CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
BULLETIN 16

THE GROUNDHOG COALFIELD, BRITISH COLUMBIA

BY

A. F. Buckham and B. A. Latour

OTTAWA
EDMOND CLOUTIER, C.M.G., B.A., L.Ph.,
KING'S PRINTER AND CONTROLLER OF STATIONERY
1950

Price, 75 cents

View looking north into the Groundhog coalfield, from a point on the Groundhog trail at the summit of Groundhog Pass (elevation 5,400 feet). Trail Creek and Mount Jackson appear in right foreground and Skeena River Valley in centre background. (Photo by A. F. Buckham, July 18, 1948.) (5-6-'48 (A.F.B.))

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PREFACE

The Groundhog coalfield lies some 150 miles north of Hazelton and 95 miles northeast of Stewart in one of the most inaccessible parts of the province of British Columbia. The occurrence there of anthracitic coals had been recognized in 1900; and public interest quickened in succeeding years to reach a maximum in 1911-12 when large blocks of claims were staked and much surface work and sampling of coal seams undertaken. At that time it was expected that a branch railway would be constructed up Skeena River from Hazelton on the main line of the Grand Trunk Pacific, and with the deflation of that project interest in the coalfield rapidly waned.

The present report deals fully with the location, means of access, and history of the Groundhog area, and with what is known of the geology and structure of its coal measures. These are of late Upper Jurassic or early Lower Cretaceous age, and form an upper part of the widespread Hazelton group of northwestern British Columbia. In addition, the report includes a description of one hundred and ninety-two occurrences of coal, all for which the authors have any record, and the character of the coal is further illustrated by a table of proximate analyses of one hundred and eight samples picked by various investigators in the early years of the century. The authors offer some comments on the reserves and present worth of the coalfield, and a full bibliography gives reference to all known publications related to it.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, October 26, 1949

THE GROUNDHOG COALFIELD, BRITISH COLUMBIA

INTRODUCTION

INTRODUCTORY STATEMENT

Occurrences of anthracite coal were reported from northern British Columbia early in the present century. Between 1904 and 1912 much prospecting and development work were done on an area north of the Groundhog Range, to which the name Groundhog Coalfield was applied. At least seven hundred claims one mile square were staked, and large sums were spent in testing the field, which was recognized as the largest area in Canada underlain by anthracite coal. Its economic value, however, was not established at that time.

Little or no work has been done on the coal showings of the field since 1912, although it has become customary to refer to its potentialities in all references to, or descriptions of, the resources of northern British Columbia. However, very little published data are available on the field, and accurate, detailed information is most difficult to obtain. For this reason the writers were instructed to commence a re-survey of the field in 1948. In the course of the work considerable published and unpublished data, much of it not readily accessible, has been accumulated. This report presents a digest of this data, together with the results of the 1948 season's field work.

The writers were assisted by S. B. Bleakley, J. J. Crabb, and R. G. Urquhart, as student assistants; S. L. Nelson and P. F. Bland as packers; Pat Cook as cook; and James Blackwater as guide and axeman. To all these, thanks are due for hard work during the summer.

Many residents of Hazelton gave assistance to the party. Messrs. Hunter Simpson and Ben McKenzie were particularly helpful. Special thanks are due George Watkin Evans of Seattle for supplying unpublished reports on the area, with permission to quote from them. Mrs. Maisie Armytage-Moore of Vancouver extended similar courtesies with the reports of her father, the late R. C. Campbell-Johnston.

LOCATION AND AREA

The boundaries of the Groundhog coalfield (*See* Map 106A) outline a north-northwesterly trending parallelogram whose length is about 50 miles and width about 30 miles. The field occupies the headwaters of Stikine and Skeena Rivers. Its centre, at latitude 57° and longitude 128° 30′, is 150 miles north of Hazelton and 95 miles northeast of Stewart. Not all the area within the parallelogram is underlain by coal, for, as Malloch points out, "over large areas all the coal seams have been removed by erosion and . . . in other areas, only a very small fraction of the total number of seams has been preserved".

MEANS OF ACCESS

The Groundhog coalfield is difficult to reach. When construction of the Alaska Highway brought northern and northeastern British Columbia within reach of transportation, a point near the southeastern edge of the area became that part of British Columbia farthest from tide water, railways, highways, or navigable water routes. In air-line distance, the nearest point on tide water is 90 miles to the southwest of the area at the town of Stewart; the nearest railroad is 112 miles south at Hazelton; the nearest highways are the Alaska Highway, 160 miles northeast, and at Germansen Landing, 154 miles southeast; and the nearest point on a navigable water route is Ware, 106 miles east.

In this report, transportation into the Groundhog area will be discussed under three heads: (1) present means of transportation; (2) means of transportation that might be employed for preliminary development of the coalfield; and (3) possible railroad routes that might be used should it be intended to produce coal commercially.

At present, access into the Groundhog area may be had only by pack-trains or by aircraft. Five trails, from different directions, afford entry into the area; of these the writers have personal knowledge of only one, the Telegraph Trail, which they travelled in 1948. Information about the other four trails has been gathered from reports written at various times. To follow the descriptions a recent map of British Columbia is necessary.

A brief description of the various trails follows, and more complete data, of interest chiefly to those planning to enter the area, are given in the Appendix at the end of the report.

The Telegraph Trail was used by the writers in 1948. From Hazelton, where rail transportation is available, it follows the Skeena to the Kilankis, and the latter to Damdochax Lake, then crosses the Groundhog Pass to rejoin the Skeena at the southern edge of the coalfield. The trail distance is 120 miles. A second trail enters the area from Telegraph Creek on Stikine River, which is reached from Wrangell, Alaska, by riverboat. It follows Klastline, Klappan, and Little Klappan Rivers to the northern edge of the coalfield. It, too, is about 120 miles long. A third route commences at Ware, on Finlay River. Ware is accessible by 32 miles of truck road, and 350 miles of water travel on Parsnip and Finlay Rivers where no scheduled commercial transportation is available. The trail extends about due west from Ware to Caribou Hide and thence west and southwest to the coalfield, a trail distance of about 120 miles. A fourth route is from Takla Landing, on Takla Lake, to which a regular boat service is available; it follows Driftwood and Bear Rivers and Birdflat Creek to Thutade Lake and thence northwest and west to the coalfield, a distance of about 135 miles. The fifth trail is from Stewart, via Bear River and Meziadin Lake to Nass River and thence to the coal basin, a distance of at least 115 miles.

The writers consider the Telegraph Trail from Hazelton as good as any. No trails were described as good, and none has been much used since the reports were written, so it is probable that much work would have to be done on all of them before they would be suitable for transportation of large quantities of material by pack-horse. Aircraft equipped with pontoons can land on any one of five lakes in or near the Groundhog area, and are most useful in transporting men and equipment to and from the district, but in order to move around in the area horses are necessary. Therefore, it is recommended that planes be used to transport almost the entire load to the most convenient lake, and that the horses be sent in over one of the trails with as light a load as possible.

Of the five lakes suitable for aircraft landing, two are situated in the area itself, Buckinghorse Lake on the northeastern edge of the field and Kluayaz Lake at the east-central edge of the field. The other three lakes lie outside the area: Damdochax (Blackwater) Lake is about 30 miles south of the Groundhog area, conveniently located on the Telegraph Trail; Tatlatui Lake is about 20 miles east of the area; and Thutade Lake is 10 miles east of Tatlatui Lake. The last two lakes are situated along the trail from Takla Landing.

During the winter, supplies have been, and could be, transported into the Groundhog by dog sled. From Hazelton the route follows Skeena River throughout, deviating only in a few places where there is open water all winter. The distance is 195 miles, and the trip has been made in 21 days, by T. H. Taylor, who gives a detailed description of the trip in his report (34) [1]. Landings could also be made by ski-equipped planes on the lakes noted above, and possibly elsewhere in the area, and supplies distributed by dog sled. This would permit a longer working season, as many parts of the coalfield are snow-free long before the high passes along the various trails would permit horses to reach the area.

It will be pointed out elsewhere in this report that information now on hand about the coalfield does not, under present conditions, justify preliminary testing and development work. Should conditions change, or should new information of a more favourable nature come to hand, it might be proposed to do such work. Any work more advanced than geological mapping and surface prospecting will require movement into the area of much greater amounts of supplies and equipment than could be handled economically by the methods outlined above.

Prior to construction of the Alaska Highway, much attention was given to possible alternative routes for such a highway. The favoured routes were two (8): the "A" route began either at Hazelton or Fort St. James, and ran northwest to cross the northern boundary of British Columbia at Atlin Lake; the "B" route followed the "Trench", beginning at Prince George and leaving British Columbia at Lower Post. Ever since construction of the Alaska Highway, there has been some agitation for work along either "A" or "B" routes. If, for example, a highway were ever built along the "A" route, regardless of what variation is chosen it would pass through the Groundhog coalfield. This, of course, would greatly reduce the cost of development work, which might then be considered.

If for some other reason it is decided to do such work, winter tractor trains afford the best means of getting supplies into the area. Routes available are approximately those described under pack-trails. Those most suitable would be: first, one commencing at Hazelton and extending up Skeena River, and second, one beginning at Fort St. James and following the Stuart-Trembleur-Takla-Bear Lakes chain to the Skeena, and thence

[1] Numbers in parentheses refer to publications listed in the bibliography at the end of this report.

up that stream. The prospective opening of a large pulp mill at Port Edward will probably mean that a system of winter tractor roads will be established up Skeena and Nass Valleys. As the progress of logging extends inland, these roads and the transportation systems established may be of use in getting supplies into the Groundhog coalfield.

A necessity to commercial production of coal from the Groundhog area is a rail connection, either to an existing line or to an ocean port. Several routes were suggested in 1911 and 1912. One was from Stewart, via Bear River and Meziadin Lake, to Nass Valley and up it to Anthony and Panorama Creeks to the Groundhog area. This was at one time thought to be the shortest route, but later work has shown that to obtain suitable grades the line would be much longer than the 90 miles of the first estimate. Any reasonable railway location on this route involves adverse grades in the Meziadin Lake section. Suitable bunkering facilities would have to be constructed at Stewart; this port is occasionally icebound in winter.

A second route would lead from Nasoga Gulf, the nearest suitable harbour to Nass Valley, and thence very much as the first. Various estimates, averaging about 175 miles, have been given for the length of this railway. Good grades could be secured. Choice of this route would involve construction of a port and town at Nasoga Gulf.

A third route suggested leads up the Skeena from Hazelton. A reconnaissance of this route was run by J. S. O'Dwyer (24, 25), for the Department of Railways and Canals in 1899, hence more data on a proposed railway is available. A railway connecting with the Canadian National at Skeena Crossing and extending to the junction of Currier Creek and Skeena River would be 202 miles long. O'Dwyer's cost figures were for 1899-1900. An attempt was made to convert these to present day costs, by the use of the Enginering News-Record construction cost indices and by consulting engineering experts. The 1949 cost of such a route would probably be between $12,000,000 and $16,000,000.

It is, of course, not possible to indicate the comparative merits of the various routes unless detailed location surveys and modern engineering estimates are at hand. Nor should cost figures based on O'Dwyer's preliminary survey be taken too seriously in the absence of such data, but it would appear that the cost of supplying rail transportation to the Groundhog coalfield would be in excess, possibly in considerable excess, of $10,000,000.

HISTORY

The earliest recorded exploration of the Groundhog area was from 1865 to 1867, when it was traversed by parties reconnoitring for the Western Union Telegraph Company's line. These explorers were also interested in minerals. One of them, Vital Laforce, turned to prospecting when the telegraph project was abandoned, and soon after found rich placer deposits on Vital Creek in the Omineca. At about the same time as the telegraph exploration, prospectors had spread from the Cariboo district to all parts of northern British Columbia. The Omineca gold rush was at its peak between 1867 and 1873. Gold had been found on the Stikine in 1861, leading to the Cassiar boom between 1872 and 1878. In connection with tbe latter, a trail over which pack-horses and cattle were brought was established from Fraser Lake to the Cassiar. It passed through the Groundhog area. Although these prospectors were looking for placer gold, they must have seen coal float on the river bars and coal seams on the banks of the streams in the Groundhog area. Some probably had the curiosity to follow up these indications and discover some of the better coal showings, and it is surprising that the earliest published reference to the occurrence of coal in the area is as late as 1900.

During the years 1898, 1899, and 1900, the Department of Railways and Canals, Ottawa, carried out surveys to determine if a railway could be constructed from the Yukon to an ocean port in British Columbia, and to a point on an existing Canadian railway. J. S. O'Dwyer was engineer in charge, and V. H. Dupont one of the exploration engineers. During the summers of 1898 and 1899, O'Dwyer and Dupont explored the upper Skeena and upper Stikine Rivers, projecting a line from Hazelton to Dease Lake. They kept notes on, and collected rock specimens illustrating, the geology along the line, in the interests of the Geological Survey. In the summer of 1899, Dupont discovered a 10-foot seam of "impure coal" near the confluence of Didene Creek and Spatsizi River, a tributary of the Stikine (Loc. 60)[1]. This is in the northern part of the Groundhog coal area, near the place where both Skeena and Stikine Rivers head. Dupont's preliminary report (12), published in 1900, in noting this discovery is the first published reference to the occurrence of coal in the Groundhog area. This note is repeated in his final report (13), published in 1901. In the same year the Summary Report of the Geological Survey for 1900 (9) contained a prediction that "large and important coal-fields" would be found in the area, and noted that "anthracitic coals" occurred there. On a map prepared by the Geological Survey in 1901 (15), an attempt is made to indicate the possible extent of the coal-bearing area, a large area of Cretaceous rocks being shown that did not appear on preceding maps.

The Groundhog area had become more accessible with the building of the Yukon Telegraph Line from Quesnel to Atlin, between 1899 and 1901, and by 1900 the construction trail between Telegraph Creek and Hazelton had passed near it. In 1903, the agreement reached between the Grand Trunk Pacific Railway and the Dominion Government on the building of a National Transcontinental Railway to pass through northern British Columbia guaranteed closer transportation to this previously inaccessible area.

In 1903, James McEvoy and W. W. Leach were sent to prospect the basins of Skeena and Bulkley Rivers on behalf of an exploration syndicate whose principals were connected with the Crow's Nest Pass Coal Company. From McEvoy's report on this work it is evident that the reasons for sending out this prospecting party were geological—that it was an attempt to find the "large and important coal-fields" predicted by the Geological Survey 2 years before.

McEvoy examined coal showings around Hazelton, then prospected along the Yukon Telegraph Line as far north as Blackwater (now Damdochax) Lake. From there he crossed the Groundhog Pass on foot, following the old route of the Western Union Telegraph Company. On the headwaters

[1]Locality numbers are those on the map accompanying this report.

of Skeena River, above the pass, he found "small particles of coal in the gravel". Following the float up a small tributary of the Skeena (now Discovery Creek), he found a seam of coal 6 feet thick (Loc. 24), of which he reported: "It is all clean hard coal except a parting of shale 2½ to 3 inches thick in the middle, and the upper 6 inches, which is mixed shale and coal. . . . There is therefore a workable thickness of 5 feet 4 inches of clean hard coal exclusive of the 3-inch parting near the middle". McEvoy had only time to sample this seam, to ascertain that there must be more coal outcroppings above it, and to stake fourteen claims, each 1 mile square.

In 1904, W. W. Leach visited the field on behalf of the Western Development Company, which had been formed to exploit McEvoy's discovery. His party found, stripped, and tested several seams, and staked additional claims to bring the Western Development Company's holdings to 16 square miles, chiefly west of the Skeena and north of Currier Creek. Representatives of the same company visited the field in 1908 and 1909. In the latter year the party, under the direction of J. F. Walter, stripped new seams, and additional samples were taken by Walter and Charles Fergie.

Apparently these discoveries were not generally known, and certainly they created little interest until July 1909 when a number of claims adjoining the Western Development Company's property on the south were staked. Most of these, and others staked later, were located by F. A. Jackson and Amos Geodfrey. Control of the group, which surrounded the Western Development Company's claims on the south, east, and north, was secured by the B.C. Anthracite Company.

In 1910, George M. Beirnes staked a group of claims to the north of the Western Development Company's claims. These were visited in October 1910 by R. C. Campbell-Johnston, a Vancouver mining engineer whose writings aroused considerable interest in the field. These and other claims staked subsequently passed into the control of the B.C. Anthracite Syndicate.

During the summer of 1911 the field was very active. A large party under James McEvoy was at work on the Western Development Company's property and another, under R. C. Campbell-Johnston and G. F. Monckton, tested the ground of the B.C. Anthracite Syndicate. Men under F. A. Jackson were at work on the properties of the B.C. Anthracite Company. Many more claims were staked by prospectors, and their finds greatly extended the limits of the field.

During the winter of 1911-12 a party of men under F. B. Chettleburgh was at work on the property of the B.C. Anthracite Company. At this time the company amalgamated with other companies holding large groups of claims east of the original staking and on the Little Klappan and on Kluayetz Creek. Claims to the north and northwest of the B.C. Anthracite Syndicate's holdings were bonded by that group.

A large group of claims west of the Western Development Company's property owned by Angus Beaton and Anthony Kobes was not included in these amalgamations.

In the summer of 1912 the amalgamated holdings of the B.C. Anthracite Company were examined by George Watkin Evans, a mining engineer from Seattle, and Gustav Grossman, from Pennsylvania. Evans examined the southern part of the properties, Grossman the northern.

In the summer of 1913 the only known large-scale activity was the examination by Alfred Hasebrink, a German engineer, of a group of claims at the northern end of the field. These had been held by R. K. Lindsay, and were secured by German interests represnted by Alvo von Alvensleben.

Because, in this period of greatest activity, the field was even less accessible than at present, it should be explained that this was also a 'boom' period in railroad construction. The Canadian Northern and Grand Trunk Pacific Railways were being constructed, opening up great areas of northern British Columbia. Between 1898 and 1911 no less than twenty-one charters had been granted to railways whose routes would pass through or close to the Groundhog coalfield. In 1911, the Grand Trunk Pacific reached Hazelton, and reports were published that they would construct a branch line up the Skeena to the Groundhog area. Sir Donald Mann's Canadian Northeastern Railway was to connect the Peace River wheatfields and the Groundhog coalfields with Edmonton on the prairies and Stewart on the Pacific. The first 15 miles from Stewart had been constructed, and Mann took options on many coal claims in the Groundhog area. The development work of 1911 and 1912 brought out the unfavourable features of the field, and in the late summer of 1912 Mann decided not to construct the railway, and not to exercise his options. The Balkan wars of 1912 and 1913 caused a stringency in the world's money markets that made capital difficult to secure, and initiated a deflation in Canadian railway projects that culminated in the taking over by the Dominion of the Canadian Northern and Grand Trunk Pacific Railway systems. It became evident that a railway to the Groundhog coalfield would have to be constructed by those who would operate the field. Since 1913, although various attempts have been made to arouse interest in the field, no work has been done on it.

PREVIOUS WORK

G. S. Malloch, of the Geological Survey of Canada, spent the seasons of 1911 and 1912 in the field and reported on the Groundhog coalfield (21, 22, 23). In addition to the geological work, Malloch made a topographical map of the field, which greatly limited the time available for geological work. In 1911, W. Fleet Robertson, Provincial Mineralogist of British Columbia, published an account of the field based on reports of engineers (28), and in 1912 visited and reported on the area (29). Reference has already been made to the various engineers who worked in the coalfield. G. W. Evans published an account of the field (14), and R. C. Campbell-Johnston published several newspaper articles on it; otherwise no engineers' reports were printed.

SURVEYS AND MAPS

The first topographical map of the area was the work of Malloch. The southern part of the field is included in the Topographical Survey's manuscript Nass River sheet, publication scale 1 inch to 4 miles. In 1948, a Topographical Survey party under R. J. Parlee worked in the area, and two manuscript map-sheets of the southern part of the field, publication scale 1 inch to 1 mile, are available.

Hugh Pattinson of the Surveys Branch of the British Columbia Department of Lands carried out a triangulation survey of the area in 1942 and 1943 (26, 27).

Cadastral surveys of the sixteen coal claims of the Western Development Company were made in 1905 by A. W. Harvey for Gore and McGregor. In 1911, A. P. Augustine surveyed forty claims for the B.C. Anthracite Company. In 1918, C. W. Williams surveyed thirty claims in the vicinity of Kluatantan and Tzahny Lakes. In 1912, 1913, and 1914, T. H. Taylor, assisted in 1913 by D. O. Wing and in 1914 by T. Rognaas, laid out a system of meridians and base lines covering the coalfield (31-34). It was intended to subdivide the field into sections, but this was never done. Many of the posts of these cadastral surveys are still in position.

Besides the manuscript maps noted above, the following topographical maps are helpful in understanding the geography of the region:

Topographical Survey, Canada: Hazelton Sheet (West Half); Map 449A, 1 inch to 4 miles (1938).

——Tatlatui; Map 657A, 1 inch to 4 miles (1941).

Dept. of Lands, British Columbia: British Columbia; Map 1A, 1 inch to 15·78 miles (1945).

——Northern British Columbia; Map 1H, 1 inch to 15·78 miles (1933).

——Central British Columbia; Map 1L, 1 inch to 15·78 miles (1940).

——Departmental Reference Maps 38B and 38C, 1 inch to 2 miles.

The last set of maps gives the location of the cadastral surveys referred to above.

GENERAL CHARACTER OF THE AREA

PHYSICAL FEATURES

The following description is by Malloch (23, pp. 71-74), with present geographical names added in parentheses to those that require change.

"The entire region examined, including the coal field and the route thereto from Hazelton, is mountainous, though the differences in elevation between the valley bottoms and the summits of the mountains vary greatly in different localities. In some cases, as in the vicinity of Hazelton, these differences exceed 7,000 feet, whereas in other restricted areas, as for example, near the fourth cabin on the Yukon Telegraph trail, the general difference between the valley of the Skeena and the mountains is, in some cases, as low as 2,500 feet. A striking feature is that where the differences in elevation are greatest the valley bottoms are widest. With the exception of the immediate vicinity of Hazelton, the trend of the main valleys is in a general north-northwest direction, but there are many transverse valleys developed along an east-northeast direction, which are often wide and contain streams of large size. The Skeena itself partly follows transverse valleys, one near the mouth of the Babine and another for 30 miles below the mouth of Bear river. The main valleys are long extended, and in many cases contain very low divides so that on these divides streams head which flow in diametrically opposite directions. The main valleys in the neighbourhood of these low divides do not change their general character, and in passing away from the divides their widths do not increase nor is the slope of the walls decreased. As a result of the general structure, most of the drainage carried by the main valleys is derived by tributary streams entering from transverse valleys, while the divides in the main valleys are very often occupied by lakes.

"In certain cases where different major valleys coalesce, one of them may have at its mouth a direction intermediate to the directions of the major and of the transverse valleys, but if followed for some distance it will usually be found to conform with the north-northwest trend. This trend may be explained by the prevailing strikes of the strata, and the irregularities near Hazelton are due to the intrusions of large masses of igneous rock which, owing to their resistance, have completely prevented the development of this natural trend of the valleys. The valleys are in general U-shaped and in many cases the rivers occupy narrow canyons, in some places 200 feet below the valley floors. In the vicinity of the fourth cabin on the Yukon Telegraph trail although the valleys are narrower and the relief less, the Skeena valley approaches more nearly to the V-shape.

"The higher mountains have most irregular crest lines accompanied by the development of many characteristic cirques, but in the lower mountains there is a tendency towards a rounded summit, often truncated sharply by steep slopes. In general, there is a close relation between the topography and the dip and strike of the rocks.

"The topography of the Groundhog coal field is somewhat complicated, but is of the same general character as that of the region south of it. Three main longitudinal valleys form the most important depressions, and there are four well marked transverse valleys. None of the latter extend for the full width of the field, but serve only to connect the central longitudinal valley with the others on either side of it. The distances between the longitudinal valleys are unequal. The valley of the Nass and main branch of the Klappan, which bounds the basin on the west, is 16 miles from the central valley occupied by the main branch of the Skeena and the Stikine (Spatsizi), while the eastern valley is distant only about 8 miles. This is occupied by Moss Creek (Kluatantan River) and the Kluayetz branch of the Stikine (Kluayetz Creek). In the southeastern corner of the field the valleys of the main Skeena and that of Moss Creek (Kluatantan River) join with an acute angle; Moss Creek (Kluatantan River), after flowing in a broad flat valley for more than 10 miles, suddenly enters the narrow V-shaped lower portion and descends to the Skeena through a deep impassable rock canyon. In the extreme southeast lies the valley of the third branch of the Skeena, known as the Duti or Pebble river. About 10 miles farther north, this valley is connected with that of Moss Creek (Kluatantan River) by a flat valley which contains numerous lakes.

"The most conspicuous transverse valley is that of Currier and Panorama creeks, the first of which flows to the Skeena, and the latter into the Nass. At the divide between the two streams is a swampy flat and a lake three-fourths of a mile long which drains to Panorama creek. The elevation of this lake is 4,150 feet and of the Skeena at the mouth of Currier creek is 3,000 feet, whereas the elevation of the Nass at the mouth of

Panorama creek is only 2,400 feet. The direction of this valley is not quite at right angles to the north-northwest trend of the ranges, but is more nearly due east and west.

"A second transverse valley is occupied by Beirnes and Anthony creeks, which also flow to the Skeena and Nass respectively. The mouth of Beirnes creek has an elevation of 3,500 feet and is 9 miles higher up the Skeena than that of Currier creek. The direction of this transverse valley is west-southwest for about 8 miles from the Skeena, but from this point to the Nass it gradually swings round to the southward, and the mouth of Anthony creek is not half a mile above that of Panorama creek. The elevation of the lowest part of the top of the divide is 4,500 feet.

"Two other transverse valleys are occupied respectively by the main Stikine (Spatsizi) river and the east branch of Klappan river (Little Klappan River). The former heads with the main Skeena at an elevation of about 4,600 feet in a broad north-northwest valley, but the Stikine (Spatsizi) follows it for only about 4 miles. Below this, the river follows a transverse valley past the mouth of the Kluayetz and through the lofty range of mountains which borders the coalfield on the northeast. The longitudinal valleys in which the Stikine (Spatsizi) and Kluayetz head, both extend northwestward beyond the transverse valley of the Stikine (Spatsizi), being occupied by small tributaries to it and to the Klappan (Little Klappan) which, to the northwest, follows another transverse valley. The eastern valley in which the Kluayetz heads, however, turns more to the west than the one in which the Stikine (Spatsizi) rises; so that where these two main valleys cross the Klappan (Little Klappan) they are only about 4½ miles apart, and north of that river they practically unite to form one broad valley running east and west.

"Both Moss Creek (Kluatantan River) and the Kluayetz branch of the Stikine (Kluayetz Creek), which head in the same main, longitudinal valley, derive most of their water from the region to the east of the field, and are already streams of large size where they break through the bordering range in comparatively narrow gaps, and enter the longitudinal valleys. One of the gaps draining to Moss Creek (Kluatantan River) contains Kluayetz lake (Kluayaz Lake), which is 1½ miles long, and the same gap is connected with the valley of a branch of the Duti by a low divide running between high mountains. A large tributary of Beirnes creek comes in from the north about where the bend in the valleys occurs, and is said to head with a branch of the Nass and another from the Klappan.

"Apart from these valleys, the country may be divided into mountains and uplands, and though no very sharp line of division can be drawn between these two classes it was noticed that the uplands, below 6,000 feet in elevation, were rounded and generally covered with a mantle of morainic material, whereas the mountains, greatly exceeding them in elevation, were crowned with sharp arêtes caused by the development of cirques. In many cases these cirques drain directly to the main valleys, but in other cases the streams from them traverse the uplands for some distances in comparatively shallow valleys and then descend with a steep gradient to the main valleys. Some cirques have also been eroded into the rounded hills of the uplands, but have not usually been pushed back far enough to produce sharp ridges.

As a rule they are found on the northeast side of the hills where there was a good chance for the accumulation of snow, borne by the prevailing west winds, and at the same time protection was afforded from the sun. The highest mountains occur in two groups. The first extends along the northeastern boundary of the coal field, where many peaks exceed 7,000 feet in elevation and one, the height of which was measured by vertical angles, exceeds 7,600 feet. The second group is situated west of the divide between the Skeena and Stikine (Spatsizi) and here the height of another peak of equal elevation was measured, and a great many other peaks must exceed 7,000 feet. In both these regions large glaciers occur, but in the remainder of the field the glaciers are small and not numerous. Probably the region ranking next in elevation occurs south of Currier creek. Here one peak nearly reaches 7,150 feet and several are only a few hundred feet lower. In the area between Currier and Beirnes creeks the highest peak reaches an elevation of 6,600, but a number of peaks and arêtes exceed 6,000 feet. These are found near the Skeena, while farther west the country is of the upland type. Much of it is above 5,000 feet, and, therefore, a little above the timber line which usually follows the 5,000-foot contour. In some cases, however, stunted trees extend up to 5,600 feet.

"The mountains between the Skeena and Moss creek (Kluatantan) longitudinal valleys approach most nearly to what might be called a range. Their width amounts to nearly 7 miles in places and their height reaches 6,800 feet nearly opposite the divide between Moss creek (Kluatantan River) and the Kluayetz. Steeply dipping beds on the southwestern face of this range give rise to regular slopes on that side, while the northeastern is deeply cut by comparatively narrow cirques. The elevation of the range is much lower near the ends where, in places, it does not exceed 6,000 feet. Near the southern end the valley of Langlois creek extends from the Skeena two-thirds of the distance across the range, and the divide between this valley and that of a small tributary of Moss creek (Kluatantan River) is only about 4,500 feet in elevation. Other passes exist through the range, but few, if any, are less than 5,000 feet high. To the north the range terminates in Mount Klappan, a long rounded mass lying between the transverse valleys occupied respectively by the Spatsizi and the Little Klappan, and bounded on the east and west by the continuation of the Skeena and Moss creek (Kluatantan) longitudinal valleys.

"The Nass valley is bordered on the west by ranges of mountains exceeding 6,000 feet in elevation, but no very lofty peaks were noticed. Nor do any very high peaks occur for some distance west of the valley, for on a clear day the jagged and pinnacled masses of the peaks forming the boundary line between Alaska and British Columbia could be seen from elevations lower than 6,000 feet. As these peaks must be fully 70 miles away and as their actual height is not greatly in excess of 9,000 feet, it will be seen that, on account of the earth's curvature, any mountains near the Nass and much over 6,000 feet in elevation would have obstructed the view.

"None of the higher peaks to the east of the coal field were climbed, but it is reported that the country east as far as the head-waters of the various tributaries of the Peace, contains many broad valleys, separated by comparatively low mountain ranges."

CLIMATE AND AGRICULTURE

The summer climate of the Groundhog area may be characterized as cool and wet. All available weather data are digested in the following table:

Person	Year	Months	No. of days rained	Percentage of days rained	No. of days snowed	Temperatures (degrees F.) Maximum	Mean maximum	Minimum	Mean minimum
							Aver. at 7 p.m.		Aver. at 7 a.m.
Buckham	1948	July 17–31	7		....	83	62	38	47
		August 1–29	11	44	1	83	64	25	43
Pattinson	1943	July 15 to late September	Over 60	83					
									Aver. at 6.30 p.m.
Swannell	1935	July	16			77	62	42	55
		August	17	53	2	75	59	....	51
		September	11		3	75	54	10	Aver. at 8 a.m. 42
Taylor	1914	March	4			53	44	−21	2
		April	11	31		69	53	−12	20
		May	5			68	55	14	26
		June	4			84	65	25	32
		July	20			72	59	26	38
		August	8	48		80	64	22	35
		September 1–15	9			72	59	24	31
Taylor	1913	July	....	....	....	77	64	22	35
		August	67	74	1	83	63	20	35
		September	....	....	frequent snowfalls	....	56	....	32
Dupont	1899	June 20 to September 19	5 days a week	71					

Dupont's data cover the northern part of the Groundhog area and the country to the north towards the Stikine. Swannell's information applies to the southeast corner of the area, the Duti River, and Kluatantan and Tzahny Lakes country. The rest of the data relates only to the Groundhog area.

From the table, it appears that at least half of the days in summer will be rainy. Many days are heavily overcast, so that it is commonly cool. Sunny days provide rapid variations in temperature, and short, heavy showers are common. On July 31, 1948, the temperature was 38° F. at 7 a.m. and 83° F. at 7 p.m. Considerable snow may be expected in September, and night frosts may occur at any time throughout the summer.

Dupont refers to the summer of 1899, Taylor to 1913, and Pattinson to 1943, as exceptionally wet, as do others in reference to the climate of adjacent areas. It appears that "exceptionally wet" summers occur better than half of the time. The stumps of trees and saplings, on survey lines that had been cut clean to a 4-foot width in 1905, afforded an opportunity to compare conditions with the present. It was noted that present-day tree growth is much denser, which may indicate that the climate is becoming wetter.

To judge from the vegetation, the Groundhog area is considerably drier than most of the country traversed by the Telegraph Trail. The valley of Slowmaldo Creek, just south across Groundhog Pass, is a "rain hole"; Swannell reports that in 1931 the Tatlatui Mountains on the southeast corner of the area "seemed to be a veritable storm centre. All our bad weather (he was east of the mountains) came from that direction".

Snowfall is heavy along the Upper Skeena. In the winter of 1911-12, 4 to 6 feet of packed and drifted snow are reported, and winter temperatures are said to have ranged from -10 to -40° F., averaging -20° F. Eight feet of packed snow accumulated during the winter of 1912-13, and for several successive days a temperature of -40° F. was recorded. The winter of 1913-14 had 6 feet of packed snow. This is commonly gone from Skeena Valley by the middle of June, but snow in the Groundhog Pass limits the earliest date horses may be brought into or taken out of the area. In 1948, most of the snow was gone by July 15, but photographs taken in 1899 show much more snow in the pass on July 26 and 27. The earliest recorded crossing of the pass was June 19, 1914, at night on crusted snow. In general, the pass should not be attempted before the end of June or after mid-September.

Certain writers have suggested that the valley bottoms of the Groundhog area would be suitable for agriculture. Some of these areas are flat enough, and parts of them are sufficiently well drained or could be drained. However, the short season and the occurrence of summer frosts severely limit the agricultural possibilities of the area. As Pattinson points out, although the latitude of the area is the same as that of Peace River, the altitude is considerably higher.

FLORA AND FAUNA

Flats in the Groundhog area are covered with wild grasses, providing an abundance of feed for horses. Wild strawberries, gooseberries, raspberries, salmon berries, high- and low-bush blueberries, huckleberries, and cranberries are common in the area.

The forest cover is comparatively heavy—spruce, balsam, hemlock, cottonwood, and birch being found. There are, however, few commercial stands of timber, not many trees exceeding 2 feet at the butt. Probably sufficient of these stands could be found to provide mine timber, and lumber for small construction. Timber-line is at an elevation of about 5,000 feet. As noted above, the forest cover today is much thicker than it was 43 years ago.

The only game seen in 1948 was grizzly and black bear and a very few caribou, beaver, and groundhog. Sheep and goat sign, although noted above timber in a few places, was scanty. Older reports add moose to the list of game animals. Game was very scarce in 1948, far below expectations formed from descriptions of former years. Parties going into the area should not depend on game for meat. No sign of wolves or coyotes was seen in the area.

The Indian names for the two branches of the Skeena, Kluakaz on the west and Kluatantan on the east, are said to mean "river where fish don't go" and "river where fish are found" respectively. This was the case in 1948; salmon ran in the Kluatantan in August.

INHABITANTS

At one time the Groundhog area is said to have been frequented by both Stikine and Skeena River Indians, and it was the hideout of the fugitive Gunanoot. At present, few or none visit it, and the only people in the area in recent years have been two or three trappers in winter.

GENERAL GEOLOGY

Information on the regional geological setting of the area can be obtained from Armstrong's report (7), together with the Geological Map of British Columbia (16).

STRATIGRAPHY

The rocks of the Groundhog area consist of a thick succession of conglomerate, sandstone, shale, coal, and beds gradational between these types. The succession is a monotonous alternation, chiefly of sandstone and shale, not readily divisible into well-defined formations. Nor do parts of it possess distinctive features. Its field subdivision into recognizable mappable units is, therefore, not easy, perhaps not even possible. Thus, Malloch, who separated the beds into two main divisions, was forced to draw an arbitrary line between them. He, further, attempted to subdivide the upper unit into four groups, and makes the following statement concerning this attempt: "Because of the similarity of individual beds throughout the subdivisions of the Skeena series, and the absence of good horizon markers, it is impossible to at all sharply define the areas in which the different groups outcrop, and the task is rendered all the more difficult by the complicated geological structure which holds throughout the field". Moreover, the broader binary separation he suggests was based on a correlation with the rocks of the Hazelton area. It has since been learned that the stratigraphy of the Hazelton area is not what it was considered to be in 1912, thereby vitiating Malloch's correlation. His stratigraphical separations probably will not be those adopted when more detailed geological work has been done.

Malloch split the rocks of the Groundhog area into a lower division, the Hazelton group, and an upper, the Skeena series. These names were proposed by Leach (17), who defined them in 1909 and described them more fully (18) in the following year. According to Leach, the Hazelton group of Morice and Telkwa River Valleys consisted chiefly of andesitic flows with a few thin beds of fossilferous sandstone and shale near the top. To the north, around Hazelton, the flows gradually thinned out and were replaced by tuff, sandstone, and shale. Above, and in apparent conformity with the Hazelton group, was the Skeena series, composed of shale, sandstone, and coal seams, with, in many places, a bed of coarse crumbly conglomerate at the base. The Hazelton group was thought to be Jurassic, the Skeena series Lower Cretaceous, and the boundary between was placed somewhat arbitrarily just below the coarse crumbly conglomerate. The coal seams were thought to be confined to the Skeena series. It was recognized that in places it might be difficult to distinguish between sedimentary rocks of the Hazelton group and those of the Skeena series.

Subsequently, much work has been done on this succession, with the result that the meanings of the two terms have changed. The most recent studies were compiled by Armstrong (5, 6), and the following is paraphrased from his account.

The Hazelton group in Hazelton and Smithers map-areas consists of an apparently conformable succession, possibly 10,000 feet thick, of interbedded sedimentary and volcanic rocks ranging in age from pre-Middle Jurassic to Lower Cretaceous, and including what have been called Hazelton group and Skeena formation or series. In the vicinity of Hudson Bay Mountain and Smithers it has been subdivided into five map-units, namely:

Lower Cretaceous or later	volcanic division
Upper Jurassic and Lower Cretaceous	marine and continental sedimentary division
Middle or Upper Jurassic	volcanic division
Middle Jurassic	marine sedimentary division
Pre-Middle Jurassic	volcanic division

This subdivision is made largely on the basis of fossil collections obtained from the two sedimentary divisions. Where no fossils were found it was not possible to differentiate between the two sedimentary formations; where no fossiliferous sedimentary rocks were found it was not possible to assign associated volcanic rocks to one or other of the three volcanic divisions; and where no sedimentary rocks were found it was not possible to subdivide the volcanic series. In many places it was only possible to differentiate the Hazelton group into volcanic and sedimentary rocks.

The Middle Jurassic sedimentary division consists of at least 500 feet of marine strata containing fossil shells. The Upper Jurassic and Lower Cretaceous sedimentary division is composed of at least 5,000 feet of interbedded continental and marine strata containing fossil shells and plants. The shell collections are all of late Upper Jurassic or possibly very early Cretaceous age. The plants represent two distinct flora correlated with the Kootenay and Lower Blairmore of Alberta, and, presumably, of Lower Cretaceous age. At one place in the Smithers area fossil shells of Upper Jurassic or very early Lower Cretaceous age were collected from a bed apparently 300 feet stratigraphically above a bed containing fossil plants of Blairmore age.

Coal is associated with continental Hazelton strata throughout the Hazelton group, although the best coal appears to occur in rocks of Blairmore age. These continental coal-bearing members of the Hazelton group have hitherto been thought to comprise the Skeena formation or series and to overlie the Hazelton conformably, according to some geologists, or unconformably according to others. The work in the Hazelton and Smithers map-areas has indicated that no satisfactory stratigraphic division can be made and that continental strata comparable with the Skeena appear at various horizons in the Hazelton group.

In summary, the term Hazelton group comprises all those rocks previously classed as Hazelton and as Skeena, and the group ranges in age from Middle Jurassic to Lower Cretaceous. The term Skeena series is, consequently, dropped from the recent geological map of British Columbia (16), on which all the rocks of the Groundhog area are classed as Hazelton group, and that practice will be followed in this report.

As stated, Malloch divided the rocks into two major units, and subdivided the upper of these into four minor units. He was able to map the distribution of the major units, but not that of the minor. In this report his major division will be retained, but the rocks he termed "Skeena series" will be referred to as the Upper Part of the Hazelton group, and those termed "Hazelton group" as the Lower Part of the Hazelton group.

Lower Part of the Hazelton Group

The strata of this division are considered by Malloch to be many thousands of feet thick, for at some unstated locality he measured their upper 2,300 feet, and states that this section overlies horizons that elsewhere overlie several thousand feet of "Hazelton". The division as a whole consists of dark grey to black tuffs and tuffaceous sandstones interbedded with black, more or less carbonaceous shales. The standstones carry many rounded grains of shale, similar to the shale with which they are interbedded. Plant remains, mainly casts of tree trunks and branches, are abundant throughout. In places both shales and sandstones have been metamorphosed to schist, the former showing the greater degree of metamorphism. The areas of metamorphosed strata are closely connected with lines of thrust faults that traverse the region.

Malloch shows three areas of "Hazelton" strata on his map. The first extends southeast from the headwaters of Beirnes Creek to the headwaters of Currier Creek, and is said to lie along the crest of an anticline. The second joins the first south of Currier Creek. Thence it extends eastward to a point southeast of Mount Jackson, past which the "Hazelton" beds are shown as extending north to the junction of the Skeena and the Kluatantan. On the south side of Mount Jackson at least, the "Hazelton" beds are said to be thrust over the "Skeena" beds. The third area mapped is a long sinuous belt on the northeast side of the mountains situated between Skeena and Kluatantan Rivers, and, from the manner in which it is depicted by Malloch, it must overlie a thrust fault. G. W. Evans disagrees with this interpretation as he could find no evidence of such a thrust. The beds mapped by Malloch as "Hazelton", below the "Skeena", are considered by Evans to be high in the "Skeena". Malloch also suggests that the area southwest of the Nass, and that northeast of the range on the northeast side of Kluatantan-Kluayetz Valley, may also be underlain by "Hazelton" rocks.

Upper Part of the Hazelton Group

The strata of this division, the "Skeena series" of Malloch, are said to consist of siliceous and shaly sandstones, black, yellow, brown, and purple shales, and beds of conglomerate, composed of partly rounded pebbles of dark blue and light green cherts.

For descriptive purposes, Malloch divides these rocks into three general classes. The first of these is composed of highly siliceous materials, either conglomerates or sandstones, consisting essentially of blue and green chert grains and pebbles bound together by a siliceous cement into extremely hard masses. Conglomerates of this character occur in many places at the base of the upper part of the group, especially at the eastern edge of the coalfield.[1] Many of these siliceous beds weather to reddish tints, but are dark grey on fracture. A particularly thick and massive bed of conglomerate, lying almost at the top of the section west of the Skeena, could be traced north for more than 15 miles and caps many of the highest peaks.

The remaining sandstones of the series form the second lithological group. Though commonly containing pebbles similar to those in the conglomerates, these sandstones are characterized by a shaly matrix, and weather to various shades of brown and yellow. In some places they seem to change abruptly to shales similar to those above and below. The shales show great variation in colour. Possibly black (or grey) shales are the most common, but brown and yellow shales are nearly as abundant, and at two distinct horizons purplish colorations were noted. It seems natural to group the shales and shaly sandstones together, as it appears that they commonly replace each other from section to section.

The coal seams constitute Malloch's third lithological subdivision. They will be more fully described below.

To these three subdivisions the writers would add a fourth. At various places on Skeena River between Telfer and Davis Creeks are numerous outcrops of hard, tough, buff weathering sandstones, grey on fresh fracture, probably quite limy, which contain zones so filled with fossils as to approach a coquina. They range in thickness from 1 foot to 10 feet. Most of the fossils are pelecypods, but some gastropods were noted. The fossils are quite evident on river-washed bedding surfaces, but inconspicuous in cliff sections, where their presence is best indicated by thin crescentic holes from which fossils have weathered. G. W. Evans reports a 12-foot bed of grey, massive sandstone containing clam shells from a section he measured in Grizzly Gulch (Loc. 40), on the southwest slope of Operator Mountain. These sandstones may form only a small fraction of the rocks of the area, but, particularly if the shells prove diagnostic, may be extremely valuable horizon markers.

Present knowledge of the stratigraphy of the Groundhog coalfield is derived from three stratigraphic sections measured by Malloch. One, termed the "Main section", comprising 4,656·4 feet of strata, was measured at the top of McEvoy Ridge (Loc. 10). Another, the "Anthracite Creek section", comprising 2,076 feet, was measured about 2 miles from the first, in a cirque at the head of Anthracite Creek (Loc. 9). The third, the "Mount Jackson section", 1,624·6 feet thick, was measured on the west side of Mount Jackson. The details of these sections are given below and are shown graphically in Figure 1.

A very tentative correlation is suggested by the positions of the columnar sections in the figure. The correlation of the Main and Anthracite Creek sections is that suggested by Malloch, but the Mount Jackson section is shown 346 feet higher than he had it. He based his correlation, given below, on strata of hard siliceous sandstone, and on coal seams. Inspection will show that neither the correlations tentatively suggested by the writers, nor any others, are satisfactory. Exact identity of beds at different places is not to be expected in a near shore deposit of mixed continental and marine beds, but within such a small area at least somewhat greater continuity of coal seams would appear probable. This is particu-

[1] *See* page 24, discussion of possible occurrence of Sustut group rocks.

larly applicable to the Main and Anthracite Creek sections, where it is hoped that another season's work will, by tracing specific horizons, strengthen the suggested correlation; if it is correct, it will indicate lack of any great continuity of coal seams in this field.

Malloch offers the following observations in this regard: "A comparison of the sections shows that the various horizons of many of the seams agree as closely as might be expected, considering the probable degree of accuracy of the measurements. It seems evident, however, that certain of the seams are absent from one or more of the sections, but it is to be remembered that the seams are often so deeply buried by debris that they are easily overlooked. In one case where the writer had reason to suspect the presence of a seam, it was not until a hole 3 feet deep had been dug that the first black particles were recognized in the disintegrated fragments of shales and sandstones which had slidden down over the outcrop. Furthermore, it is believed that the tendency of heavier sandstones and shales to crush down upon the seams is responsible for some of the variations in the measured thicknesses of what, in all probability, is the same seam. Where the horizon of a coal seam in one section appears to be represented in another by beds of strong sandstone there is less chance that the seam is present, though concealed, since, in all probability, in such cases the seam has been removed by erosion shortly after its formation."

If the foregoing is correct, it may be that measurement of sections in greater detail will lead to more satisfactory correlations. However, it is the feeling of the writers that no satisfactory correlations between sections, either Malloch's three, or several by G. W. Evans, can be made at present. The best idea of the stratigraphy of the Groundhog coalfield is that conveyed by the "Main section" comprising 4,656·4 feet of strata.

The distribution of the Upper Part of the Hazelton group is shown on the accompanying map. According to Malloch, strata of this group underlie all of the area shown by the form lines to be topographically mapped, with the exception of the three areas of "Hazelton rocks" noted above.

MEASURED STRATIGRAPHIC SECTIONS

The following sections were measured by G. S. Malloch in 1911 and 1912 (21, pp. 79-80, 85; 22, pp. 79-83).

Main Section

"Skeena series"

	Thickness Feet
1. Massive bed of conglomerate with chert pebbles to the size of hens eggs	107
2. Brown shale	8
3. *Coal,* with 0·7 foot shale in centre	12
4. Brown shaly sandstone	5
5. Brown shale	10
6. *Coal*	3·2
7. Black shale	24
8. *Coal,* with 1 foot bone in centre	4·5
9. Black and brown shale	15
10. Shaly sandstone	9

	Thickness Feet
11. Black shale	8
12. *Coal*	2·8
13. Brown shales and shaly sandstones, with a few streaks of *coal*	114
14. Massive bed of sandstone, with chert pebbles in lower two-thirds, shaly above	37
15. *Coal*	1
16. Black and brown shales with a number of streaks of *coal* and ironstone concretions	250
17. Coarse sandstone, soft and crumbly	8
18. *Coal* seam, dirty	2
19. Black shale	12
20. Hard siliceous sandstone, weathering red, fairly coarse in places	34
21. Black and brown shale with three thin seams of *coal*	33
22. *Coal*	1
23. Black and brown shale with ironstone concretions	16
24. Shaly sandstone	16
25. Brown sandstone with bands of calcareous shale below and chert pebbles above	51
26. Brownish shale with bands of fossiliferous ironstone concretions and streaks of *coal*	23
27. Brown sandstone, fine grained above, with some pyrite crystals, coarser with chert pebbles below	15
28. Partly concealed, probably all brown shale	16
29. Siliceous sandstone, weathering red	6
30. Black shale	8
31. Shaly sandstone (streaks of *coal*)	4
32. *Coal*	1·3
33. Black shale	21
34. Shaly sandstone	2
35. Dirty *coal*	2·5
36. Black shale and shaly sandstone, with three streaks of *coal*	41
37. *Coal*	4·5
38. Black shale and a little shaly sandstone	41
39. Beds of soft yellow sandstones with some chert pebbles and shale bands	39
40. Coarse sandstone with many chert pebbles below, finer above	35
41. Black and brown shales, with streaks of *coal*	40
42. *Coal*	1·3
43. Black shale with streak of *coal*	22
44. Coarse grey sandstone, with lines parallel to bedding planes	2
45. Black shales and streak of *coal*	11
46. *Coal*	1·1
47. Black shales	17
48. *Coal*	1
49. Black shale and shaly sandstones	39
50. Hard siliceous sandstones	20
51. Black shales and brown shaly sandstones, some streaks of *coal*	142
52. Black shales, separated by thin beds of brown shaly sandstones	219
53. Coarse grey sandstone, weathering brown	12
54. Black shale	21
55. Dirty seam of *coal*	2
56. Black shales, with a few streaks of *coal* and some shaly sandstones	140
57. Sandstones, separated by a few bands of black shales	75
58. Black shales, with a few streaks of *coal*	155
59. Siliceous sandstone, weathering red	2

	Thickness Feet
60. Black and brown shales, with three seams of *coal*, apparently under 1 foot thick	350
61. *Coal*	0·5
62. Black shale and soft shaly sandstones	88
63. Coarse grey sandstone, with a rather weak cement, weathering yellow	46
64. Shaly sandstones and black shales, with at least one *coal* seam not dug out	50
65. Coarse grey sandstones, separated by shales, weathering yellow	38
66. Shaly sandstones	8
67. Fine shaly sandstones and shales with streak of *coal* and fossil plants	41
68. *Coal* (roof fallen in, at least 1 foot)	1
69. Soft shaly sandstones and yellow shales with calcareous concretions	111
70. Coarser sandstone, showing banding parallel to bedding planes, weathers yellow	6
71. Black shales and shaly sandstones, partly concealed	158
72. Brown shales and shaly sandstones, with numerous concretions	61
73. Brown shales and shaly sandstones, sometimes with purplish tints. One bed with fossils and a streak of *coal*	196
74. Coarse sandstones and shales similar to the above, the shales predominating	214
75. Hard siliceous sandstone, weathering red	25
76. Black shale, with beds of concretions	143
77. Conglomerate	6
78. Black shale	15
79. *Coal*	0·4
80. Black shales and shaly sandstones, the shales predominating	73
81. Massive bed of hard sandstone	38
82. Brown shales, with a few thin beds of shaly sandstone, and streaks of *coal*	86
83. *Coal*	0·3
84. Black shales and grey shaly sandstones	115
85. Hard grey sandstone	7
"Hazelton group"	
86. Black shales, with a few bands of shaly sandstone	30
87. Alternating beds of brown sandstone (grey on fracture) and black shale	36
88. Grey sandstone and black shales, the shales greatly predominating	80
89. Grey sandstones predominating over black shales	326
90. Black shales, with calcareous concretions	36
91. Hard grey sandstone, crossbedded, with grains of black shale	6
92. Black shale, bottom not seen, at least (This bed in 1911 section only)	300
	4,656·4

Anthracite Creek Section

1. Thin-bedded brown sandstone	90
2. Conglomerate in heavy beds	137
3. *Coal* (dirty)	3·5
4. Black shale with dirty *coal* seams	133
5. Coarse crumbly grey sandstone	14
6. Black shales	18
7. Brown shaly sandstone with fossil plants and pebbles	48

	Thickness Feet
8. Conglomerate	47
9. Brown shaly sandstones	27
10. Conglomerate (crumbly); this thins out and is replaced by shale 300 feet to the south	21
11. Black shales with several dirty *coal* seams	133
12. Yellow sandstone with pebbles at base; shows crossbedding and fossil plants	55
13. *Coal* seam, about	1
14. Black shale	14
15. Hard siliceous grey sandstone, weathering red	23
16. Black shales and grey shaly sandstone with some brown concretions	42
17. Conglomerate, crumbly	6
18. Black shale and grey shaly sandstone	43
19. Greenish grey sandstone	6
20. Black shales	53
21. Greenish grey sandstone with 10 feet containing pebbles near bottom	46
22. Black shale and purplish shale and sandstone	105
23. *Coal*	1
24. Black shale	138
25. Hard siliceous sandstone	43
26. Black shales and beds of coarse, grey, purplish sandstones	248
27. Grey sandstone	50
28. Black shale	73
29. Siliceous sandstone, weathering red	6
30. Black shale	42
31. Grey sandstone	38
32. Black shale	29
33. Shaly sandstone	5
34. Black shale, bituminous in two places	84
35. Sandstone, with pebbles	5
36. Black shale	74
37. Coarse grey sandstone	17
38. Black shale	53
39. Concealed (probably black shale)	70
40. Coarse grey sandstone, rather soft	17
41. Black shale	15
42. Dirty *coal*	2·5
	2,076·0

Mount Jackson Section

1. Brown shale and rather coarse crumbly sandstone	56
2. Blue shale, with plant remains	10
3. Soft yellow shale	10
4. *Coal*	3·3
5. Yellow sandstone	33
6. Bituminous shale	1
7. Black shale	17
8. Crumbly sandstone with some chert pebbles	5
9. Yellow shale, with bed of black shale near top	69
10. *Coal* seam (dirty)	6
11. Brown flaky shale	88
12. Bituminous shale	3
13. Black shale	25
14. Dirty *coal*	1

		Thickness Feet
15.	Black and brown shale	134
16.	Hard siliceous sandstone	20
17.	Black shale	70
18.	*Coal*	1
19.	Black shale	16
20.	Thin-bedded, shaly sandstone	10
21.	Yellow and black shale	127
22.	Rather coarse grey sandstone	47
23.	Black shale	41
24.	*Coal* seam (dirty)	1·8
25.	Yellow and black shale	62
26.	*Coal* seam (dirty)	3·1
27.	Black shale	3
28.	Yellow shale	50
29.	*Coal* seam (dirty)	4·2
30.	Yellow and black shales	16
31.	Thin-bedded grey sandstone	24
32.	*Coal*	1
33.	Brown and black shale	13
34.	Crumbly yellow and brown sandstone	42
35.	*Coal*	1
36.	Black shale	5
37.	Rather coarse sandstone, massive in centre, but rather shaly above and below	21
38.	Black shale	24
39.	*Coal* (dirty)	4
40.	Black shale	74
41.	Yellow sandstone, very shaly below, more massive above	19
42.	Black shale	22
43.	Yellow shaly sandstone	21
44.	Black shale	15
45.	*Coal*	1
46.	Concealed, probably black shale	15
47.	Heavy beds of shaly sandstone, weathers yellow	37
48.	Black shale	10
49.	*Coal* not dug out............(end of 1912 section)	
	47. Massive grey sandstone, weathering yellow.... 21 48. Black shale.... 15 These beds are the part of the 1911 section that overlaps the 1912 section.	
49.	*Coal*	4·3
50.	Black shale	3
51.	Massive grey sandstone, weathering yellow	18
52.	Black shale, partly concealed	16
53.	Dirty *coal*	1·4
54.	Black shale	42
55.	*Coal*	3·5
56.	Black shale	10
57.	Grey sandstone, weathering yellow	27
58.	Black shale, slightly arenaceous above	17
59.	Partly concealed, probably all black shale	46
60.	*Coal*	3·6
61.	Black shale	2·5
62.	*Coal*	0·9
63.	Light yellow shaly sandstone	15
64.	Black shale, with a few thin beds of sandstone near top	43
65.	Coarse yellow sandstone	5
66.	Partly concealed, probably all black shale	39
67.	Shaly sandstone	3
68.	Black shale, rather arenaceous in places	42
		1,624·6

According to Malloch (22, pp. 82, 83), these sections may be correlated as follows:

Mount Jackson section			Main section			Anthracite Creek section		
Bed No.		Feet	Bed No.		Feet	Bed No.		Feet
			3	Coal with 0·7 foot shale in centre	12	3	Coal (dirty)	3·5
			18	Coal seam (dirty)	2	13	Coal seam, about	1
			20	Hard siliceous sandstone, weathering red, fairly coarse in places	34	15	Hard siliceous grey sandstone, weathering red	23
4	Coal	3·3	46	Coal	1·1			
8	Crumbly sandstone with some chert pebbles	5	50	Hard siliceous sandstones	20	25	Hard siliceous sandstone	43
16	Hard siliceous sandstone	20				29	Siliceous sandstone, weathering red	6
18	Coal	1	55	Dirty seam of coal	2			
32	Coal	1				42	Dirty coal	2·5
49	Coal	4·3	61	Coal	0·5			

PALÆONTOLOGY AND AGE

Fossils have not been collected from the Lower Part of the Hazelton group in the Groundhog coalfield. The nearest fossil locality in rocks assigned to this age is 20 miles south of the field.

From the Upper Part of the Hazelton group, Malloch collected a few fossil shells, none of which has yet proved diagnostic of well-determined zones. In 1948, shells were observed at twenty localities, at most too late in the season to enable collections to be made. Collections of fossil plants made by Malloch and by the writers contain sixteen species. These, according to W. A. Bell, of the Geological Survey of Canada, indicate a Kootenay (early Lower Cretaceous) age.

ABSENCE OF INTRUSIVE ROCKS

At many places in northwestern British Columbia intrusive rocks, most commonly acidic and commonly of batholithic proportions, cut rocks of the Hazelton group or its correlatives. No intrusive rocks of this, or any other, age have been reported from the Groundhog area.

POSSIBLE OCCURRENCE OF SUSTUT GROUP

In the McConnell Creek map-area (19), Lord found a group of rocks that he termed the Sustut group. The lower members of the group consist mainly of interbedded conglomerate, pebbly sandstone, and sandstone, and the upper members of interbedded sandstone and shale. Fossil wood and leaves, coaly fragments, and small lenses of coal are common through the rocks of the group, but no commercial coal seams have been found in them. Leaves from the lower part of the group indicate a lower Upper Cretaceous age, those from the upper part a Páleocene age.

In the northwestern part of McConnell Creek map-area, the Sustut rocks occupy two adjacent areas. In one, northeast of the Omineca fault zone, the strata are relatively undisturbed; in the other, southwest of the fault zone, they lie in open, northwesterly trending folds with dips commonly as high as 55 degrees, locally higher. Rocks of this group, with the same structural pattern, can be traced northwesterly, using air photographs, for at least 100 miles, as far as Ross Creek near Hyland Post. The distinction between disturbed Sustut and older disturbed rocks cannot be made with certainty on these photographs.

This belt of Sustut rocks passes along the northeastern edge of the Groundhog area. The rocks along the northeast slopes of the range northeast of Kluatantan River-Kluayetz Creek Valley, included by Malloch in the "Skeena" formation of the Groundhog coalfield, are reported to be chiefly conglomerate. Private reports by G. W. Evans contain geological sections showing contorted "Skeena" beds thrust from the southwest over conglomerate beds that show more open folding. The "Skeena" beds also contain conglomerates. In 1912, Malloch visited coal occurrences on Sustut River within the McConnell Creek map-area, and included rocks of the Sustut group in his Skeena series.

It is inferred from the foregoing that a belt of Sustut rocks limits the Groundhog coalfield on the northeast side, and that coal-bearing rocks of the Hazelton group are, in places at least, overthrust on rocks of the Sustut group. This inference must be tested in the field, and will be positively confirmed if fossils of Sustut age can be found. As conglomerates occur in both groups, their distinction may be difficult. Lord informs the writers that at least 50 per cent of the Sustut conglomerates in the McConnell Creek map-area carry granite pebbles. Conglomerates of the Hazelton group in the Groundhog area have not been reported to carry such pebbles, and this may provide a means of separation.

If part of the Groundhog area mapped as "Skeena series" by Malloch is, in reality, underlain by rocks of the Sustut group, the area of potential coal-bearing rocks is probably reduced, as the rocks of the Sustut group are not known to contain commercial coal seams.

STRUCTURAL GEOLOGY

According to Malloch (23, p. 87): "The geological structure of the Groundhog field is complex and is difficult to describe. In general the strata appear to lie in folds overturned to the northeast and whose axes strike about northwest. As a result of the structure the strata, in general, dip to the southwest, though locally the measures dip to the northeast. The main folding in many places is complicated by minor folds and crumples. The intricate structure due to the folding has been further complicated by pronounced faulting. The faults, in general, strike about north 60 degrees west and appear to be in most cases of the nature of thrust faults by which blocks of the recumbent folds have been thrust northeastward." Malloch adds that the area of "Skeena" rocks south of Currier Creek is unusual in that it shows east strikes and north dips.

Field work in 1948 did not supply sufficient new data to either add to, or revise, the structural picture given by Malloch, but it amply confirmed his conclusions as to the complexity of the structures and the high degree of disturbance in the area.

The writers wish to emphasize particularly the minor folds and crumples mentioned by Malloch as having a great bearing on the economic value of the field. S- and Z-folds are common. Exposures are most complete above timber-line. There it is common experience to find that areas that from a distance seem to have a uniform strike and dip are not only bounded by disturbed zones but on closer inspection are seen to be crossed by crumpled and faulted zones. Overturned beds, in places nearly completely overturned, are not rare. In places, S-shaped folds were seen with horizontal axial planes, and folds whose axial planes dip at 40 to 60 degrees are common. Similar folds have been noted in the valley bottoms, where exposures are less complete. This, and the monotonous succession of coal-bearing beds, make it very difficult to correlate coal seams across the area or even within limited parts of the area. It means that the assumption of continuity of coal seams beneath concealed areas may not be warranted, and that the determination of their position at depth by projection of strike and dip is very hazardous. It also means that the number of coal outcrops in a given area is not a reliable guide to the number of coal seams underlying that area. Because much more trenching, test-pitting, and diamond drilling than normal will be required in the Groundhog coalfield to prove a given area, development work there will be slow and costly.

ECONOMIC GEOLOGY

The coal deposits of the Groundhog area are its only known mineral resource of value. It has been pointed out that neither the stratigraphy nor the structure of the area has been worked out. Lacking this information it is not possible to state that the area contains a definite number of coal seams, occurring at stated horizons in the stratigraphic column, and to give thicknesses of these seams. Nor is it possible to correlate the various coal occurrences.

From the writers' work, and from a compilation of all available data, information on one hundred and ninety-two occurrences of coal seams has been assembled. The locations of these are plotted on the accompanying map, where it may be seen that they are spread fairly uniformly over the area. The 1948 work showed that many more could be added if detailed work were continued, and that the number of seams reported in a given area is mainly an indication of the amount of prospecting in, and the completeness of the records for, that area.

DESCRIPTION OF INDIVIDUAL OCCURRENCES

Under this heading are recorded all occurrences of coal in the Groundhog area known to the writers. The locality numbers are those of the map. Localities 1 and 2 are outside the map-area.

Loc. 1, Mountain South of Damdochax Lake. On the top of the mountain south of Damdochax (Blackwater) Lake, Malloch, in 1911 and 1912, examined an area underlain by the "Skeena series" containing very thin coal seams and "fossil plants, characteristic of the Skeena series". The seams were so thin that he did not measure the section, but estimated a stratigraphic thickness of less than 500 feet of "Skeena series". Malloch does not state the relation of these beds to the underlying Hazelton group. They would appear to be an erosion remnant of limited extent, and indicate that outliers may be expected away from the main coal area.

Loc. 2, 2A, Nass River. (Loc. 2) A specimen of coal reported to have been sent in by a Mr. Wright from a point "two miles northwest of No. 7 Cabin, Yukon Telegraph Trail", was analysed for J. W. Stewart by the British Columbia Government Laboratory, August 15, 1912 (Anal. 69).[1] (Loc. 2A) Messrs. Beaton and Kobes reported to Malloch that they had found float coal in two places on Nass River. The locality indicated is that part of the Nass within their holdings.

Various references to the occurrence of coal on Nass River west of the Groundhog field have been found, but the two above are the nearest approach to specific localities available, and obviously neither is conclusive.

[1] Analyses are listed in a table at the end of this report.

Loc. 3, Mouth of Anthony Creek. A 3-foot seam of coal near the mouth of Anthony Creek was reported to Malloch by Messrs. Beaton and Kobes.

Loc. 4, Headwaters of Anthony Creek. On the main south fork of Anthony Creek, Malloch measured a seam section, which he recorded as follows:

	Ft.	Ins.
Coal	2	11½
Bone	1	0
Coal	2	3
Bone		9
Coal		11
Total	7	10½
Total coal	6	1

The seam strikes north 76 degrees east and dips 17 degrees southeast. A sample was taken, omitting the bone and quartz stringers, and an analysis (Anal. 1) gave 41·14 per cent ash. Malloch states: "The high percentage ash is due to fine lamellæ of bone occurring in the coal".

Loc. 5, Panorama Creek. Messrs. Beaton and Kobes reported to Malloch the presence of a 3-foot and a 6-foot seam on Panorama Creek. R. C. Campbell-Johnston also reports the presence of "strong outcrops of coal on Panorama Creek".

Loc. 6, Lower Kobes Creek. On the first large tributary (Kobes Creek) of Panorama Creek from the south, Malloch discovered a 4½-foot seam. The outcrop was 200 yards upstream from the mouth of the creek and 70 feet above it. The seam strikes north 62 degrees west and dips 42 degrees northeast. Malloch adds: "One 8-inch seam occurs at the stream level below this. The rocks in the area are much crumpled".

Loc. 7, 7A, Headwaters Kobes Creek. (Loc. 7) In 1911, Malloch notes that a 10-foot seam in this vicinity was reported to him by Messrs. Beaton and Kobes, and these two men furnished him with a picked specimen of coal from this seam. An analysis (Anal. 70) of the specimen gave 4·39 per cent ash, but Malloch says: "From a comparison with other seams the writer doubts whether a sample across the entire seam would yield nearly so low a percentage of ash". In 1912, Malloch again refers to this seam, but he now states that it is 12 feet thick. He also adds that, in addition to this seam, Messrs. Beaton and Kobes report a 20-foot seam and a 6-foot seam in the same locality. (Loc. 7A) Malloch states that Messrs. Beaton and Kobes reported seeing "seams in the mountain southeast of the mouth of Panorama Creek similar to the 3-foot and 6-foot seams seen along Panorama Creek" (Loc. 5).

Loc. 8, Headwaters of Currier Creek. Messrs. Beaton and Kobes reported to Malloch that they had seen two 4-foot seams and a 6-foot seam at the headwaters of Currier Creek.

Loc. 9, Headwaters Anthracite Creek. Malloch measured a 2,076-foot stratigraphic section at this point, and called it the Anthracite Creek section.

It contains the following coal seams, whose positions are shown on Figure 1. He describes the seams as:

	Ft.	Ins.
3. Coal (dirty)	3	6
4. Black shale with dirty coal seams		
11. Black shales with several dirty coal seams		
13. Coal seam, about	1	0
23. Coal	1	0
34. Black shale, bituminous in two places		
42. Dirty coal	2	6

Loc. 10, McEvoy Ridge. Here Malloch measured his Main section of 4,656·4 feet, and enumerates the following seams:

	Ft.	Ins.
3. Coal, with 8½ inches of shale in centre	12	0
6. Coal	3	2½
2. Coal, with 1 foot bone in centre	4	6
12. Coal	2	9½
15. Coal	1	0
18. Coal seam, dirty	2	0
21. Black and brown shale, with three thin seams of coal		
22. Coal	1	0
32. Coal	1	4
35. Dirty coal	2	6
37. Coal	4	6
42. Coal	1	4
46. Coal	1	1
48. Coal	1	0
55. Dirty seam of coal	2	0
60. Black and brown shales, with three seams of coal apparently less than 1 foot thick		
61. Coal	0	6
64. Shaly sandstones and black shales, with at least one coal seam not dug out		
68. Coal (roof fallen in, at least 1 foot)	1	0
72. Coal	0	5
83. Coal	0	4

A picked specimen from the uppermost, 12-foot seam contained 19·65 per cent ash (Anal. 71).

Loc. 11, Augustine Creek. G. W. Evans described two prospects near the mouth of this creek. He named the prospect farthest upstream Currier No. 2 (here Loc. 11A), and the downstream prospect Currier No. 1 (here Loc. 11B). He says that both prospects are in the same seam on the property of the B.C. Anthracite Coal Company. Both prospects consist of drifts 15 feet in length.

G. S. Malloch reports a dirty seam on the south bank of Canyon Creek (now Augustine Creek), and this is evidently that at locality 11A. He states that this same seam was seen again farther downstream on Currier Creek, but he does not say how far downstream. He also mentions a 2-foot seam occurring "a short distance above the mouth of Canyon Creek".

(Loc. 11A). The following section was measured by G. W. Evans at the face of the drift:

	Ft.	Ins.
Roof, shale above coal and sandy shale and sandstone for 50 feet		
Coal and shale		2
Coal, impure		11
Rock and carbonaceous shale	2	0
Impure coal		7
Floor, shaly sandstone		
Total	3	8

The coal seam strikes north 52 degrees west and dips 10 degrees northeast. Analysis (Anal. 2) of a sample taken from the seam gave 27·10 per cent ash, which seems to be quite low considering sample is said to include the 2-foot band of rock and carbonaceous shale.

(Loc. 11B). The following section was measured by G. W. Evans at the fact of the drift:

	Ft.	Ins.
Roof, rich shale for 6 to 10 feet, then sandstone above		
Impure coal and quartz		2
Impure coal		11
Shale and carbonaceous shale	1	1
Floor, sandy shale		
Total	2	2

This seam strikes north 48 degrees west and dips 17 degrees northeast.

Loc. 12, Brewer Creek. Evans only mentions one 3-foot 10-inch seam on this creek, but Robertson speaks of two 4½-foot seams. It is probable that Robertson confused Augustine Creek and Brewer Creek. The seam that Evans describes was on the B.C. Anthracite Coal Company property and was exposed at the face of a 15-foot drift. Evans' section is as follows:

	Ft.	Ins.
Roof, impure coal; real roof concealed		
Coal and shale mixed	3	10
Floor, shale, stratified		

The seam strikes north 68 degrees west and dips 39 degrees southwest. An analysis (Anal. 3) of the 3-foot 10-inch band gave 20·80 per cent ash.

Loc. 13, Currier Creek. Leach reports the occurrence of a 3-foot seam on Currier Creek, about ¾ mile above the point where the trail crosses Currier Creek. Evans reports three seam outcrops on Currier Creek; one is the outcrop of the same seam as described at locality 11A, the second has 3 feet of fairly clean coal; and the third has 2 feet of coal overlying 2 feet of bone. The exact locations of these three seams are not known.

Loc. 14, Lower Trail Creek. The seam here was on the property of the Western Development Company and was one of the first seams reported in the Groundhog area. Leach in 1904 described the seam as seen on the outcrop, but Robertson, McEvoy, and Malloch described the seam as it was seen in a slope that was driven down the dip of the seam for 50 feet.

The seam is reported to have the following sections:

(W. W. Leach)

	Ft.	Ins.
Roof—grey clay shale		
Ferruginous nodular shale ...	1	0*
Carbonaceous shale and coal..	0	6*
Coal	4	6
Grey and carbonaceous shale	1	5*
Coal	2	1
Carbonaceous shale	0	1*
Coal	1	6
Total	10	1
Total coal	8	1

(G. S. Malloch)

	Ft.	Ins.
Bone and coal ...	7	7

(W. F. Robertson and J. McEvoy (1911))

	Ft.	Ins.
Coal with small shale streaks	4	2
Shale, soft	0	6*
Coal	2	6

(W. F. Robertson (1912))

	Ft.	Ins.
Top coal about .	2	0
Dirt—parting ...	0	3*
Dirty coal	0	10*
Dirt—parting ...	0	3*
Coal	0	4
Dirt—parting ...	0	2*
Coal, hard	1	0
Coal, soft	0	8
Dirt—parting ...	0	3*
Coal	2	0
Total	7	9
Total coal	6	10

* Indicates band not sampled.

The strike of this seam is north 47 degrees west and the dip 17 degrees northeast. Robertson reports: "the coal was much shattered, with a large number of small seamlets of quartz showing in the fracture planes".

Leach sampled the upper 4-foot 6-inch bench and the lower 3-foot 7-inch bench, and analyses (Anals. 4 and 5) gave 20·75 per cent and 28·75 per cent ash respectively. The analysis (Anal. 7) of the sample taken by McEvoy gave 29·84 per cent ash, and a similar sample taken by J. F. Walters gave 37·37 per cent ash (Anal. 6). Malloch sampled 6 feet 6 inches of the total thickness of 7 feet 7 inches, and an analysis (Anal. 8) of this sample gave 42·41 per cent ash. Robertson's sample, omitting all partings more than 1 inch thick, gave 48·8 per cent ash (Anal. 9).

Loc. 15, Trail Creek. Six coal occurrences have been reported on Trail Creek, all of them within a ½-mile stretch (*See* Figure 2). The lowest occurrence (15A), downstream on the creek, was on the property of the Western Development Company, and the remaining five (15-B, C, D, E, and F) were on the property of the B.C. Anthracite Company.

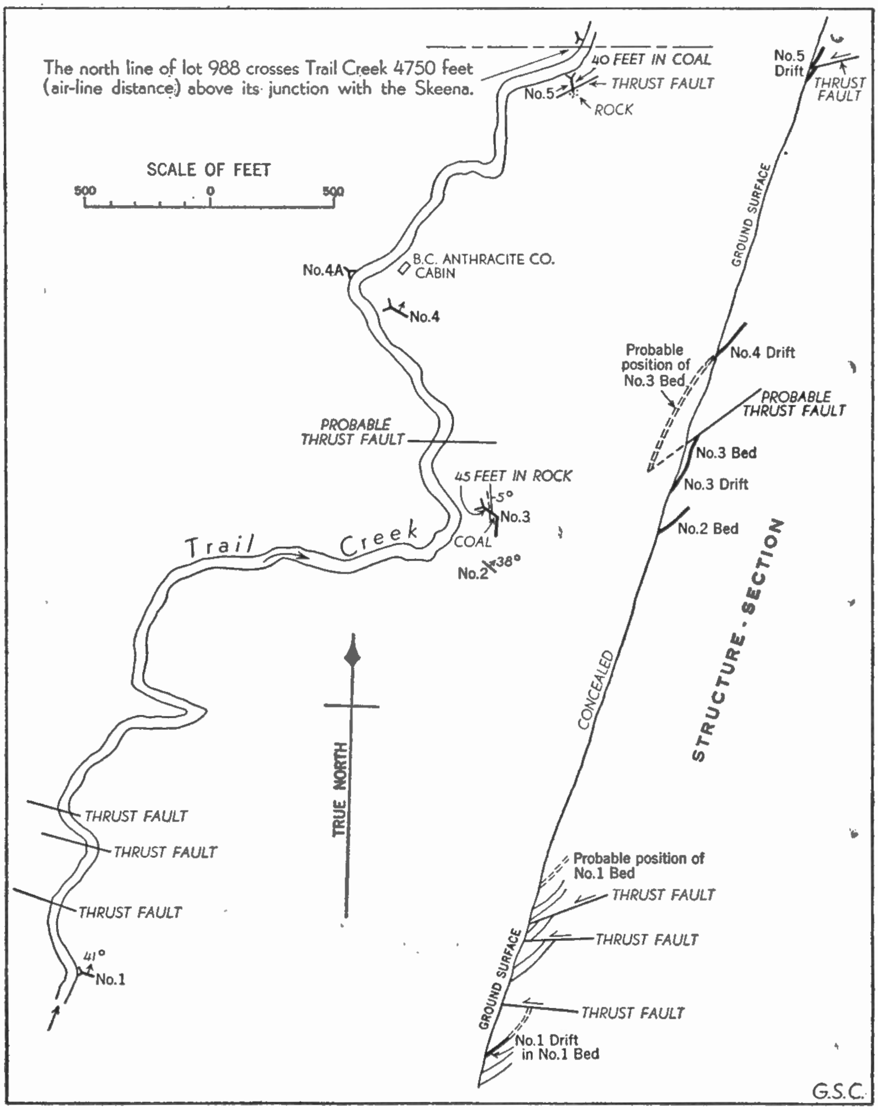

Figure 2. Sketch map and structure-section, showing coal prospects on Trail Creek. Map and geology by G. W. Evans, 1912.

(Loc. 15A) (Unnumbered drift, Figure 2). The following section was measured by G. W. Evans on the outcrop of this seam, which strikes north 5 degrees west and dips 14 degrees northeast:

	Ft.	Ins.
Glacial drift		
Bone and carbonaceous shale	3	0
Coal	1	5
Carbonaceous shale and coal	1	8
Coal, impure	2	5
Floor, shale, black, smooth		
Total	9	6

(Loc. 15B) (Evans' No. 5 drift, Figure 2). This seam outcrops on the east side of the creek a short distance upstream from locality 15A, and is said by Evans to be the eastern extension of the seam exposed at 15A. On it a drift was run for 40 feet, where a fault was encountered, past which the working was driven an additional 16 feet in rock.

No section is given for the seam at this locality, but Robertson says that the coal is very dirty and much shattered. Robertson took two samples, one of which was a general sample giving 38·3 per cent ash (Anal. 10), and the other a sample of lump coal free from all partings, which gave 21·5 per cent ash (Anal. 72).

(Loc. 15C) (Evans' No. 4 drift, Figure 2). This seam was opened by a drift that followed the coal for 111 feet. An air chute, 30 feet long, was also driven. These workings are also on the east side of Trail Creek, a short distance above locality 15B. The following section of the coal seam is reported by Evans:

	Ft.	Ins.
Roof, shale		
Coal left in roof		4-6*
Coal	1	1
Calcite concretion		1*
Coal		6
Shale		1*
Coal	1	4
Shale		9*
Coal		5
Shale		4*
Coal		5
Floor, massive sandstone beneath shaly sandstone		
Total	5	5

Robertson mentions this seam, but does not give a section for it. He does state that the seam is about 7 feet thick and that it includes several dirt partings. The seam strikes north 67 degrees west and dips 31 degrees northeast. The coal is said to be sheared and slickensided. Evans' sample, in which he omitted the partings, as shown above, gave 40·35 per cent ash (Anal. 11), and a picked sample of lump coal contained 20·4 per cent ash (Anal. 73).

(Loc. 15D) (Evans' No. 4A drift, Figure 2). Across the creek from the tunnel at 15C is another drift 15 feet long evidently driven on the same seam as at 15C. These are the only reported data on the occurrence.

(Loc. 15E) (Evans' No. 3 drift, Figure 2). This seam was opened by a drift 183 feet long, the first 45 feet in sandrock and the remaining 138 feet in coal.

The following section was taken by G. W. Evans 70 feet back from the face of the drift.

	Ft.	Ins.
Roof, dark shale		
Coal in roof		4–6*
Coal, cubical fracture, some calcite	2	6
Shale, carbonaceous	1	2*
Coal, bottom bench		10½
Floor, sandstone, massive		
Total	4	11½

The seam strikes north 5 degrees west and dips 15 degrees northeast. At the face of the drift, the seam, due to a roll, pinched to 2 feet in thickness, and the coal is badly slickensided and graphitic in character.

(Loc. 15F) (Evans' No. 2 seam, Figure 2). A 6-foot cut was made on the outcrop of this seam, and Evans reports that the following section was exposed:

	Ft.	Ins.
Roof, shale, stratified, jointed 20 feet		
Coal, fairly clean	2	0
Floor, shale, black, smooth		

The seam strikes north 47 degrees west and dips 38 degrees northeast.

Loc. 16 (Evans' No. 1 drift, Figure 2). Evans reports a seam in this locality and states that a 40-foot drift was driven on it, and that the seam strikes north 73 degrees west and dips 41 degrees northeast. No other data are recorded.

Loc. 17, Little Creek. Three coal seams, all on the property of the B.C. Anthracite Company, have been reported on Little Creek. The three seams are in the general locality shown on the map, but their exact location is not known.

(Loc. 17A) At this locality the seam outcrops on the east side of Little Creek. It strikes north 15 degrees west and dips 25 degrees northeast. Evans refers to it as the Jackson No. A, and records the following measured section on the outcrop face:

	Ft.	Ins.
Roof, shale and shaly sandstone		
Coal, impure		2*
Coal, clean, soft	1	4
Shale, carbonaceous		7*
Coal, slabby	1	10
Floor, shale for 30 feet		
Total	3	11
Total sampled	2	4

An analysis (Anal. 12) of the sampled part gave 30·04 per cent ash.

(Loc. 17B) The seam at this locality lies a short distance upstream from locality 17A, and is referred to by Evans as the Jackson No. 1 seam.

It was opened by a drift 26 feet long, and is reported by Evans to have the following section:

	Ft.	Ins.
Roof, shaly sandstone		
Carbonaceous shale		6*
Coal, bright	1	0*
Coal and carbonaceous shale		7*
Carbonaceous shale and clay	1	6*
Coal, bright		11
Shale, carbonaceous		1
Coal, bright	1	4
Carbonaceous shale and coal mixed	1	2*
Floor, sandy shale		
Total	7	1
Total sampled	2	4

The seam strikes north 58 degrees east and dips 70 degrees northwest. An analysis of the sample (Anal. 13) taken gave 25·20 per cent ash.

(Loc. 17C). Malloch reports a seam on the northwestern slope of the hill 2·65 miles south of Currier Creek, which is near localities 17A and 17B. The seam is reported to be 2 feet 5 inches thick, to strike north 75 degrees west, and to dip 15 degrees northeast.

Loc. 18, Headwaters of Jackson Creek. Three prospects, close together, have been reported on the headwaters of Jackson Creek. They were all on the property of the B.C. Anthracite Company.

(Loc. 18A). The seam at this locality has been referred to as the Jackson No. 2. A 20-foot drift was driven southeasterly on the seam, which strikes north 40 degrees west and dips 74 degrees southwest, and the following section was measured by Evans:

	Ft.	Ins.
Roof, brown shale		
Coal and streaks of carbonaceous shale	5	8*
Coal, fairly clean	4	0
Floor, shale		
Total	9	8
Total sampled	4	0

An analysis of the sampled part (Anal. 14) gave 29·73 per cent ash.

(Loc. 18B) The seam at this locality was termed the Jackson No. 4. A drift was driven on it for 15 feet, and the following section was measured by G. W. Evans:

	Ft.	Ins.
Roof, sandstone, rolling		
Coal, bright		11
Shale, carbonaceous		2½*
Coal, bright		9
Shale, carbonaceous		6*
Coal, bright	1	0
Shale, carbonaceous	2	0*
Floor, shaly sandstone		
Total	5	4½
Total sampled	2	8

The seam strikes north 56 degrees west and dips 20 degrees northeast. An analysis (Anal. 15) gave 23·78 per cent ash.

(Loc. 18C). The seam at this locality was termed the Jackson No. 3. A 25-foot drift was driven on the seam and the following section measured by G. W. Evans:

	Ft.	Ins.
Roof, shaly sandstone, smooth		
Coal and shale mixed, best of bed but poor	4	5
Coal and shale mixed	1	3*
Floor, shale, sandstone		

The seam strikes north 45 degrees west and dips 35 degrees southwest. An analysis (Anal. 16) gave 25·84 per cent ash.

Loc. 19, Mount Jackson. Here Malloch's third section, the Mount Jackson section, was measured. It contained the following coal seams:

	Ft.	Ins.
4. Coal	3	3
10. Coal seam (dirty)	6	0
14. Dirty coal	1	0
18. Coal	1	0
24. Coal seam (dirty)	1	9½
26. Coal seam (dirty)	3	1
29. Coal seam (dirty)	4	2
32. Coal	1	0
35. Coal	1	0
39. Coal (dirty)	4	0
45. Coal	1	0
49. Coal	4	4
53. Dirty coal	1	5
55. Coal	3	6
60. Coal	3	7
61. Black shale	2	6
62. Coal	0	10

The uppermost seam from this section was sampled (Bed No. 4) by Malloch and contained 20·32 per cent ash (Anal. 17). Malloch notes that the sample was taken from weathered coal.

Loc. 20, Mount Jackson. Here Malloch sampled a seam 6 feet 2 inches thick, which strikes north 53 degrees west and dips 40 degrees southwest. The sample, probably of weathered coal, contained 26·52 per cent ash (Anal. 18).

Loc. 21, Lower Jackson Creek. Brief mention has been made of two seams in this locality.

(Loc. 21A). The seam here occurs about ½ mile above the mouth of Jackson Creek. The outcrop was stripped and the following section was exposed and measured by W. W. Leach:

	Ft.	Ins.
Shale		
Coal	2	0
Shale	0	2½
Coal	5	0

The analysis of a sample from the above section gave 22·80 per cent ash (Anal. 19).

(Loc. 21B) The seam at this locality is about 30 or 40 feet upstream from the seam at 21A. W. W. Leach reports about 3 feet of hard, bright coal. He also states that several small seams were seen above this point along the creek.

Loc. 22, Skeena River below Duke Creek. Three seams have been found in an outcrop that extends for 200 feet along the east bank of Skeena River just below the mouth of Duke Creek. One seam, at locality 22A, is at the upstream end of the outcrop; the second seam, at locality 22B, is 100 feet downstream from 22A; and the third seam, at 22C, is another 100 feet downstream from 22B (*See* Figure 3).

(Loc. 22A) The seam here was first discovered by Leach in 1904. He described it as a seam of impure coal 3½ feet thick. In 1948 the writers measured the following section:

	Ft.	Ins.
Glacial drift		
Weathered coal (bloom)		9
Coal, bone, and shale		10
Coal	1	6
Floor, shale		
Total	3	1

The seam strikes north 64 degrees west and dips 27 degrees northeast. It lies 100 feet upstream from, and on the hanging-wall side of, a normal fault with a downthrow of at least 6 feet and probably more than 20 feet.

A sample was taken in 1904, the analysis (Anal. 20) of which gave 35·22 per cent ash.

(Loc. 22B) The seam here lies on the foot-wall side of, and a short distance from, the normal fault mentioned above. It strikes north 68 degrees west and dips 25 degrees northeast. The following section was measured by the writers in 1948:

	Ft.	Ins.
Shale roof		
Mining dirt		1
Coal		2
Mining dirt		2½
Coal		7½
Parting		
Coal		10
Interbedded shale and sandstone floor		
Total	1	11

(Loc. 22C) Only the lower part and floor of the coal seam were observed by the writers here. The beds at this point strike north 77 degrees west and dip 17 degrees northeast.

Loc. 23, Abraham Creek. The seam at this locality was explored in 1911 and 1912 by a drift about 20 feet long. In 1948, the writers' party exposed it by a cut a few feet north of the drift, which had caved.

McEvoy, in 1911, reports that the seam comprised 6 feet of coal with a 2- to 3-inch shale parting. Others found:

(G. S. Malloch)

	Ft.	Ins.
Roof, arenaceous shale		
Coal	2	4
Bone		6
Coal	2	8½
Floor		
Total	5	6½
Total clean coal	5	0½

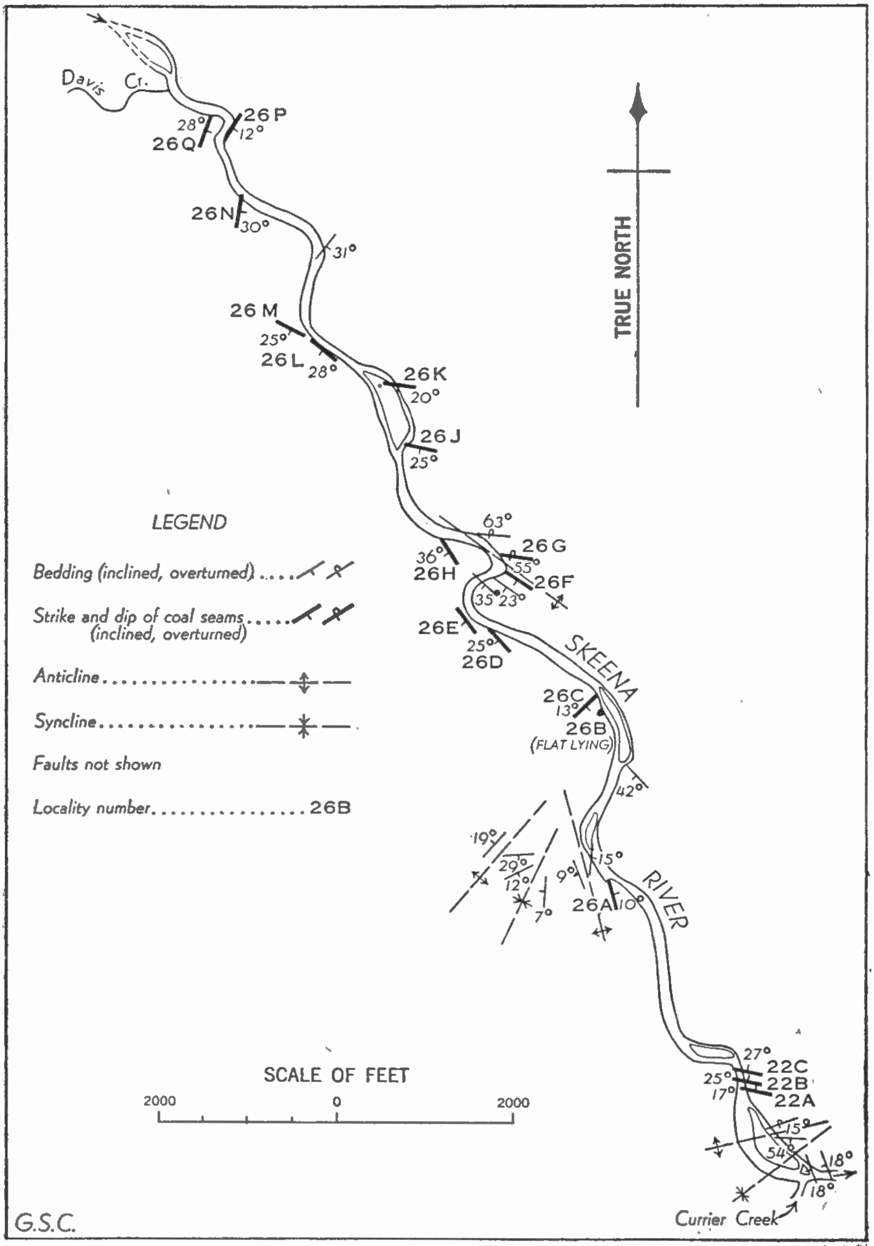

Figure 3. Sketch map of Skeena River from Currier Creek to Davis Creek, showing outcrops of coal seams.

(G. W. Evans)

Roof, shale, brownish grey	Ft.	Ins.
Coal	2	3
Shale, carbonaceous		5½
Coal	2	8
Floor, shale		
Total	5	4½
Total clean coal	4	11

(W. F. Robertson)

Roof, sandy shale		
Coal, dirty		6
Coal, shattered	2	0
Dirt parting		3
Coal, hard	1	6
Coal, shattered	1	9
Floor		
Total	6	0
Total clean coal	5	3

Where exposed by the writers' party, the seam was thicker:

Roof, sandy shale	Ft.	Ins.
Coal, some quartz veins in top 3 inches		7
Mining dirt		1
Coal, rather crushed		10½
Shale and coal		1½
Coal, top 4 inches rather crushed	1	2
Shale		7
Coal		6
Bone and coal		2½
Coal, with numerous pyrite lenses and a few bony streaks in the bottom foot	3	4
Floor, bone		
Total	7	5
Total clean coal	6	4½

Former observers agreed that the seam appeared one of the best in the district, the only better seams being the two on Discovery Creek. It appeared to the writers to be a reasonably satisfactory seam from the standpoint of cleanliness. However, the coal appeared more crushed and friable than many other seams seen, one from which the output would be very high in fine coal.

The seam strikes about east and dips 15 degrees north. Five analyses (Anals. 21-25), excluding the bone or shale band, showed a range between 16·58 and 27·90 per cent ash.

Malloch correlates this seam with those on Discovery Creek (Locs. 24, 25), and also with the 4-foot 6-inch seam, Bed No. 37, in his main section.

Loc. 24, Lower Drift, Discovery Creek. McEvoy's original discovery was made on the south side of Discovery Creek, 2¼ miles above its mouth. This and the upper prospect, 1,400 yards above on the same creek, were the best showings on the Western Development Company's property. The seam here was prospected by a 16-foot drift. This had caved by 1948, and the writers' party exposed the seam by a cut 200 feet downstream.

A full descriptive section measured by the writers was:

	Ft.	Ins.
Roof, shale		
Mining dirt—black, soft, powdery, carbonaceous shale		11
Mixture of bright hard coal, bone, and niggerheads, dense quartzose material in rounded masses		6
Coal, bright, hard, banded, with $\frac{1}{16}$ to $\frac{1}{4}$-inch laminæ; very tender, breaks into $\frac{1}{4}$-inch cubes	1	11½
Shale, hard, bony, not frozen to coal		9
Coal, as above; tender	1	3
Mining dirt		1
Coal, bright, very hard, tough	1	10
Floor, bony shale and shale		
Total	5	10½

Other sections are:

(J. McEvoy)

	Ft.	Ins.
Soft black shale		
Coal and shale		6
Coal, clean, hard	2	4
Shale		2½–3
Coal, clean, hard	3	0
Shale, highly carbonaceous		
Total	5	7

(G. S. Malloch)

Coal	1	7
Bone		5
Coal	3	10
Total	5	10

(G. W. Evans)

Shale, black		
Coal, bright, clean, few quartz stringers	5	0
Coal, impregnated with quartz	1	6
Shale		

Some quartz stringers and niggerheads occur in the seam, and Malloch undertook to measure the amount of such material. As he points out, the applicability of his figures depends on how near the face measured was to average conditions. He rejected the bone band, quartz stringers, and niggerheads in his sample, and finds that bone plus quartz stringers would add 20 per cent to the ash content of the seam. The bone band could be easily eliminated in mining, but the quartz stringers and niggerheads would add 10 per cent ash to the 10·64 per cent of his sample, unless they could be eliminated by washing.

The seam strikes north 68 degrees east, and dips 9 degrees southeast. Six analyses of samples (Anals. 26-31), and one of a picked specimen from this seam (Anal. 74), show ash percentages between 4·05 and 27·66 per cent, with all but one less than 12 per cent.

Malloch correlates this seam with that on Abraham Creek (Loc. 23), and with the seam at the upper tunnel on Discovery Creek (Loc. 25). Both correlations seem reasonable, and there is good evidence for the latter correlation.

Loc. 25, Upper Drift, Discovery Creek. The seam at this locality was discovered in 1904 by W. W. Leach. It is exposed 1,400 yards above the lower drift, 600 yards of which show outcrop and 800 yards only swamp and overburden. It was exposed by a 20-foot drift, now caved, and by a cut put in by the writers 30 feet downstream.

The writers' section gave:

	Ft.	Ins.
Roof, shale		
Bone, would make good roof		10
Coal, clean, much crushed	2	4½
Shale, bony		6
Coal, good, strong cleat, breaks to ½-inch to 1-inch prisms	1	1½
Silt, yellowish brown, unconsolidated		2½
Coal, clean, very hard and tough	1	4
Coal, crushed, rather bony		8
Coal, clean		2½
Floor, bone grading into shale		
Total	7	3

Other sections are:

(W. W. Leach)

	Ft.	Ins.
Carbonaceous shale and coal	1	6
Coal	2	8
Shale		5
Coal	3	2
No floor, water level		
Total	7	9

(G. S. Malloch)

	Ft.	Ins.
Coal	1	6
Bone		7
Coal	3	11
Total	6	0

(G. W. Evans)

	Ft.	Ins.
Shale, black		
Coal, impure but hard		7
Coal, bright, clean	1	1
Shale lenses		6
Coal, best in district so far	2	8
Floor, shale and carbonaceous shale		
Total	4	10

Some quartz stringers occur in the seam, which strikes north 22 degrees west and dips 16 to 23 degrees northeast. Four analyses (Anals. 32-35) gave ash percentages between 7·55 and 15·81.

Malloch suggests that the seam may be correlated with the 4½-foot seam about 900 feet below the top of his main section (Bed No. 37), and the present writers concur in this correlation.

Loc. 26, Skeena River, between Discovery Creek and Davis Creek. Nineteen outcrops of seams, all but one previously undescribed, were found by the writers along this part of the Skeena. The structure here is complicated (*See* Figure 3). The beds are folded, and three overturned folds were observed; one of these is at locality 26F, 26G, and two with flat axial planes (26L, 26M), at the mouth of Davis Creek, have been omitted for clarity. Faults are common, and several outcrops may belong to one seam, but pending further work the outcrops are listed as they occur. Because of structural disturbance, probably none is workable.

(Loc. 26A) Here, on the west side of a normal fault striking north 20 degrees west, and dipping 68 degrees southwest, was a seam composed as follows:

	Ft.	Ins.
Glacial drift		
Coal, crushed		6
Shale and mining dirt	1	0
Coal, crushed	1	4
Shale floor		
Total	2	10

The seam strikes north 17 degrees west and dips 10 degrees northeast.

(Loc. 26B) At this locality a thin seam occurs in gently undulating beds:

	Ft.	Ins.
Roof, shale		
Mining dirt		11
Bone and one-third coal		6
Coal and one-third bone		4
Bone		5
Floor, shale		
Total	2	2

(Loc. 26C) Here is another thin seam, striking north 45 degrees west and dipping 13 degrees southwest:

	Ft.	Ins.
Roof, shale		
Coal, minor shale		8
Shale		2
Coal		8
Shale	1	5
Coal, good, to 1 ft. 7 ins., average	1	0
Floor, shale		
Total	3	11

(Loc. 26D) Here a 6-inch layer of bone occurs.

(Loc. 26E) The seam at this locality, high on the bank, was discovered by Malloch, and reported by him as consisting of:

	Ft.	Ins.
Bone, with some clean coal	1	3*
Coal (rather dirty)	2	1
Shale		7*
Coal, with many quartz stringers	2	0
Bone		6*
Coal	1	1
Bone, with some coal		6*
Coal	2	1
Bone and some coal		5*
Total	10	6

A sample that excluded the marked bands and all niggerheads and quartz contained 37·14 per cent ash (Anal. 36).

What is probably the same seam was exposed by the writers, and measured:

Roof concealed, contains some coaly matter	Ft.	Ins.
Shale	1	0
Coal		2½
Bone		5½
Coal		6
Quartz vein		1
Bone		4
Coal, good; some quartz veins		3
Shale and bone		4
Coal, good; some quartz veins		10
Bone		2
Coal, good; some quartz veins		8
Mining dirt		1¼
Silt, yellowish grey		¾
Coal, good; some crushed streaks; skins of pyrite on joint cracks	1	2½
Mining dirt		1½
Coal, good; skins of pyrite on joint cracks; much quartz in bottom 4 inches	1	0
Floor, shale		
Total	7	4

(Loc. 26F, 26G) Here, a seam about 5 feet thick is exposed on both flanks of an overturned anticline.

(Loc. 26H) Three coal seams are exposed here in a cliff face, in the bottom half of an overturned fold with a flat axial plane. Halfway, or 100 feet, up the cliff the beds are overturned and the section is repeated in reverse order:

	Feet
Coal seam	
Strata, approx.	90
Coal seam	1-2
Strata, approx.	10
Coal seam	1-2

(Loc. 26J) The seam at this locality is:

Roof, shale	Ft.	Ins.
Coal, bright, hard		2½
Shale		7
Coal, bright, hard		3
Shale		6
Coal, bright, hard	1	2
Floor, shale		
Total	2	8½

(Loc. 26K) The section of the seam here is:

Shale roof	Ft.	Ins.
Mining dirt		2½
Coal, good; numerous thin quartz veins	3	2
Shale, soft, grey		4½
Bone		2
Coal, about one-third quartz veins		4½
Bone and coal		11
Shale floor		
Total	5	1½

(Loc. 26L, 26M) The section is:

Shale roof	Ft.	Ins.	
Coal, rather crushed, in places much quartz in top 3 inches (26L)	1	8	
Shale	3	0	
Coal, good		4	
Bone		2	
Shale, with concretionary layers	8	6	
Sandstone, massive, yellowish	15	0	
Clay shale	5	6	
Coal, bright, hard, rather crushed	1	2	
Limy concretions, 0-4 inches		2	
Coal, bright, hard, rather crushed		3	
Mining dirt		1	5 ft. 2 ins.
Coal, bright, hard; some quartz and pyrite	1	7	
Shale, sheared		3	
Coal; some bone and quartz (26M)	1	8	
Bone		6	
Shale, with sandy shale and sandstone interbeds	25+		
Shale, with five coaly streaks	3—		
Shale	3		
Coal, bright, hard; much quartz (26M)	3		
Shale	10+		

The two seams at 26M may correspond to the Davis Creek seams at Loc. 27.

(Loc. 26N) This seam consists of:

Roof, shale	Ft.	Ins.
Coal, clean, hard, much sheared		11
Coal, bone, and shale	1	3
Shale		9
Coal		3
Coal and bone	1	1
Coal, dirty, sheared and crushed	2	0
Coal, good, hard		9
Mining dirt		4
Shale, with streaks of coal	1	6
Coal		1
Shale	1	8
Coal and shale		8
Coal		3
Coal, bone, and shale		8
Floor, shale		
Total	13	1

(Loc. 26P) The section here is:

Roof, shale	Ft.	Ins.
Coal, good, strong cleat		7
Coal, badly crushed with pyrite lenses	2	6
Bony shale	1	0
Bone and coal	1	1
Coal		6
Floor, shale		
Total	5	8

(Loc. 26Q) The section here is:

	Ft.	Ins.
Roof, fissile shale		
Coal	1	0
Shale		3
Coal	2	6
Floor, shale		
Total	3	9

The seam was too badly weathered to measure accurately.

Loc. 27, Lower Davis Creek. On the south bank of Davis Creek, 400 yards above its mouth, two seams outcrop. On the upper (Loc. 27A), about 30 feet above creek level, McEvoy drove a 7-foot drift. The lower (Loc. 27B) is separated from the upper by 22 feet 10 inches of shaly sandstone and shale. Both Malloch and McEvoy describe the upper seam; the lower was found by the writers.

(Loc. 27A) The seam here was measured in a cut made by the writers' party, beside McEvoy's drift, which has now caved. The following section was exposed:

	Ft.	Ins.
Roof, shale		
Coal, good; with a few quartz veins		10
Mining dirt, with streaks of coal		6
Coal, good; with ½-inch chert; pyrite films on joint faces, bottom 3 inches, very rusty	2	4
Coal, badly crushed and sheared; some quartz veins	1	0
Floor, shaly sandstone		
Total	4	8

McEvoy refers to this as a 4-foot seam with numerous quartz veinlets, and Malloch as a 4-foot 5-inch seam with rather numerous pyritiferous concretions and quartz stringers. A sample taken by McEvoy (Anal. 37) contained 21·86 per cent ash; one by Malloch (Anal. 38) 25·36 per cent.

(Loc. 27B) The seam here strikes north 21 degrees east and dips 21 degrees southeast:

	Ft.	Ins.
Roof, shale		
Coal, good, in places badly crushed	1	2
Shale, bony		8
Mining dirt; with pyrite concretions		6
Coal, good; numerous quartz veins	1	4
Floor, bony shale		
Total	3	8

Loc. 28, Upper Davis Creek. Two seams have been reported in this locality, one on the north fork of Davis Creek and the other on the south fork of that creek.

(Loc. 28A) The seam here, on the north fork of Davis Creek, was reported in 1907 by Leach as consisting of:

	Ft.	Ins.
Coal	2	0
Shale	1	0
Coal	1	0

He states that the floor of the seam was not reached, as it was below water level in the creek.

In 1911, McEvoy reports that a short drift showed an exposed thickness of 4½ feet, overlain by clay; total thickness unknown. Malloch confirms this. The strike of the seam is about north 70 degrees west, and the dip is to the northeast. A sample taken by McEvoy gave 12·61 per cent ash (Anal. 39).

(Loc. 28B) The seam at this locality, on the south fork of Davis Creek, is reported on by Leach, in 1904, as "about 2 feet of coal continuing below water level"; in 1911, Malloch states that several openings were made on the east (south) fork but no satisfactory seam was found.

Loc. 29, Evans Creek. A seam is exposed on Evans Creek about ¾ mile above the trail crossing. Leach reports that about 3 feet of clean coal is exposed, but that this is not the total thickness as the upper part of the seam had been eroded. The seam dips 10 degrees to the northeast. McEvoy briefly mentions that a seam 1½ feet thick was uncovered in this locality.

Loc. 30, Skeena River, Davis Creek to Anthracite Creek. Six seams have been reported along Skeena River between Davis Creek and Anthracite Creek, a distance of nearly 4 miles.

(Loc. 30A) McEvoy reports that a seam 2 feet 2 inches thick outcrops on the Skeena between Davis and Evans Creeks.

(Loc. 30B) Leach reports: "At the mouth of the creek (Evans Creek) several seams, a few inches in thickness, were noticed dipping southwest".

(Loc. 30C) Malloch reports a seam on the west bank of the Skeena, a short distance above the mouth of Langlois Creek. He gives the following section:

	Ft.	Ins.
Coal		7
Shale		11
Coal		7
Bone		1
Coal		9½
Bone		1
Coal		3½
Total	3	4
Total coal	2	3

The seam strikes north 28 degrees west and dips about 40 degrees northeast.

(Loc. 30D) The seam here is on the east bank of the Skeena, opposite locality 30C, and is the lower of the two seams, according to Malloch. It is said to be "apparently quite thick", but a slide of sandstone blocks from above prevented accurate measurements. A picked specimen yielded 20·17 per cent ash (Anal. 75).

(Loc. 30E) Malloch reports a seam on Skeena River "at some distance above Langlois Creek". He believes this seam to be the same as the upper seam reported at the mouth of Davis Creek.

(Loc. 30F) Malloch states: "Other seams on the property of the British Columbia Anthracite Company were found on the Skeena below the mouth of Anthracite Creek. In lot 2190, a seam 4 feet 7 inches thick was measured, and it is repeated twice farther down owing to faults as the dips are to the south at low angles. Abrupt changes in strikes also occur."

Loc. 31, Lower Anthracite Creek. Three coal seams have been reported on the lower part of Anthracite Creek. The lowest one was termed No. 1 Anthracite Creek seam; 500 yards upstream from it is No. 2 Anthracite Creek seam; and 200 yards above the last is No. 3 Anthracite Creek seam. The location shown on the map is for one of these three, but it is not known which. All three of these seams were on the property of the B.C. Anthracite Syndicate. A section was prepared by R. C. Campbell-Johnston and G. F. Monckton to show their stratigraphic position and relation to the seams on lower Beirnes Creek. It is cited and discussed under locality 32.

(Loc. 31A) No. 1 Anthracite Creek seam is subdivided as follows:

(R. C. Campbell-Johnston)	Ft.	Ins.	(G. S. Malloch)	Ft.	Ins.
Roof			Roof		
Coal	2	3	Bone and dirty coal	4	0
Shale	1	3	Cleaner coal	2	5
Coal	1	6			
Shale	1	6			
Coal	1	0			
Floor			Floor		
Total	7	6	Total	6	5
Total clean coal	4	9	Total clean coal	2	5

Malloch states: "The seam is much crumpled and possibly it corresponds with the seam in the lower tunnel at Davis Creek (Loc. 27A)". A picked specimen of coal from this seam contained 14·73 per cent ash (Anal. 76).

(Loc. 31B) No. 2 Anthracite Creek seam is sectioned as follows:

(R. C. Campbell-Johnston)	Ft.	Ins.	(G. S. Malloch)	Ft.	Ins.
Roof, shale			Roof		
Coal, clean	3	0	Coal	4	2
Floor, shale			Floor		
Total	3	0	Total	4	2
Total clean coal	3	0	Total clean coal	4	2

The seam strikes north 23 degrees west and dips 45 degrees southwest. A picked specimen contained 19·86 per cent ash (Anal. 77).

(Loc. 31C) No. 3 Anthracite Creek seam is reported to have the following composition:

(R. C. Campbell-Johnston and G. F. Monckton)	Ft.	Ins.	(G. S. Malloch)	Ft.	Ins.
Roof, shale			Roof		
Coal, clean, with one 2-inch shale parting	5	9	Coal	2	4
			Bone and dirty coal		6
			Coal	1	7½
Floor, shale			Floor		
Total	5	9	Total	4	5½
			Total coal	3	11½

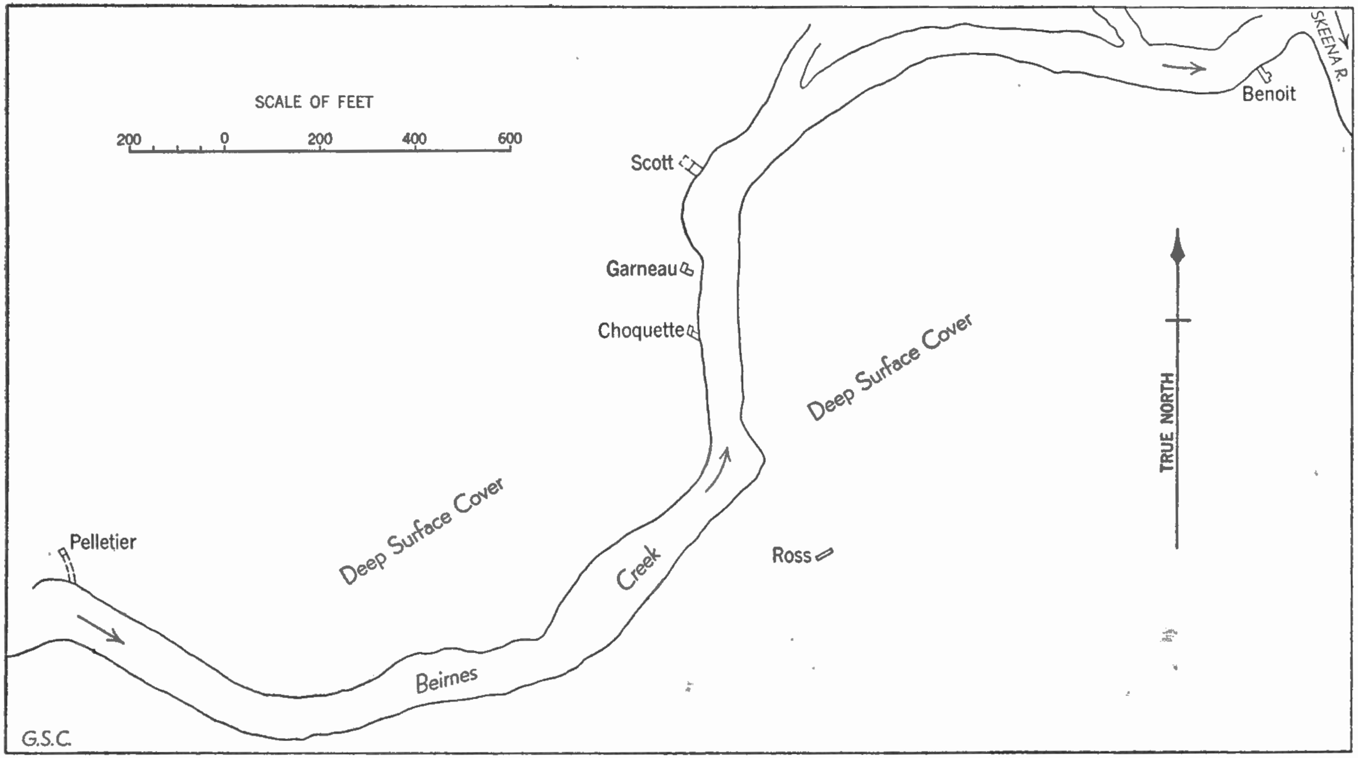

Figure 4. Sketch map, showing coal prospects on Beirnes Creek. Map by R. C. Campbell-Johnston and G. F. Monckton, 1911.

The seam strikes north 88 degrees west and dips 21 degrees south. An analysis of a picked specimen gave 6·28 per cent ash (Anal. 78), and that of a sample (Anal. 40) gave 14·69 per cent ash.

Loc. 32, Lower Beirnes Creek. Eight coal showings are said to occur on lower Beirnes Creek in the first 2,800 feet (air-line distance) above its mouth. Their position is shown in Figure 4, prepared in 1911 by R. C. Campbell-Johnston and G. F. Monckton and published by kind permission of Mrs. Maisie Armytage-Moore, Mr. Campbell-Johnston's daughter. These were the main showings on the property of the B.C. Anthracite Syndicate, and the Campbell-Johnston party, working on the Syndicate's behalf in 1911, did most of its work on them. At all of these showings the strike is approximately northwest and the dip northeast. The dip of the westernmost showing is nearly vertical, that of the others fairly gentle. Malloch reports that the structure is synclinal, that is, the farther southwest a seam occurs the lower its stratigraphic position. He states that past the westernmost showing is an anticlinal axis, beyond which the dip is southwest.

Messrs. Campbell-Johnston and Monckton prepared a stratigraphic section covering this part of Beirnes Creek and part of Anthracite Creek. The section includes four gaps. The authors were unable to estimate the extent of one of these, but the other three are presumably computed from the attitude of the strata on either side of the concealed intervals. The previous discussion on the structure of the area shows that folding or faulting may have taken place in the concealed intervals, and that the relations of the five sequences of measured strata may be materially different from that indicated in the section. The section follows, with average seam thicknesses, and with additional details from the published and unpublished reports of the authors added by the present writers.

(By R. C. Campbell-Johnston and G. F. Monckton)

	Thickness Feet	Total thickness Feet
Shale	75+	75
No. 3 Anthracite Creek seam	5—	80
Shale	80	160
Sandstone	65	225
—Concealed—	195	420
Shale	60	480
No. 2 Anthracite Creek seam	4	484
Shale	100+	584
—Gap in section not measured—		
No. 1 Anthracite Creek seam	7	7
Shale	160	167
Small coal seam	—	—
Shale	140	307
"Main" sandstone	480	787
Shale	20	807
Benoit seam	6	813
—Concealed—	554	1,367
Scott seam	8	1,375
Shale containing coaly horizons less than 2 feet thick	115	1,490
Garneau seam	3	1,493
Shale containing small seams of coal, maximum thickness 15 inches	50	1,543
Choquette seam	0	1,543
Sandstone	80	1,623

	Thickness Feet	Total thickness Feet
Ross seam	15	1,638
Sandstone	150	1,788
—Concealed—	600	2,388
Shale	5	2,393
Pelletier seam	200	2,593

NOTE: It was not found possible to correlate the above section with any of the other sections measured in this coalfield.

The Anthracite Creek seams have already been described in detail. Description of the Beirnes Creek seams follows.

(*Loc. 32A*) *Benoit Seam.* This was the initial discovery on the B.C. Anthracite Syndicate's ground, made by R. C. Campbell-Johnston and G. M. Beirnes in the autumn of 1910. As the water was unusually low at that time, they were able to measure and sample the seam where it outcropped in the bed of Beirnes Creek. Campbell-Johnston reported the following section:

	Ft.	Ins.	
Roof, shale			
Coal, clean	4	0	(Anal. 80)
Coal and shale	1	0	(Anal. 81)
Shale		10	
Coal, clean		6	(Anal. 82)
Floor, shale			
Total	6	4	
Total clean coal	4	6	

Analyses, as noted above, were made of picked specimens from the various bands, analysis 81 being of clean coal from the coal and shale band. They showed from 7 to 9 per cent ash.

In 1911, the outcrop referred to above was under water and considerable trenching and test pitting was done to find the seam on the south bank. When found, an 11-foot drift encountered the floor, and Campbell-Johnston reported: . . . "a slope on the floor was sunk 14 feet deep to catch a solid rock roof. Sufficient work on the actual seam has not yet been accomplished to speak with accuracy of the normal width and quality. It would appear that the seam will be normally six feet thick when it finds itself." He adds that near the surface it contains lenses of quartz. Monckton states that the seam shows "5 feet of clean coal, with about 12 inches of shale near the top". Malloch found: "No true roof was found for the Benoit but there seemed to be at least 2 to 3 feet of coal". The seam as found in the drift and slope was almost at grass roots and no doubt weathered, but it also appears to have deteriorated from where first seen at the creek outcrop 72 feet away. Three picked specimens from the slope contained 10·8, 12·9, and 15·8 per cent ash, respectively (Anals. 79, 83, and 84).

(*Loc. 32B*) *Scott Seam.* This seam is considered by Malloch to be the most important of the Beirnes Creek seams. A cut exposed it for 35 feet and a drift for an additional 42 feet. Seam sections are:

(R. C. Campbell-Johnston)

	Ft.	Ins.
Roof		
Coal	10	0
Floor, shale		
Total	10	0

(G. F. Monckton)

	Ft.	Ins.
Roof		
Coal, clean, hard, with shale seam, usually 4 ins., near middle; varies from 5 ft. 8 ins. to	7	0
Floor		
Total	7	0
Total clean coal	6	8

(G. S. Malloch)

	Ft.	Ins.
Roof		
Bone and dirty coal; varies from 2 ft. 0 ins. to	3	0
Coal cont. 2½ ins. bone	5	6
Floor		
Total	8	6
Total clean coal	5	3½

(This seam is said to have thickened at the end of the drift. If the 1 foot 4 inches increase reported by Monckton be added to Malloch's 8 feet 6 inches, the total is 9 feet 10 inches.)

The seam has a northwest strike and low northeast dip. Six analyses of picked specimens showed a range between 10·8 and 19·21 per cent ash (Anals. 85-90). The analysis of a sample taken by Malloch (Anal. 41) of the lower bench of clean coal, omitting its bone band, gave 26·89 per cent ash.

(*Loc. 32C*) *Garneau Seam.* This seam was opened by a short drift, which showed:

(R. C. Campbell-Johnston)

	Ft.	Ins.
Roof, shale cont. lenses of coal		
Coal, clean, up to	3	0
Floor, shale		
Total	3	0

(G. F. Monckton)

	Ft.	Ins.
Roof		
Coal, clean, no shale; varies from 2 ft. 6 ins. to	3	0
Floor		
Total	3	0

(G. S. Malloch)

	Ft.	Ins.
Roof		
Coal, clean	2	6
Floor		
Total	2	6

It, too, has a northwest strike and northeast dip. Analyses of picked specimens showed 9·5 and 10·5 per cent ash (Anals. 91, 92).

(*Loc. 32D*) *Choquette Seam.* This "seam" is apparently only a carbonaceous zone. It was opened by a short drift in which Campbell-Johnston reports it is "pinched", and Malloch says "almost no clean coal was found in it". It has a northwest strike and northeast dip.

(*Loc. 32E*) *Ross Seam.* This seam was exposed by a cut along strike for 36 feet, said to be in coal and a cut across the dip for 34 feet, said to be in coal and shale, with a timbered drift 6 feet long at the end, said to be in solid coal. The seam apparently outcrops in Beirnes Creek as well, and is there said to be 20 feet thick with partings. In the cuts and drift it is reported as:

(R. C. Campbell-Johnston)

Roof, sandstone	Ft.
Seam may be	10-20
Floor	

(G. F. Monckton)

	Ft.	Ins.
Roof		
Coal and shale[1]	2	6
Coal	4	0
Shale	3	0
Coal		8
Shale	1	6
Coal	1	6
Shale	1	6
Coal	1	3
Floor		
Total	15	10
Total clean coal	7	5

[1] Weathered, shale may decrease in solid.

(G. S. Malloch)

Roof, sandstone, good
Seam not fully exposed at time of examination
Floor

This seam has a workable section of 4 feet according to Monckton's measurements. The underlying benches of coal probably cannot be dug profitably in an underground operation. The seam strikes northwest and dips northeast. Analysis of a picked specimen from it gave 9·73 per cent ash.

(Loc. 32F) Pelletier Seam. This seam was exposed by a cut along strike, and by a shaft sunk on the seam for 40 or 45 feet. It is reported to show, in the shaft:

(R.C. Campbell-Johnston)

	Ft.	Ins.
Roof		
Coal, clean	6	0
Floor		
Total	6	0

(G. F. Monckton)

Roof		
Coal, clean, with a little associated shale	5	2
Floor		
Total	5	2

(G. S. Malloch)

Roof		
Coal	5	2
Floor		
Total	5	2

This seam is the lowest exposed in the syncline at the mouth of Beirnes Creek. It strikes northwest, and dips nearly vertically to the northeast.

Its dip is quite different from the relatively gentle dip reported for the other seams. Just upstream an anticline occurs, and Malloch suggests that the thickness noted above may not be typical of the seam. Analyses of six picked specimens showed ash percentages of 8·5, 15·7, 17·15, 21·0, 26·65, and 29·0 respectively (Anals. 94-99), and a sample cut by Malloch across the seam (Anal. 42) gave 29·06 per cent. The high ash content of picked specimens from this seam, as compared with that of other seams in the vicinity, suggests that the coal in the Pelletier seam is bony or dirty, or both.

Loc. 33, Upper Beirnes Creek. Malloch measured two seams on Beirnes Creek about 2 miles above Skeena River. He notes that the strata in the vicinity of these seams are disturbed and as a result the seams may be locally thickened.

(Loc. 33A) Here, the lower of the two seams showed the following section:

	Ft.	Ins.
Coal	2	5
Bone	2	7
Coal	5	9½
Total	10	9½
Total coal	8	2½

(Loc. 33B) Here, the higher of the two seams showed:

	Ft.	Ins.
Dirty coal	6	0
Shale	8	6
Coal	3	0
Total	17	6
Total coal	9	0

Loc. 34, Upper Beirnes Creek. Beaton and Kobes reported that on Beirnes Creek, near the mouth of the second tributary from the north, they had found a 6-foot seam of coal.

Loc. 35, Upper Beirnes Creek. Beaton and Kobes reported finding a 12-foot seam and a 16-foot seam near the bend of Beirnes Creek. Campbell-Johnston reports additional seams in this locality, but their thickness and exact location are uncertain.

Loc. 36, Telfer Creek. Eight coal seams have been reported in Telfer Creek, about midway between the bend and the mouth of the creek, and within a distance of about 950 feet. The position of seven of the seams is shown on Figure 5, and the eighth seam, not shown, is 150 feet downstream from No. 1. All eight of these seams were on the property of the B.C. Anthracite Coal Company.

(Loc. 36A) The seam at this locality is the lowest on the creek, and was termed Telfer No. A. Evans reports that after the seam "was properly opened" the following section was measured:

	Ft.	Ins.
Roof, shale		
Coal	2	3
Dirt, soft		2
Coal	2	4
Floor, shale		

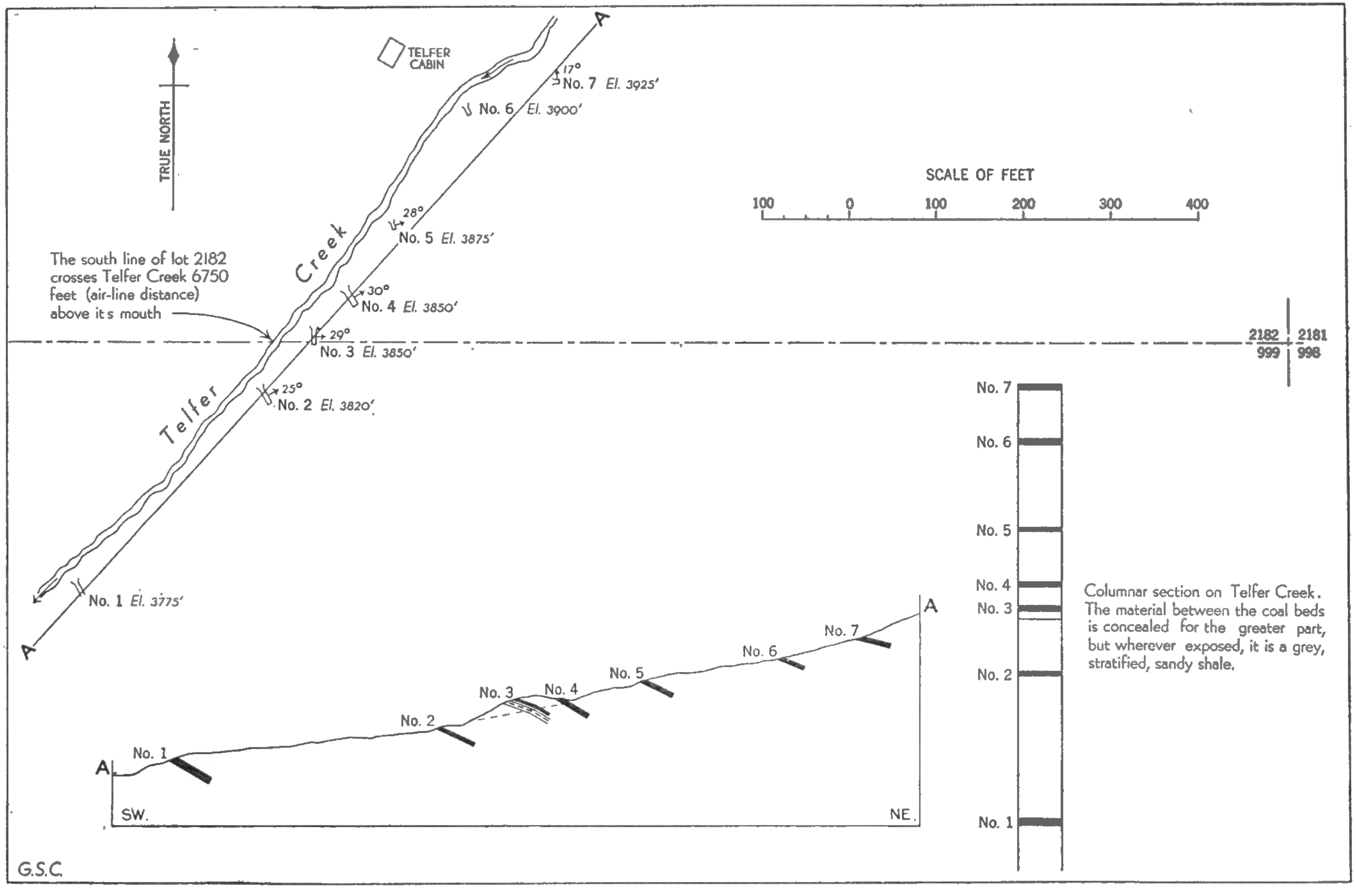

Figure 5. Sketch map, structure-section, and columnar section, showing coal prospects on Telfer Creek. Map and geology by G. W. Evans, 1912.

The seam strikes about north 75 degrees west and dips 65 degrees northeast. This strike is at variance with those of the other beds higher up the creek, and Evans says that it may be because allowance was not made for the magnetic variation at the time of measurement. A sample from this seam gave 21·75 per cent ash (Anal. 43).

(Loc. 36B) The seam at this locality is about 150 feet upstream from locality 36A, and was referred to as Telfer No. 1. It was opened by a drift about 20 feet long. Caving of this drift prevented Evans from measuring the seam, but it was reported to him that the bed is about 5 feet thick, of which 3 feet is coal.

(Loc. 36C) The seam here, termed Telfer No. 2, is about 300 feet upstream from locality 36B. It was opened by a drift 20 feet long, and the following section was measured by Evans at the face of the drift:

	Ft.	Ins.
Roof, sandy shale, grey, stratified		
Carbonaceous shale		3*
Coal	4	3
Carbonaceous shale		6–8*
Floor, sandy shale, stratified, grey		

The seam strikes north 22 degrees west and dips 25 degrees northeast. A sample of the 4-foot 3-inch coal bench contained 34·36 per cent ash (Anal. 44).

(Loc. 36D) The seam here is 80 feet upstream from that at 36C, and was called Telfer No. 3. A 6-foot drift was driven into the outcrop, and at the face the following section was measured by Evans:

	Ft.	Ins.
Roof, shale		
Coal and streaks of carb. shale	3	4
Shale	1	3
Carb. shale and coal mixed	10	
Floor, shale		

The seam strikes north 9 degrees east and dips 29 degrees southeast. A sample contained 41·52 per cent ash (Anal. 45).

(Loc. 36E) The seam here, 70 feet upstream from that of 36D, was termed Telfer No. 4. Evans measured the following section at the face of a 22-foot drift:

	Ft.	Ins.
Roof, shale, grey		
Coal and nodules of quartz	5	0
Floor, shale, black		

The seam strikes north 30 degrees west and dips 30 degrees northeast. A sample contained 34·21 per cent ash (Anal. 46).

(Loc. 36F) The seam at this locality, termed Telfer No. 5, is about 100 feet upstream from the seam at 36E. It was opened by a 10-foot drift, at the face of which Evans measured the following section:

	Ft.	Ins.
Roof, shale		
Shale with some carb. shale	2	6
Coal with some carb. shale	1	6
Carb. shale and shale	2	6
Floor, shale		

The seam strikes north 15 degrees west and dips 28 degrees northeast.

(Loc. 36G) The seam here is 160 feet upstream from that at 36F, and was termed Telfer No. 6 by Evans. It was opened by a drift 10 feet long, and Evans measured the following section at the face:

	Ft.
Roof, shaly sandstone	
Carb. shale, shale, and some coal	6
Floor, shaly sandstone	

Neither the strike nor dip could be determined, and no sample was taken.

(Loc. 36H) The coal seam here (Telfer No. 7) is the farthest upstream of the eight seams in this general locality (36) and about 90 feet upstream from the seam at 36G. The following section was measured by Evans at the face of a drift 10 feet long:

	Ft.	Ins.
Roof, decomposed shale and soil		
Carb. shale and coal	3	6
Floor, shale, black		

The seam strikes east, dips 17 degrees north, and contains 34·06 per cent ash (Anal. 47).

Loc. 37, Hill South of Head of Telfer Creek. Malloch briefly notes the occurrence of two seams in this general locality. He reports:

(Loc. 37A) "A seam, perhaps 4 feet in thickness was exposed on the hill northeast of the mouth of Currier Creek at the head of Telfer Creek."

(Loc. 37B) "A seam 16 feet in thickness is reported from the head of the small creek east of this hill." This small creek may be Duke Creek.

Loc. 38, Pleasant Vale Creek. Two seams, only 16 feet apart, occur at this locality. Both seams were on the property of the B.C. Anthracite Coal Company. They outcrop on the south side of the creek at an elevation of 4,300 feet. Evans reports that each seam is about 4 feet thick, and that stratified, grey to black shales occur above and below each of them. Evans did not consider either of these seams good enough to sample. The attitude of the lower one is: strike, north 10 degrees east; dip, 17 degrees northwest.

Loc. 39, Saddle East of Langlois Creek. Three seams were opened on the property of the B.C. Anthracite Coal Company, on the saddle between Langlois and Lonesome Creeks, far above timber-line. They are said by Evans to occur near the nose of an overturned syncline, and to show evidence of local crumpling and thickening. He suggests that they may be three outcrops of the same seam.

(Loc. 39A) The most northwesterly exposure, at this locality, was tested by a 40-foot drift, in which the seam showed no improvement beyond 6 feet from the portal. Evans provides the following section:

	Ft.	Ins.
Roof, thinly bedded sandstone		
Coal, bright, some iron stains	3	6
Carbonaceous shale		6
Carbonaceous shale and coal, about	15	
Floor, stratified sandstone		
Total	19	

The normal thickness of the bed is believed to be 5 or 6 feet. It strikes north 38 degrees west and dips vertically at the floor and 45 degrees southwest at the roof. A sample of the band of coal, which although hard was very friable, contained 24·79 per cent ash (Anal. 48).

(Loc. 39B) Southeast, and approximately on the strike, of the preceding exposure, a 12-foot drift exposed another thick, dirty seam measured by Evans:

Roof, sandstone, stratified, above the grass roots	Ft.	Ins.	
Impure coal and shale	1	0	
Coal		4	
Carbonaceous shale and clay		10	
Coal		2	
Shale (roof of best bench)	4	1	
Coal, bright, clean	2	0	2 ft. 7 ins.
Coal, impure		3	
Shale, carbonaceous		1	
Coal, bright		3	
Shale,		3	
Coal, impure		10	
Carbonaceous shale and impure coal	1	6	
Total	11	7	

Some of the coal (the 2-foot seam according to W. F. Robertson) is fairly hard, but most of it is soft and friable. The seam strikes north 40 degrees west and dips 40 degrees southwest. A sample of the best 2 feet 7 inches of the seam, excluding the carbonaceous shale, contained 20·77 per cent ash (Anal. 49).

(Loc. 39C) The seam here lies northeast of locality 39B. Although it was alleged to be 17 feet thick, only the upper 4 feet were exposed in a 12-foot drift. Evans reports:

Roof, sandstone, stratified	Ft.	Ins.
Coal, none too clean; shale near top and bottom; shale at bottom	3	6
Shale		6
Concealed, "several feet"		
Floor, probably stratified sandstone		

The seam strikes north 45 degrees west and dips 16 degrees southwest. Analysis of a sample showed 30·87 per cent ash (Anal. 50).

Loc. 40, Grizzly Gulch. On the west side of Operator Mountain, in a valley on the property of one of the companies amalgamated with the B.C. Anthracite Coal Company, G. W. Evans measured a section of 938 feet of strata containing five coal seams. The details of this section may be summarized as follows:

	Feet
Strata	199
40E—coal seam	9
Strata	54
40D—coal seam	4
Strata	92
40C—coal seam	5
Strata	199
40B—coal seam	4
Strata	38
Sandstone, massive, grey; some clam shells	12
Strata	58
40A—coal seam	8
Strata	256

The stratigraphic intervals between these five coal seams are similar to the intervals between the Telfer Creek seams (*See* Figure 5). The three upper seams correspond very closely to Telfer Nos. 7, 6, and 5; the two lower correspond to Telfer Nos. 2 and 1; and no equivalent appears for Telfer Nos. 4 and 3 seams. The sandstone member bearing clam shells is referred to in this report under "Stratigraphy". The following are the details at the localities where the coal seams are exposed:

(Loc. 40A)

	Ft.	Ins.
Roof, shale		
Impure coal and shale in bands, one or two 2-inch stringers of coal	8	0
Floor, black shale		

This seam strikes north 55 degrees west and dips 15 degrees northeast.

(Loc. 40B)

	Ft.	Ins.
Roof, iron-stained shale		
Coal, impure	1	3
Shale, carbonaceous		5*
Coal, impure	2	4
Floor, black shale		
Total	4	0

The seam strikes north 7 degrees west, dips 27 degrees east, and contains 45·45 per cent ash (Anal. 51).

(Loc. 40C)

	Ft.	Ins.
Roof, sandstone		
Coal, decomposed		7*
Shale and clay	1	0*
Coal, bright, cubical fracture	1	0
Dirt		4
Coal, and stringers of dirt	2	8
Floor, black stratified shale		
Total	5	7

The seam here strikes north 35 degrees west and dips 15 degrees northeast. Analysis 52 gave 37·70 per cent ash.

(Loc. 40D)

	Ft.	Ins.
Roof, shale		
Coal, impure, iron-stained		3½
Coal, impure, grey colour; quartz stringers		4
Coal, cubical fracture		4
Shale, carbonaceous		4
Coal, rather impure, platy		10
Shale, carbonaceous; quartz stringers		7
Coal, impure	1	5
Floor, sandy shale		
Total	4	1½

Here, the seam strikes north 50 degrees west and dips 11 degrees northeast. Analysis 53 (including carbonaceous shale) gave 40·45 per cent ash.

(Loc. 40E)

	Ft.	Ins.
Roof, brown, decomposed shale		
Yellow dirt		3*
Impure coal and dirt		6*
Coal and dirt mixed		10*
Sandy shale, decomposed		6*
Coal, cubical fracture, not clean	3	8
Shale, grey		3½
Coal and dirt in alternating layers with some stringers of quartz	2	8
Floor, shale		
Total	8	8½

This seam strikes north 56 degrees west and dips 23 degrees northeast. Analysis 54 gave 38·85 per cent ash, including the shale band; without it, the sample is calculated to contain 32·8 per cent ash.

Loc. 41, Operator Mountain. This seam, whose total areal extent is said to be small, was sampled by Evans and showed:

	Ft.	Ins.
Roof, shale		
Coal and carbonaceous shale mixed	3	0
Floor, shale		

The seam strikes north 32 degrees west and dips 88 degrees northeast. Analysis 55 gave 24·25 per cent ash.

Loc. 42, Ridge northeast of Operator Mountain. Two seams occur here, that to the south at locality 42A and the other at 42B.

(Loc. 42A) Evans reports:

	Ft.	Ins.
Roof, brown shale		
Carbonaceous shale and some coal	2	6*
Shale, brown		9*
Impure coal and shale	3	6
Coal, best in the bed, but frozen	2	6
Floor, shale		
Total	9	3

The seam strikes north 55 degrees west and dips vertically, but it is believed that it can be traced to lower altitudes where the beds are less disturbed. The elevation of the seam is stated to be 5,820 feet, and the bottom bench was frozen hard on August 4. Analysis 56 gave 22·23 per cent ash.

(Loc. 42B) The bed here was sectioned by Evans at two places, 250 feet apart, with the following results:

	Ft.	Ins.		Ft.
Roof, brown shale			Roof, brown shale	
Carbonaceous shale		6		
Coal, bright; cubical fracture		5		
Carbonaceous shale, soft		3	Carbonaceous shale, with a few streaks of coaly material	12
Coal, platy, in slabs		8		
Carbonaceous shale and a little coal	2	2		
Floor, carbonaceous shale			Floor, concealed	
Total	4	0		

The beds strike north 23 degrees west, dip 80 degrees southwest, and were folded in this vicinity.

Loc. 43, Mount Gordon. A coal occurrence, for which no data except the strike and dip of the seam, namely, north 10½ degrees west, 15 degrees southwest, have been recorded, is reported from this point.

Loc. 44. As for Loc. 43; attitude north 29 degrees west, 30 degrees southwest.

Loc. 45. As for Loc. 43; attitude north 10 degrees west, 70 degrees northeast.

Loc. 46, Lonesome Creek and Adjacent Parts of Kluatantan River. R. C. Campbell-Johnston reports several seams in this vicinity. One or more occur on Lonesome Creek and two or more on the Kluatantan. One of the latter is downstream from the mouth of Lonesome Creek and is referred to as a "big seam". Another is said to be 6 feet thick, underlying, and upstream from, the "big seam". Further details are wanting, and the number and location of the seams is not clear from Campbell-Johnston's description. He gives four analyses of picked specimens from these seams (Anals. 100-103), showing 24·6, 27·8, 29·0, and 45·6 per cent ash respectively. This would strongly suggest that these seams are too dirty to be commercially valuable.

Loc. 47, Creek North of Kluatantan Lake. Here Evans sampled a bed of coal and carbonaceous shale 4 feet 6 inches thick. It contained lumps of coal that burned like anthracite, but the seam as a whole is too dirty to work. Analysis 57 gives 40·95 per cent ash. The attitude of this seam is north 35 degrees west, 24 degrees southwest.

Loc. 48, Mount Laidlaw. Evans found this bed, where trenched, was adjacent to a fault, and, although it appeared to be exposed elsewhere, he was not able to measure the true section. At the fault the seam showed:

	Ft.	Ins.
Roof, grass roots		
Coal, best in bed	1	6
Coal and dirt		8
Clay, grey, plastic		2
Carbonaceous shale and some coal		2
Floor, shale		

The coal beds here strike north 15 degrees west and dip 42 degrees northeast.

Loc. 49, East End of Mount Laidlaw. In the bluffs on the east face of the mountain, three seams were found. Evans states that the first, at locality 49A, underlies the other two, and that the seam at 49B is about 165 feet stratigraphically below the one at 49C. The following are the details supplied for these localities:

(Loc. 49A)

	Ft.	Ins.	
Roof, grass roots and soil			
Carbonaceous shale and bone	2	2*	
Shale		1*	
Coal, impure		4*	
Shale, grey		5*	
Coal, impure	1	2	6 ft. 5 in.
Shale, grey		2*	
Coal and shale (best 6 inches sampled)	1	4	
Shale		2*	
Coal, best in seam		11	
Shale, grey		3*	
Coal with shale streaks (best 18 inches sampled)	2	5	
Shale, grey		4*	
Floor, carbonaceous shale			
Total	9	9	

The seam here strikes east and dips 26 degrees south. Although sampling was more selective than would be possible in mining, analysis 58 gives 44·65 per cent ash.

(Loc. 49B) Here a 3-foot 4-inch bed of impure coal with shale roof and floor strikes north 55 degrees west, dips 40 degrees southwest, and contains (Anal. 59) 40·60 per cent ash.

(Loc. 49C) Here a 4-foot 10-inch bed of impure coal, overlain by carbonaceous shale and underlain by shale, contains a few lumps of clean coal, and several quartz stringers. It strikes east, dips 55 degrees south, and shows 42·15 per cent ash (Anal. 60).

Loc. 50, Tupso Creek. Here the beds are strongly folded and faulted, particularly in the upper part of the creek. About ¾ mile above the mouth of the creek, Evans found a bed of carbonaceous shale 20 feet thick with a 3-foot band of coal stringers and shale in the centre. Two hundred yards southeast, along the strike, the bed is 12 feet thick and the band 2 feet. The coal is of good quality, but does not form a large enough proportion of the whole to make a workable seam. This was the only outcrop of coal found by Evans on prospecting the creek. Campbell-Johnston reports "strong outcrops of coal" occur on it, and also on Tzahny Creek (Loc. 50A).

Loc. 51, South End Prudential Mountain. The following section was measured by Evans:

	Ft.	Ins.
Roof, carbonaceous shale		
Coal, impure		7*
Shale, grey		7*
Coal	1	3
Shale and 1 inch of coal		11*
Coal	1	0
Shale		2*
Coal		7
Floor, shale and carbonaceous shale		
Total	5	1

The seam strikes north 43 degrees west and dips 17 degrees southwest. Although all the shale bands were omitted from the sample, it contained 43·95 per cent ash (Anal. 61).

Loc. 52, Headwaters of Prudential Creek. Here, although Evans found several beds of carbonaceous shale, some of which contained coal, the deformation is so intense he reports that none could be worked regardless of thickness or quality.

Loc. 53, Prudential Creek. Evans reports the following section:

	Ft.	Ins.
Roof, grass roots		
Coal, impure	2	8
Shale, black		7*
Coal		8
Shale		7*
Coal		5
Floor, shale and carbonaceous shale		
Total	4	11

This seam, which strikes north and dips 30 degrees west, is also high in ash — 37·45 per cent by analysis 62.

Loc. 53A, Kluayaz Creek. R. C. Campbell-Johnston reports "strong outcrops of coal" on this creek.

Loc. 54, Campbell-Johnston Creek. Malloch found two seams of coal on this creek, one at locality 54A, near its mouth, and the other at 54B, ½ mile above the mouth. The first is said to be "so badly crushed that it was neither measured nor sampled".

(Loc. 54B) At this locality, Malloch provides the following section:

	Ft.	Ins.
Coal	3	0
Bone		1
Coal	1	1
Bone		1
Coal	1	11
Total	6	2

The seam here strikes north 77 degrees east and dips 34½ degrees northwest. Faults cross the creek a short distance above and below it. A sample, which omitted the bone bands, contained 21·65 per cent ash (Anal. 63).

Loc. 55, Kluatantan River Just Below Wash Creek. Both Malloch and Evans have described a seam here, which, according to Evans, is exposed in an overturned syncline.

(G. W. Evans)

	Ft.	Ins.
Roof, dark shaly sandstone		
Shale and some coal		6
Coal	2	9
Shale, black, soft		4
Coal	2	8
Shale, hard		1
Coal		9
Black clay and coal		4
Coal		11
Shale, quartz, and a little coal	1	11
Floor, sandy shale		
Total	10	3

(G. S. Malloch)

	Ft.	Ins.
Bone and dirty coal	3	10
Coal, with bone bands and quartz stringers	5	½
Bone		6
Coal		2
Total	9	6½

Evans gives the strike as north 55 degrees west and the dip as 62 degrees southwest; Malloch, as north 68 degrees west and 63 degrees southwest. Evans' sample, including only the bands listed as coal, contained 28·75 per cent ash (Anal. 64); Malloch's, of the lower 5 feet of coal only and omitting 10 inches of bone bands and quartz stringers, 31·00 per cent ash (Anal. 65).

Loc. 56, Head of Wash Creek. Malloch reports a seam here as comprising:

	Ft.	Ins.
Coal	2	0
Bone and dirty coal	2	0
Coal		9
Bone		5
Coal	1	0
Bone		5
Coal	2	5
Total	9	0

Loc. 57, Merry Creek and Vicinity. R. C. Campbell-Johnston reports a number of seams on Merry Creek and other creeks in the vicinity. Neither the locations of the seams nor those of the other creeks can now be definitely identified. The analysis of a picked specimen collected from Merry Creek (Anal. 104) gave 13·0 per cent ash. Analyses of picked specimens from four other seams, which may be in this vicinity, showed 19·6, 39·0, 39·0, and 50·0 per cent ash respectively. These are not listed with the other analyses because of the doubtful location of the seams.

Loc. 58, Kluatantan-Kluayetz Creek Divide. O'Dwyer, in the course of his railway reconnaissance survey, set a post here to mark the divide between Skeena and Stikine drainage. Near this post, R. C. Campbell-Johnston found pieces of coal in the dumps from groundhog holes. He inferred the presence of a seam not far beneath. One of the pieces of coal contained 9·8 per cent ash (Anal. 105).

Loc. 59, Ranger Creek. R. C. Campbell-Johnston reports "many seams" on Moccasin Creek (now Ranger Creek). He gives an analysis of a picked specimen from a seam on the creek, which contained 9·0 per cent ash (Anal. 106).

Loc. 60, Didene Creek and Spatsizi River. On both streams, within 1,500 feet above their junction, Dupont, in the course of his railway reconnaissance, came upon the "vein of about 10 feet of impure coal" previously referred to as the first recorded in published accounts of the Groundhog area. In Dawson's report, this coal is said to be "anthracite". Curiously, none of the later workers has recorded finding these outcrops.

Locs. 61 and 62, Conglomerate Creek and Creek East of Indian Graves. Malloch reports that among the seams prospected by Grossman's party: "A much crushed seam in the disturbed belt occurs and outcrops both on Conglomerate Creek and on the creek immediately east of the Indian graves".

Loc. 63, Mountain West of Little Klappan. Malloch reports two seams on this mountain, separated by a fault. The lower "has a thickness of nearly 3 feet, but is dirty", and the upper "has a thickness of 3 feet 3 inches and is apparently much cleaner". Analysis of a picked specimen from it gave 7·16 per cent ash (Anal. 107). W. F. Robertson reports that a specimen from a seam in this locality contained 6·6 per cent ash (Anal. 108). The Eaglenest Creek referred to in this connection in Robertson's report is not the Eaglenest Creek shown on his map entering the Klappan from the east 3 miles below its junction with the Little Klappan.

Loc. 64, Little Klappan River. Malloch reports that two seams about 4 miles above the Indian graves were trenched by Grossman's party. The lower at locality 64A, is overlain, 75 feet above, by the other at 64B. Details of the seam at 64A are:

	Ft.	Ins.
Coal	1	2
Bone and dirty coal		9½
Coal	2	8
Bone		3
Coal	1	10
Bone	1	3
Coal	2	5½
Total	10	5

More coal occurred above and below, but none of it was clean. The seam strikes north 63 degrees west and dips 78 degrees northeast. It lies in a disturbed belt, but unlike the seam at locality 64B, 75 feet above, is not much crushed. Malloch's sample, which probably included all the coal bands above, contained 22·06 per cent ash (Anal. 66).

(Loc. 64B) Malloch stated: "a 3-foot seam only 75 feet higher up is crushed to powder and was not sampled".

Loc. 65, Klappan Mountain. W. F. Robertson reports that a seam occurs near a fault on this mountain at an elevation of 5,000 feet, but that its disintegration prevented him from seeing it in place, and he states: "it can only be reported that coal of fair quality exists here". The measures strike north 45 degrees east and dip about 15 degrees southeast.

Loc. 66, Saddle on Klappan Mountain. Malloch states Grossman's party did some test pitting here on seams believed to be the continuation of those at locality 64.

Loc. 67, Blume Creek. Malloch reports that a sample from a 9-foot seam on this creek contained 21·31 per cent ash (Anal. 66).

Loc. 68, Porky Creek. Malloch reports that a sample from a 6-foot seam on this creek contained 21·65 per cent ash (Anal. 67).

CHARACTER OF THE COAL

The best coal seams seen by the writers were composed of bright, hard coal with a resinous lustre. Much of the coal is banded, in alternating laminæ of very bright and somewhat duller coal up to ⅛ inch thick. All gradations from coals with a slightly duller lustre, through coals obviously bony and dirty, to carbonaceous shales occur. Bands of sheared, dirty, crushed coal also were found in some seams. Most of the coal has a well-developed cleat, which appears in surface exposures as a system of intersecting joints breaking the coal into rhombs. In some places these joints are so closely spaced that no pieces larger than a grain of wheat could be picked from the face. In other places, the coal was sheared and crushed to a powder.

All coal seams carry stringers and veinlets, chiefly of quartz; less commonly they are composed of calcite, and some of them carry pyrite. These may either parallel the banding of the seams, or cross it at an angle, commonly occupying the cleat planes transverse to the bedding. Similar veinlets are less abundant in the sandstones and shales of the area. The veinlets are too continuous and widespread throughout the field to have been deposited by surface waters, as has been suggested. It seems necessary to invoke the agency of heated waters under pressure to transport the materials for the veinlets. The source of these waters may be igneous bodies as yet unexposed by erosion, or it may have been water circulating in the rocks when they were folded and faulted, and deriving its heat from their deformation. The latter possibility, with the suggestion that the water was derived from the coals themselves as they were metamorphosed to anthracite, seems most probable. In any case, it is improbable that the proportion of veinlets to coal in any surface outcrop will be found to diminish with increasing depth.

The analyses given below show that most of the coals are of anthracite rank. Some of them show more moisture than is ordinarily present in anthracite coal; most of these are of samples obtained at or above timberline, and the high moisture is believed to be due to weathering, for at high elevations the rock is shattered to a considerable depth.

Apart from the quartz and calcite veinlets, whose origin is doubtful, there is no evidence that igneous intrusion or volcanic activity had any part in the origin of the anthracite. The degree of structural disturbance seen in the rock indicates that pressures and temperature during deformation were adequate to account for the rank of the coal.

The sections of the coal seam on Discovery Creek (Loc. 24) bring out a point that prospective operators in the field must consider. Most of the cleat or jointing in the coal is an original feature and not one due to weathering. Hence, although the seams may be more solid at depth they will always be tender and subject to degradation on handling. Coal produced from the top bench of this seam, for example, by the time it had been shipped to, say, Prince Rupert, would be reduced to chiefly buckwheat size; that from the middle bench would be mainly nut size; and only that from the bottom bench would remain in lump form. In other words, the output would be approximately 40 per cent buckwheat, 25 per cent nut, and 35 per cent lump. Similar, although not identical, figures apply to other seams tested by the writers. This has not been sufficiently emphasized in previous publications.

A second point, previously emphasized by W. F. Robertson, is that these coals do not withstand weathering well. He visited the field in 1912, and found that in the dumps at prospects examined the coal mined the previous year had disintegrated to a sandy mass. The only coal seen by the writers that resists weathering is that from the bottom bench at locality 24. This comprises 40 per cent of the seam at that point.

Statements have been made contradicting those in the two preceding paragraphs, and as proof it is said that samples have been kept in the office for several years without deterioration. The explanation is that samples from the above-noted bottom bench could well have been kept in this way. Conclusions drawn from such samples refer only to the bench from which they came, and not to coal from the seam as a whole, or to coals from the field generally.

ANALYSES OF THE COAL

All available analyses of the coal from the Groundhog field have been collected and are listed in the table of analyses that follows this section of the report. A total of one hundred and eight are given, of which sixty-eight are analyses of *samples* properly taken to give a fair representation of the seam, and forty are analyses of *picked specimens* from the seams. The latter give no indication of the grade of the coal that could be mined from the seams, but do indicate the character of the coal. Where the ash content is high, it indicates that run-of-mine coal from such seams would be very dirty.

Initials are used in the table to indicate by whom the sample was taken. The samplers were:

Angus Beaton	A.B.
Arthur Challoner	A.C.
G. W. Evans	G.W.E.
Charles Fergie	C.F.
R. C. Campbell-Johnston	R.C.C.-J.
W. W. Leach	W.W.L.
G. F. Monckton	G.F.M.
G. S. Malloch	G.S.M.
James McEvoy	J. McE.
W. F. Robertson	W.F.R.
J. F. Walter	J.F.W.
—. Wright	W.

It will be noted that almost half the samples analysed were taken by G. W. Evans. These are previously unpublished, and thanks are due Mr. Evans for his courtesy in allowing them to be used here.

Letters are used in the table to indicate the analysts, who were:

Laboratory of Mines Branch, Dept. of Mines, Ottawa	A
British Columbia Government Laboratory, Victoria	B
Faulkenburg and Laucks, Seattle	C
R. W. Coulthard, Crow's Nest Pass Coal Company, Fernie	D
Thos. Heys and Sons, Toronto	E
Milton Hersey Company, Limited, Montreal	F
J. O'Sullivan, Vancouver	G

The columns "Moist, M(ineral)-M(atter)-Free, B.T.U." and "Dry M(ineral)-M(atter)-Free F(ixed) C(arbon)" were calculated from the proximate analyses by standard formulæ in order to obtain the last column, "Classification". The classification is according to "Standard Specifications for Classification of Coals by Rank", by the American Society for Testing Materials, Designation D 388-38.

It should be noted that all of the analyses are on an "as received" basis. The samples or picked specimens to be analysed were taken from the field in canvas sample bags, and a month or more elapsed before the analyses were made, so that the moisture given is probably not that of the coal "as mined".

PROXIMATE ANALYSES OF SAMPLES OF COAL SEAMS, GROUNDHOG COALFIELD

Analysis No.	Loc. No.	Locality	Remarks	Thickness sampled		Surface or tunnel	Sampler	Analyst	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B.T.U. per lb.	Moist, M.M.-free B.T.U.	Dry, M.M.-free F.C.	Classification
				Ft.	Ins.				Per cent	Per cent	Per cent	Per cent	Per cent			Per cent	
1	4	S. fork Anthony Creek	....	6	1½	S	G.S.M.	A	4·09	8·48	46·29	41·14	....	....	....	91·4	Semi-anthracite
2	11A	Augustine Creek..	....	1	8	T	G.W.E.	C	3·75	6·47	62·68	27·10	0·86	10,290	14,679	94·4	Anthracite
3	12	Brewer Creek.....	....	3	10	T	G.W.E.	C	4·52	4·75	69·93	20·80	2·31	11,900	15,476	96·6	Anthracite
4	14	Lower Trail Creek	Top bench........	4	6	S	W.W.L.	D	4·71	7·03	67·51	20·75	....	....	....	93·2	Anthracite
5	14	Lower Trail Creek	Bottom bench....	3	7	S	W.W.L.	D	3·40	8·08	59·77	28·75	....	....	....	92·1	Anthracite
6	14	Lower Trail Creek	....	6	8±	T	J.F.W.	A	1·57	7·49	53·57	37·37	....	....	....	93·6	Anthracite
7	14	Lower Trail Creek	....	6	8	T	J.McE.	E	1·39	5·75	63·02	29·84	1·08	10,541	15,716	95·9	Anthracite
8	14	Lower Trail Creek	....	6	6	T	G.S.M.	A	1·36	7·17	49·04	42·41	....	....	....	94·5	Anthracite
9	14	Lower Trail Creek	....	6	10	T	W.F.R.	B	2·5	6·1	42·6	48·8	....	....	....	97·4	Anthracite
10	15B	Trail Creek.......	Cf. Anal. No. 72..	3	10±	T	W.F.R.	B	2·7	5·6	53·4	38·3	....	....	....	96·9	Anthracite
11	15C	Trail Creek.......	Cf. Anal. No. 73..	3	9	T	G.W.E.	C	3·20	7·02	49·43	40·35	0·99	7,860	14,100	94·4	Anthracite
12	17A	Little Creek......	....	2	4	S	G.W.E.	C	4·42	6·58	58·96	30·04	1·61	9,930	14,864	94·5	Anthracite
13	17B	Little Creek......	This sample may have been of weathered coal	2	4	T	G.W.E.	C	4·01	13·08	57·71	25·20	2·42	9,600	13,325	84·8	Low vol. bituminous
14	18A	Headwaters of Jackson Creek	....	4	0	T	G.W.E.	C	2·45	3·86	63·96	29·73	1·93	10,280	15,318	98·9	Meta-anthracite
15	18B	Headwaters of Jackson Creek	....	2	8	T	G.W.E.	C	2·71	6·09	67·42	23·78	3·05	12,650	17,161	94·9	Anthracite
16	18C	Headwaters of Jackson Creek	....	4	5	T	G.W.E.	C	2·97	5·59	65·60	25·84	1·90	11,520	16,136	95·8	Anthracite
17	19	Mount Jackson....	This sample of weathered coal	3	4	S	G.S.M.	A	10·16	23·73	45·79	20·32	....	....	....	67·8	....
18	20	Mount Jackson....	....	6	2½	S	G.S.M.	A	10·52	22·15	40·81	26·52	....	....	....	67·7	....
19	21A	Lower Jackson Creek	....	7	0	S	W.W.L.	D	6·42	9·83	60·95	22·80	....	....	....	89·1	Semi-anthracite

20	22A	Skeena R., near Duke Creek	....	3	6	....	J.F.W.	A	3·66	7·30	53·82	35·22	....	....	....	93·6	Anthracite
21	23	Abraham Creek..	....	6	0±	T	J.F.W.	A	2·48	5·20	64·42	27·90	....	....	....	96·4	Anthracite
22	23	Abraham Creek..	....	6	0	T	J.McE.	E	1·17	6·05	76·20	16·58	0·72	12,215	14,952	94·6	Anthracite
23	23	Abraham Creek..	....	5	6	T	G.S.M.	A	1·04	8·39	67·89	22·68	....	....	....	91·8	Semi-anthracite
24	23	Abraham Creek..	....	5	9	T	W.F.R.	B	2·5	8·1	62·3	27·1	....	....	....	92·1	Anthracite
25	23	Abraham Creek..	....	5	9	T	G.W.E.	B	3·0	6·6	66·0	24·4	....	....	....	94·1	Anthracite
26	24	Lower tunnel, Discovery Creek	Cf. Anal. No. 74..	5	4	S	J.McE.	E	2·39	7·90	78·54	11·17	0·99	....	....	92·1	Anthracite
27	24	Lower tunnel, Discovery Creek	Cf. Anal. No. 74..	5	7±	T	J.F.W.	A	3·83	6·37	62·14	27·66	....	....	....	94·5	Anthracite
28	24	Lower tunnel, Discovery Creek	Cf. Anal. No. 74, top bench	1	7±	T	C.F.	F	4·12	7·43	82·60	5·85	0·46	12,775	13,660	92·4	Anthracite
29	24	Lower tunnel, Discovery Creek	Cf. Anal. No. 74, bottom bench	3	9½±	T	C.F.	F	3·95	8·00	84·00	4·05	0·49	12,995	13,607	91·8	Semi-anthracite
30	24	Lower tunnel, Discovery Creek	Cf. Anal. No. 74.	6	2	T	J.McE.	E	2·62	6·96	84·49	5·93	0·57	13,814	14,787	93·0	Anthracite
31	24	Lower tunnel, Discovery Creek	CF. Anal. No. 74.	5	5	T	G.S.M.	A	2·88	7·64	78·84	10·64	....	....	....	92·4	Anthracite
32	25	Upper tunnel, Discovery Creek	....	5	10	S	W.W.L.	D	5·75	7·34	75·26	11·65	....	....	....	92·5	Anthracite
33	25	Upper tunnel, Discovery Creek	....	5	10±	T	W.W.L.	A	1·45	7·51	75·23	15·81	....	....	....	92·7	Anthracite
34	25	Upper tunnel, Discovery Creek	....	5	5±	T	J.F.W.	A	4·45	8·75	79·25	7·55	....	....	....	90·8	Semi-anthracite
35	25	Upper tunnel, Discovery Creek	....	5	5±	T	J.McE.	E	1·17	6·54	83·37	8·92	0·74	13,328	14,870	94·9	Anthracite
36	26E	Skeena R., opp. Telfer Creek	.. ..	7	3	S	G.S.M.	A	3·84	7·85	51·17	37·14	....	....	....	92·6	Anthracite
37	27	Mouth of Davis Creek	....	4	0	T	J.McE.	E	1·40	6·06	70·68	21·86	1·60	11,788	15,520	94·8	Anthracite
38	27	Mouth of Davis Creek	....	4	5	T	G.S.M.	A	1·57	7·55	65·52	25·36	....	....	....	92·9	Anthracite
39	28A	Upper Davis Creek	....	4	6	S	J.McE.	E	4·72	10·65	72·02	12·61	0·65	....	....	88·5	Semi-anthracite

PROXIMATE ANALYSES OF SAMPLES OF COAL SEAMS, GROUNDHOG COALFIELD—*Con.*

Analysis No.	Loc. No.	Locality	Remarks	Thickness sampled	Surface or tunnel	Sampler	Analyst	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B.T.U. per lb.	Moist, M.M.-free B.T.U.	Dry, M.M.-free F.C.	Classification
				Ft. Ins.				Per cent	Per cent	Per cent	Per cent	Per cent			Per cent	
40	31C	Anthracite Creek.	Cf. Anal. No. 78..	3 11½	S	G.S.M.	A	6·09	13·70	65·52	14·69	....	....	....	84·3	Low vol. bituminous
41	32B	Scott seam, Beirnes Creek	Cf. Anals. Nos. 85–90	5 4	T	G.S.M.	A	1·08	7·06	64·97	26·89	....	....	....	93·8	Anthracite
42	32F	Pelletier seam, Beirnes Creek	Cf. Anals. Nos. 94–99	5 2½	T	G.S.M.	A	1·35	7·69	61·90	29·06	....	....	....	92·9	Anthracite
43	36A	Seam A, Telfer Creek	....	4 7	T	A.C.	C	3·55	4·02	70·68	21·75	0·99	11,980	15,767	97·5	Anthracite
44	36C	Seam No. 2, Telfer Creek	....	4 3	T	G.W.E.	C	3·75	5·74	56·15	34·36	1·57	9,600	15,750	98·1	Meta-anthracite
45	36D	Seam No. 3, Telfer Creek	....	3 4	S	G.W.E.	C	4·50	6·25	47·73	41·52	0·99	7,800	14,383	96·0	Anthracite
46	36E	Seam No. 4, Telfer Creek	....	5 0	T	G.W.E.	C	3·77	4·27	57·75	34·21	0·60	9,580	15,374	98·6	Meta-anthracite
47	36H	Seam No. 7, Telfer Creek	....	3 6	T	G.W.E.	C	5·95	13·32	46·67	34·06	0·44	9,360	14,978	82·5	Low vol. bituminous
48	39A	Pass E. of Langlois Creek	....	3 6	T	G.W.E.	C	4·55	5·82	64·84	24·79	1·73	10,030	13,823	95·3	Anthracite
49	39B	Pass E. of Langlois Creek	....	3 1½	T	G.W.E.	C	4·52	4·88	69·83	20·77	2·22	11,710	15,221	96·4	Anthracite
50	39C	Pass E. of Langlois Creek	....	3 6	T	G.W.E.	C	3·65	4·64	60·84	30·87	1·73	9,950	15,107	97·7	Anthracite
51	40B	Seam No. 2, Grizzly Gulch, Operator Mt.	....	4 0	S	G.W.E.	C	4·85	8·30	41·40	45·45	0·21	6,740	13,485	91·7	Semi-anthracite
52	40C	Seam No. 3, Grizzly Gulch, Operator Mt.	This sample probably of weathered coal	4 0	S	G.W.E.	C	12·35	21·20	28·75	37·70	0·82	4,070	6,964	62·3	....

53	40D	Seam No. 4, Grizzly Gulch, Operator Mt.	....	4	1½	S	G.W.E.	C	4·65	7·95	46·95	40·45	0·75	9,240	16,669	95·4	Anthracite
54	40E	Seam No. 5, Grizzly Gulch, Operator Mt.	....	6	7½	S	G.W.E.	C	7·10	13·45	40·60	38·85	0·96	6,580	11,509	81·1	Low vol. bituminous
55	41	Operator Mountain	....	3	0	S	G.W.E.	C	5·10	5·82	68·43	24·25	1·10	9,550	13,044	95·2	Anthracite
56	42A	Ridge 1½ miles NE. of Operator Mountain	Sample frozen when taken	6	0	S	G.W.E.	C	8·48	12·59	56·70	22·23	1·58	10,340	13,715	84·7	Low vol. bituminous
57	47	Creek north of Kluatantan Lake	....	4	6	S	G.W.E.	C	5·85	11·27	41·92	40·95	1·10	5,640	10,284	85·7	Low vol. bituminous
58	49A	East end Mt. Laidlaw	....	3	0	S	G W.E.	C	10·45	21·00	23·90	44·65	1·17	5,170	10, 183	59·2	....
59	49B	East end Mt. Laidlaw	....	3	4	S	G.W.E.	C	6·30	14·85	38·25	40·60	0·41	7,670	13,870	78·0	....
60	49C	East end Mt. Laidlaw	....	4	10	S	G.W.E.	C	9·95	17·45	30·45	42·15	0·34	5,320	9,925	69·7	....
61	51	South end, Prudential Mt.	....	2	10	S	G.W.E.	C	8·85	18·75	28·45	43·95	0·21	7,820	15,146	66·5	....
62	53	Prudential Creek.	....	3	9	S	G.W.E.	C	6·60	15·10	40·85	37·45	0·48	7,050	11,987	78·3	....
63	54B	Campbell-Johnston Creek	....	6	0	S	G.S.M.	A	5·02	6·38	66·95	21·65	....	....	....	94·1	Anthracite
64	55	Kluatantan R., just below Wash Creek	....		?	S	G.W.E.	C	4·25	4·35	63·55	27·85	0·62	11,430	16,493	97·7	Anthracite
65	55	Kluatantan R., just below Wash Creek	....	4	2½	S	G.S.M.	A	3·40	5·33	60·27	31·00	....	....	....	96·6	Anthracite
66	63A	Little Klappan R. 4 mi. above Graveyard	....	6	1½	S	G.S.M.	A	4·48	9·98	63·48	22·06	....	....	....	88·0	Semi-anthracite
67	66	Blume Creek.....	....		?	S	G.S.M.	A	6·85	13·76	58·08	21·31	....	....	....	83·4	....
68	67	Porky Creek......	....		?	S	G.S.M.	A	5·02	6·38	66·95	21·65	....	....	....	94·2	Anthracite
69	2	NW. of Seventh Cabin	....	....		?	W.	B	3·3	12·2	80·3	4·2	....	....	....	87·3	Semi-anthracite

PROXIMATE ANALYSES OF SAMPLES OF COAL SEAMS, GROUNDHOG COALFIELD—*Con.*

Analysis No.	Loc. No.	Locality	Remarks	Thickness sampled	Surface or tunnel	Sampler	Analyst	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B.T.U. per lb.	Moist, M.M.-free B.T.U.	Dry, M.M.-free F.C.	Classification
				Ft. Ins.				Per cent	Per cent	Per cent	Per cent	Per cent			Per cent	
70	7	Mt. S. of headwaters, Panorama Creek	....	....	?	A.B.	A	3·83	8·80	82·98	4·39	....	....	....	90·9	Semi-anthracite
71	10	12-ft. seam, McEvoy Ridge	....	....	S	G.S.M.	A	2·23	13·73	64·39	19·65	....	....	....	84·6	Low vol. bituminous
72	15B	Trail Creek........	Cf. Anal. No. 10..	....	T	W.F.R.	B	2·3	5·1	71·1	21·5	....	....	....	96·1	Anthracite
73	15C	Trail Creek........	Cf. Anal. No. 11 .	....	T	W.F.R.	B	3·4	5·4	70·8	20·4	....	....	....	95·6	Anthracite
74	24	Discovery Creek.	Cf. Anals. Nos. 26–31	....	T	J.McE.	B	2·80	3·70	85·6	7·90	....	....	....	96·8	Anthracite
75	30D	Skeena R., above Langlois Creek	....	....	S	G.S.M.	A	3·24	7·67	68·92	20·17	....	....	....	91·9	Semi-anthracite
76	31A	Anthracite Creek.	....	....	?	R.C.C.-J.	G	13·51		71·76	14·73	0·16	....	....	....	....
77	31B	Anthracite Creek.	....	....	?	G.F.M.	G	6·78		73·36	19·86	0·12	....	....	....	....
78	31C	Anthracite Creek.	Cf. Anal. No. 40	....	?	G.F.M.	G	6·98		86·74	6·28	0·13	....	....	....	....
79	32A	Benoit seam, Beirnes Creek	....	....	T	R.C.C.-J.	B	3·9	2·9	80·3	12·9	....	....	....	98·1	Meta-anthracite
80	32A	Benoit seam, Beirnes Creek	From 4-ft. top bench	....	S	R.C.C.-J.	G	4·0	5·1	82·6	8·3	0·8	14,216	15,658	95·1	Anthracite
81	32A	Benoit seam, Beirnes Creek	Coal from coal and shale, 1 ft.	....	S	R.C.C.-J.	G	4·0	5·0	82·0	9·0	1·0	14,214	15,793	95·3	Anthracite
82	32A	Benoit seam, Beirnes Creek	From 6 ins. bottom bench	....	S	R.C.C.-J.	G	4·5	4·5	84·0	7·0	1·0	14,138	15,334	95·7	Anthracite
83	32A	Benoit seam, Beirnes Creek	....	....	T	R.C.C.-J.	G	4·5	4·6	80·1	10·8	0·8	12,852	14,597	95·8	Anthracite
84	32A	Benoit seam, Beirnes Creek	....	....	T	G.F.M.	G	3·0	6·6	74·6	15·8	0·8	....	....	93·8	Anthracite

85	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	R.C.C.-J.	B	3·40	3·10	75·9	17·6	....	....	....	98·3	Meta-anthracite
86	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	R.C.C.-J.	G	4·5	4·5	77·0	14·0	1·0	12,323	14,583	96·2	Anthracite
87	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	R.C.C.-J.	G	4·5	6·5	78·0	11·0	1·0	12,843	14,627	93·6	Anthracite
88	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	R.C.C.-J.	G	11·17		75·66	13·17	0·04	....	....	....	....
89	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	R.C.C.-J.	G	9·72		71·07	19·21	0·02	....	....	....	....
90	32B	Scott seam, Beirnes Creek	Cf. Anal. No. 41..	....	T	G.F.M.	G	3·5	4·6	81·1	10·8	0·8	....	....	95·9	Anthracite
91	32C	Garneau seam, Beirnes Creek	....	....	T	R.C.C.-J.	B	4·3	2·9	82·3	10·5	....	....	....	97·9	Anthracite
92	32C	Garneau seam, Beirnes Creek	....	....	T	R.C.C.-J.	G	4·0	4·0	82·5	9·5	1·0	13,455	15,041	97·7	Anthracite
93	32E	Ross seam, Beirnes Creek	....	....	T	G.F.M.	G	9·33		80·94	9·73	0·77	....	....	....	....
94	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	R.C.C.-J.	B	3·1	3·5	77·7	15·7	....	....	....	97·7	Anthracite
95	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	R.C.C.-J.	G	4·0	4·0	71·0	21·0	1·0	11,340	14,765	97·5	Anthracite
96	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	R.C.C.-J.	G	4·0	7·0	60·0	29·0	1·0	10,374	15,256	93·75	Anthracite
97	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	R.C.C.-J.	G	4·5	3·5	83·5	8·5	1·0	....	....	97·0	Anthracite
98	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	R.C.C.-J.	G	8·42		64·93	26·65	1·74..	....	....	....	..............—
99	32F	Pelletier seam, Beirnes Creek	Cf. Anal. No. 42..	....	T	G.S.M.	A	1·07	6·53	75·25	17·15	....	....	....	94·1	Anthracite
100	46	Lonesome Creek..	....	....	S	R.C.C.-J.	G	3·0	7·7	43·7	45·6	0·6	8,076	16,223	93·4	Anthracite
101	46	Big seam, Skeena River, by Lonesome Creek	....	....	S	R.C.C.-J.	G	2·0	15·0	54·0	29·0	1·0	10,898	16,026	81·8	Low vol. bituminous

PROXIMATE ANALYSES OF SAMPLES OF COAL SEAMS, GROUNDHOG COALFIELD—*Con.*

Analysis No.	Loc. No.	Locality	Remarks	Thickness sampled	Surface or tunnel	Sampler	Analyst	Moisture	Volatile matter	Fixed carbon	Ash	Sulphur	B.T.U. per lb.	Moist, M.M.-free B.T.U.	Dry, M.M.-free F.C.	Classification
				Ft. Ins.				Per cent	Per cent	Per cent	Per cent	Per cent			Per cent	
102	46	Lower 6-ft. seam on Skeena R. by Lonesome Creek	....	....	S	R.C.C.-J.	G	2·5	14·6	51·1	27·8	0·8	10,914	15,739	76·4	Med. vol. bituminous
103	46	No. 2 seam, Skeena R. by Lonesome Creek	....	....	S	R.C.C.-J.	G	3·0	10·7	61·7	24·6	0·6	11,312	15,521	88·3	Semi-anthracite
104	57	Merry Creek......	....	....	S	R.C.C.-J.	G	4·0	10·5	72·5	13·0	1·0	12,998	15,184	88·8	Semi-anthracite
105	58	At O'Dwyer's old post, Kluatantan-Stikine summit	Float only........	....	S	R.C.C.-J.	G	5·0	11·6	73·6	9·8	0·8	13,464	15,104	87·4	Semi-anthracite
106	59	Ranger Creek....	....	....	S	R.C.C.-J.	G	4·0	14·5	72·5	9·0	1·0	13,702	15,224	84·3	Low vol. bituminous
107	62	Seam west of Little Klappan River	....	....	S	G.S.M.	A	4·14	8·43	80·27	7·16	....	....	....	91·3	Semi-anthracite
108	62	Seam west of Little Klappan River	....	....	S	W.F.R.	B	5·00	9·00	79·40	6·60	....	....	....	90·6	Semi-anthracite

RESERVES AND PRESENT WORTH OF THE GROUNDHOG COALFIELD

It will be evident from this report that data are not available from which to calculate reserves of the field. Although fully recognizing this, several have attempted to estimate the value of the reserves, among them Dowling (9) and MacKay (20). All calculations such as these are an attempt to indicate, under stated limiting conditions, the amount of coal in the ground that can be mined. They are not intended to indicate the amount of coal that can be mined *at a profit*. As this is essentially a review of previous work, and as work in the area is not completed, it is not thought advisable to offer any present estimate of the reserves.

Enough information has been gathered, however, to give some idea of the present worth of the Groundhog coalfield. The large area underlain by coal-bearing rocks, in which numerous occurrences of coal seams of anthracite rank, many of mineable thickness, have been found, is in its favour. Against it, however, are several disadvantages. Nearly all of the seams thus far sampled are much too dirty to yield a saleable product as mined. Many of the seams are jointed and crushed, and the proportion of fine coal to lump in output from them would be high. Coal produced would be "tender" and suffer considerable degradation to "fines" in transportation. The degree of structural disturbance in the field is high. In many areas the coal will be too broken to mine. As previously pointed out, prospecting and development costs will be greater than in many fields and the cost of providing an outlet to market would be great.

In a field of this great size it is probable that areas exist where the coal is sufficiently clean and sufficiently undisturbed to be mined successfully, but it will be expensive to find such areas and to determine their size relative to that of the field as a whole. It is not considered that prospecting for such areas is advisable unless, or until, transportation conditions are much more favourable than at present.

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APPENDIX: DETAILED DESCRIPTION OF TRAILS

THE TELEGRAPH TRAIL

The pack-horse route commonly used to reach the Groundhog coalfield is the Telegraph Trail. This trail was originally constructed in 1900 to serve the Dominion Government's Yukon telegraph line, although for much of its length it followed older trails. It runs north from Hazelton 114 miles to Damdochax (Blackwater) Lake, where a branch trail to the Groundhog coal basin leaves it. The Telegraph Trail continues west 60 miles to the headwaters of Bell-Irving River. During the period of operation of the telegraph line the trail was kept in good repair to service the telegraph operators. These were stationed at intervals along the trail: First Cabin, 28 miles north of Hazelton; Second, 24 miles north of First; and Third to Ninth an average of 17 miles apart. Between each pair of cabins were Quarterway, Halfway, and Threequarterway cabins. Operators and linemen at the various cabins provided sources of first-hand information, and packers were available in Hazelton to supply transportation needs. Probably for these reasons, no detailed account of the route has been published. Since 1936, when the telegraph line was abandoned, the trail has been little used. Many of the feed grounds for pack animals have gone back to weeds and brush. The trail has deteriorated badly; most of the bridges have been washed away; and corduroy laid on boggy places has rotted or been displaced. The writers' party cleared the trail in 1948, but before this it was badly blocked with windfall and a rank growth of underbrush. The condition of the trail has changed so much that information from those who have not travelled it since 1936 may be badly misleading, however familiar they may have been with it previously. On leaving Hazelton in the spring, it should be noted that if the grass there is well advanced, then the grass at the various feeding grounds along the trail will be sufficient for the horses, but if spring has been late and growth of the grass has been retarded, it will be necessary to carry some feed for the horses. About 30 pounds of oats per horse, as a supplement to whatever green feed is available, should suffice until arrival at Jackson Flat, where there is good grazing.

The Telegraph Trail as far as Blackwater Lake is, therefore, described here. Maps on which the description may be followed are: Nos. 449A (Hazelton sheet, west half) and 657A (Tatlatui), Department of Mines and Technical Surveys, Ottawa, both on a scale of 1 inch to 4 miles; and Nos. 1A (British Columbia), 14 (Northern British Columbia), and 1L (Central British Columbia) by the B.C. Department of Lands, Victoria, all on a scale of 1 inch to 15·78 miles. In this description considerable stress is laid on the location of feed grounds for pack animals. These occur only at intervals along the trail, and each day's journey must be arranged to end at one. If it is intended to break the journey to rest for a day or so, it is desirable to do so at one of the better feed grounds. These are at First Cabin, Second Cabin, Old Kuldo, Slamgeesh Lake and Fifth Cabin, and Blackwater Lake.

An automobile road extends for 22 miles north of Hazelton to Beirnes' ranch. Just north of the ranch a badly deteriorated bridge halts the passage of all but light cars. It was being repaired in the autumn of 1948. Beyond it, a poor road extends for 6·3 miles to First Cabin, the northernmost point on the Telegraph Trail accessible by car.

Good feed grounds and a large corral at "Seventeen Mile", about a mile past the second bridge over the Kispiox, provide a good place for pack-horses while outfitting. Just north of the creek at Beirnes' ranch is a good camp ground, with poor feed, sufficient for thirty head for one night. A good camp ground, with excellent feed is at First Cabin. These three places are all suitable to rig pack and camp outfits. Journeys along the Telegraph Trail are generally considered to begin at First Cabin. Three-quarters of a mile past this cabin the trail turns right[1] and climbs a hill from a point, not well marked, to the right of a small meadow. About 6·6 miles north of First Cabin is the Quarterway Cabin, and 1½ miles farther, or 8·1 miles from First Cabin, is "Burnt Hill" camp. This is a poor camp—a small, open space on a sidehill facing west. Just past it, a trail to the feed ground (swamp hay), turns left, and about half a mile on a slough provides water. It is more common practice, however, to continue 1·6 miles farther, a total of 9·7 miles from First Cabin, to "Beaverdam" camp. This is just beyond three swampy areas, the last of which is crossed by a bridged stream, the water supply. North of the camp a trail leads left to an area of swamp hay, the feed ground. Commonly this is the first halt past First Cabin going north, and going south it is usual to go from "Beaverdam" camp to Beirnes' ranch.

The Halfway Cabin is 1·7 miles north of "Beaverdam" camp, and 2 miles north, or 3·7 miles from "Beaverdam" camp, is "Trout Lake" camp, another small, poor camp. Here water is obtained from Trout Lake on the left, and the feed is swamp hay at the north end of the lake. Five miles north of "Beaverdam" camp is "Dead Horse Lake" camp, where feed and water are at the lake about 300 yards to the right of the camp.

Three miles north of "Dead Horse Lake" camp, the trail crosses Deep Creek. This stream is about 60 feet wide and 2 feet deep, and has a good gravel bottom. It is easily crossed at normal flow, but during high water could present difficulties. A telegraph wire cable, on which a small car rides, spans the creek upstream from the trail.

Another creek is crossed 3·7 miles north of Deep Creek. This ordinarily is 15 feet across and a foot deep, but it has rock walls, and in high water could present difficulties. Its southern approach is a steep drop of about 100 feet across a clayey sidehill, which is difficult to traverse in wet weather.

Second Cabin is 6·3 miles north of Deep Creek. There are extensive flats from Kuldo Creek, just north of Second Cabin, south for more than 1½ miles, and on these flats is an abundance of horsefeed. Camp may be made anywhere in this area where water is convenient. The usual spots are at Second Cabin, which is on a second, higher level, flat, or at the north end of the lower flat a mile south of the cabin.

Just north of Second Cabin is Kuldo Creek, a good-sized stream. The trail formerly went 0·6 mile upstream to a narrow spot where the river was bridged. Now only the abutments remain although the gap is spanned by a telegraph-wire cable and small car. Horses ford the river, following

[1] For ease in description, directions will be referred to as to the right or left of a traveller going north.

a trail down the south bank, which begins to the right of the northernmost building and leads to the ford. About halfway across the river is a gravel bar, which is followed upstream to where it angles into the north bank. Thence a trail is cut to reach the old trail 100 yards past the bridge. The normal depth of Kuldo Creek is less than 3 feet, and in high water horses could probably swim from the south bank to the gravel bar.

North of Second Cabin, the trail continues to the abandoned Indian village of Old Kuldo. The Indian village of New Kuldo, now also abandoned, is below the trail to the right, on Skeena River. Trails to it turn off at 2·6 and 2·8 miles north of Second Cabin and the village itself may be seen from a log skidway that leaves the trail 2·65 miles north of Second Cabin. The Quarterway Cabin is to the left of the trail, 4·5 miles north of Second Cabin. At 8·6 miles north of Second Cabin is a fairly strong creek, locally known as Old Kuldo Creek, although it is shown on W. F. Robertson's 1912 map as Alawkish Creek. The Halfway Cabin is to the right of the trail 9 miles north of Second Cabin. Just beyond it are two creeks that join immediately below the trail and 0·1 mile beyond is the "Old Kuldo" camp ground. Here the trail crosses open prairie for 0·3 mile, and the open ground is about ½ mile wide, chiefly to the right of and below the trail. Horsefeed is abundant, both on the slopes below the trail and on meadows that extend from ½ mile to a mile above (west of) the camp. The latter are reached by crossing the small creek, the northerly fork of that just past Halfway Cabin. These meadows were not seen by the writers.

An excellent view of "Pool Canyon" on the Skeena can be had 1·6 miles north of "Old Kuldo" camp. At 2·2 miles north of this camp a creek is crossed. The trail up the north bank of this creek climbs across a talus bank to rise 60 feet, and is based on logs laid slanting uphill. These catch enough fine talus to make a footing. The logs are rotten, and it is a wise precaution to visit this place from "Old Kuldo" camp the evening before moving north and check its condition. Three and a half miles north of Old Kuldo camp, a stream midway between Kuldo and Old Kuldo Creeks in size is crossed. This is Guish or Grift Creek, but is not the creek 4 miles farther north to which the name Guish is applied on the Tatlatui map. One mile past, is a small feed ground good for ten head for one night. One and a half miles past, or 5 miles from Old Kuldo, the Threequarter Cabin is on the right of the trail. One mile past the Threequarter Cabin is a creek locally known as "Willow Grouse" Creek, shown on the Tatlatui map as Willowflat Creek. One-tenth mile farther, or 6·2 miles from Old Kuldo camp, is "First Willow Grouse" camp. The feed ground, although rather swampy here, will feed thirty horses for one night. A second feed ground, about a mile farther along the trail, and below it near the Skeena, is said to be good for fifteen head for one night.

At 8·3 miles and 8·7 miles from "Old Kuldo" camp, or 2·1 and 2·5 miles from "First Willow Grouse" camp, the trail crosses Little Shalatams or Little Cedar Creek, and Big Shalatams or Big Cedar Creek. The former is erroneously named Guish Creek on the Tatlatui map. The latter is crossed by a bridge over a canyon. The bridge is in poor repair, and if it collapses it will be necessary to find a place, probably above the canyon where the walls are less steep, to relocate the trail.

At 10·3 miles from "Old Kuldo", or 4·1 miles from "First Willow Grouse" camp, is Third Cabin. This is a suitable place to camp, and feed is sufficient for thirty horses for 2 nights. "Foot of Poison Mountain" camp is 2·1 miles north of Third Cabin. Its feed ground barely suffices for sixteen head for one night. The water supply is a spring to the right of, and 150 feet below, the trail. This camp is not recommended; its only advantage is that it shortens the next day over Poison Mountain.

About half a mile past this camp, or 2·7 miles north of Third Cabin, the delta of Tschiboytseesa Creek is crossed, and the climb over Poison Mountain begins. This mountain was named from the abundant poison weed, hellebore *(Veratrum viride)*, which is found at many other places along the Telegraph Trail and in the Groundhog basin. The Quarterway Cabin is 3·7 miles from Third Cabin. A mile farther is the top of the flat mountain that extends another 2½ miles. There are several camp grounds on this flat mountain top, the first being just over the brow of the mountain. The feed is chiefly swamp grass.

Halfway Cabin is off the trail to the right, and an extra Threequarter Cabin stands left of the trail 8·4 miles from Third Cabin. Beyond it is O'Dwyer Creek, in which a small patch of quicksand lies in the line of the trail. This can be avoided by bearing upstream. A third of a mile beyond, 8·9 miles from Third Cabin, is "O'Dwyer Cache" camp, where there is enough feed for thirty head for one night. Three-quarters of a mile farther, or 8·9 miles from Third Cabin, is "Totem Flats" camp, which is 0·1 mile north of a pond to the right of the trail. There are feed grounds here and for ¾ mile beyond. A new Threequarterway Cabin is 10·1 miles north of Third Cabin; the old one, at the end of the feed ground, is 10·4 miles north. At 11·3 miles north of Third Cabin, or 2·5 miles from "Totem Flats" Camp, is Canyon Creek.

Less than 0·1 mile south of Canyon Creek, 0·9 mile past the old Threequarterway Cabin, a trail goes west to Nass River, following the valleys of Canyon and Vile Creeks. For the first 2 miles at least it is very steep and rough, and very hard on pack animals.

Canyon Creek, if it is at all high, is the greatest obstacle to travel between Hazelton and the Groundhog area. It must be crossed where it joins the Skeena, and as both it and the Skeena are deep and swift, there is a possibility that horses will be swept into the Skeena and lost. The writers' party strung a telegraph-wire cable across the stream and transferred the packs on a small car hung from it. The horses were 'lined' across at the mouth of the stream. This will probably be necessary at all times except lowest water, and it is wise to carry about 150 feet of rope for this purpose. About ¼ mile above the crossing, men can cross the stream on a log. At very high water it will be safer to follow the trail to the Nass for about a mile to a place where the creek runs over gravel bars and can be forded. There is no cut trail on the north side of Canyon Creek to regain the Telegraph Trail, and, as previously noted, the first part of the trail to the Nass is very steep and rough, so that this detour is not recommended unless absolutely necessary. The best procedure in going north is to erect a brush gate to hold the pack animals at the steep hill just north of the pond before "Totem Flats" camp, to camp at Canyon Creek, and to push the animals back to "Totem Flats" feed grounds.

Fourth Cabin is 3·9 miles north of Canyon Creek. Feed is sufficient in this vicinity for thirty horses for 2 days. "Second Willow Grouse" camp is 1·9 miles farther on, or 5·8 miles from Canyon Creek. The feed grounds here are good, better than any past Old Kuldo but not as good as those to the north at Slamgeesh Lake.

The Quarterway Cabin is on the north side of a creek 4·2 miles past Fourth Cabin, or 2·3 miles beyond "Second Willow Grouse" camp. On the south side of the creek a post marks the commencement of the "Mounted Police Trail", which follows the north bank of the Skeena to the Sustut crossing just above the junction, and thence 10 miles up the Sustut to Birdflat Creek. The Sustut trail joins the network of trails that connect Takla, Bear, and Thudade Lakes. The "Mounted Police Trail" is not known to have been used in recent years, and should probably be termed a route for a trail rather than a trail.

Beyond the Quarterway Cabin the Telegraph Trail climbs the south slope of Babiche Hill for 1·3 miles. The local name of this hill, for which Babiche is a euphemism, gives a false impression, as it is not a difficult climb, and the north slope of Poison Mountain is as steep. On the flat mountain top, crossed by the trail for about 3 miles, are several camp grounds—one, $\frac{1}{4}$ mile past the southern brow of the hill; another, "Gunny Sack" camp, 1·4 miles past; and others close to the northern brow of the hill. The feed at all these is swamp grass, and they are most suitable for emergency camps. The Halfway Cabin is well below the northern brow of the hill, 8·7 miles past Fourth Cabin or 6·8 miles past "Second Willow Grouse" camp. Nine miles from Fourth Cabin the trail reaches the valley bottom of Kilankis River.

Shaslomal Creek is 12·1 miles beyond Fourth Cabin. At the trail crossing, several channels thickly grown with alders make it difficult to follow. At 12·5 miles from Fourth Cabin is "Beaverdam" camp. For the next 7 miles, extensive, good feed grounds occur at many intervals along the trail. Between "Beaverdam" and "Slamgeesh" camps are several bridges that may need repairs. At 14·3 miles from Fourth Cabin, or 12·4 miles from "Second Willow Grouse" camp, is "Slamgeesh" camp. It is on the west side of Kilankis River and $\frac{1}{4}$ mile south of Shilahou Creek, and may be recognized by a very old grave on the north side of the trail at the west edge of the camp ground.

A quarter mile past "Slamgeesh" Camp, Shilahou Creek is crossed. Here are several Indian graves, caches, and a smokehouse. This is the site of the former Indian village, Galanskeast. All these names are variants of the same Indian word meaning fish-spawning ground. Fifth Cabin is 2·8 miles beyond "Slamgeesh" camp, and here, too, feed is available. Just beyond, the trail passes Damshilgwit ("other side of Slamgeesh") Lake, and 4·7 miles from "Slamgeesh" camp it crosses from the southwest to the northeast side of the valley at the divide between Skeena and Nass drainage. The centre of the valley, 5·0 miles from "Slamgeesh" camp, is known as Martins' cabin, although the cabin is now burnt. Here, too, are extensive feed grounds. The trail follows the northeast side of the valley, past Wiminasik Lake, locally known as Damermschwit (Devil's Club) Lake, and Damdochax (Blackwater) Lake. The Halfway Cabin is 11·6 miles, and "Blackwater" camp is 13·2 miles, from "Slamgeesh" camp. The latter is in an open prairie near two Indian cabins. Feed grounds are extensive here, and Damdochax River is the water supply.

Damdochax Lake is the first place along the trail where aircraft can land. The landing used in 1948 was at the north end of the lake, ½ mile back along the trail from "Blackwater" camp.

Half a mile past "Blackwater" camp the trail crosses Sansixmor Creek. The bridge here is out, and the ford is below the bridge. The stream is faster and deeper than it looks, and care should be taken to keep the animals to the upstream side of the bar at the ford. The Groundhog Trail leaves the Telegraph Trail 0·6 mile from "Blackwater" camp, and follows the east bank of Slowmaldo Creek.

TRAILS TO GROUNDHOG COALFIELD

The trail to the Groundhog coalfield from the Telegraph Trail has been little used since 1912, and was very badly choked with windfall. It was cleared by the writers' party in 1948 and is now a fair trail, although boggy in places.

The first camp on the Groundhog Trail is "Six-mile" camp, 4·1 miles from "Blackwater" camp. There is enough feed here for thirty horses for 2 days. Half a mile farther on, "Lonesome" Creek is crossed, and 10·0 miles from "Blackwater" camp is Schluianjap or "Deadfall" Creek. There are several possible camp grounds along the trail, but feed is poor at all until "Big Slide" camp is reached 14·5 miles from "Blackwater" camp. Here the feed grounds are in clearings formed by slides on either side of Slowmaldo Creek. Another possible camp-site is "Blueberry" camp, 15·4 miles from "Blackwater" camp.

A trail branches off to the east at 15·8 miles from "Blackwater" camp, following at first the east fork of Slowmaldo, then Bark Creek, and reaching the Skeena just above its confluence with Duti River. This trail is said to be almost impassable. Within the first mile from the Groundhog Trail are several meadows, which are said to provide feed grounds, so the trail forks is a possible camp-site.

Beyond the east fork of Slowmaldo Creek the trail climbs steeply over Groundhog Pass and then drops down the east fork of Trail Creek. The first camp ground, 6·9 miles from "Big Slide" camp, is ¼ mile above the point where the trail crosses this creek. There are extensive upland feed grounds here. Another camp, 9·3 miles from "Big Slide" camp, or 2·1 miles past the creek crossing, is below and to the left of the trail. The feed is sufficient for sixteen head for one night.

The trail crosses Currier Creek, 12·3 miles from "Big Slide" camp. On either side of Currier Creek, on the west bank of the Skeena, are extensive flats suitable for feed grounds, that to the south being called Jackson Flats, and that to the north of Currier Creek, McEvoy Flats. There are also feed grounds on the east side of the Skeena.

In summary, the distance from Hazelton is:

	Miles
Hazelton to Beirnes' ranch (road)	22·0
Beirnes' ranch to "Blackwater" camp (horse trail)	92·5
"Blackwater" camp to Currier Creek (horse trail)	27·2
	141·7

A second route into the Groundhog area is from Telegraph Creek, over a trail approximately 120 miles long. Telegraph Creek, situated 187 miles up Stikine River, is reached by river boat from Wrangell, Alaska, near the mouth of Stikine River. Leaving Telegraph Creek the trail goes east to Buckley Lake and then follows up Klastline River. Continuing east, it crosses a 3,940-foot summit, then drops down and crosses Klappan River. From the Klappan crossing the trail turns southeast, following up first, Klappan River, and then the Little Klappan, passes over a divide, and then down Didene Creek to Spatsizi River. Here the trail forks; one fork turns south, following up the Spatsizi to the Spatsizi-Skeena divide and then down the Skeena; the other fork continues southeasterly up Kluayetz Creek and finally down Kluatantan River to the Skeena. Many reports say that this is a better route than that between Hazelton and the Groundhog. However, around 1912, when many travelled to the Groundhog field, hardly anyone used the Telegraph Creek trail. This may be explained, in part, by the greater availability of pack-horses at Hazelton than at Telegraph Creek. However, ranching is now carried on around Telegraph Creeek, and horses can be procured there. The difficulty of access to Telegraph Creek is the main drawback for using this route, especially if it is desired to use one's own horses. A more detailed description of this trail is given by W. F. Robertson (28), and Hugh Pattinson (26).

A third route affording access to the Groundhog is from Prince George by way of Ware. From Prince George a road extends 32 miles north to Summit Lake, and from this lake the remaining 350 miles to Ware are covered in 5 days by river boats. The course followed from Summit Lake is down Little Crooked, Pack, and Parsnip Rivers to Finlay Forks, and finally up Finlay River to Ware. From Ware the Groundhog is reached by a trail about the same length as the trail from Hazelton. Leaving Ware, it runs westerly, up Bower Creek, crossing the Finlay south of Fishing Lakes and following Toodoggone River to Caribou Hide on Stikine River. From Caribou Hide, Indian and game trails can be followed to the head of Stikine River and on down Shelhorne Creek to the existing trail in Kluatantan Valley. Pat Cook, packer, who was with the party in 1948, and who has travelled extensively in northern British Columbia, considers that this trail is in better condition and passes through more open country than the trail from Hazelton. Hugh Pattinson (27) used this trail in 1943, and he reports that there is not much difference between it and the Telegraph Creek trail that he used in 1942. Because of the long boat trip, Ware is rather difficult of access, particularly if one's own horses are to be used. J. O. Davidson, a packer who is very familiar with this country, has a string of pack-horses that can be rented at Ware. It is reported that he winters the horses in the Spatsizi country in the vicinity of Hyland Post.

Fort St. James is the starting point of a fourth, northwesterly trending route into the Groundhog. Takla Landing, 100 miles northwest of Fort St. James, can be reached by water or by land; a weekly boat service is maintained between Fort St. James and Takla Landing by David Hoy, who handles mail, passengers, and freight; the land route first follows a road connecting Fort St. James to Germansen Landing about 100 miles to the north, then west for 30 miles along a good trail to Old Hogem, and lastly by a truck road for another 30 miles to Takla Landing. From Takla Landing a trail continues northwesterly up Driftwood River, along Bear Lake, and down Bear River to Sustut River, crossing this river close to the mouth of Birdflat Creek. It then proceeds northerly up Birdflat Creek and over South Pass to the southwest end of Thutade Lake where it turns west, passes close to the south end of Tatlatui Lake, and on down Malloch Creek to Duti River, which it crosses and follows down for a short distance to Tzahny Creek. Here the trail turns west up Tzahny Creek to Tzahny and Kluatantan Lakes, and finally joins the main trail in Kluatantan Valley. According to C. S. Lord, this route passes close enough to the wet belt so that thick underbrush and frequent muddy stretches would probably make it as poor a trail as the Telegraph Trail from Hazelton. Excluding the trip from Fort St. James to Takla Landing, this route is still about 15 miles longer than the Telegraph Trail. Other disadvantages of this trail are the crossing of Sutsut River, especially in the spring at high water, and the climbing of three passes—South Pass, that between Thutade and Tatlatui Lakes, and that between Tatlatui Lake and the head of Malloch Creek.

The fifth route commences at tide-water at the town of Stewart. This route has been reported as being only 90 miles long, but that mileage is based on the straight-line distance from Stewart to the southern edge of the Groundhog coalfield, whereas the actual trail distance over this route would be at least 115 miles. From Stewart the trail follows up Bear River to its head, over a low pass (2,031 feet) occupied by glaciers, and down Strohn Creek to Meziadin Lake. Leaving this lake it goes up Nass River, joining the Telegraph Trail at a point near Sixth Cabin, and following it up Nass River to Muckaboo Creek, then up the Nass to Panorama Creek. From here two routes lead into the Groundhog: one route follows up Panorama Creek, over a low pass, and down Currier Creek to the Skeena; the other route leads up Anthony Creek, over a slightly higher pass than the first route, and down Beirnes Creek to the Skeena. T. H. Taylor mentions this route in his 1913 report and adds: "A good trail was cut this summer between Anthony Creek and the bridge (where the Telegraph Trail crosses the Nass just above its junction with Muckaboo Creek) and I understand the greater part has been cut from Stewart towards the bridge. It is intended to complete this trail next summer." In 1927 and 1928, P. M. Monckton worked from Meziadin Lake north to Bowser Lake, but he does not mention this trail, although he does state: " . . . . . found the country hard to travel through owing to dense underbrush and the difficulty of crossing the streams, which are high and rapid during the summer months". No other reference to this route could be found, so it is uncertain whether the trail was ever completed. If it was completed, it has not been much used and would probably be in a very bad state of repair.