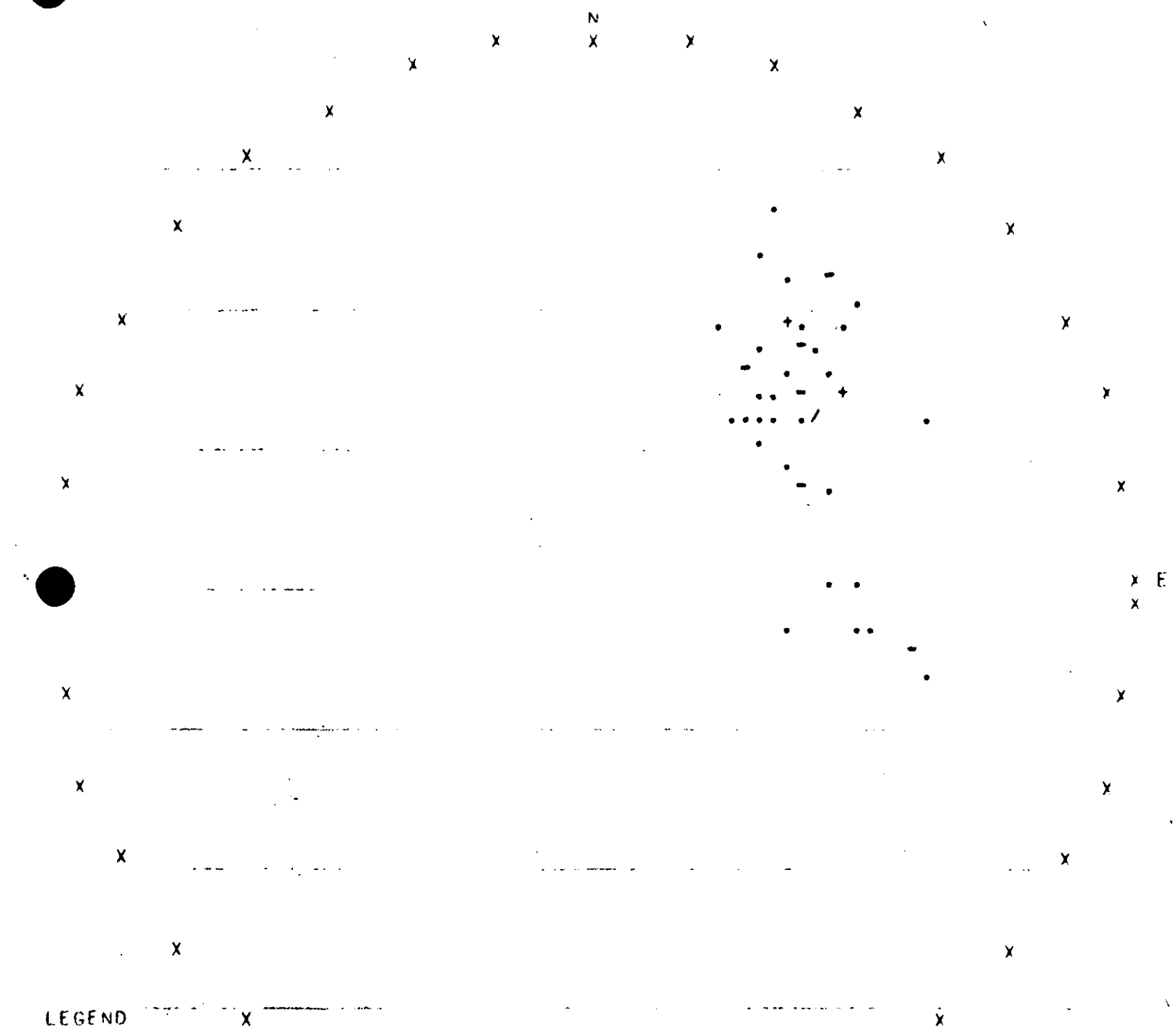
Finally, both sets were run together, to provide a total for the season: ONWA & WEON.

These diagrams are presented on the six pages following.

STEREO 8021559 -- WEST ONION AND ONION KAPITI ANTICLINE -- STRUCTURAL MAPPI

TRAVERSE - ONWA

46 ORIGINAL POLES



LEGEND

.	1 POLE
-	2
+	3
*	4
-9	5,6,7,8,9
-	10,11,...

SCATTER DIAGRAM
LOWER HEMISPHERE
EQUAL AREA PROJECTION

/ MEAN VECTOR = 43.87/ 230.24

FIG. 4

STEREO 8021559 -- WEST UNION AND ONION WAPITI ANTICLINE -- STRUCTURAL WAPITI

TRAVERSE = UNWA

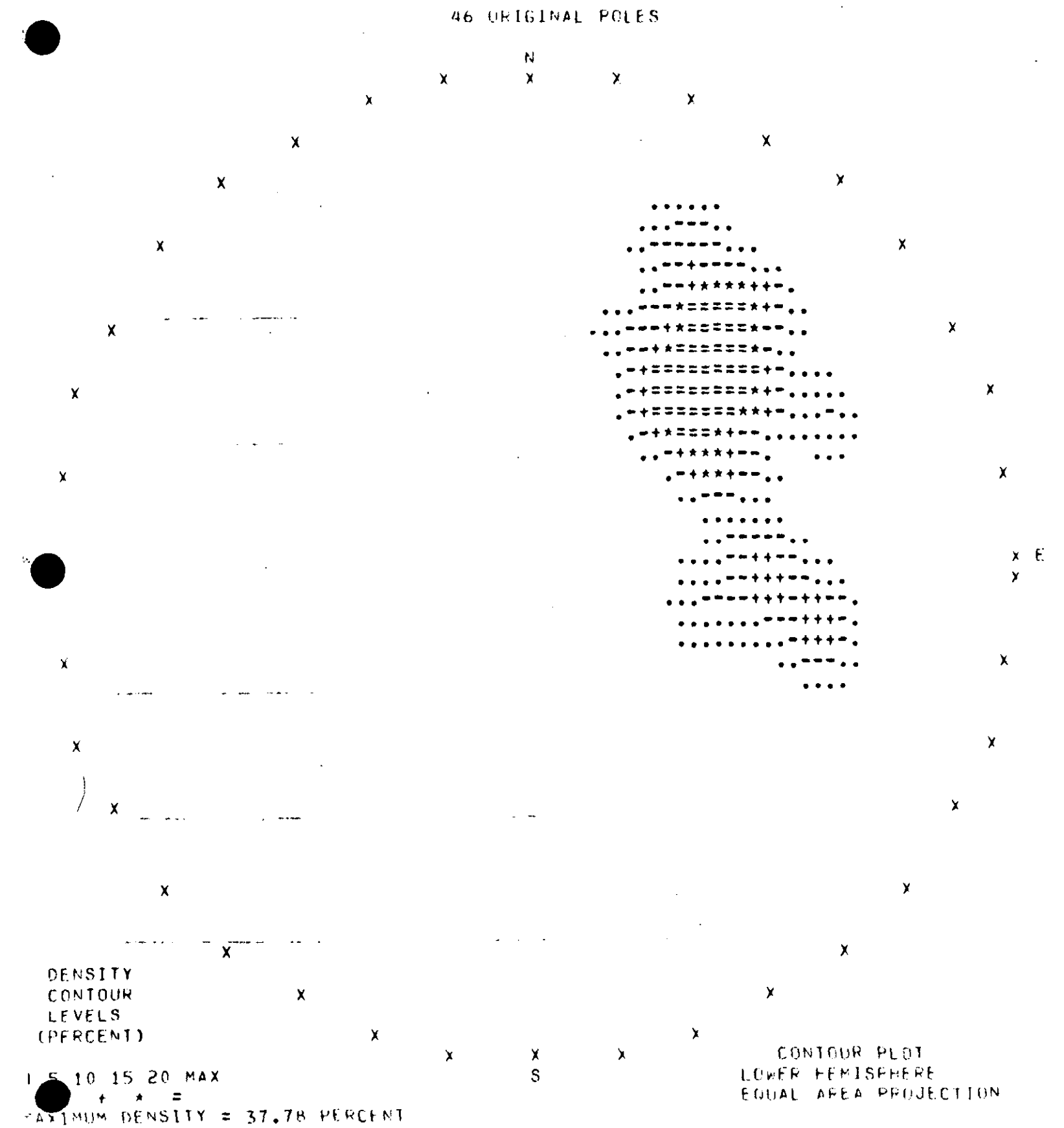


FIG. 5

STEREO 8021559 -- WEST UNION AND ONION PAPITI ANTICLINE -- STRUCTURAL MAPPI

-AVERSE - WEON

91 ORIGINAL POLES

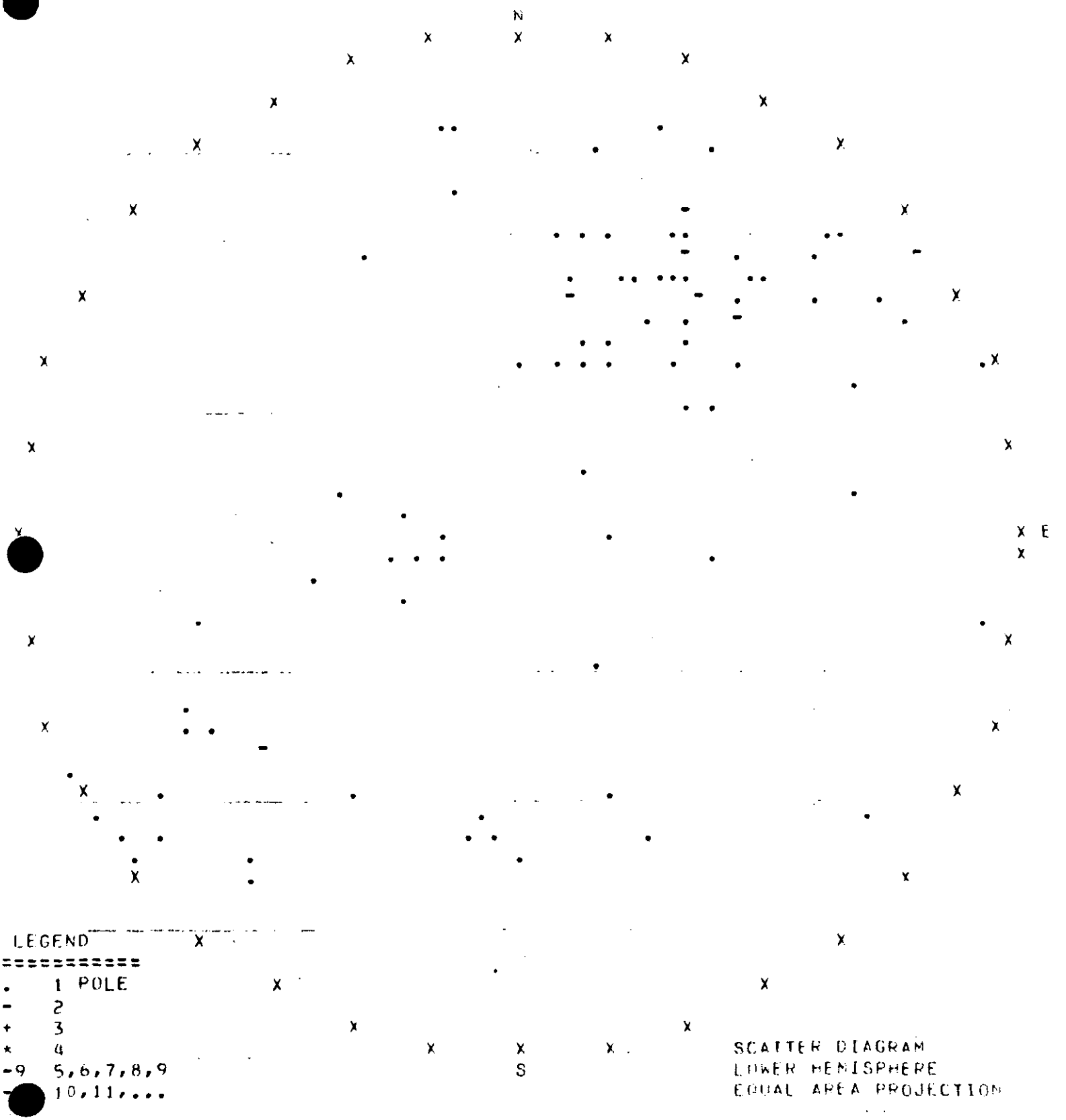


FIG. 6

STEREO 8021559 -- WEST ONION AND ONION KAPITI ANTICLINE -- STRUCTURAL MAPPI

TRAVERSE - WEON

91 ORIGINAL POLES

DENSITY
CONTOUR
LEVELS
(PERCENT)

4 8 12 16 MAX
\+ * =

CONTOUR PLOT
LOWER HEMISPHERE
EQUAL AREA PROJECTION

AXIMUM DENSITY = 16.11 PERCENT

FIG. 7

STEREO 8021559 -- WEST ONION AND ONION WAPITI ANTICLINE -- STRUCTURAL MAPPI

TRAVERSES -- ONWA + WEON

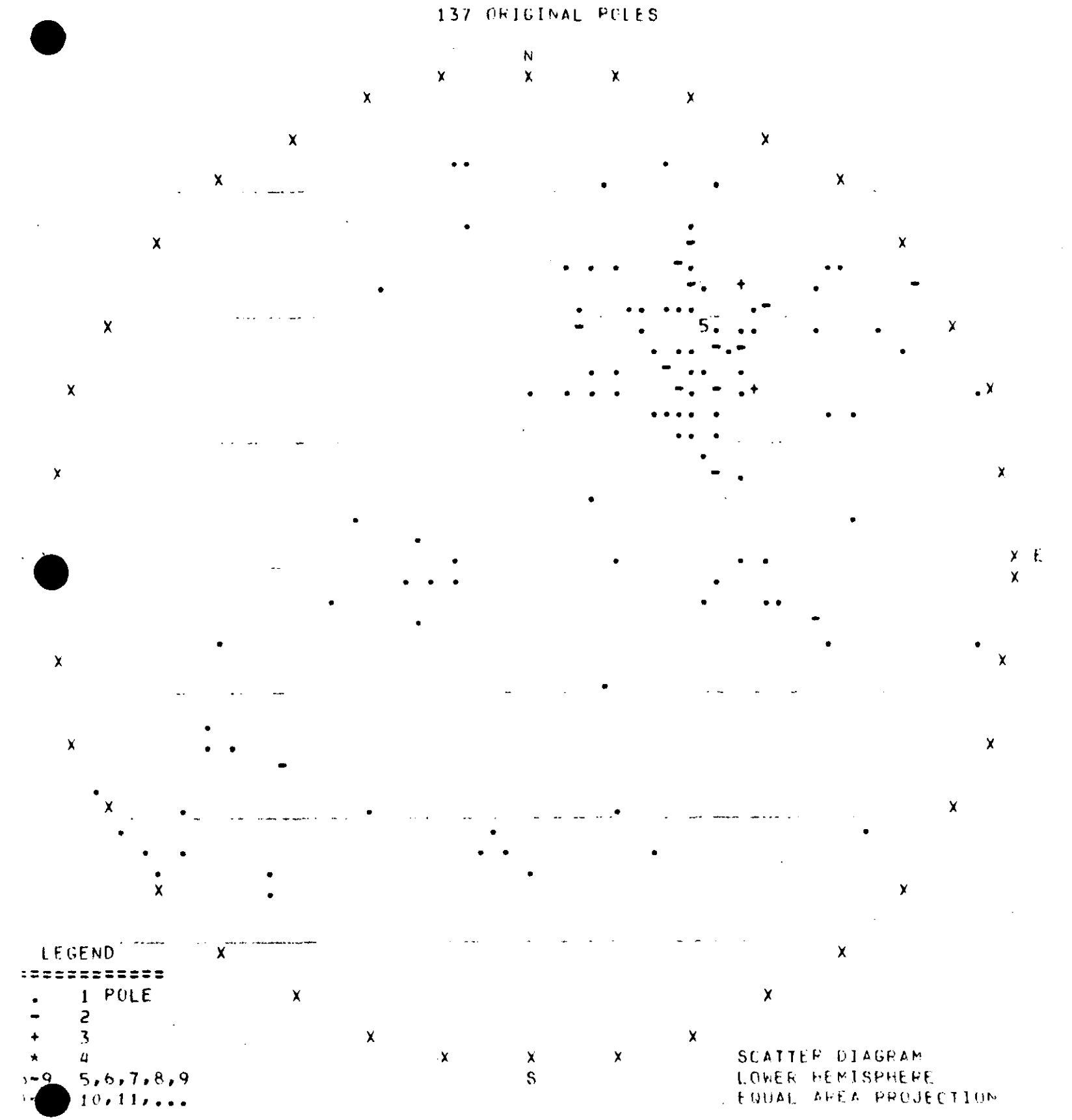


FIG. 8

STEREO 8021559 -- WEST ONION AND ONION KAPITI ANTICLINE -- STRUCTURAL KAPPI

TRAVERSES -- ONWA + WEON

137 ORIGINAL POLES

DENSITY CONTOUR LEVELS (PERCENT)

1 4 8 12 16 MAX

. + * =

MAXIMUM DENSITY = 19.66 PERCENT

CONTOUR PLOT
LOWER HEMISPHERE
EQUAL AREA PROJECTION

FIG. 9

5.0 BIBLIOGRAPHY

Hoffman, Georgia, 1979: "1979 Geological Report, Onion Lake Coal Property"; internal Crows Nest Resources Limited

filed at the B.C. Ministry of Energy, Mines and Petroleum Reosurces

PR-Onion Lake 80(2)A

"Onion Lake Coal Exploration"
1980

Maps, Cross Sections

CL# 4220-4223, 4749

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APPENDIX A

Abbreviations Legend, Geological Base Maps 1:5,000

This part of the legend for the 1:5,000 map sheets is included here because of space limitations on the map sheets themselves.

ABBREVIATIONS LEGEND

GEOLOGICAL BASE MAPS

SCALE 1:5 000

1.	Sizes	cm	centimeters true thickness
		m	meters true thickness
2.	Lithologic Types	cg, cgs	conglomerate, -s
		md	mudstone
		sh	shale
		slt	siltstone
		ss	sandstone
		qzt	quartzite, -itic
3.	Grain Sizes	bld, blds	boulder, -s
		cb, cbs	cobble, -s
		pb, pbs	pebble, -s
		cs	coarse-grained sandstone
		ms	medium-grained sandstone
		fs	fine-grained sandstone
		vfs	very fine-grained sandstone
4.	Bed Thickness	fiss	fissile
		flgy	flaggy
		msv	massive
		plty	platey
5.	Bedding	bd, bds	bed, -s
		intbd	interbedded
		x-bd	cross-bedded
6.	Colours	blk	black
		brn	brown
		grn	green
		gry	gray
		rsty	rusty
		lt	light
		drk	dark
7.	Miscellaneous	otc, otcs	outcrop, -s
		occ	occasional
		mnr	minor
		cov	covered
		rcv	recessive
		res	resistant
		hd	hard
		ovln	overlain
		unln	underlain
		wth,wthg	weathers, weathering

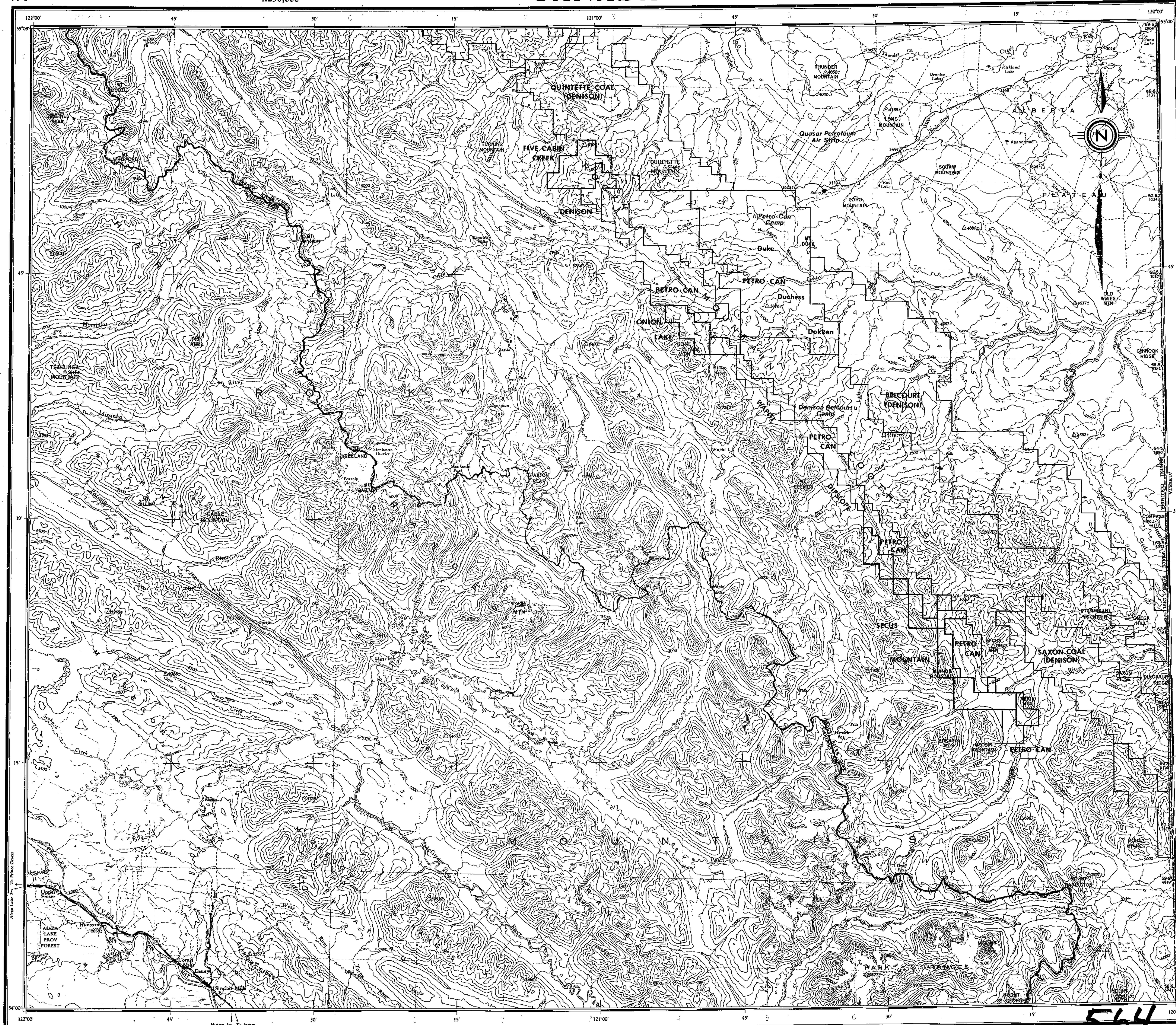
APPENDIX B

1:250,000 Location Map

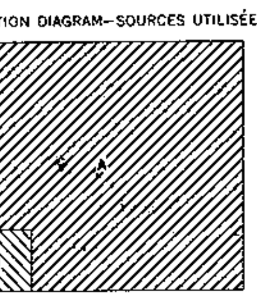
93 I 1:250,000

CANADA

EDITION 1 93 I



COMPILATION DIAGRAM—SOURCES UTILISÉES



A– Large scale topographic manuscripts, photogrammetric, 1956–59
B– Large scale topographic maps, photogrammetric, 1961.

A– Manuscrits topographiques et photogrammétriques à grande échelle, de 1956–59
B– Cartes topographiques et photogrammétriques à grande échelle, de 1961.

Produced by the ARMY SURVEY ESTABLISHMENT, R.C.E.
Information depicted current as of 1963. Printed 1966.

1964 Magnetic declination for this map varies from 26°44' easterly at the centre of the west edge to 26°24' easterly at the centre of the east edge. Annual change decreasing 3.7'

Crows Nest Resources Limited

EXPLORATION

SECUS MOUNTAIN
N.E. B.C.

LOCATION MAP

Scale 1:250,000 Échelle

Miles 5 0 5 10 15 20 Milles

Kilometres 5 0 5 10 15 20 25 30 Kilomètres

Transverse Mercator Projection
North American Datum 1927
Contour Interval 500 feet
Elevations in feet above Mean Sea Level

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927
Équidistance des courbes 500 pieds
Élévations en pieds au-dessus du niveau moyen de la mer

Copies may be obtained from the Map Distribution Office, Department of Mines and Technical Surveys, Ottawa.

Ces cartes sont en vente au Bureau de distribution des cartes, ministère des Mines et des Relevés techniques, Ottawa.

Publiée par le SERVICE TOPOGRAPHIQUE DE L'ARMÉE, (G.R.C.) Renseignements à jour en 1963. Imprimée en 1966.

La déclinaison magnétique (1964) varie de 26°44' vers l'est au centre de la bordure ouest de la feuille à 26°24' vers l'est au centre de la bordure est. Variation annuelle décroissante 3.7'

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PR-Onion Lake 80(2)A
APPENDIX B

Roads: / Routes:
- hard surface, all weather .... pavée, toute saison ..... more than 2 lanes / plus de 2 voies; 2 lanes / 2 voies; less than 2 lanes / moins de 2 voies
- loose surface, all weather .... de gravier, toute saison ... 2 lanes or more / 2 voies ou plus; less than 2 lanes / moins de 2 voies; dry weather / période sèche
- cart track or trail .... de terre ou sentier

Railway, normal gauge . Chemin de fer, écartement normal: station / gare; multiple track / voies multiples; flagstop / arrêt; single track / voie unique; (abandoned) / (abandonné)

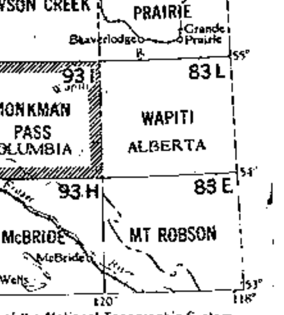
Township or Parish .... Canton ou Paroisse ...... surveyed / levée; unsurveyed / non levée

Depression contours .... Courbes de cuvette

Spot elevation; precise, approximate ..... Point coté; précis, approximatif ..... 950 . 950±

Power transmission line ..... Ligne de transport d'énergie

Town	Ville	Stream intermittent or dry	Cours d'eau intermittent ou à sec
Village or Settlement	Village ou hameau	Intermittent lake	Lac intermittent
Post Office	Bureau de poste	Rapids; falls	Rapides; chute
Church	Église	Marsh or Swamp	Marais ou marécage
School	École	Lighthouse	Phare
Boundary monument	Borne-frontière	Horizontal control point	Point géodésique
Airport	Aéroport	Landing ground	Piste d'atterrissage
Seaplane base	Base d'hydravions	Seaplane anchorage	Amarrage d'hydravions

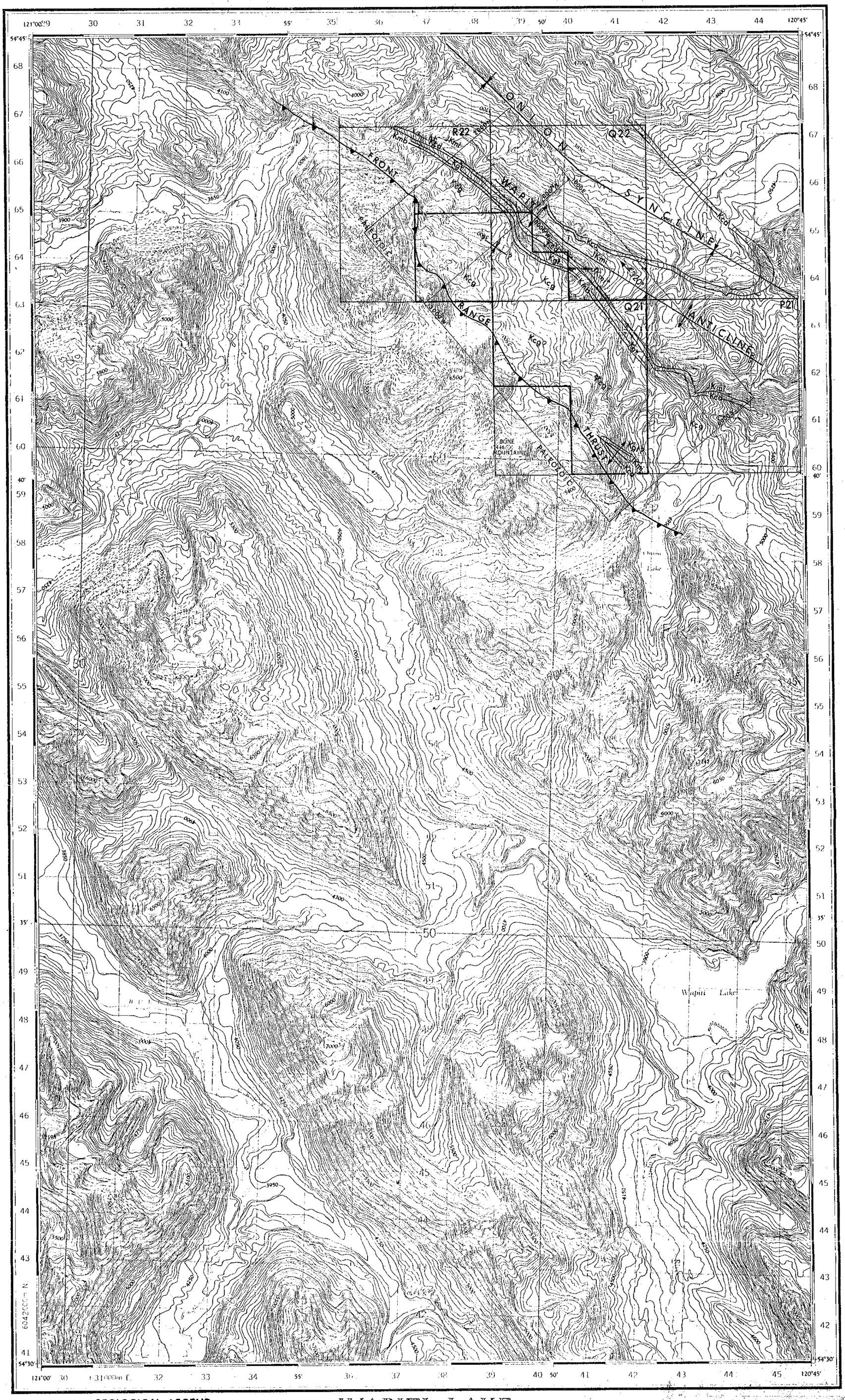


Index to adjoining maps of the National Topographic System
Tableau d'assemblage du Système National de Référence Cartographique

MONKMAN PASS
93 I
EDITION 1

APPENDIX C

1:50,000 Index and Geological Compilation Map



GEOLOGICAL LEGEND

LOWER CRETACEOUS

- Kcg — COMMOTION FORMATION (Gates Member)
- Kmb — MOOSEBAR FORMATION
- Kgt — GETHING FORMATION
- Kcd — CADOMIN FORMATION

FORT ST. JOHN GROUP

BULLHEAD GROUP

JURASSIC - CRETACEOUS

- JKmi — MINNES GROUP

WAPITI LAKE

PEACE RIVER DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Metres 1000 500 0 1000 2000 3000 4000 Metres

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Crows Nest Resources Limited

EXPLORATION APPENDIX C

ONION LAKE

N.E. B.C.

INDEX AND GEOLOGICAL COMPILATION MAP

PR-Onion Lake 80 C/2A

WAPITI LAKE 93 I/10W

AUTHOR: D. BELL	SCALE: 1 : 50,000	ENCLOSURE No:
DATE: MARCH 81	REVISED:	DRAWING No HK-70A
To Accompany		

APPENDIX D

1:25,000 Index and Geological Compilation Map

T S R Q P

121° 00' 00" 120° 57' 00" 120° 54' 00" 120° 51' 00" 120° 48' 00" 120° 45' 00"

54° 50' 25 54° 48' 24 54° 46' 23 54° 44' 22 54° 42' 21 54° 40' 20

N

KINUSEO FALLS

KINUSEO CREEK

ONION CREEK

CABIN CREEK

FELLERS CREEK

ONION LAKE

WAPITI SYNCLINE

WAPITI ANTICLINE

ONION SYNCLINE

PALEOZOICS

LINE OF CROSS-SECTION

Z Z'

Kcg Kmb Kgt Kcd Kcb JKmi

CL 4223 CL 4222 CL 4221 CL 4220 CL 4749

@ MDD 76-8 MDD 76-6 @ 76-8

CNRL PETRO CANADA

NOTE: STRUCTURAL CONTORTIONS WITHIN 1 km OF FRONT RANGE THRUST.

PALEOZOICS WAPITI ANTICLINE ONION SYNCLINE

2,000 1,500 1,000 500

TOPOGRAPHIC LEGEND

- MAIN ACCESS ROAD — DRY WEATHER
- EXPLORATION ROAD
- EXPLORATION TRAIL
- AIR STRIP
- SEISMIC LINE, CUT LINE
- POWER TRANSMISSION LINE
- RIVER
- STREAM
- LAKE
- SWAMP
- CONTOURS 1625 1500
- DEPRESSION CONTOUR

GEOLOGICAL LEGEND

LOWER CRETACEOUS

- Ksh SHAFTESBURY FORMATION
- Kcb COMMOTION FORMATION (Boulder Creek Member)
- Kch COMMOTION FORMATION (Hulcross Member)
- Kcg COMMOTION FORMATION (Gates Member)
- Kmb MOOSEBAR FORMATION
- Kgt GETHING FORMATION
- Kcd CADOMIN FORMATION

FORT ST. JOHN GROUP

BULLHEAD GROUP

JURASSIC — CRETACEOUS

- JKmi MINNES GROUP

PALEOZOIC

- P DEVONIAN, MISSISSIPPIAN

SYMBOLS

- GEOLOGICAL CONTACT
- DIP AND STRIKE: REGULAR
- VERTICAL
- HORIZONTAL
- OVERTURNED
- THRUST: FLAGS SHOW DIP DIRECTION
- NORMAL FAULT
- ANTICLINE, SYNCLINE
- DRILL HOLE COLLAR
- TRENCH
- ADIT

KEY MAP

SURVEY NOTE

Control Survey was carried out for Photogrammetric Mapping to cover MONKMAN COAL PROJECT COAL LEASES. Mapping outside of the Coal Leases was taken from existing N.T.S. maps, and 25 metre contour intervals were interpolated.

CONTOUR INTERVAL 25m

R.M. HAROY & ASSOCIATES LTD.

1978

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Crows Nest Resources Limited

EXPLORATION APPENDIX D

ONION LAKE
N.E. B.C.

GEOLOGIC COMPILATION

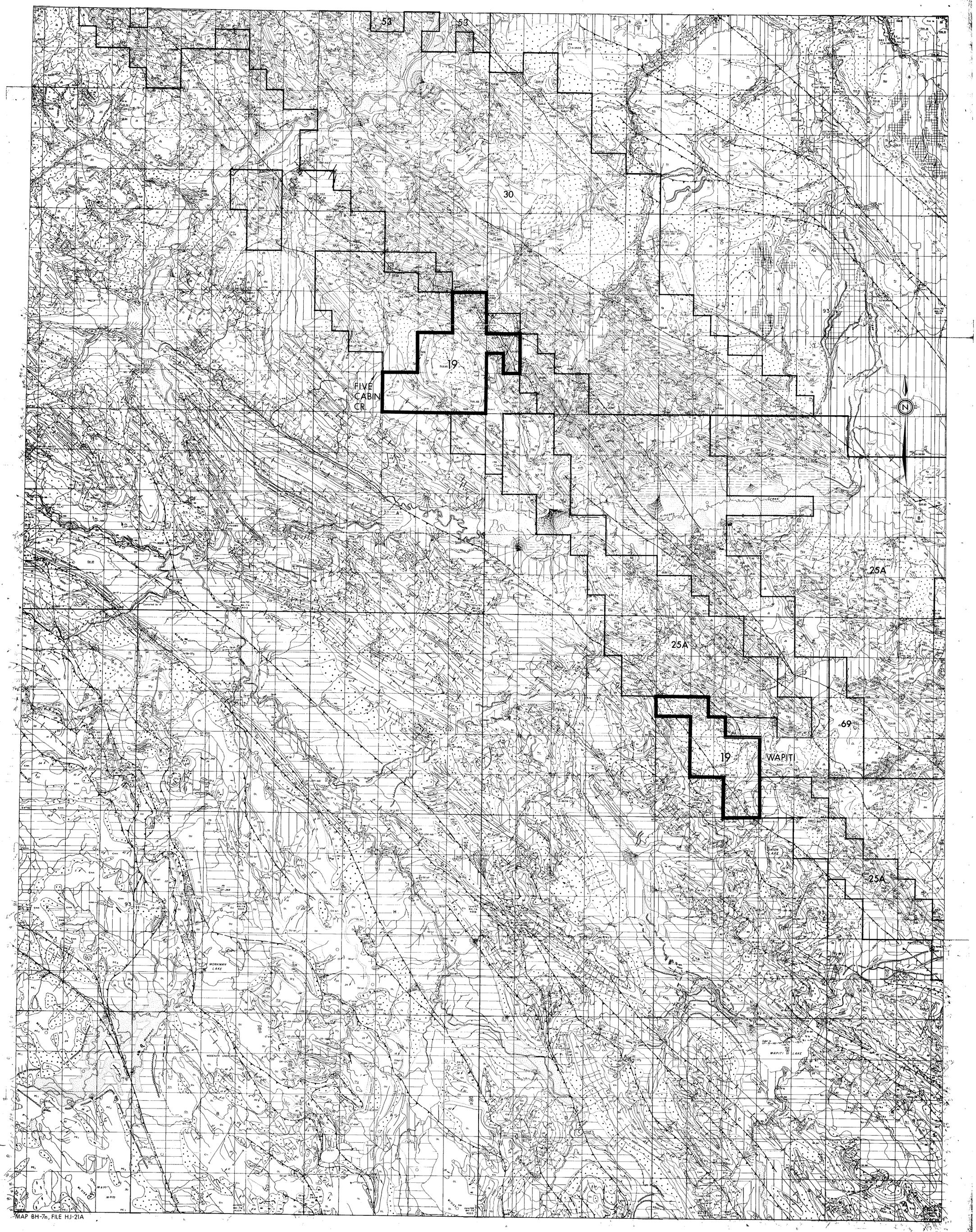
km 5 0 5 10 15 km

PR- Onion Lake 80(2)A

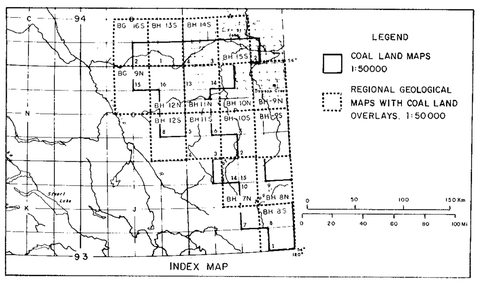
AUTHOR: A. WHITE	SCALE: 1 : 25 000	ENCLOSURE No:
DATE: 81 03 06	REVISED:	DRAWING No: HJ-69D
To Accompany WAPITI DIP SLOPE COMPILATIONS		

APPENDIX E

Regional 1:50,000 Geologic Map

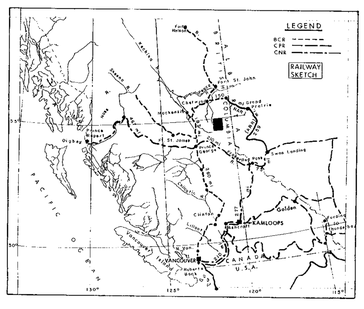


MAP BH-7n, FILE HJ-21A



LEGEND

18. MASTER EXPLORATIONS LTD. (MANALTA COAL LTD.)
19. SHELL CANADA RESOURCES LIMITED – CROWS NEST RESOURCES LIMITED (OPERATOR)
22. DENISON COAL LTD. AND/OR DENISON MINES LTD.
23. BRAMEDA RESOURCES LTD.
23A. BRAMEDA RESOURCES LTD. OPTIONED TO RANGER OIL (CANADA) LIMITED (30% CARRIED INTEREST TO BRAMEDA RESOURCES LTD.) – MOUNT SPIEKER PROPERTY AND RANGER OIL (CANADA) LIMITED
23B. BRAMEDA RESOURCES LTD. – BURNT RIVER PROPERTY
24. BRAMEDA RESOURCES LTD. & TECK CORPORATION LTD.
25. McINTYRE MINES LIMITED
25A. McINTYRE MINES LIMITED & CANADIAN SUPERIOR EXPLORATION LIMITED OPTIONED TO PACIFIC PETROLEUMS LTD.
26. CINNABAR PEAK MINES LTD.
28. UTAH MINES LTD.
28B. UTAH MINES LTD. – BH1 PROPERTY
29. BELCOURT COAL LIMITED (DENISON COAL LTD. – 66% GULF OIL CANADA LIMITED – 40%)
30. QUINTETTE COAL LIMITED (DENISON COAL LTD. – 38¾% WITH PARTNERS MITSUI MINING CO. – 22½% TOKYO BOEKI LTD. 22½% AND IMPERIAL OIL LIMITED – 16 3/4%)
31. SAXON COAL LIMITED (DENISON COAL LTD. WITH PARTNERS RUHRKOHLE AG, MITSUI AND CO. LTD., UNION SIDERURGIQUE DU NORD ET DE L'EST SA DE LA FRANCE)
33. GENTHERM COAL LIMITED (DENISON COAL LTD.)
44A. BP EXPLORATION CANADA LIMITED
44B. BP EXPLORATION CANADA LIMITED (BP CANADA LIMITED AND BP CANADIAN HOLDINGS LTD., GETHING COAL MEASURES; BRAMEDA RESOURCES LTD., GATES COAL MEASURES) – BULLMOOSE PROPERTY
44C. BP EXPLORATION CANADA LIMITED – CHAMBERLAIN PROPERTY
47. NORCEN ENERGY RESOURCES LTD.
49. GULF OIL CANADA LIMITED
53. DUPONT OF CANADA EXPLORATION LTD.
60. PAN OCEAN OIL LTD.
60A. PAN OCEAN OIL LTD. OPTIONED TO NORCEN ENERGY RESOURCES LTD.
69. PACIFIC PETROLEUMS LTD.
78. J.W. MACLEOD
80. IMPERIAL OIL LIMITED/ESSO RESOURCES LTD.
101. BP EXPLORATION LIMITED, BP CANADIAN HOLDINGS LTD., BRASCAN RESOURCES LIMITED (12½%), AND COALITION MINING LTD.
107. BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
107A. BRITISH COLUMBIA HYDRO AND POWER AUTHORITY & AYLARD, GETHING, AND GREEN



564

Crows Nest Resources Limited

EXPLORATION

APPENDIX 6

N.E. BRITISH COLUMBIA

REGIONAL GEOLOGICAL MAPS WITH COAL LAND OVERLAYS

BH-7N

SHELL-CNRL PROJECTS
WAPITI-FIVE CABIN CR

NTS 93I/10W,11E,14E,15W
PR-Onion Lake 80(2)A

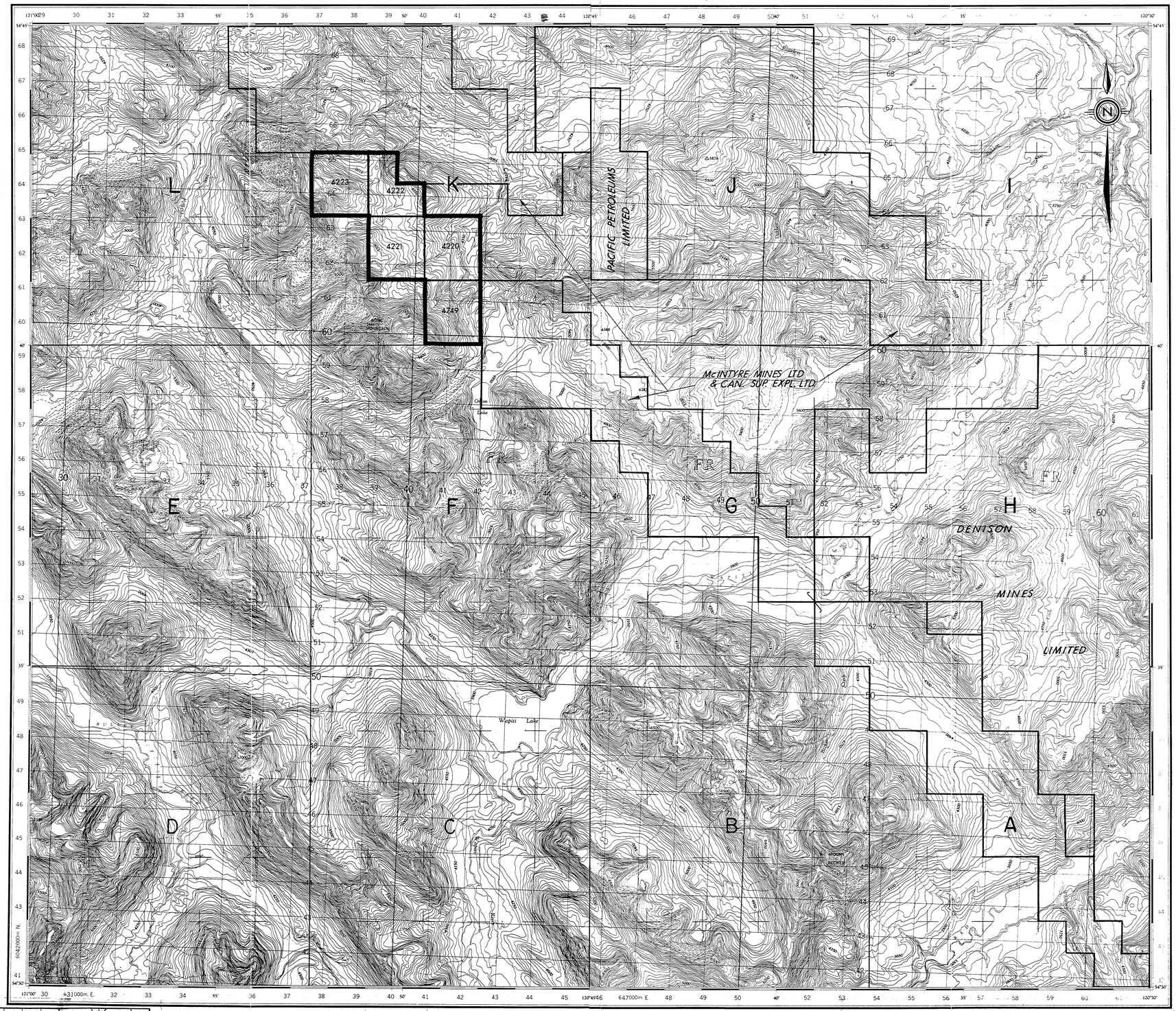
AUTHOR: MARTONHEGYI	SCALE: 1:50000	ENCLOSURE No.:
DATE: MAY 1979	REVISED:	DRAWING No: HJ-21A
To Accompany		

APPENDIX F

Coal Land 1:50,000 Disposition Map (1)

93 I/10W 1:50,000 CANADA EDITION 1

1:50,000 CANADA EDITION 1 93 I/10E

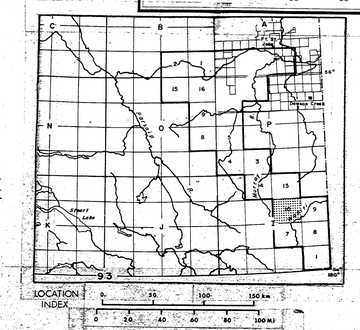


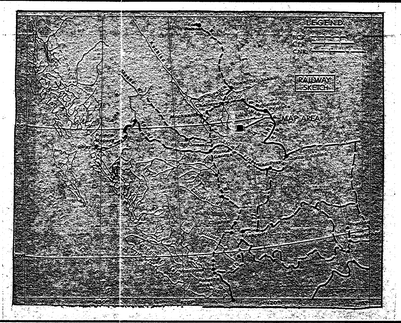
184.53
184.57
184.60
184.64
184.68
184.72
184.76
184.80
184.83
184.87
184.91
184.95
184.98
185.02
185.05
185.09
185.13
185.17
185.21
185.25
185.28
185.32
185.36
185.40
185.43
185.47
185.51
185.55
185.59
185.63

121°00' 30 631000m. E. 32 33 34 55' 36 37 38 39 40 50' 41 42 43 44 45 120°45'46 647000m. E. 48 49 50 40' 52 53 54 55 56 35' 57 58 59 60 120°30'

604200m. N.

54°45' 54°30'





WAPITI LAKE

PEACE RIVER DISTRICT

BRITISH COLUMBIA

SCALE 1:50,000 ÉCHELLE

Miles 0 1 2 3 Miles

Metres 1000 500 0 1000 2000 3000 4000 Metres

Yards 1000 500 0 1000 2000 3000 4000 Yards

CONTOUR INTERVAL 50 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 25°42' EAST
AT CENTRE OF MAP 1965
Annual change decreasing 4.0'

ÉQUIDISTANCE DES COURBES 50 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1965 : 25°42' EST
Variation annuelle décroissante 4.0'

Crows Nest Resources Limited

EXPLORATION

APPENDIX F

564

WAPITI LAKE

NORTHEASTERN B.C.
PEACE RIVER LAND DISTRICT

COAL LAND DISPOSITION MAP

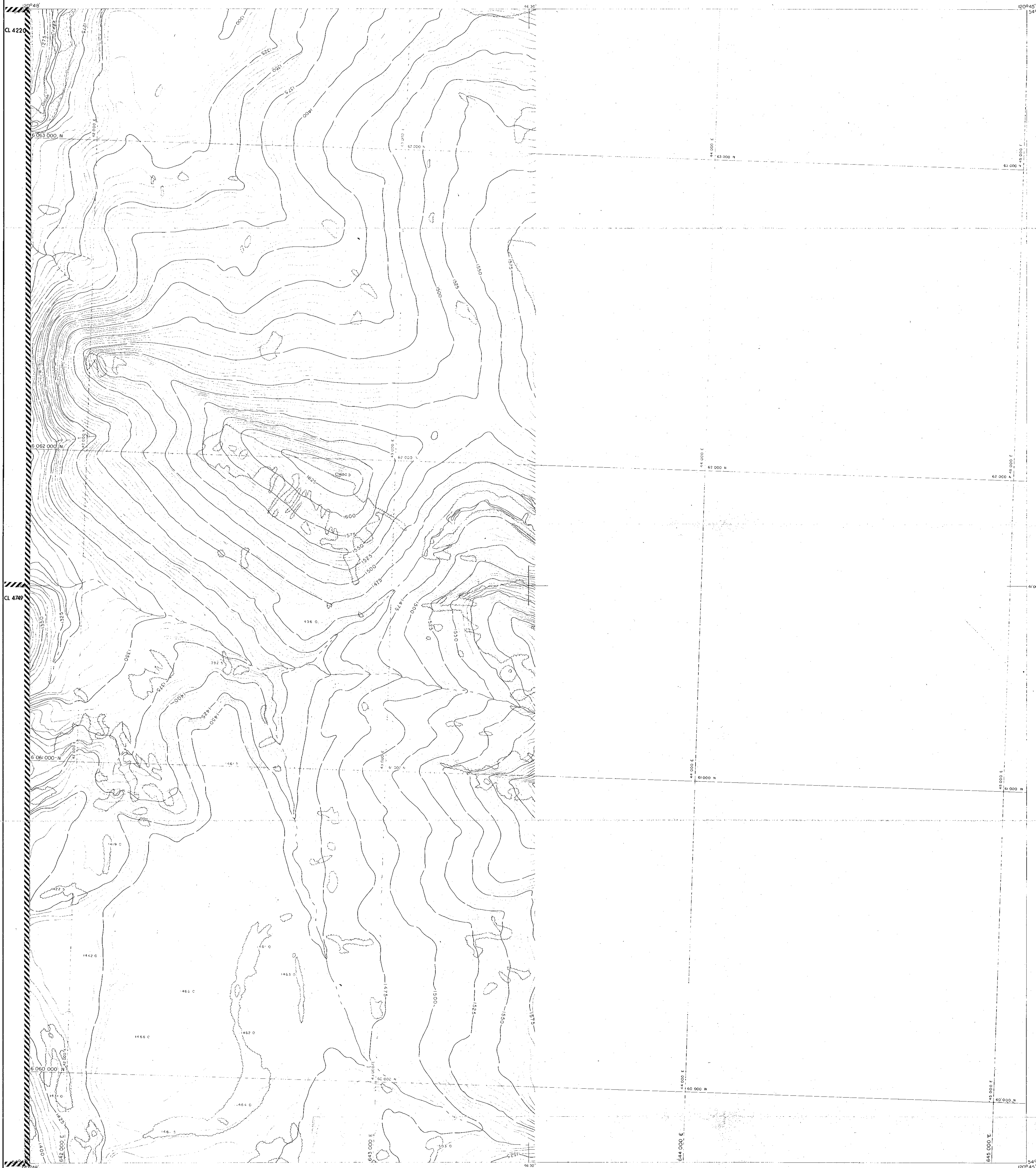
SHELL - CNRL LICENCES : ONION LAKE (WAPITI)
NTS 93- I -10 BLK K
MAP 1 OF 1

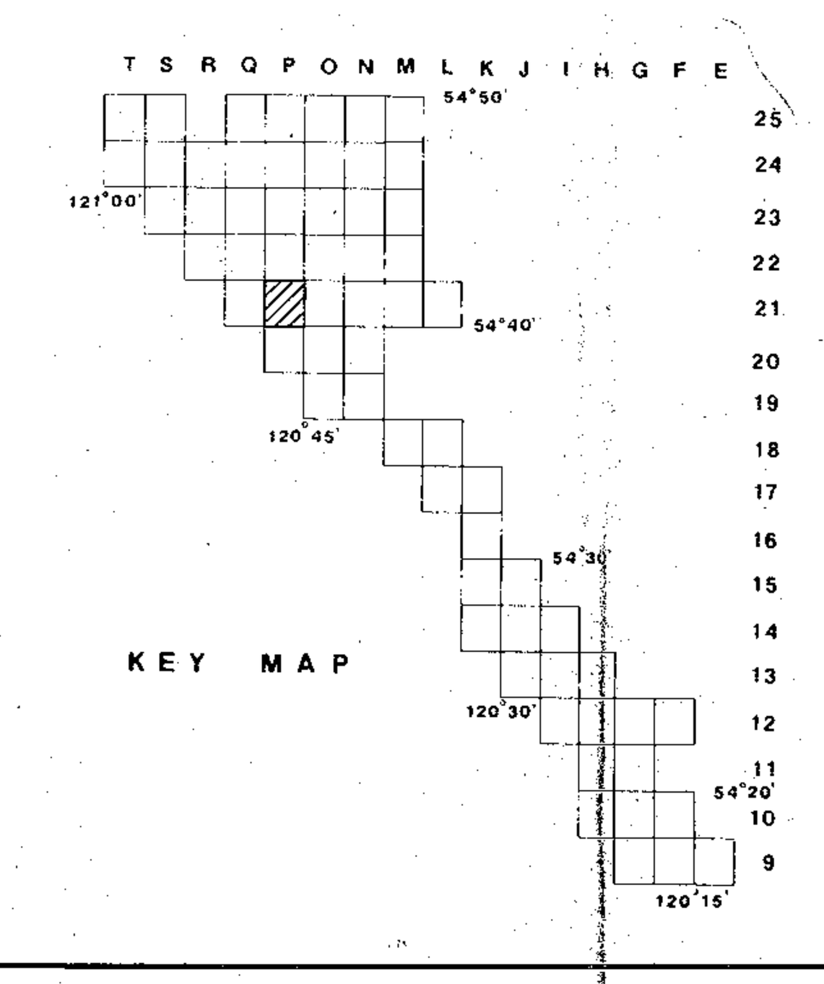
PR-Onion Lake 80(2)A NTS 93 I/10

AUTHOR: OLSON-MARTONHEGYI	SCALE: 1:50 000	ENCLOSURE No :
DATE: DEC. 1979	REVISED:	DRAWING No: HC-18B
To Accompany		

APPENDIX G

1:5,000 Geologic Base Maps (4)





LEGEND

Improved road
Secondary road
Track or trail
Cut line
Tree area
River
Steam
Intermittent stream
Swamp
Contours — 1300
Horizontal control — △ 390
Vertical control — ○ V 1372
Spot elevation — 1247 9
Iron Pin — ◇ IP

CONTOUR INTERVAL: 5 METRES
DATE OF PHOTOGRAPHY: SEPTEMBER 1975
DATE OF SURVEY: 1977 - 1978
DATE OF MAPPING: 1977 - 1978

SURVEY NOTE

The Horizontal and Vertical Co-ordinates were established by D W Watson, B C L S using conventional and E D M survey equipment. Horizontal and vertical co-ordinates and elevations are derived from Trig. Stations Quintette E, Quintette S W, Mamie, Hawk, Marcia, Kinuseo. All co-ordinates referred to Universal Traverse Mercator Grid Zone 10. Elevations are above Mean Sea Level were established by trig levelling vertical angles being read at both ends of each course simultaneously

Scale 1:5000

Metres 100 0 100 200 300 400 500

564

Crows Nest Resources Limited

EXPLORATION APPENDIX G

ONION LAKE

N.E. BRITISH COLUMBIA

No Geology + No outcrops on map ∴ Not digitized

PR-Onion Lake 80(2)A P 21

AUTHOR: D. BELL	SCALE: 1 : 5000	ENCLOSURE No:
DATE: MAR/81	REVISED:	DRAWING No: HG-70
To Accompany		

CL 4223 CL 4222 CL 4221 CL 4220

NOTE: This entire region north of Outwash Creek is composed of hummocky glacial outwash terrain.

Paleozoic carbonate erratic boulders are common. No outcrop is visible from helicopter. The lower eastern slopes are heavily forested; closer to the barren slopes and cliffs of Bone Mtn. the cover is mostly alpine meadow and tree-line zone – prime grizzly-grazing terrain.

NOTE: This creek was traversed on foot from the the Paleozoics to Onion Creek; the only outcrop is as mapped here. The entire upstream portion is banked by layered glacial gravels; several constituent boulder beds occasionally give the illusion, from helicopter or air-photograph, of flat-lying outcrop.

NOTE: Position of front-range thrust: The position of the thrust was not mapped on the ground on this mapsheet; the position as drawn here is based on mapping from a helicopter and should be accurate to ±300m horizontally.

These two cliff ridges are paleozoic carbonates: therefore the the thrust is mostly buried in the lower scree slopes.

NOTE This mostly-hidden anticline appears to be associated with the near-by front-range thrust and may be typical of the structural distortion which experience shows exists within one km of this thrust along the Rockies front through this part of British Columbia.

NOTE: ONION LAKE is 1.1km. south of the southeast corner of this licence.

NORTH OUTWASH CREEK

OUTWASH CREEK

APPROXIMATE POSITION FRONT RANGE THRUST

BONE MOUNTAIN

BONE MOUNTAIN

MINNES GROUP

CADOMIN

GETHING

MOOSEBAR

GATES

DEADFALL

Heavy forest

Heavy forest, low visibility along Onion Creek

Hummocky glacial outwash terrain covered with tree-line brush, no outcrop visible from helicopter.

Heavily forested abundant deadfall

Heavy forest, deadfall

Heavy forest no outcrop

Grassy, no outcrop

Helicopter landing on grassy, rubble-covered knob.

Tree-line zone.

Steep slope with a 40% exposure of CADOMIN cg in small cliff faces.

Stream has strong flow of water. Banks are 5-10m. high and are composed of glacial till.

This stream section is approximately 40% exposed outcrop: brn Minnes cg with minor ss and carbonate trash.

Cliffs of Paleozoic Carbonates

Cg; brn, sandy mx, closely packed pebbles, occ. sand lense

brn, pb-cg; brn, fs, well sorted, bedded

pb-cg

brn, pb-cg & mod. sandy mx.

soft brn, pb & cb-cg; abundant brn & gry pbs, occ. white qtz or light-grn pbs;

MINNES cg brn-stained cbs in a brn, soft, sandy matrix; cbs are easily broken out of matrix

CADOMIN cg resistant, gry, closely-packed cbs, eroding into msv 3m × 5m blocks.

CADOMIN cg pbs & blds.

brn, pb-cg with ss cap

brn x-bd ss

brn, platey ss

Covered, some coal bloom

1.5m coal

GATES intbd brn ss & pb-cg

MINNES brn soft cg ss bds≤1m

GETHING ms

GETHING; less resistant, brn pb-cg with occ. 20cm ss beds

CADOMIN cg small outcrop on stream bank.

GETHING brn, soft cg.

swamp

swampy

No outcrop

CL 4749

Scale 1:5000

Metres 100 0 100 200 300 400 500 Metres

LEGEND

Improved road
Secondary road
Track or trail
Cut line
Tree area
River
Steam
Intermittent stream
Swamp
Contours
Horizontal control
Vertical control
Spot elevation
Iron Pin

CONTOUR INTERVAL: 5 METRES
DATE OF PHOTOGRAPHY: SEPTEMBER 1975
DATE OF SURVEY: 1977 - 1978
DATE OF MAPPING: 1977 - 1978

SURVEY NOTE

The Horizontal and Vertical Co-ordinates were established by D. W. Watson, B.C.L.S. using conventional and E.D.M. survey equipment. Horizontal and vertical co-ordinates and elevations are derived from Trig Survey Quintette E, Quintette S.W., Mamie, Hawk, Marcia, Knuseo. All co-ordinates referred to Universal Transverse Mercator Grid Zone 10. Elevations are above Mean Sea Level were established by trig levelling, vertical angles being read at both ends of each course simultaneously.

LOWER CRETACEOUS
- Ksh Shaftesbury
- Kcb Boulder Creek
- Kcg Gates (includes overlying Transition Beds & Torrens Sandstone)
- Kmb Moosebar
- Kgt Gething
- Kcd Cadomin

JURASSIC - CRETACEOUS
- JKmi Minnes Group (undivided)

Thrust fault, position exposed
Thrust fault, position approximate
Fault other than thrust
Anticline
Syncline

Isolated outcrop, sketched to extent and size:
Strike & dip where strike line of symbol touches outcrop outline
Strike & dip where strike & dip lines of symbols intersect
Patchy, indeterminate outcrop
Outcrop with exposed contact
Chain-and-compass line (tick marks are stations) with outcrop sketched to size and limits along chained line; strike & dip where strike line of symbol touches chained line
Chain & compass line; attitudes refer to strike & dip at nearest tick (chain station)

NOTE: See Report for Legend of Abbreviations

KEY MAP

564

Crows Nest Resources Limited
EXPLORATION APPENDIX 6
N.E. B.C.

ONION LAKE PROJECT

DESTROY JUNE 7/92 BY D.S. FRIESEN 564-HG-70B OC only

PR-Onion Lake 80(2)HQ 21

AUTHOR: D. BELL	SCALE: 1:5000	ENCLOSURE NO.:
DATE: MARCH, 1981	REVISED:	
To Accompany		DRAWI HG-70B

120°51'
54°44'
6 067 000 N

120°48'
54°44'

ONION CANYON

ONION SYNCLINE

First Waterfall

Erosion has placed Onion Creek down down the approximate centre of the syncline's axial trace. At this point, the gravel flats give way to the beginning of Onion Canyon, in the waterfall beds of the Boulder Creek.

This northeastern lower slope of Bone Mtn is covered by dense brush & forest with patchy tree cover over the harder units

End of seismic line: As of 1980, this is closest trail to Onion Lake property

This northeastern lower slope of Bone Mtn is covered by dense brush and forest, with patchy brush over the harder units.

6 066 000 N

1 000 N

000 N/S

small ledge CADOMIN qtz ss

Helicopter pick up in grassy trough

CADOMIN

GETHING

MOOSEBAR

TRANSITION BEDS

TORRENS SS

brn TORRENS ss

CL 4223 CL 4222

GORGE

GORGE OUTCROP CREEK

No outcrop visible from helicopter. Gorge is alder and boulder-clad; ground visibility almost zero.

Heavy brush, no outcrop visible from air

brn MINNES cb & bld-cg relatively hd, lg clasts, weathers similar to GETHING

rcv, grass-cov

Major GETHING and CADOMIN units visible on cliffs

Almost continuous MINNES bd-cg

5m brn ss

brn ss

ply ss

TORRENS brn, ply x-bd ss

GATES- Intbd cg & ss

Cliffs of brn MINNES cg

Waterfall is top unit of CADOMIN

top unit of CADOMIN - hd grey pb ss

Cliff face of MINNES cg brn, mod - hd.

1981 Proposed Drill Holes

200 m

MOOSEBAR, thickness 30 m, completely exposed in this gorge, thin overlain by lower TRANSITION BDS under trees near top of bank. At base of bank is top ss unit of GETHING SS.

300 m

grassy cov.

GETHING brown ss

dip slope CADOMIN

hd grey ms

bottom unit CADOMIN typical hd grey cb-cg ~10 m true thickness

Dip-slope GETHING ss, platey

3m brn ss

MSV cliffs of GETHING cg

5m GETHING SS

An obsure fault in GETHING cg and ss

1m GETHING cg

15m intbd brn ss, sll, & sh

2m flaggy brn ss

1m flaggy brn ss

dip slope CADOMIN

This heavily forested slope has patchy CADOMIN outcrop throughout

Swamps, helicopter sites

Swamp

Heavy forest; some swamp

alpine fir & brush at treeline zone. Dense grizzly grazing

6 064 000 N

No outcrop

Swamp, helicopter site

GETHING

MOOSEBAR

CREEK

No outcrop

Swamp

Heavy forest
No outcrop visible from helicopter

GORGE

1 000 S

639 000 E

1 000 W

640 000 E

CL 4221

WAPITI ANTICLINE

MINNES GRP.

CADOMIN

GETHING

Kgt Kcd JKmi

Kcd Kgt Kmb Kcg

No outcrop on this grassy knob; why is it here? The pebbly gravel of which it is composed appears to be of glacial origin

Heavy forest

2 000 S

000 E/W

1 000 E

CL 4220

Scale 1:5000

Metres 100 0 100 200 300 400 500 Metres

LEGEND

- Improved road
- Secondary road
- Track or trail
- Cut line
- Tree area
- River
- Steam
- Intermittent stream
- Swamp
- Contours — 1300
- Horizontal control — 390
- Vertical control — V 372
- Spot elevation — 1247.9
- Iron Pin — IP

CONTOUR INTERVAL: 5 METRES
DATE OF PHOTOGRAPHY: SEPTEMBER 1975
DATE OF SURVEY: 1977 - 1978
DATE OF MAPPING: 1977 - 1978

SURVEY NOTE

The Horizontal and Vertical Co-ordinates were established by D. W. Watson B.C.L.S. using conventional and E.D.M. survey equipment. Horizontal and vertical co-ordinates and elevations are derived from Eng. Stations Quintuple E - Quintette S.W. Mainel Hawk Mainel Kinuseo. All co-ordinates referred to Universal Traverse Mercator Grid Zone "0". Elevations are above Mean Sea Level, were established by trig levelling vertical angles being read at both ends of each course simultaneously.

LOWER CRETACEOUS
- Ksh Shaftesbury
- Kcb Boulder Creek
- Kcg Gates (includes overlying Transition Beds & Torrens Sandstone)
- Kmb Moosebar
- Kgt Gething
- Kcd Cadomin

JURASSIC - CRETACEOUS
- JKmi Minnes Group (undivided)

Thrust fault, position exposed

Thrust fault, position approximate

Fault other than thrust

Anticline

Syncline

Isolated outcrop, sketched to extent and size:

Strike & dip where strike line of symbol touches outcrop outline

Strike & dip where strike & dip lines of symbols intersect

Patchy, indeterminate outcrop

Outcrop with exposed contact

Chain-and-compass line (tick marks are stations) with outcrop sketched to size and limits along chained line; strike & dip where strike line of symbol touches chained line

Chain & compass line; attitudes refer to strike & dip at nearest tick (chain station)

NOTE: See Report for Legend of Abbreviations

KEY MAP

T S R Q P O N M L K J I H G F E

25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9

54°50' 54°40' 54°30' 54°20'

121°00' 120°45' 120°30' 120°15'

564

Crows Nest Resources Limited

EXPLORATION APPENDIX G

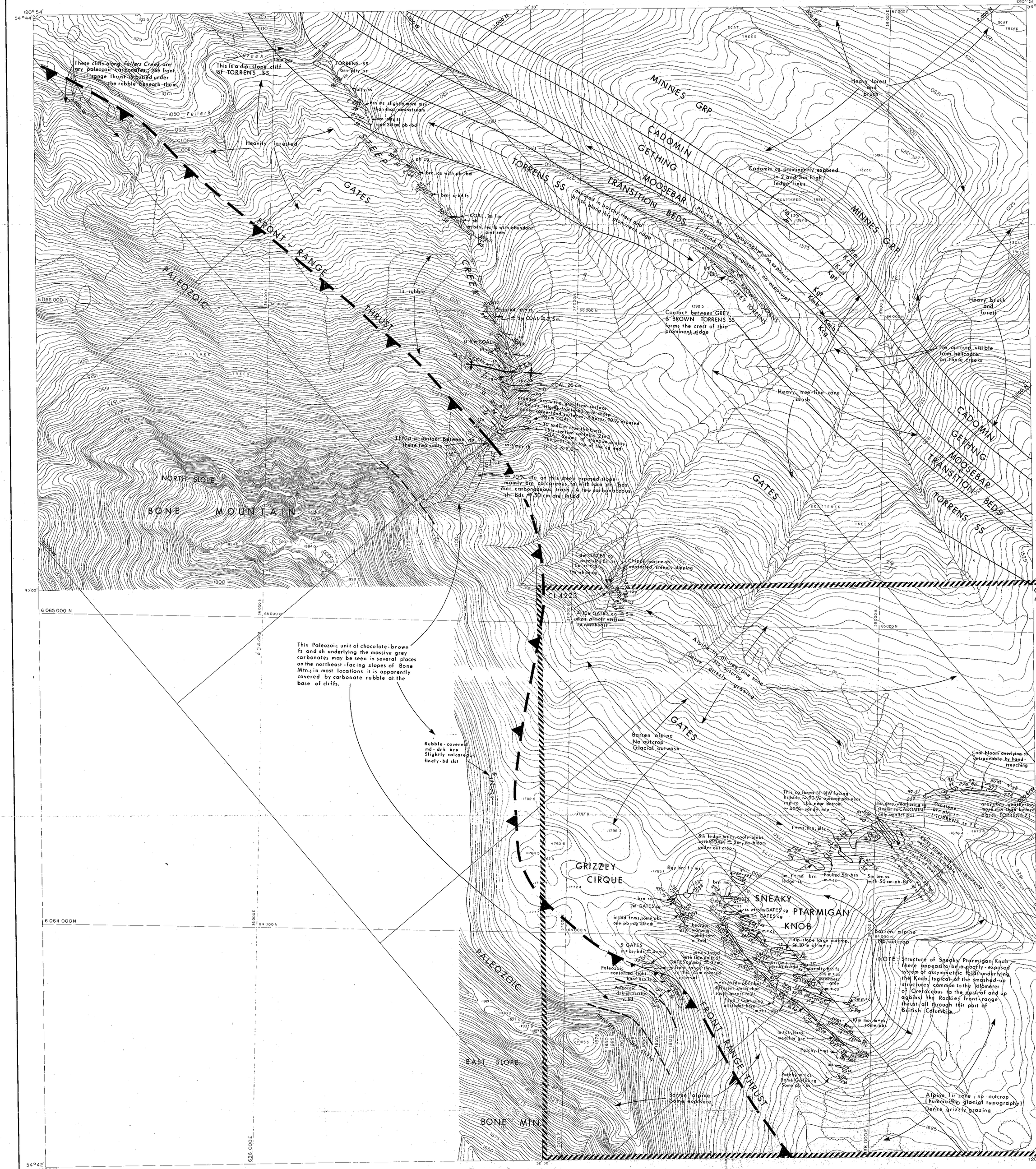
ONION LAKE

Digitized by B.S Stark 6/92 Outcrops only OC File = 564-HG70A

N.E. BRITISH COLUMBIA

PR- Onion Lake 80 (2)A Q22

AUTHOR: D. BELL	SCALE: 1:5000	ENCLOSURE No:
DATE: MAR/81	REVISED:	DRAWING No HG-70A
To Accompany		



Scale 1:5000

Metres 100 0 100 200 300 400 500 Metres

LEGEND

- Improved road
- Secondary road
- Track or trail
- Cut line
- Tree area
- River
- Steam
- Intermittent stream
- Swamp
- Contours 1300
- Horizontal control △ 390
- Vertical control ○ V 1372
- Spot elevation 1247.9
- Iron Pin ◇ IP

CONTOUR INTERVAL: 5 METRES
DATE OF PHOTOGRAPHY: SEPTEMBER 1975
DATE OF SURVEY: 1977 - 1978
DATE OF MAPPING: 1977 - 1978

SURVEY NOTE

The Horizontal and Vertical Co-ordinates were established by D. W. Watson, B.C.L.S. using conventional and E.D.M. survey equipment. Horizontal and vertical co-ordinates and elevations are derived from Trig. Stations Quintette E. Quintette S.W. Marmot Hawk, Marcia, Kinuseo. All co-ordinates referred to Universal Traverse Mercator Grid Zone 10. Elevations are above Mean Sea Level were established by trig. levelling, vertical angles being read at both ends of each course simultaneously.

LOWER CRETACEOUS
- Ksh Shaftesbury
- Kcb Boulder Creek
- Kcg Gates (includes overlying Transition Beds & Torrens Sandstone)
- Kmb Moosebar
- Kgt Gething
- Kcd Cadomin

JURASSIC - CRETACEOUS
- JKmi Minnes Group (undivided)

- Thrust fault, position exposed
- Thrust fault, position approximate
- Fault other than thrust
- Anticline
- Syncline

Isolated outcrop, sketched to extent and size:

Strike & dip where strike line of symbol touches outcrop outline

Strike & dip where strike & dip lines of symbols intersect

Patchy, indeterminate outcrop

Outcrop with exposed contact

Chain-and-compass line (tick marks are stations) with outcrop sketched to size and limits along chained line; strike & dip where strike line of symbol touches chained line

Chain & compass line; attitudes refer to strike & dip at nearest tick (chain station)

NOTE: See Report for Legend of Abbreviations

KEY MAP

T S R Q P O N M L K J I H G F E

25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9

54°50' 54°40' 54°30' 54°20'

121°00' 120°45' 120°30' 120°15'

564

Crows Nest Resources Limited

EXPLORATION APPENDIX G

N.E. BRITISH COLUMBIA

ONION LAKE

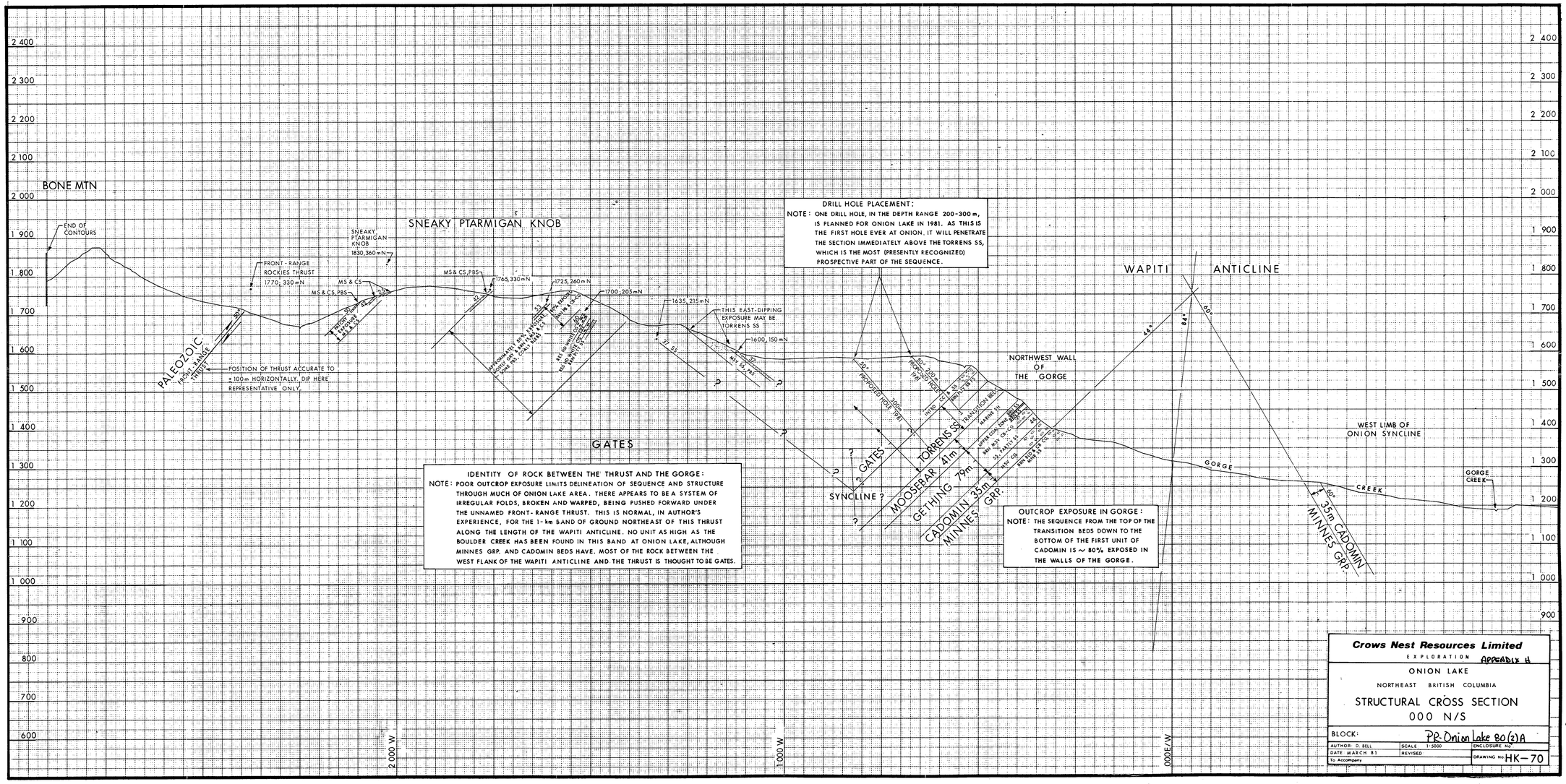
Digitize Jones 6 of 7 By E.S. File Name: SW-HG70C Conly.

PR-Onion Lake 80(2)A R22

AUTHOR: D. BELL	SCALE: 1:5 000	ENCLOSURE No.:
DATE: 81 03	REVISED:	DRAWING No: HG-70C
To Accompany		

APPENDIX H

1:5,000 Structural Cross-Section (1)



DRILL HOLE PLACEMENT:
NOTE: ONE DRILL HOLE, IN THE DEPTH RANGE 200-300 m, IS PLANNED FOR ONION LAKE IN 1981. AS THIS IS THE FIRST HOLE EVER AT ONION, IT WILL PENETRATE THE SECTION IMMEDIATELY ABOVE THE TORRENS SS, WHICH IS THE MOST (PRESENTLY RECOGNIZED) PROSPECTIVE PART OF THE SEQUENCE.

IDENTITY OF ROCK BETWEEN THE THRUST AND THE GORGE:
NOTE: POOR OUTCROP EXPOSURE LIMITS DELINEATION OF SEQUENCE AND STRUCTURE THROUGH MUCH OF ONION LAKE AREA. THERE APPEARS TO BE A SYSTEM OF IRREGULAR FOLDS, BROKEN AND WARPED, BEING PUSHED FORWARD UNDER THE UNNAMED FRONT-RANGE THRUST. THIS IS NORMAL, IN AUTHOR'S EXPERIENCE, FOR THE 1-km BAND OF GROUND NORTHEAST OF THIS THRUST ALONG THE LENGTH OF THE WAPITI ANTICLINE. NO UNIT AS HIGH AS THE BOULDER CREEK HAS BEEN FOUND IN THIS BAND AT ONION LAKE, ALTHOUGH MINNES GRP. AND CADOMIN BEDS HAVE. MOST OF THE ROCK BETWEEN THE WEST FLANK OF THE WAPITI ANTICLINE AND THE THRUST IS THOUGHT TO BE GATES.

OUTCROP EXPOSURE IN GORGE:
NOTE: THE SEQUENCE FROM THE TOP OF THE TRANSITION BEDS DOWN TO THE BOTTOM OF THE FIRST UNIT OF CADOMIN IS ~ 80% EXPOSED IN THE WALLS OF THE GORGE.

Crows Nest Resources Limited
EXPLORATION APPENDIX H

ONION LAKE
NORTHEAST BRITISH COLUMBIA
STRUCTURAL CROSS SECTION
000 N/S

BLOCK: PR-Onion Lake 80(2)A

AUTHOR D. BELL	SCALE 1:5000	ENCLOSURE No.
DATE MARCH 81	REVISED	DRAWING No. HK-70
To Accompany		

564