HC Hat Creek 51(1)A

CONFIDENTIAL

COAL

REPORT

ON

THE

HAT CREEK

PROJECT

ASHCROFT

MINING DIVISION

C. M. CAMPBELL

MINING ENGINEER

1951

C. M. CAMPBELL

MINING ENGINEER

216 - 602 WEST HASTINGS ST.

VANCOUVER, B.C.

HC Hat Creek 51(1)A

REPORT

ON

HAT CREEK PROJECT

Ashcroft Mining Division
British Columbia

BY

C. M. CAMPBELL
Mining Engineer

216 - 602 West Hastings
Vancouver, B.C.

1 9 5 1

C O N T E N T S

C. M. CAMPBELL
MINING ENGINEER

216 - 602 West Hastings
VANCOUVER, B.C.
October 1st 1951

REPORT

ON

THE HAT CREEK PROJECT

ASHCROFT MINING DIVISION
BRITISH COLUMBIA

SUMMARY AND CONCLUSIONS

This project concerns the centrally located coal, clay and shale, and limestone deposits at Hat Creek; the primary production therefrom of coal, clay products, and cement; and the secondary production of numerous and valuable by-products.

Dawson, in 1877, referred to the coal deposit as "an enormous lignite bed." Actually it is a series of beds and this series is of indefinite extent. For various reasons little development work has been done, the main reasons being that the mining of lignite, essentially a lower grade coal, by high-cost underground methods, with a seasonal market, the danger of fires due to spontaneous combustion, and a transportation problem except for the local market, is not an attractive project. Even strip mining with modern equipment means not only costly treatment plants but the disposal to waste of too large a proportion of the product to definitely justify an operation. The property, therefore, except for the small tonnage used locally, has remained idle.

Recent examination of the series, however, has shown that the material between the coal seams, instead of being valueless sandstone and conglomerate, is clay and shale, the basis, with the heat from coal, of the clay products and ceramics industry. The surrounding mountains also are high-grade limestone; and limestone with the shale and the heat from the coal form the raw materials for a cement industry. Total extraction of many millions of tons, above a drainage floor, is possible by low-cost shovel operation and reasonably complete utilization by means of the industries mentioned seems possible. There are few places in the world where the raw materials are so conveniently grouped for a successful industrial operation.

Statements in this report are based on reports prepared by the Ottawa and the Victoria Departments of Mines. Such work as has been done since confirms their general accuracy; there is tangible evidence of the enormous tonnages referred to by Dawson, not only of coal but of clay, shale, and limestone. Primary treatment procedure was worked out decades ago. Research has indicated, and continues to indicate, great value in the by-products.

Before any final plan is prepared, however, it is necessary that certain check and supplementary drilling be done; that further tests and reports be made not only in regard to coal but in regard to the clay and the limestone and their final products; and that other industrial minerals in the district be further examined and reported upon. The cost of this work, plus payments on possible options on additional property, will beof the order of $100,000. With the information obtained a proper plan can be prepared. Such a plan is necessary before major financing can be arranged and it will mean an additional expenditure of about $50,000. It will be prepared by recognized experts in coal preparation and marketing, in the production and marketing of clay products and cement, and in the best type of plant for the production of steam-electric power. The available information indicates that the above expenditures are fully warranted.

LOCATION

Following this page are Location Maps 1 and 2, and an air photo. No. 1 shows Hat Creek in reference to the southern half of the province. No. 2 and the air map show in more detail the area immediately surrounding Hat Creek.

The mine has an elevation of 2850 feet above sea level. The precipitation is about 15 inches. The Hat Creek watershed above, however, has a precipitation of 20 inches and its area is about 150 square miles. The area about the mine is covered with sage brush, with considerable valuable timber beyond. To retain the moisture, however, it is imperative that much of this remain. The climate is very healthful and pleasant.

TRANSPORTATION

The broken red line on Map No. 2 shows the logical location for a 50-mile link connecting the Pacific Great Eastern Railway with the Canadian National and the Canadian Pacific. This route passes through Hat Creek. While there is a good connecting highway between these points, and while modern trucks have solved many transportation problems, a direct railway connection is essential for the lowest costs and is justified by the tonnage indicated, aside from its desirability.

MAP NO. 1

The map following shows the central position of Hat Creek in the populated southern half of the province. Its favorable location offers it the opportunity to compete in the Vancouver area and gives it a dominant position in the rapidly expanding central and northern parts.

The map clarifies certain phases of the project;

COAL - In 1950 the coal production amounted to 1,756,667 tons. This was produced from Vancouver Island (575,228 tons), Northern B.C. (25,121 tons), Nicola-Princeton (17,929 tons) and East Kootenay (1,138,389 tons). The chief consuming area is the southern Coast. East Kootenay coal is not a domestic coal and little comes to the Coast. Other sources are inadequate and about a million tons is brought from Alberta at a cost averaging about $5.00 per ton for freight. With a properly prepared coal there is an opportunity for Hat Creek to duplicate in Vancouver the performance of Saskatchewan coal in Winnipeg. Another advantage is that the P.G.E. has been starved for freight and would make every effort to aid in the transportation of Hat Creek products to Vancouver.

CLAY PRODUCTS - Because of the high price of brick and the low price for lumber the latter has been featured in construction work. The prevailing high prices for lumber offer an opportunity for moderately priced brick. There is also a growing market for other clay products.

CEMENT - At the present time the province is supplied by two plants. One is at Bamberton, on Tod Inlet, north of Victoria. Its shale and part of its lime come from a nearby source; its coal from Cumberland, and most of its lime from Blubber Bay, near Van Anda. These latter sources are about 100 miles to the north. The other plant is at Exshaw, near Banff, in Alberta. The leading project under consideration just now is the construction of the huge dam on the Nechako River, shown on the map. This work will last for some years and will use much cement. It is definitely in Hat Creek territory.

POWER - There is a widespread shortage of power. About 50 miles west of Hat Creek is Shalalth, site of the major plant of the B.C.Power Co., with an ultimate capacity of 600,000 HP. Its logical market is the Vancouver area. To the east, near Needles on the Lower Arrow Lake, is the Whatshan project of the B.C.Power Commission, good for 60,000 HP. This will hardly support the North Okanagan and Kamloops areas. A large plant will be needed at Hat Creek for its own needs and those of the district.

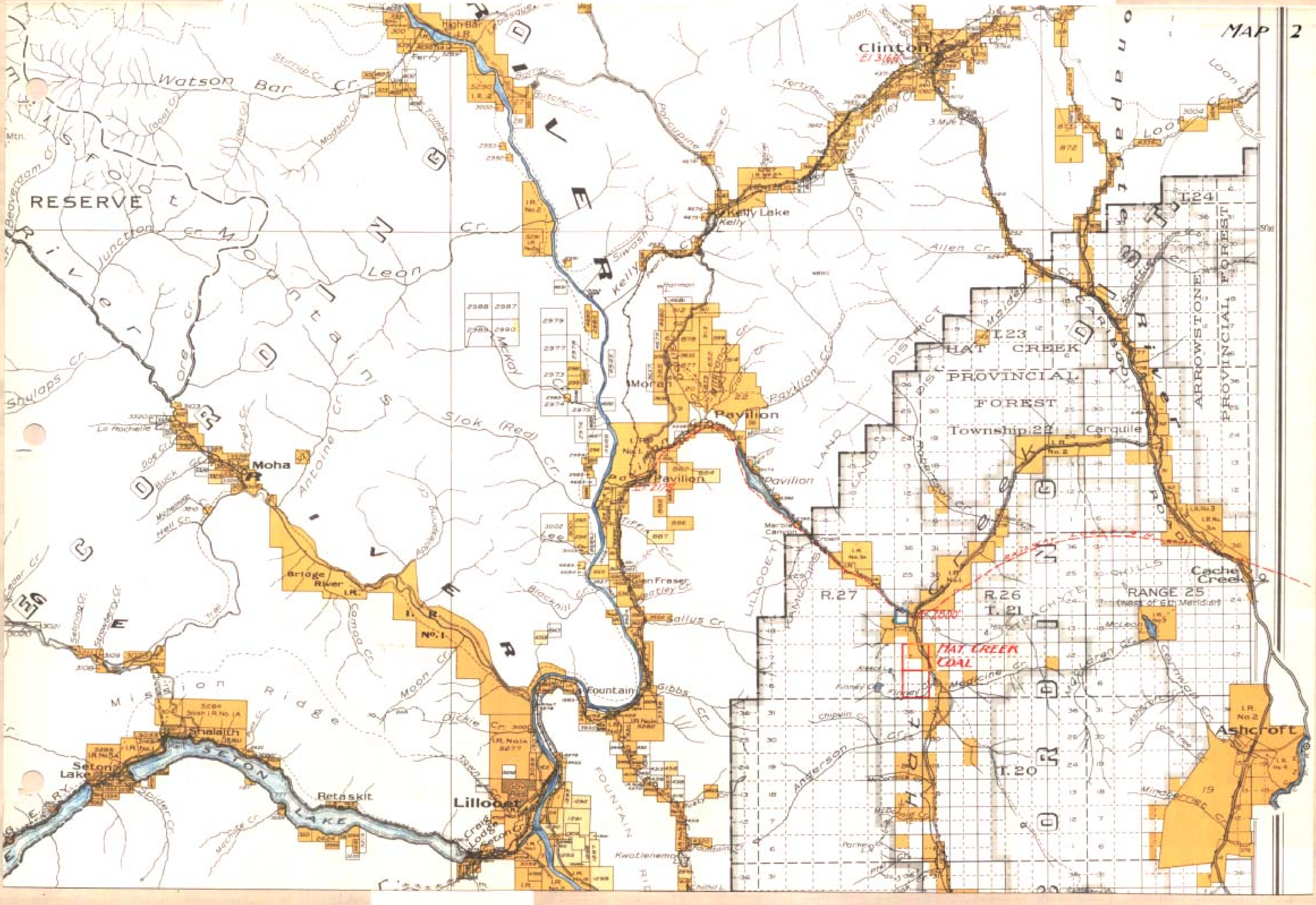
MAP 1
PRINCE RUPERT
Burns Lake
Kitimat
PRINCE GEORGE
McBride
TWEEDSMUIR PARK
Quesnel
Wells
Williams Lake
Bella Coola
QUEEN CHARLOTTE SOUND
STRAIT
Mt. Waddington 13260
Mt. Queen Bess 10700
Monarch Mtn.
Mt. Silverthrone
CHILKO LAKE
Lytton
KAMLOOPS
SALMON ARM
ENDERBY
ARMSTRONG
VERNON
MERRITT
KELOWNA
Penticton
REVELSTOKE
Nakusp
New Denver
KASLO
NELSON
TRAIL
ROSSLAND
GREENWOOD
GRAND FORKS
CRANBROOK
KIMBERLEY
FERNIE
VANCOUVER
NORTH VANCOUVER
NEW WESTMINSTER
CHILLIWACK
Abbotsford
Hope
NANAIMO
LADYSMITH
COURTENAY
CUMBERLAND
VICTORIA
Tofino
JASPER PARK
BANFF PARK
Lake Louise
Banff
Calgary
Edmonton
U. S. A.
Mt. Baker
① 00120
Scale
City Municipalities
Village
Post Offices
Settlements
Main Highways
, Projected
Local Roads
Main Travel Routes designated thus
Road Mileages between points
Railways and Stations
Ferries
F or Ferry
Ferry Routes
Customs Ports of Entry.
Cust
Park Boundaries
Layer Contours—
0 feet to 3000 feet
3000 " to 6000 "
6000 " and over

MAP NO. 2

This map shows the leading features of the Hat Creek area in more detail. The property is in the Kamloops Recording District and the townships, ranges, and sections are marked.

An up-country connection between the P.G.E. and the C.N.R. has long been advocated from the standpoint of convenience. As the shortest distance is between Clinton and Ashcroft a connection between these points has been considered the logical solution. Actually, because of grades, the connection would be with a point east of Ashcroft. The same purpose would be attained by a connection between Pavilion, via Hat Creek, and the C.N.R. This route would have the argument, and it should be decisive, that it would originate a large amount of freight.

00120 (2)


MAP 2
Clinton
El 3168'
Kelly Lake
Kelly
Pavilion
Moha
Bridge River I.R.
Fountain
Lillooet
Shalalth
Seton Lake
SETON LAKE
Retaskit
Marble Canyon
Cache Creek
Ashcroft
Carquile
RESERVE
Watson Bar Cr.
Leon Cr.
Slok (Red) Cr.
Pavilion Cr.
Allen Cr.
Loon Cr.
Medicine Cr.
Anderson Cr.
Mission Ridge
HAT CREEK PROVINCIAL FOREST
Township 22
T.23
T.24
T.21
T.20
R.27
R.26
RANGE 25 (West of 6th Meridian)
ARROWSTONE PROVINCIAL FOREST
HAT CREEK COAL
LILLOOET LAND DISTRICT
KAMLOOPS DIST
FOUNTAIN RIDGE

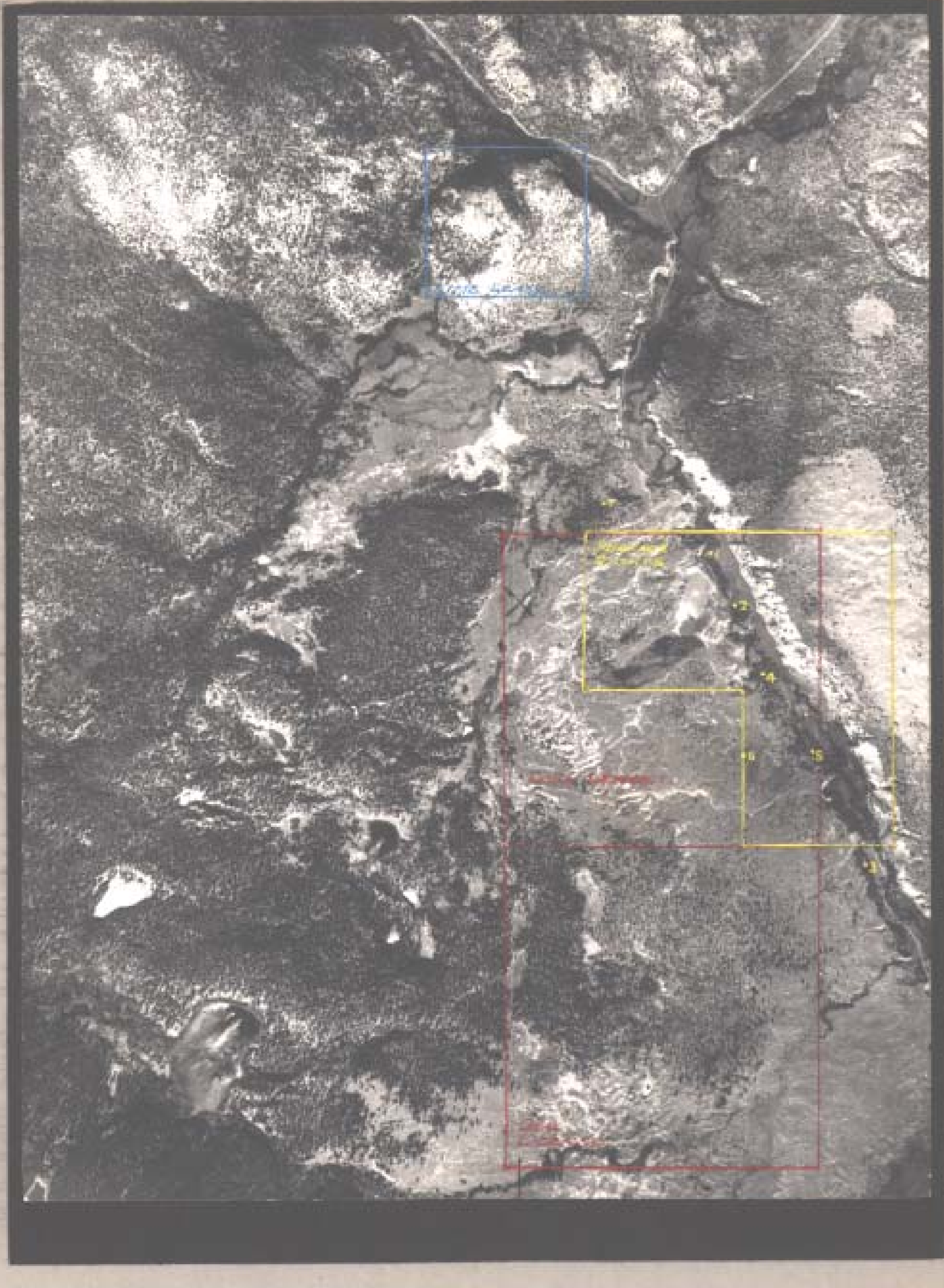
AERIAL MAP

In the photo following the mile-square coal areas will give some idea of the scale.

The area is, except in the lower sections, covered with a forest. The bare portions are covered with sage brush and grazing areas.

The south-western section shows a dozen small lakes. The largest is Finney Lake, covering an area 2000' x 1000'. These lakes, dammed and used as reservoirs, with water from Hat Creek will, it is believed, supply the needs for a large operation. The watershed of these lakes should, however, be protected. Storage and water rightsshould be checked.

The drill holes are shown as yellow dots. The bottom of the coal in No. 2 hole should come to the surface just south of No. 1 hole and the probability is that both holes 1 and 2 are just outside the basin. Both these holes were drilled in boulder clay to depths of about 100 feet. Hole 3, to the south, was stopped after going through clay and shale for 291 feet. It is quite possible that the coal in hole 5, to the north, dips under the bottom of this hole. Essentially however the results in No. 3 block any idea of surface operation in that direction. No. 6 hole, the farthest to the southwest met with coal just below the overburden and was in the coal series when stopped at 504 feet.



GEOLOGY

According to the MacKay report (see map following) the lowest rocks belong to the Carboniferous period and comprise the Cache Creek series and the extended limestones characteristic of the district. Intruded into the limestones are several granodiorite stocks which have changed the limestone into marble. Lying unconformably on the above is the Coldwater series of lake deposits, several thousand feet thick, consisting of a basal conglomerate, overlain by sandstone, clays, and shales, and carrying seams of lignite in the upper part. On the above was at one time a wide-spread volcanic flow. This was followed by erosion and later by a deposition of boulder clays and glacial gravel. Further erosion has exposed the coal along Hat Creek. The overburden is still, however, so widespread that outcrops of underlying rock are prectically non-existent and much further work must be done before the limits of the deposit can be determined.

Dealing with the Coldwater series, that carries the coal beds, Dawson (CGS, Vol. VII, 1894, p. 211B) says;

> "From the analogy with the Nicola Valley occurrences, it is quite possible that in beds beneath the lignite already known, fuels of the character of true coals may yet be found. Whether this is or is not the case in this locality can be told by boring only. It is further to be remembered, that the lignite-bearing rocks, if correctly referred to the Coldwater series, should extend beneath the great accumulations of the Clear Mountains. This implies that the mountains bordering the valley do not necessarily mark the limit of the lignite series in a westerly or southerly direction."

EXPLORATION TO DATE (See Map in Pocket)

This map shows a plan of the area with inserts showing more detail. The "Key Map" shows the course of Hat Creek and the location of the diamond drill holes. These are numbered, left to right - 3, 5, 6, 4, 2, 1, and 7. Holes 3 (291 ft. deep), 1 (93 feet), and 7 (100 ft.) did not encounter any coal. These holes may not have been deep enough, may be in a faulted area, or they may be outside the basin altogether. Graphic logs of the other holes are shown on the second map following. In the main, the limits of the deposit have not been reached to the west, south-west, or east. To the south-west hole 6 is still in the coal series at a point 504 feet below the surface. This indicates important possibilities both to the west and the south; even the coal in hole 5 may dip under the bottom of hole 3. To the north, hole 2 cut a seam 200 feet thick, an unprecedented thickness, and the continuation of this seam along its strike to the east has not been followed at all.

The need for this connection has long been recognized and the idea has been that it would ultimately be made between some point east of Ashcroft, and Clinton. Direct connection with Ashcroft is impossible because of the very steep grade just north of Ashcroft. Connection by way of Hat Creek would serve the same purpose as the Ashcroft-Clinton connection, and would provide the freight without which a railway cannot be economically profitable.

THE PROPERTY

Based on Map 2 the blocks of ground held can be described as follows:

Two coal areas, each one mile square, are held by the company. The northern one covers the W $\frac{1}{4}$ Sec. 7, Tp. 21, R. 26 and the E $\frac{3}{4}$ Sec. 12, Tp. 21, R. 27. This area was acquired under the old Act, may be crown-granted, and calls for a royalty of ten cents per ton on the coal mined. The southern square mile covers the W $\frac{1}{4}$ Sec. 6, Tp 21, R. 26 and the E $\frac{3}{4}$ Sec. 1, Tp. 21, R. 27. It is held by license, cannot be crown-granted, and the royalty is 25 cents per ton. The surface rights that go with the property are colored yellow and include the W $\frac{1}{2}$ Sec. 7, Tp. 21, R. 26, and the NE $\frac{1}{4}$ Sec. 12 Tp. 21, R. 27.

The limestone rights on the NW 1/8 Sec. 13, Tp. 21, R. 27 and the adjoining SW 1/8 Sec. 24, Tp. 21, R. 27 have also been acquired. This quarter-section is shown in blue on the maps.

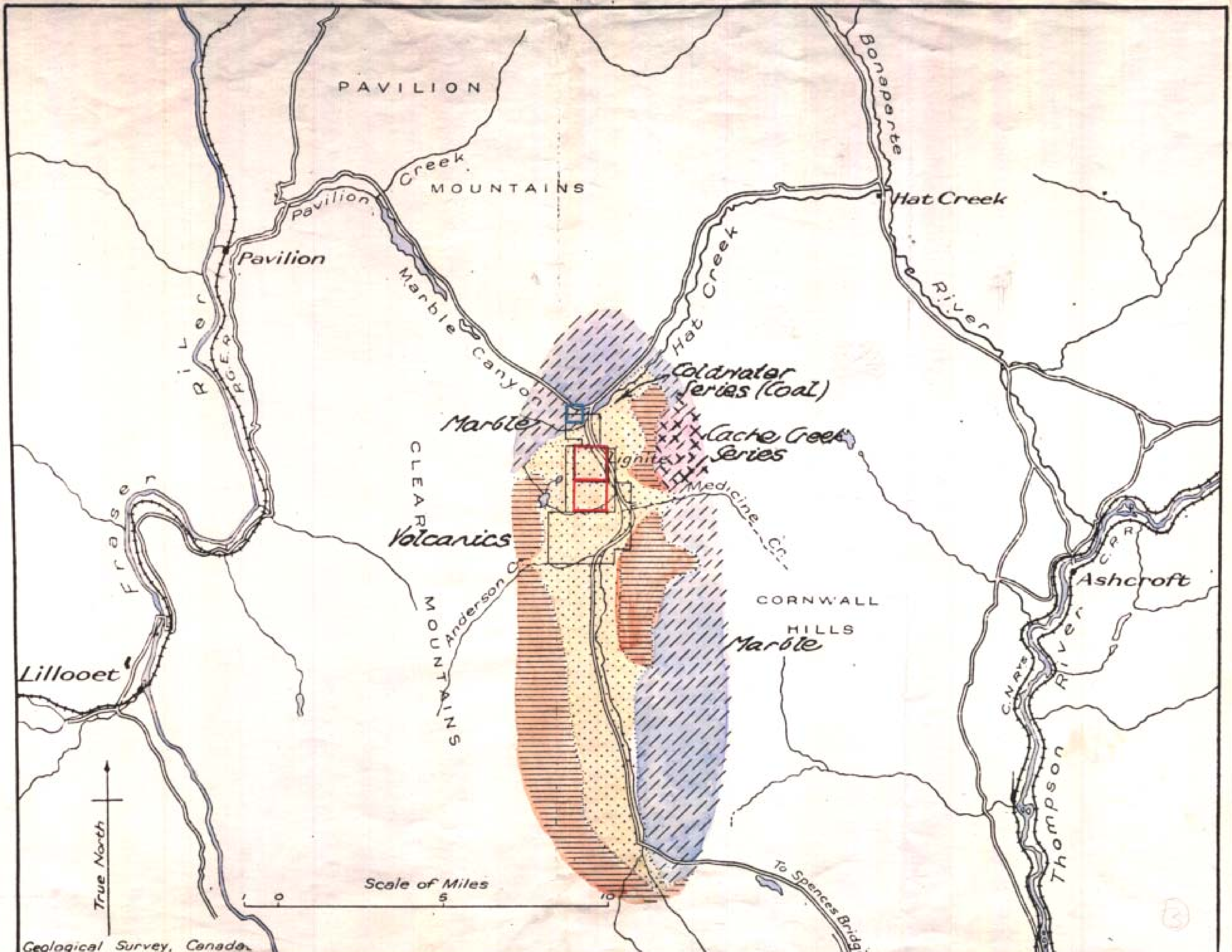
HISTORY

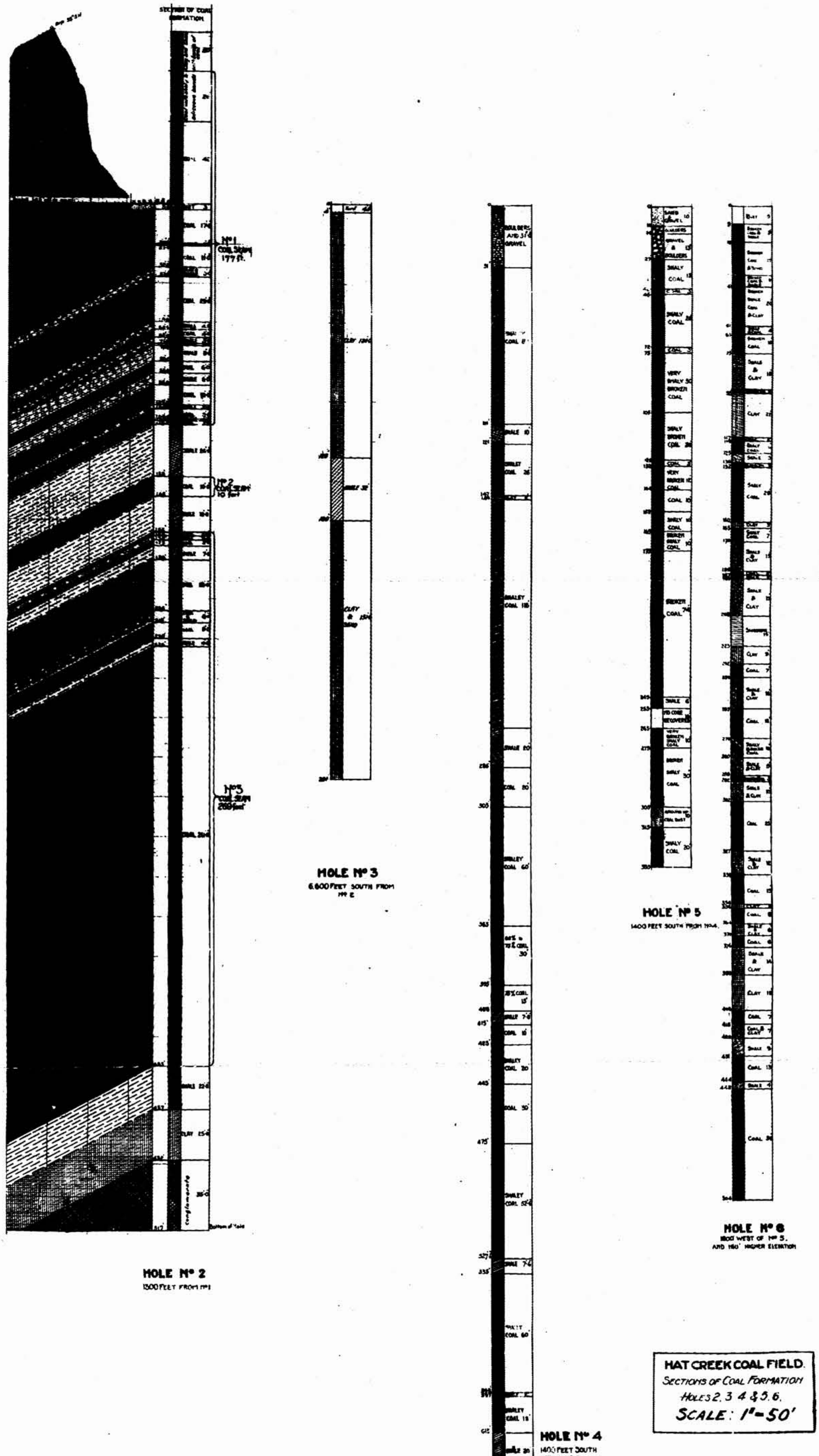
Aside from supplying local fuel needs the property was idle until about 1924 when an organization, after diamond drilling, boomed it as having hundreds of millions of tons of bituminous coal. This claim resulted in Government investigations and a joint report by George Wilkinson and J. D. Galloway, of the Victoria Department of Mines; and a second report by B. R. MacKay, of the Ottawa department, were printed in the British Columbia Minister of Mines' Report for 1925. These reports deflated the estimates prevalent and classed the coal as lignite. However, the fact remains that in the small 110-acre area drilled an estimate of 30 million tons of coal, including shaley coal, was made. About half of this is clean coal. The shaley coal is marketable locally. Great possibilities beyond were admitted. While the coal was given a lower grade than bituminous its value as a fuel was not questioned. No reference was made to the value of the deposit if operated in conjunction with the clay and limestone available.

GEOLOGICAL MAP

Coal and other locations are shown. Definite boundaries of the Coldwater series, containing the lignite beds, are, because of the overburden, somewhat conjectural. While certain drill holes did not encounter the coal the conclusion that coal does not exist in these sections is, because of the shallow depths reached, not yet final. Coal has also been reported in other parts of the Coldwater series at some distance from the present known showings.

The map is based on Dawson's map made over half a century ago. Since then little detailed geology has been done and further work of this sort is required in the area adjacent to the coal outcrops. More information, for example, is needed in regard to the limits of the lava flows. While there appears to be ample tonnage, free from any volcanic overflow, that can be cheaply extracted, to outlast the century, it is desirable in order that there may be proper planning that more geological study be done in the surrounding area.


PAVILION
MOUNTAINS
Pavilion Creek
Pavilion
Hat Creek
Bonaparte River
Marble Canyon
Hat Creek
Coldwater Series (Coal)
Marble
Cache Creek Series
Lignite
Medicine Cr.
CLEAR MOUNTAINS
Volcanics
Anderson Cr.
Fraser River
P.G.E.R.
CORNWALL HILLS
Marble
Ashcroft
C.P.R.
C.N.Rys.
Thompson River
Lillooet
True North
Scale of Miles
1 0 5 10
To Spences Bridge
Geological Survey, Canada



HAT CREEK COAL FIELD.
Sections of Coal Formation
Holes 2, 3, 4 & 5, 6.
Scale: 1" = 50'

The map in the pocket shows, in orange, the locations of the coal exposures along the creek and in pits and underground work. The location of the volcanics will be noticed. Because of the extended overburden the boundaries of the formations are very indefinite. Only one actual volcanic outcrop in the map area is known and this is marked "Volcanic Pinnacle." It consists of a column about ten feet in diameter and about 20 feet high, standing by itself on a side-hill. This volcanic formation is a flow and Dawson's comment is that the coal may go under this flow for miles. It will cost more to remove coal under this lava by surface methods and much of it will have to be obtained by underground methods at greater cost. Actually, however, there is enough coal indicated that is available by surface methods to last for decades. The indications are, also, that this tonnage may be greatly increased by further exploration.

THE SECTIONS

Sections have been made and they are shown on the map. A study of them will give a better understanding of the deposit.

SECTION 1

The Finney shaft (caved) is stated to have been in coal for 150 feet, while Hole 2, nearby, went out of coal at 435 feet. Conglomerate, the only occurrence recorded, was met with at 482 feet. The upward course of the coal extended would bring it out close to the collar of Hole 1. which encountered 93 feet of boulder clay. One would expect that the conglomerate met with at the bottom of Hole 2 would be cut in Hole 1. Instead, boulder clay is recorded. A slight flattening of the dip would bring the conglomerate below the bottom of Hole 1, in which case the boulder clay in that hole might correspond with the clay and shale in Hole 2. Further coal might be encountered below the conglomerate if Hole 1 or Hole 2 were drilled deeper. This possibility should be borne in mind.

In the section the "Opencut" marked on the map was worked in the early days. As the walls have slid in coal is not now visible but, during low water, strongly defined coal with strike and dip as shown is seen in the creek adjoining for over 50 feet. Coal was also encountered in the bull-dozer cut shown on the section. Here the overburden is not more than six feet deep.

SECTION 2

Tunnel 3 passes through clay for a short distance when it meets the coal. The strike of the contact is shown on the map and as this strike is different from the strike of the coal a fault may be indicated. At the west end of this section the opencut shows coal but with a dip to the east. Whether or not this is the west rim of the coal basin can only be demonstrated by further work. Logical development is to drive the tunnel ahead and also drift to the north to expose the structure. This tunnel shows good lignite.

SECTION 3

This section shows coal outcropping along the creek bank while the tunnel is all in coal. An important fault is indicated. This is shown in some detail in the insert of No. 2 tunnel. To the west of the fault the coal has a strike and dip much as in Section 1; while to the east of the fault the strike and dip are about the same as in Section 4. Further development is needed to clarify the matter.

SECTION 4

The greatest amount of work has been done in No. 1 tunnel where an area 700 feet by 300 feet has been opened up. The great bulk of the tonnage mined has been marketed locally. The work shows a fairly uniform dip of 65° to the west, except that at the end of the third drift to the south a change is indicated. The last hundred feet of the main entry to the west shows clay and carbonaceous shale with negligable marketable coal. Coal may again be encountered with further work.

Probably the most important feature of this section is, however, the fact that Hole 4 continued in the coal series for 615 feet, and the fact that it was stopped after being in shale for a few feet does not mean that the bottom of the series has been reached. The hole went through 31 feet of boulders and gravel before striking coal.

SECTION 5

Holes 5 and 6 bottomed in coal. Hole 5 went through 25 feet of boulders and gravel before striking coal and Hole 6 passed through nine feet of dirt before coal was met with. This section is, therefore, open both laterally and at depth and the area beyond is a logical location for further drilling. It is for this reason that the lease on the southern square mile was obtained. A shallow shaft following No. 6 hole is worth consideration in order to obtain the strike, dip, and such other information as it would provide.

NATURE OF THE COAL

The coal is black lignite and it makes a high percentage of lump. It burns with a good flame and will retain fire all night. The average of 55 samples, taken by the Victoria Department of Mines, air dried, showed 17.4% moisture, 31.4% volatile, 36.6% carbon, 14.6% ash, and 8,056 B. T. U's. In view of the fact that these samples ranged from 2.0% to 38.9% ash, it is logical to believe that the average grade can be materially improved by selection and further treatment. Further exploration may open up appreciable tonnages of the higher grade coal, and modern preparation methods may greatly increase the grade of such coal as is mined.

NATURE OF THE RESERVES

While the tonnage is obviously large any estimate is largely hypothetical. Some probabilities are here outlined.

Suppose it is assumed that the deposit ends at Section 2, and that an open pit would start there at the elevation of the tunnel - 2845 feet above sea level. The collar of hole six is 3055 feet. This means that, allowing for a slight grade, a pit would have a face 200 feet high at Hole 6, and 40 feet high at Hole 5, or an average height of 120 feet. The average height over the entire distance would therefore be 60 feet. The width varies from 600 feet at the north to 1000 feet between Holes 5 and 6 at the south, or an average of 800 feet. The distance between Section 2 and 5 is 3300 feet. Based on 20 cu. ft. of clay, shale, and coal to the ton the reserve in this block amounts to 8 million tons. All this, however, is only a starter. At Hole 6 the height of the pit is 200 feet and the height increases as the work proceeds. There is also no reason, as precipitation is light and the creek could be diverted, why the pit should not go to 600 feet below the creek level, which is the known depth of the coal series in Hole 4.

While there seems to be no lack of material the whole situation points to the need for further work to confirm and amplify the results already reported, determine the locations of the best coal, clay, and shale; supply information necessary to properly locate the plant and determine its size, and to justify an application for such additional leases, or revision of leases, as may be required to protect the project.

AS A COAL MINE

As a coal producer, using coal as fuel, the situation is similar to that in Saskatchewan, where a large tonnage of Estevan coal of similar grade is mined and shipped to Winnipeg at a profit. In recent years the tonnage has been over 500,000 tons annually. Estevan is 300 miles from Winnipeg, while Hat Creek, assuming through railway service, is less than 200 miles to Vancouver. This credit in mileage would more than offset the 20-mile up-grade from Pemberton to Alta Lake. A probability of this sort warrants investigation.

COAL BY-PRODUCTS

There are hundreds of uses for coal, aside from its fuel value, and for some of these lignite is better adapted than coals with a greater fuel value. Probably the outstanding use is the production of gasoline. Reports from Germany indicate that methods used there during the war greatly reduced the price from that of the pre-war days. Lignite is adapted to this use.

Former Secretary of the Interior Ickes, summed up the situation in regard to the conditions in the United States in the December, 1945, issue of the "American Magazine" in these words;

> "Synthetic motor fuel can probably be made from coal at 18 cents a gallon in large plants. The Bureau of Mines is experimenting in the production of synthetic gasoline in commercial sized plants. Costs of from 12 to 15 cents are possible after the techniques have been fully developed."

This means 14½ to 18 cents per Imperial gallon. With the low initial cost of Hat Creek coal, there is no apparent reason why costs should be higher than in the United States.

In recent years electric power based on cheap low-grade coal has challenged the supremacy previously held by Hydro-electric power. The plant of the Granby Company at Princeton, using strip coal brought from Alberta, is evidence of this. The nearest hydro-power plant is at Shalalth, 30 miles in a direct line to the west of Hat Creek. The general understanding is that this power will be needed in the Vancouver area and will not be competitive. If it should be able to compete it only means that Hat Creek could get cheaper power than it otherwise could and would be able to reduce the prices of its other products.

CLAY PRODUCTS

In different parts of the world clay and shale seams, associated with coal, are used to produce clay products and, in this way, to increase the dividend rate. At Hat Creek the situation lends itself to this procedure. Clay products are high-priced throughout the province, particularly in the Vancouver area, and there are times when they have to be brought all the way from Alberta.

There is room for much further investigation into this phase. Some clay samples were sent to Ottawa and, according to the report obtained, they did not show real merit and called for some blending. One sample, however, approached fire-clay grade. Samples sent to the brick yard at Port Moody produced some good and some indifferent brick and the information that with a little blending a good product would result. Some work by T.G.Kinvig, of Medicine Hat, gave good results. Some clays in the area, near a lava flow, have been baked into a most attractive product.

This phase of the situation is still, however, largely unexplored. Very few of the clay and shale seams in the series have been opened up and sampled and no worth-while investigation has been made of the clays in the tributary area. Some idea of the compositions of the different clays is given in the following table which represents some samples sent to Nepheline Products, Lakeside, Ontario, for analysis. The location numbers are also marked on the map in the pocket.

NO.	LOCATION	SiO_2 %	Fe_2O_3 %	Al_2O_3 %	Ignition %
411C	Clay seam, No. 1 T.	52.16	2.66	24.54	13.14
412C	2 clay seams "	49.52	4.16	23.90	15.04
413C	Clay seam "	57.12	3.83	19.86	11.10
414C	Black clay "	48.80	2.16	18.06	26.02
415C	White clay "	48.80	1.83	23.94	22.56
416C	Brown clay, No.3 T.	49.52	2.33	21.03	24.04
417C	Brown clay, 2nd seam	55.20	1.49	25.97	12.38
418C	Brown clay outcrop	63.26	1.66	19.71	8.92
420C	Clay, Outlet Mud Lake	28.96	1.16	31.30	22.04

Nepheline Products, commenting on the high alumina content of sample 420C, said that with also a high alumina ash coal, and the high grade limestone, this clay would be of interest as a source of alumina for the production of the metal.

In so far as tonnages are concerned, the drill-hole records indicate a vary large tonnage of clay in general. Drill cores of Holes 1, 3, and 7 were almost entirely of clay or shale.

A report entitled "Improving the Properties of Clays and Shales" (GSC publication No. 793) states;

"Throughout Canada the greater part of the surface (overlying the bed rock) is the result of, or has been subjected to extreme glaciation, which accounts for the heterogeneous character of the soil mantle, and the nature of the clay deposits. The clays were mostly deposited from the waters of melting receding glaciers, which left gravel, sand, silt, boulder clays, stoneless clays, and highly colloidal clays, depending upon the conditions under which the waters laid down their burden of suspended material."

Canadian clays, in general, are therefore second class. Notwithstanding this the chief shortcomings have been counteracted by different procedures and Canada has built up an important industry.

The generalization quoted has a bearing on Hat Creek, inasmuch as Holes 1, 3, and 7 show boulder clays. While these have undoubted value the situation is entirely different with the clay and shale seams between the lignite beds. These are not the result of glacial action. Some idea of the content of a small area only is given in the first six samples in the above table.

J. G. Phillips, the author of the report referred to, mentions silica and alumina as desirable, and iron and lime, because of their fluxing action, as undesirable if a refractory brick is needed. Lime also has a bleaching effect and produces a pale colored brick, which, of course, may be what is wanted. We have no clay analysis that gives the lime content, a deficiency that will be corrected. One sample, sent to Ottawa, is reported to approach the fire-clay grade; such brick as have been made have a red color; and the clays burned in place, due to contact with an intrusive, range in color from a pleasing buff, through red to a deep reddish purple. Brick plants have produced a product with as high as 40% lime, and a sand-lime brick with about 7% lime, treated with steam and producing a hydrated-lime-silicate as a bonding agent, is reported to be very strong.

There is, therefore, an ample tonnage of clays and shales, and of these to date, only a superficial examination has been made.

CERAMIC PRODUCTS

From these clays and shales and other industrial minerals, with heat, is formed that great group known as ceramic products. Of these minerals, chrome, gypsum, magnesite, silica, sodium minerals, and diatomite are reported to exist in the area. No adequate investigation has ever been made of these products. Probably the most important are the sodium compounds and silica which, with limestone and the heat from the coal, make up the raw materials for the production of glass, now of increasing importance as a structural material.

LIMESTONE AND CEMENT

Limestone mountains in the Hat Creek area cover about 100 square miles, the nearest exposure to the coal being only about a mile distant. The limestone has many well known uses the one featured here being the one where, in conjunction with clay or shale and the heat from the coal, cement is produced.

The general high-grade nature of this limestone is responsible for the following comment by M. F. Gouge, of the Ottawa Department of Mines. It appears on page 63 of "Investigations of Mineral Resources and the Mining Industry, 1929." He says;

> "The Marble Mountains between Lillooet and Clinton are, as the name implies, composed principally of limestone much of which is exceedingly pure as is indicated by the following analysis made of a sample obtained at the eastern end of the Marble Canyon on the highway from Cache Creek to Pavilion;

Silica	0,20 %	
Ferric Oxide	0.08 %	
Alumina	0.06 %	
Calcium carbonate	99.02 %	
Mg. carbonate	0.59 %	99.95 %"

The above sample was probably taken from the north side of the lease included in this project. The following results were obtained from the talus on the south side of the same area;

SAMPLE NUMBER	159 W	160 W	
Insoluble (Silica)	1.3 %	1.6 %	
Iron and Alumina (Fe_2O_3, Al_2O_3)	1.0 %	0.3 %	
Lime (CaO)	54.2 %	54.5 %	Av. 97% $CaCO_3$
Magnesia (MgO)	0.4 %	0.3 %	
Loss on ignition	42.8 %	43.2 %	
Undetermined	0.3 %	0.1 %	
	100.0 %	100.0 %	

There is quite a demand for lime not only for cement but, in its various forms, for building and agricultural purposes. The supply for the lower coast is obtained largely from Texada Island, but reserves of good lime there have their limitations and mining and handling charges are considerable. Hat Creek and the Marble Canyon generally have the great advantage that huge tonnages are available in talus piles. Mining charges and handling charges can be brought to a minimum.

GENERAL CONCLUSIONS

Regardless of the fact that there is visual evidence of a huge tonnage of coal with its clay and shale seams, further work is needed to get a more adequate idea of their extent and grade. This will eliminate errors in the resulting plan. It is also desirable, if not imperative, that in view of the need for a railway, a tonnage large enough to impress the railway authorities be blocked out in such a way that its magnitude can be convincingly demonstrated.

Little additional work is needed on the limestones as the reserves are visible and sufficient samples have been taken to give a fair idea of the grade. More complete information can be quickly and cheaply obtained.

More examination work is necessary to outline the merits of tributary resources such as gypsum, silica, etc. throughout the area.

It is impossible to say how much this preliminary work will cost as the main problem is to determine the general extent of a coal and clay deposit of unknown extent; and a secondary problem is to investigate other deposits of which little is known. In some cases exhaustive tests will have to be made followed by reports by experts. A total appropriation of $150,000 has been suggested.

Respectfully submitted

C. M. Campbell
Mining Engineer

P H O T O S

The first four photos should be studied in connection with the map in the pocket.

Of these the first three, taken from the east side of the Hat Creek Valley looking west, form a panorama with the Clear Mountains in the distance. According to Dawson (page 4) the coal series "should extend beneath the great accumulations of the Clear Mountains."

THE SOUTH END

The upper view is a view to the south-west, and shows the mine buildings at the lower right. Beyond are Holes 4, 5, and 6. Holes 4 and 5 were drilled from the floor of the valley and showed 31 and 23 feet respectively of overburden before the coal series was reached. Hole 6 showed only 9 feet of overburden.

Should an open cut be started at the northern end of the deposit it would have a face 200 feet high when it reached Hole 6, and from then on the height would increase.

CENTRAL SECTION

The lower picture gives another view of the mine buildings. Cuts show that the coal often conforms to the irregularities of the surface and is sometimes only a few feet beneath.

Hole 2

Hole 2

THE NORTH END

The most northerly coal exposures are marked on the photo. The coal either outcrops or is found close to the surface over most of the area in the foreground. These outcrops are doubtless those of the 200-ft. thick seam, and other seams, cut in Hole 2 and shown on the different maps. The strike and general extent of this coal can be cheaply determined by diamond drilling.

LOOKING NORTH FROM ABOVE MUD LAKE

The Hat Creek valley runs along the centre of the picture horizontally to the extreme left and then turns sharply to the right.

In the foreground is the volcanic pinnacle referred to in the text. It is the remnant of a lava bed of considerable extent. Lava float is found in large amount at the lower left of the area. Beyond there are no signs of lava.

Mud Lake, shown in the centre foreground, was formerly a marshy area which has been drained.

The mountains in the distance are all limestone or marble and extend for miles to the left and form the sides of what is known as "The Marble Canyon."


CLEAR MOUNTAINS

THE WHITE CLIFFS OF THE MARBLE CANYON

The Marble Canyon, of which the following pictures show the north-east side, has alength of eight miles and the walls have an appearance much as is shown in the pictures. For over three miles the average height above the floor of the canyon is over 3,000 feet.

In all cases a talus pile extends along the base of the mountains. In some places it is bare and it is shovelled forect for road material. Generally there is a very light cover, such as is shown in the foreground, where lumps of broken limestone show through the vegetation. It is very likely that the talus can be used with little or no further treatment.

A lease has been obtained covering the quarter-section closest, about a mile, to the coal outcrops.

093666-[illegible]

Received 10/13/67

COPY

Appendix

HARRY M. HOPE ENGINEERING COMPANY

SEATTLE 1

R. R. WILSON MATERIAL:

1. General Correspondence & Proposed contract.
   Maps.
   Coal Distillation Brochure.
2. Chrome possibilities in area.
3. Lime and Limestone utilization.
4. Diatomite and Permalite.
5. Refractories (Basic)
6. Gypsum & Gypsum products.
7. Silicon Carbide.
8. Magnesium.
9. Alumina & Aluminum USMM Process.
10. Glass Plant.
11. Expanded Shale.
12. Salts.

COPY

HARRY M. HOPE ENGINEERING COMPANY

SEATTLE 1.

August 1, 1951.

Mr. R. R. Wilson,
c/o Bank of Nova Scotia Building,
602 West Hastings Street,
Vancouver, B. C.

Hat Creek Coal Resources:

Dear Mr. Wilson:

At your request we outline below our understanding of the study you wish to have made of the Hat Creek Coal Resources, to determine the most profitable use to which they may be put.

In this connection, in addition to the sale of coal on the open market, we would consider using it as fuel for six types of industrial plants, the products of which would seem to have a ready market now, or in the near future. It is assumed that all of these plants would be developed and controlled by the Hat Creek interests.

The industrial plants considered are as follows:

1. A modern steam turbo-electric generating station, located at the mines, or at a near mine location, depending on the availability of suitable condensing water facilities. This station to deliver power to the industrial plants given below, and the surplus to the British Columbia Electric Company's System to augement their present hydro-electric power.

2. A modern cement plant of suitable capacity located at a point economical to the transportation of coal, limestone, etc., and the finished product.

3. A brick and tile plant of suitable capacity and economical location.

4. An expanded aggregate plant using shale from coal or other sources.

5. Since there is evidence of the presence of the high grade limestone necessary for the production of burned lime, a plant for its production would seem to be worth considering in this program.

6. Other types of plants which may indicate profit possibilities as the study progresses.

The study of the Hat Creek coal deposit would entail a drilling program of sufficient extent to block out the coal resources with sufficient accuracy to warrant the investment in the various plants over their reasonable life expectancy. The grades of coal available and their accurate average analyses woudl be determined. Pilot plant and full operating tests would also be made to determine most suitable methods of burning.

Studies to determine most economical methods of mining, together with preliminary layouts and estimates of development costs. Operating cost estimates and estimates of profit under various conditions of market and local utilization would be made.

In considering the erection of a modern steam turbo-electric generating station, using Hat Creek coal, studies would be made to determine type and initial installed generating capacity. The type of plant would depend to some extent on the cost and quality of coal delivered at the plant, estimated annual load factor and estimated return of invested capital. Initial installed generating capacity would depend on study of possible load sources, etc.

Study of the various plants outlined under items 2, 3, 4, 5, and 6, would involve a study of each type of plant as representative in its own field, The fact that each plant would be a user of Hat Creek coal or power is an important factor and would constitute the basis of this study, this arrangement may lead to profits not otherwise obtainable.

In order to determine this, each plant and the possible markets for its products would be investigated. Samples of available raw materials would be secured, proper laboratory tests made to determine quality, and actual commercial operating runs made on the most suitable samples to determine finished products.

If market conditions seem favorable, preliminary plans would be prepared and estimates of investment costs, operating costs and possible revenue would be made.

While we believe in the above method of studying the revenue producing possibilities of the various plants under consideration we are mindful of the savings in operating and sales expense that will accrue to central ownership and control. This phase would, of course, also be considered as well as the influence of the various corporation tax laws.

It is impossible to determine in advance the exact course an investigation of this kind might take, but we believe that you should be in a position to stop any phase, or all of it at any time, should events show you that this is desirable and without your obligating yourselves to useless expenditures.

In this connection we submit herewith, for your consideration, a suggested type of agreement for engineering services.

Yours very truly,

(Sgd.) Harry M. Hope.

President.

HMH:cjh

HARRY M. HOPE ENGINEERING COMPANY

SEATTLE 1.

August 1, 1951.

Mr. R. R. Wilson,
c/o Bank of Nova Scotia Building,
602 West Hastings Street,
Vancouver, B. C.

Dear Sir:

We hereby propose to make an engineering study and report for you on the mining and utilization of the Hat Creek Coal deposits, as described in Section 1 of this proposal, acting as your own engineering department, and being guided in all respects by such instructions as you may, from time to time, give us.

1. SCOPE OF WORK:
   See letter attached.

2. SERVICES TO BE RENDERED:
   As engineers we will make all necessary engineering studies and determinations, recommend to you the necessary borings to be made, samples to be taken and tests and analyses to be secured. We will prepare a report of our findings to you containing proposed plant arrangements, estimated construction and operating costs and probable earnings. This report will be prepared in suitable form for submission to such financial agencies as may be interested in financing the projects.

3. WE WILL FURNISH YOU:
   a. The services of our Executive Officers who will direct and oversee all the work performed under this agreement.
   b. All general expense of our Seattle and/or Vancouver office, including rent, lights, heat, etc., the services of stenographers, clerks, etc.
   c. The service of all engineers used in connection with the engineering and design work.
   d. The services of all draughtsmen used in connection with the preparation of plans and drawings.
   e. All drawings material, blueprints, photographs, etc., as may be used in connection with the work.

4. YOU ARE TO ASSUME:
   a. The cost of all traveling expense or expenses of a similar character incurred in connection with the work, also expenses of telegrams, telephone tolls, etc.,
   b. The cost of all borings, sample tests and analyses, commercial or pilot plant runs of raw materials and tests of similar nature.

5. COMPENSATION:
   You are to pay us as compensation for providing the organization and serving you, the sum of sixty thousand dollars ($60,000.00).

6. TERMS OF PAYMENT:
   All accounts accruing for services, materials, and expenses as outlined under IVa will be forwarded to you, monthly, for the previous month, and we will render you at the same time, a bill for the proportion of our compensation as follows:

Advance for expenses		$3,000.
End of 1st month		5,000.
" " 2nd "		10,000
" " 3rd "		15,000.
" " 4th "		12,500.
" " 5th "		10,000.
" " 6th "		4,500.
	Total	$60,000.

   All paymemts are to be made by you in Canadian Funds within ten days.

7. AUDITS:
   Our books of accounts, correspondence, records, vouchers, insofar as work done or money expended under this agreement are concerned, will be always open to your inspection.

8. TERMINATION OF EMPLOYMENT:
   If you should become at any time dissatisfied with the manner in which our services are being rendered, or should you wish for any reason, to discontinue the work, you are at liberty after ten days notice in writing, to terminate our employment.

   In case you take such action, we shall be entitled to receive as compensation for our services, an amonnt based on our expert per diem rates to the date of termination, including any other accounts which may be due and payable.

9. ACCEPTANCE:

On acceptance of this proposition by you, it will constitute an agreement betwsen us.

HARRY M. HOPE ENGINEERING COMPANY

By (Sgd.) Harry M. Hope
President.

Accepted:

HMH:cjh

HARRY M. HOPE ENGINEERING COMPANY

COPY

SEATTLE 1.

July 13, 1951.

Mr. R. R. Wilson, President,
Wilson Exploration Co. Ltd.,
602 W. Hastings St.,
Vancouver, B. C.

Dear Mr. Wilson:

It will be necessary for us to have another conference with you before we can make an intelligent proposal for engineering services in connection with the survey we discussed with you on June 29th.

We are very much interested in your project as a whole and we desire to be sure that we have an accurate understanding of your wishes in the matter.

We will telephone you next Monday or Tuesday for an appointment at your convenience.

Yours very truly,

(Sgd.) Harry M. Hope.

President.

HMH/M


120
(4)
MAP OF
HAT CREEK MINE
ASHCROFT M.D. B.C.
SCALE: 200 FT. = 1 IN
OCT. 1945
C.M.C.
COAL &c.
DRILL HOLES
HC 51(1)A
1cm=40m N
1cm=40 mE
NORTH
LANDSLIP AREA
HOLE 7
MUD LAKE (DRAINED)
APPROXIMATE EASTERN LIMIT VOLCANICS
GRANODIORITE
598350E
5625700N
598325E
5626060N
598620E
5625435N
HAT CREEK
HIGHWAY
BLOCK "A"
FINNEY SHAFT
HOLE 1
HOLE 2
HOLE 4
HOLE 5
HOLE 6
HOLE 3
SECTION 1
SECTION 2
SECTION 3
SECTION 4
SECTION 5
CAT ROAD
LANDSLIP AREA
COAL DIPS 65° TO WEST
CLAY SHALE AND COAL
CONGLOMERATE
No. 2 TUNNEL
KEY MAP
CONSIDERABLE TIMBER
SAGE BRUSH
OCCASIONAL TIMBER
NO OUTCROPS
OPEN GRAZING
COAL LEASE AND LIGNITE RIGHTS
SURFACE
LIME LEASE

CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS
GEOLOGICAL SURVEY OF CANADA

LEGEND

CENOZOIC

TERTIARY
MIOCENE OR EARLIER
KAMLOOPS GROUP (23,24)

- **24** — *Basalt, andesite, and rhyolite; associated tuffs and breccias*
- **23** — *COLDWATER BEDS (?): sandstone, shale, and conglomerate; coal*

EOCENE

- **22** — *Conglomerate, breccia, arkose, and shale; basaltic lava and breccia (relations to Kamloops group unknown)*

MESOZOIC

CRETACEOUS OR TERTIARY

- **21** — *Conglomerate, sandstone, and shale*

CRETACEOUS
LOWER CRETACEOUS
KINGSVALE GROUP

- **19, 20** — 19. *Arkose, conglomerate, shale, and greywacke*; 20. *Basalt and andesite; agglomerate, tuff, and breccia*

SPENCES BRIDGE GROUP

- **18** — *Andesite, dacite, basalt, and rhyolite; tuff, breccia, and agglomerate; conglomerate, sandstone, greywacke, and arkose*

JACKASS MOUNTAIN GROUP

- **15, 16, 17** — 15. *DIVISION A: greywacke, argillite, and siltstone; arkose and conglomerate*; 16. *DIVISION B: conglomerate, greywacke, and argillite*; 17. *DIVISION C: greywacke, argillite, conglomerate; arkose*

LILLOOET GROUP

- **14** — *Argillite, volcanic conglomerate, and tuffaceous sandstone*

BREW GROUP

- **13** — *Argillite, quartzite, and conglomerate*

JURASSIC
MIDDLE AND UPPER JURASSIC

- **12** — *Shale, conglomerate, and sandstone*

TRIASSIC
UPPER TRIASSIC
NICOLA GROUP

- **11** — *Basalt and andesite; tuff and agglomerate; limestone, quartzite, argillite, greywacke, and arkose*

TRIASSIC OR EARLIER

- **8-10** — 8. *Phyllite, quartzite, limestone; greenstone; schist*; 9. *Argillite, slate, phyllite, quartzite, greywacke, chert, limestone; greenstone; schist*; 10. *Phyllite, argillite, conglomerate, greywacke. May be in part of late Mesozoic age*
- **7** — *Schist and gneiss*

PALÆOZOIC

PERMIAN AND(?) EARLIER
CACHE CREEK GROUP

- **5, 6** — 5. *Greenstone; chert, argillite, minor limestone and quartzite; chlorite and quartz-mica schist*; 6. *MARBLE CANYON FORMATION: limestone*

INTRUSIVE ROCKS

MESOZOIC — COAST INTRUSIONS

CRETACEOUS OR LATER
LOWER CRETACEOUS OR LATER

- **4** — *Quartz diorite, albite syenite*

CRETACEOUS
LOWER CRETACEOUS

- **3** — *Granodiorite*

JURASSIC OR CRETACEOUS
LOWER CRETACEOUS OR EARLIER

- **2** — *MOUNT LYTTON BATHOLITH: granodiorite, quartz diorite, and diorite*

JURASSIC
LOWER JURASSIC

- **1** — *GUICHON CREEK BATHOLITH: granite, granodiorite, quartz diorite, diorite*

JURASSIC (?)

- **A** — *Hornblende diorite and related rocks*
- **B** — *Serpentinized ultrabasic rocks*

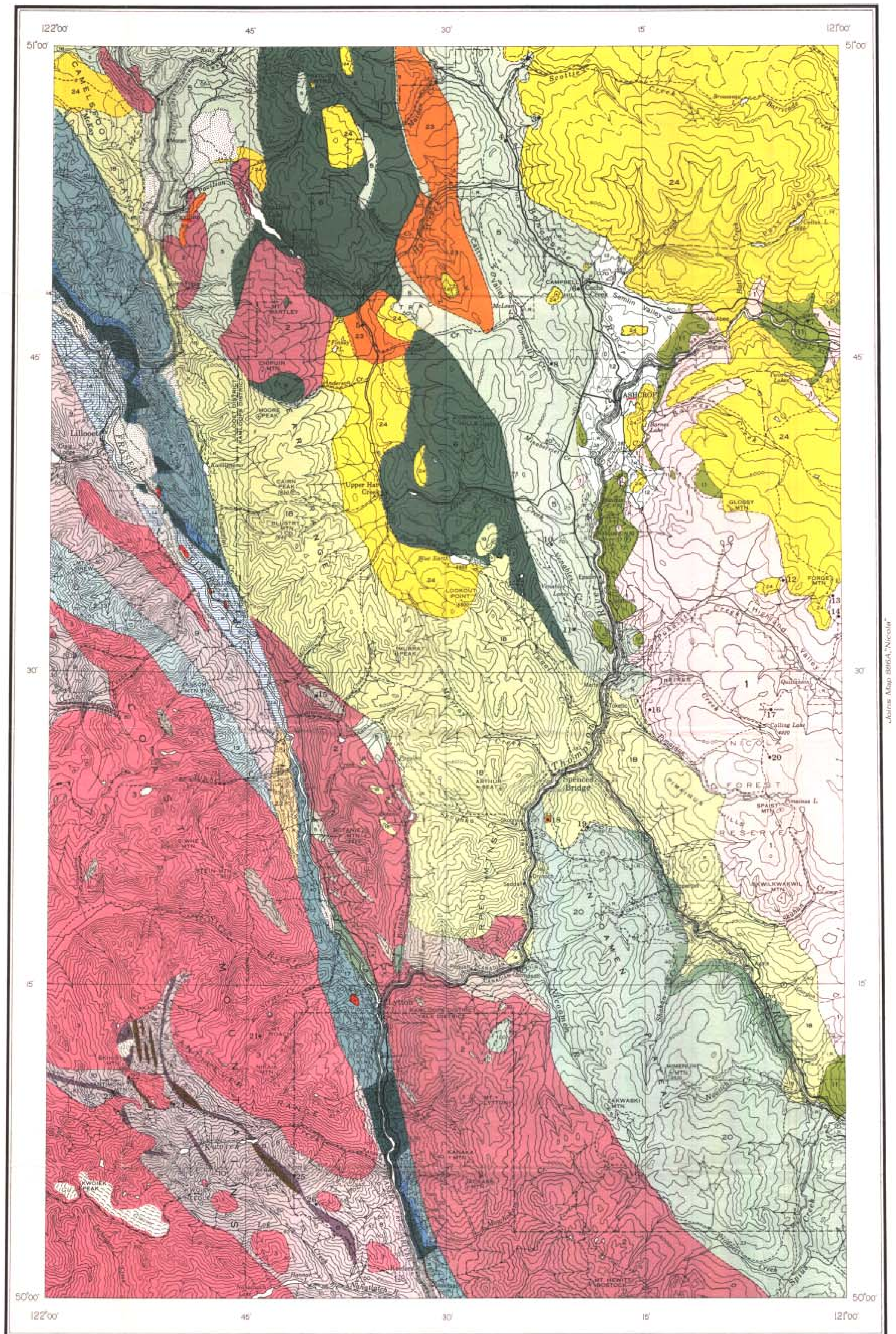
Heavily drift-covered area
Bedding (horizontal, inclined, vertical, overturned)
Schistosity (inclined, vertical)
Foliation (inclined, vertical)
Glacial striæ (direction of ice-movement known, direction unknown)
Fault
Fossil locality
Mining property ... 23

INDEX TO MINING PROPERTIES

1 Big Slide (Grange) mine (Gold, silver, copper)
2 Scottie Creek deposits (Chromium)
3 Ferguson Creek deposits (Chromium)
4 Maggie mine (Copper, silver, lead, zinc)
5 Hat Creek coal (Coal)
6 Cache Creek occurrence (Chromium)
7 Fairview group (Zinc)
8 Cornwall Creek (Chrome Pit) occurrence (Chromium)
9 Coronation group (Silver, lead, zinc)
10 Basque epsomite deposits (Magnesium sulphate)
11 Martel mine (Gold, molybdenum)
12 Glossy group (Copper)
13 Transvaal group (Copper)
14 Highland group (Copper)
15 Victory claim (Copper)
16 Toketic deposit (Iron)
17 O.K. mine (Chataway group) (Copper)
18 Spences Bridge coal (Coal)
19 Soap Lake deposit (Sodium Carbonate)
20 Kathleen claim (Copper)
21 Lytton Gold prospect (Gold)
22 Clarke prospect (Antimony)
23 Green Gold Jade claims (Vesuvianite)
24 Glacier group (Gold, silver)
25 Paystreak group (Silver)
26 Serpentine and Summit groups (Gold)

Geology by S. Duffell and K.C. McTaggart, 1945-46, and K.C. McTaggart, 1947

Cartography by the Geological Mapping Division, 1951



Joins Map 737A, "Hope"

PUBLISHED, 1951

MAP 1010A

ASHCROFT

KAMLOOPS, LILLOOET AND YALE DISTRICTS
BRITISH COLUMBIA

Scale: One Inch to Four Miles = 1/253,440
Miles
4 3 2 1 0 4 8 12

Approximate magnetic declination, 24° is East

HC 51(1)A

120
(5)

REFERENCE

Main highway with route number
Other roads
Trail
Church
Post Office
Land District boundary
Forest Reserve boundary
Indian Reserve boundary
Intermittent stream
Glacier
Contours (interval 500 feet)
Contours (position approximate)
Height in feet above mean sea-level

Base-map compiled by the Bureau of Geology and Topography from surveys and from information supplied by the Department of Lands and Forests, British Columbia

DESCRIPTIVE NOTES

West of Fraser River, the map-area occupies part of the Coast Mountains of British Columbia, and the high ridges southeast of Lytton mark the northern extremity of the Cascade Mountains. Elsewhere the area forms part of the Interior Plateau, and its vegetation and climate are largely characteristic of the 'dry belt' of this region.

The Cache Creek group (5, 6) constitutes a thick succession of mainly chert, argillite, altered volcanic rocks, and crystalline limestone, much of which is deformed and largely altered to talc, chlorite, and sericite schists. The distinctive crystalline limestone of Marble Canyon and Pavilion Mountains is mapped separately as the Marble Canyon formation (6).

Lenses and patches of metamorphosed rocks (7) within the Coast intrusions consist in part of chlorite, hornblende, and quartz-mica schists, and in part of granitic gneiss. Some parts of the large area of these rocks on Scarped Mountains are identifiable as Cache Creek (5), but other lenses may include strata of Mesozoic age.

Unfossiliferous, metamorphosed rock groups of uncertain identity (8-10), west of Fraser River, probably comprise strata of both Palæozoic and Mesozoic age. One group of mainly micaceous and graphitic phyllite (8) is probably of late Palæozoic age, but may include younger formations. Another varied assemblage of sedimentary and volcanic rocks (9), at least 7,500 and probably 10,000 feet thick, is probably in part Cache Creek. Still another group, comprising many thousands of feet of grey to black phyllite, grey argillite, conglomerate, and greywacke (10), extends southeast into Hope map-area, where it appears to include rocks of the Upper Jurassic (?) or Lower Cretaceous Ladner group. It also affords points of resemblance with the Lower Cretaceous Brew group (13).

Nicola group rocks (11) consist mainly of medium-grained, basaltic and andesitic lavas, largely altered to greenstones, greenish grey tuff, and agglomerate. Argillite, chert, greywacke, and limestone, associated with volcanic rocks near Basque, have yielded marine fossils of Upper Triassic age. The group has been metamorphosed by the Guichon Creek batholith (1) and occurs as small roof pendants within, or as relatively small bodies along, the border of the batholith.

Conglomerates, shales, and sandstones of Jurassic age (12) occupy a narrow synclinal belt near Ashcroft. The sandstones, commonly arkosic, and the conglomerates are greenish grey. The black shales, commonly carbonaceous, have yielded ammonites of Middle and Upper Jurassic age. East of Basque, conglomerate at the base of the succession rests unconformably on granitic rocks (1).

The Brew group (13) consists mainly of banded argillite, impure quartzite, and boulder conglomerate, and contains marine fossils of early Lower Cretaceous age.

The Lillooet group (14) and the Jackass Mountain group (15-17) form a belt of folded and deformed Lower Cretaceous sedimentary rocks along Fraser River, and are in faulted contact with all adjacent rock groups.

The Spences Bridge group (18), consisting of about 5,000 feet of varicoloured volcanic rocks, mainly lavas, and minor continental sediments, has yielded fossil plant remains of mid-Lower Cretaceous age. The lavas are generally much decomposed, and are commonly traversed by thin stringers of pink and white calcite. The group is gently folded, much of it lying horizontally or nearly so.

Sedimentary rocks (19) and volcanic rocks (20) of the Kingsvale group unconformably overlie the Spences Bridge group along Nicola River. The light-coloured sedimentary strata at the base of the group reach a thickness of 800 to 1,000 feet on Shakan Creek, but may be missing elsewhere. Fossil plant remains collected from them are of late Lower Cretaceous age. Small areas of sedimentary rocks on Botanie Creek and Fraser River near Stein River were mapped with the Kingsvale group on the basis of fossil evidence. The volcanic rocks, which constitute the bulk of the group, are largely of andesitic and basaltic composition and flows are commonly amygdaloidal.

Evidence obtained in Nicola map-area to the east suggests that certain local accumulations of conglomerate and sandstone (21) may be either of Cretaceous or Tertiary age. The conglomerate contains boulders and pebbles of Cache Creek and Nicola group rocks as well as of granite.

A succession of sedimentary and volcanic rocks (22) 4,500 feet thick has yielded fossil leaves of Eocene age. Coarse conglomerates in the exposed sections contain easily recognized boulders of Lower Cretaceous rocks (13-17). These Eocene strata form one of the many fault blocks along Fraser River, and the steep dips and close folds are mainly the result of fault movements.

Most of the Kamloops group consists of volcanic rocks (24), but with them are included several small areas of Tertiary sedimentary beds (23), which at upper Hat Creek and south of Spences Bridge are coal bearing. The sedimentary strata are probably the equivalent of the Coldwater beds of the adjoining Nicola map-area. The volcanic rocks exhibit a wide range of colours; they are mainly dark, dense, fine-grained basalts, but include thick beds of agglomerate, minor breccia, and tuff. Thin beds of argillaceous material yielded poorly preserved leaves of Tertiary age.

All of the map-area was covered by ice during Pleistocene time except perhaps some of the higher peaks of the Coast Mountains. Pleistocene and Recent drift mantles most of the plateau region. White silt deposits are prominent along Thompson River east of Spences Bridge. Alluvial fans, and ice-contact and glacial outwash deposits are common, and the major valleys are lined with marginal terraces of sand, gravel, and clay.

Batholithic rocks of the Coast intrusions consist mainly of granite, granodiorite, quartz-diorite, and diorite. The Guichon Creek batholith (1) intrudes Upper Triassic rocks (11) and is overlain by Middle and Upper Jurassic rocks (12). The Mount Lytton batholith (2) is overlain by lavas of the Spences Bridge and Kingsvale groups (18-20) and may be of early Lower Cretaceous age, but is probably more nearly contemporaneous with the Guichon Creek mass. The widespread granodiorite (3) of the Coast Mountains is believed to be of mid-Lower Cretaceous age.

Elongate bodies of ultrabasic rocks (B), with which are associated bodies of hornblende diorite and related rocks (A), are exposed in the Coast Mountains. The rocks of the main serpentine belt in the southwest corner of the map-area are, apparently, about in line with those of the serpentine belt to the southeast in Hope map-area, and are probably of Cretaceous age. Small undifferentiated bodies of serpentine associated with Cache Creek rocks along Bonaparte River carry significant chromite deposits.

Several minor intrusions (4) cut rocks of the Fraser River Lower Cretaceous belt (14-17).

The belt of Lower Cretaceous rocks along Fraser River may be regarded as a series of fault blocks or slices involved in a major zone of faulting along which rocks to the west have been relatively elevated. From the south border of the map-area to Cinquefoil Creek the Cretaceous rocks appear to occupy a graben. Farther north, rocks to the west of the Cretaceous belt appear to be elevated, and those to the east relatively depressed, with respect to the Lower Cretaceous rocks.

Albitization and, to a lesser extent, prehnitization are features of many of the rocks in and adjacent to the Fraser River Cretaceous belt. The abundant albite of some of the intrusive rocks is a product of metasomatism, a process that is believed also to have affected the older bedded rocks (14) of the Cretaceous belt; the albite of the younger formations is probably of detrital origin.

The map-area contains a variety of metallic and industrial mineral deposits, several of which have been productive. Placer gold has been mined on all major streams, but only in small amount since early years of the present century. Stibnite is found in irregular quartz veinlets along a fault zone in granodiorite near the headwaters of Stein River. Plutonic rocks of the Guichon Creek batholith are host to copper deposits near Highland Valley, and contain hematite deposits in shear zones near Toketic. The copper minerals occur in veins and shattered zones associated with tourmaline and hematite, and the wall-rocks are commonly highly sericitized. The greatest production came from the O.K. mine, which during the period of its activity mined and concentrated 10,000 tons of ore containing 3.6 per cent copper. The Maggie mine on Bonaparte River was prospected underground as a copper deposit. Fifty tons of selected ore yielded 2 ounces of silver a ton, 8 per cent copper, and low assays in lead and zinc. Chromite occurs in ultrabasic rocks along Bonaparte River, the principal discoveries having been made on Scottie Creek and the creek south of it. Gold and silver have been reported from quartz veins in the schist, argillites, and batholithic rocks in the southwest corner of the map-area. The Big Slide (Grange) mine has produced gold, copper, and silver from narrow quartz veins in diorite. Considerable exploration work has been done at the Martel property on narrow lenticular quartz veins in Cache Creek rocks that contain molybdenum and gold. Narrow quartz veins carrying sphalerite, galena, and chalcopyrite occur in Triassic rocks east of Ashcroft.

Coal has been mined with limited success from the deposit at upper Hat Creek. Occurrences of gypsum, jade, vesuvianite, magnesium sulphate, and sodium carbonate have been recorded, and some magnesium sulphate has been produced from the deposit at Basque. Much of the Marble Canyon formation is composed of very pure limestone.