RECONNAISSANCE GEOLOGY AND COAL POTENTIAL OF THE GROUNDHOG COALFIELD, BRITISH COLUMBIA

by

R.M. Bustin, Ph.D.

Coal Licences Nos. 6916 to 7016 inclusive
Granted April, 1981
Cassier Land District

NATIONAL TOPOGRAPHIC SYSTEM
LOCATION 104A/16 and 104H/1
57° 00' North Latitude, 128° 10' West Longitude

Submitted July 13th, 1982
by
PETRO-CANADA EXPLORATION INC.
COAL DIVISION

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Summary

The Groundhog coalfield is underlain by a thick sequence (4000 m) of Late Jurassic-Early Cretaceous clastic sediments. The strata comprise an overall coarsening upwards (regressive) sequence from marine (Jackson member), through deltaic (Currier and Prudential members), lacustrine and fluvial (McEvoy member) and alluvial plain-alluvial fan (Devils Claw member) deposits. To the north and northeast the facies coarsen. Carbonaceous partings and thin coal seams occur in the McEvoy and Prudential members. The Currier member is the main coal bearing facies and includes coal seams locally up to 4 metres thick.

The coalfield is characterized by a northeast-southwest structural grain. The structure of the Devils Claw and McEvoy members varies from broad open folds to tight upright, northeasterly or southwesterly overturned folds. The Currier, Prudential and Jackson members are everywhere characterized by tight upright to northeasterly overturned folds. Back limb and fore limb thrust faults are common but there is no evidence for major thrusts anywhere in the coalfield. A late phase of normal faulting has resulted in minor offsets.

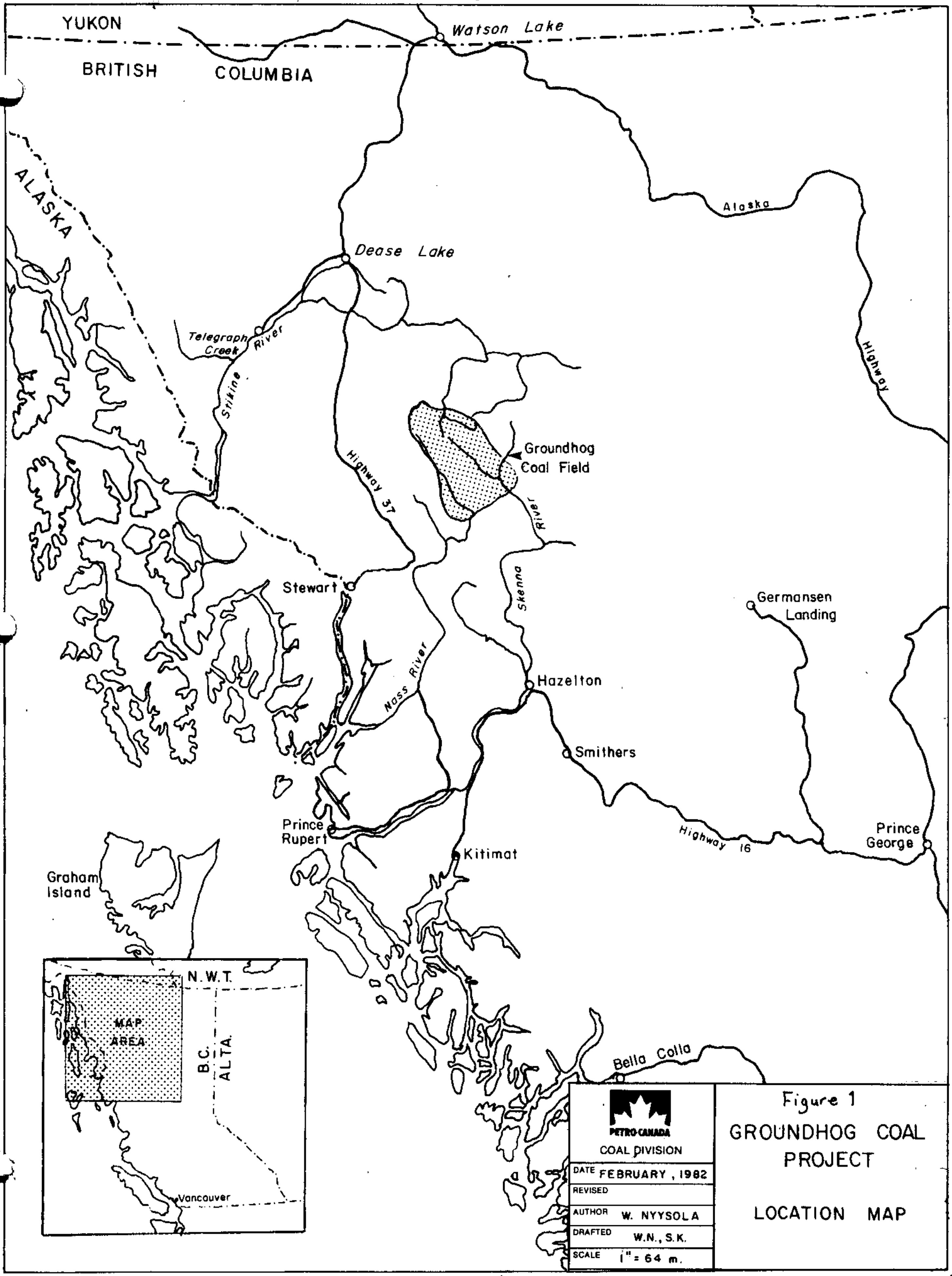
The coal ranges in rank from semi-anthracite to meta-anthracite and semi-graphite. It is commonly sheared, cut by quartz veins, argillaceous with numerous partings and has a highly variable sulphur content (up to 3%). All surface samples are highly oxidized. Because the coal is sheared, oxidation is probably pronounced to several metres from the surface.

The Petro-Canada coal licences are underlain entirely by strata assigned to the Prudential or McEvoy members. Observed coal in the licence area range from carbonaceous partings to rare seams up to 1.5 metres thick.

The licences are considered to have no potential for development because of the absence of seams of suitable thickness and quality, and the preponderance of tight folding which would inhibit conventional mining.

The Currier member crops out in low lying areas along the Skeena River Valley and tributaries, at Mt. Klappan, along Tahtsedle Creek, Panorama Lakes and Mt. Jackson. All areas of significant coal outcrop are presently under licence. Although coal seams up to 4 metres thick locally occur in the Currier member they are considered to have no potential for development in the foreseeable future. The general absence of thick seams, rapid facies changes and tight folding and faulting (which characterizes the Currier member) inhibit conventional mining on a scale that would warrant the establishment of the infrastructure necessary to mine, wash and transport the coal.

It is recommended that the presently held licences be dropped and no further coal exploration be undertaken in the area of the study. Although there is no encouragement for further coal exploration in the Bowser Basin at present, it is recommended that the Geological Survey of Canada mapping programs be closely monitored as well as the activities of the remaining coal licence holders of the area.


YUKON
BRITISH COLUMBIA
Watson Lake
ALASKA
Alaska
Dease Lake
Telegraph Creek
Stikine River
Highway
Highway 37
Groundhog Coal Field
River
Skeena
Stewart
Germansen Landing
Nass River
Hazelton
Smithers
Prince Rupert
Highway 16
Prince George
Kitimat
Graham Island
N.W.T.
MAP AREA
B.C.
ALTA.
Vancouver
Bella Colla
PETRO-CANADA
COAL DIVISION
DATE FEBRUARY, 1982
REVISED
AUTHOR W. NYYSOLA
DRAFTED W.N., S.K.
SCALE 1" = 64 m.
Figure 1
GROUNDHOG COAL PROJECT
LOCATION MAP

Introduction

The Groundhog coalfield is an informal name for a coal bearing region in the Skeena Mountains of central British Columbia (Figure 1). The boundaries of the coalfield have not been defined, but it is generally considered to include parts of the upper Skeena, Nass, Klappan and Spatzizi watersheds (Buckham and Latour, 1950). Although coal has been actively explored for in the coalfield since about 1910, the area has never been mapped, neither the structure nor the stratigraphy resolved and little is known about the distribution of coal.

In order to establish a framework for evaluation of the coal potential of the area a reconnaissance survey was undertaken of the stratigraphy and structure of the coalfield prior to making a more detailed evaluation of Petro-Canada's Kluayaz coal licences. The purpose of this report is to outline the regional stratigraphy and structure of the coalfield, to make a detailed analysis of the geology of Petro-Canada's Kluayaz coal licences and to provide a synthesis of the coal potential of the coalfield.

Acknowledgments

R.M. Bustin, Ph.D. prepared this Groundhog report for Petro-Canada Exploration Inc. Not only was he involved in all aspects of the fieldwork but also provided guidance and expertise to the geological staff.

Geography

Location and Means of Access

The Groundhog coalfield is situated in the Skeena Mountains, Northwestern B.C., District of Cassiar some 270 air kilometers north of Smithers, B.C.

Rivers and lakes are the most easily recognized reference points which define the perimeter of the 'field'. The Skeena River practically runs through the middle of the Groundhog; the Nass Rivers forms the western boundary; and the Spatzizi and Little Klappan Rivers the northern boundary.

The larger lakes to the north are Buckinghorse and Cold Fish while to the south lie Kluayaz and Panorama. Immediately to the northeast of the coalfield lies the Spatzizi Plateau Wilderness Park.

Fixed-wing or helicopter is the most convenient method of transportation into the Groundhog. However, the only lake with a central location that is of sufficient size to land float planes on is Kluayaz. A number of airstrips in good operating condition capable of accommodating heavily loaded twin-engined aircraft are located along the railbed.

There are no roads paralleling the rail line that allow vehicular access into the area.

Topography

The overall topography of the Groundhog Coalfield is mountainous with a mean elevation of 1650 metres.

Broad river valleys such as the Nass and Skeena divide the ranges. Mixed forests of spruce and alder grow on lower elevations and in the river valleys. Wet ground and marshes are quite common. Somewhat unique is the Fireflats, a barren Quaternary outwash plain, which is tundra-like in appearance. The Fireflats extend from northwest of Kluayaz Lake up around Mount Klappan.

Various kinds of wildlife, such as goats, grizzlies, black bears, moose, cariboo and groundhogs inhabit the Groundhog.

Climate

The summer weather in the Groundhog is very unpredictable. During the course of a day the weather can change from one extreme to another. On July 5th a fair snow storm was encountered at higher elevations while rain fell on low-lying areas. Due to the heavy winter snow most north-facing slopes are not accessible until mid-July. Snow still remains on the ground till the end of June.

Field Camp and Services

An outfitters-guide camp, situated on the east shore of Kluayaz Lake was leased to provide accommodations for the field crew. The camp was complete with three cabins, dock, storage facilities, and a functional kitchen - dining room. Three tents were set up to provide extra living quarters.

On June 2nd the exploration group arrived in Smithers. After the necessary camp supplies were packed up and travel arrangements made the crew flew up to Kluayaz Lake on the 5th of June. Mapping work began on the 15th. By mid-August the objectives set for the mapping program had been achieved. The camp was closed on August 18th.

Helicopter support for the project was provided by a Bell 206 contracted from Alpine Helicopters of Kelowna. Fuel and supplies were brought in by fixed-wing aircraft chartered from several companies.

Personnel consisted of six people involved with geology, two helpers, a cook, pilot and engineer. Staff involved with the project are listed in Table 1 and the suppliers and contractors in Table 2.

TABLE 1

LIST OF PERSONNEL EMPLOYED

OFFICE STAFF

E. Schiller	General Manager of Exploration
S. Santiago	Manager of Coal Exploration
A. Karnapke	Geologist
W. Nyysola	Geological Technologist
D. Kinton	Division Landman
S. Klotz	Draftsperson

FIELD STAFF

A. Karnapke	Geologist, Party Chief
W. Nyysola	Geological Technologist

TEMPORARY STAFF

Dr. R. M. Bustin	Consultant
K. Ladouceur	Assistant Party Chief
E. van der Flier	Geologist
M. Back	Geological Assistant
J. Davis	Field Assistant
T. Jerhoff	Field Assistant
B. McLean	Cook

TABLE 2

LIST OF CONTRACTORS AND SERVICES

AIRCRAFT CHARTER

Kelowna Flightcraft	Kelowna, B.C.
Alpine Helicopters	Kelowna, B.C.
Smithers Air Service	Smithers, B.C.
Trans Provincial Airlines	Terrace, B.C.

CAMP

Collingwood Bros.	Smithers, B.C.

CONSULTANT

Dr. R. M. Bustin	Vancouver, B.C.

GRAPHIC SERVICES

R.M. Hardy & Associates	Calgary, Alta.
West Canadian Graphics	Calgary, Alta.

EXPEDITOR

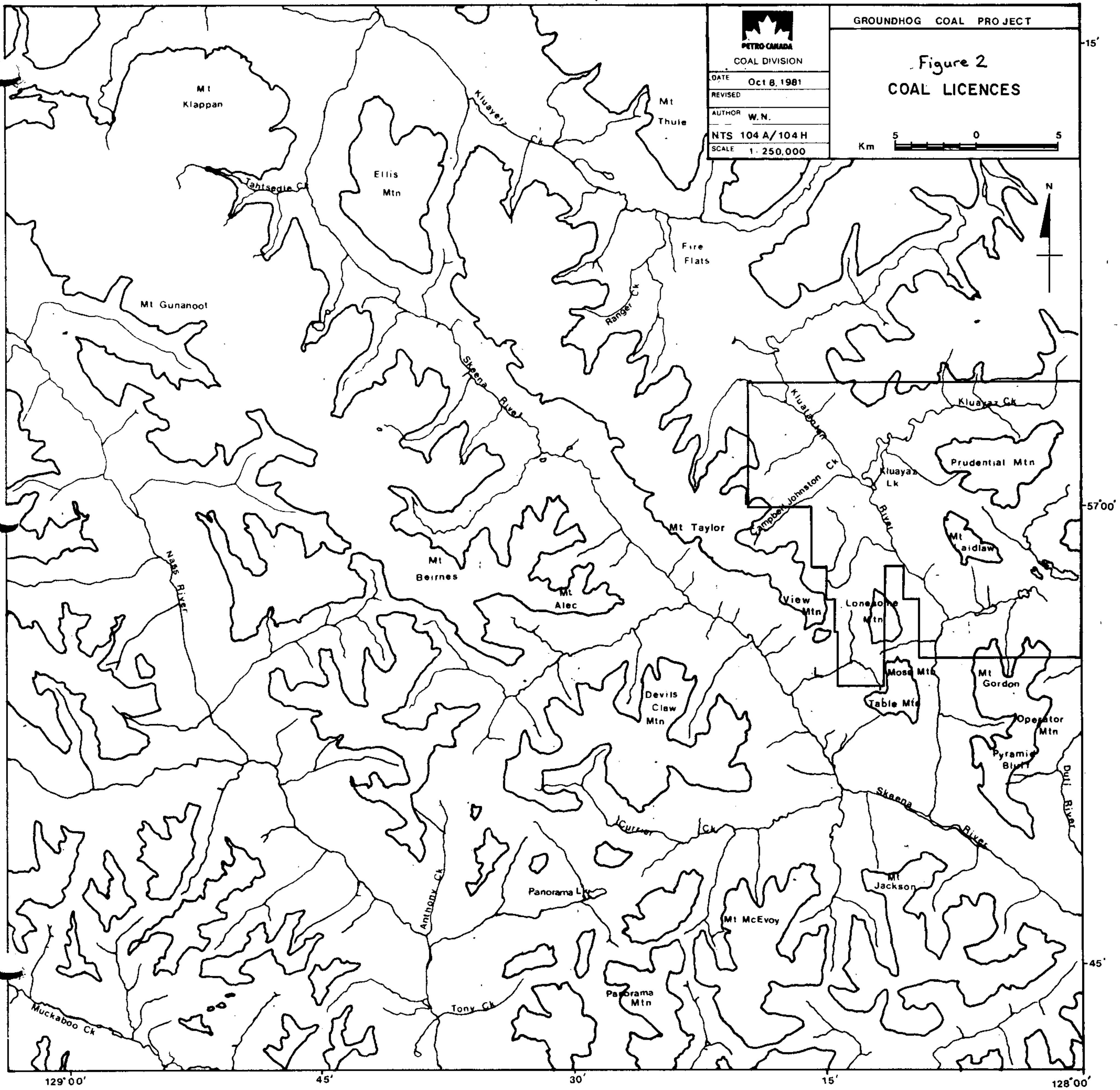
Bema Industries	Smithers/Langley, B.C.

MISCELLANEOUS SERVICES

Bowmac Truck Rentals	Smithers
Canadian Freightways	Calgary/Smithers
Canadian Propane	Smithers
Chevron Canada	Smithers
Shell Canada	Smithers
Smithers Hardware	Smithers
Smithers Lumberyard	Smithers
Super-Value	Smithers
Neville Crosby Inc.	Vancouver

Licence Groupings

The coal licences now held by Petro-Canada in the Groundhog were applied for on December 10th, 1980 and issued by the British Columbia government April 13th, 1981. The licences can be located on map sheets McEvoy Flats 104-16 (Licences #6918-6964) and Skelhorne Creek 104 H-1 (Licences 6965-7016). Total area covered by the licences is 28,214 hectares, (see Figure 2).


PETRO CANADA
COAL DIVISION
DATE Oct 8, 1981
REVISED
AUTHOR W.N.
NTS 104 A/104 H
SCALE 1:250,000
GROUNDHOG COAL PROJECT
Figure 2
COAL LICENCES
Km 5 0 5
N
Mt Klappan
Ellis Mtn
Kluayetz Ck
Mt Thule
Tahtsedle Ck
Fire Flats
Ranger Ck
Mt Gunanoot
Skeena River
Kluayaz Ck
Prudential Mtn
Kluayaz Lk
Campbell Johnston Ck
Mt Taylor
Mt Laidlaw
Nass River
Mt Beirnes
Mt Alec
View Mtn
Lonesome Mtn
Moss Mtn
Mt Gordon
Table Mtn
Devils Claw Mtn
Operator Mtn
Pyramid Bluff
Duti River
Currier Ck
Mt Jackson
Panorama Lk
Anthony Ck
Mt McEvoy
Panorama Mtn
Tony Ck
Muckaboo Ck
15′
57°00′
45′
129°00′
45′
30′
15′
128°00′

Regional Geological Setting

The Groundhog coalfield is located within the central part of the Bowser Basin - a non-volcanic successor basin developed upon older volcanic complexes of the central Cordillera. The Bowser Basin probably initially developed in middle Jurassic time with uplift of the easterly trending Skeena Arch which divided the early and middle Jurassic Hazelton trough into two separate basins; the Bowser Basin to the north and Nechako Basin to the south (Tipper and Richards, 1976). The northern boundary of the Bowser Basin is the Stikine Arch, whereas the eastern boundary is the Columbian Orogeny.

The Bowser Basin is comprised by a succession of marine and continental clastics and minor volcanics considered to be in the order of 6000 metres (G.S.C., 1957) to 10000 metres (Koch, 1974) thick. The strata was initially referred to informally as the Bowser Assemblage (Souther and Armstrong, 1966) and were considered to range in age from mid-Jurassic (Collovian) to Early Cretaceous (Albian). More recently from studies in the southern part of the Bowser Basin, Tipper and Richards (1976) have divided the Bowser Assemblage into a lower Bowser Lake Group composed of mid (Bajocian) to late Jurassic (Kimmeridgian) marine and non-marine sediments with minor volcanics, and the Skeena Group which comprises Early Cretaceous to earliest Late Cretaceous (Hauterivian to Albian or Cenomanian) age marine and non-marine sediments (including coal) and volcanic strata. Tipper and Richards (1976) considered the major depositional basin of the Bowser Lake Group to be the Bowser Basin (bounded by the Stikine and Skeena Arches) but the depositional basin of the Skeena Group was not considered coincidental with the Jurassic Bowser Basin. Furthermore, Tipper and Richards (1976) recognized a hiatus between the Bowser Lake and Skeena Groups. The major sediment source during deposition in the Bowser Basin was apparently highly variable. In the northern part of the basin the sediment source was to the east or northeast, whereas along the southern margin of the basin the source was intrabasinal, westerly or southeasterly (Eisbacher, 1974a, Duffell and Souther, 1964, Tipper in Eisbacher, 1974c and Tipper and Richards, 1976).

Deformation of the Bowser Lake Group apparently preceeded deposition of the Skeena Series as defined by Tipper and Richards. The major phase of deformation in the Bowser Basin was, however post-Skeena Group and pre-Sustut Group (late Cretaceous), inasmuch, as tightly folded and locally penetratively deformed strata of the 'Bowser Assemblage' are unconformably overlain by Sustut Group rocks. The structural style of the Bowser Basin is characterized by broad to extremely tightly folded northeast-southwest trending folds which are characteristically overturned to the northeast. Evidence for thrust faulting is rare in much of the basin but those that are evident indicate shortening in a southwest-northeast direction. The Groundhog coalfield is anomalous when compared to the surrounding Bowser Basin. Strata correlative with the Bowser Lake Group occur but are overlain by a thick succession of non-marine clastics with minor coals that are unlike the Skeena Group described by Tipper and Richards (1976) to the south. The structure of the coalfield is highly variable (as will be discussed later) and the different stratigraphic units impart a major control on the structure.

Previous Studies

Coal was probably initially discovered in the Groundhog coalfield by prospectors travelling between Fraser Lake and Cassiar during the Cassiar gold rush in the years 1872 through 1878 (Buckham and Latour, 1950). Subsequent studies by Dupont (1901), Dawson (1901), Malloch (1912, 1914), Leech (1910), Evans (1913) and Dowling (1915) established the presence of anthracite throughout a large area of the Skeena, Nass, Klappan and Spatzizi watersheds.

The first stratigraphic studies of the coalfield were made by Malloch (1912 - 1914). He divided the strata into two main 'divisions'; the lower Hazelton Group and the Upper Skeena Series. Malloch (op. cit.) considered the Hazelton Group to include dark grey to black tuffs, tuffaceous sandstones and black shales which he considered to be locally metamorphosed to schists. The Skeena Series according to Malloch included conglomerate, sandstone, vari-colored shales and coal. Buckham and Latour (1950) described the results of a reconnaissance survey made in 1948 and summarized much of the exploration to that date. They (op. cit.) retained Malloch's stratigraphic sub-divisions, but because of semantic problems renamed the two divisions the Lower and Upper Hazelton Group.

During Operation Stikine (Geo. Surv. Can., 1957) the Geological Survey of Canada made a preliminary map of the Stikine River area, but apart from a cursory examination no attempt was made to determine the stratigraphy or structure of the coal field. Eisbacher (1974c) made a reconnaissance survey of the eastern margin of the Bowser Basin and examined several sections in the coal field area. Eisbacher (1974c) described three facies belts which in ascending order are: 1) Duti River-Slamgeesh which comprise shales, siltstones, conglomerates and thin coal seams that unconformably overlie volcanic rocks of the Takla-Hazelton assemblage; 2) Groundhog -Gunanoot facies-comprised of conglomerate, sandstone and coal; and 3) Jenkins Creek facies composed of 'continental' fine-grained clastics and concretionary limestones. Eisbacher (1974c) suggested the Jenkins Creek facies was possibly part of the Sustut Group. Most recently Richards and Gilchrist (1979) from a reconnaissance survey defined four basic map units; channel, channel overbank, overbank channel and overbank facies.

Unpublished coal exploration reports on open-file with the BCMMPR provide the most comprehensive analysis of local areas of the coalfield.

History of Coal Exploration

Coal exploration in the Groundhog area closely followed Dupont's (1901) published account of the occurrence of coal near the confluence of Didene Creek and Spatsizi River. In 1903 James McEvoy and W.W. Leech staked the first coal claims on behalf of a syndicate known as "Western Development Company". In subsequent years the Western Development Company drove adits and trenched on their holdings on Currier, Davis and Discovery Creeks and on the Skeena River. In 1909 A. Geodfrey and F.A. Jackson staked claims surrounding those of the Western Development Company and in 1910 G.M. Biernes and R.C. Campbell-Johnson acquired claims to the north. From 1910-1912 exploration peaked in the coal field, many companies consolidated or expanded their holdings and many individuals acquired ground. In 1911-1912 the B.C. Anthracite Company did extensive exploration in the area and amalgamated with other companies. Early expectations of a rail line into the Groundhog area by the Canadian Northeastern Railway promoted exploration in 1910-1912. In 1912 however, a decision was made not to construct the rail line and the Balkan wars of 1912-1913 placed a strain on world money markets (Buckham and Latour, 1950) which curtailed exploration. In 1913 the only exploration in the coalfield was by A. Hasebrink who examined claims in the northern part of the coalfield (Tompson et al., 1970).

From 1914 until 1948 no coal exploration in the area has been documented. In 1948 Buckham and Latour of the Geological Survey of Canada visited the area. Their report (Buckham and Latour, 1950) summarized both the history of exploration to that date and previously reported occurrences of coal.

In 1966-1968 Coastal Coal acquired 24 coal licences in the southern part of the coalfield. Following mapping (Boyd and Associates, 1967) the licences were dropped.

In 1970 the National Coal Corporation Ltd. together with Placer Development Ltd. and Quintana Mineral Corporation conducted a mapping and diamond drilling program on 80 licences in the southern part of the coal field (Tompson, et al., 1970). Many of the licences were dropped some of which were later acquired by Groundhog Coal.

In 1978 and 1979 Imperial Oil acquired licences covering about 15,000 hectares near Mt. Klappan. Following mapping (Waters, 1979) the licences were allowed to lapse. Petrofina in 1978 acquired licences which surrounded Imperial's licences; these licences were also subsequently dropped.

In 1980 Gulf Oil Canada acquired the area previously held by Imperial Oil as well as additional licences in the southern part of the coal field. Tony Mould and Associates subsequently filed on the area immediately south of Mt. Klappan and along the Skeena Valley, but the area was not licenced.

In 1981 Petro-Canada acquired the presently held licences in the Prudential mountain area. Most recently Suncor has acquired licences south of Prudential Mountain; Gulf has acquired additional licences north of Mt. Klappan and M. Suska has filed on licences previously held by Petrofina.

Stratigraphy

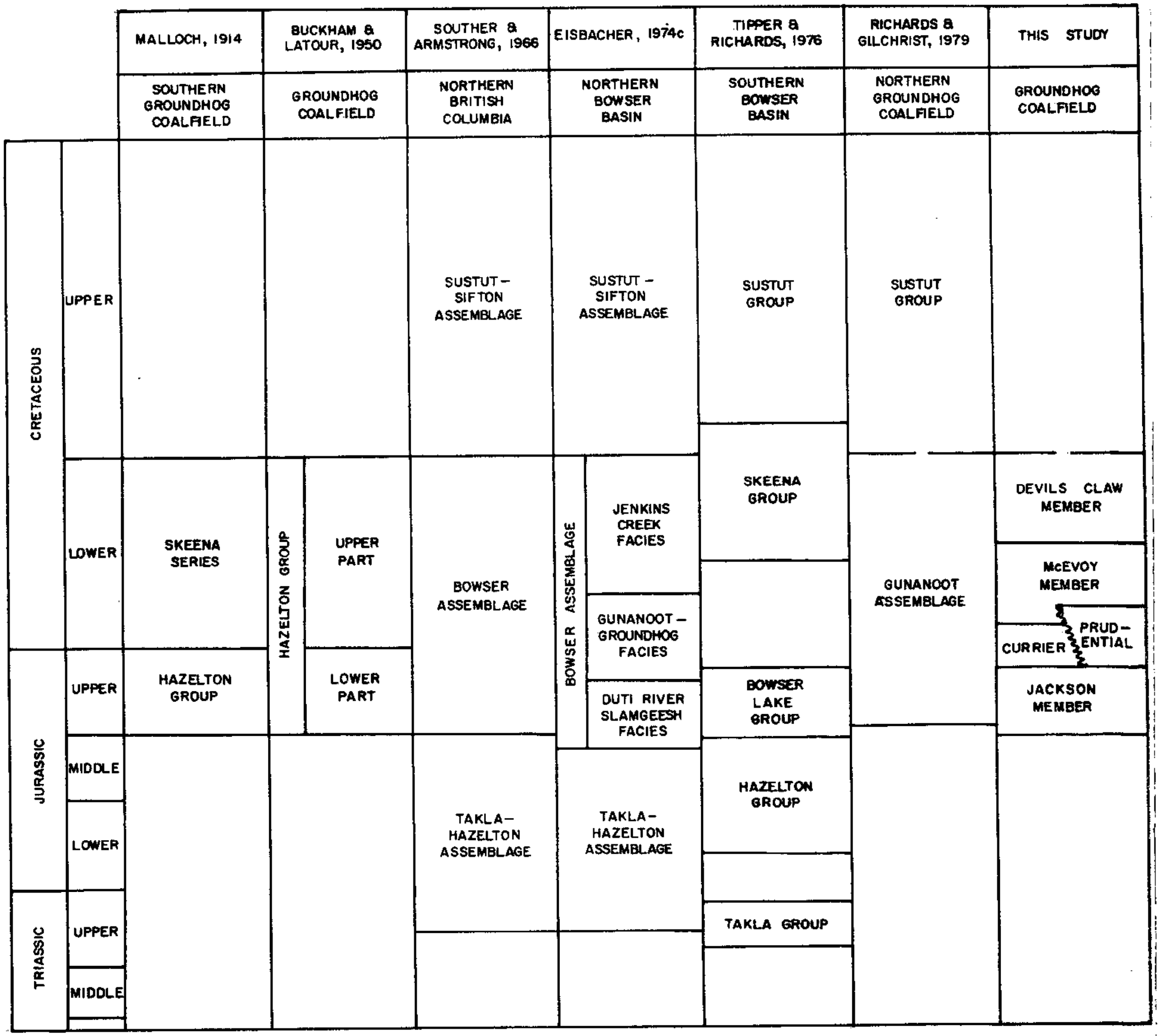
In order to determine the regional stratigraphy a total of 57 sections were examined of which 39 were measured (Appendix 1) in the area between the Nass River on the west, the Stikine River in the north, the Kluatantan River in the east and the Duti River in the south.

The total stratigraphic thickness exposed in the coalfield is considered to be between 4000 and 4500 meters. Neither the base nor the top of the succession is exposed in the study area. Northeast of the study area the succession unconformably overlies the Takla-Hazelton assemblage and is in turn unconformably overlain by the Late Cretaceous Tango Creek member of the Sustut Group (Eisbacher, 1974a).

Within much of the study area the strata are divisible into five mappable units herein referred to informally in ascending order as the Jackson, Currier, McEvoy, Prudential and Devils Claw. The Jackson and McEvoy members are recognized throughout the area whereas the Currier and Devils Claw members are only distinguished between the Nass and Skeena Rivers. The correlation between members mapped in this study and those of previous studies are at best tentative (Figure 3). In many areas re-measurement of sections previously described resulted in completely different 'impressions' of the lithology. In particular the thickness and number of coal seams previously documented appear to be highly exaggerated.

In the following section the different map units are described and their distribution discussed. Correlations and restored stratigraphic cross-sections across the coalfield are shown in (Figures 4,5,6,7 and 8) and the measured sections are appended to the report (Appendix 1).

FIGURE 3 — REGIONAL STRATIGRAPHIC BOWSER BASIN AND GROUNDHOG COAL FIELD



The units of this study are not corellated with previous work with the following exceptions:

Jackson Member = Hazelton Group of Malloch (1914) and Duti River - Slamgeesh of Eisbacher (1974c)

McEvoy Member = Jenkins Creek facies of Eisbacher (1974c) Eisbacher's (1974c) Groundhog-Gunanoot facies = Devils Claw and Currier Members. Eisbacher (1974c) has Jenkins Creek overlying Groundhog-Gunanoot facies which it actually underlies.

Jackson Member

A thick succession of marine and transitional marine shales, siltstones, sandstones and locally conglomerates comprise the lowest stratigraphic interval in the coalfield. The Jackson member is well exposed on the south slope of Mt. Jackson, in the Groundhog Ranges, and in a wide belt along the eastern and northeastern margin of the coalfield. The base of the member is not exposed in the study area but to the north equivalent strata described by Eisbacher (1974a) unconformably overlie volcanic rocks of the Hazelton Group. At Mt. Jackson, the Jackson member coarsens upwards and is gradational to the overlying Currier member. East of the Kluatantan River, where the Currier member cannot be distinguished, the Jackson member passes upwards into the overlying Prudential member. The contact between the Jackson member and Currier or Prudential member is placed at the first occurrence of coal or the last occurrence of distinguishable marine sediments.

No complete section of the Jackson member was measured but it is estimated to be at least 1800 meters thick in the study area based on examination of partial sections. At McCumber Creek and Happy Lake, east of the coal field; two sections 380 meters and 200 meters thick were measured within what is considered the middle succession of the Jackson member. At these localities and in other areas along the eastern and southern margin of the coalfield the Jackson member is composed of thick bedded, dark grey to black shales and siltstones, minor very-fine to fine-grained sandstones and thin to thick bedded conglomerates (Figure 10). The sandstones are commonly massive and only locally cross-bedded. The conglomerates are up to 5 meters thick, commonly lensoidal and consist of chert and quartz pebbles and cobbles up to 5 centimeters in diameter.

At Mt. Jackson the uppermost 300 metres of the Jackson member is exceptionally well exposed (Figure 11). Here the member is composed of tan weathering to dark grey siltstones and shales and tan weathering, fine to medium grained and locally calcareous sandstones up to 0.5 metres thick. The sandstones are ripple cross-bedded or planar bedded and locally contain abundant rip-up clasts. Sandstones near the top of the succession contain abundant bivalves and fossil debris. The upper part of the section becomes progressively coarser grained and grades vertically into the overlying Currier member. East of the Kluatantan River (where the Currier member is absent) the contact between the Jackson and Prudential members was not observed; however it is considered to be gradational based on the general similarities in lithology.

The age of strata equivalent to the Jackson member has been reported by Eisbacher (1974c) from north of the study area. At the base of the succession; Roots (1957 _in_ Eisbacher, 1974c) reported the occurrence of _Kepplerites_, _Cobbanites_, _Pleuromya_, _Cadoceras_, _Trigonia_ and _Pholas_ which indicate a Callovian age. At other localities Tipper (_in_ Eisbacher, 1974c) identified _Cadoceras_ and _Buchia concentrica_ of Oxfordian age. A collections made 200 meters from the top of the Mt. Jackson section in the study includes pelecypod tentatively identified as _Buchia_, _Oxtyoma_ and _Eopecten_. It, therefore appears that the Jackson member at least spans the interval from Callovian to Oxfordian time.

Figure 10: Cleaved siltstones and shales, Jackson member at Mt. Jackson.

Figure 11: Upper part of Jackson member at Mt. Jackson.

Currier Member

Between the Nass and Kluatantan Rivers a sequence of thin to thick bedded sandstones with minor shale, siltstones and coal occur. The sequence is recessive and best exposures occur at lower elevations along the Skeena and Nass River valleys and Panorama, Currier and Tahtsedle Creek and on Mt. Klappan and Mt. Jackson. The base of the Currier member is well exposed at Mt. Jackson, where it gradationally overlies the Jackson member. The base of the Currier member is selected at the first occurrence of coal or identifiable non-marine strata. The Currier member can be seen to be overlain by the McEvoy member at Currier, Anthracite and Tahtsedle Creek Valleys and along the eastern side of Skeena River Valley. The contact between the Currier and McEvoy members is selected at the first occurrence of bedded limestones and/or massive and thick siltstone units which also corresponds to a marked decrease in sandstone and coal. East of the Kluatantan River the Currier member cannot be recognized and the Jackson member is overlain by the Prudential member which, in part, is considered stratigraphically equivalent to the Currier member.

No complete section of the Currier member is exposed in the coalfield. A section 450 metres thick was measured at Mt. Jackson overlying the Jackson member and a section 392 metres thick was measured at Tahtsedle Creek underlying the McEvoy member. Partial sections of the Currier member were examined at Currier Creek, Anthracite Creek, Tony Creek, along the Skeena River Valley and near Mt. Klappan. The total thickness of the member is estimated to be between 600 and 800 meters.

The base of the Currier member comprises a series of coarsening upward sequences ranging from 5 to 25 metres thick (Figure 12). The basal member of the fining upward sequence is composed of thinly interbedded medium to dark grey shales which coarsen upwards to tan weathering, fine to medium grained and locally coarse grained sandstones. The sandstones are quartzose and cherty, thin to thick bedded, ripple cross-laminated and locally trough cross-bedded. The coarsening upward sequences are commonly capped by thin coal seams varying between 20 centimeters to 1.5 metres in thickness (Figure 13).

The middle strata of the Currier member, exposed between Mt. Jackson and Tahtsedle Creek, is composed of fine to medium grained, tan to dark grey weathering sandstone, dark brown to brown mudstone, siltstone and coal. The sandstones are quartzose, cherty and locally carbonaceous. Locally the sandstones, siltstones and mudstones comprise members of distinct fining upwards sequences up to 4 metres thick. A minimum of eight coal seams thicker than 0.5 metres and numerous thin seams and partings occur in the sequence. The thickest observed seam measured 4 meters but most seams range from 0.5 to 2 metres in thickness. Because of the paucity of exposures, rapid facies changes and structural complexities, correlation of these seams at different localities is not possible.

The upper part of the Currier member exposed at Tahtsedle Creek is comprised predominantly of medium to dark grey siltstone and shale, buff to medium grey, thin to thick bedded sandstone, carbonaceous partings and coal. The sandstones are quartzose and cherty and are ripple cross-laminated, planar cross-bedded, parallel bedded or massive. Some sandstone channels wedge out laterally over a distance of 10's of metres. In the uppermost 472 metres of strata, four coal seams ranging in thickness from 0.8 to 2.5 metres outcrop. Because of the paucity of exposure their lateral continuity could not be assessed.

The age of the Currier member is unknown. Fossil plants collected by Malloch and unidentified by W.A. Bell suggest an early Cretaceous 'Kootenay age' (Buckham and Latour, 1950). No fossil collection adequate for age determination was collected in this study.

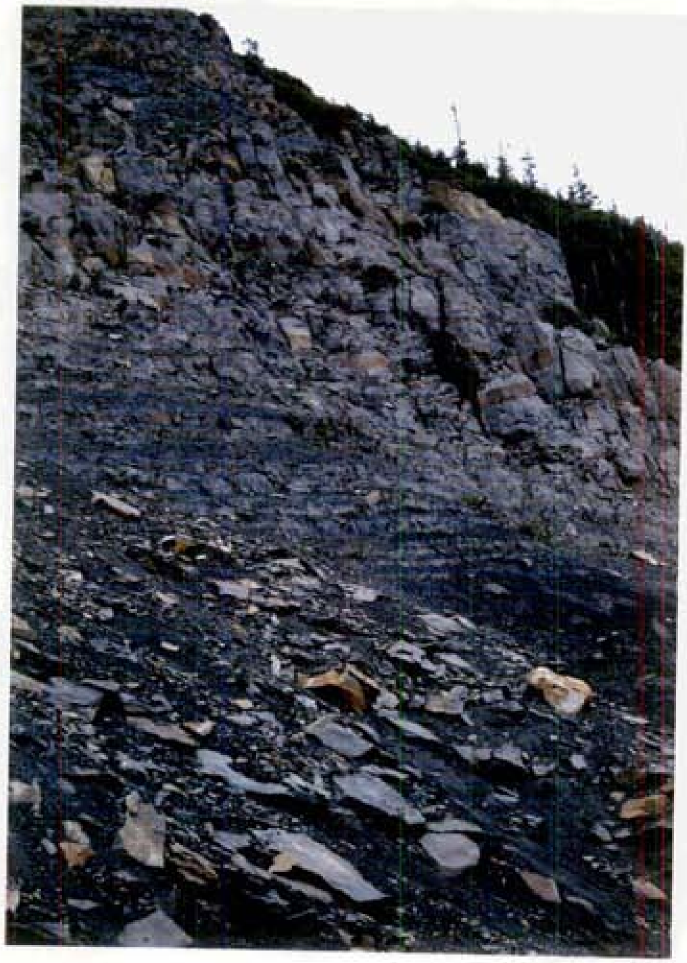


Figure 12: Coarsening upward sequences in the Currier member at Mt. Jackson.

Figure 13: Coal seam overlying coarsening upward sequence in Currier member at Mt. Jackson.

Figure 14: McEvoy member east of the Skeena River. (Note the white channel sandstone in the center of the photo.)

McEvoy Member

The McEvoy member is exposed mainly between the Nass and Kluatantan Rivers, and between Tahtsedle Creek and the Groundhog Range. It is comprised of a thick sequence of siltstone and shale with minor limestone, coal and sandstones which is underlain by the Currier member and which is overlain by a conglomerate bearing unit of the Devils Claw member. East of the Kluatantan River the McEvoy member cannot be distinguished and is either stratigraphically equivalent to the upper Prudential member or absent.

The McEvoy member can be distinguished from the underlying Currier member by the paucity of sandstone and coal and occurrence of thick siltstone and shale and minor limestone of the McEvoy member. The McEvoy member can be distinguished from the Devils Claw member by the occurrence of massive conglomerates in the latter.

The thickness of the McEvoy member is highly variable. In the north, near Tahtsedle Creek it is about 200-300 metres thick, whereas to the south at McEvoy Ridge it is 1000 metres thick. To the east, at Ranger Creek it is a minimum of 500 metres thick. In all localities the McEvoy member is composed of monotonously interbedded dark grey siltstone and shale with thin to thick bedded sandstones and minor coal and limestone (Figure 14). The siltstones and shales are well indurated, dark to medium grey, thin to thick-bedded and comprise intervals up to 40 metres thick. They are locally carbonaceous and grade to coal. The sandstones are thin-to thick-bedded, massive or planar and trough cross-bedded. They are most commonly fine to medium grained but locally coarse-grained. Mineralogically they are comprised mainly of chert and quartz and minor feldspar and rock fragments. Many of the thicker sandstones are channels. Limestone, although a minor component, occur throughout and characterize the succession (Figure 15). They occur in tan weathering beds up to 0.5 metres thick or as concretionary horizons.

Locally root casts and carbonaceous partings pervade the limestone. Coal varies in thickness from partings a few centimeters thick to seams up to 0.5 metres thick and comprises a very small proportion of the succession. The thicker occurrences of coal described by Buckham and Latour (1950) from strata mapped in this study as McEvoy member could not be confirmed.

Devils Claw Member

The Devils Claw member is named for a succession of conglomerates, sandstones, siltstones and shales which cropout between the Nass and Skeena Rivers and Tahtsedle Creek and the Groundhog Range. East of the Kluatantan River, conglomerates equivalent to the Devils Claw member are not recognized. The contact between the Devils Claw member and the underlying McEvoy Ridge member has been selected at the first occurrence of thick conglomerate (greater than 2 metres).

The Devils Claw member varies from 300 metres thick at Devils Claw Mountain to about 500 metres thick at Mt. Gunanoot. At Devils Claw Mountain and adjacent areas, the Devils Claw member is comprised predominantly of massive, moderate to poorly indurated pebble-cobble conglomerate with rare lenticular sandstones. The conglomerates are light grey or vari-colored and comprised of well rounded and well sorted clasts of chert, quartz, volcanic and rare granodiorite clasts (Figure 16). The conglomerates are massive or locally trough cross-bedded. The sandstones are medium to coarse grained and composed primarily of quartz, and chert with minor carbonaceous fragments. In the northern part of the coalfield the contact between the McEvoy and Devils Claw member is more gradational. The lower part of the Devils Claw member includes thick sequences of siltstones, shales, minor sandstones, limestones and coal interbedded with massive conglomerate (Figure 17). Near the top of the Devils Claw member conglomerate is more prevalent, but the very thick sequence of conglomerate exposed to the south is not preserved.

Figure 15: Thinly interbedded limestones (tan), siltstones and shales in the McEvoy member at McEvoy Ridge.

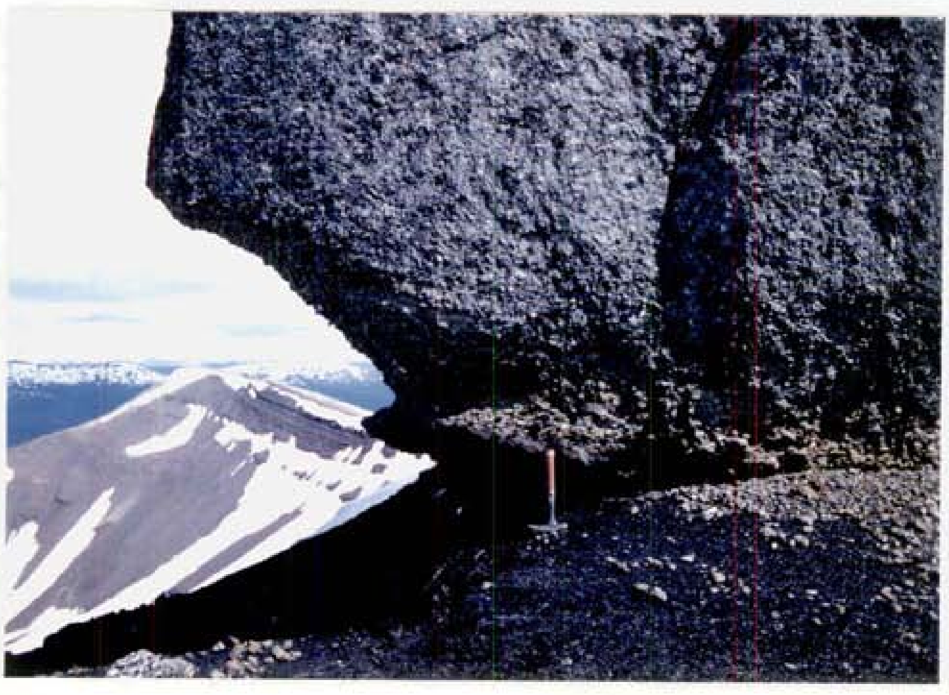


Figure 16: Massive conglomerates of the Devils Claw member at Devils Claw Mountain.

Prudential Member

East of the Kluatantan River the Jackson member is overlain by a sequence of conglomerate, sandstone, siltstone, shale and minor coal assigned to the Prudential member. The Prudential member is thus considered a coarser grained equivalent of the Currier member and possibly the lower part of the McEvoy member. The top of the Prudential member is not exposed in the study area nor is the contact between the Jackson and Prudential members exposed. The Prudential member is distinguished by the presence of coal, and thick sandstones neither of which occur in the Jackson member.

The total thickness of the Prudential member is estimated to be in the order of 500 to 800 metres although no complete section is known. On Prudential Mountain two sections 320 and 250 metres thick respectively were measured ((Appendix 1, Sect. 119, 120) and additional localities to the north and south of Prudential Mountain were examined.

The Prudential member is comprised in all localities of thick bedded sandstones, siltstones, carbonaceous shale and locally conglomerate and coal (Figure 18). The sandstones are grey to tan weathering fine to coarse-grained and most commonly massive. The siltstones and shales are tan to dark grey weathering, well indurated and locally ridge forming. They locally comprise intervals up to 80 metres thick. The conglomerates are vari-colored, massive, and composed of well rounded cobbles and pebbles of chert and quartz. Coal comprises less than 1% of the succession and varies from thin carbonaceous partings to seams up to 1.5 metres thick.

Figure 17: Massive conglomerates of the Devils Claw member interbedded with shales and siltstones between the Skeena and Nass Rivers.

Figure 18: Tightly folded - interbedded siltstones and sandstones of the Prudential member at Prudential Mountain.

Figure 19: Tightly folded - interbedded siltstones and very fine-grained sandstones of the Prudential Member.

Facies Relationships and Correlations

Stratigraphic correlation and analysis within the coalfield are complicated by the structural complexity of some areas, rapid facies changes, and lack of marker horizons or recognizable biostratigraphic zones. Of particular importance in evaluating the stratigraphy in the coal field is the nature of the contact between the Currier member and overlying McEvoy member. The structural style of the Jackson, Currier, and Prudential members is markedly different from the overlying McEvoy and Devils Claw members. As discussed later the different structural styles are considered a product of the competency of the different units, nevertheless more detailed studies may prove the existence of an angular unconformity or decollement separating the Jackson, Currier and Prudential members from overlying strata.

The overall sequence of strata in the coal field comprise a coarsening upward-regressive sequence starting with the Jackson member at the base and culminating with massive conglomerates of the Devils Claw member at the top. In Figures 4, 5, 6, 7, 8 and 9 the facies relationships and suggested correlations of some of the measured sections are shown. In Figure 20 and 21 interpretative restored stratigraphic sections across the coalfield are shown. The Currier member and lower McEvoy member are considered fine grained equivalents of the Prudential member to the east. The upper part of the McEvoy member in the southern part of the coalfield is at least in part correlative with the lower Devils Claw member in the northern part of the coalfield. The upper part of the Devils Claw member is clearly younger than the McEvoy member which it locally overlies. The overall facies relationships indicate coarsening of the facies to the north and northeast. The proposed facies relationships in conjunction with paleocurrent measurements indicate that the provenance of the strata was to the north and/or northeast.

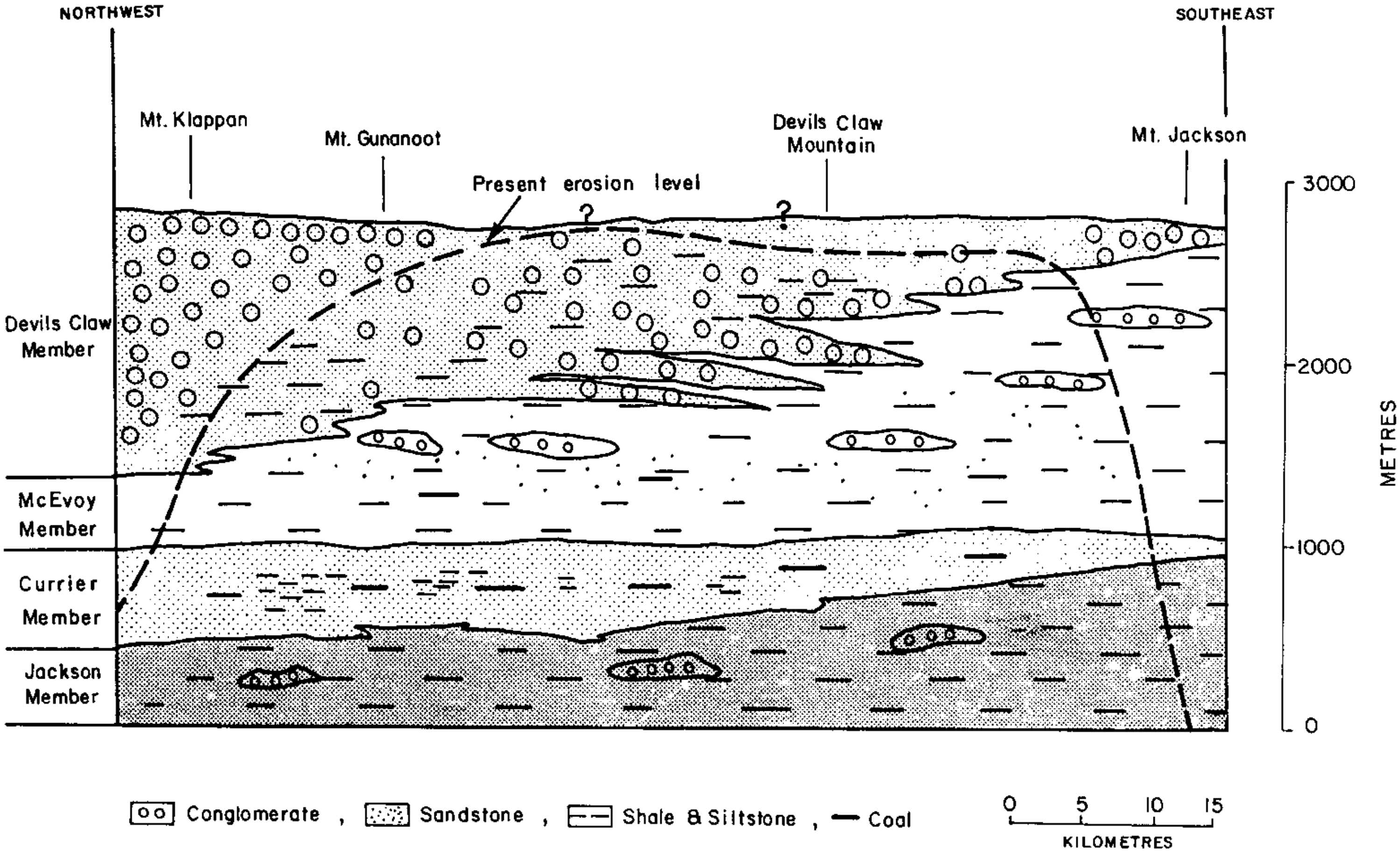


FIGURE 20 — Restored and highly schematic. Interpreted cross-section across the coalfield.

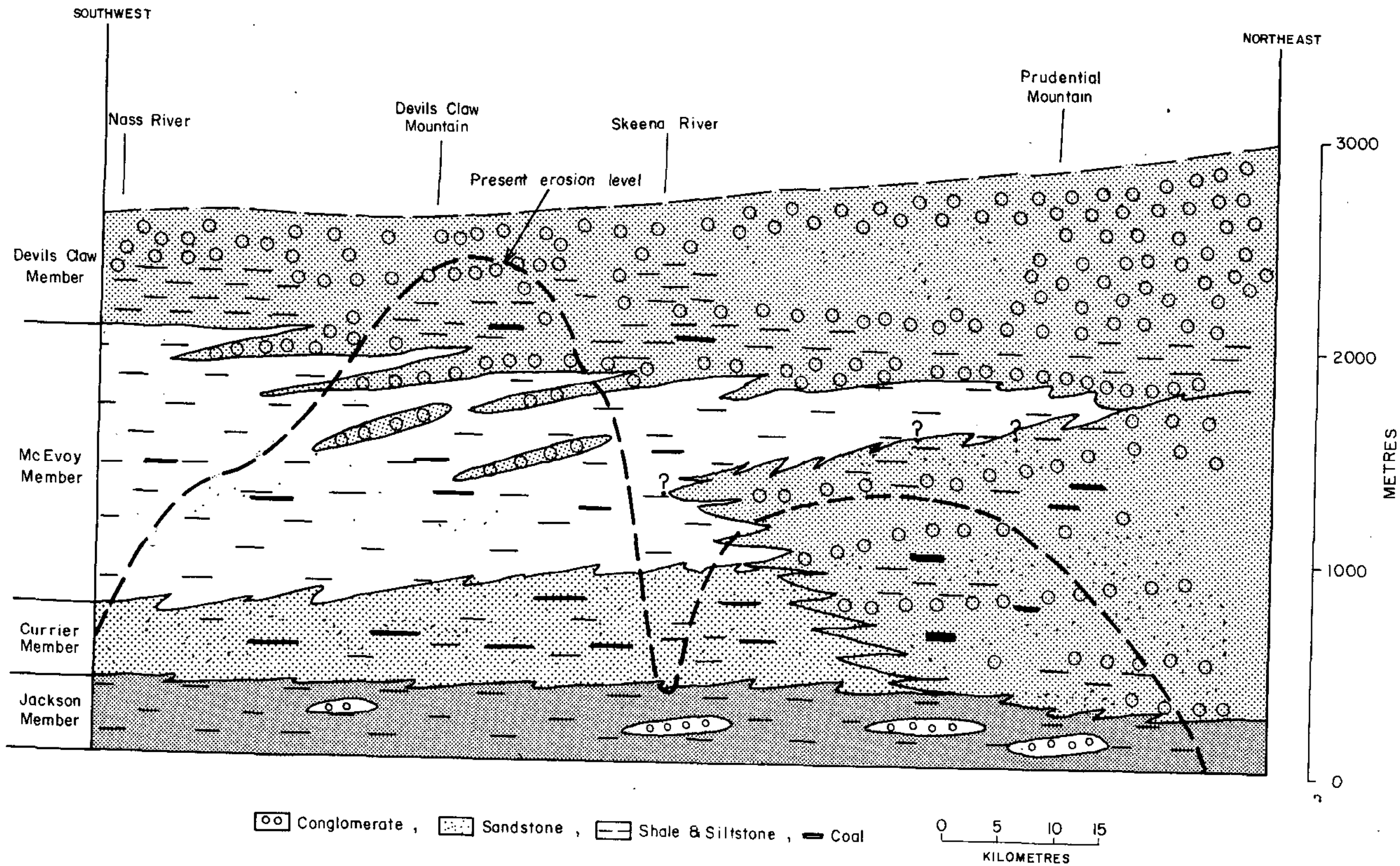


FIGURE 21 — Restored and highly schematic. Interpreted cross-section across the study area.

Structure

The structural style of the Groundhog coalfield is characterized by upright to northeasterly overturned folds that have northwest to southeasterly trends. Along the Nass Valley the folds are locally overturned to the southwest. The amplitude, plunge and wave length of the folds are highly variable both laterally and stratigraphically and are described in more detail later. Thrust faults which climb out of surfaces of interstrata slip and fore-limb and back-limb faults are common elements in the coalfield. In the area between the Nass and Skeena Rivers a later phase of extension faulting is apparent. There is no evidence to suggest major stratigraphic separation in the coalfield as a result of thrusting nor is there evidence for lateral translation.

The rocks throughout most of the coalfield area are not penetratively deformed. The only evidence for penetrative deformation is the occurrence of well developed cleavage which is restricted to rocks that lie east of an arcuate trend from Mt. Jackson to Lonesome Mountain along Kluatantan River and apparently along Tahtsedle Creek (Figure 22; Waters, 1979). Cleavage east of the trend is developed in strata of the Jackson, McEvoy, Currier and Prudential members. Whether or not strata of the Jackson member are cleaved everywhere is unknown but strata of the McEvoy and Devils Claw members and locally the Currier member are not cleaved to the west.

Major Lineaments and Structural Domains

The Nass River, Skeena River - Tahtsedle Creek and Kluatantan River comprise three major, subparallel northwest-southeast trending lineaments which serve to divide the coalfield into three structural domains. Although these structural domains are characterized by different structural styles (as discussed later) they are also characterized by different stratigraphic packages and thus there is some doubt as to the structural significance of the lineaments.

In previous studies Richards and Gilchrist (1979) attributed the Skeena and Nass River systems to thrust faults. Examination of the strata on both sides of the Nass, Skeena, Tahtsedle and Kluatantan Rivers provided no evidence to suggest any significant stratigraphic separation across the linears. Although lateral strike-slip movement may have occurred along the valleys, the structure adjacent to the lineaments, show no evidence that can be attributed to lateral translation. For lack of other evidence the major lineaments are therefore considered parallel consequent river valleys which simply parallel the structural grain.

Structural Domains

Three schematic structural cross-sections across the coalfield based on airphoto interpretation are shown in Figures 22, 23, 24 and 25. In the following section the structure of the three domains referred to above are described.

Nass River to Skeena River

The mountains between the Nass and Skeena River south of Tahtsedle Creek are dominated by the 'Biernes' syncline, a broad southwesterly trending structure developed in the McEvoy and Devils Claw members (Figure 26). To the east of the syncline, adjacent the Skeena river, the strata are more tightly folded. The folds are locally overturned to the northeast, have wavelengths in the order of 100-300 metres and amplitudes generally less than 100 metres. Immediately to the west of Biernes syncline a series of tight, southwesterly overturned folds occur which give way further to the west to upright to northeasterly overturned folds with wavelengths in the order of 100 metres and amplitudes between 100 and 300 metres.

Between the Nass and Skeena Rivers there is an excellent correlation between lithology and structural style; where massive competent conglomerates of the Devils Claw member occur the style is one of broad, low amplitude concentric folds; where the conglomerates are absent the strata are folded into high amplitude, short wavelength chevron folds (Figure 27). Numerous back-limb and fore-limb thrusts occurs. 'Late' extension faults are common in the area but there is no evidence for major offsets. The Currier member which is exposed in low lying areas along the Nass, Skeena, Currier, Tahtsedle rivers and Panorama Lake is invariably tightly folded and locally faulted. In the Panorama Lake and Currier Creek the structural style of the Currier member is disharmonic with overlying strata. At these localities the Currier member is much more tightly folded than overlying strata of the McEvoy and Devils Claw members. The folds however, are cozonal and the difference in style is considered a product of the competence of the units.

South of Currier Creek the style of the Currier member and underlying Jackson member (similar to that in the north) is characterized by tight folds. Here, however, the strata have a well developed cleavage.

Throughout the region between the Nass and Skeena Rivers the strata are locally well jointed with fractures and fault zones commonly filled with quartz or carbonate.

Skeena River - Tahtsedle Creek to Kluatantan River - Kluayetz Creek

In the area between the Skeena River - Tahtsedle Creek and the Kluatantan River - Kluayetz Creek the structure is highly variable (Figure 28). The Currier member, exposed along the Skeena valley and Mt. Klappan is tightly folded. The folds are characterized by upright to southwest dipping axial surfaces and have wavelengths in the order of 100 to 200 metres and amplitudes ranging from 100 to 200 metres (Figure 29). Thrust faults with throws likely less than 100 metres are common (see also Waters, 1979). The McEvoy member is at least locally disharmonious with the underlying Currier member.

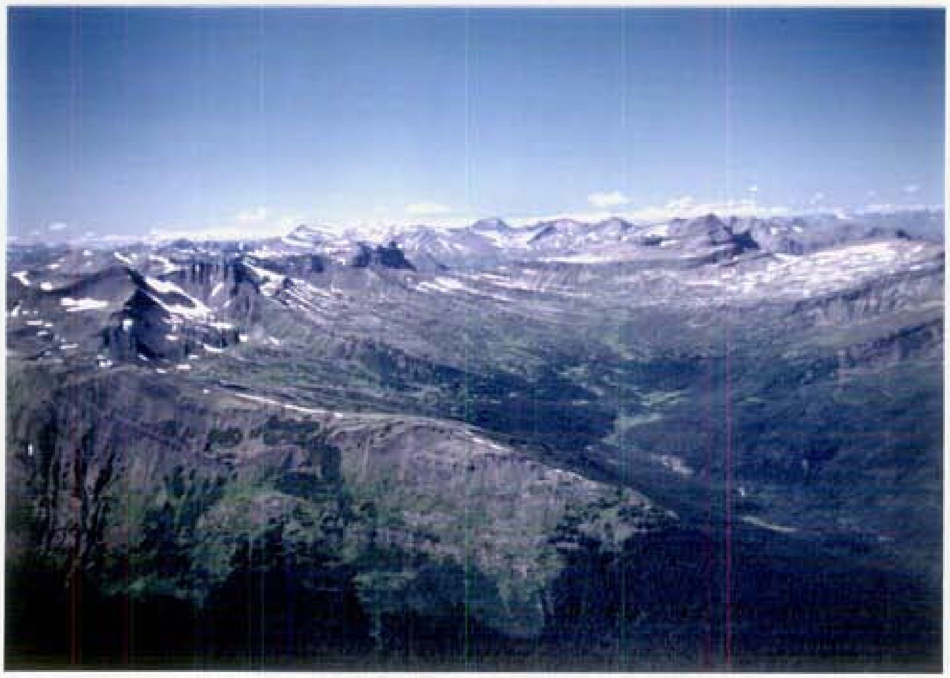


Figure 26: Biernes syncline, view is to the northwest parallel to fold axis.

Figure 27: Tight 'chevron' style folds in McEvoy member near Tony Creek.

The McEvoy member is more broadly folded although locally, adjacent thrusts, the strata are drag folded and overturned to the northeast (Figure 30). In some areas overturned, very tight interstratal peels occur in what otherwise appear to be broadly folded strata (Figure 31). There is thus a large amount of interstratal slippage and shortening not readily apparent from reconnaissance mapping.

Cleavage is well developed in the McEvoy member south of View Mountain and in underlying strata of the Currier member. To the north cleavage is poorly developed or absent. Waters (1979) has described cleavage from the Currier member at Mt. Klappan. Strata throughout the area are jointed and most fractures are filled by quartz or carbonate.

East of Kluatantan River - Kluayetz Creek

East of the Kluatantan River and Kluayetz Creek the Prudential member and underlying Jackson member are tightly folded along northwest - south-easterly trends (Figure 32). The fold style is highly variable ranging from tight chevron folds adjacent Prudential Mountain to locally broad concentric folds to the east. The chevron folds have wavelengths of about 100 metres and amplitudes of up to 200 metres and are invariably overturned to the northeast. The concentric folds conversely have amplitudes of 50 metres and wavelengths up to several hundreds of meters and upright axial surfaces. Thrust faults, most of which are back-limb or fore-limb faults are common throughout the area. Isoclinal drag folds are common adjacent some of the major faults. On Prudential Mountain and areas to the south the anticlinal hinges are commonly faulted out.

Figure 28: Broad folds in the McEvoy member near Mount Taylor.

Figure 29: Folds and faulted strata in the Currier member at Mt Klappan.

Figure 30: Overturned and faulted folds in the McEvoy member north of Mt. Taylor.

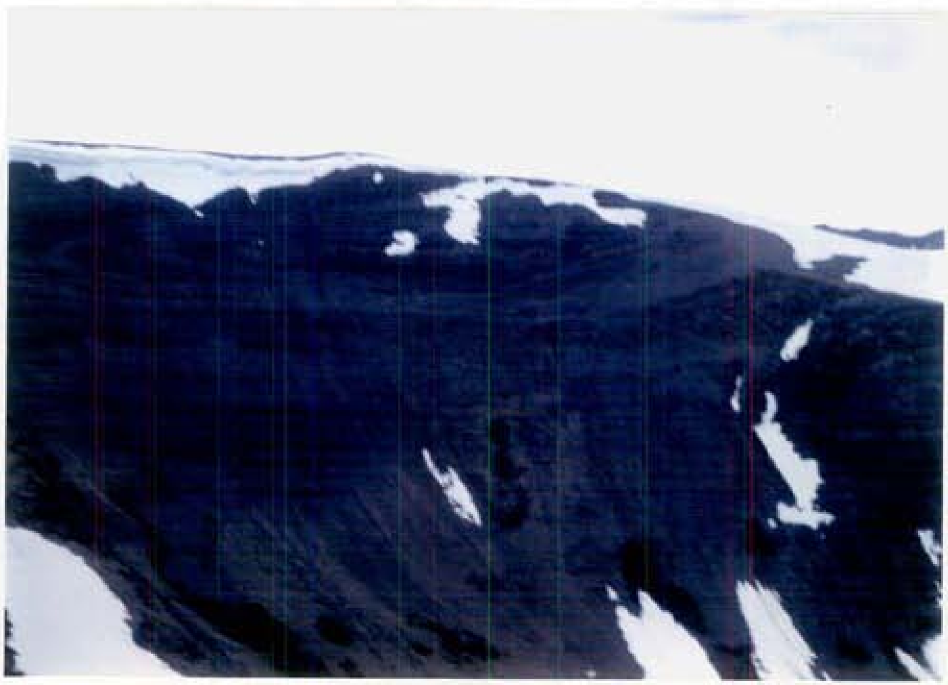


Figure 31: Intrastratal peels in the McEvoy member near Moss Mountain.

Figure 32: Tight folds in the Jackson member north of Prudential Mountain.

The structure of the Jackson member is more highly variable than the Prudential member. Where massive conglomerates are present in the Jackson member, such as near Happy Lake, the folds are broad and concentric and high angle thrust faults are common. To the north and south of Prudential Mountain conglomerates are thinner or absent and the Jackson member is characterized by tight chevron style folds similar to those of the Prudential member.

In all localities east of Kluatantan River and Kluayetz Creek the strata are cleaved. Cleavage is best developed in the Prudential member, whereas the occurrence of well developed cleavage in the Jackson member is dependent on the local lithology. The strata are well jointed throughout the area and quartz fills most fractures and fault zones.

Structural Synthesis

The structure of the coalfield is consistent with a single phase of deformation resulting in shortening in a southwest-northeasterly direction. The variations in structural style observed are considered the result of variations in the stratigraphy (Figure 33). The occurrence of broad low amplitude concentric folds corresponds to strata composed of competent conglomerates, whereas chevron folded strata are typically comprised on unconformably interbedded sandstones, siltstones and shales. The importance of lithology in controlling the structural style is best exemplified by folds west of Biernes syncline which are overturned to the southwest opposite the regional direction of overturning. Southwesterly overturning of these folds suggests that the massive conglomerates of the Devils Claw member acted as a buttress during deformation.

As previously discussed the disharmony between the Currier and Prudential members and overlying strata may indicate an angular unconformity and two phases of folding. Evidence against the two phases of folding are the similar structural trends (folds are cozonal) and that the Currier, Prudential and McEvoy members are all locally cleaved.

The restriction of visible cleavage to strata along the eastern edge of the coalfield corresponds to the occurrence of more tightly folded strata along the eastern margin of the Bowser Basin.

High paleo-heat flow in the coalfield area is suggested by the exceedingly high rank of the coals. Preliminary analysis of vitrinite reflectance data further indicate a marked stratigraphic variation in rank which suggests high paleo-geothermal gradients in the area. Very high heat flows are further required for the formation of the very high coal ranks observed in these relatively young strata.

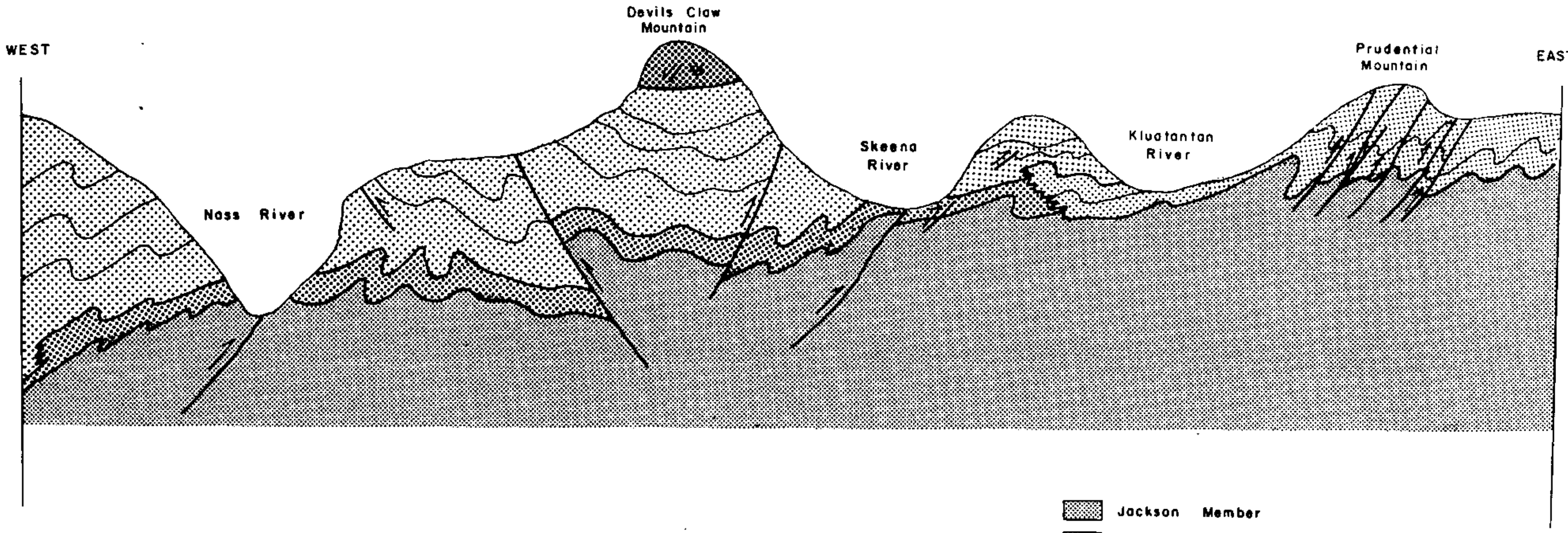


Figure 33. Cartoon showing variations in structure across the Groundhog Coalfield. (not to scale).

Coal-Occurrence and Economic Potential

Within the Groundhog coalfield coal occurs in the McEvoy, Prudential and Currier members. In the following section the occurrence, rank, quality, reserves and potential of the coal are outlined.

McEvoy Member

In the McEvoy member coal ranging in thickness from thin carbonaceous partings to seams up to 0.80 metres thick occur at almost all examined localities (Figure 34). At no locality, however do coal seams of significant thickness or number occur. At McEvoy ridge, for example, in a section 800 metres thick nine seams occur, the thickest of which is 0.40 metres. At Ranger Creek in the northeastern part of the coalfield in a section 320 metres thick nine seams occur ranging up to 0.50 metres.

Because of the absence of coal seams thicker than 0.80 metre and the paucity of coal at all localities the McEvoy member is considered to have no potential anywhere in the study area. The reported occurrences of thick coal seams in strata equivalent to the McEvoy member by Malloch (in Buckham and Latour, 1950) could not be confirmed.

Prudential Member

In the Prudential member coal varying in thickness from carbonaceous partings to coal seams up to 1.5 metres thick occur. At localities along the Kluatantan River and tributaries to the east, on Prudential Mountain and Mt. Laidlaw thin coal seams were observed. Because of the structural complexity and paucity of outcrop in these areas the total number of seams and their lateral continuity could not be predicted. In areas of adequate outcrop no strata were observed in which multiple seams thicker than 1.0 metres occur.

Coal Rank and Quality

The rank of coal in the Prudential member has been determined by vitrinite reflectance. Preliminary results indicate the rank ranges from anthracite to meta-anthracite. The quality of the coal is uniformly poor. Most coal seams grade to carbonaceous shale and locally visible pyrite comprises up to 20% of the coal. All surface samples are pervasively oxidized. Because the coal is finely sheared as a result of tectonics and cross-cut by quartz veins the coal is undoubtedly oxidized to considerable depths below the surface.

Resources and Economic Potential

The structural complexity and paucity of the outcrop in the area preclude coal resource estimates. The coal resources in the Prudential member are, however considered minimal because of the absence of thick or multiple seams anywhere in the coalfield. The coal of the Prudential member is, therefore not considered to have any potential for development. In addition, the tight folding that characterizes the Prudential member everywhere would not facilitate mining by conventional methods even if considerable resources did exist.

Currier Member

The Currier member is the main coal bearing unit in the coalfield. Coal varying in thickness from partings to seams up to 4 metres thick were observed at all examined localities. At Mt. Jackson, in the southernmost part of the coalfield, five seams occur within the basal 450 metres of the member (Figure 35). (See Table 3 for data on the number of coal seams, thicknesses and location).

In the Skeena River Valley and major tributaries multiple coal seams were observed. The lateral continuity and total number of seams are unknown because of tight folding coupled with the paucity of outcrop. On coal licences (National Coal Corporation, et. al) along the Skeena River Valley, Tompson et al. (1970) have summarized coal occurrences in strata herein assigned to the Currier Member (Table 3).

Tompson, et al. (1970) further reported the results of a diamond drilling program that intersected the Currier Member. On Biernes Creek they reported a total of 9.6 metres of coal distributed between 16 seams in a 177 metres interval a total of nine seams with a cumulative thickness of 10.8 metres occur. On lower Discovery Creek 12.8 metres of coal occur in 17 (?) seams through a 152 metre interval and on Abraham Creek a total of 6.2 metres of coal and 11 seams occur in a 168 metre interval. Two additional drill holes (data not available) intersected similar coal thicknesses.

On Mt. Klappan coal, in strata of the Currier Member, has been described by Waters, (1979). Along the eastern flank of Mt. Klappan at least two seams and probably up to four seams, three to four metres thick occur. On the western side of Mt. Klappan at least two seams, 2.5 metres and 1.8 metres thick occur and on central Mt. Klappan at least one seam 1.2 metres thick outcrops. To the south of Mt. Klappan on licences formerly held by Petrofina, Talbot, (1979) reports the occurrence of four seams, 0.9 m, 1.8 m, 2.5 m and 2.7 metres thick.

TABLE 3

COAL OCCURRENCES IN CURRIER MEMBER

(modified from Tompson *et al.* (1970)

LOCATION	NO. OF SEAMS	INDIVIDUAL SEAM THICKNESS (metres)
Mt. Jackson	5	0.3 - 0.8 - 1.0 - 1.2 - 1.5
Tahtsedle Creek	11	1.7 - 0.8 - 2.5 - 0.2 - 0.2 - 0.2 - 0.3 - 0.3 - 0.5 - 0.2 - 1.5
Biernes Creek	6	1.4 - 3.0 - 1.2 - 1.4 - 0.8 - 1.4
Davis Creek	1	1.4
Telfer Creek	8	1.4 - 1.5 - 1.6 - 1.0 - 1.8 - 0.5 - 1.8 - 1.0
Discovery Creek	4	1.8 - 1.4 - 1.8 - 0.6
Trail Creek	6	0.8 - 0.6 - 1.2 - 1.3 - 1.2 - 2.5
Jackson Creek	6	2.0 - 0.7 - 1.2 - 1.7 - 0.8 - 1.0
Abraham Creek	1	1.7
Wolf Meadows	1	1.3
Dave Creek	6	2.3 - 0.9 - 1.2 - 0.5 - 0.5 - 1.5

Figure 34: A one metre thick argillaceous seam in the McEvoy member near Mt. Biernes.

Figure 35: A 1.5 metre coal seam in the Currier member near Mt. Jackson.

(Buckham and Latour, 1950) summarized many of the major occurrences of coal in strata considered equivalent to the Currier member. The thicknesses of coal reported by them is suspect and many of the occurrences could not be confirmed in the field.

Coal Rank and Quality

Preliminary vitrinite reflectance measurements indicate the coal rank ranges from anthracite to meta-anthracite-semi-graphite. Rank determinations based on fixed carbon summarized by Buckham and Latour, 1950) and Waters (1979) suggest the coal ranges from low volatile bituminous to anthracite.

The quality of surface coal samples examined is consistently poor. The coal contains abundant ash, commonly visible pyrite and is cross-cut by quartz filled fractures. All the coal seams examined are pervasively sheared and oxidized. Tompson *et al*. (1970) have reported that coal intersected in drill holes is commonly argillaceous, contains numerous splits and is cross-cut by veins of quartz and calcite. The sulphur and ash content of the coal is highly variable. Buckham and Latour, (1950) report sulphur values ranging from 0.1% to 3.0%. Mould (1979) reports sulphur values from the former Petrofina licenses ranging from 0.4 to 5.0% and Waters (1979) reports values from Mt. Klappan ranging from about 0.3% to 1.1%. The ash content of the coal is difficult to assess from reported analysis. Buckham and Latour (1950) summarize values ranging from 9 to 42%. Waters (1979) and Mould (1979) describe values ranging from 5% to in excess of 50%.

Resources and Economic Potential

Significant thicknesses of coal occur locally in the Currier member in the Skeena River valley and tributaries of the Skeena. The total coal resources cannot be estimated with confidence because of the paucity of outcrop, structural complexities and rapid facies changes. Waters (1979) estimated the resources at Mt. Klappan to be 1.5 to 2 million tonnes, whereas Mould (1979) estimated the resources of the Petrofina licences to be in order of 90 million tonnes considering a mineable depth of overburden to be 530 metres. Tompson et al. (1970) considered that the total coal reserves(?) of the area underlain by strata equivalent to the Currier member to be 4.1 billion tonnes. These resource calculations with the exception of Waters' (1979) are exceedingly optimistic and are not considered realistic.

Even considering the more optimistic coal thicknesses, the Currier member has little or no economic potential in the foreseeable future. The Currier member everywhere in the coalfield is tightly folded and/or faulted. The structural style of the folding precludes any major structural thickening of coal such as found in the southeastern British Columbia coalfields. Because of the structure, the coal would be impossible to mine by underground methods and there is no significant amount of coal amenable to strip mining. If the coalfield was located in a readily accessible area, small tonnage of coal could be economically mined (robbed) by surface mining. The mineable coal in the coalfield is not however of sufficient quantity nor quality to justify the infrastructure required to economically mine and transport the coal in the foreseeable future. In addition, because of the ash content and locally high sulphur values a wash plant would be required for almost any use of the coal.

Kluayaz Coal Licences

Petro-Canada's coal licences cover Prudential Mountain, Mount Laidlaw and low lying areas to the east along the Kluatantan River (Figure 2). In order to fully assess the licenced area airphoto interpretation and follow-up detailed mapping on a scale of 1:5,000 was undertaken. Air-photo studies resolved much of the structure of Prudential Mountain and adjacent topographical high areas. In the low lying areas along the Kluatantan drainage there is no outcrop with the exception of patchy exposures in the more deeply incised creeks. Although the outcrop was not adequate (considering the structural complexity) to enable detailed stratigraphy or structural studies it was sufficient to evaluate any potential coal resources.

Geology

The Kluayaz coal licences are underlain by strata of the McEvoy and Prudential members. The McEvoy member crops out only to the west of the Kluatantan River. The Prudential member crops out to the east of the Kluatantan River and along deeply incised creeks to the west. Measured sections within the licenced area are appended to the report and should be examined for a detailed account of the lithology.

Within the licenced area the cyclic character of the lithology, lack of marker horizons and paucity of outcrop did not enable differentation of the McEvoy or Prudential members into sub-units.

Stratigraphy

McEvoy Member

The McEvoy member underlies the area to the west of the Kluatantan River and is well exposed on Mount Taylor, Lonesome, View and Moss Mountains at the edge of the licences (Figure 37). The McEvoy member is about 350 metres thick in the licenced area and overlies (conformably?) the Prudential member.

In all the localities the McEvoy member is comprised of a monotonous sequence of interbedded siltstones, shales, sandstones, thin carbonates and rare coal seams. The siltstones and shales are dark grey to brown weathering, very well indurated, thin to thick bedded and occur in intervals up to 10 metres thick. The sandstones are tan to buff weathering, very fine to fine-grained and quartzose. Most sandstones are massive but ripple cross-laminated, planar and cross-bedded sandstones occur locally. Some sandstones comprise distinct channels up to 15 metres wide and 5 metres thick. The limestones are tan weathering, up to 0.5 metres thick and locally nodular. The coal varies in thickness from carbonaceous partings to seams up to 0.5 metres thick. The coal is typically argillaceous and locally is inter-laminated with discrete partings of pyrite up to 0.5 centimetres thick.

The strata are well indurated and on Lonesome and Moss Mountains a well developed cleavage is present. To the north the strata are more poorly indurated and the cleavage is less distinct. The strata are locally well jointed and cross-cut by quartz veins.

Prudential Member

The Prudential member is everywhere tightly folded and faulted and no complete section is present. Two partial sections were measured on Prudential Mountain (Appendix 1; sections 119 and 120) and all accessible outcrops were examined. The total thickness of the Prudential member in the licenced area is estimated to be in the order of 500 to 800 metres. It is comprised of interbedded shales, siltstones, sandstones, conglomerates and coal seams. The shales and siltstones are brown to medium grey, comprise up to 70% of the strata, are exceedingly well indurated and are ridge forming. The sandstones are tan to buff weathering, very fine to coarse grained and quartzose. They are massive or parallel bedded and range in thickness from 0.5 to 10 metres. The conglomerates are vari-colored, up to 5 metres thick and are composed of well sorted quartz and chert pebbles.

Coal comprises a very minor component of the Prudential member, although carbonaceous partings are common. On the eastern flank of Mt. Laidlaw and on Prudential Mountain seams between 1 and 1.5 metres thick crop out. At many localities seams ranging from 10 centimetres to 80 centimetres in thickness occur (Figure 38).

The strata are well indurated, cleaved, and fracture filling quartz veins occur throughout.

Structure

The structure of the licenced area differs markedly on either side of the Kluatantan River which corresponds to the area underlain by the McEvoy and Prudential members (Figure 25). East of the Kluatantan River strata of the McEvoy Ridge are characterized by low amplitude folds with a wavelength in the order of 300 to 400 metres and by high angle reverse faults. The folds are northwest-southeast trending and upright to overturned to the northeast. Locally, areas of tight folding are associated with high angle reverse faults or zones of interstratal slip (Figure 31). Interstratal peels are common and indicate more shortening than the overall structure initially suggests. On Prudential Mountain and areas to the south and north, the Prudential member is characterized by tight upright to northeasterly overturned, northwest-southeast trending folds (Figures 38 and 39). The folds have high amplitudes and wavelengths commonly less than 150 metres. Many anticlinal hinges are faulted and subsequently synclines are commonly juxtaposed. No major thrust faults are evident.

In the Kluatantan valley and Mt. Laidlaw there is very little outcrop. What outcrop does exist however, suggests the strata are tightly folded and locally faulted - similar to that described on Prudential Mountain.

Figure 37: McEvoy member, northwest of the licenced area.

Figure 38: A 0.5 metre thick argillaceous coal seam on eastern Prudential Mountain.

Figure 39: Prudential Mountain (foreground), Mount Laidlaw (middle) and Kluatantan Valley (background). View to the northwest.

Figure 40: Prudential Mountain - view to the southeast. Steeply dipping resistant beds of siltstone and conglomerate define tight northwest-southeast trending folds. The folds are upright to overturned to the northeast.

Coal - Occurrence and Potential

Within the Kluayaz coal licences carbonaceous partings and thin coal seams occur in the McEvoy and Prudential members. Nowhere were seams thicker than 1.5 metres observed nor do multiple seams thicker than 1.0 metres occur in any stratigraphic interval. The thickest seams observed occur on the east flank of Mt. Laidlaw where two seams varying from 1.0 to 1.5 metres thick outcrop and on eastern Prudential Mountain where one seam 1.0 metre thick occurs. Malloch and Tohers described the occurrence of a number of coal seams in the licences area (Buckham and Latour, 1950). Although many of the described occurrences were confirmed most of the thicker seams are best described as interbedded carbonaceous shale and coal.

Coal Rank and Quality

Based on vitrinite reflectance determinations the coal rank varies from meta-anthracite to semi-graphite. The coal is argillaceous, pervasively sheared and commonly cross-cut by quartz veins. All surface samples are highly oxidized. No samples suitable for proximate analysis were collected during the study. Analysis of eight samples from the study area reported by Malloch (in Buckham and Latour, 1950) averaged 38% ash.

Resources and Economic Potential

No attempt has been made to calculate the coal resources in the licenced area because of structural complexity and the paucity of outcrop throughout much of the property.

The complete absence of seams of mineable thickness, the tight folding coupled with the poor quality of the observed coal indicate the licenced area has no potential for mining by conventional methods.

Conclusions and Recommendations

The Groundhog coalfield is characterized by a succession of fine to coarse grained clastics up to 4500 metres thick of highly variable structural style. Five mappable units are distinguished which are referred to informally as the Jackson, Currier, McEvoy, Devils Claw and Prudential members. The Jackson member - the lowest stratigraphic unit in the coalfield, comprises approximately 1800 metres of interbedded marine shales, siltstones, sandstones and minor conglomerates of Late Jurassic age. East of the Kluatantan River the Jackson member is overlain conformably by a sequence of deltaic and fluvial-deltaic sandstone, shale, siltstone and coal up to 800 metres thick of the Currier member. East of the Kluatantan River the Jackson member is overlain conformably by a coarser grained sequence of sandstone, shale, siltstone, rare coal and conglomerate up to 800 metres thick of the Prudential member. The Prudential member is considered in part to be stratigraphically equivalent to the Currier member and includes deltaic and fluvial deposits. The Currier member is overlain by the McEvoy member which is composed of up to 1000 metres of fluvial and lacustrine siltstones, shales, very fine- to fine-grained sandstones and rare limestones and coal. The McEvoy member is in turn conformably overlain and in part a lateral equivalent to fluvial and locally lacustrine siltstone, shale, sandstone, and massive conglomerate up to 500 metres thick of the Devils Claw member. The overall stratigraphic sequence within the coal field represents a major regressive sequence which prograded from the north and northeast.

The structure of the coalfield is dominated by a northwest-southeast trending structural grain. The structure is highly variable both stratigraphically and across the coalfield. Between the Nass and Kluatantan Rivers strata of the Devils Claw and McEvoy members are characterized by broad open folds of low amplitude and locally, tight northeast and rarely southwesterly overturned folds and drag folds. The Currier, Prudential and Jackson members are typified by high amplitude, short wavelength, chevron style folds which are upright to overturned to the northeast. Back-limb and fore-limb thrust faults are common throughout the coalfield but there is no evidence for major thrust faults. The Prudential and Jackson members and locally the Currier and McEvoy members are cleaved. A late phase of normal faulting is evident in some areas. The variation in structural style between the McEvoy and Devils Claw members and the Jackson, Currier and Prudential members is considered a product of the differing lithologies. The possibility cannot be ruled out, based on this study, that an angular unconformity separates the Prudential and Currier members from the overlying McEvoy member. There is no evidence to suggest the Nass River, Skeena River-Tahtsedle Creek or other northwest-southeast lineaments are major thrust faults nor is there evidence for strike-slip faulting along them.

Coal occurs in the McEvoy, Prudential and Currier members. The coal rank varies in rank from semi-anthracite through anthracite to meta-anthracite and semi-graphite. Coal in the McEvoy and Prudential members consists of carbonaceous partings to seams up to 1.5 metres thick but everywhere comprises a very small (and insignificant) part of the succession. The Currier member is the main coal bearing member in the coalfield. Coal seams locally up to 4 metres thick occur but most seams are less than 1.0 metres thick. Coal never comprises a significant component of the member. The coal is mainly anthracite and meta-anthracite, commonly 0.5 to 2.5 metres but coal rarely comprises a significant component of the member. The coal is mainly anthracite and meta-anthracite, commonly cross-cut by quartz veins, argillaceous and has a highly variable sulphur content (up to 3%). Because of the paucity of outcrop, lack of marker horizons, and complex structure it is not possible to estimate the lateral extent, total number of seams or resources with confidence.

Although locally thick seams occur in the Currier member, seams of suitable thickness, quality and structural setting to facilitate conventional mining do not occur. The Currier member within the study area is thus considered to have no potential for development at a scale which would warrant implacing the infrastructure necessary to mine, wash and transport the coal at this time.

Petro-Canada's Kluayaz coal licences are underlain entirely by the Prudential and McEvoy members. Folding in the area is exceedingly tight and no coal seams thicker than 1.5 metres were observed anywhere on the licenced areas. Because of the absence of thick coal seams and structural complexity, the licenced area is considered to have no potential for coal development in the foreseeable future.

Based on the absence of observed seams of suitable thickness and quality and structural complexities which would inhibit conventional mining, it is recommended that the Kluayaz licences be dropped and no further exploration be undertaken. Other areas of coal potential in the central and northern part of the Bowser Basin are unknown. The Bowser Basin, an area of 70,000 $kilometres^2$, however remains one of the least known areas of Canada. Although there is no encouragement for further coal exploration at present, the results of mapping programs by the Geological Survey of Canada should be closely monitored.

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APPENDIX /

SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance			$360,819.63
Detail—			$ 40,091.01
Surface			
Underground			
Other (specify)*			
Geophysical/Geochemical Surveys			
Method			
Grid			
Topographic			
Other (specify)*			
Road Construction			
On licences Nos.			
Access to			
Surface Work			
Trenching			
Seam tracing			
Crosscutting			
Other (specify)*			
Underground Work			
Test adits			
Other workings*			
Drilling			
Core—			
Diamond			
Wireline			
Rotary—			
Conventional			
Reverse circulation			
Other (specify)*			
Contractor			
Where core stored			
Logging			
Sampling			
Testing			
Other work: (specify details)*			
Reclamation work (Permit No.)			

ON-PROPERTY COSTS $ 294,669.32

OFF-PROPERTY COSTS $ 106,241.32

TOTAL EXPENDITURES $ 400,910.64

July 12, 1982
(Date)

[signature] Ph.D (General Manager - Coal Division)
(Signature and position)

*A full explanation of "Other" work is to be included.

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Victoria, 1980

1M-180-9859

CATEGORY 21

A121005 BOWSER BASIN GROUNDHOG PROJECT GROSS = 500.000 00 NET = 500.000 00 W I = 1 000000

		AUTHORIZED	EXPENDED	VARIANCE
143	CAPITALIZED MINING EXPENDITURES			
099	MISCELLANEOUS		5.432 71CR	5.432 71
261	CAMP & CATERING	85.000 00	22.104 10	62.895 90
262	COMMUNICATIONS	5.000 00	4.497 10	502 90
263	FREIGHT AND HAULING	269.000 00	66.837 97	202.162 03
264	EQUIPMENT RENTALS		432 23	432 23CR
277	PRINTING AND REPRODUCTION		46 00	46 00CR
283	DIRECT CO LABOR - SUP & TECHNICAL	70.000 00	141.101 86	71.101 86CR
342	POWER & FUEL	25.000 00		25.000 00
345	BULK FUEL		37.612 70	37.612 70CR
389	NON-CONTROLLABLE MATERIALS	21.000 00	18.415 11	2.584 89
423	AIR CHARTER-HELECOPTERS		37.622 73	37.622 73CR
583	CONTRACT LABOUR-SUPERVN & TECHN		22.747 51	22.747 51CR
629	SURVEYING AND PHOTOGRAMMETRY.	15.000 00	980 25	14.019 75
631	ASSAYING AND TESTING		220 12	220 12CR
635	TRAVEL & AUTOMOTIVE EXPENSE	10.000 00	39.328 56	29.328 56CR
638	GEOLOGICAL AND MAPPING STUDIES		13.513 61	13.513 61CR
659	GEOCHEMICAL STUDIES		883 50	883 50CR
	TOTAL MAJOR	500.000 00	400.910 64	99.089 36
	AFE GROSS TOTAL	500.000 00	400.910 64	99.089 36
998	CO-OWNERS SHARE			
	NET TOTAL	500.000 00	400.910 64	99.089 36

GROUNDHOG COAL PROJECT

SCHEDULE OF COAL LICENSES

ISSUED APRIL 13, 1981

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6916	104A/16E	G	87, 88, 97, 98*	129	$ 645
6917	"	-	Lot 2187	259	1,295
6918	"	I	1, 2, 11, 12	283	1,415
6919	"	I	3, 4, 13, 14	283	1,415
6920	"	I	5, 6, 15, 16	283	1,415
6921	"	I	7, 8, 17, 18	283	1,415
6922	"	I	9, 10, 19, 20	283	1,415
6923	"	I	21, 22, 31, 32	283	1,415
6924	"	I	23, 24, 33, 34	283	1,415
6925	"	I	25, 26, 35, 36	283	1,415
6926	"	I	27, 28, 37, 38	283	1,415
6927	"	I	29, 30, 39, 40	283	1,415
6928	"	I	41, 42, 51, 52	283	1,415
6929	"	I	43, 44, 53, 54	283	1,415
6930	"	I	45, 46, 55, 56	283	1,415
6931	"	I	47, 48, 57, 58	283	1,415
6932	"	I	49, 50, 59, 60	283	1,415
6933	"	I	61, 62, 71, 72	283	1,415
6934	"	I	63, 63, 73, 74	283	1,415
6935	"	I	65, 66, 75, 76	283	1,415
6936	"	I	67, 68, 77, 78	283	1,415
6937	"	I	69, 70, 79, 80	283	1,415
6938	"	I	81, 82, 91, 92	283	1,415
6939	"	I	83, 84, 93, 94	283	1,415
6940	"	I	85, 86, 95, 96	283	1,415
6941	"	I	87, 88, 97, 98	283	1,415
6942	"	I	89, 90, 99, 100	283	1,415
6943	"	J	1, 2, 11, 12	283	1,415

cont'd....

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6944	104A/16E	J	7, 8, 17, 18*	268	$1,340
6945	"	J	9, 10, 19, 20*	160	800
6946	"	J	21, 22, 31, 32	283	1,415
6947	"	J	27, 28, 37, 38	283	1,415
6948	"	J	29, 30, 39, 40*	282	1,410
6949	"	J	41, 42, 51, 52	283	1,415
6950	"	J	43, 44, 53, 54	283	1,415
6951	"	J	47, 48, 57, 58	283	1,415
6952	"	J	49, 50, 59, 60	283	1,415
6953	"	J	61, 62, 71, 72	283	1,415
6954	"	J	63, 64, 73, 74	283	1,415
6955	"	J	65, 66, 75, 76	283	1,415
6956	"	J	67, 68, 77, 78	283	1,415
6957	"	J	69, 70, 79, 80	283	1,415
6958	"	J	81, 82, 91, 92	283	1,415
6959	"	J	83, 84, 93, 94	283	1,415
6960	"	J	85, 86, 95, 96	283	1,415
6961	"	J	87, 88, 97, 98	283	1,415
6962	"	J	89, 90, 99, 100	283	1,415
6963	104A/16W	K	61, 62, 71, 72	283	1,415
6964	"	K	81, 82, 91, 92	283	1,415
6965	104H/1E	A	1, 2, 11, 12	282	1,410
6966	"	A	3, 4, 13, 14	282	1,410
6967	"	A	5, 6, 15, 16	282	1,410
6968	"	A	7, 8, 17, 18	282	1,410
6969	"	A	9, 10, 19, 20	282	1,410
6970	"	A	21, 22, 31, 32	282	1,410
6971	"	A	23, 24, 33, 34	282	1,410
6972	"	A	25, 26, 35, 36	282	1,410
6973	"	A	27, 28, 37, 38	282	1,410
6974	"	A	29, 30, 39, 40	282	1,410
6975	"	A	41, 42, 51, 52	282	1,410
6976	"	A	43, 44, 53, 54	282	1,410
6977	"	A	45, 46, 55, 56	282	1,410

cont'd.....

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6978	104H/1E	A	47, 48, 57, 58	282	$1,410
6979	"	A	49, 50, 59, 60	282	1,410
6980	"	A	61, 62, 71, 72	282	1,410
6981	"	A	63, 64, 73, 74	282	1,410
6982	"	A	65, 66, 75, 76	282	1,410
6983	"	A	67, 68, 77, 78	282	1,410
6984	"	A	69, 70, 79, 80	282	1,410
6985	"	B	1, 2, 11, 12	282	1,410
6986	"	B	3, 4, 13, 14	282	1,410
6987	"	B	5, 6, 15, 16	282	1,410
6988	"	B	7, 8, 17, 18	282	1,410
6989	"	B	9, 10, 19, 20	282	1,410
6990	"	B	21, 22, 31, 32	282	1,410
6991	"	B	23, 24, 33, 34	282	1,410
6992	"	B	25, 26, 35, 36	282	1,410
6993	"	B	27, 28, 37, 38	282	1,410
6994	"	B	29, 30, 39, 40	282	1,410
6995	"	B	41, 42, 51, 52	282	1,410
6996	"	B	43, 44, 53, 54	282	1,410
6997	"	B	45, 46, 55, 56	282	1,410
6998	"	B	47, 48, 57, 58	282	1,410
6999	"	B	49, 50, 59, 60	282	1,410
7000	"	B	61, 62, 71, 72	282	1,410
7001	"	B	63, 64, 73, 74	282	1,410
7002	"	B	65, 66, 75, 76	282	1,410
7003	"	B	67, 68, 77, 78	282	1,410
7004	"	B	69, 70, 79, 80	282	1,410
7005	104H/1W	C	1, 2, 11, 12	282	1,410
7006	"	C	3, 4, 13, 14	282	1,410
7007	"	C	5, 6, 15, 16	282	1,410
7008	"	C	21, 22, 31, 32	282	1,410
7009	"	C	23, 24, 33, 34	282	1,410
7010	"	C	25, 26, 35, 36	282	1,410
7011	"	C	41, 42, 51, 52	282	1,410

cont'd.......

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
7012	104H/1W	C	43, 44, 53, 54	282	$ 1,410
7013	"	C	45, 46, 55, 56	282	1,410
7014	"	C	61, 62, 71, 72	282	1,410
7015	"	C	63, 64, 73, 74	282	1,410
7016	"	C	65, 66, 75, 76	282	1,410
TOTAL				28,214	$141,070

*Excludes surveyed lots - see below for description

6916 - save and except that part within Lot 2185, 2186 and Lot 2187
6944 - save and except that part within Lot 2187
6945 - save and except that part within Lot 2187 and Lot 2193
6948 - save and except that part within Lot 2193

APPENDIX 2

RECONNAISSANCE GEOLOGY AND COAL
POTENTIAL OF THE GROUNDHOG COALFIELD,
BRITISH COLUMBIA

by

R.M. Bustin, Ph.D.

Coal Licences Nos. 6916 to 7016 inclusive
Granted April, 1981
Cassier Land District

NATIONAL TOPOGRAPHIC SYSTEM
LOCATION 104A/16 and 104H/1
57 ° 00' North Latitude, 128 ° 10' West Longitude

Submitted July 13th, 1982
by
PETRO-CANADA EXPLORATION INC.
COAL DIVISION

dup #106 (2)

[redacted]

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Summary

The Groundhog coalfield is underlain by a thick sequence (4000 m) of Late Jurassic-Early Cretaceous clastic sediments. The strata comprise an overall coarsening upwards (regressive) sequence from marine (Jackson member), through deltaic (Currier and Prudential members), lacustrine and fluvial (McEvoy member) and alluvial plain-alluvial fan (Devils Claw member) deposits. To the north and northeast the facies coarsen. Carbonaceous partings and thin coal seams occur in the McEvoy and Prudential members. The Currier member is the main coal bearing facies and includes coal seams locally up to 4 metres thick.

The coalfield is characterized by a northeast-southwest structural grain. The structure of the Devils Claw and McEvoy members varies from broad open folds to tight upright, northeasterly or southwesterly overturned folds. The Currier, Prudential and Jackson members are everywhere characterized by tight upright to northeasterly overturned folds. Back limb and fore limb thrust faults are common but there is no evidence for major thrusts anywhere in the coalfield. A late phase of normal faulting has resulted in minor offsets.

The coal ranges in rank from semi-anthracite to meta-anthracite and semi-graphite. It is commonly sheared, cut by quartz veins, argillaceous with numerous partings and has a highly variable sulphur content (up to 3%). All surface samples are highly oxidized. Because the coal is sheared, oxidation is probably pronounced to several metres from the surface.

The Petro-Canada coal licences are underlain entirely by strata assigned to the Prudential or McEvoy members. Observed coal in the licence area range from carbonaceous partings to rare seams up to 1.5 metres thick.

The licences are considered to have no potential for development because of the absence of seams of suitable thickness and quality, and the preponderance of tight folding which would inhibit conventional mining.

The Currier member crops out in low lying areas along the Skeena River Valley and tributaries, at Mt. Klappan, along Tahtsedle Creek, Panorama Lakes and Mt. Jackson. All areas of significant coal outcrop are presently under licence. Although coal seams up to 4 metres thick locally occur in the Currier member they are considered to have no potential for development in the foreseeable future. The general absence of thick seams, rapid facies changes and tight folding and faulting (which characterizes the Currier member) inhibit conventional mining on a scale that would warrant the establishment of the infrastructure necessary to mine, wash and transport the coal.

It is recommended that the presently held licences be dropped and no further coal exploration be undertaken in the area of the study. Although there is no encouragement for further coal exploration in the Bowser Basin at present, it is recommended that the Geological Survey of Canada mapping programs be closely monitored as well as the activities of the remaining coal licence holders of the area.

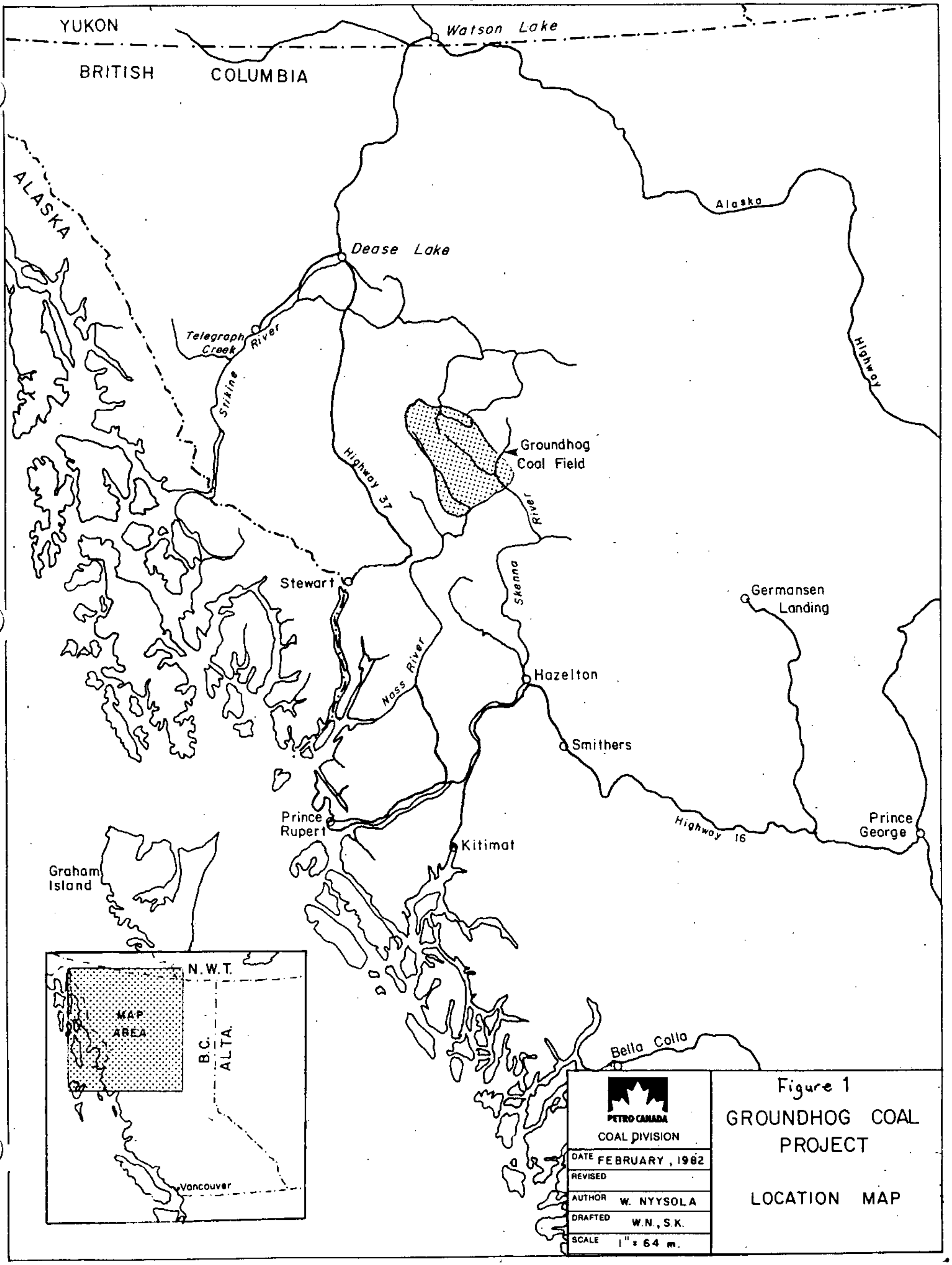


Figure 1
GROUNDHOG COAL PROJECT

LOCATION MAP

Introduction

The Groundhog coalfield is an informal name for a coal bearing region in the Skeena Mountains of central British Columbia (Figure 1). The boundaries of the coalfield have not been defined, but it is generally considered to include parts of the upper Skeena, Nass, Klappan and Spatzizi watersheds (Buckham and Latour, 1950). Although coal has been actively explored for in the coalfield since about 1910, the area has never been mapped, neither the structure nor the stratigraphy resolved and little is known about the distribution of coal.

In order to establish a framework for evaluation of the coal potential of the area a reconnaissance survey was undertaken of the stratigraphy and structure of the coalfield prior to making a more detailed evaluation of Petro-Canada's Kluayaz coal licences. The purpose of this report is to outline the regional stratigraphy and structure of the coalfield, to make a detailed analysis of the geology of Petro-Canada's Kluayaz coal licences and to provide a synthesis of the coal potential of the coalfield.

Acknowledgments

R.M. Bustin, Ph.D. prepared this Groundhog report for Petro-Canada Exploration Inc. Not only was he involved in all aspects of the fieldwork but also provided guidance and expertise to the geological staff.

Geography

Location and Means of Access

The Groundhog coalfield is situated in the Skeena Mountains, Northwestern B.C., District of Cassiar some 270 air kilometers north of Smithers, B.C.

Rivers and lakes are the most easily recognized reference points which define the perimeter of the 'field'. The Skeena River practically runs through the middle of the Groundhog; the Nass Rivers forms the western boundary; and the Spatzizi and Little Klappan Rivers the northern boundary.

The larger lakes to the north are Buckinghorse and Cold Fish while to the south lie Kluayaz and Panorama. Immediately to the northeast of the coalfield lies the Spatzizi Plateau Wilderness Park.

Fixed-wing or helicopter is the most convenient method of transportation into the Groundhog. However, the only lake with a central location that is of sufficient size to land float planes on is Kluayaz. A number of airstrips in good operating condition capable of accommodating heavily loaded twin-engined aircraft are located along the railbed.

There are no roads paralleling the rail line that allow vehicular access into the area.

Topography

The overall topography of the Groundhog Coalfield is mountainous with a mean elevation of 1650 metres.

Broad river valleys such as the Nass and Skeena divide the ranges. Mixed forests of spruce and alder grow on lower elevations and in the river valleys. Wet ground and marshes are quite common. Somewhat unique is the Fireflats, a barren Quaternary outwash plain, which is tundra-like in appearance. The Fireflats extend from northwest of Kluayaz Lake up around Mount Klappan.

Various kinds of wildlife, such as goats, grizzlies, black bears, moose, cariboo and groundhogs inhabit the Groundhog.

Climate

The summer weather in the Groundhog is very unpredictable. During the course of a day the weather can change from one extreme to another. On July 5th a fair snow storm was encountered at higher elevations while rain fell on low-lying areas. Due to the heavy winter snow most north-facing slopes are not accessible until mid-July. Snow still remains on the ground till the end of June.

Field Camp and Services

An outfitters-guide camp, situated on the east shore of Kluayaz Lake was leased to provide accommodations for the field crew. The camp was complete with three cabins, dock, storage facilities, and a functional kitchen - dining room. Three tents were set up to provide extra living quarters.

On June 2nd the exploration group arrived in Smithers. After the necessary camp supplies were packed up and travel arrangements made the crew flew up to Kluayaz Lake on the 5th of June. Mapping work began on the 15th. By mid-August the objectives set for the mapping program had been achieved. The camp was closed on August 18th.

Helicopter support for the project was provided by a Bell 206 contracted from Alpine Helicopters of Kelowna. Fuel and supplies were brought in by fixed-wing aircraft chartered from several companies.

Personnel consisted of six people involved with geology, two helpers, a cook, pilot and engineer. Staff involved with the project are listed in Table 1 and the suppliers and contractors in Table 2.

TABLE 1

LIST OF PERSONNEL EMPLOYED

OFFICE STAFF

E. Schiller	General Manager of Exploration
S. Santiago	Manager of Coal Exploration
A. Karnapke	Geologist
W. Nyysola	Geological Technologist
D. Kinton	Division Landman
S. Klotz	Draftsperson

FIELD STAFF

A. Karnapke	Geologist, Party Chief
W. Nyysola	Geological Technologist

TEMPORARY STAFF

Dr. R. M. Bustin	Consultant
K. Ladouceur	Assistant Party Chief
E. van der Flier	Geologist
M. Back	Geological Assistant
J. Davis	Field Assistant
T. Jerhoff	Field Assistant
B. McLean	Cook

TABLE 2

LIST OF CONTRACTORS AND SERVICES

AIRCRAFT CHARTER

Kelowna Flightcraft	Kelowna, B.C.
Alpine Helicopters	Kelowna, B.C.
Smithers Air Service	Smithers, B.C.
Trans Provincial Airlines	Terrace, B.C.

CAMP

Collingwood Bros.	Smithers, B.C.

CONSULTANT

Dr. R. M. Bustin	Vancouver, B.C.

GRAPHIC SERVICES

R.M. Hardy & Associates	Calgary, Alta.
West Canadian Graphics	Calgary, Alta.

EXPEDITOR

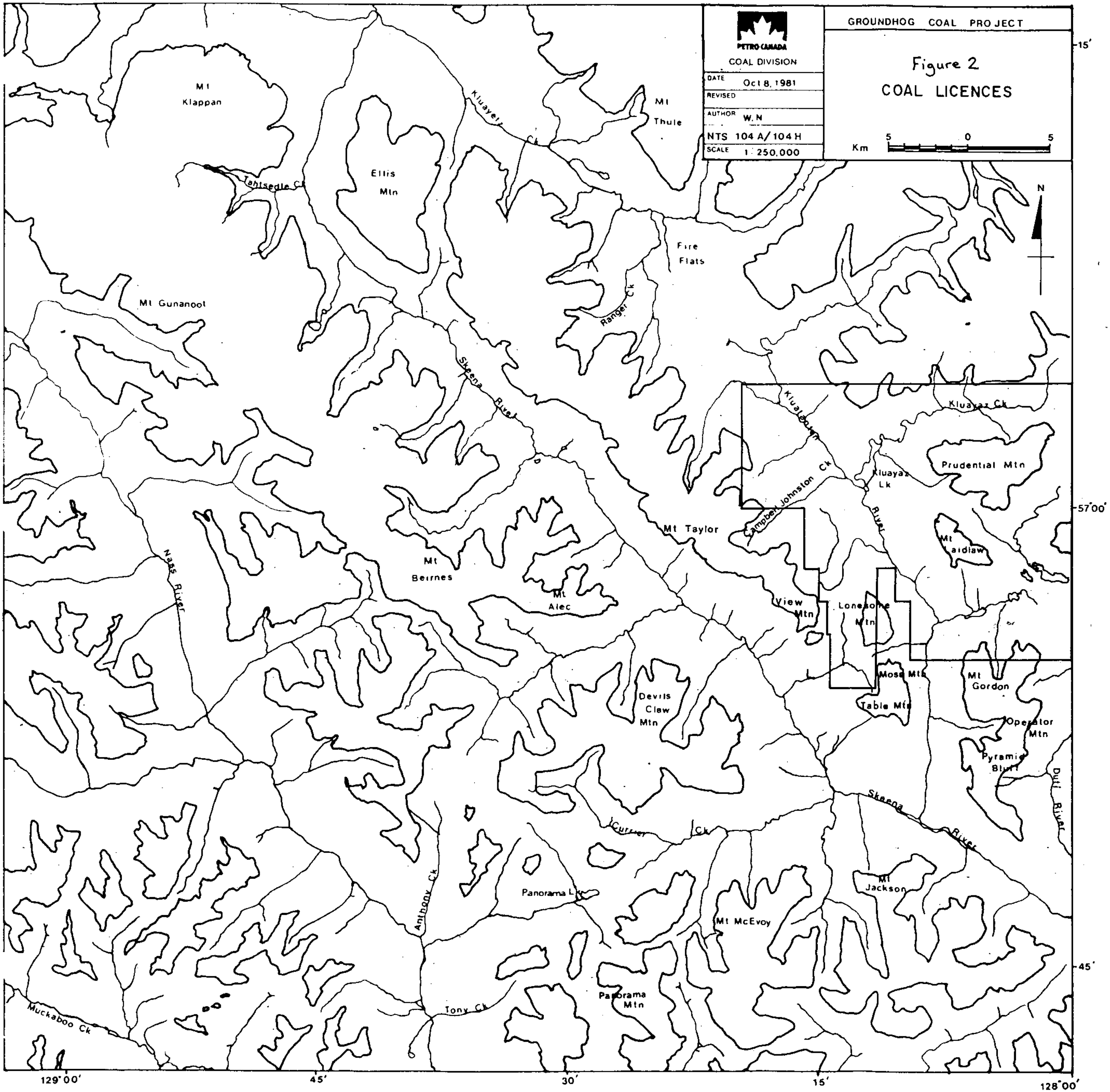
Bema Industries	Smithers/Langley, B.C.

MISCELLANEOUS SERVICES

Bowmac Truck Rentals	Smithers
Canadian Freightways	Calgary/Smithers
Canadian Propane	Smithers
Chevron Canada	Smithers
Shell Canada	Smithers
Smithers Hardware	Smithers
Smithers Lumberyard	Smithers
Super-Value	Smithers
Neville Crosby Inc.	Vancouver

Licence Groupings

The coal licences now held by Petro-Canada in the Groundhog were applied for on December 10th, 1980 and issued by the British Columbia government April 13th, 1981. The licences can be located on map sheets McEvoy Flats 104-16 (Licences #6918-6964) and Skelhorne Creek 104 H-1 (Licences 6965-7016). Total area covered by the licences is 28,214 hectares, (see Figure 2).


PETRO CANADA
COAL DIVISION
DATE Oct 8, 1981
REVISED
AUTHOR W. N
NTS 104 A/104 H
SCALE 1 : 250,000
GROUNDHOG COAL PROJECT
Figure 2
COAL LICENCES
Km 5 0 5
N
Mt Klappan
Ellis Mtn
Tahtsedle Ck
Kluayetz Ck
Mt Thule
Fire Flats
Ranger Ck
Mt Gunanoot
Skeena River
Kluatantan
Kluayaz Ck
Prudential Mtn
Kluayaz Lk
Campbell Johnston Ck
River
Mt Laidlaw
Mt Taylor
Nass River
Mt Beirnes
Mt Alec
View Mtn
Lonesome Mtn
Moss Mtn
Mt Gordon
Table Mtn
Devils Claw Mtn
Operator Mtn
Pyramid Bluff
Duti River
Skeena River
Currier Ck
Anthony Ck
Panorama Lk
Mt Jackson
Mt McEvoy
Panorama Mtn
Tony Ck
Muckaboo Ck
15'
57°00'
45'
129°00'
45'
30'
15'
128°00'

Regional Geological Setting

The Groundhog coalfield is located within the central part of the Bowser Basin - a non-volcanic successor basin developed upon older volcanic complexes of the central Cordillera. The Bowser Basin probably initially developed in middle Jurassic time with uplift of the easterly trending Skeena Arch which divided the early and middle Jurassic Hazelton trough into two separate basins; the Bowser Basin to the north and Nechako Basin to the south (Tipper and Richards, 1976). The northern boundary of the Bowser Basin is the Stikine Arch, whereas the eastern boundary is the Columbian Orogeny.

The Bowser Basin is comprised by a succession of marine and continental clastics and minor volcanics considered to be in the order of 6000 metres (G.S.C., 1957) to 10000 metres (Koch, 1974) thick. The strata was initially referred to informally as the Bowser Assemblage (Souther and Armstrong, 1966) and were considered to range in age from mid-Jurassic (Collovian) to Early Cretaceous (Albian). More recently from studies in the southern part of the Bowser Basin, Tipper and Richards (1976) have divided the Bowser Assemblage into a lower Bowser Lake Group composed of mid (Bajocian) to late Jurassic (Kimmeridgian) marine and non-marine sediments with minor volcanics, and the Skeena Group which comprises Early Cretaceous to earliest Late Cretaceous (Hauterivian to Albian or Cenomanian) age marine and non-marine sediments (including coal) and volcanic strata. Tipper and Richards (1976) considered the major depositional basin of the Bowser Lake Group to be the Bowser Basin (bounded by the Stikine and Skeena Arches) but the depositional basin of the Skeena Group was not considered coincidental with the Jurassic Bowser Basin. Furthermore, Tipper and Richards (1976) recognized a hiatus between the Bowser Lake and Skeena Groups. The major sediment source during deposition in the Bowser Basin was apparently highly variable. In the northern part of the basin the sediment source was to the east or northeast, whereas along the southern margin of the basin the source was intrabasinal, westerly or southeasterly (Eisbacher, 1974a, Duffell and Souther, 1964, Tipper _in_ Eisbacher, 1974c and Tipper and Richards, 1976).

Deformation of the Bowser Lake Group apparently preceeded deposition of the Skeena Series as defined by Tipper and Richards. The major phase of deformation in the Bowser Basin was, however post-Skeena Group and pre-Sustut Group (late Cretaceous), inasmuch, as tightly folded and locally penetratively deformed strata of the 'Bowser Assemblage' are unconformably overlain by Sustut Group rocks. The structural style of the Bowser Basin is characterized by broad to extremely tightly folded northeast-southwest trending folds which are characteristically overturned to the northeast. Evidence for thrust faulting is rare in much of the basin but those that are evident indicate shortening in a southwest-northeast direction. The Groundhog coalfield is anomalous when compared to the surrounding Bowser Basin. Strata correlative with the Bowser Lake Group occur but are overlain by a thick succession of non-marine clastics with minor coals that are unlike the Skeena Group described by Tipper and Richards (1976) to the south. The structure of the coalfield is highly variable (as will be discussed later) and the different stratigraphic units impart a major control on the structure.

Previous Studies

Coal was probably initially discovered in the Groundhog coalfield by prospectors travelling between Fraser Lake and Cassiar during the Cassiar gold rush in the years 1872 through 1878 (Buckham and Latour, 1950). Subsequent studies by Dupont (1901), Dawson (1901), Malloch (1912, 1914), Leech (1910), Evans (1913) and Dowling (1915) established the presence of anthracite throughout a large area of the Skeena, Nass, Klappan and Spatzizi watersheds.

The first stratigraphic studies of the coalfield were made by Malloch (1912 - 1914). He divided the strata into two main 'divisions'; the lower Hazelton Group and the Upper Skeena Series. Malloch (op. cit.) considered the Hazelton Group to include dark grey to black tuffs, tuffaceous sandstones and black shales which he considered to be locally metamorphosed to schists. The Skeena Series according to Malloch included conglomerate, sandstone, vari-colored shales and coal. Buckham and Latour (1950) described the results of a reconnaissance survey made in 1948 and summarized much of the exploration to that date. They (op. cit.) retained Malloch's stratigraphic sub-divisions, but because of semantic problems renamed the two divisions the Lower and Upper Hazelton Group.

During Operation Stikine (Geo. Surv. Can., 1957) the Geological Survey of Canada made a preliminary map of the Stikine River area, but apart from a cursory examination no attempt was made to determine the stratigraphy or structure of the coal field. Eisbacher (1974c) made a reconnaissance survey of the eastern margin of the Bowser Basin and examined several sections in the coal field area. Eisbacher (1974c) described three facies belts which in ascending order are: 1) Duti River-Slamgeesh which comprise shales, siltstones, conglomerates and thin coal seams that unconformably overlie volcanic rocks of the Takla-Hazelton assemblage; 2) Groundhog -Gunanoot facies-comprised of conglomerate, sandstone and coal; and 3) Jenkins Creek facies composed of 'continental' fine-grained clastics and concretionary limestones. Eisbacher (1974c) suggested the Jenkins Creek facies was possibly part of the Sustut Group. Most recently Richards and Gilchrist (1979) from a reconnaissance survey defined four basic map units; channel, channel overbank, overbank channel and overbank facies.

Unpublished coal exploration reports on open-file with the BCMMPR provide the most comprehensive analysis of local areas of the coalfield.

History of Coal Exploration

Coal exploration in the Groundhog area closely followed Dupont's (1901) published account of the occurrence of coal near the confluence of Didene Creek and Spatsizi River. In 1903 James McEvoy and W.W. Leech staked the first coal claims on behalf of a syndicate known as "Western Development Company". In subsequent years the Western Development Company drove adits and trenched on their holdings on Currier, Davis and Discovery Creeks and on the Skeena River. In 1909 A. Geodfrey and F.A. Jackson staked claims surrounding those of the Western Development Company and in 1910 G.M. Biernes and R.C. Campbell-Johnson acquired claims to the north. From 1910-1912 exploration peaked in the coal field, many companies consolidated or expanded their holdings and many individuals acquired ground. In 1911-1912 the B.C. Anthracite Company did extensive exploration in the area and amalgamated with other companies. Early expectations of a rail line into the Groundhog area by the Canadian Northeastern Railway promoted exploration in 1910-1912. In 1912 however, a decision was made not to construct the rail line and the Balkan wars of 1912-1913 placed a strain on world money markets (Buckham and Latour, 1950) which curtailed exploration. In 1913 the only exploration in the coalfield was by A. Hasebrink who examined claims in the northern part of the coalfield (Tompson _et al_., 1970).

From 1914 until 1948 no coal exploration in the area has been documented. In 1948 Buckham and Latour of the Geological Survey of Canada visited the area. Their report (Buckham and Latour, 1950) summarized both the history of exploration to that date and previously reported occurrences of coal.

In 1966-1968 Coastal Coal acquired 24 coal licences in the southern part of the coalfield. Following mapping (Boyd and Associates, 1967) the licences were dropped.

In 1970 the National Coal Corporation Ltd. together with Placer Development Ltd. and Quintana Mineral Corporation conducted a mapping and diamond drilling program on 80 licences in the southern part of the coal field (Tompson, et al., 1970). Many of the licences were dropped some of which were later acquired by Groundhog Coal.

In 1978 and 1979 Imperial Oil acquired licences covering about 15,000 hectares near Mt. Klappan. Following mapping (Waters, 1979) the licences were allowed to lapse. Petrofina in 1978 acquired licences which surrounded Imperial's licences; these licences were also subsequently dropped.

In 1980 Gulf Oil Canada acquired the area previously held by Imperial Oil as well as additional licences in the southern part of the coal field. Tony Mould and Associates subsequently filed on the area immediately south of Mt. Klappan and along the Skeena Valley, but the area was not licenced.

In 1981 Petro-Canada acquired the presently held licences in the Prudential mountain area. Most recently Suncor has acquired licences south of Prudential Mountain; Gulf has acquired additional licences north of Mt. Klappan and M. Suska has filed on licences previously held by Petrofina.

Stratigraphy

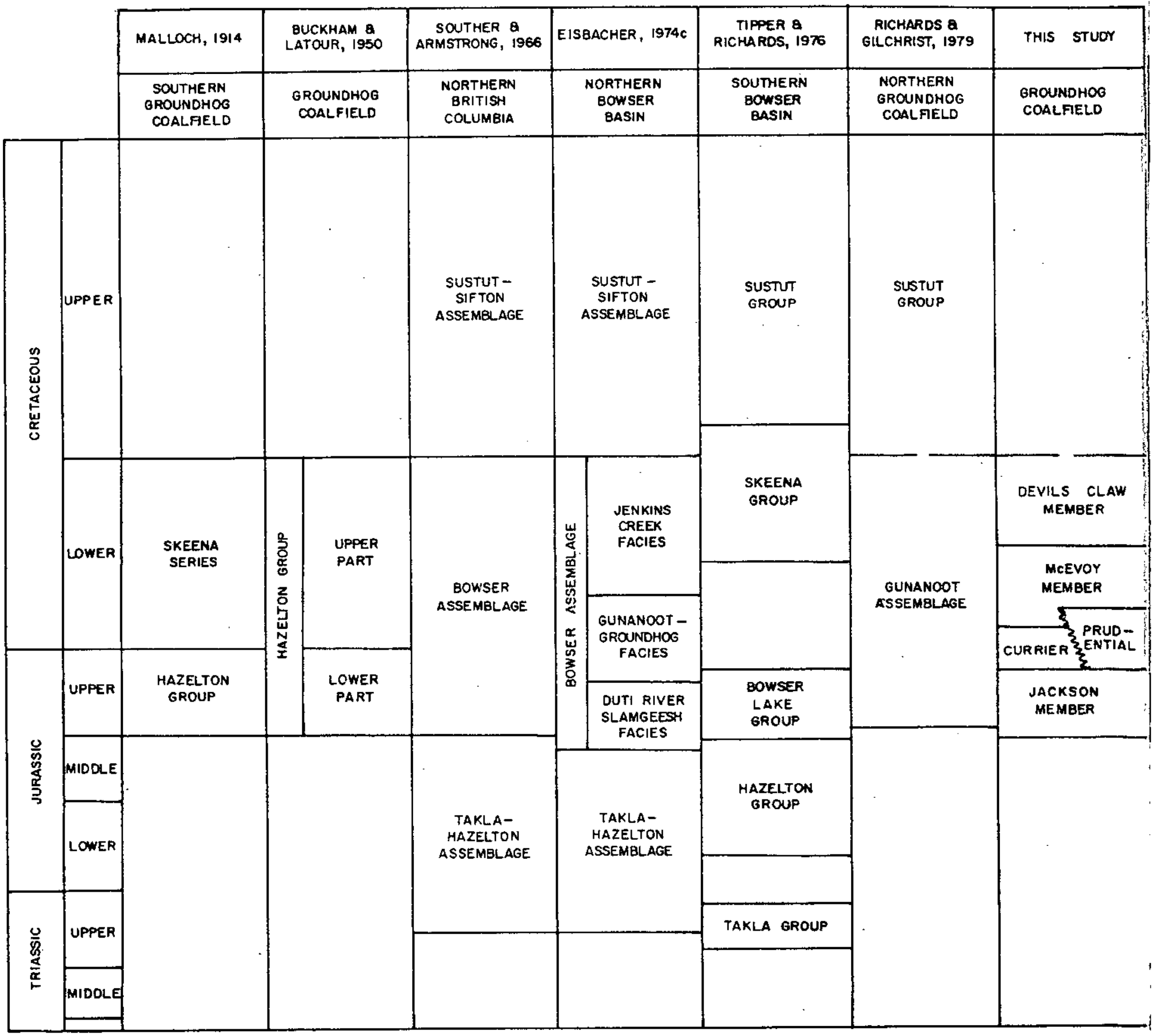
In order to determine the regional stratigraphy a total of 57 sections were examined of which 39 were measured (Appendix 1) in the area between the Nass River on the west, the Stikine River in the north, the Kluatantan River in the east and the Duti River in the south.

The total stratigraphic thickness exposed in the coalfield is considered to be between 4000 and 4500 meters. Neither the base nor the top of the succession is exposed in the study area. Northeast of the study area the succession unconformably overlies the Takla-Hazelton assemblage and is in turn unconformably overlain by the Late Cretaceous Tango Creek member of the Sustut Group (Eisbacher, 1974a).

Within much of the study area the strata are divisible into five mappable units herein referred to informally in ascending order as the Jackson, Currier, McEvoy, Prudential and Devils Claw. The Jackson and McEvoy members are recognized throughout the area whereas the Currier and Devils Claw members are only distinguished between the Nass and Skeena Rivers. The correlation between members mapped in this study and those of previous studies are at best tentative (Figure 3). In many areas re-measurement of sections previously described resulted in completely different 'impressions' of the lithology. In particular the thickness and number of coal seams previously documented appear to be highly exaggerated.

In the following section the different map units are described and their distribution discussed. Correlations and restored stratigraphic cross-sections across the coalfield are shown in (Figures 4,5,6,7 and 8) and the measured sections are appended to the report (Appendix 1).

FIGURE 3 – REGIONAL STRATIGRAPHIC BOWSER BASIN AND GROUNDHOG COAL FIELD



The units of this study are not corellated with previous work with the following exceptions:

Jackson Member = Hazelton Group of Malloch (1914) and Duti River – Slamgeesh of Eisbacher (1974 c)

McEvoy Member = Jenkins Creek facies of Eisbacher (1974c) Eisbacher's (1974 c) Groundhog-Gunanoot facies = Devils Claw and Currier Members. Eisbacher (1974c) has Jenkins Creek overlying Groundhog – Gunanoot facies which it actually underlies.

Jackson Member

A thick succession of marine and transitional marine shales, siltstones, sandstones and locally conglomerates comprise the lowest stratigraphic interval in the coalfield. The Jackson member is well exposed on the south slope of Mt. Jackson, in the Groundhog Ranges, and in a wide belt along the eastern and northeastern margin of the coalfield. The base of the member is not exposed in the study area but to the north equivalent strata described by Eisbacher (1974a) unconformably overlie volcanic rocks of the Hazelton Group. At Mt. Jackson, the Jackson member coarsens upwards and is gradational to the overlying Currier member. East of the Kluatantan River, where the Currier member cannot be distinguished, the Jackson member passes upwards into the overlying Prudential member. The contact between the Jackson member and Currier or Prudential member is placed at the first occurrence of coal or the last occurrence of distinguishable marine sediments.

No complete section of the Jackson member was measured but it is estimated to be at least 1800 meters thick in the study area based on examination of partial sections. At McCumber Creek and Happy Lake, east of the coal field; two sections 380 meters and 200 meters thick were measured within what is considered the middle succession of the Jackson member. At these localities and in other areas along the eastern and southern margin of the coalfield the Jackson member is composed of thick bedded, dark grey to black shales and siltstones, minor very-fine to fine-grained sandstones and thin to thick bedded conglomerates (Figure 10). The sandstones are commonly massive and only locally cross-bedded. The conglomerates are up to 5 meters thick, commonly lensoidal and consist of chert and quartz pebbles and cobbles up to 5 centimeters in diameter.

At Mt. Jackson the uppermost 300 metres of the Jackson member is exceptionally well exposed (Figure 11). Here the member is composed of tan weathering to dark grey siltstones and shales and tan weathering, fine to medium grained and locally calcareous sandstones up to 0.5 metres thick. The sandstones are ripple cross-bedded or planar bedded and locally contain abundant rip-up clasts. Sandstones near the top of the succession contain abundant bivalves and fossil debris. The upper part of the section becomes progressively coarser grained and grades vertically into the overlying Currier member. East of the Kluatantan River (where the Currier member is absent) the contact between the Jackson and Prudential members was not observed; however it is considered to be gradational based on the general similarities in lithology.

The age of strata equivalent to the Jackson member has been reported by Eisbacher (1974c) from north of the study area. At the base of the succession; Roots (1957 in Eisbacher, 1974c) reported the occurrence of Kepplerites, Cobbanites, Pleuromya, Cadoceras, Trigonia and Pholas which indicate a Callovian age. At other localities Tipper (in Eisbacher, 1974c) identified Cadoceras and Buchia concentrica of Oxfordian age. A collections made 200 meters from the top of the Mt. Jackson section in the study includes pelecypod tentatively identified as Buchia, Oxtyoma and Eopecten. It, therefore appears that the Jackson member at least spans the interval from Callovian to Oxfordian time.

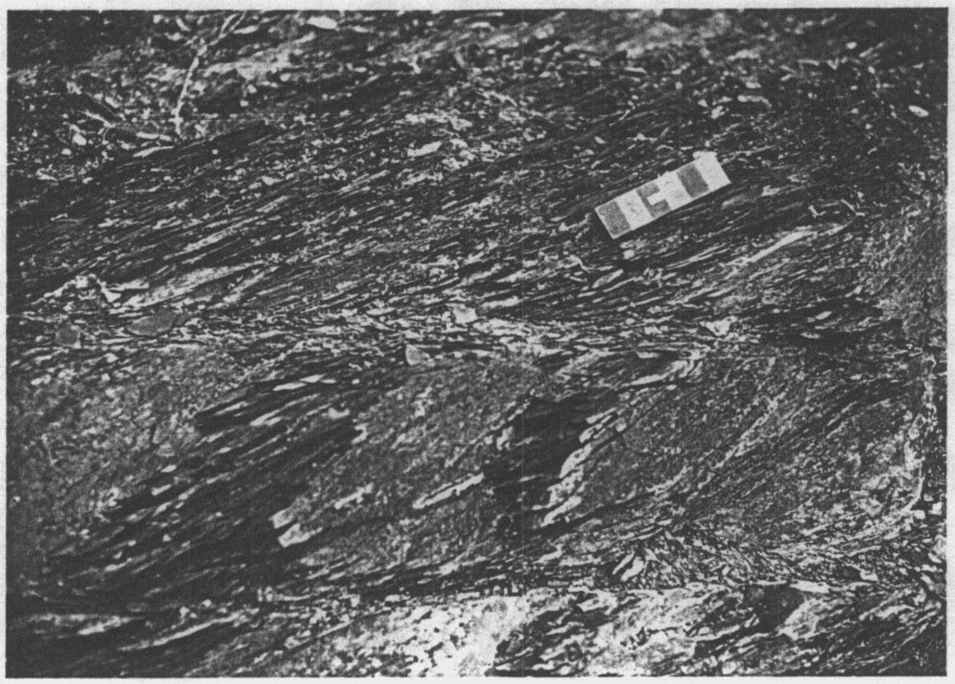


Figure 10: Cleaved siltstones and shales, Jackson member at Mt. Jackson.

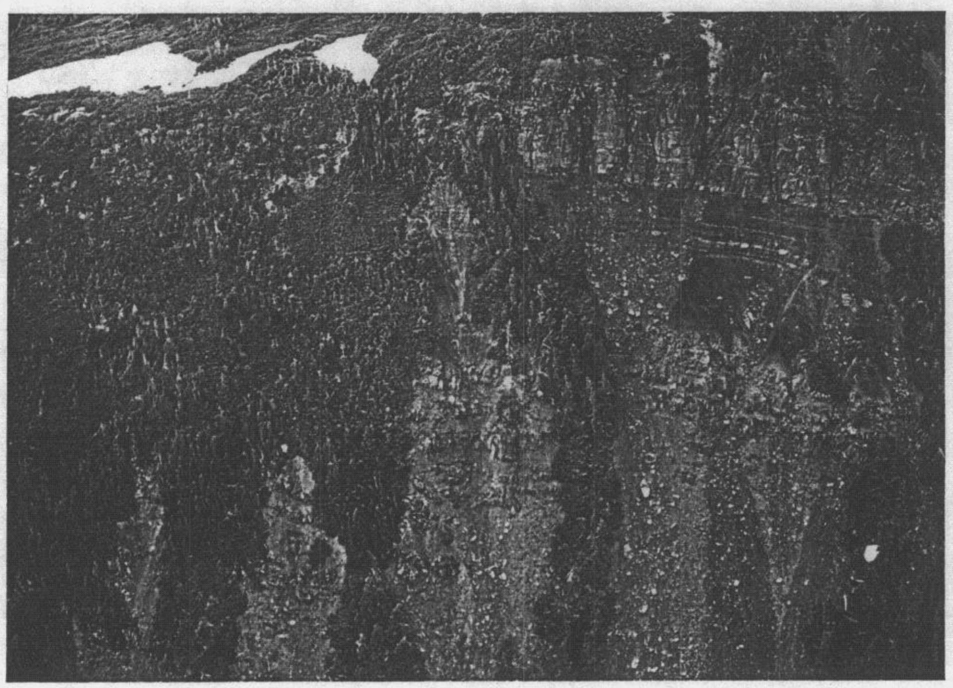


Figure 11: Upper part of Jackson member at Mt. Jackson.

Currier Member

Between the Nass and Kluatantan Rivers a sequence of thin to thick bedded sandstones with minor shale, siltstones and coal occur. The sequence is recessive and best exposures occur at lower elevations along the Skeena and Nass River valleys and Panorama, Currier and Tahtsedle Creek and on Mt. Klappan and Mt. Jackson. The base of the Currier member is well exposed at Mt. Jackson, where it gradationally overlies the Jackson member. The base of the Currier member is selected at the first occurrence of coal or identifiable non-marine strata. The Currier member can be seen to be overlain by the McEvoy member at Currier, Anthracite and Tahtsedle Creek Valleys and along the eastern side of Skeena River Valley. The contact between the Currier and McEvoy members is selected at the first occurrence of bedded limestones and/or massive and thick siltstone units which also corresponds to a marked decrease in sandstone and coal. East of the Kluatantan River the Currier member cannot be recognized and the Jackson member is overlain by the Prudential member which, in part, is considered stratigraphically equivalent to the Currier member.

No complete section of the Currier member is exposed in the coalfield. A section 450 metres thick was measured at Mt. Jackson overlying the Jackson member and a section 392 metres thick was measured at Tahtsedle Creek underlying the McEvoy member. Partial sections of the Currier member were examined at Currier Creek, Anthracite Creek, Tony Creek, along the Skeena River Valley and near Mt. Klappan. The total thickness of the member is estimated to be between 600 and 800 meters.

The base of the Currier member comprises a series of coarsening upward sequences ranging from 5 to 25 metres thick (Figure 12). The basal member of the fining upward sequence is composed of thinly interbedded medium to dark grey shales which coarsen upwards to tan weathering, fine to medium grained and locally coarse grained sandstones. The sandstones are quartzose and cherty, thin to thick bedded, ripple cross-laminated and locally trough cross-bedded. The coarsening upward sequences are commonly capped by thin coal seams varying between 20 centimeters to 1.5 metres in thickness (Figure 13).

The middle strata of the Currier member, exposed between Mt. Jackson and Tahtsedle Creek, is composed of fine to medium grained, tan to dark grey weathering sandstone, dark brown to brown mudstone, siltstone and coal. The sandstones are quartzose, cherty and locally carbonaceous. Locally the sandstones, siltstones and mudstones comprise members of distinct fining upwards sequences up to 4 metres thick. A minimum of eight coal seams thicker than 0.5 metres and numerous thin seams and partings occur in the sequence. The thickest observed seam measured 4 meters but most seams range from 0.5 to 2 metres in thickness. Because of the paucity of exposures, rapid facies changes and structural complexities, correlation of these seams at different localities is not possible.

The upper part of the Currier member exposed at Tahtsedle Creek is comprised predominantly of medium to dark grey siltstone and shale, buff to medium grey, thin to thick bedded sandstone, carbonaceous partings and coal. The sandstones are quartzose and cherty and are ripple cross-laminated, planar cross-bedded, parallel bedded or massive. Some sandstone channels wedge out laterally over a distance of 10's of metres. In the uppermost 472 metres of strata, four coal seams ranging in thickness from 0.8 to 2.5 metres outcrop. Because of the paucity of exposure their lateral continuity could not be assessed.

The age of the Currier member is unknown. Fossil plants collected by Malloch and unidentified by W.A. Bell suggest an early Cretaceous 'Kootenay age' (Buckham and Latour, 1950). No fossil collection adequate for age determination was collected in this study.

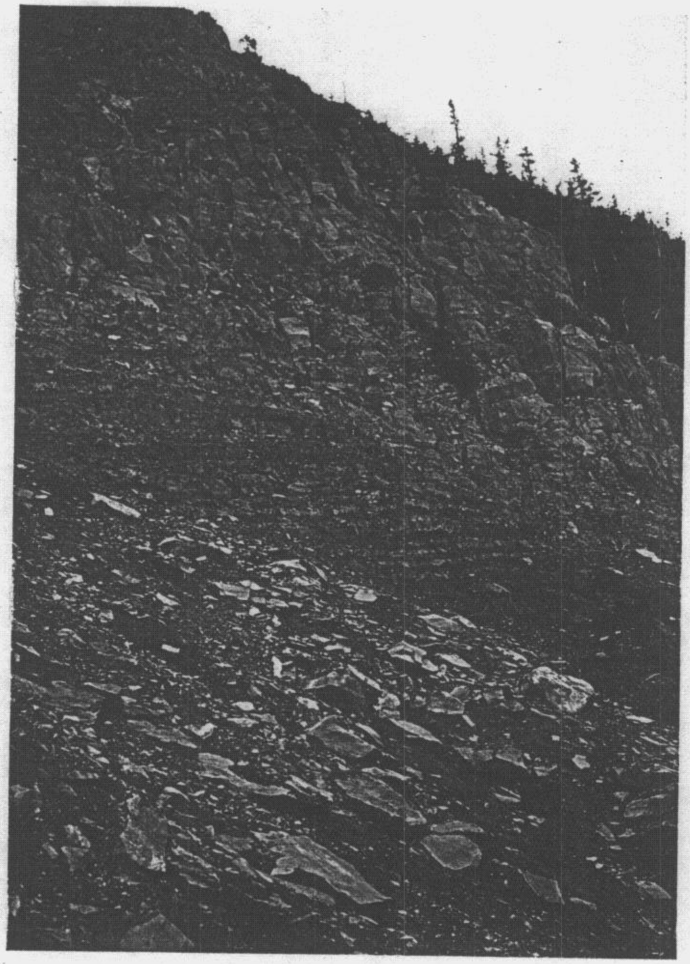


Figure 12: Coarsening upward sequences in the Currier member at Mt. Jackson.

Figure 13: Coal seam overlying coarsening upward sequence in Currier member at Mt. Jackson.

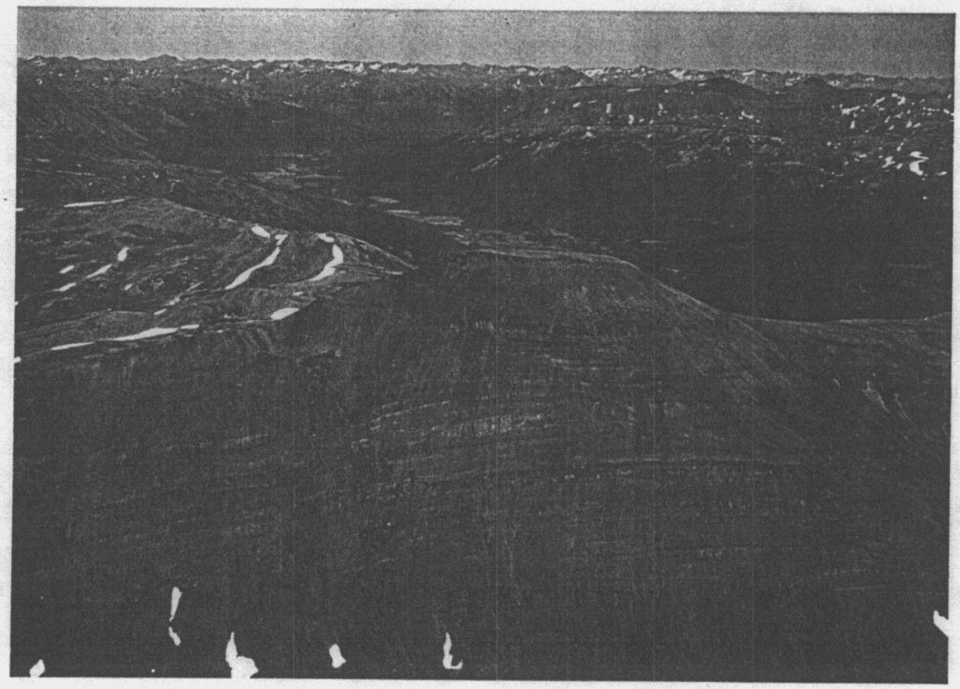


Figure 14: McEvoy member east of the Skeena River. (Note the white channel sandstone in the center of the photo.)

McEvoy Member

The McEvoy member is exposed mainly between the Nass and Kluatantan Rivers, and between Tahtsedle Creek and the Groundhog Range. It is comprised of a thick sequence of siltstone and shale with minor limestone, coal and sandstones which is underlain by the Currier member and which is overlain by a conglomerate bearing unit of the Devils Claw member. East of the Kluatantan River the McEvoy member cannot be distinguished and is either stratigraphically equivalent to the upper Prudential member or absent.

The McEvoy member can be distinguished from the underlying Currier member by the paucity of sandstone and coal and occurrence of thick siltstone and shale and minor limestone of the McEvoy member. The McEvoy member can be distinguished from the Devils Claw member by the occurrence of massive conglomerates in the latter.

The thickness of the McEvoy member is highly variable. In the north, near Tahtsedle Creek it is about 200-300 metres thick, whereas to the south at McEvoy Ridge it is 1000 metres thick. To the east, at Ranger Creek it is a minimum of 500 metres thick. In all localities the McEvoy member is composed of monotonously interbedded dark grey siltstone and shale with thin to thick bedded sandstones and minor coal and limestone (Figure 14). The siltstones and shales are well indurated, dark to medium grey, thin to thick-bedded and comprise intervals up to 40 metres thick. They are locally carbonaceous and grade to coal. The sandstones are thin-to thick-bedded, massive or planar and trough cross-bedded. They are most commonly fine to medium grained but locally coarse-grained. Mineralogically they are comprised mainly of chert and quartz and minor feldspar and rock fragments. Many of the thicker sandstones are channels. Limestone, although a minor component, occur throughout and characterize the succession (Figure 15). They occur in tan weathering beds up to 0.5 metres thick or as concretionary horizons.

Locally root casts and carbonaceous partings pervade the limestone. Coal varies in thickness from partings a few centimeters thick to seams up to 0.5 metres thick and comprises a very small proportion of the succession. The thicker occurrences of coal described by Buckham and Latour (1950) from strata mapped in this study as McEvoy member could not be confirmed.

Devils Claw Member

The Devils Claw member is named for a succession of conglomerates, sandstones, siltstones and shales which cropout between the Nass and Skeena Rivers and Tahtsedle Creek and the Groundhog Range. East of the Kluatantan River, conglomerates equivalent to the Devils Claw member are not recognized. The contact between the Devils Claw member and the underlying McEvoy Ridge member has been selected at the first occurrence of thick conglomerate (greater than 2 metres).

The Devils Claw member varies from 300 metres thick at Devils Claw Mountain to about 500 metres thick at Mt. Gunanoot. At Devils Claw Mountain and adjacent areas, the Devils Claw member is comprised predominantly of massive, moderate to poorly indurated pebble-cobble conglomerate with rare lenticular sandstones. The conglomerates are light grey or vari-colored and comprised of well rounded and well sorted clasts of chert, quartz, volcanic and rare granodiorite clasts (Figure 16). The conglomerates are massive or locally trough cross-bedded. The sandstones are medium to coarse grained and composed primarily of quartz, and chert with minor carbonaceous fragments. In the northern part of the coalfield the contact between the McEvoy and Devils Claw member is more gradational. The lower part of the Devils Claw member includes thick sequences of siltstones, shales, minor sandstones, limestones and coal interbedded with massive conglomerate (Figure 17). Near the top of the Devils Claw member conglomerate is more prevalent, but the very thick sequence of conglomerate exposed to the south is not preserved.

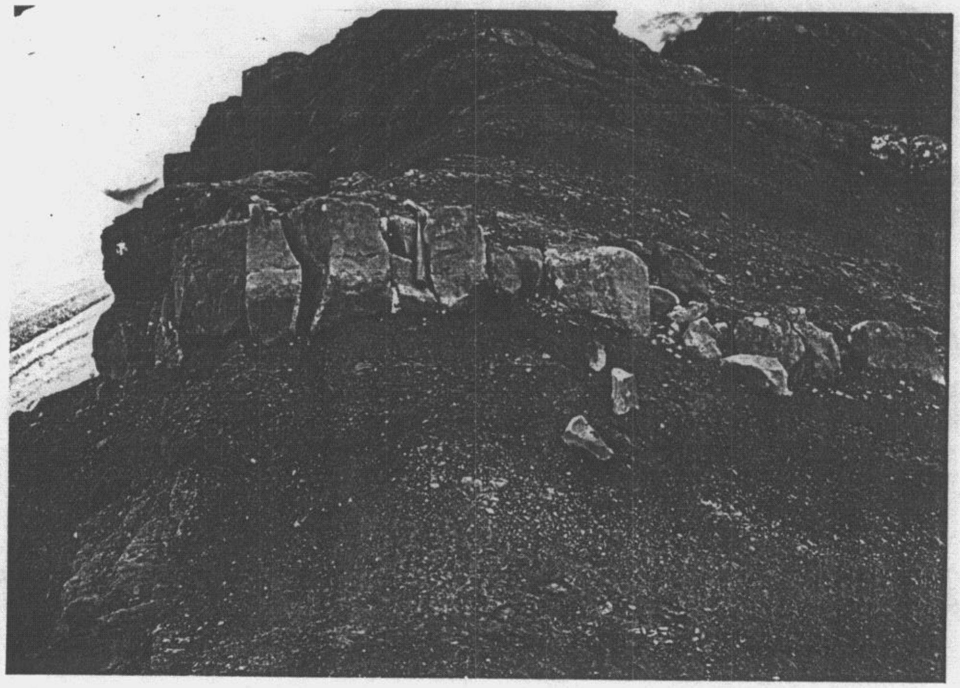


Figure 15: Thinly interbedded limestones (tan), siltstones and shales in the McEvoy member at McEvoy Ridge.

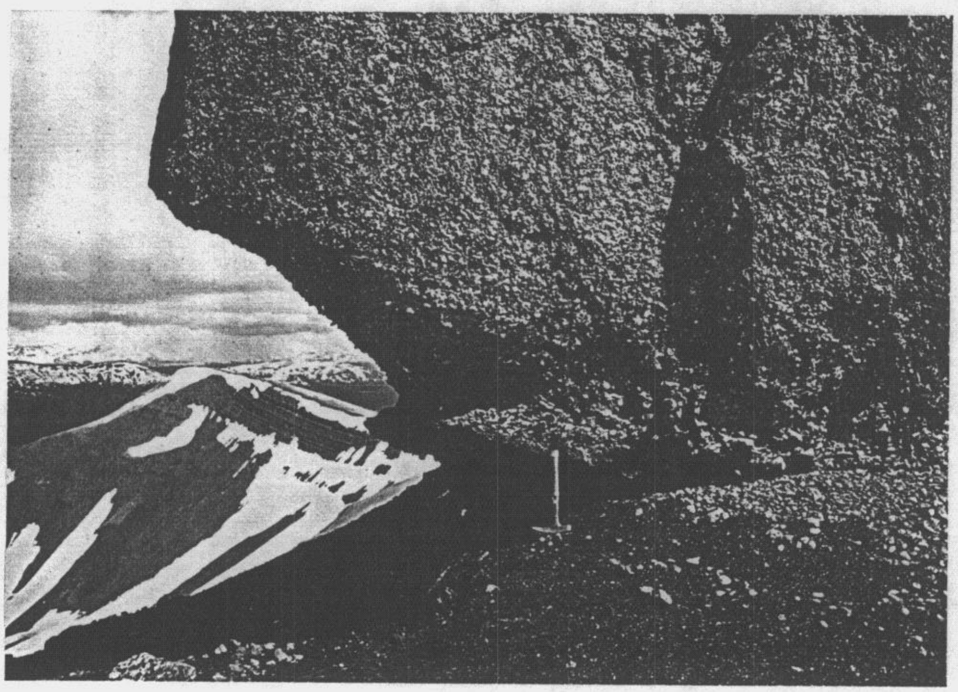


Figure 16: Massive conglomerates of the Devils Claw member at Devils Claw Mountain.

Prudential Member

East of the Kluatantan River the Jackson member is overlain by a sequence of conglomerate, sandstone, siltstone, shale and minor coal assigned to the Prudential member. The Prudential member is thus considered a coarser grained equivalent of the Currier member and possibly the lower part of the McEvoy member. The top of the Prudential member is not exposed in the study area nor is the contact between the Jackson and Prudential members exposed. The Prudential member is distinguished by the presence of coal, and thick sandstones neither of which occur in the Jackson member.

The total thickness of the Prudential member is estimated to be in the order of 500 to 800 metres although no complete section is known. On Prudential Mountain two sections 320 and 250 metres thick respectively were measured ((Appendix 1, Sect. 119, 120) and additional localities to the north and south of Prudential Mountain were examined.

The Prudential member is comprised in all localities of thick bedded sandstones, siltstones, carbonaceous shale and locally conglomerate and coal (Figure 18). The sandstones are grey to tan weathering fine to coarse-grained and most commonly massive. The siltstones and shales are tan to dark grey weathering, well indurated and locally ridge forming. They locally comprise intervals up to 80 metres thick. The conglomerates are vari-colored, massive, and composed of well rounded cobbles and pebbles of chert and quartz. Coal comprises less than 1% of the succession and varies from thin carbonaceous partings to seams up to 1.5 metres thick.

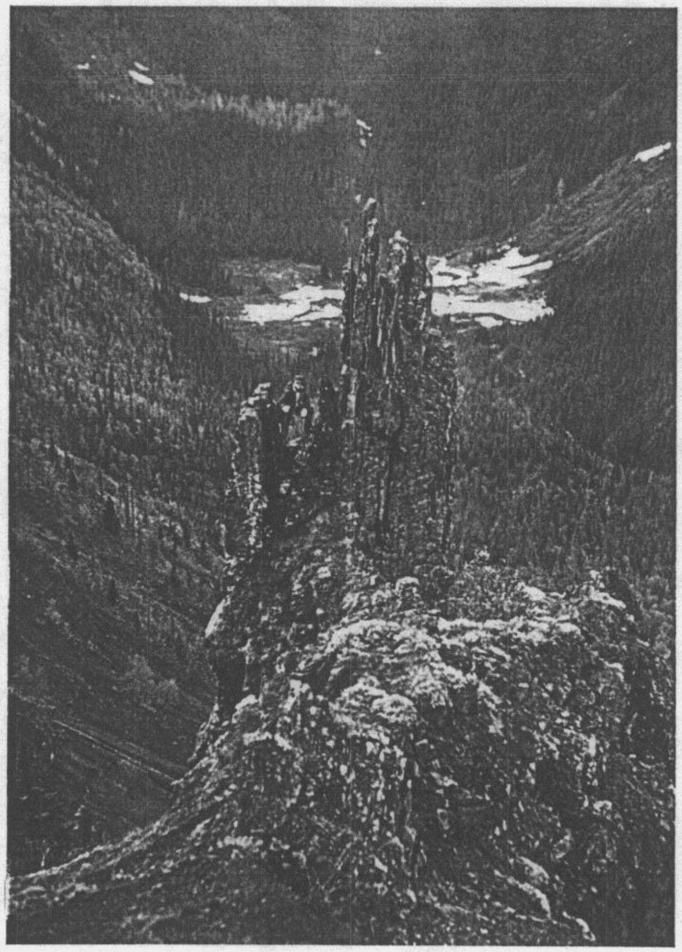


Figure 17: Massive conglomerates of the Devils Claw member interbedded with shales and siltstones between the Skeena and Nass Rivers.

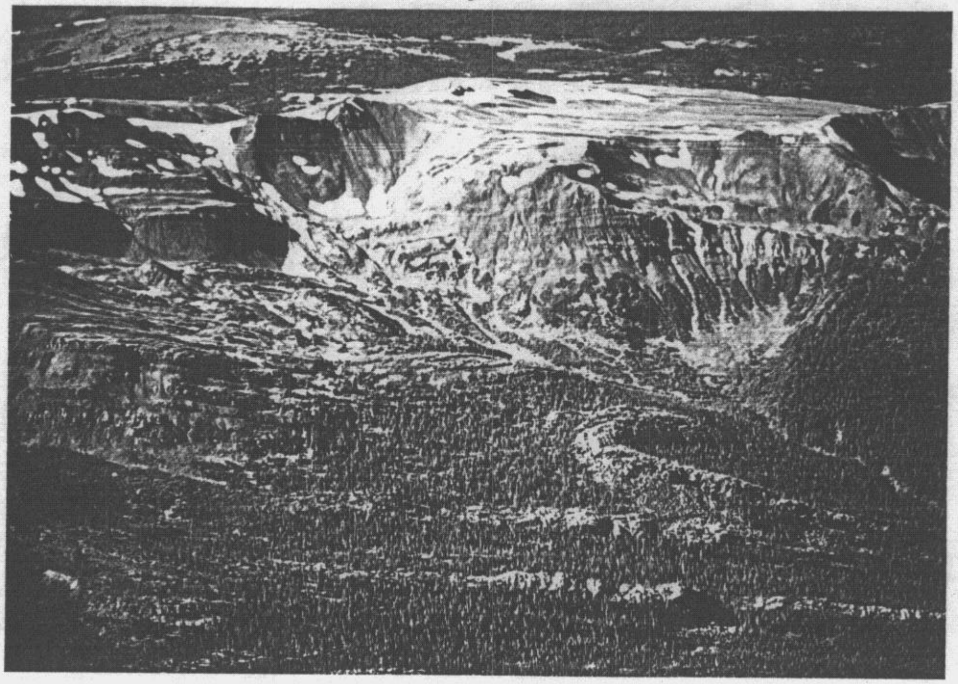


Figure 18: Tightly folded - interbedded siltstones and sandstones of the Prudential member at Prudential Mountain.

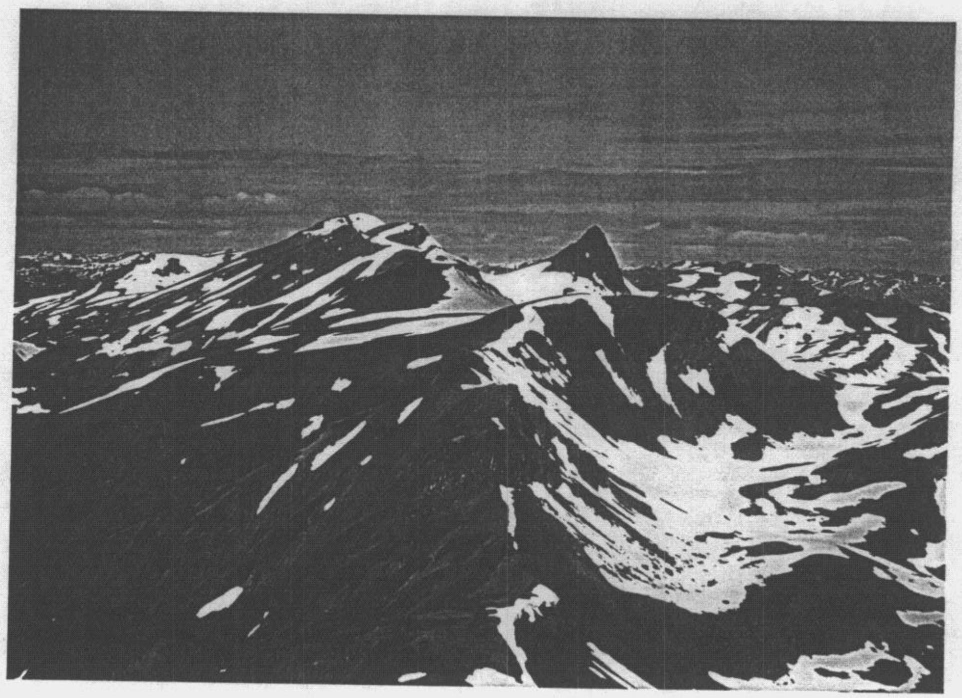


Figure 19: Tightly folded - interbedded siltstones and very fine-grained sandstones of the Prudential Member.

Facies Relationships and Correlations

Stratigraphic correlation and analysis within the coalfield are complicated by the structural complexity of some areas, rapid facies changes, and lack of marker horizons or recognizable biostratigraphic zones. Of particular importance in evaluating the stratigraphy in the coal field is the nature of the contact between the Currier member and overlying McEvoy member. The structural style of the Jackson, Currier, and Prudential members is markedly different from the overlying McEvoy and Devils Claw members. As discussed later the different structural styles are considered a product of the competency of the different units, nevertheless more detailed studies may prove the existence of an angular unconformity or decollement separating the Jackson, Currier and Prudential members from overlying strata.

The overall sequence of strata in the coal field comprise a coarsening upward-regressive sequence starting with the Jackson member at the base and culminating with massive conglomerates of the Devils Claw member at the top. In Figures 4, 5, 6, 7, 8 and 9 the facies relationships and suggested correlations of some of the measured sections are shown. In Figure 20 and 21 interpretative restored stratigraphic sections across the coalfield are shown. The Currier member and lower McEvoy member are considered fine grained equivalents of the Prudential member to the east. The upper part of the McEvoy member in the southern part of the coalfield is at least in part correlative with the lower Devils Claw member in the northern part of the coalfield. The upper part of the Devils Claw member is clearly younger than the McEvoy member which it locally overlies. The overall facies relationships indicate coarsening of the facies to the north and northeast. The proposed facies relationships in conjunction with paleocurrent measurements indicate that the provenance of the strata was to the north and/or northeast.

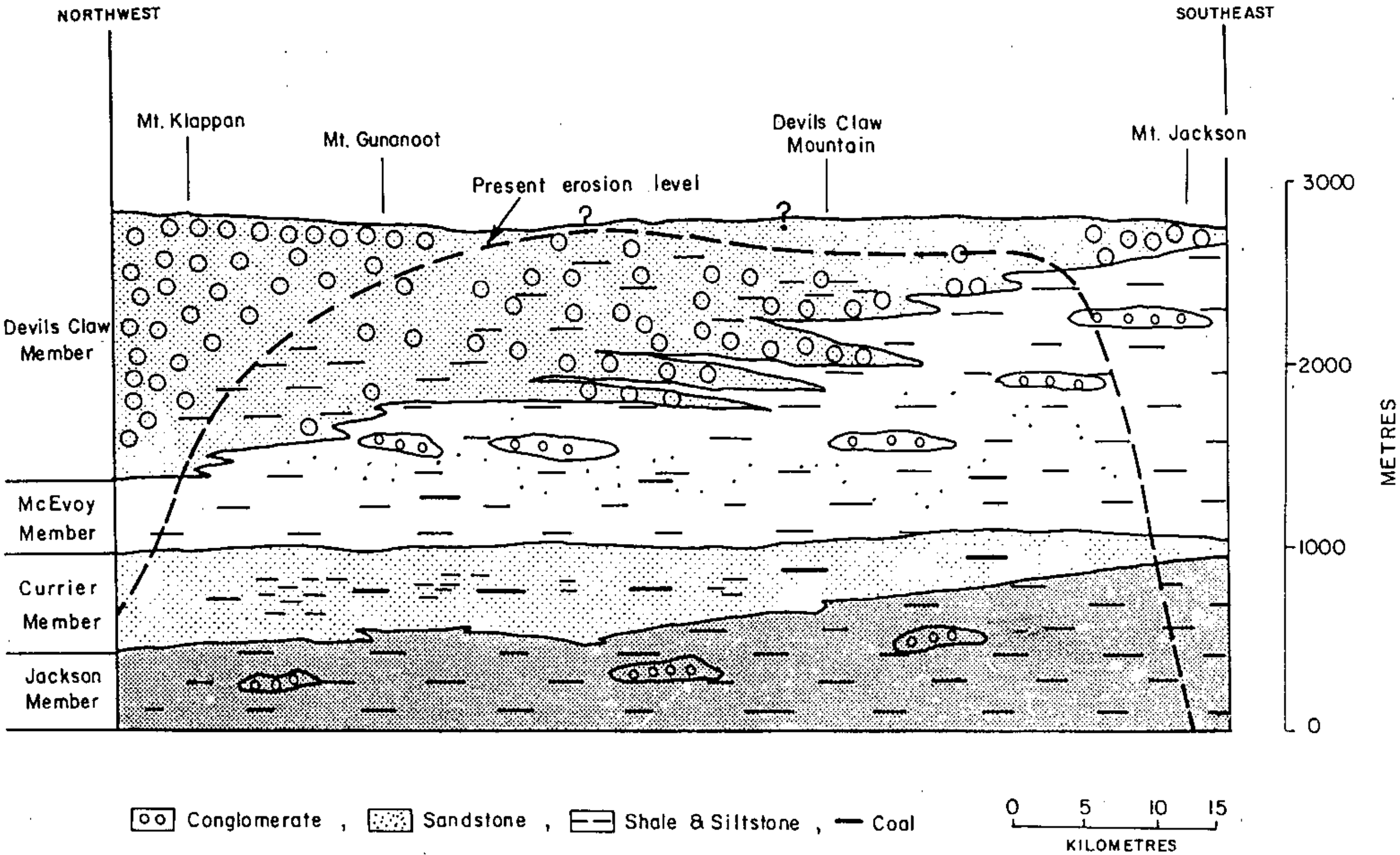


FIGURE 20 — Restored and highly schematic. Interpreted cross-section across the coalfield.

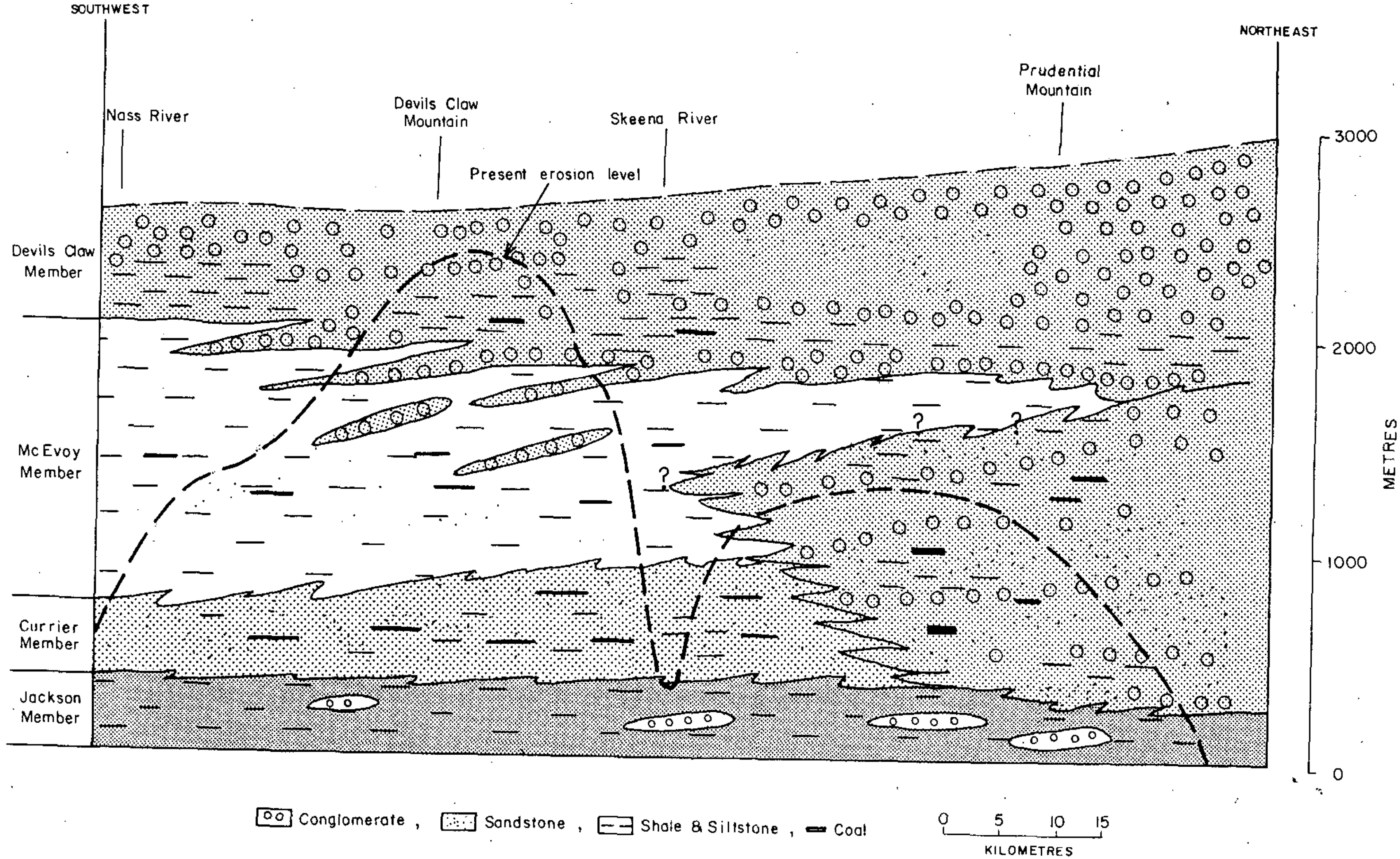


FIGURE 21 — Restored and highly schematic. Interpreted cross-section across the study area.

Structure

The structural style of the Groundhog coalfield is characterized by upright to northeasterly overturned folds that have northwest to southeasterly trends. Along the Nass Valley the folds are locally overturned to the southwest. The amplitude, plunge and wave length of the folds are highly variable both laterally and stratigraphically and are described in more detail later. Thrust faults which climb out of surfaces of interstrata slip and fore-limb and back-limb faults are common elements in the coalfield. In the area between the Nass and Skeena Rivers a later phase of extension faulting is apparent. There is no evidence to suggest major stratigraphic separation in the coalfield as a result of thrusting nor is there evidence for lateral translation.

The rocks throughout most of the coalfield area are not penetratively deformed. The only evidence for penetrative deformation is the occurrence of well developed cleavage which is restricted to rocks that lie east of an arcuate trend from Mt. Jackson to Lonesome Mountain along Kluatantan River and apparently along Tahtsedle Creek (Figure 22; Waters, 1979). Cleavage east of the trend is developed in strata of the Jackson, McEvoy, Currier and Prudential members. Whether or not strata of the Jackson member are cleaved everywhere is unknown but strata of the McEvoy and Devils Claw members and locally the Currier member are not cleaved to the west.

Major Lineaments and Structural Domains

The Nass River, Skeena River - Tahtsedle Creek and Kluatantan River comprise three major, subparallel northwest-southeast trending lineaments which serve to divide the coalfield into three structural domains. Although these structural domains are characterized by different structural styles (as discussed later) they are also characterized by different stratigraphic packages and thus there is some doubt as to the structural significance of the lineaments.

In previous studies Richards and Gilchrist (1979) attributed the Skeena and Nass River systems to thrust faults. Examination of the strata on both sides of the Nass, Skeena, Tahtsedle and Kluatantan Rivers provided no evidence to suggest any significant stratigraphic separation across the linears. Although lateral strike-slip movement may have occurred along the valleys, the structure adjacent to the lineaments, show no evidence that can be attributed to lateral translation. For lack of other evidence the major lineaments are therefore considered parallel consequent river valleys which simply parallel the structural grain.

Structural Domains

Three schematic structural cross-sections across the coalfield based on airphoto interpretation are shown in Figures 22, 23, 24 and 25. In the following section the structure of the three domains referred to above are described.

Nass River to Skeena River

The mountains between the Nass and Skeena River south of Tahtsedle Creek are dominated by the 'Biernes' syncline, a broad southwesterly trending structure developed in the McEvoy and Devils Claw members (Figure 26). To the east of the syncline, adjacent the Skeena river, the strata are more tightly folded. The folds are locally overturned to the northeast, have wavelengths in the order of 100-300 metres and amplitudes generally less than 100 metres. Immediately to the west of Biernes syncline a series of tight, southwesterly overturned folds occur which give way further to the west to upright to northeasterly overturned folds with wavelengths in the order of 100 metres and amplitudes between 100 and 300 metres.

Between the Nass and Skeena Rivers there is an excellent correlation between lithology and structural style; where massive competent conglomerates of the Devils Claw member occur the style is one of broad, low amplitude concentric folds; where the conglomerates are absent the strata are folded into high amplitude, short wavelength chevron folds (Figure 27). Numerous back-limb and fore-limb thrusts occurs. 'Late' extension faults are common in the area but there is no evidence for major offsets. The Currier member which is exposed in low lying areas along the Nass, Skeena, Currier, Tahtsedle rivers and Panorama Lake is invariably tightly folded and locally faulted. In the Panorama Lake and Currier Creek the structural style of the Currier member is disharmonic with overlying strata. At these localities the Currier member is much more tightly folded than overlying strata of the McEvoy and Devils Claw members. The folds however, are cozonal and the difference in style is considered a product of the competence of the units.

South of Currier Creek the style of the Currier member and underlying Jackson member (similar to that in the north) is characterized by tight folds. Here, however, the strata have a well developed cleavage.

Throughout the region between the Nass and Skeena Rivers the strata are locally well jointed with fractures and fault zones commonly filled with quartz or carbonate.

Skeena River - Tahtsedle Creek to Kluatantan River - Kluayetz Creek

In the area between the Skeena River - Tahtsedle Creek and the Kluatantan River - Kluayetz Creek the structure is highly variable (Figure 28). The Currier member, exposed along the Skeena valley and Mt. Klappan is tightly folded. The folds are characterized by upright to southwest dipping axial surfaces and have wavelengths in the order of 100 to 200 metres and amplitudes ranging from 100 to 200 metres (Figure 29). Thrust faults with throws likely less than 100 metres are common (see also Waters, 1979). The McEvoy member is at least locally disharmonious with the underlying Currier member.

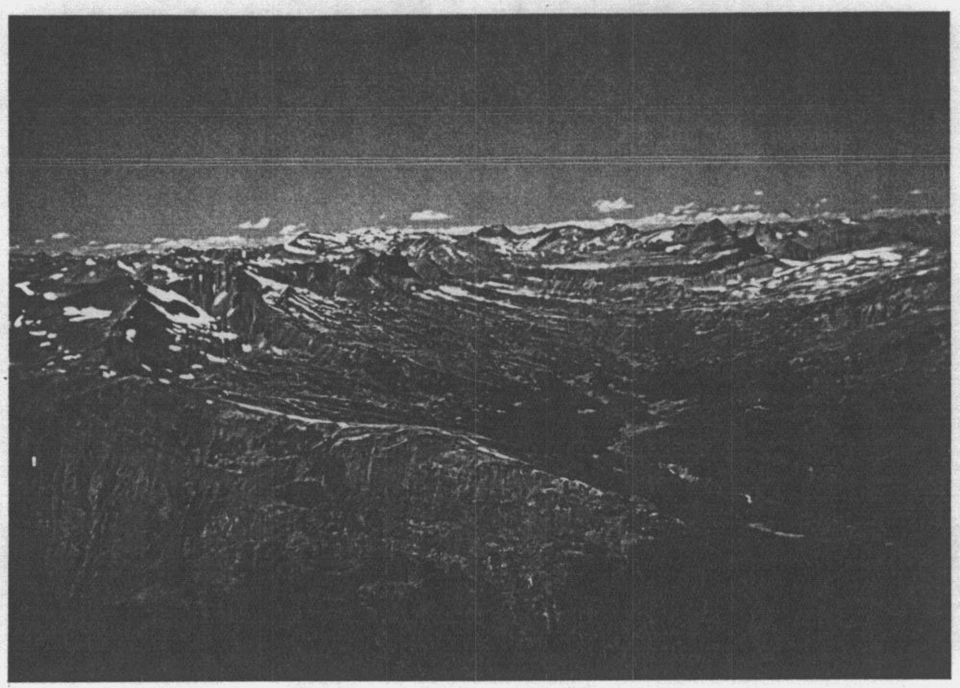


Figure 26: Biernes syncline, view is to the northwest parallel to fold axis.

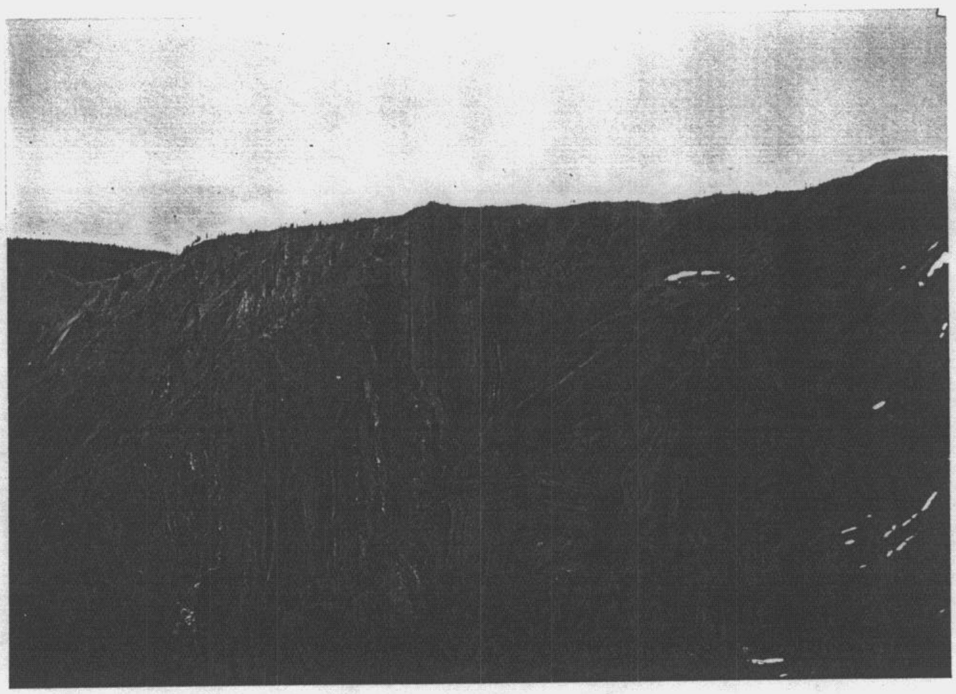


Figure 27: Tight 'chevron' style folds in McEvoy member near Tony Creek.

The McEvoy member is more broadly folded although locally, adjacent thrusts, the strata are drag folded and overturned to the northeast (Figure 30). In some areas overturned, very tight interstratal peels occur in what otherwise appear to be broadly folded strata (Figure 31). There is thus a large amount of interstratal slippage and shortening not readily apparent from reconnaissance mapping.

Cleavage is well developed in the McEvoy member south of View Mountain and in underlying strata of the Currier member. To the north cleavage is poorly developed or absent. Waters (1979) has described cleavage from the Currier member at Mt. Klappan. Strata throughout the area are jointed and most fractures are filled by quartz or carbonate.

East of Kluatantan River - Kluayetz Creek

East of the Kluatantan River and Kluayetz Creek the Prudential member and underlying Jackson member are tightly folded along northwest - south-easterly trends (Figure 32). The fold style is highly variable ranging from tight chevron folds adjacent Prudential Mountain to locally broad concentric folds to the east. The chevron folds have wavelengths of about 100 metres and amplitudes of up to 200 metres and are invariably overturned to the northeast. The concentric folds conversely have amplitudes of 50 metres and wavelengths up to several hundreds of meters and upright axial surfaces. Thrust faults, most of which are back-limb or fore-limb faults are common throughout the area. Isoclinal drag folds are common adjacent some of the major faults. On Prudential Mountain and areas to the south the anticlinal hinges are commonly faulted out.

Figure 28: Broad folds in the McEvoy member near Mount Taylor.

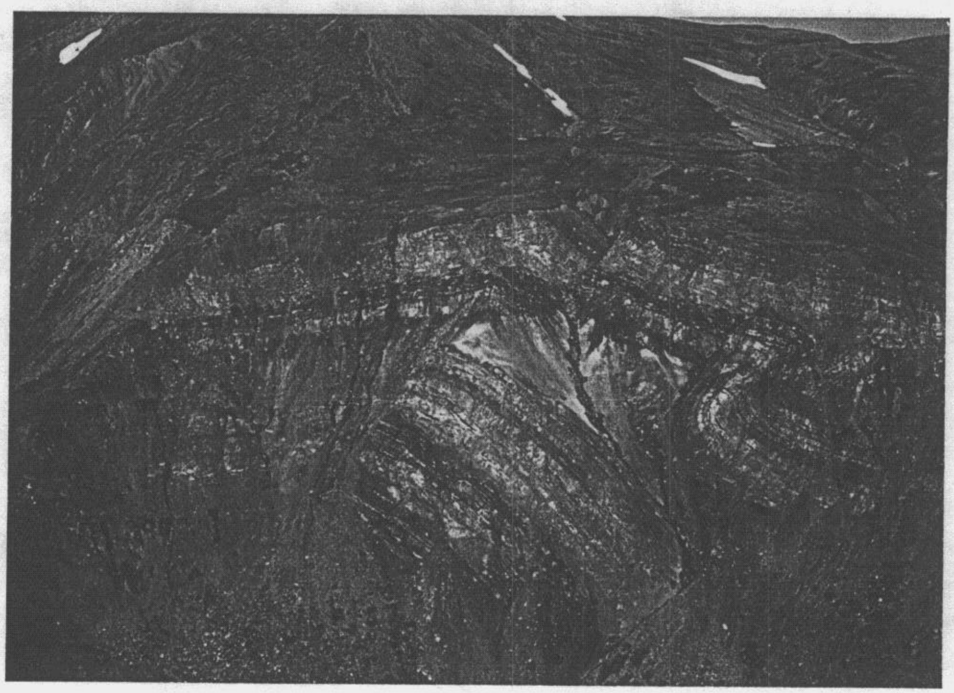


Figure 29: Folds and faulted strata in the Currier member at Mt Klappan.

Figure 30: Overturned and faulted folds in the McEvoy member north of Mt. Taylor.

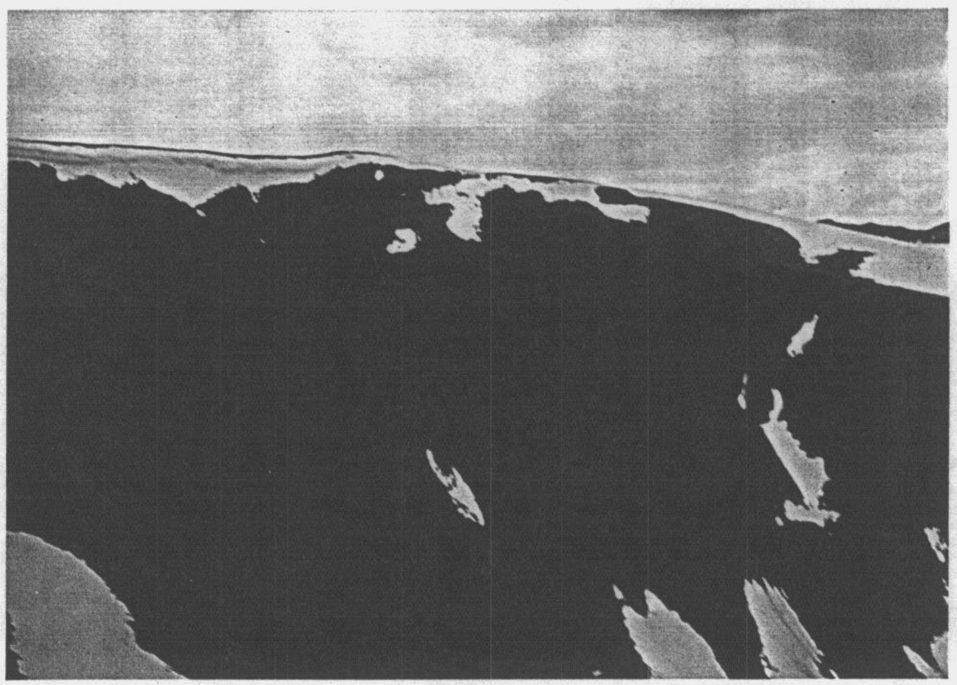


Figure 31: Intrastratal peels in the McEvoy member near Moss Mountain.

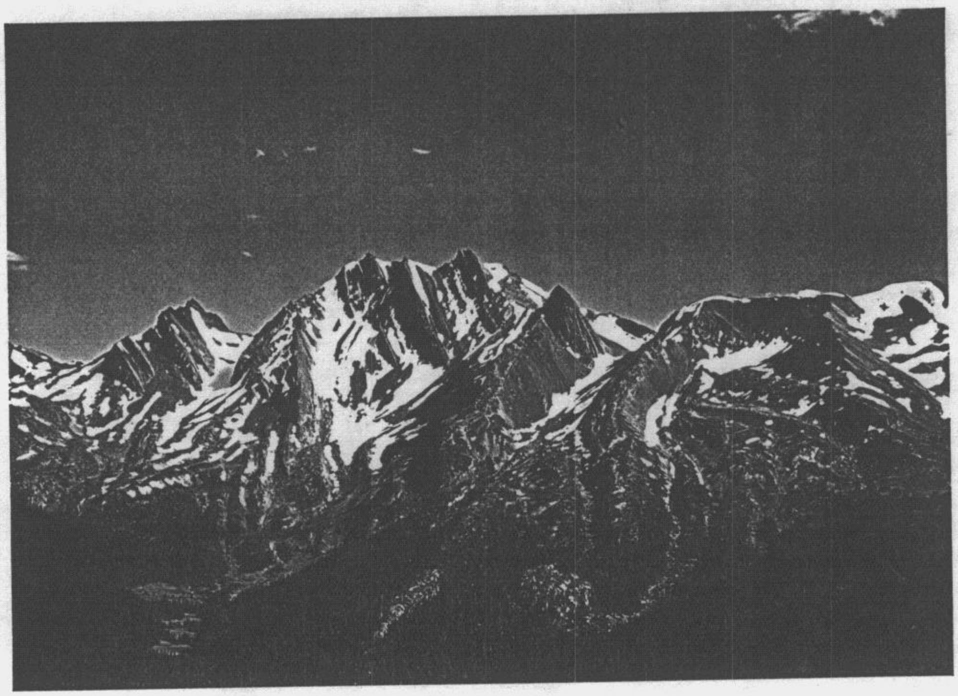


Figure 32: Tight folds in the Jackson member north of Prudential Mountain.

The structure of the Jackson member is more highly variable than the Prudential member. Where massive conglomerates are present in the Jackson member, such as near Happy Lake, the folds are broad and concentric and high angle thrust faults are common. To the north and south of Prudential Mountain conglomerates are thinner or absent and the Jackson member is characterized by tight chevron style folds similar to those of the Prudential member.

In all localities east of Kluatantan River and Kluayetz Creek the strata are cleaved. Cleavage is best developed in the Prudential member, whereas the occurrence of well developed cleavage in the Jackson member is dependent on the local lithology. The strata are well jointed throughout the area and quartz fills most fractures and fault zones.

Structural Synthesis

The structure of the coalfield is consistent with a single phase of deformation resulting in shortening in a southwest-northeasterly direction. The variations in structural style observed are considered the result of variations in the stratigraphy (Figure 33). The occurrence of broad low amplitude concentric folds corresponds to strata composed of competent conglomerates, whereas chevron folded strata are typically comprised on unconformably interbedded sandstones, siltstones and shales. The importance of lithology in controlling the structural style is best exemplified by folds west of Biernes syncline which are overturned to the southwest opposite the regional direction of overturning. Southwesterly overturning of these folds suggests that the massive conglomerates of the Devils Claw member acted as a buttress during deformation.

As previously discussed the disharmony between the Currier and Prudential members and overlying strata may indicate an angular unconformity and two phases of folding. Evidence against the two phases of folding are the similar structural trends (folds are cozonal) and that the Currier, Prudential and McEvoy members are all locally cleaved.

The restriction of visible cleavage to strata along the eastern edge of the coalfield corresponds to the occurrence of more tightly folded strata along the eastern margin of the Bowser Basin.

High paleo-heat flow in the coalfield area is suggested by the exceedingly high rank of the coals. Preliminary analysis of vitrinite reflectance data further indicate a marked stratigraphic variation in rank which suggests high paleo-geothermal gradients in the area. Very high heat flows are further required for the formation of the very high coal ranks observed in these relatively young strata.

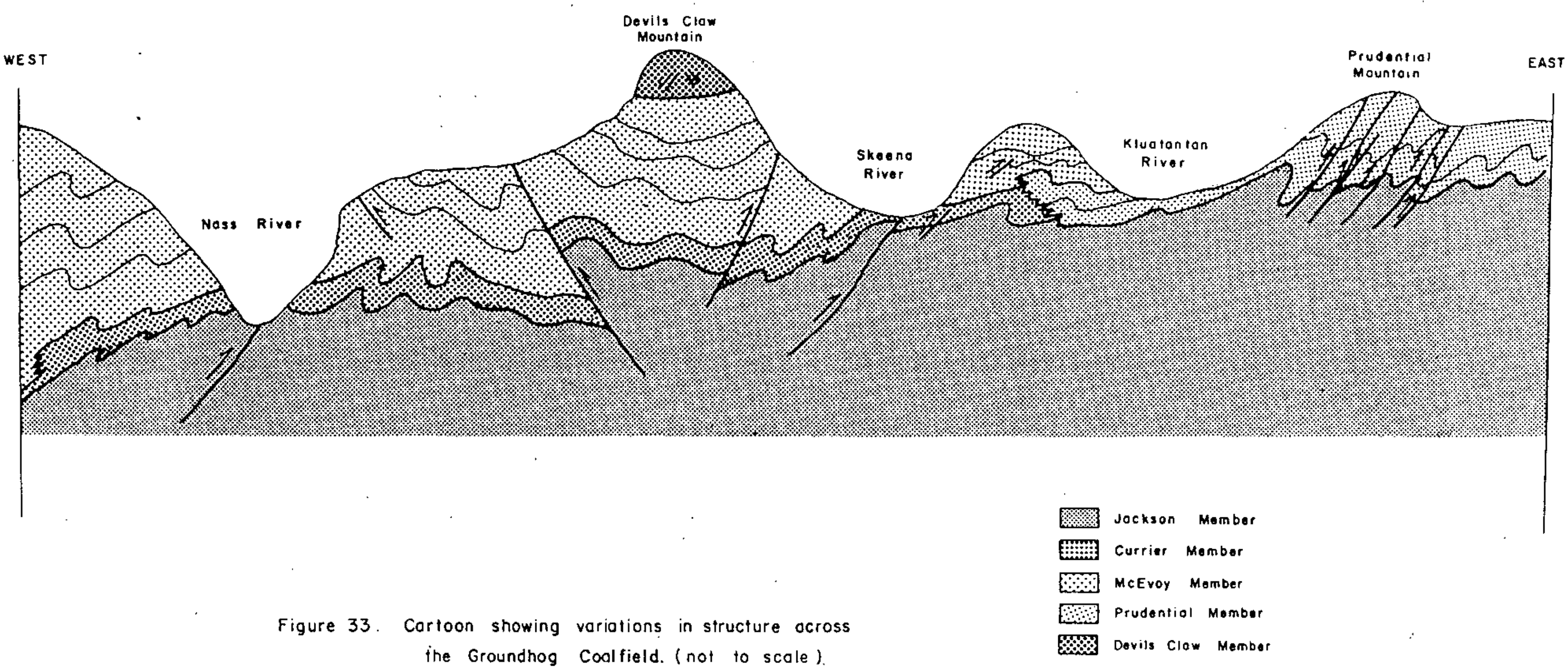


Figure 33. Cartoon showing variations in structure across the Groundhog Coalfield. (not to scale).

Coal-Occurrence and Economic Potential

Within the Groundhog coalfield coal occurs in the McEvoy, Prudential and Currier members. In the following section the occurrence, rank, quality, reserves and potential of the coal are outlined.

McEvoy Member

In the McEvoy member coal ranging in thickness from thin carbonaceous partings to seams up to 0.80 metres thick occur at almost all examined localities (Figure 34). At no locality, however do coal seams of significant thickness or number occur. At McEvoy ridge, for example, in a section 800 metres thick nine seams occur, the thickest of which is 0.40 metres. At Ranger Creek in the northeastern part of the coalfield in a section 320 metres thick nine seams occur ranging up to 0.50 metres.

Because of the absence of coal seams thicker than 0.80 metre and the paucity of coal at all localities the McEvoy member is considered to have no potential anywhere in the study area. The reported occurrences of thick coal seams in strata equivalent to the McEvoy member by Malloch (in Buckham and Latour, 1950) could not be confirmed.

Prudential Member

In the Prudential member coal varying in thickness from carbonaceous partings to coal seams up to 1.5 metres thick occur. At localities along the Kluatantan River and tributaries to the east, on Prudential Mountain and Mt. Laidlaw thin coal seams were observed. Because of the structural complexity and paucity of outcrop in these areas the total number of seams and their lateral continuity could not be predicted. In areas of adequate outcrop no strata were observed in which multiple seams thicker than 1.0 metres occur.

Coal Rank and Quality

The rank of coal in the Prudential member has been determined by vitrinite reflectance. Preliminary results indicate the rank ranges from anthracite to meta-anthracite. The quality of the coal is uniformly poor. Most coal seams grade to carbonaceous shale and locally visible pyrite comprises up to 20% of the coal. All surface samples are pervasively oxidized. Because the coal is finely sheared as a result of tectonics and cross-cut by quartz veins the coal is undoubtedly oxidized to considerable depths below the surface.

Resources and Economic Potential

The structural complexity and paucity of the outcrop in the area preclude coal resource estimates. The coal resources in the Prudential member are, however considered minimal because of the absence of thick or multiple seams anywhere in the coalfield. The coal of the Prudential member is, therefore not considered to have any potential for development. In addition, the tight folding that characterizes the Prudential member everywhere would not facilitate mining by conventional methods even if considerable resources did exist.

Currier Member

The Currier member is the main coal bearing unit in the coalfield. Coal varying in thickness from partings to seams up to 4 metres thick were observed at all examined localities. At Mt. Jackson, in the southernmost part of the coalfield, five seams occur within the basal 450 metres of the member (Figure 35). (See Table 3 for data on the number of coal seams, thicknesses and location).

In the Skeena River Valley and major tributaries multiple coal seams were observed. The lateral continuity and total number of seams are unknown because of tight folding coupled with the paucity of outcrop. On coal licences (National Coal Corporation, et. al) along the Skeena River Valley, Tompson et al. (1970) have summarized coal occurrences in strata herein assigned to the Currier Member (Table 3).

Tompson, et al. (1970) further reported the results of a diamond drilling program that intersected the Currier Member. On Biernes Creek they reported a total of 9.6 metres of coal distributed between 16 seams in a 177 metres interval a total of nine seams with a cumulative thickness of 10.8 metres occur. On lower Discovery Creek 12.8 metres of coal occur in 17 (?) seams through a 152 metre interval and on Abraham Creek a total of 6.2 metres of coal and 11 seams occur in a 168 metre interval. Two additional drill holes (data not available) intersected similar coal thicknesses.

On Mt. Klappan coal, in strata of the Currier Member, has been described by Waters, (1979). Along the eastern flank of Mt. Klappan at least two seams and probably up to four seams, three to four metres thick occur. On the western side of Mt. Klappan at least two seams, 2.5 metres and 1.8 metres thick occur and on central Mt. Klappan at least one seam 1.2 metres thick outcrops. To the south of Mt. Klappan on licences formerly held by Petrofina, Talbot, (1979) reports the occurrence of four seams, 0.9 m, 1.8 m, 2.5 m and 2.7 metres thick.

TABLE 3

COAL OCCURRENCES IN CURRIER MEMBER

(modified from Tompson et al. (1970)

LOCATION	NO. OF SEAMS	INDIVIDUAL SEAM THICKNESS (metres)
Mt. Jackson	5	0.3 - 0.8 - 1.0 - 1.2 - 1.5
Tahtsedle Creek	11	1.7 - 0.8 - 2.5 - 0.2 - 0.2 - 0.2 - 0.3 - 0.3 - 0.5 - 0.2 - 1.5
Biernes Creek	6	1.4 - 3.0 - 1.2 - 1.4 - 0.8 - 1.4
Davis Creek	1	1.4
Telfer Creek	8	1.4 - 1.5 - 1.6 - 1.0 - 1.8 - 0.5 - 1.8 - 1.0
Discovery Creek	4	1.8 - 1.4 - 1.8 - 0.6
Trail Creek	6	0.8 - 0.6 - 1.2 - 1.3 - 1.2 - 2.5
Jackson Creek	6	2.0 - 0.7 - 1.2 - 1.7 - 0.8 - 1.0
Abraham Creek	1	1.7
Wolf Meadows	1	1.3
Dave Creek	6	2.3 - 0.9 - 1.2 - 0.5 - 0.5 - 1.5

Figure 34: A one metre thick argillaceous seam in the McEvoy member near Mt. Biernes.

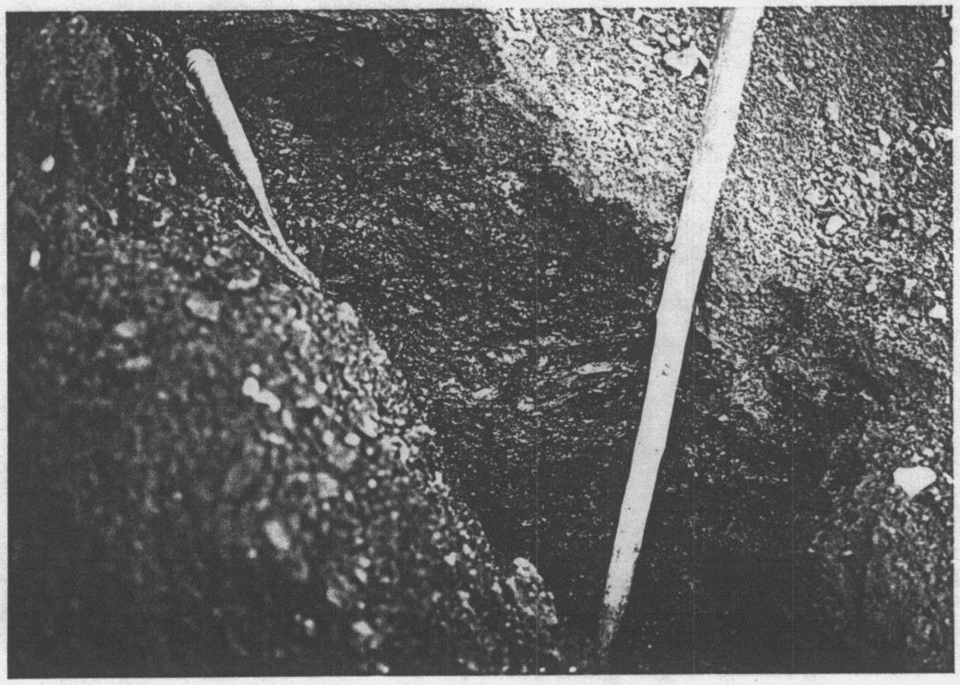


Figure 35: A 1.5 metre coal seam in the Currier member near Mt. Jackson.

(Buckham and Latour, 1950) summarized many of the major occurrences of coal in strata considered equivalent to the Currier member. The thicknesses of coal reported by them is suspect and many of the occurrences could not be confirmed in the field.

Coal Rank and Quality

Preliminary vitrinite reflectance measurements indicate the coal rank ranges from anthracite to meta-anthracite-semi-graphite. Rank determinations based on fixed carbon summarized by Buckham and Latour, 1950) and Waters (1979) suggest the coal ranges from low volatile bituminous to anthracite.

The quality of surface coal samples examined is consistently poor. The coal contains abundant ash, commonly visible pyrite and is cross-cut by quartz filled fractures. All the coal seams examined are pervasively sheared and oxidized. Tompson et al. (1970) have reported that coal intersected in drill holes is commonly argillaceous, contains numerous splits and is cross-cut by veins of quartz and calcite. The sulphur and ash content of the coal is highly variable. Buckham and Latour, (1950) report sulphur values ranging from 0.1% to 3.0%. Mould (1979) reports sulphur values from the former Petrofina licenses ranging from 0.4 to 5.0% and Waters (1979) reports values from Mt. Klappan ranging from about 0.3% to 1.1%. The ash content of the coal is difficult to assess from reported analysis. Buckham and Latour (1950) summarize values ranging from 9 to 42%. Waters (1979) and Mould (1979) describe values ranging from 5% to in excess of 50%.

Resources and Economic Potential

Significant thicknesses of coal occur locally in the Currier member in the Skeena River valley and tributaries of the Skeena. The total coal resources cannot be estimated with confidence because of the paucity of outcrop, structural complexities and rapid facies changes. Waters (1979) estimated the resources at Mt. Klappan to be 1.5 to 2 million tonnes, whereas Mould (1979) estimated the resources of the Petrofina licences to be in order of 90 million tonnes considering a mineable depth of overburden to be 530 metres. Tompson et al. (1970) considered that the total coal reserves(?) of the area underlain by strata equivalent to the Currier member to be 4.1 billion tonnes. These resource calculations with the exception of Waters' (1979) are exceedingly optimistic and are not considered realistic.

Even considering the more optimistic coal thicknesses, the Currier member has little or no economic potential in the foreseeable future. The Currier member everywhere in the coalfield is tightly folded and/or faulted. The structural style of the folding precludes any major structural thickening of coal such as found in the southeastern British Columbia coalfields. Because of the structure, the coal would be impossible to mine by underground methods and there is no significant amount of coal amenable to strip mining. If the coalfield was located in a readily accessible area, small tonnage of coal could be economically mined (robbed) by surface mining. The mineable coal in the coalfield is not however of sufficient quantity nor quality to justify the infrastructure required to economically mine and transport the coal in the foreseeable future. In addition, because of the ash content and locally high sulphur values a wash plant would be required for almost any use of the coal.

Kluayaz Coal Licences

Petro-Canada's coal licences cover Prudential Mountain, Mount Laidlaw and low lying areas to the east along the Kluatantan River (Figure 2). In order to fully assess the licenced area airphoto interpretation and follow-up detailed mapping on a scale of 1:5,000 was undertaken. Airphoto studies resolved much of the structure of Prudential Mountain and adjacent topographical high areas. In the low lying areas along the Kluatantan drainage there is no outcrop with the exception of patchy exposures in the more deeply incised creeks. Although the outcrop was not adequate (considering the structural complexity) to enable detailed stratigraphy or structural studies it was sufficient to evaluate any potential coal resources.

Geology

The Kluayaz coal licences are underlain by strata of the McEvoy and Prudential members. The McEvoy member crops out only to the west of the Kluatantan River. The Prudential member crops out to the east of the Kluatantan River and along deeply incised creeks to the west. Measured sections within the licenced area are appended to the report and should be examined for a detailed account of the lithology.

Within the licenced area the cyclic character of the lithology, lack of marker horizons and paucity of outcrop did not enable differentation of the McEvoy or Prudential members into sub-units.

Stratigraphy

McEvoy Member

The McEvoy member underlies the area to the west of the Kluatantan River and is well exposed on Mount Taylor, Lonesome, View and Moss Mountains at the edge of the licences (Figure 37). The McEvoy member is about 350 metres thick in the licenced area and overlies (conformably?) the Prudential member.

In all the localities the McEvoy member is comprised of a monotonous sequence of interbedded siltstones, shales, sandstones, thin carbonates and rare coal seams. The siltstones and shales are dark grey to brown weathering, very well indurated, thin to thick bedded and occur in intervals up to 10 metres thick. The sandstones are tan to buff weathering, very fine to fine-grained and quartzose. Most sandstones are massive but ripple cross-laminated, planar and cross-bedded sandstones occur locally. Some sandstones comprise distinct channels up to 15 metres wide and 5 metres thick. The limestones are tan weathering, up to 0.5 metres thick and locally nodular. The coal varies in thickness from carbonaceous partings to seams up to 0.5 metres thick. The coal is typically argillaceous and locally is inter-laminated with discrete partings of pyrite up to 0.5 centimetres thick.

The strata are well indurated and on Lonesome and Moss Mountains a well developed cleavage is present. To the north the strata are more poorly indurated and the cleavage is less distinct. The strata are locally well jointed and cross-cut by quartz veins.

Prudential Member

The Prudential member is everywhere tightly folded and faulted and no complete section is present. Two partial sections were measured on Prudential Mountain (Appendix 1; sections 119 and 120) and all accessible outcrops were examined. The total thickness of the Prudential member in the licenced area is estimated to be in the order of 500 to 800 metres. It is comprised of interbedded shales, siltstones, sandstones, conglomerates and coal seams. The shales and siltstones are brown to medium grey, comprise up to 70% of the strata, are exceedingly well indurated and are ridge forming. The sandstones are tan to buff weathering, very fine to coarse grained and quartzose. They are massive or parallel bedded and range in thickness from 0.5 to 10 metres. The conglomerates are vari-colored, up to 5 metres thick and are composed of well sorted quartz and chert pebbles.

Coal comprises a very minor component of the Prudential member, although carbonaceous partings are common. On the eastern flank of Mt. Laidlaw and on Prudential Mountain seams between 1 and 1.5 metres thick crop out. At many localities seams ranging from 10 centimetres to 80 centimetres in thickness occur (Figure 38).

The strata are well indurated, cleaved, and fracture filling quartz veins occur throughout.

Structure

The structure of the licenced area differs markedly on either side of the Kluatantan River which corresponds to the area underlain by the McEvoy and Prudential members (Figure 25). East of the Kluatantan River strata of the McEvoy Ridge are characterized by low amplitude folds with a wavelength in the order of 300 to 400 metres and by high angle reverse faults. The folds are northwest-southeast trending and upright to overturned to the northeast. Locally, areas of tight folding are associated with high angle reverse faults or zones of interstratal slip (Figure 31). Interstratal peels are common and indicate more shortening than the overall structure initially suggests. On Prudential Mountain and areas to the south and north, the Prudential member is characterized by tight upright to northeasterly overturned, northwest-southeast trending folds (Figures 38 and 39). The folds have high amplitudes and wavelengths commonly less than 150 metres. Many anticlinal hinges are faulted and subsequently synclines are commonly juxtaposed. No major thrust faults are evident.

In the Kluatantan valley and Mt. Laidlaw there is very little outcrop. What outcrop does exist however, suggests the strata are tightly folded and locally faulted - similar to that described on Prudential Mountain.

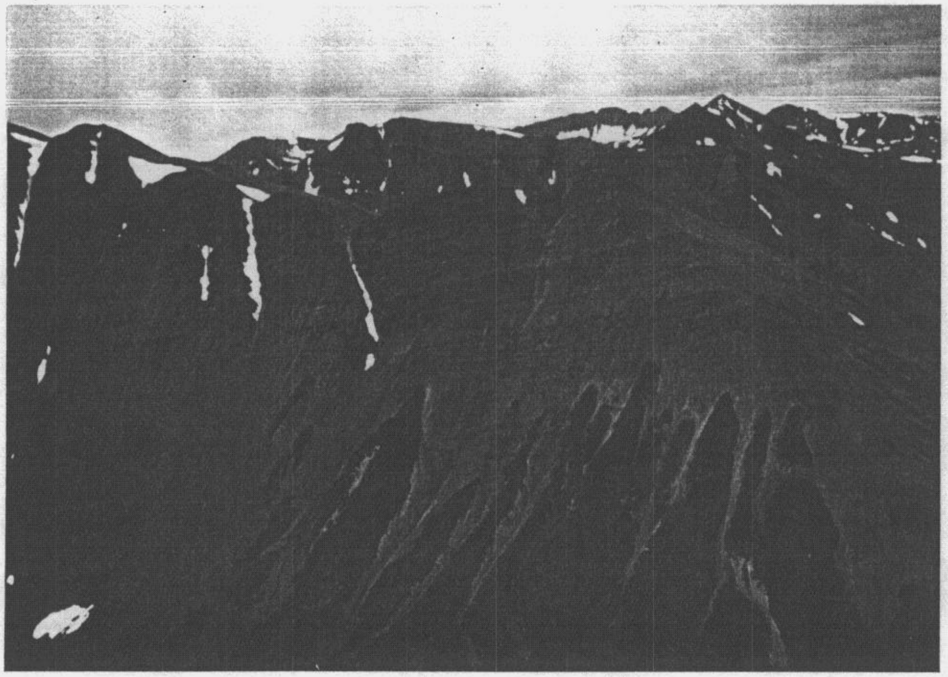


Figure 37: McEvoy member, northwest of the licenced area.

Figure 38: A 0.5 metre thick argillaceous coal seam on eastern Prudential Mountain.

Figure 39: Prudential Mountain (foreground), Mount Laidlaw (middle) and Kluatantan Valley (background). View to the northwest.

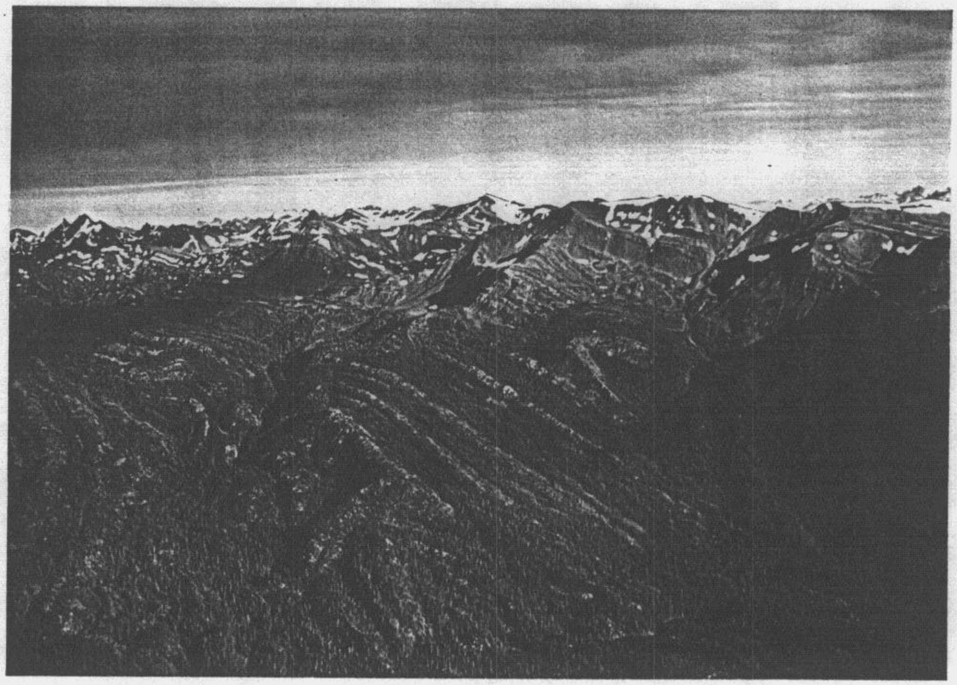


Figure 40: Prudential Mountain - view to the southeast. Steeply dipping resistant beds of siltstone and conglomerate define tight northwest-southeast trending folds. The folds are upright to overturned to the northeast.

Coal - Occurrence and Potential

Within the Kluayaz coal licences carbonaceous partings and thin coal seams occur in the McEvoy and Prudential members. Nowhere were seams thicker than 1.5 metres observed nor do multiple seams thicker than 1.0 metres occur in any stratigraphic interval. The thickest seams observed occur on the east flank of Mt. Laidlaw where two seams varying from 1.0 to 1.5 metres thick outcrop and on eastern Prudential Mountain where one seam 1.0 metre thick occurs. Malloch and Tohers described the occurrence of a number of coal seams in the licences area (Buckham and Latour, 1950). Although many of the described occurrences were confirmed most of the thicker seams are best described as interbedded carbonaceous shale and coal.

Coal Rank and Quality

Based on vitrinite reflectance determinations the coal rank varies from meta-anthracite to semi-graphite. The coal is argillaceous, pervasively sheared and commonly cross-cut by quartz veins. All surface samples are highly oxidized. No samples suitable for proximate analysis were collected during the study. Analysis of eight samples from the study area reported by Malloch (in Buckham and Latour, 1950) averaged 38% ash.

Resources and Economic Potential

No attempt has been made to calculate the coal resources in the licenced area because of structural complexity and the paucity of outcrop throughout much of the property.

The complete absence of seams of mineable thickness, the tight folding coupled with the poor quality of the observed coal indicate the licenced area has no potential for mining by conventional methods.

Conclusions and Recommendations

The Groundhog coalfield is characterized by a succession of fine to coarse grained clastics up to 4500 metres thick of highly variable structural style. Five mappable units are distinguished which are referred to informally as the Jackson, Currier, McEvoy, Devils Claw and Prudential members. The Jackson member - the lowest stratigraphic unit in the coalfield, comprises approximately 1800 metres of interbedded marine shales, siltstones, sandstones and minor conglomerates of Late Jurassic age. East of the Kluatantan River the Jackson member is overlain conformably by a sequence of deltaic and fluvial-deltaic sandstone, shale, siltstone and coal up to 800 metres thick of the Currier member. East of the Kluatantan River the Jackson member is overlain conformably by a coarser grained sequence of sandstone, shale, siltstone, rare coal and conglomerate up to 800 metres thick of the Prudential member. The Prudential member is considered in part to be stratigraphically equivalent to the Currier member and includes deltaic and fluvial deposits. The Currier member is overlain by the McEvoy member which is composed of up to 1000 metres of fluvial and lacustrine siltstones, shales, very fine- to fine-grained sandstones and rare limestones and coal. The McEvoy member is in turn conformably overlain and in part a lateral equivalent to fluvial and locally lacustrine siltstone, shale, sandstone, and massive conglomerate up to 500 metres thick of the Devils Claw member. The overall stratigraphic sequence within the coal field represents a major regressive sequence which prograded from the north and northeast.

The structure of the coalfield is dominated by a northwest-southeast trending structural grain. The structure is highly variable both stratigraphically and across the coalfield. Between the Nass and Kluatantan Rivers strata of the Devils Claw and McEvoy members are characterized by broad open folds of low amplitude and locally, tight northeast and rarely southwesterly overturned folds and drag folds. The Currier, Prudential and Jackson members are typified by high amplitude, short wavelength, chevron style folds which are upright to overturned to the northeast. Back-limb and fore-limb thrust faults are common throughout the coalfield but there is no evidence for major thrust faults. The Prudential and Jackson members and locally the Currier and McEvoy members are cleaved. A late phase of normal faulting is evident in some areas. The variation in structural style between the McEvoy and Devils Claw members and the Jackson, Currier and Prudential members is considered a product of the differing lithologies. The possibility cannot be ruled out, based on this study, that an angular unconformity separates the Prudential and Currier members from the overlying McEvoy member. There is no evidence to suggest the Nass River, Skeena River-Tahtsedle Creek or other northwest-southeast lineaments are major thrust faults nor is there evidence for strike-slip faulting along them.

Coal occurs in the McEvoy, Prudential and Currier members. The coal rank varies in rank from semi-anthracite through anthracite to meta-anthracite and semi-graphite. Coal in the McEvoy and Prudential members consists of carbonaceous partings to seams up to 1.5 metres thick but everywhere comprises a very small (and insignificant) part of the succession. The Currier member is the main coal bearing member in the coalfield. Coal seams locally up to 4 metres thick occur but most seams are less than 1.0 metres thick. Coal never comprises a significant component of the member. The coal is mainly anthracite and meta-anthracite, commonly 0.5 to 2.5 metres but coal rarely comprises a significant component of the member. The coal is mainly anthracite and meta-anthracite, commonly cross-cut by quartz veins, argillaceous and has a highly variable sulphur content (up to 3%). Because of the paucity of outcrop, lack of marker horizons, and complex structure it is not possible to estimate the lateral extent, total number of seams or resources with confidence.

Although locally thick seams occur in the Currier member, seams of suitable thickness, quality and structural setting to facilitate conventional mining do not occur. The Currier member within the study area is thus considered to have no potential for development at a scale which would warrant implacing the infrastructure necessary to mine, wash and transport the coal at this time.

Petro-Canada's Kluayaz coal licences are underlain entirely by the Prudential and McEvoy members. Folding in the area is exceedingly tight and no coal seams thicker than 1.5 metres were observed anywhere on the licenced areas. Because of the absence of thick coal seams and structural complexity, the licenced area is considered to have no potential for coal development in the foreseeable future.

Based on the absence of observed seams of suitable thickness and quality and structural complexities which would inhibit conventional mining, it is recommended that the Kluayaz licences be dropped and no further exploration be undertaken. Other areas of coal potential in the central and northern part of the Bowser Basin are unknown. The Bowser Basin, an area of 70,000 kilometres^2, however remains one of the least known areas of Canada. Although there is no encouragement for further coal exploration at present, the results of mapping programs by the Geological Survey of Canada should be closely monitored.

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APPENDIX I

SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance			$360,819.63
Detail—			$ 40,091.01
Surface			
Underground			
Other (specify)*			
Geophysical/Geochemical Surveys			
Method			
Grid			
Topographic			
Other (specify)*			
Road Construction			
On licences Nos.			
Access to			
Surface Work			
Trenching			
Seam tracing			
Crosscutting			
Other (specify)*			
Underground Work			
Test adits			
Other workings*			
Drilling			
Core—			
Diamond			
Wireline			
Rotary—			
Conventional			
Reverse circulation			
Other (specify)*			
Contractor			
Where core stored			
Logging			
Sampling			
Testing			
Other work: (specify details)*			
Reclamation work (Permit No.)			

ON-PROPERTY COSTS $ 294,669.32

OFF-PROPERTY COSTS $ 106,241.32

TOTAL EXPENDITURES $ 400,910.64

July 12, 1982
(Date)

[signature] Ph.D (General Manager - Coal Division)
(Signature and position)

*A full explanation of "Other" work is to be included.

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1M-180-9859

CATEGORY 21

A121005 BOWSER BASIN GROUNDHOG PROJECT GROSS = 500.000 00 NET = 500.000 00 W I = 1 000000

		AUTHORIZED	EXPENDED	VARIANCE
142	CAPITALIZED MINING EXPENDITURES			
099	MISCELLANEOUS		5.432 71CR	5.432 71
261	CAMP & CATERING	85.000 00	22.104 10	62.895 90
262	COMMUNICATIONS	5.000 00	4.497 10	502 90
263	FREIGHT AND HAULING	269.000 00	66.837 97	202.162 03
264	EQUIPMENT RENTALS		432 23	432 23CR
277	PRINTING AND REPRODUCTION		46 00	46 00CR
283	DIRECT CO LABOR - SUP & TECHNICAL	70.000 00	141.101 86	71.101 86CR
342	POWER & FUEL	25.000 00		25.000 00
345	BULK FUEL		37.612 70	37.612 70CR
389	NON-CONTROLLABLE MATERIALS	21.000 00	18.415 11	2.584 89
423	AIR CHARTER-HELECOPTERS		37.622 73	37.622 73CR
583	CONTRACT LABOUR-SUPERVN & TECHN		22.747 51	22.747 51CR
629	SURVEYING AND PHOTOGRAMMETRY.	15.000 00	980 25	14.019 75
631	ASSAYING AND TESTING		220 12	220 12CR
635	TRAVEL & AUTOMOTIVE EXPENSE	10.000 00	39.328 56	29.328 56CR
638	GEOLOGICAL AND MAPPING STUDIES		13.513 61	13.513 61CR
659	GEOCHEMICAL STUDIES		883 50	883 50CR
	TOTAL MAJOR	500.000 00	400.910 64	99.089 36
	AFE GROSS TOTAL	500.000 00	400.910 64	99.089 36
998	CO-OWNERS SHARE			
	NET TOTAL	500.000 00	400.910 64	99.089 36

GROUNDHOG COAL PROJECT

SCHEDULE OF COAL LICENSES

ISSUED APRIL 13, 1981

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6916	104A/16E	G	87, 88, 97, 98*	129	$ 645
6917	"	–	Lot 2187	259	1,295
6918	"	I	1, 2, 11, 12	283	1,415
6919	"	I	3, 4, 13, 14	283	1,415
6920	"	I	5, 6, 15, 16	283	1,415
6921	"	I	7, 8, 17, 18	283	1,415
6922	"	I	9, 10, 19, 20	283	1,415
6923	"	I	21, 22, 31, 32	283	1,415
6924	"	I	23, 24, 33, 34	283	1,415
6925	"	I	25, 26, 35, 36	283	1,415
6926	"	I	27, 28, 37, 38	283	1,415
6927	"	I	29, 30, 39, 40	283	1,415
6928	"	I	41, 42, 51, 52	283	1,415
6929	"	I	43, 44, 53, 54	283	1,415
6930	"	I	45, 46, 55, 56	283	1,415
6931	"	I	47, 48, 57, 58	283	1,415
6932	"	I	49, 50, 59, 60	283	1,415
6933	"	I	61, 62, 71, 72	283	1,415
6934	"	I	63, 63, 73, 74	283	1,415
6935	"	I	65, 66, 75, 76	283	1,415
6936	"	I	67, 68, 77, 78	283	1,415
6937	"	I	69, 70, 79, 80	283	1,415
6938	"	I	81, 82, 91, 92	283	1,415
6939	"	I	83, 84, 93, 94	283	1,415
6940	"	I	85, 86, 95, 96	283	1,415
6941	"	I	87, 88, 97, 98	283	1,415
6942	"	I	89, 90, 99, 100	283	1,415
6943	"	J	1, 2, 11, 12	283	1,415

cont'd....

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6944	104A/16E	J	7, 8, 17, 18*	268	$1,340
6945	"	J	9, 10, 19, 20*	160	800
6946	"	J	21, 22, 31, 32	283	1,415
6947	"	J	27, 28, 37, 38	283	1,415
6948	"	J	29, 30, 39, 40*	282	1,410
6949	"	J	41, 42, 51, 52	283	1,415
6950	"	J	43, 44, 53, 54	283	1,415
6951	"	J	47, 48, 57, 58	283	1,415
6952	"	J	49, 50, 59, 60	283	1,415
6953	"	J	61, 62, 71, 72	283	1,415
6954	"	J	63, 64, 73, 74	283	1,415
6955	"	J	65, 66, 75, 76	283	1,415
6956	"	J	67, 68, 77, 78	283	1,415
6957	"	J	69, 70, 79, 80	283	1,415
6958	"	J	81, 82, 91, 92	283	1,415
6959	"	J	83, 84, 93, 94	283	1,415
6960	"	J	85, 86, 95, 96	283	1,415
6961	"	J	87, 88, 97, 98	283	1,415
6962	"	J	89, 90, 99, 100	283	1,415
6963	104A/16W	K	61, 62, 71, 72	283	1,415
6964	"	K	81, 82, 91, 92	283	1,415
6965	104H/1E	A	1, 2, 11, 12	282	1,410
6966	"	A	3, 4, 13, 14	282	1,410
6967	"	A	5, 6, 15, 16	282	1,410
6968	"	A	7, 8, 17, 18	282	1,410
6969	"	A	9, 10, 19, 20	282	1,410
6970	"	A	21, 22, 31, 32	282	1,410
6971	"	A	23, 24, 33, 34	282	1,410
6972	"	A	25, 26, 35, 36	282	1,410
6973	"	A	27, 28, 37, 38	282	1,410
6974	"	A	29, 30, 39, 40	282	1,410
6975	"	A	41, 42, 51, 52	282	1,410
6976	"	A	43, 44, 53, 54	282	1,410
6977	"	A	45, 46, 55, 56	282	1,410

cont'd.....

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
6978	104H/1E	A	47, 48, 57, 58	282	$1,410
6979	"	A	49, 50, 59, 60	282	1,410
6980	"	A	61, 62, 71, 72	282	1,410
6981	"	A	63, 64, 73, 74	282	1,410
6982	"	A	65, 66, 75, 76	282	1,410
6983	"	A	67, 68, 77, 78	282	1,410
6984	"	A	69, 70, 79, 80	282	1,410
6985	"	B	1, 2, 11, 12	282	1,410
6986	"	B	3, 4, 13, 14	282	1,410
6987	"	B	5, 6, 15, 16	282	1,410
6988	"	B	7, 8, 17, 18	282	1,410
6989	"	B	9, 10, 19, 20	282	1,410
6990	"	B	21, 22, 31, 32	282	1,410
6991	"	B	23, 24, 33, 34	282	1,410
6992	"	B	25, 26, 35, 36	282	1,410
6993	"	B	27, 28, 37, 38	282	1,410
6994	"	B	29, 30, 39, 40	282	1,410
6995	"	B	41, 42, 51, 52	282	1,410
6996	"	B	43, 44, 53, 54	282	1,410
6997	"	B	45, 46, 55, 56	282	1,410
6998	"	B	47, 48, 57, 58	282	1,410
6999	"	B	49, 50, 59, 60	282	1,410
7000	"	B	61, 62, 71, 72	282	1,410
7001	"	B	63, 64, 73, 74	282	1,410
7002	"	B	65, 66, 75, 76	282	1,410
7003	"	B	67, 68, 77, 78	282	1,410
7004	"	B	69, 70, 79, 80	282	1,410
7005	104H/1W	C	1, 2, 11, 12	282	1,410
7006	"	C	3, 4, 13, 14	282	1,410
7007	"	C	5, 6, 15, 16	282	1,410
7008	"	C	21, 22, 31, 32	282	1,410
7009	"	C	23, 24, 33, 34	282	1,410
7010	"	C	25, 26, 35, 36	282	1,410
7011	"	C	41, 42, 51, 52	282	1,410

cont'd.......

License No.	N.T.S. Ref. No.	Block	Units	Hectares	Annual Rental
7012	104H/1W	C	43, 44, 53, 54	282	$ 1,410
7013	"	C	45, 46, 55, 56	282	1,410
7014	"	C	61, 62, 71, 72	282	1,410
7015	"	C	63, 64, 73, 74	282	1,410
7016	"	C	65, 66, 75, 76	282	1,410
TOTAL				28,214	$141,070

*Excludes surveyed lots - see below for description

6916 - save and except that part within Lot 2185, 2186 and Lot 2187

6944 - save and except that part within Lot 2187

6945 - save and except that part within Lot 2187 and Lot 2193

6948 - save and except that part within Lot 2193

APPENDIX 2

OPERATOR TABLE

OPERATOR	OPRTR
01	ESSO (IMPERIAL)
02	WEST COAST PETROLEUM
03	MANALTA COAL
04	CANADIAN OCCIDENTAL
05	UNION OIL
06	PACIFIC PETROLEUM
07	MCGREGOR TELEPHONE
08	SHELL CANADA LTD.
09	BP EXPLORATION

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
BP-1	09	-402.0	-805.0	33	53	18	5
BP-2	09	-1609.0	-1207.0	34	53	18	5
BP-3	09	.0	-1609.0	22	53	18	5
CO-7801	04	-205.0	-1568.0	11	51	23	5
CO-7802	04	-460.0	-79.0	17	51	23	5
CO-8104	04	-1012.0	-1016.0	27	51	23	5
CO-8105	04	-504.0	-556.0	30	51	23	5
CO-8106	04	-1421.0	-1020.0	21	52	22	5
CO-8111	04	-563.0	-1158.0	36	51	23	5
M-L31	03	-1037.0	-1198.0	9	51	23	5
M-L3381	03	-1019.0	-1175.0	9	51	23	5
M-L3481	03	-1006.0	-1163.0	9	51	23	5
M-RL3281	03	-1042.0	-1192.0	9	51	23	5
M-TPL1	03	-986.0	-1148.0	9	51	23	5
M-TPL2	03	-981.0	-1142.0	9	51	23	5
M-TPL381	03	-973.0	-1135.0	9	51	23	5
M-U31	03	-525.0	-732.0	9	51	23	5
M-U32	03	-509.0	-719.0	9	51	23	5
M-U3481	03	-474.0	-688.0	9	51	23	5
M-U3581	03	-466.0	-677.0	9	51	23	5
M-U3681	03	-433.0	-652.0	9	51	23	5
M-U3781	03	-423.0	-642.0	9	51	23	5
M-10081	03	-508.0	-1563.0	8	51	23	5
M-10181	03	-417.0	-1487.0	8	51	23	5
M-10281	03	-822.0	-607.0	8	51	23	5
M-10381	03	-787.0	-558.0	8	51	23	5
M-10481	03	-674.0	-474.0	8	51	23	5
M-10481C	03	-674.0	473.0	8	51	23	5
M-10581	03	-615.0	-402.0	8	51	23	5
M-10781	03	-994.0	-1158.0	9	51	23	5
M-1080	03	-1180.0	-1180.0	10	51	23	5
M-1081	03	-484.0	-696.0	9	51	23	5
M-10881	03	-797.0	-976.0	9	51	23	5
M-10981C	03	-714.0	-907.0	9	51	23	5
M-11081	03	-1038.1	-1136.0	10	51	23	5
M-11181	03	-1548.0	-474.0	10	51	23	5
M-11281	03	-1428.0	-373.0	10	51	23	5
M-11381	03	-1304.0	-271.0	10	51	23	5
M-11481	03	-364.0	-963.0	2	51	23	5
M-11581	03	-314.0	-909.0	2	51	23	5
M-11681C	03	-277.0	-866.0	2	51	23	5
M-11781	03	-220.0	-814.0	2	51	23	5
M-1180	03	-1115.0	-1130.0	10	51	23	5
M-1181C	03	-445.0	-661.0	9	51	23	5
M-11881	03	-167.0	-789.0	2	51	23	5
M-11981	03	-861.0	-1387.0	1	51	23	5
M-11981C	03	-860.0	-1387.0	1	51	23	5
M-12081	03	-753.0	-1322.0	1	51	23	5
M-12181	03	-1534.0	-712.0	1	51	23	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
M-12281	03	-1433.0	-624.0	1	51	23	5
M-12381C	03	-1377.0	-603.0	1	51	23	5
M-1273	03	-122.0	-1402.0	22	51	24	5
M-1280	03	-740.0	-805.0	10	51	23	5
M-1281	03	-339.0	-564.0	9	51	23	5
M-1373	03	-274.0	-1174.0	22	51	24	5
M-1373A	03	-274.0	-1174.0	22	51	24	5
M-1380	03	-660.0	-730.0	10	51	23	5
M-1380A	03	-660.0	-730.0	10	51	23	5
M-1381CD	03	-197.0	-449.0	9	51	23	5
M-1473	03	-707.0	-640.0	22	51	24	5
M-1480	03	-810.0	-850.0	10	51	23	5
M-1481	03	-116.0	-380.0	9	51	23	5
M-1573	03	-1006.0	-317.0	22	51	24	5
M-1580	03	-860.0	-1380.0	11	51	23	5
M-1581	03	-586.0	-727.0	10	51	23	5
M-1673	03	-1311.0	-290.0	22	51	24	5
M-1680	03	-940.0	-1460.0	11	51	23	5
M-1681	03	-519.0	-662.0	10	51	23	5
M-17A81	03	-984.0	-22.0	10	51	23	5
M-17C81	03	-983.0	-22.0	10	51	23	5
M-173	03	-857.0	-1387.0	10	51	24	5
M-174	03	-482.0	-966.0	24	51	26	5
M-1774	03	-770.0	-1464.0	10	51	24	5
M-1780	03	-1521.0	-351.0	10	51	23	5
M-1780A	03	-1521.0	-351.0	10	51	23	5
M-180	03	-1520.0	-1000.0	17	51	23	5
M-18081	03	-1500.0	-1605.0	9	51	23	5
M-181	03	-1498.0	-1007.0	17	51	23	5
M-18181	03	-42.0	-108.0	5	51	23	5
M-18281	03	-194.0	-246.0	5	51	23	5
M-18381	03	-421.0	-446.0	5	51	23	5
M-18481	03	-623.0	-631.0	5	51	23	5
M-18581	03	-799.0	-783.0	5	51	23	5
M-18681	03	-930.0	-1446.0	1	51	23	5
M-187A81	03	-1025.0	-1551.0	1	51	23	5
M-1874	03	-887.0	-1372.0	10	51	24	5
M-1880	03	-1405.0	-255.0	10	51	23	5
M-1881	03	-765.0	-1451.0	11	51	23	5
M-1974	03	-704.0	-1494.0	10	51	24	5
M-1980	03	-1200.0	-1290.0	9	51	23	5
M-1981	03	-1506.0	-547.0	11	51	23	5
M-2074	03	-290.0	-1021.0	10	51	24	5
M-2080	03	-510.0	-1160.0	1	51	23	5
M-2081	03	-1432.0	-493.0	11	51	23	5
M-2081C	03	-1433.0	-493.0	11	51	23	5
M-2180	03	-580.0	-122.0	1	51	23	5
M-2181	03	-1353.0	-410.0	11	51	23	5
M-2280	03	-760.0	-1360.0	1	51	23	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
M-2281	03	-1273.0	-351.0	11	51	23	5
M-2380	03	-870.0	-1460.0	1	51	23	5
M-2381	03	-575.0	-1163.0	1	51	23	5
M-2481	03	-450.0	-1077.0	1	51	23	5
M-2580	03	-470.0	-1130.0	1	51	23	5
M-2581	03	-391.0	-1026.0	1	51	23	5
M-26A81	03	-1176.0	-404.0	1	51	23	5
M-2680	03	-1170.0	-435.0	1	51	23	5
M-2681	03	-117.0	-404.0	1	51	23	5
M-273	03	-942.0	-1256.0	10	51	24	5
M-273A	03	-942.0	-1256.0	10	51	24	5
M-274	03	-805.0	-1128.0	24	51	26	5
M-2780	03	-1090.0	-365.0	1	51	23	5
M-2781CD	03	-1061.0	-305.0	1	51	23	5
M-280	03	-95.0	-1140.0	8	51	23	5
M-281	03	-1333.0	-876.0	17	51	23	5
M-2840	03	-1225.0	-1240.0	10	51	23	5
M-2880	03	-1455.0	-670.0	1	51	23	5
M-2980	03	-1390.0	-650.0	1	51	23	5
M-2981	03	-1484.0	-1315.0	6	51	22	5
M-3080	03	-1540.0	-1415.0	6	51	22	5
M-3080A	03	-1541.0	-1416.0	6	51	22	5
M-3081	03	-1424.0	-1248.0	6	51	22	5
M-3180	03	-1500.0	-1380.0	6	51	22	5
M-3381	03	-499.0	-711.0	9	51	23	5
M-3580	03	-1263.0	-1283.0	10	51	23	5
M-3580A	03	-1263.0	-1283.0	10	51	23	5
M-374	03	-805.0	-79.0	31	51	25	5
M-380	03	-40.0	-1110.0	8	51	23	5
M-381	03	-108.0	-1223.0	8	51	23	5
M-473	03	-771.0	-1463.0	10	51	24	5
M-480	03	-760.0	-115.0	7	51	23	5
M-573	03	-658.0	-1518.0	10	51	24	5
M-580	03	-720.0	-75.0	7	51	23	5
M-581	03	-321.0	-95.0	8	51	23	5
M-673	03	-351.0	-1427.0	10	51	24	5
M-680	03	-970.0	-1080.0	9	51	23	5
M-681	03	-250.0	-43.0	8	51	23	5
M-773	03	-247.0	-768.0	10	51	24	5
M-780	03	-893.0	-1003.0	9	51	23	5
M-780A	03	-893.0	-1003.0	9	51	23	5
M-781	03	-200.0	-1608.0	9	51	23	5
M-781C	03	-200.0	-1609.0	9	51	23	5
M-873	03	-1579.0	-716.0	15	51	24	5
M-880	03	-400.0	-570.0	9	51	23	5
M-881	03	-137.0	-1562.0	9	51	23	5
M-9781	03	-795.0	-183.0	7	51	23	5
M-980	03	-320.0	-490.0	9	51	23	5
M-981	03	-68.0	-1487.0	9	51	23	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
M-9881C	03	-657.0	-63.0	7	51	23	5
M-9981	03	-585.0	.0	7	51	23	5
MT-1	07	-805.0	-216.0	7	53	27	5
MT-1074	07	-14.0	-363.0	12	52	27	5
MT-1174	07	-369.0	-20.0	12	52	27	5
MT-12	07	-1408.0	-1387.0	9	53	27	5
MT-1274	07	-735.0	-872.0	7	53	27	5
MT-13	07	-1308.0	-101.0	8	53	27	5
MT-1374	07	-747.0	-960.0	7	53	27	5
MT-14	07	-1308.0	-1207.0	8	53	27	5
MT-1474	07	-759.0	-1046.0	7	53	27	5
MT-174	07	-555.0	-503.0	11	52	27	5
MT-2	07	-713.0	-402.0	7	53	27	5
MT-2074	07	-832.0	-1302.0	8	53	27	5
MT-2174	07	-835.0	-1542.0	8	53	27	5
MT-274	07	-639.0	-527.0	11	52	27	5
MT-3	07	-738.0	-604.0	7	53	27	5
MT-374	07	-725.0	-631.0	11	52	27	5
MT-4	07	-860.0	-805.0	8	53	27	5
MT-474	07	-850.0	-1207.0	18	52	26	5
MT-5	07	-649.0	-768.0	7	53	27	5
MT-574	07	-978.0	-1225.0	18	52	26	5
MT-674	07	-1314.0	-1253.0	18	52	26	5
MT-774	07	-1503.0	-1253.0	18	52	26	5
MT-874	07	-125.0	-1274.0	7	52	26	5
MT-974	07	-341.0	-1404.0	7	52	26	5
PP-781	06	-520.0	-75.0	33	51	25	5
PP-782	06	-1440.0	-250.0	12	52	25	5
PP-783	06	-270.0	-850.0	3	52	25	5
PP-784	06	-740.0	-510.0	33	52	25	5
PP-785	06	-80.0	-680.0	29	52	25	5
PP-786	06	-570.0	-70.0	24	52	26	5
PP-787	06	-1460.0	-200.0	34	52	26	5
PP-788	06	-170.0	-1160.0	15	53	26	5
PP-789	06	-1200.0	-380.0	36	51	26	5
PP-789A	06	-1200.0	-380.0	36	51	26	5
PP-791	06	-1610.0	-920.0	3	52	26	5
PP-792	06	-1000.0	-800.0	9	52	26	5
PP-793	06	-1000.0	-420.0	36	51	26	5
S-BH1	05	-600.0	-1194.0	6	53	24	5
S-1	08	-12.0	-421.0	14	53	20	5
S-10	08	-689.0	-177.0	12	54	21	5
S-144	08	-15.0	-1566.0	7	57	15	5
S-145	08	-1468.0	-18.0	15	57	16	5
S-15	08	-1572.0	-1265.0	2	55	20	5
S-17	08	-460.0	-402.0	33	54	21	5
S-21	08	-1106.0	-1017.0	28	55	20	5
S-25	08	-1401.0	-394.0	31	55	21	5
S-599367	08	-518.0	-1220.0	15	53	25	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
S-608419	08	-122.0	-335.0	34	53	25	5
S-7	08	-15.0	-6.0	1	54	20	5
U-RH2	05	.0	-1042.0	29	54	23	5
U-RH3	05	-960.0	-198.0	28	53	24	5
U-RH4	05	-1552.0	-869.0	19	54	23	5
U-7305	05	-983.0	-975.0	16	53	26	5
U-7402	05	-32.0	-237.0	29	54	23	5
U-7403	05	.0	-1405.0	13	54	24	5
U-7404	05	-500.0	-892.0	32	54	23	5
U-7405	05	-1445.0	-1524.0	11	55	23	5
U-7406	05	-975.0	-549.0	22	55	23	5
U-7407	05	-1052.0	-476.0	35	55	23	5
U-7408	05	-1341.0	-1061.0	36	55	23	5
U-7409	05	-704.0	-152.0	20	55	22	5
U-7410	05	-1425.0	-655.0	35	54	23	5
U-7411	05	-892.0	-1372.0	13	54	23	5
U-7412	05	-591.0	-183.0	5	55	22	5
U-7413	05	-762.0	-655.0	12	56	23	5
U-7415	05	-1372.0	-282.0	19	56	22	5
U-7416	05	-1433.0	-183.0	4	57	22	5
U-7417	05	-488.0	-91.0	29	56	22	5
U-7418	05	-1381.0	-152.0	20	56	22	5
U-7419	05	-518.0	-1155.0	19	56	22	5
U-7421	05	-137.0	-1311.0	34	56	22	5
U-7422	05	-1384.0	-673.0	13	56	23	5
U-7423	05	-1125.0	-533.0	26	55	23	5
U-7424	05	-488.0	-1280.0	27	55	23	5
U-7427	05	-937.0	-1431.0	34	53	26	5
U-7433	05	-1341.0	-335.0	25	51	26	5
U-7435	05	-549.0	-1082.0	30	51	25	5
U-7439	05	-610.0	-1006.0	29	51	25	5
U-7440	05	-1014.0	-1311.0	36	51	26	5
U-7445	05	-610.0	-114.0	9	52	25	5
U-7448	05	-216.0	-1273.0	5	53	25	5
U-7449	05	-1440.0	-1014.0	33	51	25	5
U-7450	05	-564.0	-1312.0	34	51	26	5
U-7458	05	-1311.0	-1524.0	30	54	20	5
U-7459	05	-1524.0	-305.0	24	54	21	5
U-7461	05	-823.0	-1366.0	8	53	24	5
U-7462	05	-1585.0	-878.0	8	53	24	5
U-7463	05	-259.0	-527.0	6	53	24	5
U-7464	05	-320.0	-390.0	31	52	24	5
U-7465	05	-747.0	-756.0	31	52	24	5
U-7466	05	-518.0	-1129.0	31	52	24	5
U-7467	05	-716.0	-1183.0	17	53	24	5
U-7468	05	-899.0	-908.0	21	53	24	5
U-7469	05	-701.0	-1076.0	27	53	24	5
U-7470	05	-259.0	-1228.0	27	53	24	5
U-7471	05	-686.0	-1305.0	7	54	23	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
U-7472	05	-930.0	-1152.0	18	54	23	5
U-7473	05	-1417.0	-680.0	18	54	23	5
U-7474	05	-91.0	-808.0	17	54	23	5
U-7475	05	-28.0	-308.0	18	54	23	5
U-7476	05	-831.0	-710.0	19	54	23	5
U-7477	05	-793.0	-238.0	19	54	23	5
U-7478	05	-671.0	-1487.0	29	54	23	5
U-7478A	05	-674.0	-1487.0	29	54	23	5
U-7479	05	-686.0	-946.0	34	54	23	5
U-7480	05	-667.0	-1609.0	33	54	23	5
U-7481	05	-777.0	-802.0	28	54	23	5
U-7482	05	-1606.0	-1152.0	8	53	24	5
U-7482A	05	-1609.0	-1152.0	22	53	24	5
U-7483	05	-1501.0	-253.0	21	53	24	5
U-7484	05	-899.0	-1198.0	16	53	24	5
U-7485	05	-472.0	-131.0	8	53	24	5
U-7486	05	-1280.0	-146.0	7	53	24	5
U-7487	05	-604.0	-1408.0	34	54	24	5
U-7501	05	-1006.0	-201.0	30	53	23	5
U-7503	05	-76.0	-253.0	19	54	23	5
U-7504	05	-1052.0	-474.0	33	54	23	5
U-7505	05	-31.0	-1548.0	34	54	23	5
U-7506	05	-46.0	-1198.0	33	54	23	5
U-7507	05	-701.0	-764.0	3	55	23	5
U-7601	05	-351.0	-1609.0	31	52	24	5
U-7602	05	-406.0	-932.0	36	52	25	5
U-7603	05	-71.0	-959.0	31	52	24	5
U-7604	05	-459.0	-960.0	6	53	24	5
U-7605	05	-199.0	-1465.0	5	53	24	5
U-7606	05	-438.0	-809.0	17	53	24	5
U-7607	05	-137.0	-436.0	17	53	24	5
U-7608	05	-1405.0	-759.0	20	53	24	5
U-7609	05	-1312.0	-1533.0	21	53	24	5
U-7609A	05	-1289.0	-1537.0	21	53	24	5
U-7610	05	-1366.0	-1161.0	21	53	24	5
U-76100	05	-1390.0	-1297.0	18	54	23	5
U-76101	05	-859.0	-1498.0	18	54	23	5
U-76102	05	-508.0	-999.0	19	54	23	5
U-76102A	05	-491.0	-965.0	19	54	23	5
U-76103	05	-1259.0	-1278.0	22	53	24	5
U-76104	05	-1272.0	-1376.0	22	53	24	5
U-76105	05	-1353.0	-1112.0	20	53	24	5
U-76106	05	-275.0	-443.0	5	53	24	5
U-76107	05	-368.0	-353.0	5	53	24	5
U-76108	05	-1557.0	-713.0	32	54	23	5
U-7611	05	-352.0	-583.0	21	53	24	5
U-7611A	05	-355.0	-586.0	21	53	24	5
U-7612	05	-1301.0	-516.0	28	53	24	5
U-7613	05	-739.0	-1426.0	27	53	24	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
U-7614	05	-1363.0	-718.0	27	53	24	5
U-7615	05	-582.0	-721.0	27	53	24	5
U-7616	05	-437.0	-128.0	28	53	24	5
U-7617	05	-701.0	-604.0	21	53	24	5
U-7617A	05	-704.0	-597.0	21	53	24	5
U-7618	05	-1120.0	-376.0	21	53	24	5
U-7619	05	-1558.0	-689.0	21	53	24	5
U-7620	05	-560.0	-1500.0	16	53	24	5
U-7621	05	-461.0	-1581.0	15	53	24	5
U-7622	05	-567.0	-693.0	16	53	24	5
U-7623	05	-1253.0	-1180.0	8	53	24	5
U-7624	05	-1314.0	-1505.0	22	53	24	5
U-7625	05	-1380.0	-1179.0	18	54	23	5
U-7626	05	-275.0	-988.0	7	54	23	5
U-7626A	05	-278.0	-991.0	7	54	23	5
U-7627	05	-956.0	-793.0	18	54	23	5
U-7628	05	-893.0	-398.0	18	54	23	5
U-7629	05	-51.0	-424.0	7	54	23	5
U-7630	05	-43.0	-1301.0	17	54	23	5
U-7630A	05	-40.0	-1304.0	17	54	23	5
U-7630B	05	-46.0	-1298.0	17	54	23	5
U-7631	05	-327.0	-326.0	18	54	23	5
U-7632	05	-1100.0	-907.0	19	54	23	5
U-7633	05	-1167.0	-338.0	19	54	23	5
U-7634	05	-260.0	-625.0	19	54	23	5
U-7635	05	-405.0	-1140.0	29	54	23	5
U-7636	05	-142.0	-1433.0	29	54	23	5
U-7637	05	-1137.0	-1094.0	32	54	23	5
U-7638	05	-850.0	-269.0	32	54	23	5
U-7639	05	-441.0	-1181.0	18	54	23	5
U-7640	05	-497.0	-24.0	7	54	23	5
U-7641	05	-1204.0	-1134.0	7	54	23	5
U-7642	05	-1390.0	-200.0	30	54	24	5
U-7643	05	-1028.0	-1602.0	29	54	23	5
U-7644	05	-1021.0	-990.0	29	54	23	5
U-7645	05	-1473.0	-416.0	32	54	23	5
U-7646	05	-1599.0	-200.0	8	53	24	5
U-7647	05	-1160.0	-1379.0	9	53	24	5
U-7648	05	-659.0	-1214.0	9	53	24	5
U-7649	05	-1132.0	-542.0	16	53	24	5
U-7650	05	-991.0	-78.0	16	53	24	5
U-7651	05	-860.0	-1288.0	15	53	24	5
U-7652	05	-346.0	-975.0	15	53	24	5
U-7653	05	-229.0	-608.0	5	53	24	5
U-7654	05	-1145.0	-481.0	8	53	24	5
U-7655	05	-398.0	-928.0	8	53	24	5
U-7656	05	-1578.0	-461.0	17	53	24	5
U-7657	05	-1262.0	-12.0	17	53	24	5
U-7658	05	-1061.0	-654.0	17	53	24	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
U-7659	05	-1082.0	-1228.0	17	53	24	5
U-7660	05	-1284.0	-58.0	18	53	24	5
U-7661	05	-76.0	-1601.0	8	53	24	5
U-7662	05	-431.0	-335.0	7	53	24	5
U-7663	05	-835.0	-428.0	7	53	24	5
U-7664	05	-1218.0	-502.0	7	53	24	5
U-7665	05	-148.0	-896.0	6	53	24	5
U-7666	05	-559.0	.0	6	53	24	5
U-7667	05	-875.0	-472.0	6	53	24	5
U-7668	05	-1335.0	-1076.0	5	53	24	5
U-7669	05	-1399.0	-142.0	6	53	24	5
U-7670	05	-131.0	-7.0	31	52	24	5
U-7671	05	-36.0	-1423.0	9	53	24	5
U-7672	05	-919.0	-494.0	28	54	23	5
U-7673	05	-374.0	-1558.0	27	54	23	5
U-7674	05	-1566.0	-1507.0	34	54	23	5
U-7675	05	-841.0	-1554.0	34	54	23	5
U-7676	05	-3.0	-842.0	34	54	23	5
U-7677	05	-1188.0	-879.0	2	55	23	5
U-7678	05	-1517.0	-375.0	3	55	23	5
U-7679	05	-831.0	-194.0	3	55	23	5
U-7680	05	-605.0	-1327.0	2	55	23	5
U-7681	05	-829.0	-1504.0	3	55	23	5
U-7682	05	-240.0	-761.0	3	55	23	5
U-7683	05	-35.0	-558.0	3	55	23	5
U-7684	05	-1216.0	-1012.0	3	55	23	5
U-7685	05	-1058.0	-122.0	10	55	23	5
U-7686	05	-449.0	-1544.0	34	54	23	5
U-7687	05	-251.0	-439.0	31	52	24	5
U-7688	05	-129.0	-138.0	6	53	24	5
U-7689	05	-868.0	-651.0	21	53	24	5
U-7690	05	-522.0	-498.0	21	53	24	5
U-7691	05	-893.0	-537.0	21	53	24	5
U-7692	05	-1410.0	-464.0	6	53	24	5
U-7693	05	-1187.0	-1244.0	5	53	24	5
U-7694	05	-789.0	-320.0	18	54	23	5
U-7695	05	-853.0	-510.0	32	54	23	5
U-7696	05	-148.0	-583.0	3	55	23	5
U-7697	05	-830.0	-373.0	3	55	23	5
U-7698	05	-828.0	-1017.0	3	55	23	5
U-7699	05	-579.0	-575.0	34	54	23	5
U-7701	05	-1609.0	-1609.0	31	54	20	5
U-7702	05	-305.0	-780.0	13	55	21	5
U-7703	05	-402.0	-335.0	9	56	21	5
U-7704	05	-655.0	-701.0	30	55	20	5
U-7705	05	-823.0	-152.0	12	59	21	5
U-7706	05	-201.0	-402.0	8	59	23	5
U-7710	05	-457.0	-701.0	15	55	21	5
U-7711	05	-1433.0	-168.0	36	55	21	5

PROSPECT 810 LOCATIONS

HOLE ID	OPERATOR	NORTH	EAST	SEC	TWP	RG	M
U-7712	05	-183.0	-704.0	6	56	20	5
U-7801	05	-1207.0	-1207.0	18	56	19	5
U-7802	05	-805.0	-402.0	6	56	19	5

GR - GROUNDHOG COALFIELD 81 (2)A

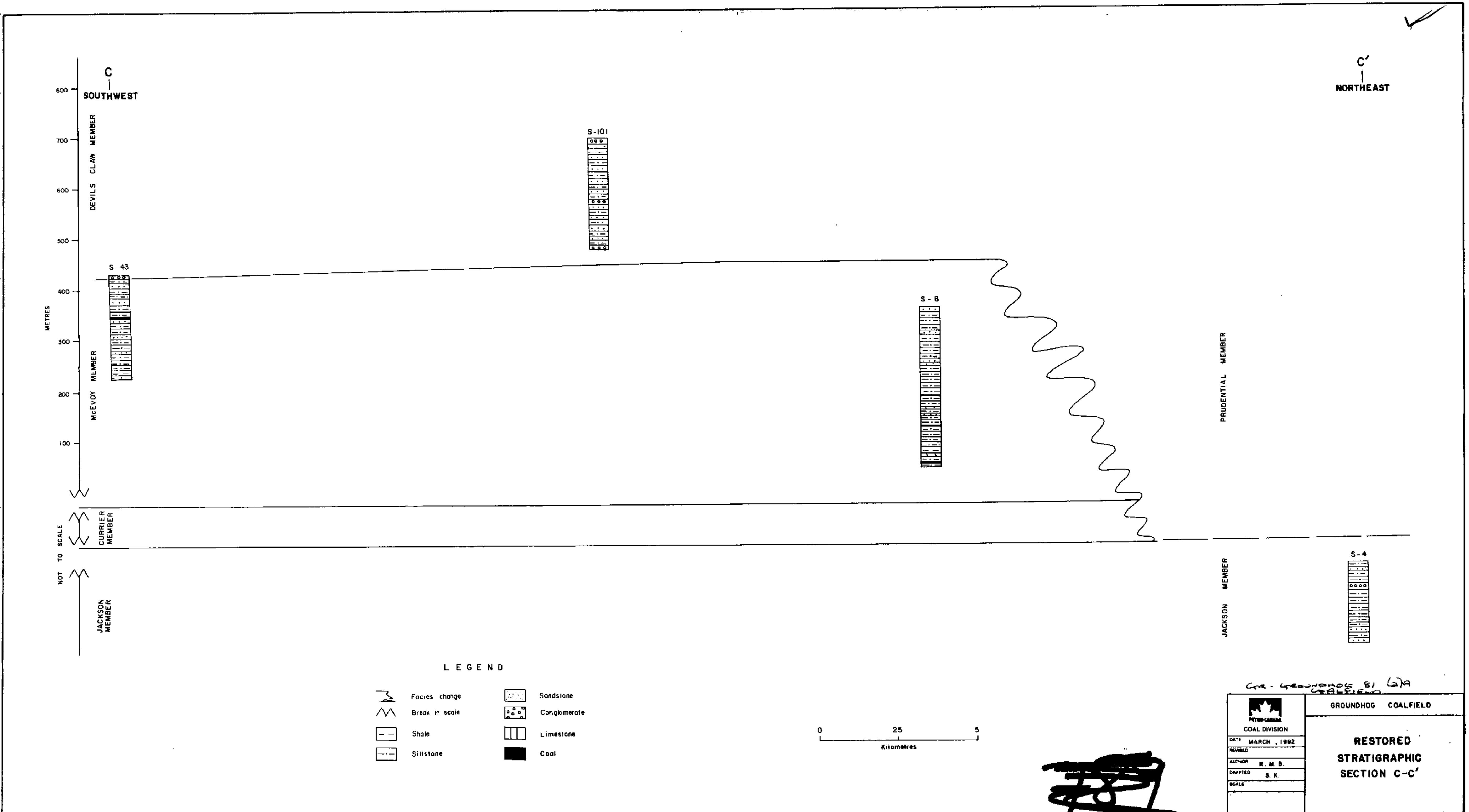
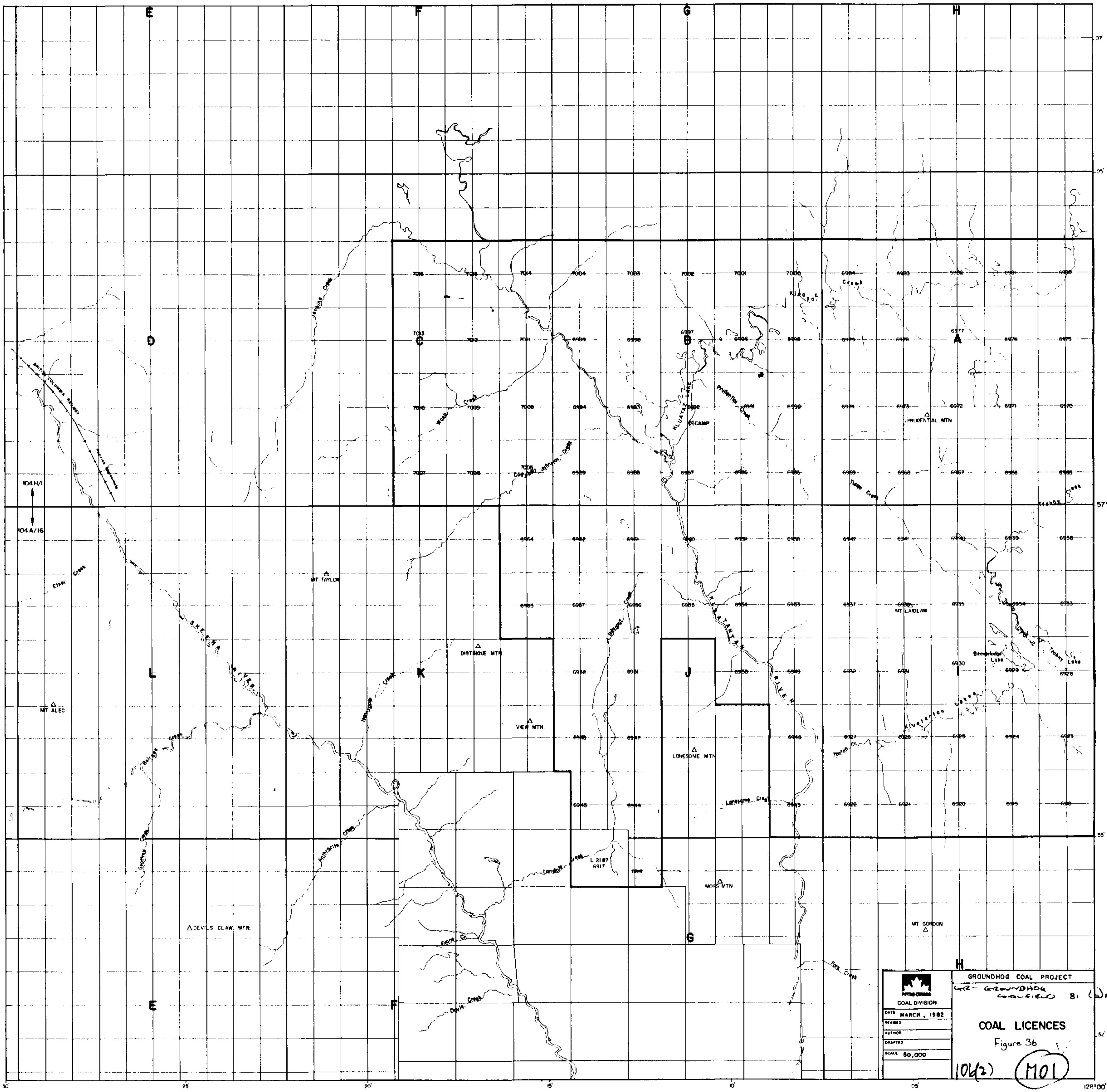

C
SOUTHWEST
C′
NORTHEAST
METRES
800
700
600
500
400
300
200
100
NOT TO SCALE
DEVILS CLAW MEMBER
McEVOY MEMBER
CURRIER MEMBER
JACKSON MEMBER
PRUDENTIAL MEMBER
JACKSON MEMBER
S-43
S-101
S-8
S-4
LEGEND
Facies change
Break in scale
Shale
Siltstone
Sandstone
Conglomerate
Limestone
Coal
0
2.5
5
Kilometres
COAL DIVISION
DATE MARCH, 1982
REVISED
AUTHOR R. M. B.
DRAFTED S. K.
SCALE
GROUNDHOG COALFIELD
RESTORED STRATIGRAPHIC SECTION C-C′

Figure 7



E
F
G
H
D
C
B
A
L
K
J
7016
7015
7014
7004
7003
7002
7001
7000
7013
7012
7011
6999
6998
6997
7010
7009
7008
6994
6993
6992
6991
6990
6974
6973
6972
6971
6970
7007
7006
7005
6989
6988
6987
6986
6985
6969
6968
6967
6966
6965
CAMP
KLUAYAZ LAKE
Prudential Creek
PRUDENTIAL MTN
Johanson Creek
Tsaia Creek
104 H/1
104 A/16
Ethel Creek
MT TAYLOR
DISTINGUE MTN
VIEW MTN.
LONESOME MTN
MT LAIDLAW
MT ALEC
SKEENA RIVER
KLAPPAN RIVER
Lonesome Creek
Kluatantan Lakes
Beaverlodge Lake
Langlois Creek
L 2187
6917
MOSS MTN
MT GORDON
DEVILS CLAW MTN.
Devils Creek
Fork Creek
57°00'
55'
52'
128°00'
05'
10'
15'
20'
25'
30
GROUNDHOG COAL PROJECT
GR - GROUNDHOG COALFIELD 81 (1)A
COAL DIVISION
DATE MARCH, 1982
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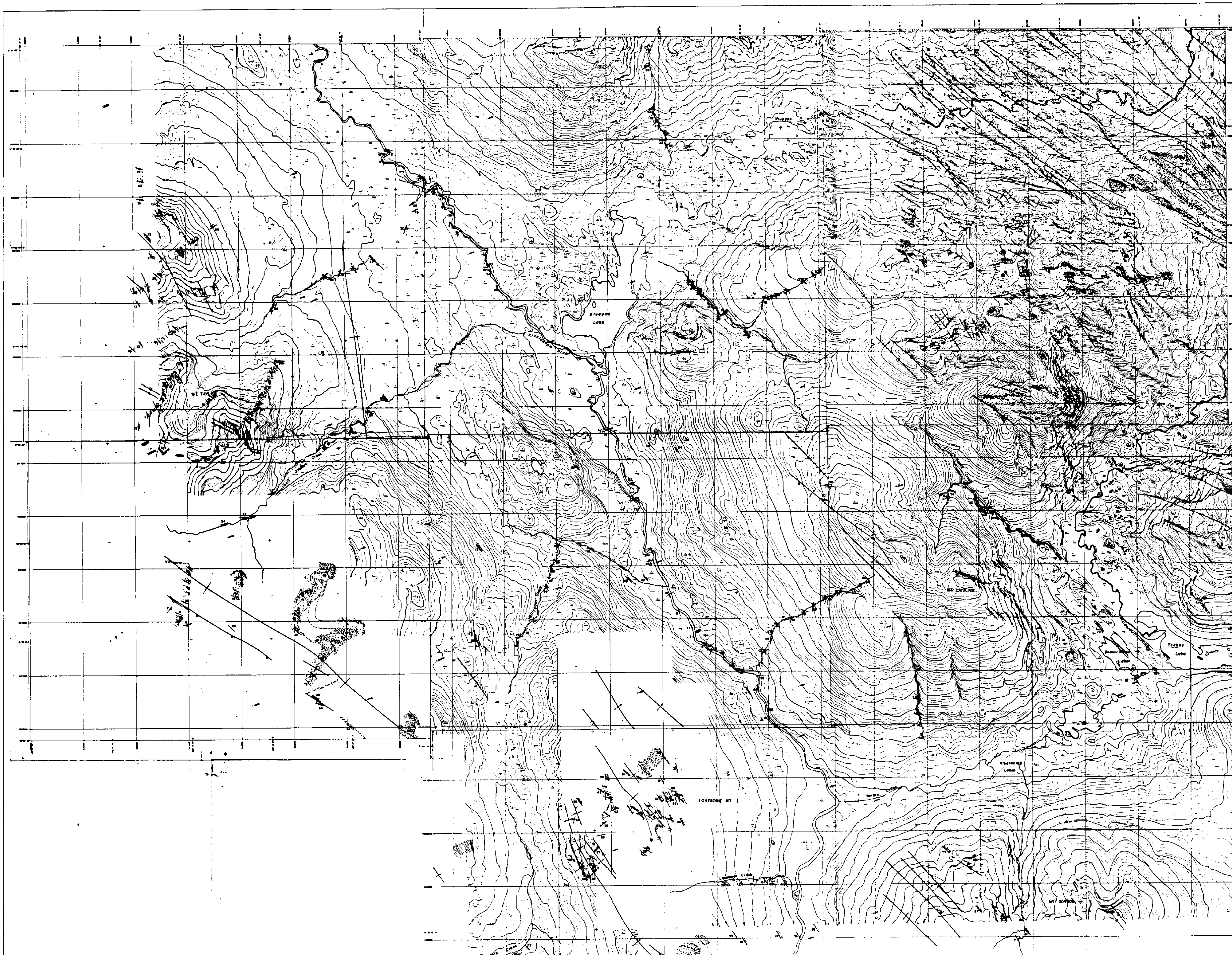
AUTHOR
DRAFTED
SCALE 50,000
COAL LICENCES
Figure 36
104(2)
M01



GR-GROUNDHOG COALFIELD 81 (2)

PETRO CANADA
COAL DIVISION

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SCALE 1:25,000

GROUNDHOG COAL PROJECT

GEOLOGY MAP

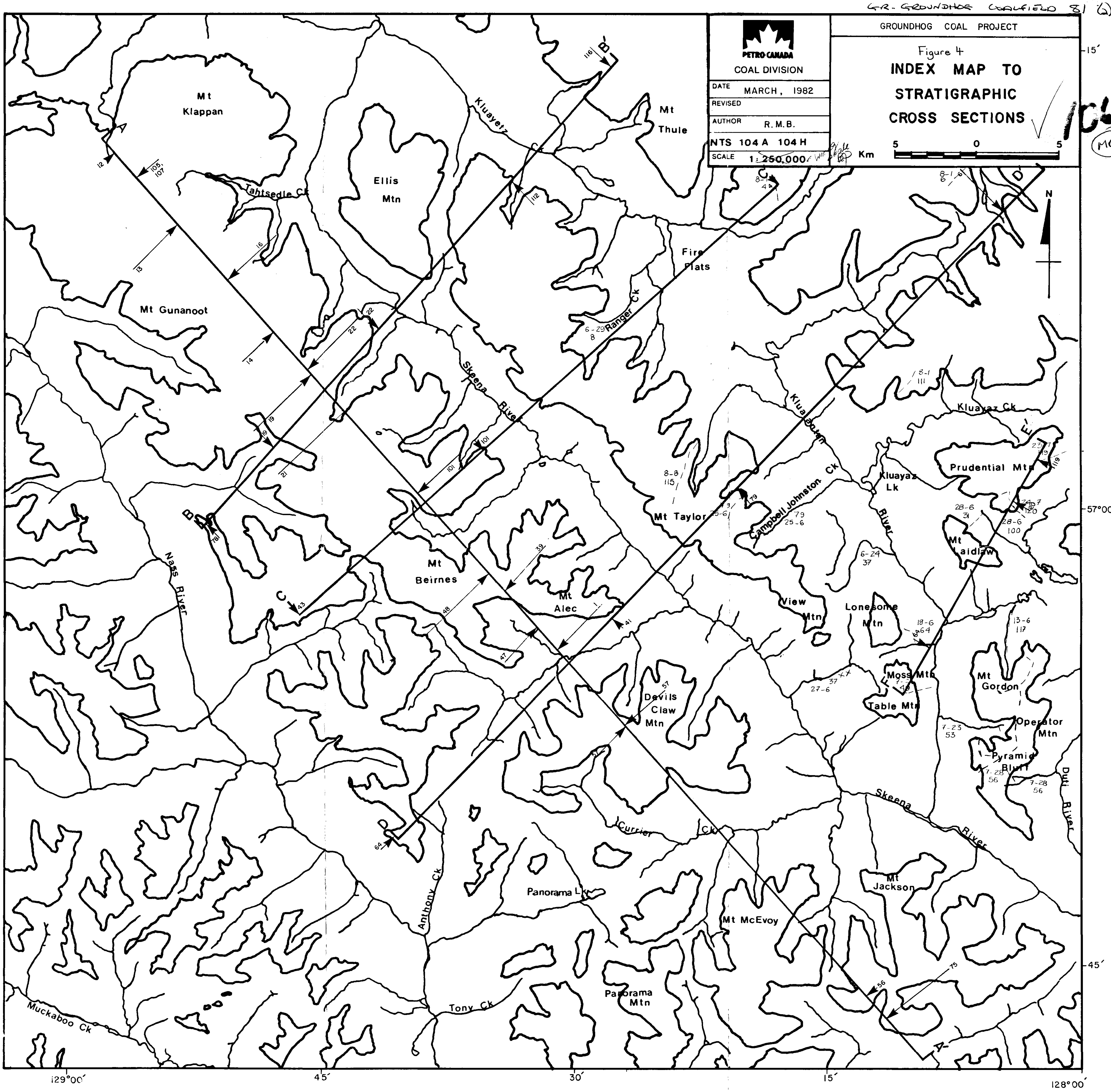
Figure 30

M02

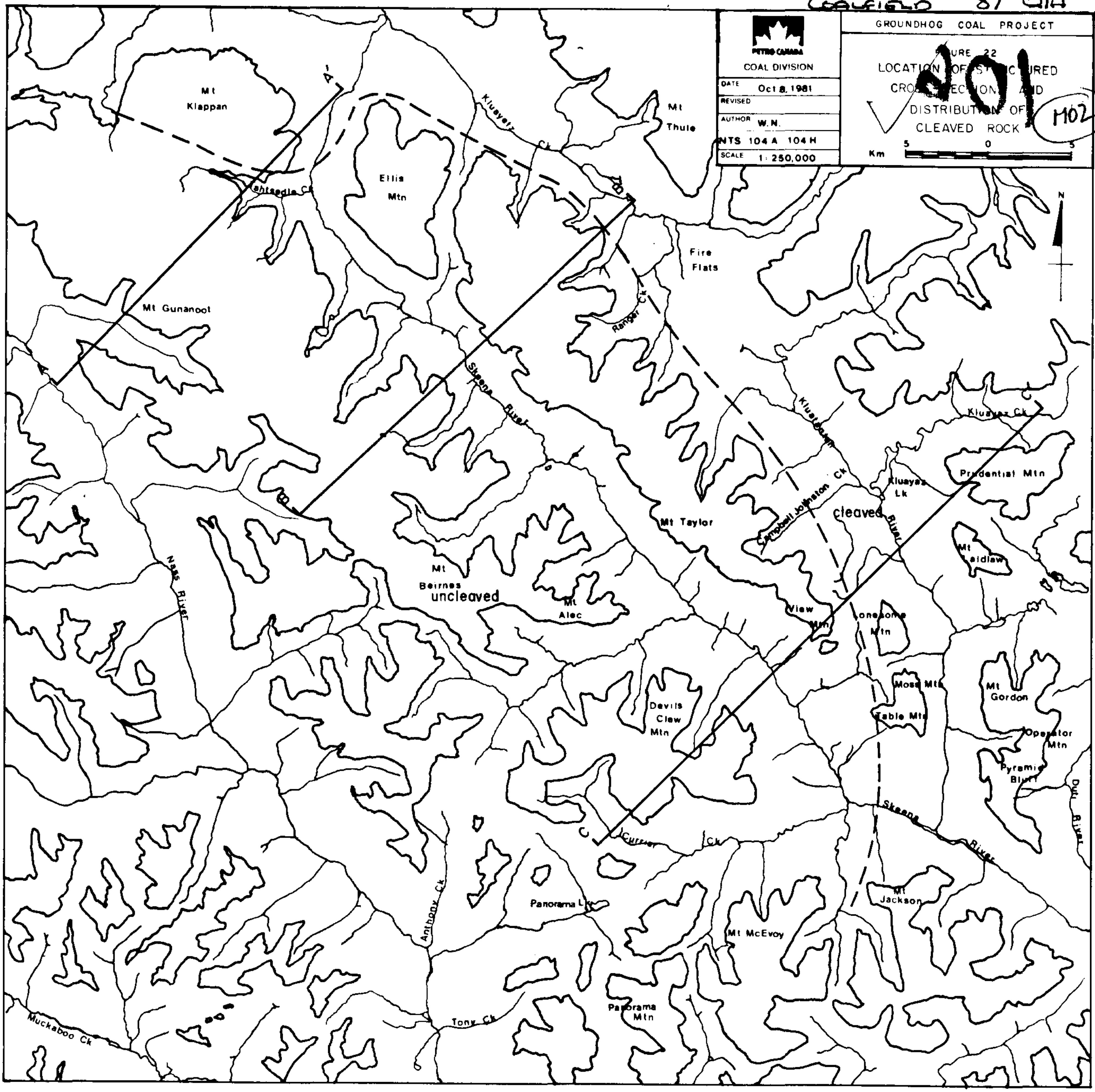

A
NORTHWEST
A'
SOUTHEAST
DEVILS CLAW MEMBER
CURRIER MEMBER
JACKSON MEMBER
S-29
S-13
S-16
S-30
S-22
S-19
S-21
S-101
S-48
S-47
S-41
S-57 & 63
S-103 & 107
S-75
L E G E N D
Facies change
Break in scale
Shale
Siltstone
Sandstone
Conglomerate
Limestone
Coal
Kilometres
106 (2) M03
GR- GROUNDHOG COALFIELD 81
COAL DIVISION
DATE MARCH, 1982
REVISED
AUTHOR R M B
DRAFTED S K
SCALE
GROUNDHOG COALFIELD
RESTORED STRATIGRAPHIC SECTION A-A'

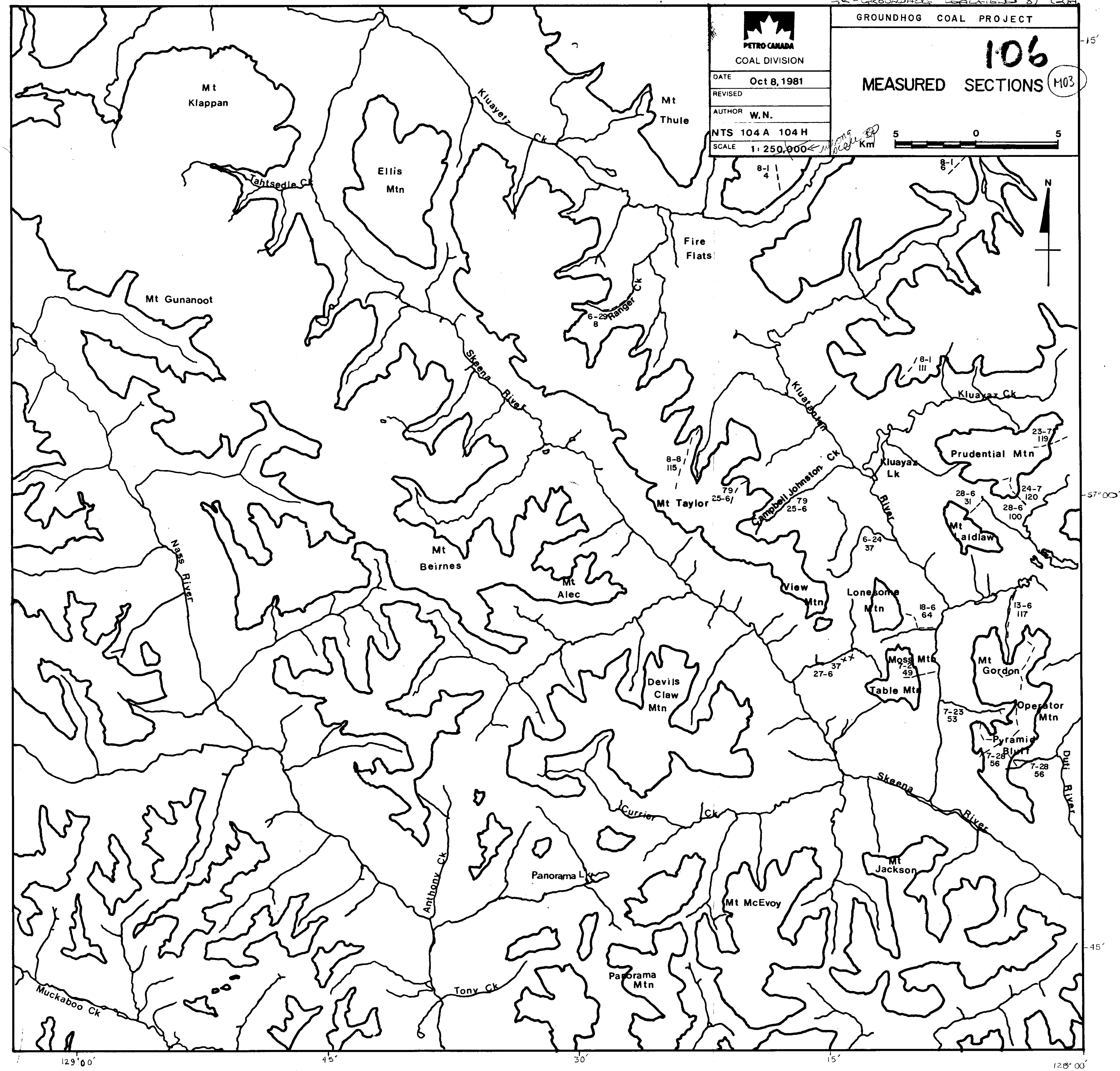
Figure 5

GR-GROUNDHOG COALFIELD 81 (2)A



GR- GROUNDHOG COALFIELD 81 G1A




GROUNDHOG COAL PROJECT
PETRO-CANADA
COAL DIVISION
DATE Oct 8, 1981
REVISED
AUTHOR W.N.
NTS 104 A 104 H
SCALE 1: 250,000
106
MEASURED SECTIONS
M03
5 0 5
Km
N
Mt Klappan
Mt Thule
Kluayetz Ck
Tahtsedle Ck
Ellis Mtn
Fire Flats
Mt Gunanoot
Ranger Ck
6-29
8
8-1
4
8-1
6
8-1
111
Skeena River
Kluatantan
Kluayaz Ck
Kluayaz Lk
23-7
119
Prudential Mtn
8-8
115
79
25-6
Mt Taylor
Campbell Johnston Ck
79
25-6
24-7
120
28-6
31
28-6
100
River
Mt Laidlaw
6-24
37
Nass River
Mt Beirnes
Mt Alec
View Mtn
Lonesome Mtn
18-6
64
13-6
117
Moss Mtn
7-2
49
27-6
37
Table Mtn
Mt Gordon
Devils Claw Mtn
7-23
53
Operator Mtn
Pyramid Bluff
7-28
56
7-28
56
Duti River
Skeena River
Currier Ck
Anthony Ck
Mt Jackson
Panorama Lk
Mt McEvoy
Panorama Mtn
Muckaboo Ck
Tony Ck
15′
57°00′
45′
129°00′
45′
30′
15′
128°00′


A
NORTHWEST
A'
SOUTHEAST
DEVILS CLAW MEMBER
CURRIER MEMBER
JACKSON MEMBER
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
S-29
S-13
S-16
S-30
S-22
S-19
S-21
S-101
S-48
S-29A
S-29B
S-47
S-41
S-57 & 63
S-103 & 107
S-75B
S-75
LEGEND
Facies change
Break in scale
Shale
Siltstone
Sandstone
Conglomerate
Limestone
Coal
0
2.5
5
Kilometres
106
GR- GROUNDHOG COALFIELD 81 (2A)
PETRO-CANADA
COAL DIVISION
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DRAFTED S. K.
SCALE
GROUNDHOG COAL FIELD
RESTORED STRATIGRAPHIC SECTION A-A'

Figure 5


B
SOUTHWEST
B′
NORTHEAST
METRES
1100
1000
900
800
700
600
500
400
300
200
100
0
DEVILS CLAW MEMBER
McEVOY MEMBER
PRUDENTIAL MEMBER
S-19
S-22
S-78
S-112A & 112B
S-116
LEGEND
Facies change
Shale
Siltstone
Sandstone
Conglomerate
Limestone
Coal
0
25
5
Kilometres
PETRO CANADA
COAL DIVISION
DATE MARCH, 1982
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AUTHOR R. M. B.
DRAFTED S. K.
SCALE
GROUNDHOG COALFIELD
RESTORED STRATIGRAPHIC SECTION B-B′
GR-GROUNDHOG 81 (2)A COALFIELD
106
MOS

Figure 6

M06

106

GR - GROUNDHOG 81 (2)A COALFIELD

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SCALE

GROUNDHOG COALFIELD

RESTORED STRATIGRAPHIC SECTION C-C′

Figure 7


D
SOUTHWEST
D′
NORTHEAST
METRES
400
300
200
100
0
NOT TO SCALE
S-64
S-41
S-79
S-6
McEVOY MEMBER
CURRIER MEMBER
JACKSON MEMBER
PRUDENTIAL MEMBER
HAPPY LAKE
LEGEND
Facies change
Break in scale
Shale
Siltstone
Sandstone
Conglomerate
Limestone
Coal
0
25
5
Kilometres
PETRO CANADA
COAL DIVISION
DATE MARCH, 1982
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AUTHOR R. M. B.
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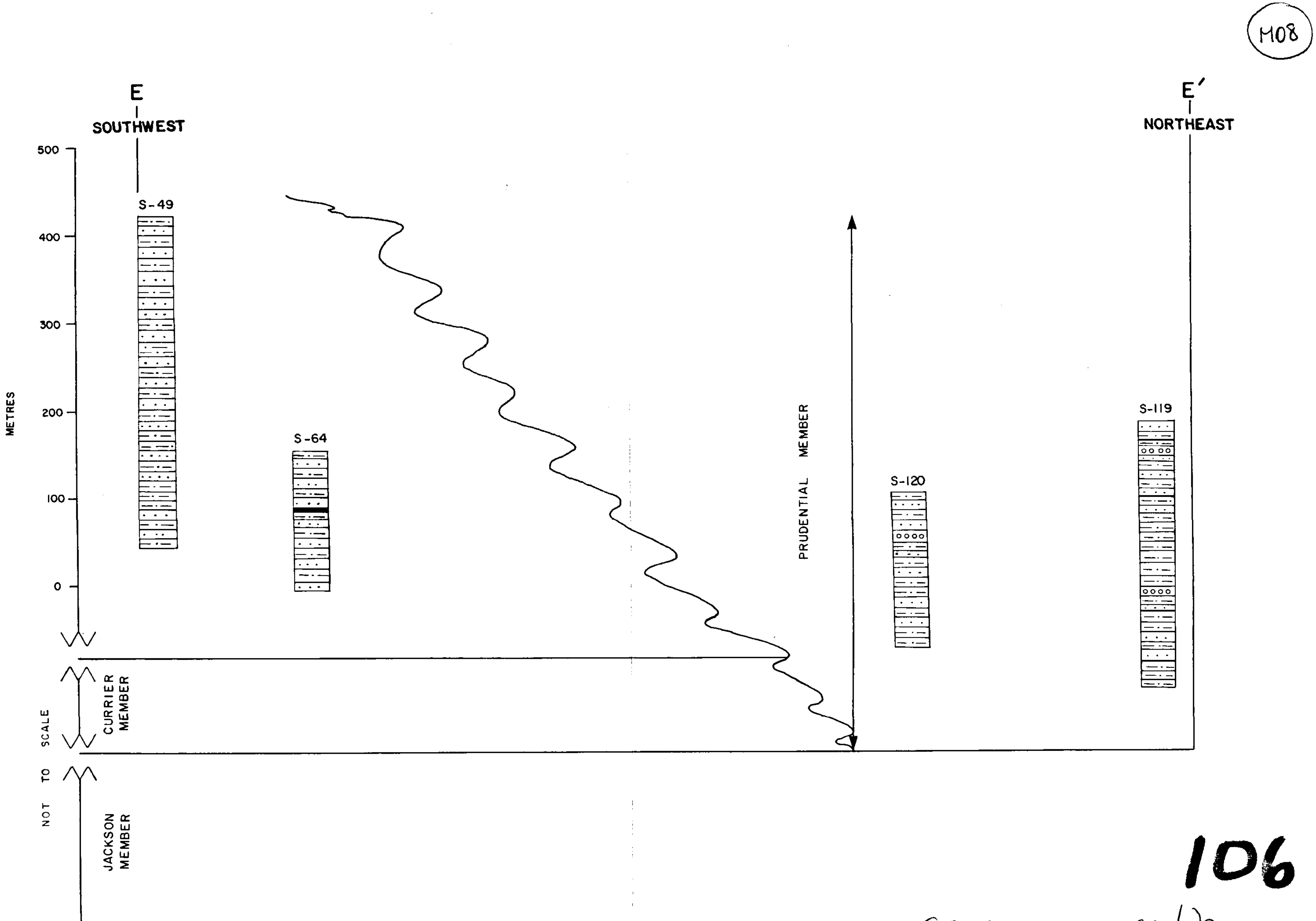
SCALE
GROUNDHOG COALFIELD
RESTORED STRATIGRAPHIC SECTION D-D′
GR-GROUNDHOG COALFIELD
87 (2)A
106
M07
Figure 8



L E G E N D

Facies change		Sandstone	
Break in scale		Conglomerate	
Shale		Limestone	
Siltstone		Coal	

0 — 2.5 — 5
Kilometres

GR- GROUNDHOG COALFIELD 81 6(a)

PETRO CANADA
COAL DIVISION

GROUNDHOG COALFIELD

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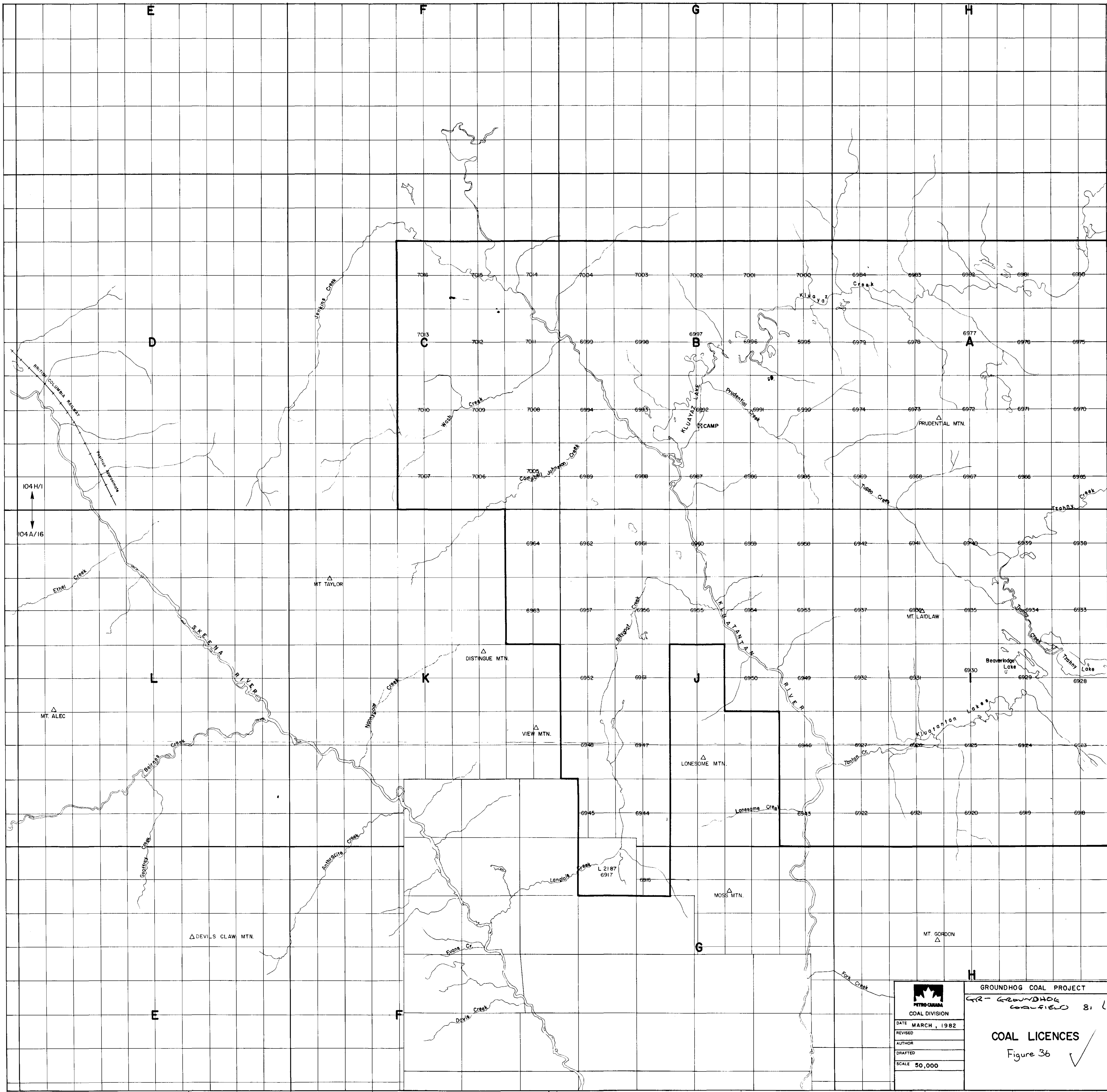
DRAFTED	S. K.
SCALE	

RESTORED STRATIGRAPHIC SECTION E–E′

Figure 9



GROUNDHOG COAL PROJECT

GR- GROUNDHOG COALFIELD 81 (WA)

PETRO CANADA COAL DIVISION

DATE MARCH, 1982

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AUTHOR

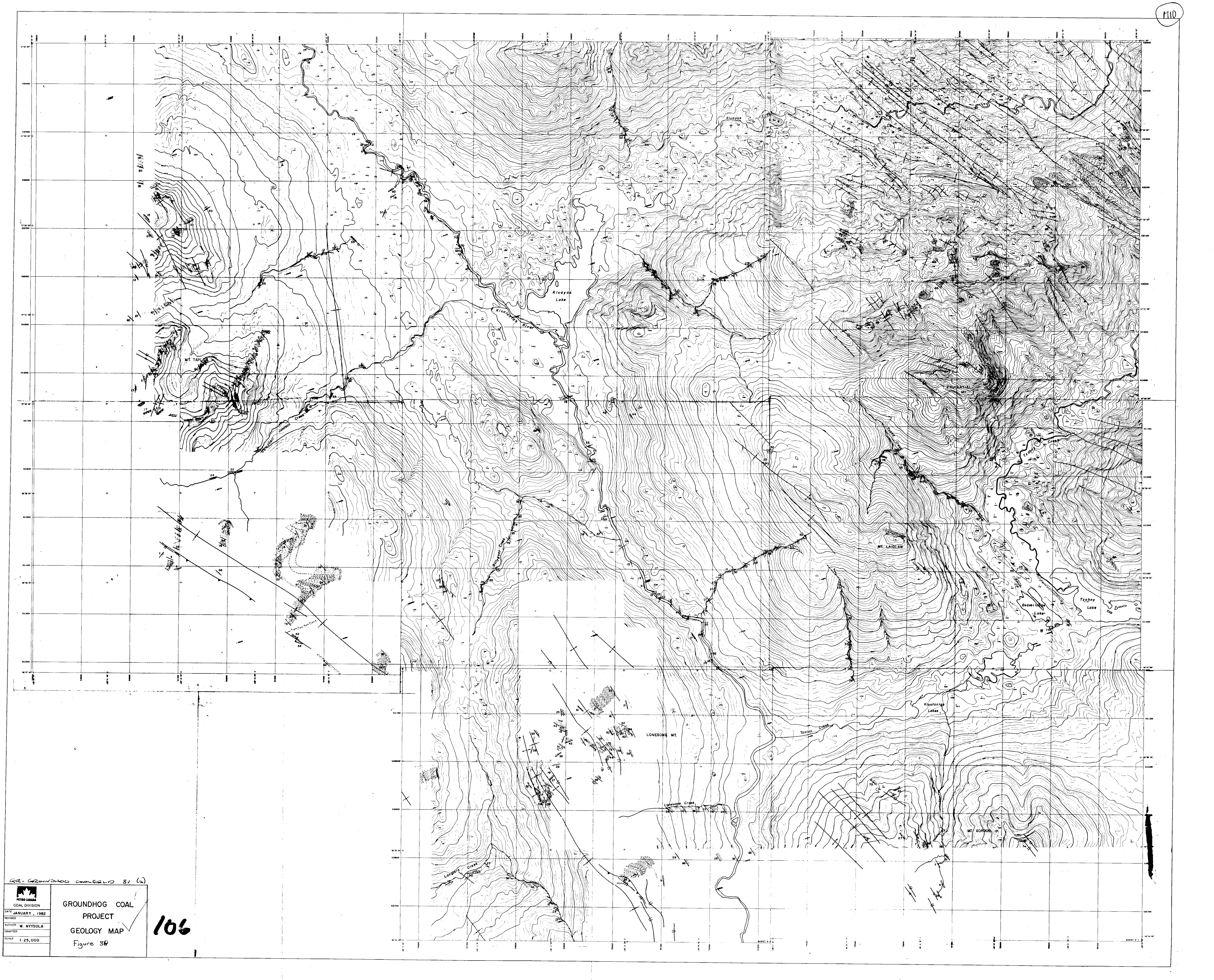
DRAFTED

SCALE 50,000

COAL LICENCES

Figure 36

106 (M09)



GR- GROUNDHOG COALFIELD 81 (2)

PETRO CANADA
COAL DIVISION

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DRAFTED	
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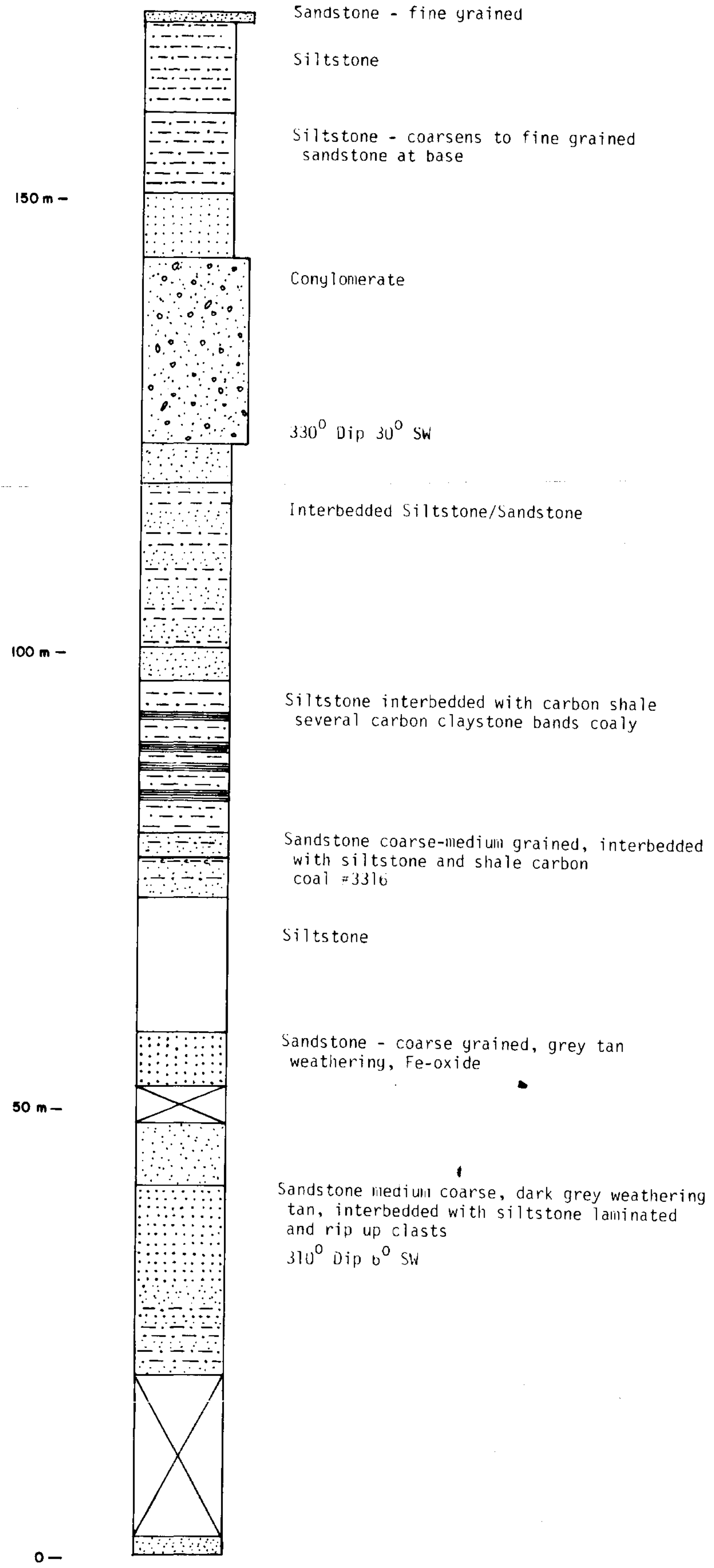
GROUNDHOG COAL PROJECT
GEOLOGY MAP
Figure 38

106

GR- GROUNDHOG COALFIELD
81 (2)A

106 (M11)

Section 120



PETRO-CANADA
COAL DIVISION

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AUTHOR	
DRAFTED	W.N., SK.
SCALE	1:500

GROUNDHOG

Section 120
Scale 1:500

GR-GROUNDHOG COALFIELD
81 (2)A

106 M12

Section 119

Siltstone

Sandstone

Siltstone

Sandstone

Siltstone

Carb Shale, sample #3315, equivalent to #3314?

Sandstone - coarse grained inside limb of syncline on ridge

Claystone - base of syncline

Siltstone

Sandstone - coarse grained massive, fe oxide stain interbed with siltstone tan weathering

Sandstone/Siltstone - sandstone fairly coarse grained

Shale - carbonaceous, sample #3314

Claystone - carbonaceous, recessive

Sandstone/Siltstone - fine-coarse grained sandstone

Siltstone - some recessive

Sandstone/Siltstone - 2m coarse grained sand

Siltstone

S 290° D 20° SE

Siltstone - very fine grained sandstone - 2 m carb shale unit, perhaps coaly units

Sandstone - coarse grained, fe-oxide, band of pebble conglomerate 50 cm
S 310°
D 40° S

Siltstone

Sandstone - medium-coarse grained, dark grey, tan weathered, siltstone rip up clasts and claystone nodules

Covered

Sandstone - siltstone bands throughout

Sandstone - medium-fine grained, dark grey, grey weathered, interbeds of fine grained sandstone and siltstone

Siltstone - tan weathered

Covered

Siltstone

Sandstone - medium grained, very port covered, dark grey, fe oxide

PETRO-CANADA COAL DIVISION	GROUNDHOG
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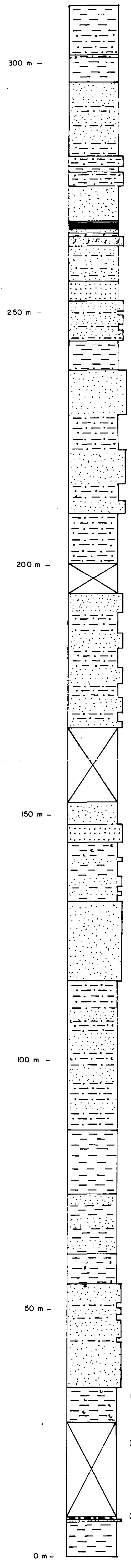
Section 119
SCALE 1:500

GR - GROUNDHOG COALFIELD
81 (2)A

106 (M13)

Section 79



Siltstone/Shale - interbedded

Sandstone - 60% grey weathered buff, Fe stain. Fine grained.
Siltstone - grey weathered buff, fissile cross-bedded, flaggy

Siltstone/Claystone - massive

Sandstone - very fine grained, gradational, blocky poorly indurated.

Coal KL6-5 1 metre thick 295° Dip 30° SW

Interbedded Sandstone - very fine-coarse indurated. Claystone/Siltstone, fissile, recessive.

Sandstone - interbedded Siltstone, fine-medium grained, medium grey weathered brown, carbon, block, odd cross-bed, well indurated.

Siltstone - fissile, dark grey. 312° Dip 31° S

Siltstone/Claystone - interbedded

Siltstone - 65% fissile, recessive interbedded.
Sandstone - 35% grey weathered grey, blocky, massive 345° Dip 14° SW

Recessive

Claystone - 60% weathered buff, fissile.

Sandstone - very fine grained cross-bedded, flaggy friable.

Sandstone - interbedded, medium-coarse grained bands. dirty, poorly indurated.

Siltstone - 60% grey, medium grey weathered, some carbon claystone, well indurated, plant fragments 290° Dip 19° S

Sandstone - 40% medium grained weathered buff, flaggy, poorly indurated

Claystone - carbonaceous

Claystone - Fe-stone nodules

Sandstone - medium grained, dirty. Flaggy

Claystone -

Sandstone - 80%, fine grained jointed, calcite veins, carbonaceous, poorly indurated

Siltstone - 20%, 280° Dip 46° S

Claystone - carb, friable. Fe-stains, fissile coaly stringers.

Recessive

Claystone - carbon, Fe-nodules.

Very fine grained sandstone, weathered tan, 277° Dip 17° SW

PETRO-CANADA COAL DIVISION	GROUNDHOG	**Section 79** SCALE 1:500
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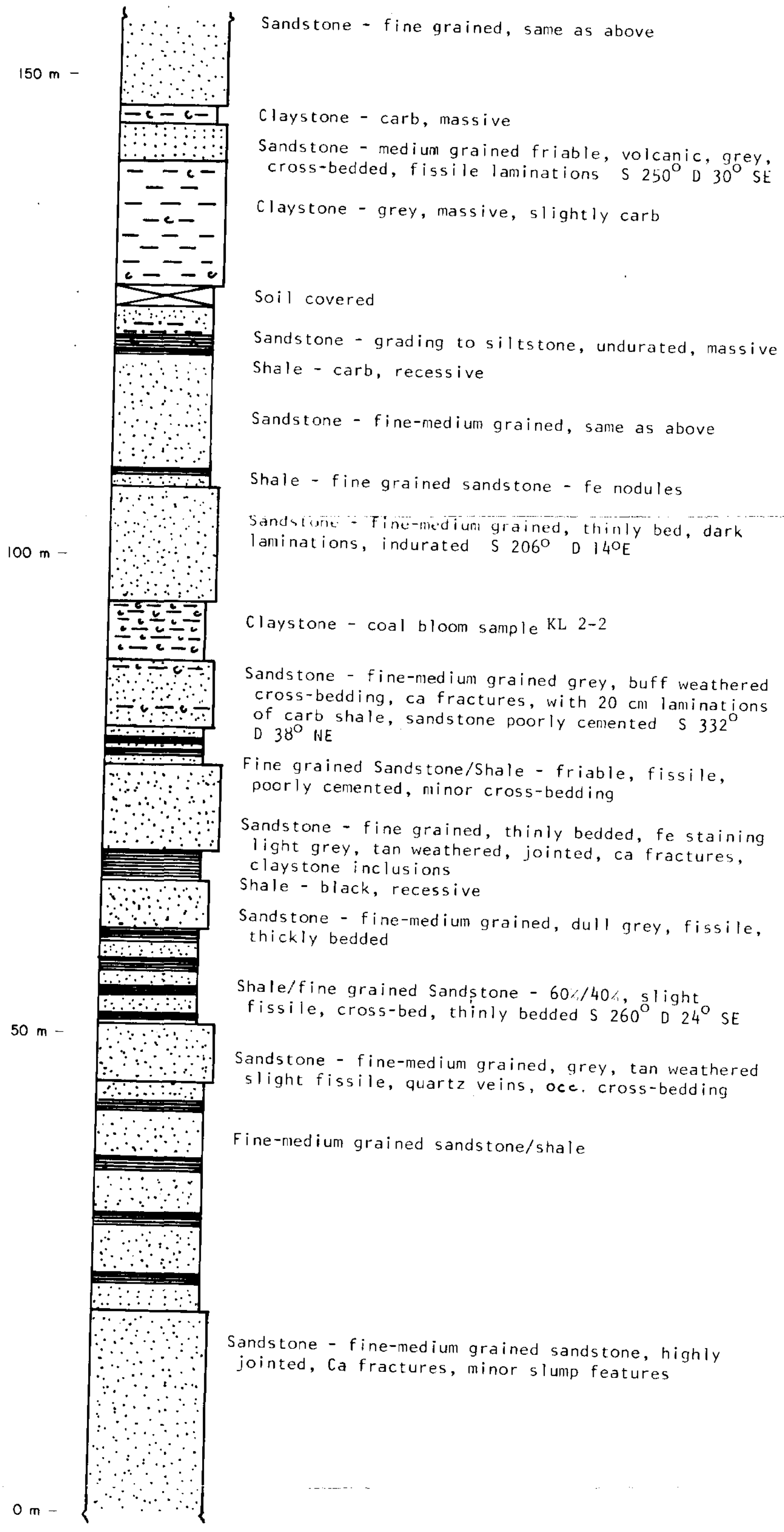
SCALE 1:500		

GR-GROUNDHOG COALFIELD
81 (27A)

106 M14

Section 64 Ext.



PETRO-CANADA
COAL DIVISION

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DRAFTED	
SCALE	

Section 64 Ext.

SCALE 1:500

106

Section 64

PETRO-CANADA COAL DIVISION	GROUNDHOG
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SCALE 1:500	

Section 64
SCALE 1:500

GR-GROUNDHOG COALFIELD
81 (2)A

106 (M16)

Section 49

Sandstone - fine grain, light grey, dark grey, weathered, iron staining

Soil covered, siltstone probably

Sandstone - medium grain

Soil covered for majority of interval, predominantl siltstone, 1 fragment hard coal

sandstone- medium grain, dark grey, brown grey weathered, well indurated

Siltstone/very fine grain sandstone - well developed cleavage, sandier at top, 60%/40%

Sandstone - fine grain, light grey, brown grey weathered, friable, quartz veins, occasional carbonaceous speck
Siltstone - hacky, black, dark grey weathered, quartz vein

Siltstone/fine grain sandstone - 60%/40%, silt-stone-dark grey, sandstone iron staining in parts

Sandstone - fine grain .dark grey, brown grey, weathered parallel bedding.carbonaceous specks quartz, siltstone, interbeds at base

Siltstone - recessive

Sandstone - medium grain, parallel bedding,rip-up clasts, quartz veins, occasional siltstone interbeds, fining upwardsto fine grain sandstone at 95 m,5m siltstone interbeds,iron staining 'dirty' sandstone, siltstone-dark grey weathered kahki sandstone.

Siltstone - recessive, hacky spilt

Sandstone - fine grain, light grey, brown grey weathered, iron staining, 'dirty' occasional siltstone interbeds, 95% sandstone 5% siltstone, well cleaned S 178° D 9° W.

Siltstone - dark grey, medium grey weathered, hacky, well indurated

Siltstone - dark grey,grey brown weathered carbonaceous cleaved, grades to fine grain sandstone at top

Sandstone - fine grain, brown grey weathered, indurated, silty at base, coarsens up wards thinly parallel bedded cross-bedded, well developed cleavage

Siltstone - dark grey, medium grey weathered, hacky, well cleaved

PETRO-CANADA COAL DIVISION	GROUNDHOG
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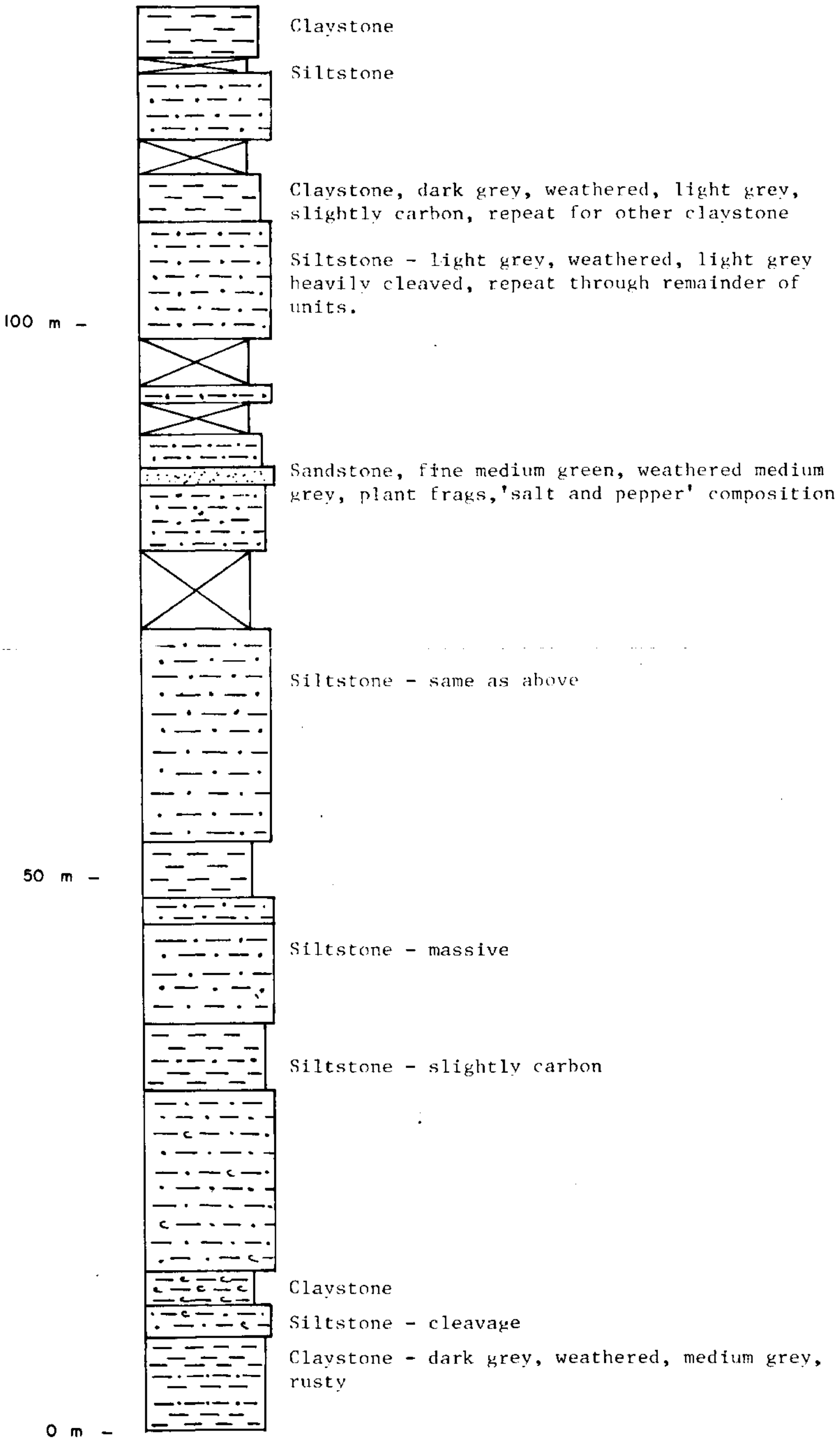
DRAFTED W.N., S.K.	
SCALE 1:500	

Section 49
Scale 1:500

GR GROUNDHOG COALFIELD
81 (2)a

106 (MIT)

Section 6



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DRAFTED	W.N., S.K
SCALE	1 : 500

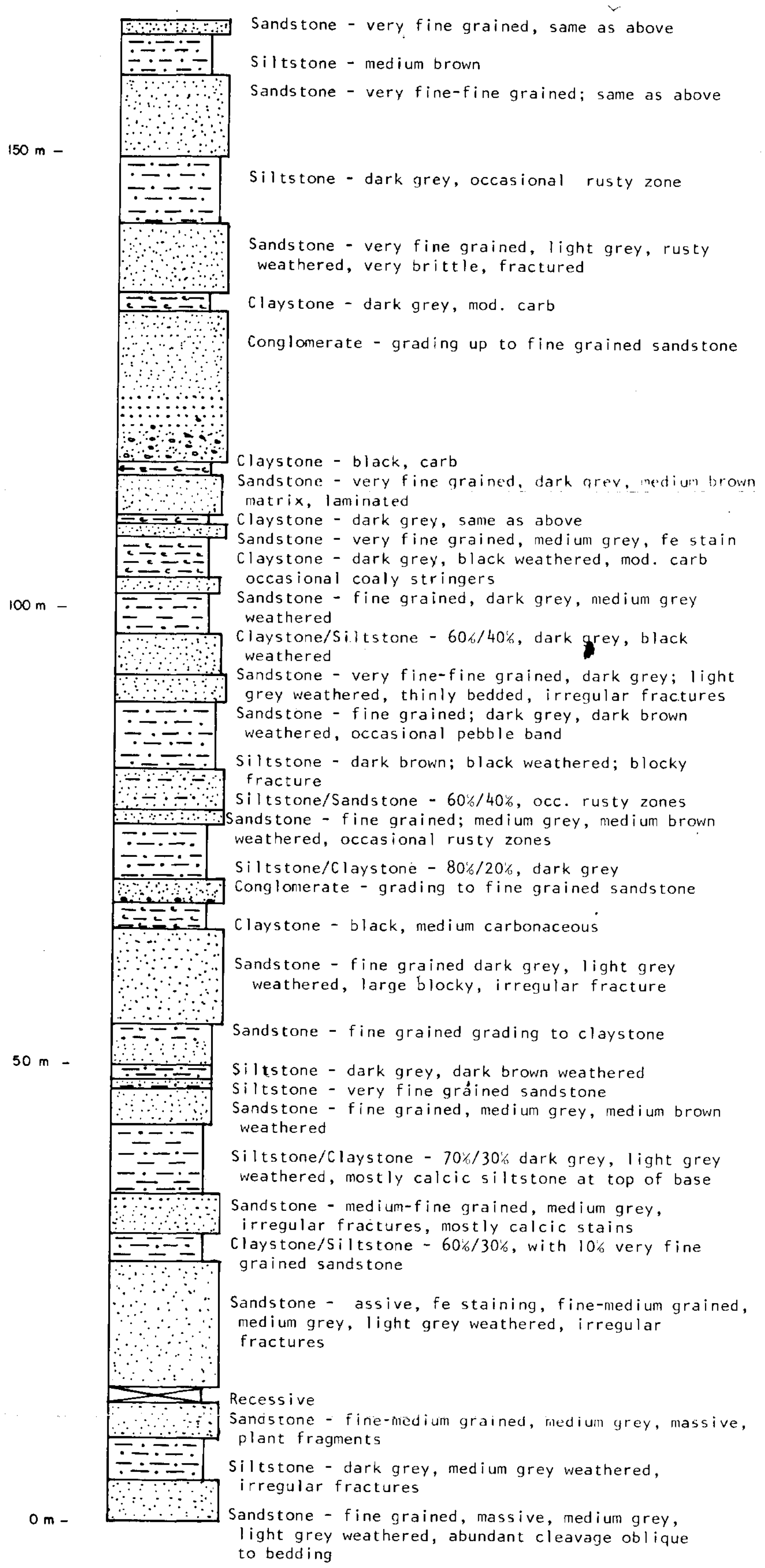
GROUNDHOG

Section 6
SCALE 1:500

GR-GROUNDHOG COALFIELD
81 (2)A

106 (M18)

Section 4



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DATE AUGUST, 1981		
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AUTHOR		
DRAFTED W.N., S.K.		
SCALE 1:500		

LEGEND

- Jackson Member
- Prudential Member
- Currier Member
- McEvoy Member
- Devils Claw Member

PETRO-CANADA
COAL DIVISION

DATE	APRIL, 1982
REVISED	
AUTHOR	R.M.B.
DRAFTED	S.K.
SCALE	

FIGURE 23

Sketched-Schematic Structural Cross-Section

Based on air photo interpretation. Highly diagrammatic and not balanced.

M20

106

LEGEND

- Jackson Member
- Prudential Member
- Currier Member
- McEvoy Member
- Devils Claw Member

GR-GROUNDHOG COALFIELD 81 (2)A

PETRO-CANADA
COAL DIVISION

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DRAFTED	S.K.
SCALE	

FIGURE 24

Sketched - Schematic Structural Cross-Section

Based on air photo interpretation
Highly diagrammatic and not balanced.

M21

106

GR-GROUNDHOG COALFIELD 81 *(2)a *(1)

LEGEND

- Jackson Member
- Prudential Member
- Currier Member
- McEvoy Member
- Devils Claw Member

PETRO CANADA
COAL DIVISION

DATE	APRIL, 1982
REVISED	
AUTHOR	R.M.B.
DRAFTED	S.K.
SCALE	
FIGURE 25	

Sketched-Schematic Structural Cross-Section

Based on air photo interpretation
Highly diagrammatic and not balanced.