Coal in Northwestern British Columbia

An Overview

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Ministry of
Energy, Mines and
Petroleum Resources
Hon. Jack Davis, Minister

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GEOLOGICAL SURVEY BRANCH
MINERAL RESOURCES DIVISION

Cover Photo. Looking southeasterly over Gulf Canada Resources' Lost Ridge–Fox Creek deposit, Klappan Coalfield 1985. Photo by J. Koo.

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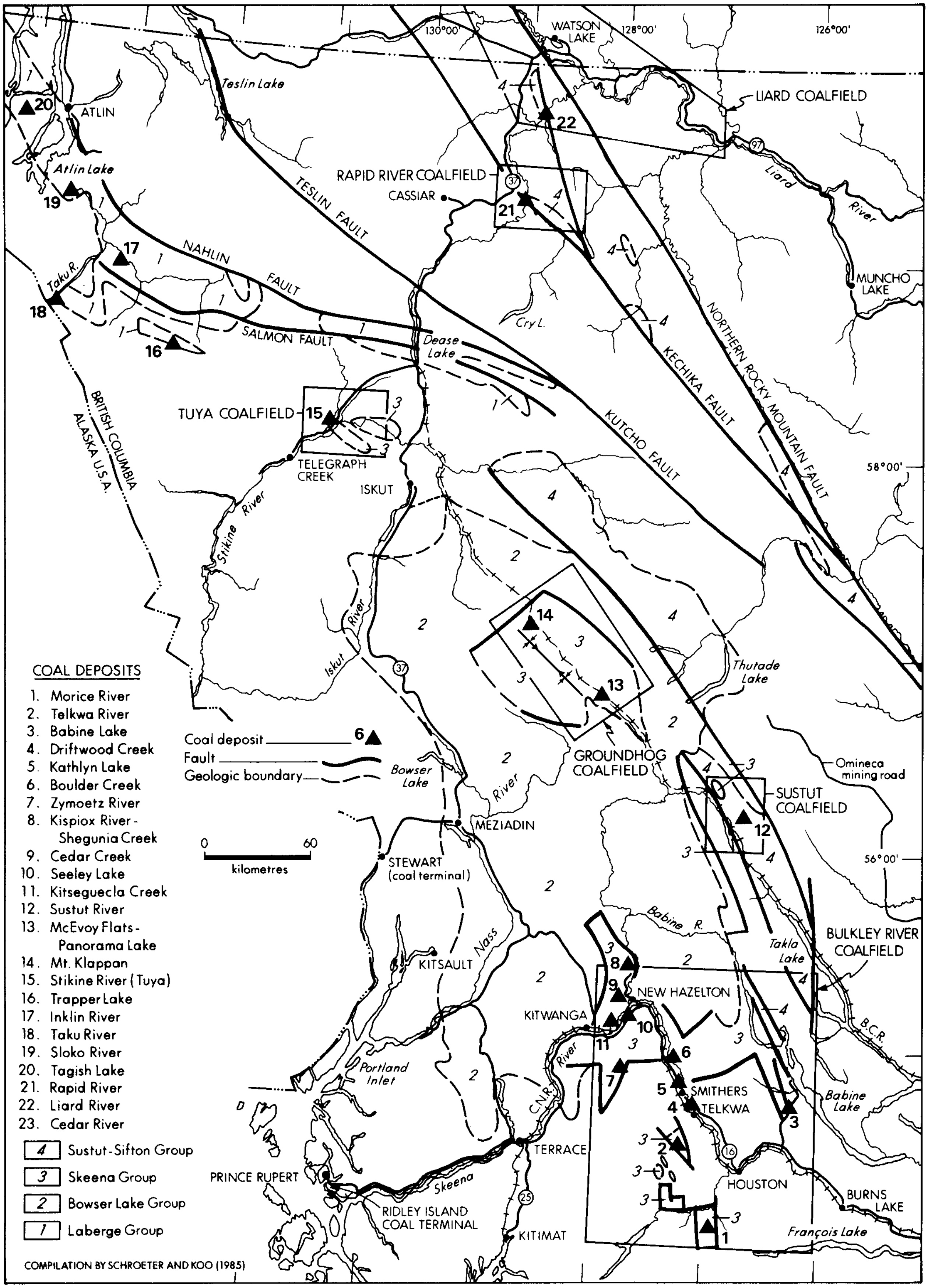


Figure 1. Coal distribution in northwestern British Columbia.

COAL IN NORTHWESTERN BRITISH COLUMBIA AN OVERVIEW

INTRODUCTION

In coastal British Columbia coal was first discovered in 1835 at Suquash, on northwestern Vancouver Island, and shortly afterward at Nanaimo. Later that century coal from the Queen Charlottes was used for fuel for steamers servicing the west coast of North America. As railroads began to penetrate the northern interior of the province in the early 1900s, exploration for coal increased in anticipation of finding a commercial deposit close to the proposed rail route. It was, in fact, the period between 1900 and 1912 which saw the most concerted and successful exploration for new coal deposits in northwestern British Columbia. Coal exploration centred on the route of the Grand Trunk Pacific Railway being built from Prince Rupert to Prince George, which passes through the Bulkley River Coalfield, and in the Groundhog Coalfield in anticipation of a railroad being built from Stewart approximately 200 kilometres to the coalfield to rival the Grand Trunk Pacific Railway. The Grand Trunk railway, forerunner of the Canadian National Railway, which runs from Prince Rupert to Hazelton, was completed in 1913. The Bulkley River Coalfield was at that time accessible by road from Hazelton. In 1918 the railway began using coal from Telkwa in its locomotives. Between 1918 and 1984, the Telkwa deposits saw intermittent production and nearly 447 890 tonnes total was produced (Table 1) for domestic uses from seven small underground mines and two small open pits. No other production from northwestern British Columbia has been recorded, and only limited coal quality data exist for many of the coal occurrences.

**TABLE 1.
APPROXIMATE PRODUCTION,
TELKWA COAL DEPOSIT***

	Tonnes	Period
McNeill Mine	19 259	1918 - 1929
No. 1 Mine	54 420	1930 - 1943
No. 2 Mine	82 084	1943 - 1951
No. 3 Mine	21 315	1950 - 1951
Surface (2 pits)	270 812	1952 - 1983
No. 4 Mine (extension)		
Total	447 890	

*Over 90 per cent from Bulkley Valley Collieries Ltd.

The possibility of a large volume of anthracite in the Groundhog Coalfield was recognized at the turn of the century, and exploration during the first decade outlined most of the coal areas known today. Unfortunately the railroad being built from Stewart, under the direction of McKenzie and Mann interests, was abandoned prior to World War I; it was only 25 kilometres out of Stewart.

Promises of a railroad from Telegraph Creek to the Dease Lake goldfields during the Klondike gold rush prompted exploration and led to the discovery of several small coal occurrences in that area.

During the 1920s the demand for coal decreased because of the conversion of ships to fuel oil. This, however, was offset by a growing demand for domestic and industrial heating coal. By the late 1950s, railroads had converted completely to diesel, and domestic users to oil and natural gas; coal exploration in northwest British Columbia ceased. Thus most of the published inventories on coal in the northwest comes from information gathered prior to 1960.

Recent interest in the coalfields of northwestern British Columbia has resulted in successful exploration programs; significant new information on the Telkwa and Klappan coal deposits is now available. Crows Nest Resources Ltd. has outlined mineable reserves of 21 760 000 tonnes of high volatile A bituminous coal at Telkwa (Crows Nest Resources Ltd., 1985) and Gulf Canada Corp. has outlined inferred resources exceeding 1 billion tonnes of anthracite at Klappan (Gulf Canada Resources Inc., 1985).

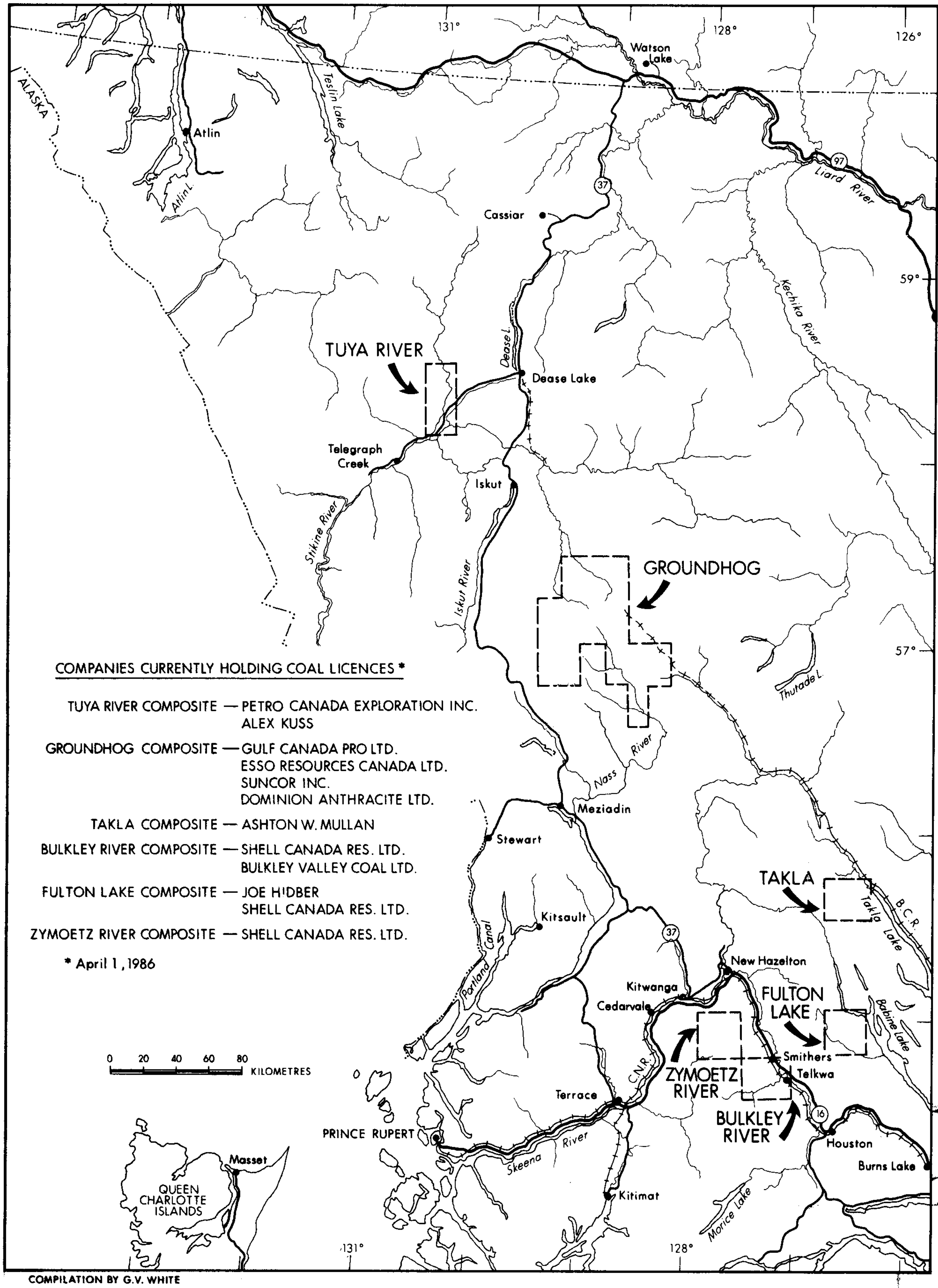
Completion of the Ridley Island coal terminal at Prince Rupert in 1984, and the upgrading of the Canadian National Railway line between Prince George and Prince Rupert to transport coal from the northeast coal development have greatly enhanced transportation and handling services available in the northwest.

LOCATION AND ACCESS

The northwestern British Columbia coalfields lie between latitude 54° 30′ north, the latitude of Burns Lake and Prince Rupert and the British Columbia-Yukon border at the 60th parallel (Fig. 1). The region is bounded on the east by the northern Rocky Mountain Trench, and on the west by the Coast Range Mountains, essentially the British Columbia-Alaska panhandle boundary.

The Bulkley River Coalfield, which includes the Telkwa deposit, is traversed by the northern branch of the Canadian National Railway which provides rail access to tidewater at Prince Rupert. The Klappan deposit is traversed by the grade for the British Columbian Railway Dease Lake Extension, which ceased construction in 1977, approximately 85 kilometres south of the deposit. Access to the southern end of the Groundhog Coalfield is currently by aircraft. The northern end of the field can be reached either by a 105-kilometre dirt road east then south from Highway 37 near Eddontenajon, or by aircraft.

Stewart is the most northerly year-round ice-free port on the west coast; it is currently being used for trial shipments of anthracite from Gulf Canada's Klappan deposit.



COMPILATION BY G.V. WHITE

Figure 2. Composite of existing coal licences in northwestern British Columbia.

PHYSIOGRAPHY

The northwestern interior region of British Columbia comprises a series of broad uplands or plateaus which are bounded by the Rocky Mountains on the east and the Coast Range Mountains on the west. These plateaus are sharply incised by four major river systems and their tributaries: the Taku, Stikine, Nass, and Skeena Rivers.

Pleistocene glacial erosion and deposition have resulted in a sparsity of good coal exposures and a seeming lack of continuity of beds. Coal has been preserved in isolated grabens, which often form valleys (for example, the Bulkley River Coalfield).

CURRENT COAL TENURE

Current (1986) coal licence composites in northwestern British Columbia are shown on Fig. 2. The owners/operators and anniversary dates of the licences are also indicated. The major licence holders are Gulf Canada Corp. with 211 licences (51 194 ha) in the Groundhog Coalfield, and Crows Nest Resources Ltd. which holds or controls 12 821 hectares of coal rights in the Bulkley River Coalfield.

REGIONAL GEOLOGY OF THE COAL MEASURES

COAL-BEARING SUCCESSIONS

Coal in northwestern British Columbia occurs in four major sedimentary successions: the Early to Middle Jurassic Laberge, the Middle to Late Jurassic Bowser Lake, the Early Cretaceous Skeena and the Late Cretaceous to Tertiary Sustut-Sifton Groups (Fig. 1). However, only coal measures of the Bowser Lake and Skeena Groups are potentially economic at present. Regional and detailed geological studies of potentially economic coal measures in the coalfields of northwest British Columbia have been carried out by the Geological Survey Branch of the British Columbia Ministry of Energy, Mines and Petroleum Resources (Koo, 1983, 1984, 1985, 1986). The brief regional geological outline presented in this paper is based on these studies. Detailed reports are in preparation for publication.

The Bowser Lake and Skeena Groups occur within the Bowser Basin, a wide region which underlies nearly a quarter of the total area of northwestern British Columbia. As a successor basin to the volcanogenic Hazelton Trough of Early to Middle Jurassic age, the Bowser Basin was bounded to the south by the Skeena Arch, to the north by the Stikine Arch, and to the east by the Columbian orogen; the basin was open to the Pacific Ocean. Potentially economic coal measures within the Bowser Basin are best documented in the areas surrounding Telkwa River and Mount Klappan.

Recently, the Bowser Basin has attracted exploration by Crows Nest Resources Ltd., Gulf Canada Corp., Esso Resources Canada Ltd., Suncor Inc., and other companies.

STRATIGRAPHY OF THE TELKWA COAL MEASURES

The Telkwa River area is located in the southern part of the Bulkley River Coalfield (Fig. 1). It is underlain by a 400-metre coal-bearing succession, referred to here as the Telkwa coal measures (Fig. 3). This succession also underlies other parts of the Bulkley River Coalfield and several other areas of the southern Bowser Basin (Fig. 1). The Red Rose coal measures in the northern part of the Bulkley River Coalfield correlate with this succession. The Telkwa coal measures can be divided into Lower, Middle, and Upper units and form the lower part of the Skeena Group succession.

The Lower Unit ranges in thickness from 15 to 120 metres. Seven fining upward cycles have been recognized in the unit. These cycles grade from conglomerate through coarse to fine-grained sandstone, to siltstone and claystone; the coal seams are associated with the finer clastics. Clasts in these rocks are derived mainly from subaerial volcanic rocks of the Early to Middle Jurassic Hazelton Group, which underlies the Telkwa coal measures. The Lower Unit contains a coal-bearing sequence near its top that includes up to four coal seams. The coal seams are 1 to 15 metres apart, and range in thickness from 1 to 6 metres; the aggregate thickness is 2 to 12 metres. The lower coal sequence varies from 2 to 40 metres in thickness.

The Lower Unit is a typical fluvial clastic sequence. It was deposited on the Skeena Arch terrane which initially had an irregular land surface and subsequently underwent stages of peneplanation. Coal swamp environments prevailed together with extensive floodplains during the later stages of peneplanation.

The Middle Unit consists of 90 to 140 metres of medium to fine-grained sandstones and mudstones. Intensely bioturbated sandstone and mudstone layers with marine molluscan fauna are dominant in the unit. Coal formation ceased during times of shallow marine incursion during deposition of the Middle Unit.

The Upper Unit consists of more than 330 metres of sandstones, mudstones, and coal seams. The lower part of this unit contains the upper coal sequence, and consists of 180 metres of medium to fine-grained sandstone, mudstone, and coal. Eight fining upward cycles are recognized in this sequence. The coal occurs in as many as 15 seams with individual thicknesses ranging between 1 and 5 metres and having an aggregate thickness of up to 26 metres. Individual coal seams are 2 to 20 metres apart. The upper coal sequence varies in thickness from 20 to 170 metres. The upper segment of the Upper Unit is greater than 150 metres thick, and consists of mudstone layers with minor amounts of fine to medium-grained sandstone and calcareous claystone.

The Upper Unit consists of a cyclic fluvial sequence in its lower part. Coal swamps developed within floodplains in a low-lying fluvial environment. This unit ends with shallow marine incursions in its upper part.

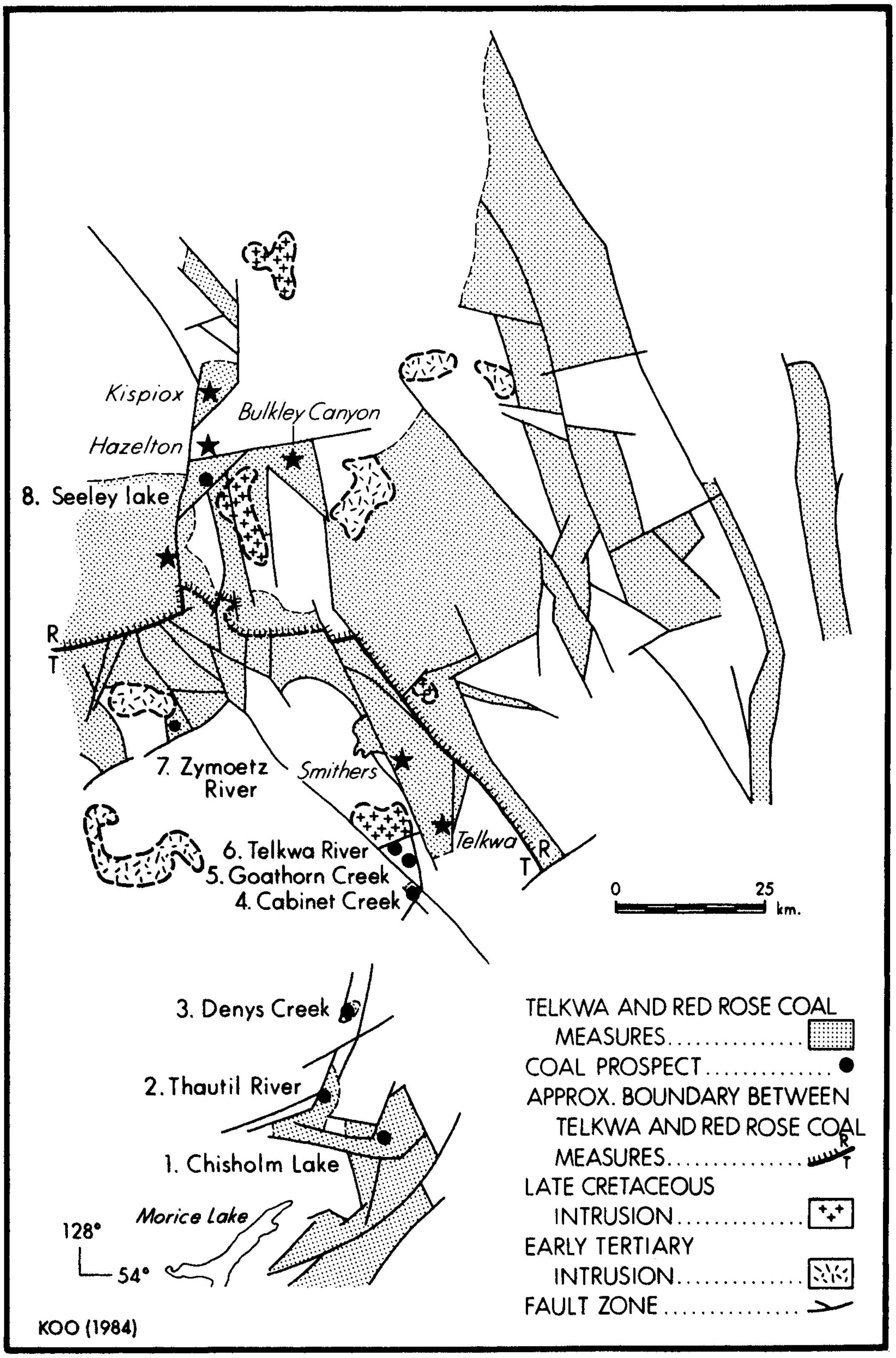


Figure 3. Distribution of the Telkwa and Red Rose coal measures.

Structural Setting of the Telkwa Coal Measures

The Telkwa coal measures are characterized by high-angle faulting, which has both disrupted and served to preserve the coal occurrences. Faults trend predominantly northwesterly; however, some trend northeasterly to easterly. Their dips range from 70 to 90 degrees, and both normal and reverse movements are indicated. All the faults form graben and horst structures. The Telkwa coal measures are commonly preserved in the grabens, which form low-lying areas of poor exposure.

The Telkwa coal measures dip from 5 to 25 degrees northeast or southwest and are affected by broad open folds. Potentially mineable coal seams occur in the gently dipping coal sequences. However, light folds and thrust faults prevail in the northern part of the Bulkley River Coalfield, where the coal measures are intruded by Cretaceous and Tertiary stocks; moreover, northwesterly trending high-angle post-Tertiary faults are superimposed upon the folds, thrust faults, and intrusions in this area.

Stratigraphy of the Klappan Coal Measures

The Klappan and Groundhog coalfields are in a thrust slice of Skeena rocks on Bowser Lake Group (Fig. 1). The Mount Klappan area is underlain by a 1 300 to 1 500-metre succession of conformable marine and nonmarine strata referred to here as the Mount Klappan succession (*see* Fig. 7) of the Bowser Group. This succession extends throughout the Groundhog Coalfield and adjacent areas of the northern Bowser Basin (Fig. 1). It can be divided into five mappable stratigraphic units, numbered from 1 to 5 in ascending order.

UNIT 1 is the lowest stratigraphic interval of the Mount Klappan succession. It is widely exposed in the northwestern part of the Mount Klappan area. Up to 11 coarsening upward cycles are included in its 200-metre thickness; individual cycle thicknesses vary from 2 to 50 metres. Each cycle consists mainly of interbeds of grey to black claystones and siltstones, and grey to brown, fine to medium-grained sandstones. Unit 1 correlates with the upper sequence of the Bowser Lake Group. Marine bivalves and intense bioturbation are common in the intercalated siltstones and sandstones. Unit 1 represents a marine deltaic sequence. The coarsening upward cycles resulted from successive progradation of delta channels over fine-grained prodelta sediments.

UNIT 2 is the principal coal-bearing sequence of the Mount Klappan area. It ranges from 350 to 420 metres in thickness, and occurs at lower elevations in the central part of the area. This unit can be subdivided into three members. The lower member, which ranges from 150 to 200 metres in thickness, contains seven to eleven coarsening upward cycles, each between 6 and 36 metres in thickness. Each cycle begins with grey to black interbedded claystones and siltstones, and grades upward to grey to brown fine to coarse-grained sandstones. Bivalves and bioturbation occur in some siltstone layers; these appear to be of marine origin. As many as six coal seams, 17 to 50 metres apart, occur in the lower member; individual seams are up to 5 metres thick. The coal seams are closely associated with the marine mudstones and commonly contain significant amounts of iron sulphides. The lower member is the type of sequence found in a constructive deltaic system with wide subaerial delta plains and intermittent coal swamps.

The middle member of Unit 2 ranges in thickness from 100 to 150 metres; it consists mainly of dark grey to brown claystones, siltstones, and fine to medium-grained sandstones. A minor amount of coarse-grained sandstone occurs as thin layers but only near the base of this member. Six to ten fining upward cycles and two coarsening upward cycles with individual thicknesses from 10 to 30 metres can be recognized. Up to six coal seams, 5 to 35 metres apart, occur in the middle member; individual thicknesses are up to 5 metres. Dwarfed, brackish water bivalves and bioturbation occur in a few black mudstone zones that occur within the coarsening upward cycles. The middle member consists mainly of fluvial cycles with several intertonguing marine cycles. The environment of deposition varied between marine deltaic and nonmarine fluvial.

The upper member of Unit 2 consists of 100 metres of claystones, siltstones, sandstones, and conglomerates. Up to 12 fining upward cycles occur with individual thicknesses from 6 to 35 metres. Four coal seams occur in the upper member; they are 6 to 35 metres apart and their individual thicknesses range up to 8 metres. The claystones and siltstones, which show widespread mud cracks and rip-up clasts, are closely associated with the potentially economic coal seams. The upper member was deposited in a fluvial channel and backswamp environment. Coal seams in Unit 2 consist of semi-anthracite, anthracite, and meta-anthracite. Their mean maximum reflectance values of vitrinite in oil range from 2.0 to 5.0 per cent.

UNIT 3 is exposed mainly at intermediate elevations in the central part of the Mount Klappan area. It consists of 220 metres of mudstones, sandstones, and conglomerates in up to 20 fining upward cycles. Individual thicknesses of the cycles vary from 5 to 30 metres. The sequence of rocks in Unit 3 represents a change in depositional environment from fluvial plain to distal alluvial fan.

UNIT 4 ranges from 280 to 300 metres in thickness. It consists mainly of coarse to medium-grained sandstones and conglomerates with minor amounts of fine-grained sandstone and mudstone. It contains as many as eight fining upward cycles. Unit 4 rocks are exposed at higher elevations in the southern part of the Mount Klappan area. They represent an environment in which a series of distal alluvial fans was crossed by a system of braided streams.

UNIT 5 consists mainly of conglomerate and coarse to medium-grained sandstone with minor amounts of fine-grained sandstone and mudstone. It is up to 170 metres thick with a maximum of eight fining upward cycles. This unit is exposed at higher elevations in the southeastern part of the Mount Klappan area. The sequence of rocks in Unit 5 represents an environment in which proximal to intermediate alluvial fans were dissected by braided streams.

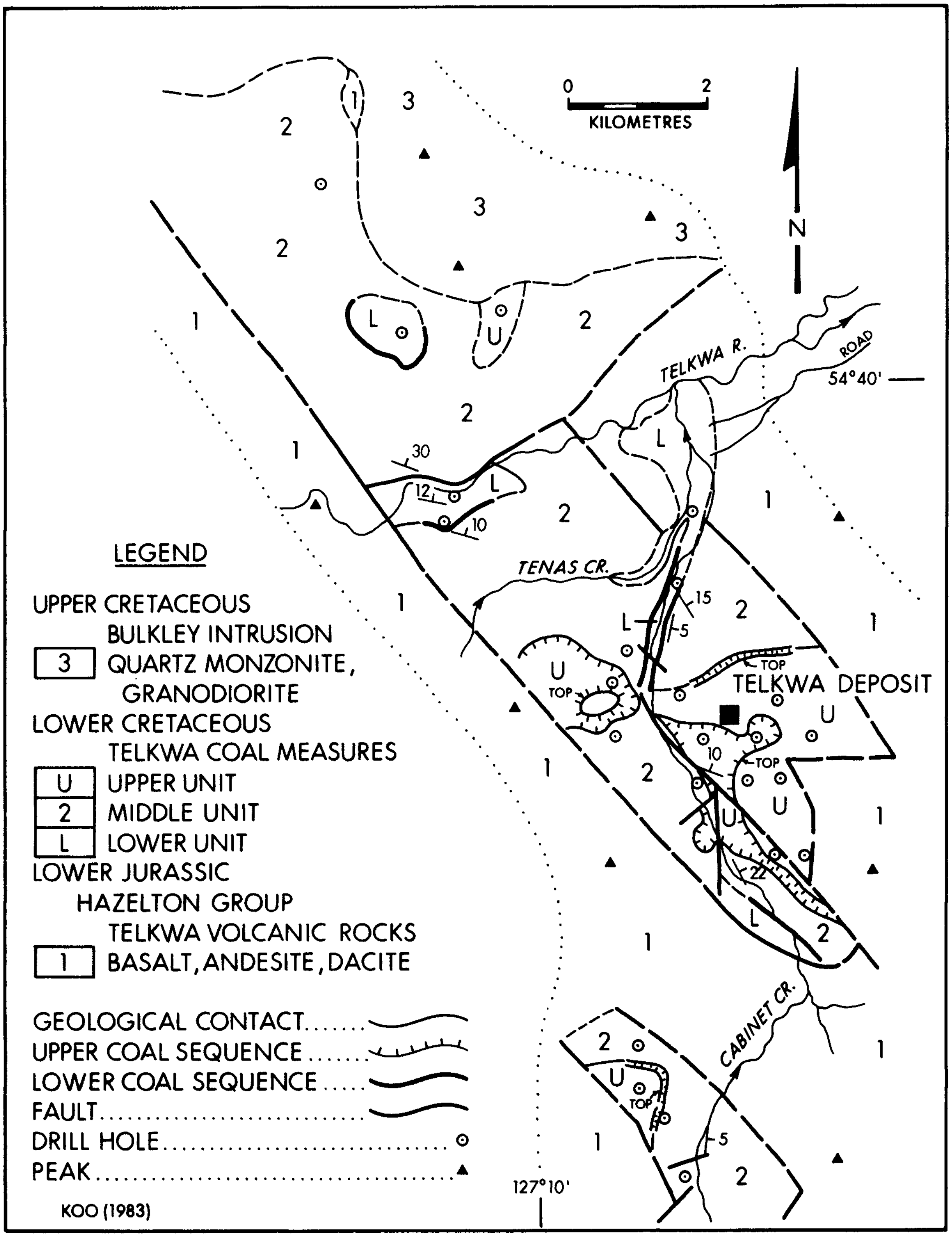


Figure 4. Geology of Telkwa coal deposit.

The Mount Klappan succession is an accretional, coarsening upward megacycle that resulted from a major marine regression in the Mount Klappan Basin. The rocks in the succession reflect a gradual transition from marine deltaic through fluvial to alluvial environments.

The potentially economic coal seams, which occur in Unit 2, were formed during the transition period between the lower marine-dominated and the upper nonmarine-dominated sequences of the Mount Klappan succession. Marine conditions ended during deposition of the middle member of Unit 2, at the top of the Bowser Lake Group. This boundary also appears to separate Jurassic and Cretaceous sequences; therefore, the economic coal seams in Unit 2 may range in age from Late Jurassic to Early Cretaceous.

Seams in the lower member of Unit 2 can be correlated with the upper part of the Bowser Lake Group; seams of the upper member of Unit 2 can be correlated with the lower part of the Skeena Group.

Structural Setting of the Klappan Coal Measures

Two phases of deformation affected the Mount Klappan succession. Folds and faults trend both northwesterly and northeasterly. The northwesterly trending deformation occurred first and created a major synclinorium with associated minor folds and faults. The synclinorium comprises the northwestern part of the Beirnes syncline of the Groundhog Coalfield (*see* Fig. 6). It is apparently asymmetrical with gently folded limbs and a vertical axial surface plane. Its axis trends north 35 degrees to 45 degrees west and plunges 10 to 35 degrees to the southeast. The limbs of the synclinorium dip approximately 35 degrees.

In Units 4 and 5 the minor folds of the synclinorium are mainly open and symmetrical in style; in Units 1, 2, and 3, which are less competent, they are mainly asymmetric chevron or nearly isoclinal in style. The steeply dipping limbs of the chevron folds are closely associated with thick layers of incompetent claystone, siltstone, and fine-grained sandstone; these limbs are commonly overturned. The gently dipping limbs of the folds occur in the competent stratigraphic intervals that are dominated locally by conglomerate and coarse to medium-grained sandstones. Potentially mineable coal seams are generally found in the gently dipping limbs, as at Lost Ridge and Hobbit Creek, where the seams may be amenable to surface mining.

Phase 1 faults and shear zones strike north 25 to 50 degrees west, and dip 40 to 80 degrees to the southwest. Movements on the faults are generally reverse and range from a few metres to 300 metres. The faults and shear zones commonly disrupt the steeply dipping axial planes and limbs of the chevron and isoclinal folds. The shear zones range up to 300 metres in width and commonly grade into faults sets. Coal seams in these structures are stretched or dismembered.

Phase 1 structures are deformed and cut by Phase 2 northeasterly trending folds and faults (*see* Fig. 7). The Phase 2 faults strike north 30 to 60 degrees east and dip vertically; displacements are vertical and up to 500 metres. The Phase 2 folds are open symmetric or tightly angular chevron types that are overturned in places. Their axial planes strike north 30 to 60 degrees east with dips from vertical to 40 degrees to the northwest. Amplitudes range from 50 to 400 metres, and wavelengths from 300 to 2 000 metres. Phase 2 folds refold Phase 1 folds; consequently, Phase 1 axial traces are curved, and axes are doubly plunging at 10 to 35 degrees either southeast or northwest.

BULKLEY RIVER COALFIELD

The distribution of coal prospects within the Bulkley River Coalfield is shown on Figure 3.

TELKWA DEPOSITS (Fig. 1, No. 2)
(54° 40′ N, 127° 10′ W; MI 93L-151-156)

History

The Telkwa deposits consist of several small erosional remnants which collectively lie within an area of approximately 125 square kilometres (Fig. 4). The first coal leases were staked in 1901 in the Telkwa area. The main area of exploration and development work was Goathorn Creek, approximately 8 kilometres south of Telkwa (Fig. 3). Between 1903 and 1906 the Cassiar Coal Company conducted exploration, including two diamond-drill holes. In 1903 the Kitimat Development Syndicate dug several adits on coal seams. The Grand Trunk Pacific Railway completed several short adits on Mud Creek and Goat Creek in 1910, and in the following year six lots were Crown granted. In 1918 production began from the McNeill mine at an initial rate of 27 tonnes per day which soon was increased to 45 tonnes per day. Coal was moved to Telkwa by sleigh and to Prince Rupert by rail.

Between 1920 and 1925 a five-year lease was obtained by Messrs. Gillespie and Wilson (from Major Aveling and Partners), and 14 tonnes per day was shipped during the winter months. During 1926 and 1927 approximately 1 280 and 1 700 tonnes were produced respectively at the Goat Creek Colliery. In 1927 the British Columbia Department of Mines provided funds for road access.

In 1930 Mr. Dockrill, representing Bulkley Valley Collieries Ltd., started to mine from the No. 1 mine, and between 1930 and 1943 all coal production came from this mine. Markets included domestic heating (mostly local) and, during the war, they supplied the United States Army near Prince Rupert (J. D. Carnahan, personal communication, 1986). In 1943 production began from the No. 2 mine, mainly supplying the domestic market of the Bulkley Valley. During the years 1943, 1946, 1950, and 1951, Bulkley Valley Collieries Ltd., together with the federal government, completed a total of 33 diamond-drill holes on both sides of Goathorn Creek valley in an attempt to locate sizable commercial quantities of coal. Unfortunately, core recovery was poor due to equipment

Plate 1. Looking northwesterly over Telkwa coal deposit.

and techniques. Between 1943 and 1952 about 9 000 tonnes of coal was sold each year. In 1950, the No. 3 mine opened; most of the coal produced was shipped to the Columbia Cellulose Co. Ltd. at Port Edward near Prince Rupert; the remainder was sent to Terrace. Coal was separated into: (1) lump, (2) nut, and (3) slack varieties and sold for $10.47, $9.37, and $8.27 per tonne, respectively, at the mine tipple. The run-of-mine coal sold for $8.00 a tonne delivered to coal bunkers at Telkwa. Mining rate in 1952 was 225 tomes per day or 2 268 tonnes per month.

In 1954, Gordon Chapman, representing Denco Development, completed drilling on seven coal licences on the north side of the Telkwa River near Pine Creek, and between 1964 and 1968 three diamond-drill holes were completed for Celgar Pulp and Paper Ltd. (Prince Rupert). Unfortunately, as was the case in earlier programs, the drilling was unsuccessful due to poor drilling techniques. By 1955 the local industrial market had disappeared, with the conversion of the pulp mill in Prince Rupert from coal to oil. Fortunately new contracts were secured to supply a number of government buildings throughout the province with coal.

In 1962 Mr. J. D. Carnahan assumed management and achieved greater efficiency in mining through improved crushing and screening plants and introduction of more modern mechanical equipment. Four years later a surface mining system was adopted (No. 2 open pit) and production totalled 7 791 tonnes by Luscar Sales Ltd. (Edmonton) utilizing a crew of nine men. During that year 3 070 tonnes of underground coal also was produced, this being the final year of underground operations. In 1968, Forestburg Collieries Ltd. succeeded Luscar Sales Ltd. and mined 12 150 tonnes from the open pit, employing eight men. The following year 8 594 tonnes was mined and 1 475 metres of rotary drilling was completed. The same year Canex Placer (now Placer Development Ltd.) explored a section of the basin drained by Pine Creek; 23 rotary holes totalling 1 443 metres were drilled and the results were reported to be inconclusive and discouraging. In March 1970, after mining 2 205 tonnes during the first quarter, the option agreement was terminated by Forestburg Collieries Ltd. During 1970, Bulkley Valley Sales Co. Ltd., a subsidiary of Bulkley Valley Collieries Ltd., took over and mined 1 814 tonnes from surface.

Between 1972 and 1982 Mr. Lloyd Gething, representing Bulkley Valley Sales Co. Ltd., under an option agreement with Mr. J. D. Carnahan, mined about 15 250 tonnes from both underground and open pit (No. 4 mine extension) and sold most of it locally.

In 1978 Cyprus Anvil, under an option agreement with Mr. J. D. Carnahan, drilled six diamond-drill holes but experienced trouble with overburden. A further four holes, totalling 310 metres, were drilled during 1979 and the option agreement was terminated, presumably due to drilling problems and structural complexities in the rocks.

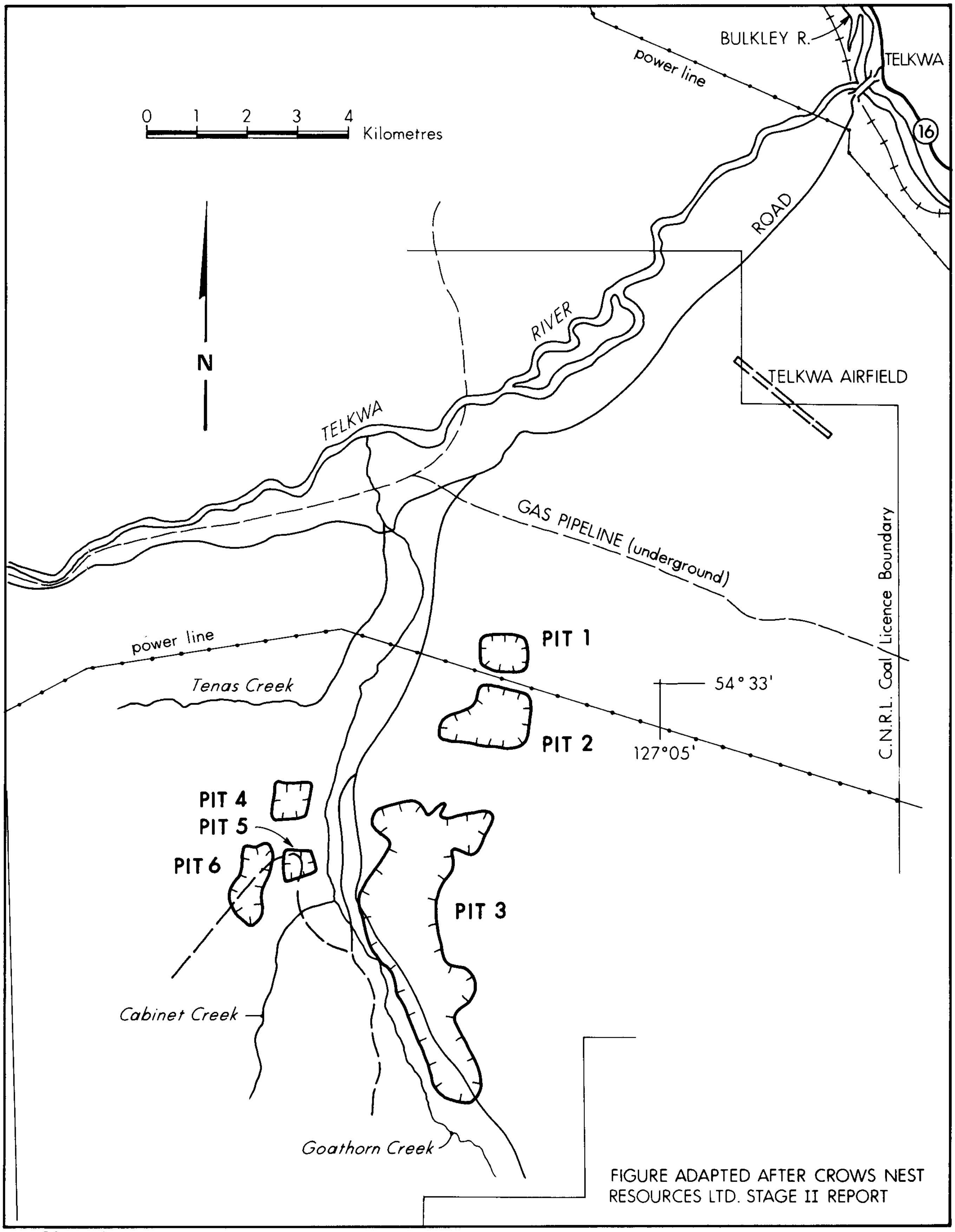
In 1979 Crows Nest Resources Ltd. obtained an option from Mr. J. D. Carnahan and conducted a large regional mapping program, put down three diamond-drill holes totalling 260 metres, and rotary drilled 13 holes totalling 1 500 metres.

In 1981 Crows Nest Resources Ltd. acquired Bulkley Valley Collieries. To the end of 1983, Crows Nest Resources Ltd., on 12 622 hectares of coal licences (90 per cent Crown coal holdings, 10 per cent freehold), completed 119 diamond-drill holes totalling 19 800 metres and 18 reverse circulation rotary holes totalling 2 900 metres to delineate mining areas and intersect all coal seams. All holes were geophysically logged and cores were logged for geological and geotechnical information. Drill-hole spacing was 200 metres in the proposed mining area. In addition, bulk samples from four 150-millimetre cores and two test pits, and 200 tonnes from seven coal seams were used to establish washability, combustion and other quality characteristics, as well as data on mining method applications (Tables 2, 3 and Plate 1). During 1984, 44 diamond-drill holes totalling 5 000 metres were completed, tightening geological control on the proposed East Goathorn pit, delineating additional reserves north of this pit, and exploring the potential of coal-bearing Skeena sediments north of the Telkwa River. Approximately 21 760 000 tonnes of excellent, high volatile bituminous A coal have been defined in 10 coal seams with an aggregate thickness of 14 to

TABLE 2.
TELKWA RAW COAL QUALITY (BASIS: AIR DRIED)
(AVERAGE FOR TOTAL LICENCE BLOCK)*

Seam	Ash Content (%)	Volatiles (%)	Calorific Values (kcal/kg)	Fixed Carbon (%)	Sulphur (%)	Moisture (%)
1	30.5 ± .90	22.7 ± .3	5618 ± 340	45.8 ± .80	1.29 ± .08	0.92 ± .02
2	24.9 ± .80	25.0 ± .2	6055 ± 62	48.6 ± .80	1.19 ± .07	1.11 ± .02
3	26.5 ± 1.0	23.8 ± .3	5714 ± 89	40.6 ± .90	1.69 ± .10	0.98 ± .07
4	19.7 ± 1.9	25.9 ± .9	6392 ± 166	52.7 ± 1.4	1.94 ± .21	1.02 ± .03
5	19.7 ± 1.4	25.7 ± .4	6578 ± 137	54.4 ± 1.2	0.87 ± .13	1.14 ± .04
6	21.0 ± 1.1	25.5 ± .2	6329 ± 75	52.4 ± .70	1.32 ± .10	1.22 ± .02
7	19.5 ± .90	26.1 ± .3	6341 ± 86	51.1 ± .70	2.21 ± .14	1.17 ± .03
8	16.6 ± .80	25.5 ± .4	6548 ± 93	54.0 ± .80	1.77 ± .23	1.45 ± .06
9	19.5 ± 1.7	28.7 ± .6	6741 ± 119	51.1 ± .80	2.90 ± .26	1.14 ± .05
10	19.5 ± 1.5	26.8 ± .3	6430 ± 118	49.1 ± .50	2.99 ± .25	1.05 ± .04

*Crows Nest Resources Ltd., Telkwa Project, Stage II Report, 1985.



COMPILATION BY G.V. WHITE

Figure 5. Proposed development of Telkwa coal deposits.

TABLE 3.
TELKWA WASH COAL QUALITY (BASIS: AIR DRIED)
(AVERAGE FOR TOTAL LICENCE BLOCK)*

Seam	Ash (%)	Volatiles (%)	Calorific Value (kcal/kg)	Fixed Carbon (%)	Sulphur (%)	Moisture (%)	Yield (%)
1	14.4 ± .42	26.1 ± .2	7005 ± 53	58.2 ± .4	0.88 ± .07	1.23 ± .01	64.7 ± 1.3
2	12.3 ± .30	27.1 ± .2	7007 ± 30	57.9 ± .4	0.81 ± .04	1.98 ± .06	74.2 ± 1.3
3	12.9 ± .40	27.4 ± .2	7057 ± 35	58.0 ± .4	1.16 ± .05	1.74 ± .05	72.6 ± 2.7
4	10.4 ± .90	28.0 ± .4	7258 ± 78	59.8 ± .7	1.87 ± .11	1.87 ± .11	77.5 ± 2.1
5	9.5 ± .70	27.7 ± .3	7319 ± 58	60.9 ± .5	0.66 ± .05	2.05 ± .14	79.9 ± 1.4
6	9.7 ± .40	28.4 ± .2	7257 ± 38	53.9 ± .4	0.88 ± .05	2.03 ± .06	78.8 ± 1.3
7	10.1 ± .50	29.0 ± .3	7262 ± 31	59.1 ± .4	1.35 ± .07	1.81 ± .08	81.4 ± 1.3
8	9.2 ± .30	28.4 ± .3	7307 ± 28	60.2 ± .4	1.11 ± .10	2.17 ± .12	84.9 ± 1.2
9	10.0 ± .40	31.9 ± .5	7368 ± 64	56.7 ± .6	1.38 ± .07	1.38 ± .07	80.5 ± 2.6
10	10.7 ± .60	30.8 ± .5	7295 ± 61	57.1 ± .5	2.11 ± .10	1.38 ± .07	81.5 ± 2.3

*Crows Nest Resources Ltd., Telkwa Project, Stage II Report, 1985.

18 metres in an 85 to 100-metre stratigraphic section (Crows Nest Resources Ltd., 1985). Coal quality for raw and washed coal in 10 seams is given in Tables 2 and 3, and is summarized in Table 4.

TABLE 4.
SUMMARY OF CLEAN COAL QUALITY DATA,
TELKWA COAL DEPOSIT*

- High volatile bituminous.
- Low tendency to slag boiler furnaces or to cause fouling of superheater tubes.
- Volatile matter is high enough to ensure stable combustion, low carbon loss and good turn-down flexibility, while maintaining a low tendency for spontaneous combustion during storage.
- Sulphur content is moderate, ensuring good fly ash precipitation while retaining SO_2 emission within environment guidelines.
- Medium hardness (hardgrove grindability index 60) which limits the size degradation during handling and storage and permits efficient pulverizer performance.
- Low ash; high calorific value.

*Crows Nest Resources Ltd., private report, 1984.

The Proposed Telkwa Mine

MINE PLAN

Crows Nest Resources Ltd. has outlined mineable reserves of 21 760 000 tonnes of high volatile A bituminous coal at an average 6.85 to 1 (bank cubic metres per tonne) overburden ratio, which would supply 15 240 000 tonnes of raw coal to the wash plant over a period of 15 years (Crows Nest Resources Ltd., 1985). Six open pits have been designed to recover the economic coal reserves (Fig. 5). The locations of the pits are outlined on Figure 4 and reserve figures for each of the six pits are given in Table 5.

Mining methods will include open-pit surface-mining techniques utilizing scrapers, trucks, loaders, and bulldozers. Clean thermal coal production would average 800 000 tonnes per year (Crows Nest Resources Ltd., 1985).

During mine development coal will be hauled by truck to open stockpiles where it will be crushed in an enclosed crushing plant. Coal from different seams will be blended at this stage to maintain consistency in coal quality. Coal will then be conveyed to the preparation plant where it will be screened into coarse (100 - 0.6 millimetre) and fine (minus 0.6 milllimetre) fractions. Coarse coal will be cleaned in a heavy media cyclone, while fine coal will be cleaned by water-only cyclones. Centrifuges and pressure filters will recover and recycle process water from both coal and waste. The cleaned coal will then be conveyed from stockpiles to a clean surge bin elevated over the railway tracks. After loading into railway cars it will be sealed with latex dust suppressant. The new Ridley Island coal terminal, located near Prince Rupert, will be utilized. A turnaround time of 38 hours for the approximate 750-kilometre round trip is anticipated (Crows Nest Resources Ltd., 1985).

TABLE 5. TELKWA PIT TONNAGES*

Pit No.	Recoverable Thermal Coal (Tonnes)	Waste (Bank M^3)	Strip Ratio
1	680 000	5 050 000	7.43
2	2 360 000	20 620 000	8.74
3	16 260 000	108 340 000	6.66
4	570 000	3 140 000	5.51
5	280 000	1 640 000	5.86
6	1 610 000	10 260 000	6.37
Total	21 760 000	149 050 000	6.85

*Crows Nest Resources Ltd., Telkwa Project, Stage II Report, 1985.

UTILITIES

Electrical power required to operate the mine will be provided by British Columbia Hydro via a 138-kilovolt line. This line, which presently crosses the northern portion of Crows Nest Resources Ltd.'s coal licences, will be brought to the proposed minesite on a pole line from the existing hydro line. A 138-kilovolt substation will be constructed adjacent to the coal preparation plant; it will have the capacity to supply

10 megavolt amperes at the 4 160-volt level. Power from the substation will be distributed by cable and transformed to lower voltages where needed (Crows Nest Resources Ltd., 1985).

Natural gas will be required by the mine to heat company buildings and produce hot water. This gas is currently available from the Pacific Northern natural gas transmission line located approximately 1 kilometre from the plant site.

Water needed by the mine will be obtained from an infiltration gallery adjacent to the Telkwa River and pumped to a storage tank at sufficient elevation to provide both service and fire protection pressures at the plant site. All water used by the mine will be treated before being released back into the watershed. Sewage will probably be treated with a package treatment plant or a septic tank and tile field. All contaminated water from the mine will be held in settlement ponds and discharge points will be monitored to ensure quality standards (Crows Nest Resources Ltd., 1985).

HOUSING AND TRANSPORTATION

A construction force of 130 to 250 employees is forecast and a projected work force of up to 300 employees will be required to operate and maintain the mine. The nearby communities of Telkwa (population 900) and Smithers (population 5 000), located 8 kilometres and 18 kilometres, respectively, from the proposed minesite, will provide housing and facilities for the mine employees. Both communities have expressed positive interest in the mine's development (Crows Nest Resources Ltd., 1985).

A modern airport at Smithers receives daily 737 service from Vancouver. Other commercial fixed-wing and helicopter services are also available. The highway system permits travel by road from Smithers to Prince Rupert via Highway 16 (375 kilometres) and to Vancouver via Highway 16 and 97 (1 150 kilometres).

The Canadian National Railway's mainline, which has recently been upgraded to handle unit trains serving the northeast coal development, passes 6 kilometres north of the Telkwa deposit (Fig. 1). Crows Nest plans to construct a 6-kilometre spurline from the minesite to join the mainline at a point east to Telkwa. The coal will then be shipped by rail to the Ridley Island Terminal; terminal specifications for the Ridley Island Terminal are listed in Table 6. From there steaming times to Japan, a potential market, from Prince Rupert, are 11 to 13 days — a day or two less than from Vancouver (Crows Nest Resources Ltd., 1985 and Plate 2).

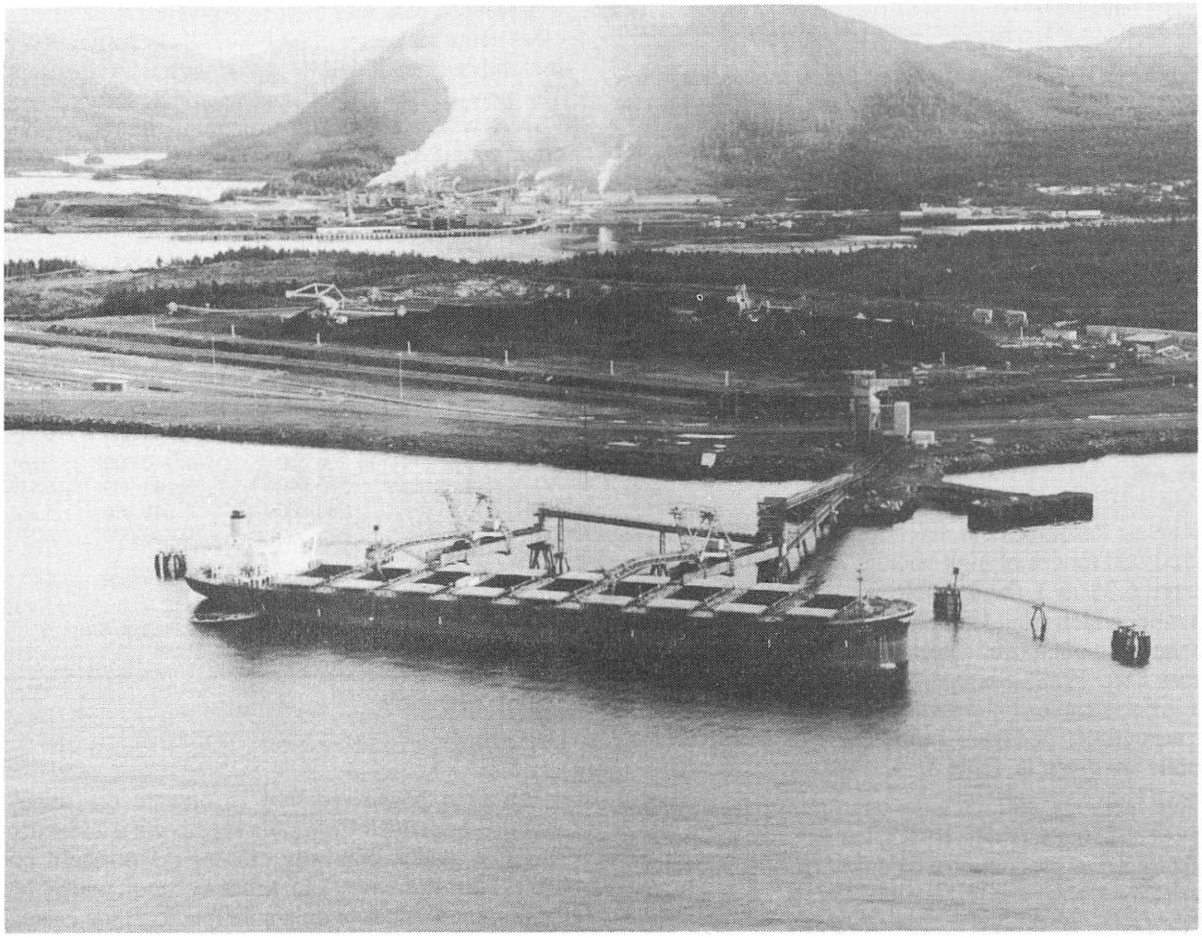


Plate 2. *M. V. River Star* during record loading, Ridley Island terminals (photo courtesy Ridley Terminals Inc.).

TABLE 6.
RIDLEY ISLAND COAL TERMINAL SPECIFICATIONS

SHIPPING/STORAGE CAPACITY		
Annual throughput	12	million tonnes
Throughput Phase 2	24	million tonnes
On-site storage	1.2	million tonnes
UNIT TRAIN UNLOADING		
Tandem rotary car dumper	1	
Railcars tipped per hour	60	
Output per hour	6 000	tonnes
STOCKING/RECLAIMING		
Rail mounted stacker/ reclaimers	2	
Stacking capacity per hour (one)	7 000	tonnes
Reclaiming capacity per hour (one)	6 000	tonnes
SHIPLOADING		
Quadrant slewing shiploaders	2	
Loading capacity per hour (one)	4 5000	tonnes
Maximum output per hour (two)	9 000	tonnes
Trimmer machine capacity per hour	2 5000	tonnes
Ship berths	1	
Maximum dwt	250 000	tonnes
Maximum draught	22	metres
Maximum length	325	metres
Maximum beam	50	metres

*Ridley Terminals Inc., 1984, Information Guide.

ENVIRONMENTAL PROGRAM

Crows Nest Resources Ltd. has undertaken extensive environmental studies of the proposed minesite and surrounding areas. Reclamation of the actual minesite will be carried out as the mine develops. As coal is mined, the pits will be filled by waste material taken from the pit, and covered with original topsoil. Grasses and trees will be planted and the entire site will be reclaimed leaving as little disturbance as possible (Crows Nest Resources Ltd., 1985).

POTENTIAL MARKETS FOR TELKWA COAL

Potential markets for Telkwa coal identified by Crows Nest Resources Ltd. include power plants in the Pacific Rim countries, western Europe, and the Far East.

At the present time world demand for thermal coal has stabilized. However, the Telkwa deposit is well placed to take advantage of future increase in demand. The project's relative small scale and access to utilities and infrastructure all support the mine's future development.

MORICE RIVER OCCURRENCES (Fig. 1, No. 1) (54° 14′ N, 127° 15′ W)

Coaly sediments in the Morice River area are located approximately 42 kilometres south of Smithers and are contained in one large (Chisholm) and two small (Clark Fork and Goldstream) remnant basins lying across the Morice River (Fig. 1).

(1) **Chisholm** (MI 93L-159): The basin occupies an area of approximately 260 square kilometres and was first recorded in 1907 by Messrs. C. B. Clark and T. Howson who reported "reasonably thick coal seams" (10 to 15 centimetres).

(2) **Clark Fork and Deny's Creek** (MI 93L-157): **Thautil Creek** (MI 93L-158): This small basin was first reported in 1908 when three seams ranging from 0.9 to 2.4 metres thick were identified. On Thautil Creek, two drill holes were completed in 1910 — one utilizing a hand drill and the other a steam-powered drill; a forest fire cut short the steam drilling. In 1915, Prince Rupert Coalfields Ltd. completed three boreholes totalling 504 metres on Deny's Creek. During 1968 Bethlehem Copper Corp. completed 606 metres of diamond drilling in three holes, over 11 coal licences. BP Exploration conducted geological mapping in the area of Lamprey Creek throughout 1979. In the same year Crows Nest Resources Ltd. obtained six coal licences (Nos. 4247, 4248, 4250, 6884, 6886, and 6887) on the Deny's Creek property and carried out some trenching. During 1981 two diamond-drill holes totalling 400 metres were drilled on the property, followed in 1983 by one diamond-drill hole totalling 288.63 metres. Potential open-pit resources have been defined and coal quality data are available (Crows Nest Resources Ltd., 1984b).

(3) **Goldstream** (MI 93L-160): This small 4 by 3.2 kilometre basin was first reported in 1907 and coal seams up to 1.7 metres thick were identified. In 1917 the Prince Rupert Coalfield Company, funded by American capital, owned 5 180 hectares in this area.

BABINE LAKE OCCURRENCE (Fig. 1, No. 3) (54° 40′ N, 126° 25′ W)

In 1909, a 0.6-metre seam of impure coal was reported on Tuchi River situated approximately 2.7 kilometres above its mouth at Babine Lake (Fig. 1). No quality data are available and the occurrence has not been located since.

DRIFTWOOD CREEK OCCURRENCE (Fig. 1, No. 4) (54° 50′ N, 127° 00′ W; MI 93L-150)

In 1905 a 0.55-metre-thick seam of hard, bright lignitic coal was observed in the valley of Driftwood Creek, 11 kilometres east of Smithers. It is contained within a 6.4 by 3.2-kilometre basin of Tertiary sediments, and is cut by several faults and numerous dykes. No information on quality is available.

LAKE KATHLYN OCCURRENCE (Fig. 1, No. 5) (54° 49′ N, 127° 17′ W; MI 93L-149)

In 1917 bituminous to semi-anthracite coal was reported near Lake Kathlyn on the outskirts of Smithers. Ten coal leases covering a small remnant basin were staked. Several short adits (12 metres) were driven into coal seams 45 to 60-degree dipping and averaging 0.76 metre in thickness. These seams have been metamorphosed by the large granitic intrusion which underlies the core of Hudson Bay Mountain. Coal quality data are available but there are insufficient data to suggest resource size. A separate occurrence (Evelyn, MI 93L-148) is reported a few kilometres to the northwest, but very little data are available on this deposit.

SEATON (BOULDER CREEK) OCCURRENCE
(Fig. 1, No. 6) (55° N, 06′ W; MI 93M-095)

In 1910, during construction of the Grand Trunk Pacific Railway, the Grand Trunk British Columbia Coal Co. Ltd. reported very hard, finely banded, high-ash bituminous coal approximately 32 kilometres upstream from Hazelton on the Bulkley River. Up to 12 seams, totalling 30.5 to 96.5 centimetres of coal, were reported to occur in a 152-metre-thick section of interbedded sandstone and shale within a relatively undisturbed small, 6.4 by 4.8-kilometre basin along the Bulkley River. Ashman Coal Mines Ltd. located carbonaceous shale around the same time. In 1916 the Seaton Coal Co. and the Wright Coal Co. completed 84 metres of drifting plus a 9-metre shaft on a 1.4-metre coal seam. A donkey engine was used to hoist waste upslope and a tramway was built to move the coal. In 1927 Bulkley Valley Coal Mines Syndicate, under Francis Glover, made a trial shipment of 18 tonnes. Insufficient data exist to estimate resource size.

ZYMOETZ RIVER OCCURRENCES (Fig. 1, No. 7)
(54° 50′ N, 127° 45′ W)

(1) **Coal Creek** (MI 93L-147): In 1908, J. Ashman staked claims on Coal Creek to cover a 1.5-metre-thick seam of bright, hard bituminous coal. The licences were located near the headwaters of the Zymoetz (Copper) River, approximately 40 kilometres west of Smithers, in a small remnant basin 3.2 kilometres wide. Five separate seams with thickness ranging from 1.8 to 4.9 metres were identified.

    All coal licences were surveyed between 1910 and 1923. Prior to 1914 several prospect adits were excavated. In 1914, 75 leases were owned by Copper River Coal Co., and between 1917 and 1927, Yorkshire and Pacific Trust Companies (under F. B. Chettleburg) owned the leases. In 1922, three diamond-drill holes totalling 774 metres were completed. Western Coal and Coke Ltd. completed 166 metres of diamond drilling in three holes in 1968 under the supervision of J. M. Black. In 1970 Western Coal and Coke Ltd. optioned the coal licences to Kaiser Resources who carried out an office evaluation but did no physical work. Kaiser estimated reserves of 281 170 tonnes (probable) and 1 353 244 tonnes (possible) of high volatile, both A and B, bituminous, high sulphur, low free swelling index coal with a calorific value in the range of 3 653 kcal/kilogram (ADB) to 3 779 kcal/kilogram (ADB). These values were estimated using an average 2.44-metre seam thickness and assuming underground mining. On a larger scale, the entire Zymoetz Basin is estimated to contain reserves of 31 745 000 tonnes (indicated) and 11.8 to 55.3 million tonnes (inferred) (Kaiser Resources Ltd., private report, 1970).

    During 1979, Crows Nest Resources Ltd. held seven coal licences within the Zymoetz coal area (Nos. 4252, 4253, 4254, 4255, 4257, 6172, 6173). Two diamond-drill holes were completed in 1979, one in 1983 and two more totalling 300 metres in 1984. Five seams were correlated over a distance of at least 0.5 kilometre with an aggregate thickness between 4 and 8 metres. No accurate resource calculations are available but there is good potential to develop reserves. Coal quality data are available (Crows Nest Resources Ltd., 1984a).

(2) **Glacier Creek:** This small coal area is located approximately 29 kilometres east of Coal Creek (near Pine Creek on the southwest flank of Hudson Bay Mountain). A number of thin very hard, high ash, highly folded and faulted coal seams (10 to 23 centimetres) have been located.

KISPIOX OCCURRENCE (Fig. 1, No. 8)
(55° 25′ N, 127° 39′ W; MI 93M-097-102)

Bituminous coal was first reported in 1909 along both banks of the Skeena River near the Kispiox River junction, and also 22.5 kilometres upstream near Big Slide. Five badly sheared seams (only one greater than 1.5 metres thick) were explored by short adits in 1912 but nothing of consequence was found. In 1979 Suncor Inc. conducted preliminary investigations but abandoned the project partly because of environmental constraints. No coal quality or resource data exist.

SHEGUNIA OCCURRENCE (Fig. 1, No. 8)
(55° 21′ N, 127° 38′ W; MI 93M-096)

In 1908 severely sheared, relatively high ash bituminous coal was reported along the Skeena River valley about 3.2 kilometres above the mouth of Sheguina (Salmon) Creek. Three seams, the largest being 1.5 metres thick, were explored by an old shaft that is 7.62 metres deep, a few open cuts, and a crosscut tunnel that is 10.7 metres long. No coal quality or resource data exist.

CEDAR CREEK (HAZELTON) OCCURRENCE
(Fig. 1, No. 9) (55° 16′ N, 127° 46′ W; MI 93M-131)

Around 1908 friable, high ash, semi-anthracite coal was reported to occur on the left bank of Cedar Creek, 12.9 kilometres west and 1.6 kilometres south of Hazelton, and also on Coyote Creek. One seam on Cedar Creek was 1.22 metres thick and the one on Coyote Creek was very thin. The occurrences were apparently discovered by two Indians. No coal quality or resource data exist.

SEELEY LAKE OCCURRENCE (Fig. 1, No. 10) (55° 11′ N, 127° 44′ W)

In 1981, anthracite to meta-anthracite was intersected in drill core by D. Groot Logging Ltd. (Smithers) on one of seven coal licences covering 542 hectares situated about 5 kilometres southwest of South Hazelton. In 1982 and 1983, 20 diamond-drill holes totalling 2 512.6 metres tested the area. Individual coal seams range up to 1.5 metres in thickness and aggregate intervals range up to 12 metres (White, 1985). The coal has been metamorphosed by a nearby igneous intrusion.

KITSEGUECLA RIVER OCCURRENCE (Fig. 1, No. 11) (55° 06′ N, 127° 48′ W; MI 93M-094)

Between 1879 and 1880, G. M. Dawson of the Geological Survey of Canada alluded to occurrences of coal in this area. In 1909, W. W. Leach of the Geological Survey of Canada reported friable, impure thin seams of coal on river banks from Kitseguecla River, approximately 10 kilometres upstream of Skeena Crossing. No other coal quality or resource data are available.

GROUNDHOG COALFIELD

McEVOY FLATS (MOUNT JACKSON), BEIRNES CREEK, TELFER CREEK, PANORAMA (SOUTH-EAST GROUNDHOG) (Fig. 1, No. 13) (57° N, 128° W; MI 104A-078, 084-089)

The Groundhog Coalfield is located near the headwaters of the Nass and Skeena Rivers (Fig. 1). Coal occurrences are known in the areas of McEvoy Flats, Beirnes Creek, Telfer Creek, Discovery Creek, Panorama Creek, and Mount Jackson.

Claims covering 31 square kilometres were first staked in the Groundhog area in 1903 by James McEvoy. He is credited with discovering a 1.83-metre-thick coal seam on Discovery Creek in 1893. In 1899 V. H. Dupont with the Federal Department of Railways reported the occurrence of coal in the area. By 1900 the reports by the Geological Survey of Canada suggested that substantial reserves of anthracite might be contained in Cretaceous sediments located within a northwesterly trending area 120 by 65 kilometres in size. During 1904 W. W. Leach staked an additional 42 square kilometres on behalf of Western Development Co., a Toronto-based syndicate. Between 1904 and 1911, two tunnels were driven to bulk sample a 1.2-metre coal seam on Discovery Creek.

Between 1909 and 1912 a large block of claims was acquired by the British Columbia Anthracite Company. Access to the coal licences from Hazelton was by about 240 kilometres of pack trail that followed the telegraph line north of 6th Cabin. Return trips took approximately one month and a maximum of three to four trips were made per year depending on weather conditions. Intense prospecting during this period, stimulated by the expectation that a railroad would be built to the coalfield from Stewart, which lies approximately 130 kilometres to the southwest, included the driving of several short adits. As a result three rail routes were proposed: (1) to Hazelton (260 kilometres), (2) down the Nass River to tidewater (320 to 360 kilometres), and (3) to Stewart (200 kilometres). Railroad construction did start from Stewart, under the direction of McKenzie and Mann interests from Great Britain, but was abandoned prior to World War I; the line extended only 25 kilometres. It is estimated that two to three million 1984 dollars was spent between 1904 and 1912 on exploration of the Groundhog Coalfield (Dolmage, Campbell & Assoc. Ltd., 1975).

During 1911 and 1912, G. S. Mallock (Geological Survey of Canada) examined the coalfield and measured three sections, including one on Mount Jackson, where he identified 17 separate seams ranging between 0.3 and 1.83 metres thick.

In 1948, a Geological Survey of Canada party under A. F. Buckham and B. A. Latour remapped the coalfield. They recorded more than 60 separate coal localities, several of which included multiple seams.

During 1968 Coastal Coal Ltd. examined 24 coal licences which they acquired in 1966. Reconnaissance by the company was directed toward finding coking coals. At the same time, Dillingham Corporation of Canada Ltd., under J. M. Black, carried out grassroots prospecting and mapping in an attempt to identify coking coals in the same area. Unfortunately, both programs were considered unsuccessful because coals identified were high in ash and also were hosted by steeply dipping sediments and therefore were not favourable for mining (Dolmage, Campbell & Assoc. Ltd., 1975).

In 1969, Placer Development Ltd., Quintanna Minerals, and National Coal Corporation explored 518 square kilometres and diamond drilled six holes totalling 1 030 metres in the three most promising areas; 4 holes were on McEvoy Flats, one hole was near the mouth of Beirnes Creek, and one hole was on Telfer Creek. The results, although inconclusive, suggested possible geological reserves of four billion tonnes in the area (Dolmage, Campbell & Assoc. Ltd., 1975). However, in the early 1970's the consortium allowed all licences to lapse.

During 1973, 1976, and 1979, field parties with the Geological Survey of Canada carried out regional geological mapping within the Groundhog and Bowser Basins.

In 1979 Esso Minerals (Coal Division, Calgary) mapped 24 coal licences, and Groundhog Coal Ltd. mapped 76 licences.

L. G. Scott (Kitimat) explored six coal licences (6 131 to 6 136) in the Telfer Creek area during 1980, and determined a potential geological reserve of 48 million tonnes of which 4.2 million would be open pittable (Kerr, Dawson & Associates Ltd., 1981).

In 1982 Suncor Inc. (Calgary) acquired 29 coal licences (7352 to 7380 inclusive) covering 6 903 hectares in the Mount Jackson area (McEvoy Flats) and carried out mapping programs on known anthracite occurrences. During 1983 they held 27 coal licences for a total of 6 439 hectares. Geological mapping was continued and two seams consid-

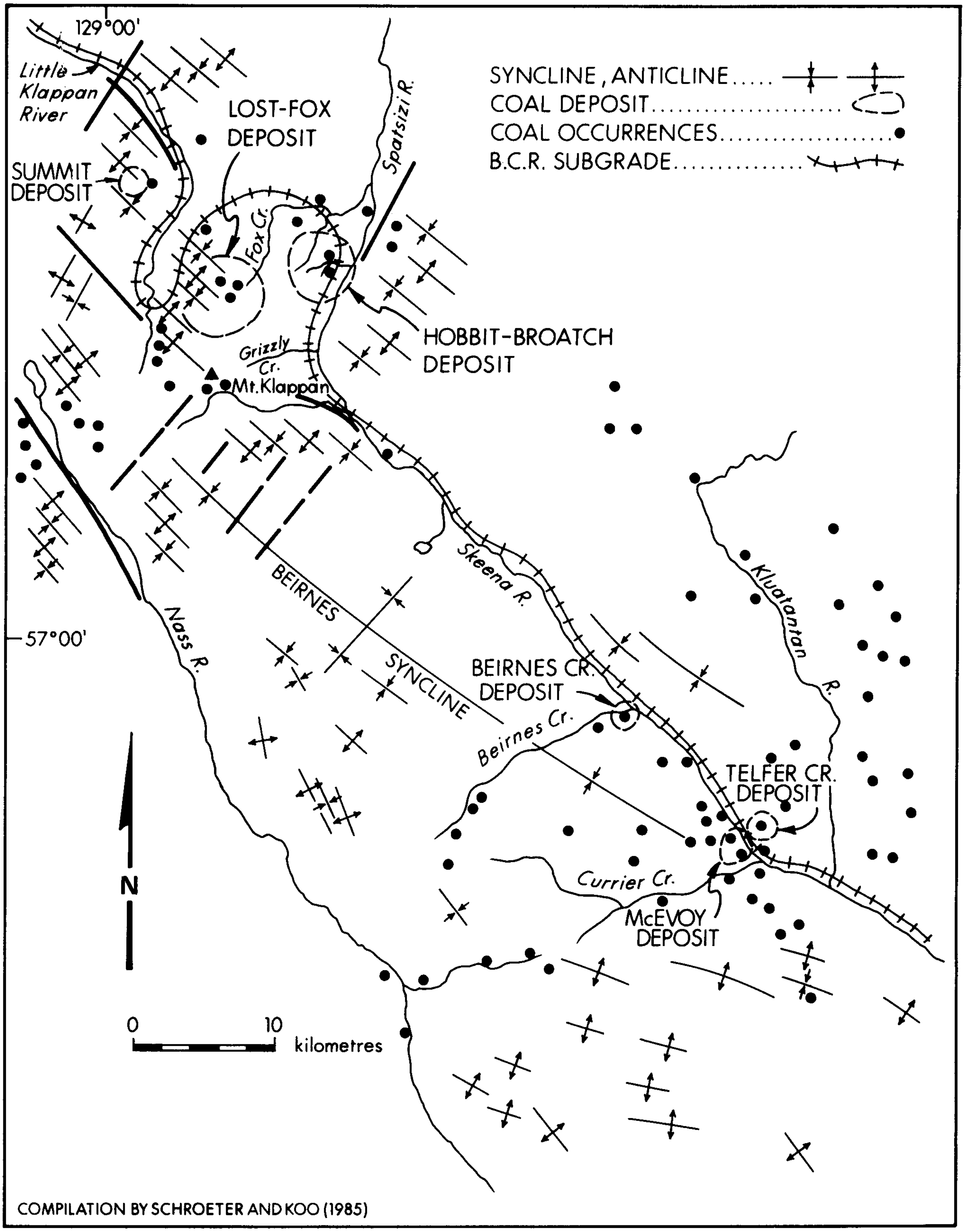


Figure 6. Geology of the Groundhog Coalfield.

ered mineable were studied at the top of Mount Jackson; dense forest cover and overburden north of Mount Jackson hindered exploration. Coal quality data are available but no resource data exist (Suncor Inc., 1982 and 1983a).

The general characteristics of "Southeast Groundhog" coal are summarized below:

- Low volatile bituminous to anthracite.
- No significant coking quality.
- Calorific values range between 2 358 and 3 480 kcal/kg, and average 2 644 kcal/kg.
- Surface mineable.
- 3.4 billion tonnes indicated.

KLAPPAN (Fig. 1, No. 14) (57° 15′ N, 128° 58′ W)

The Mount Klappan area is located in the northwestern part of the Groundhog Coalfield (Figs. 1 and 3).

Exploration History

The earliest direct reference to coal occurrenees in the Mount Klappan area was in 1911 by Mr. Grossmann and his party who dug trenches and test pits.

In 1979 Gulf Canada Resources Inc. acquired coal licences that now comprise 56 194 hectares in 211 licences in the Mount Klappan area and straddle the partially completed British Columbia Railway line between Prince George and Dease Lake (Fig. 1) (Gulf Canada Resources Inc., 1985). Prior to cessation of work on construction of the line, steel was laid to within 85 kilometres of the property, and the subgrade was constructed through and beyond the property to the Stikine River just south of Dease Lake. The property is accessed either by helicopter or fixed wing aircraft to a 1 000-metre-long airstrip or by road. Road access was established to the property in 1984 from Highway 37 via the Ealue Lake road along the British Columbia Railway subgrade.

Between 1979 and 1984, physical work carried out on the property by Gulf included 322 hand trenches, 235 mechanical trenches, 31 diamond-drill holes, 29 rotary-drill holes, and one adit from which a 35-tonne-bulk sample was obtained (Gulf Canada Resources Inc., 1984). Late in 1984, 67 tonnes of anthracite was extracted for testing in the water filtration market (*British Columbia Ministry of Energy, Mines and Petroleum Resources*, Exploration in British Columbia 1984). In the period January to March of 1985 approximately 21 000 tonnes of anthracite was mined and trucked to Stewart as a trial shipment to potential customers in Europe and Great Britain. Gulf Canada Resources Inc. is continuing an active program to prove reserves for open-pit mines at the Lost Ridge and Hobbit Creek zones (Fig. 6).

Resource Potential

The Mount Klappan anthracite property ranks as a world class resource in terms of its size. The resource within the Klappan sequence is estimated to exceed 5 billion tonnes of in-place raw coal (Gulf Canada Resources Inc., 1985).

Geological mapping of this sedimentary coal-bearing sequence has identified approximately 500 metres in thickness. Up to 16 seams, several up to 5 metres in thickness, have been drilled in this structurally complex area.

The Mount Klappan property has an inferred resource in excess of 1 billion tonnes of anthracite in-place, occurring within three areas: Lost Fox, Hobbit-Broatch, and Summit (Gulf Canada Resources Inc., 1985). To date, two potential open-pit mines have been identified:

(1) The Lost Fox resource area which covers 8.2 square kilometres, and contains resources of over 1 billion tonnes (Gulf Canada Resources Inc., 1985).

(2) The Hobbit-Broatch area which covers 18 square kilometres and contains an inferred resource of 620 million tonnes (Gulf Canada Resources Inc., 1984). During early 1985 a test shipment of 21 000 tonnes from the Hobbit-Broatch area was trucked to Stewart for shipping to potential customers in Europe and Eastern Canada (Gulf Canada Resources Inc., 1985).

Extensive coal quality analyses have been performed and the resulting data indicate that the Klappan property could produce a range of coal products required by the world anthracite market. Table 7 provides a synopsis of Mount Klappan anthracite (Gulf Canada Resources Inc., 1985).

TABLE 7.
SUMMARY OF PRODUCT COAL QUALITY*
LOST FOX RESOURCE AREA, MOUNT KLAPPAN

	6% Ash	12% Ash	25% Ash
Residual moisture	1.1	1.4	1.7
Ash	6.0	12.0	25.0
Volatile matter	6.5	7.8	8.0
Fixed carbon	86.4	78.8	65.3
Calorific value (kcal/kg)	7750	7150	5900
Total sulphur	0.5	0.5	0.4

*Gulf Canada Resources Inc., 1985.

The Proposed Mount Klappan Mine

MINE PLAN

Two potential open-pit production sites, the Lost-Fox resource area (Plate 3) and the Hobbit-Broatch resource area (Fig. 7) have been identified. Early plans call for the development of one of the resource areas, probably the Lost-Fox area at a mine production rate of 1.5 million tonnes per year over a 20-year period. This area is estimated to contain 60 million tonnes of recoverable coal in place (Gulf Canada Resources Inc., 1985, p. 26). Initial production will utilize conventional

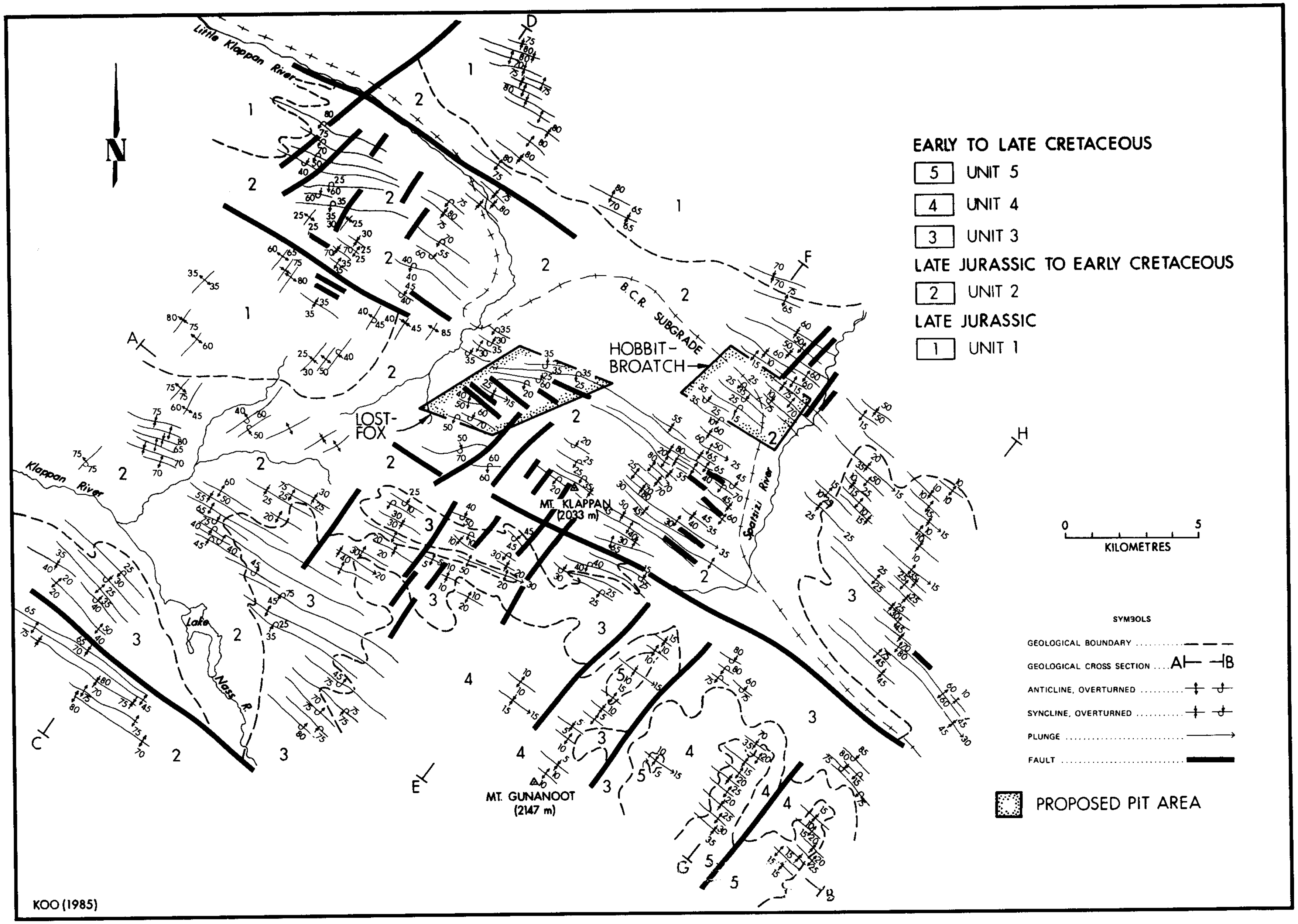


Figure 7. Geology of the Mount Klappan area.

Plate 3. Looking southeasterly over Lost-Fox Resource area (photo courtesy Gulf Canada Resources Inc.).

bench mining methods with coal mined by hydraulic excavators and front-end loaders.

RAW COAL HANDLING AND CRUSHING

Coal from the mine will be transported to a truck dump, where coal from different seams will be blended using a 7 000-tonne raw coal stacker. Scalping screens will remove 80 millimetres by 0 millimetre raw coal and a rotary breaker will reduce 600 millimetres by 80 millimetres run-of-mine material to 80 millimetres by 0 millimetre-sized material. Scalping screen underflow and roll crusher product will be conveyed to a 7 000-tonne stacker slide. The stacker slide vibrating feeder will reclaim the anthracite, discharging it onto the plant feed hopper conveyor.

A 200-tonne feed hopper will be used with a weight feeder for accurate control of the preparation plant feed rate (Gulf Canada Resources Inc., 1985).

PREPARATION PLANT

The coal preparation plant will be constructed to produce 6, 12, and 25 per cent ash coal concurrently, and will be designed to include a closed water circuit so that water can be recycled from the tailings pond back to the plant.

Clean coal products will be temporarily stored in 11 000 to 18 000-tonne silos prior to loading on trucks (Gulf Canada Resources Inc., 1985).

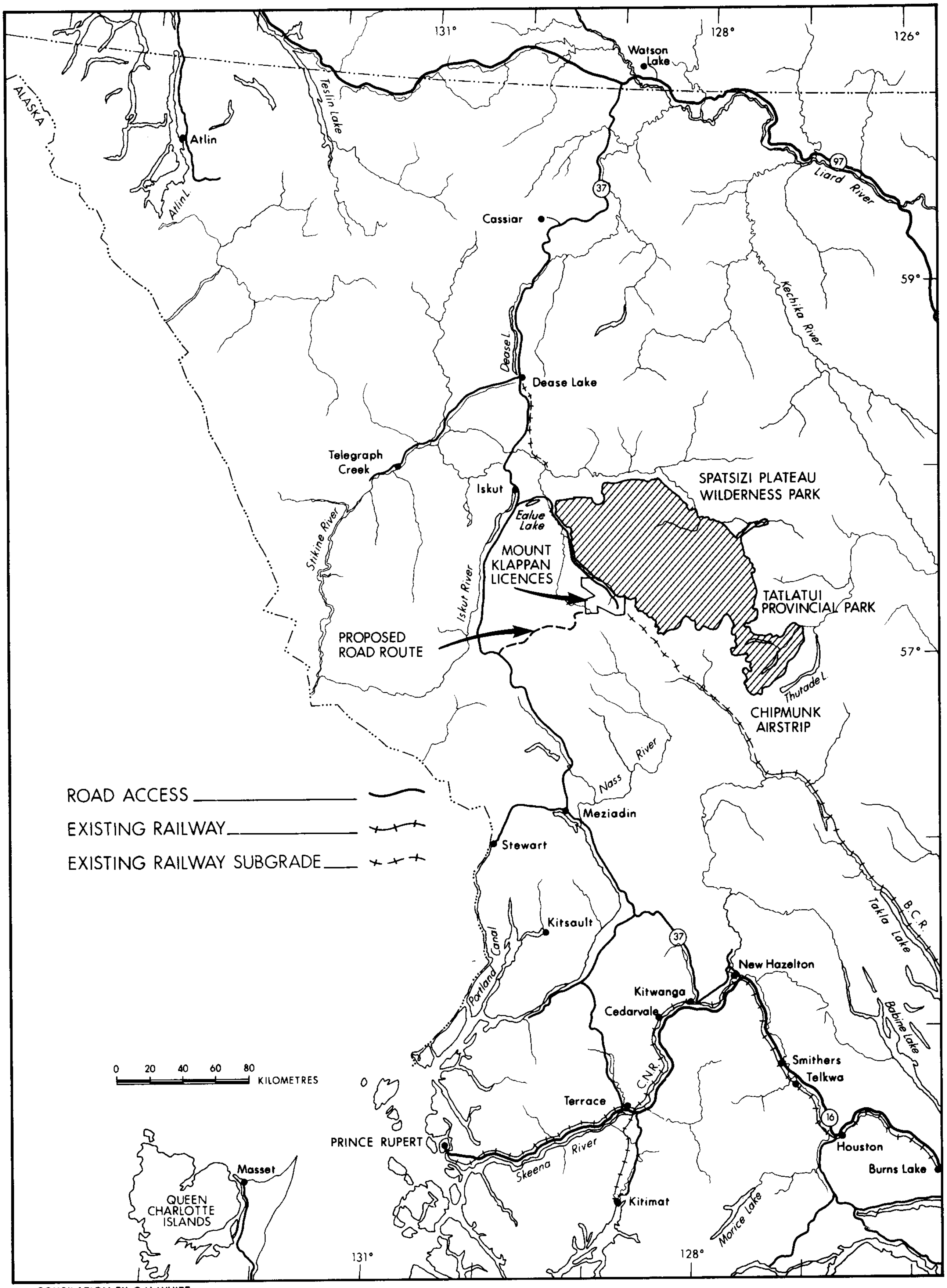
PROPOSED INFRASTRUCTURE

The British Columbia Ministry of Industry and Small Business Development commissioned Swan Wooster Engineering Co. Ltd. of Vancouver in 1984 to study alternative rail routes for transporting anthracite coal from the Mount Klappan Coalfield to terminals at Stewart, Prince Rupert, or Vancouver. The report identified potential railway routes and examined the feasibility of each route (Swan Wooster Engineering Co. Ltd., 1984).

In 1985 the British Columbia Ministry of Energy, Mines and Petroleum Resources and Gulf Canada Resources Inc. completed a study of possible road transportation corridors to link the potential minesite with the Stewart-Cassiar Highway. The study was funded as part of the 1985 Federal/Provincial Mineral Development Agreement. The proposed routes are shown on Figure 8. The turnaround time from the Mount Klappan minesite to a coal terminal located on tidewater will vary according to the transportation corridor selected.

In 1985 an access route down the Bell Irving River was proposed as the most direct transportation route.

Stewart, with a population of approximately 1 000, is located on the west coast of northern British Columbia approximately 300 kilometres by road southwest of the Mount Klappan Coalfield (Fig. 8). It is being studied for its potential for accommodating a coal terminal. The proposed terminal would evolve through several stages, with the first stage developed to accommodate a throughput of 1 to 1.5 million tonnes per year of coal. At this production level,



COMPILATION BY G.V. WHITE

Figure 8. Proposed road transportation corridors from Mount Klappan area.

trucks could be used to haul coal from the coalfield. If coal throughput were above the 1.5 million tonnes per year level, however, economic considerations would require the construction of a rail connection to the coalfield. At 1 million tonnes per year production capital costs of construction harbour facilities and a coal terminal capable of handling anthracite coals of 6, 12, and 25 per cent ash are estimated to be 40 million dollars (1984 dollars). To accommodate 3.5 million tonnes per year of coal transported by train a capital cost of 80.5 million dollars is projected for terminal construction costs (Gulf Canada Resources Inc., 1984).

MINE LABOUR FORCE

The size of the labour force needed will depend on the yearly rate of coal production. A mine producing 1.5 million tonnes per year will provide 750 direct jobs and 330 indirect jobs. A breakdown of this projected work force is as follows:

	Employees
Permanent minesite jobs	520
Truck drivers	125
Truck maintenance	75
Port operations	30
	750

(Gulf Canada Resources Inc., 1985)

Gulf is considering several housing options. With initial production between 1 and 3.5 million tonnes per year, personnel could be housed in existing communities such as Stewart, Smithers, Terrace, or Dease Lake, and flown to the mine on a rotational basis. A camp would be established at the minesite for housing employees who are on duty. If production increased to 5 million tonnes per year, consideration would be given to constructing a town near the minesite; a decision on constructing a town would depend on securing long-term contracts for Mount Klappan coal.

ELECTRICAL POWER

Initial electrical power during the mine construction could be supplied from diesel generators. Based on preliminary studies, a permanent power supply could be delivered by a 138-kilovolt line constructed from Hazelton. A second permanent power supply option is an anthracite-fired thermal plant. Additional studies are required to evaluate the relative merits of these options.

ENVIRONMENTAL PROGRAM

Current studies on the climate and air quality, vegetation, wildlife, fisheries, and water quality will provide a baseline for information on the area. Environmental impacts will occur as a result of the mine's development, however, proper planning, design, construction, and a continuing reclamation program will reduce these impacts. Mining operations will begin with the removal of topsoil which will be stockpiled for future reclamation.

POTENTIAL MARKETS FOR MOUNT KLAPPAN ANTHRACITE

Anthracite is consumed throughout the world, but the largest market is in Korea where high (12 to 25 per cent ash) ash coals are used to make briquettes for home heating. The lower ash anthracite (6 per cent) is used directly as a stove fuel in many countries in Asia and Europe. Lower ash anthracite is also used as:

- A fuel for heating industrial complexes.
- A fuel for generating electricity.
- A reductant for specific metallic ores, such as titanium ores.
- A supplementary heat and carbon source in conventional steel making, particularly for sintering or pelletizing iron ores.
- A carbon source in the production of carbon electrodes for the electrical smelting of aluminum.

Currently, anthracite is mined from deep underground mines in Korea, Europe, and other regions, and mining costs are becoming prohibitive. The opportunity exists, therefore, for the development of markets for Mount Klappan anthracite not only in Asia — in particular Korea — and Europe, but also in North America. Mount Klappan anthracite mined by conventional open-pit methods will be able to enter existing markets, as well as new markets, at a competitive rate, and long-term contracts for specific tonnages would stimulate the proposed mine's development.

SUSTUT RIVER COALFIELD

SUSTUT RIVER COALFIELD (Fig. 1, No. 12)
(56° 25′ N, 126° 45′ W; MI 94D-039-057)

The Sustut River Coalfield was discovered in 1912 by G. S. Mallock, who was carrying out field examinations in the Groundhog Coalfield, located some 80 kilometres to the northwest. Originally two 0.9-metre-thick seams of bituminous coal were located in the Saiya Lake area in moderately to steeply folded Sustut Group sedimentary rocks. Early discoveries were centred approximately 6.4 to 16 kilometres west of the junction of Red Creek and the Sustut River, immediately east of Saiya Lake. Since then substantial coal occurrences have been identified within a northwesterly trending 50 by 6.5-kilometre belt, centred approximately 25 kilometres northeast of Bear Lake, which is 170 kilometres north-northeast of Smithers (Schroeter and White, 1984).

In 1974, Dolmage, Campbell & Assoc. Ltd. examined coal occurrences near Red Creek at the northwestern end of the belt; they found the coal seams to be "relatively thick, moderately to steeply dipping and extensive".

In 1982 Suncor Inc. (Calgary) obtained 34 coal licences covering about 9 000 hectares in the area; during 1983 and 1984 they completed 2 494 metres of diamond drilling in 17 holes. Suncor reported nine coal seams in the Bowser Lake Group and two coal seams in the Sustut Group.

Coal on the property ranges from low to high volatile bituminous A; individual coal seams range in thickness up to 8 metres. Unfortunately, intense folding and faulting and thick overburden in valley bottoms inhibit stratigraphic correlation of coal seams, and much more drilling would be required to establish the potential of the area (Schroeter and White, 1984). On the positive side, the area is situated favourably with respect to the route of the British Columbia Railway.

MISCELLANEOUS COAL OCCURRENCES

TUYA (STIKINE RIVER) COALFIELD (Fig. 1, No. 15)
(58° 15′ N, 130° 45′ W; MI 104J-43, 44)

As early as 1887 mention of coal occurrences in the Stikine River area was made by G. M. Dawson of the Geological Survey of Canada. In 1904, R. D. Featherstonhaugh, Provincial Mineralogist, noted Tertiary-age, lignitic coal on behalf of the Atlin-Tuya Coal Prospecting Syndicate. Five coal occurrences were located on 13 coal leases covering 3 238 hectares on the Tuya and Tahltan Rivers. The coal seams occur within a northeasterly trending belt that is 25 kilometres in length; the belt is apparently terminated by a granitic contact to the north. Eight distinct coal seams occur between the Little Tuya River and Mansfield Creek. The sedimentary strata are faulted with gentle dips (10 to 20 degrees). Seams vary up to 3.4 metres in thickness. In 1953 W. Smitheringale examined the coalfield. During 1962 H. Gabrielse and in 1973 G. Eisbacher, both with the Geological Survey of Canada noted thin lignite seams in the Tuya River. In 1979 Esso Minerals Canada acquired 10 licences and carried out geological mapping; Petro-Canada Exploration Inc. acquired licences covering 3 569.8 hectares from Pacific Petroleums Ltd. and completed four diamond-drill holes totalling 878 metres. In 1980 they drilled a further six holes on 14 freehold Crown coal licences covering 3 023.48 hectares. Petro-Canada estimate there is a resource potential of 205 million tonnes of *in situ* high volatile C bituminous coal with calorific values ranging from 1 678 kcal/kg to 2953 kcal/kg (Petro-Canada Exploration Inc., 1980). No work has been carried out since 1980.

Further development in this area will depend on construction of an adequate transportation system.

TRAPPER LAKE OCCURRENCE (Fig. 1, No. 16)
(58° 27′ N, 132° 28′ W)

East of Trapper Lake an occurrence of resinous coal forms 2.5 to 10-centimetre-thick seams in Middle Jurassic shales. No quality data are available.

INKLIN RIVER OCCURRENCE (Fig. 1, No. 17)
(58° 50′ N, 132° 55′ W)

Coal has been reported along the Inklin River, approximately 24 kilometres east of the junction of the Inklin and Taku Rivers. No coal quality data are available.

TAKU RIVER OCCURRENCE (Fig. 1, No. 18)
(58° 35′ N, 133° 35′ W)

Bituminous coal has been reported from a 1.2-metre seam located on Taku River, approximately 48 kilometres northeast of Juneau. No coal quality data are available.

SLOKO RIVER OCCURRENCE (Fig. 1, No. 19)
(59° 08′ N, 133° 38′ W)

In 1908 Alex McDonald, acting on information provided by local Indians, discovered lignitic coal near the southeast summit of Sloko Mountain and at a point northeast of and overlooking the east end of Sloko Lake. Ten claims were staked by Mr. McDonald and others; some were controlled by the Amalgamated Development Company of Vancouver. No coal quality data are available.

TAGISH LAKE OCCURRENCE (Fig. 1, No. 20)
(59° 34′ N, 133° 56′ W)

Coal was reported on the south side of Graham Inlet, about 8 kilometres southwest of Taku Landing, but its existence has not been confirmed.

RAPID RIVER COALFIELD (Fig. 1, No. 21)
(59° 15′ N, 128° 58′ W)

Lignitic coal of Tertiary age has been recorded in the valley of the Rapid River, approximately 9.7 kilometres from the confluence of the Rapid and Dease Rivers. The coal seams, which are 15 to 30 centimetres thick, occur northeast of the river within a northwesterly trending basin that is 16 by 4.8 kilometres in size. The coal-bearing sequence is part of the northernmost extension of the Sifton Group. No coal quality data are available.

LIARD RIVER COALFIELD (Fig. 1, No. 22)
(59° 55′ N, 128° 23′ W)

Prior to the late 1970's very little was known about Tertiary-aged lignite located in a few small isolated basins within the broad, flat Liard plain, south of the British Columbia-Yukon boundary. In 1978 Placer Development conducted a small diamond-drilling program south of Watson Lake; the seams tested are thin and of poor quality.

CEDAR RIVER OCCURRENCE (Fig. 1, No. 23)
(54° 58′ N, 128° 51′ W)

Coal has been reported on the Cedar River, approximately 10 kilometres north of its junction with the Kitsumkalum River, 52 kilometres north of Terrace. No coal quality data area available.

CONCLUSIONS

Since the discovery of coal in British Columbia 150 years ago by prospectors, mining companies, and government surveys, coal has been actively explored for throughout the province. In 1984, 20 739 725 tonnes of thermal and metallurgical coal was produced in British Columbia (*B.C. Ministry of Energy, Mines, and Petroleum Resources*, Summary of Operations, 1984, page 11); most of the coal is exported to overseas markets. Although northwestern British Columbia contains significant resources of coal in the Bulkley River, Groundhog, and Sustut Coalfields, it has produced only small amounts of coal for very limited and localized markets. The lack of development of the coalfields has largely been a result of lack of infrastructure to facilitate access to world markets.

With the improvement of both road and rail transportation routes within northwestern British Columbia, export of large tonnages of coal is becoming conceivable. To complement the improved transportation system (of the interior region), the recently developed Ridley Island coal handling facility now provides the capability of exporting major production of northwestern coal.

Considering the current plans for the Telkwa and Mount Klappan deposits, an initial annual export of 800 000 and 1.5 million tonnes, respectively, of clean coal could become a reality. The Mount Klappan project has the potential to increase annual production to 5 million tonnes of coal; if this occurs, the total potential production is 5.8 million tonnes per year. Production of coal at this rate would make the northwestern region of the province a major producing area.

Development of the Telkwa and Mount Klappan deposits would intensify exploration in other, less studied known deposits and known coal-bearing sediments and coal occurrences. Among the benefits to the northwest, and the province, would be the provision of direct and indirect employment, adding to the province's economic base. The northwest is poised for development and ready to compete for world coal markets.

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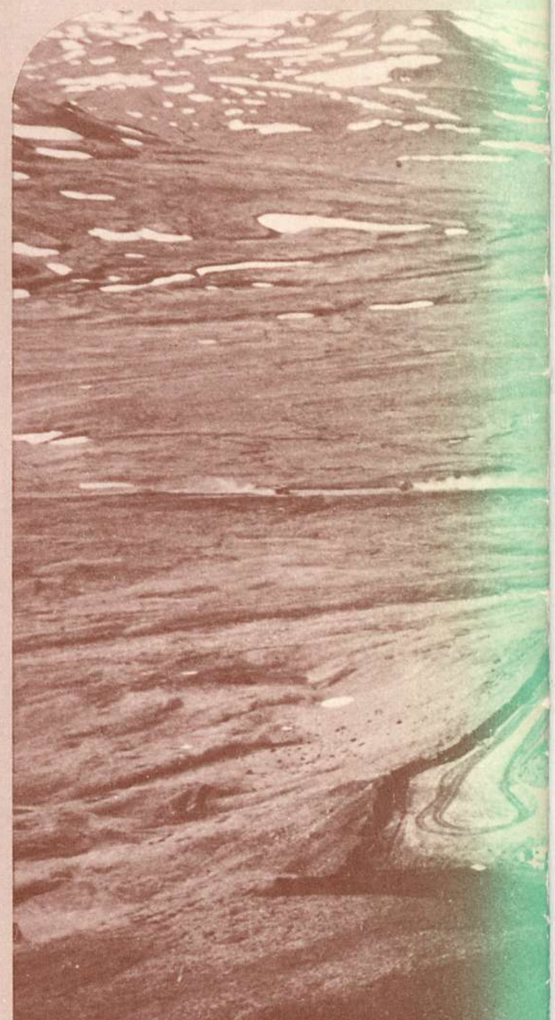

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