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DEPARTMENT OF MINES

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY

W. H. COLLINS, DIRECTOR

Summary Report, 1927, Part A

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F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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DEZADEASH LAKE AREA, YUKON

By W. E. Cockfield

CONTENTS

Illustration

INTRODUCTION

During the summer of 1927, exploratory work was done in the region lying between Kusawa and Dezadeash lakes. The area lies between latitudes 60° and 60°45′ and longitudes 136°00′ and 137°15′. The town of Champagne is a suitable base for the western part of the district. From Champagne the Dalton trail leads to Haines on the Alaskan coast, and crosses the western part of the area. This trail is still in fair condition for pack animals, although blocked to some extent by windfalls. All points on Dezadeash lake may also be reached from Champagne by ascending Dezadeash river, which is fairly deep, and, with the exception of a number of minor riffles, for the most part sluggish, so that it offers no serious obstacles to the use of poling boats, or boats equipped with small outboard motors. The lake, on the other hand, is usually very rough, and for long periods at a time cannot be crossed in safety by the ordinary light-draught river boats.

Kusawa lake (better known in the district as Arkell lake) may be reached from Whitehorse by descending Lewes river and ascending Takhini river. This route is easily navigable for steamers and shallow-draught boats of good power to a point about 4 miles above Mendenhall landing. At this point occurs a rapid, several chains long, with a considerable drop, and obstructed by numerous boulders. Small boats may be taken up and down by lining. From this rapid to the lake the river is continuously swift, with a number of very fast riffles or rapids. Boats with good power may ascend all except the swiftest water, where lining is necessary. On the whole there is sufficient water for navigation by small boats. A trail also leads from the Whitehorse-Kluane wagon road at Mendenhall landing, to the northern end of Kusawa lake, and pack animals may be taken south along the western shore of the lake for about half its length; beyond that point the shores are bordered by steep, rocky walls which render the use of pack animals impossible. A poorly defined trail leads from the central part of Kusawa lake by way of Frederick lake to the Dalton trail at Kluhini River crossing. This trail, although practicable for foot travel, is impassable for pack animals by reason of swamps and rock bluffs at the head of Frederick lake. Kusawa lake, like Dezadeash lake, is subject to violent windstorms. However, they are not so continuous, and with care, small boats may be used on the lake in comparative safety.

As no base map of sufficient accuracy existed, a survey was conducted in the district, to outline the major features of drainage and topography. No attempt was made to map the area as a whole. Narrow stretches along readily accessible routes of travel were mapped, so as to obtain, in a minimum time, as much information as possible regarding geology and topography of the district. The writer was ably assisted in this work by Messrs. N. T. Ellis, E. J. Lees, and E. A. Goranson. Mr. Ellis took charge of the party during the writer's absence on investigations of mineral properties lying outside the district.

TOPOGRAPHY

The area is on the western flank of the Coast range and in consequence is for the most part rugged. Ragged and needle-like peaks, typical of the Coast range, are well developed. The mountains west of the Coast range, using this term as meaning the terrain underlain principally by the granitic rocks of the Coast Range batholith, are fully as high as the Coast range. One or more ranges occupy the region between the Coast range and St. Elias mountains. The mountains of this range or ranges attain altitudes of about 7,000 feet, and hold many glaciers. They appear to be formed largely of folded sedimentary rocks.

One of the main features of the district is the number of large lakes. Of these the largest are Kusawa, Dezadeash, and Frederick. Kusawa lake occupies a somewhat zigzag valley, having, however, a general north-south trend. The central part of the lake is in a transverse valley having a northwest-southeast trend, and continuing beyond the lake to the northwest to Shawak valley, being occupied in turn by Frederick lake, part of Dezadeash lake, part of Kathleen lake, and lake Kluane. From this valley to the north end of the lake, terraces or benches of gravel and sand are common on one side of the lake or the other. They are, however, most commonly to be found on the western side of the lake, the other side being occupied for the most part by a steep, rocky wall. At the foot of the lake, these terraces are cut through by Takhini river, which is evidently lowering its channel at this point relatively quickly. The water flowing from the lake is quite clear, but it quickly picks up a load of sediment, and is turbid before reaching Mendenhall landing, 11 miles below. This stretch of Takhini river flows in a north-south depression, but soon enters a wide east-west valley, having a much lower grade. The river on entering this valley flows east, and save for occasional riffles, the greater part of the stretch from Mendenhall landing to the mouth is comparatively slack water. The southern end of Kusawa lake lies in a steep-walled, U-shaped depression; at the northern end the valley is more open, and the hills lower.

Dezadeash lake occupies a broad valley bordered by low hills to the east, and south of Shawak valley by a high range to the west, to which the name Dezadeash mountains has been applied. The lake is drained by Dezadeash river which flows north through a broad valley for some miles, to where, by a narrow U-shaped valley at mount Bratnober, it enters a continuation of the depression followed by Takhini river, but turns west, and flows into Alsek river. The height of land between Yukon and Alsek drainage in this valley is very low, the divide between the waters of the two rivers being probably less than 300 feet high, and formed by sand hills. Dezadeash river between the lake and Champagne is bordered for the greater part of the distance by swampy flats, with numerous lakes representing cut-off meanders.

Shawak valley is a wide depression extending southeastward from lake Kluane to Dezadeash lake, from where a valley continues in the same line to Kusawa lake. As has been pointed out, Shawak valley contains parts of some of the larger lakes of southwestern Yukon, and the divide between the drainage of this valley and the drainage directly to the Alsek by way of Klukshu lake and Klukshu river, and Tatshenshini river, and also by way of Alder creek, Bates and Mush lakes, and Tatshenshini river, is very low. The view was put forward by Brooks[1] that this valley formerly carried the drainage from Upper White river to the sea by way of Tatshenshini and Alsek rivers. Although Cairnes[2] has shown that so far as White river is concerned this course is impossible, it nevertheless is evident that Shawak valley was, previous to the Glacial epoch, the line of one of the main drainage features of the district. That there have been changes in drainage is evidenced in part by the sudden lowering in grade of Takhini river on entering the east-west valley which carries it to the Lewes; the gradual steepening in grade of Dezadeash river on entering the same valley; the broad Shawak valley, occupied in part by large lakes, and in part by small streams; and the high gravel and silt benches along parts of Kusawa lake, Dezadeash lake, Takhini, Dezadeash, and Kluhini rivers. There are not, however, sufficient data at hand to permit of outlining the preglacial drainage.

GENERAL GEOLOGY

The rocks of Dezadeash Lake area include sedimentary, igneous, and metamorphic types, ranging in age from Precambrian to Tertiary. The oldest rocks are represented by a group of schists and gneisses, thought to belong to the Yukon group, which is considered Precambrian. Following these is a thick series of argillites, presumably Palæozoic, and some volcanics tentatively classed with the 'Older Volcanics' of about Jurassic age. The Coast Range Intrusives form an extensive terrain, and cut all the formations listed above. No new evidence was obtained in Dezadeash Lake area as to the age of the intrusives. The youngest consolidated rocks of the district are dykes and small masses of quartz porphyry and granite porphyry. Overlying the rock of most of the valley bottoms, and much of the side hills and uplands, is a mantle of superficial deposits, including sand and gravel, silt, boulder clay, and talus.

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[1]Brooks, A. H.: U.S. Geol. Surv., 21st Ann. Rept., pt. 2, pp. 354–355 (1900).
[2]Cairnes, D. D.: Geol. Surv., Canada, "Upper White River District"; Mem. 50, pp. 60–62 (1915).

DESCRIPTIONS OF FORMATIONS

Yukon Group. The rocks of this group are extensively developed in Dezadeash Lake area. They are all schistose or gneissoid, and include mica, hornblende, and chlorite schists, granite-gneiss, and crystalline limestone. The mica schists are grey, medium grained, and with a pronounced development of mica on the planes of schistosity. They consist of quartz and mica, with subordinate feldspar and chlorite. The proportion of quartz to mica varies widely in different specimens; ranging from types in which mica is abundantly developed to others in which the mica is rather sparse, and which approach quartzites in composition. The quartz grains are usually intergrown. The mica is arranged in parallel bands that occasionally show intense plication even in a hand specimen, sweeping in a series of curves through the specimen.

The chlorite schists are bright green to grey rocks with pronounced foliation, and a glistening appearance on a freshly broken surface. They consist of varying amounts of chlorite, biotite, and hornblende, with laths of feldspar, and minor amounts of magnetite.

The hornblende schists are dark greenish rocks more massive in appearance than the chlorite schists, but still with pronounced foliation. They consist largely of hornblende and feldspar, with minor amounts of chlorite and magnetite.

The granite-gneiss is grey to pink, with characteristic gneissoid texture, and at many localities with an abundant development of crystals of feldspar forming an augen gneiss. It consists essentially of quartz, orthoclase, plagioclase feldspar, biotite or hornblende or both, and micropegmatite. The quartz and feldspar in some cases show granulation, but in most cases the quartz grains are intergrown, with a sutured texture. Mica when present is arranged in parallel bands. In some specimens the individual leaves of mica show bending or crushing against an individual of quartz or feldspar.

Crystalline limestone is not abundantly developed in Dezadeash Lake area, being most common on the hills east of Frederick creek, where it is associated with other members of the schist group. There is also a narrow band in the schists east of the foot of Sixmile lake. The limestone is white to brown, and more or less impure, being usually quite siliceous. Practically all traces of the original bedding have been destroyed.

On the basis of their lithological characters, and from the fact that they are the oldest rocks of the district, these rocks are tentatively classified with the Yukon group. The rocks of this group have been variously classed as pre-Ordovician, pre-Devonian, and so forth, according to the age of the oldest overlying strata in different districts, but Cairnes[1] has offered evidence to show that all developments of the Yukon group are, in all probability, Precambrian.

It is evident that they include sediments and igneous intrusions into those sediments, but it is almost impossible to unravel the original succession.

[1]Cairnes, D. D.: "Yukon-Alaska International Boundary"; Geol. Surv., Canada, Mem. 67, pp. 40–44 (1914).

Palæozoic (?) Argillites. The argillites are dark, coarsely bedded rocks seldom strongly cleaved, but in some instances considerable mica has developed and they pass into schists. A number of greyish quartzitic bands occur, and also occasional conglomeratic phases. No limestone beds were noted in the series. A similar group occurs to the southeast in Rainy Hollow district, but contains metamorphosed limestone beds.

The argillites nearly everywhere are highly inclined, the angles of dip ranging from 50 to 85 degrees. The best section of these beds seen was along part of the western shore of Dezadeash lake and west up the valley of Alder creek. Here the beds are inclined uniformly at about 85 degrees, and unless it be assumed that there has been repetition by faulting or isoclinal folding, as seems likely, a tremendous thickness is represented. Evidences of faulting were noted along some of the tributaries to Alder creek near the granitic intrusion in that locality.

No fossils were found in this group. The rocks apparently overlie the Yukon schists, and are cut by the granitic intrusives. In the limestones and argillites of Rainy Hollow district no fossils were obtained, but McConnell reported that from a group apparently belonging to the same series south of the International Boundary, specimens of a Carboniferous fauna had been obtained. Tyrrell reported finding specimens of *Bythotrephis* from dark calcareous shales along Unahini river, 7 miles north of Dalton post. Some confusion exists as to this locality, as the name Unahini is applied to different streams on different maps. It is believed, however, that the locality referred to is the stream named Klukshu river on the writer's map, and consequently that the rocks from which the fossils were obtained are included in the series under discussion. The specimens were referred by Ami to the Lower Palæozoic. The evidence as to age is, therefore, somewhat contradictory, or else rocks ranging in age from Ordovician to Carboniferous are present.

"Older Volcanics". These rocks have only a limited development in Dezadeash Lake area, occurring in a mass at the southern end of the area along the Yukon-British Columbia boundary line. At this point they have been highly altered by a nearby granite intrusion. Elsewhere they occur as dykes.

The rocks are green to black, with a texture ranging from aphanitic to porphyritic. Unaltered specimens consist mainly of hornblende or pyroxene, and plagioclase feldspar. Specimens from the area near the interprovincial boundary are almost entirely altered to serpentine and magnetite.

These rocks are cut by the granitic intrusives. Beyond this fact no other data as to their age were obtained. Because of their similarity to rocks that elsewhere in Yukon have been grouped as the "Older Volcanics" they are provisionally placed in this group, which is probably of Jurassic age. The altered rocks in the vicinity of the boundary present somewhat of a problem. It is quite possible that they should be correlated with somewhat similar rocks in southern Yukon and northern British Columbia known as the "Gold series" and probably of later Palæozoic age, but as this correlation is somewhat in doubt, the writer prefers for the present to class them with the porphyrites of Dezadeash district.

Coast Range Intrusives. The rocks of this group, considering their areal extent and their importance as possible ore bringers, constitute one of the major geological features of Dezadeash Lake area. The district includes the western edge of the Coast Range batholith, and consequently considerable areas are underlain by granitic rocks. In Kusawa Lake section, granitic rocks underlie practically the whole area except for a few curtains of schist. To the west, in Dezadeash valley, the main boundary of the batholith crosses the valley twice, and swings to the southeast towards the head of Tatshenshini river. West of this boundary, the rocks are chiefly schists and argillites.

The Coast Range granites are typically grey to pink, coarsely textured, and composed of quartz, feldspar, and mica, or hornblende, or both. The typical rock belongs to the class of monzonites and granodiorites, but more acid and more basic varieties occur, including dark types rich in ferromagnesian minerals and porphyritic types with large crystals of pink feldspar.

The western contact of the batholith is usually obscured by drift and float accumulations. At those points where the contact could actually be seen, the observed dip of the contact is steep, but the general irregular course of the contact and the widespread development of contact minerals, such as garnet in the schists, seem to indicate that the contact in general is gently sloping. The effects of metamorphism on the intruded rocks is a difficult problem, as the bordering rocks nearly everywhere are schist. It is not known what part of the metamorphism is due to the injection of the batholith, and what part is regional metamorphism. Garnet is abundant in the schists at some localities, particularly in the vicinity of the contacts, and its occurrence at these places is regarded as a phenomenon of contact metamorphism.

Pegmatite dykes occur, but are by no means common.

No new evidence with respect to the age of the batholith was obtained. The granitic rocks cut all the consolidated rock formations except a few dykes and small masses of granite porphyry and quartz porphyry. The evidence obtained to date in Yukon indicates that the granite is more recent than the lower part of the middle Jurassic and older than certain Tertiary rocks. Beyond this the age is not as yet fixed.

Quartz Porphyry and Granite Porphyry. These rocks are the youngest consolidated rocks of the district. They occur chiefly as dykes and small masses.

Typically they are light coloured, weathering either red or yellow, so that they are conspicuous for long distances and may lead the prospector to believe that they are the weathered outcrops of veins. The coloration, however, is due to the oxidation of pyrite which nearly everywhere is a primary constituent of the rocks. Almost all these rocks are porphyritic, although fine-grained or aphanitic varieties occur. They have in most cases a white to yellow groundmass in which lie occasional crystals of quartz, feldspar, or mica.

These rocks cut the granitic intrusives. In other parts of the Yukon, they are referred to the late Tertiary or early Pleistocene.

Overlying all the consolidated rock formations is a mantle of superficial deposits. This covers most of the floors of the valleys, and also much of the valley walls and upland surface. It consists chiefly of sand and gravel, silt, boulder clay, talus, and rock rubble.

ECONOMIC GEOLOGY

No mineral deposits are being worked within the region mapped. This is not surprising since little or no prospecting has been done, and such as has been done has mostly been a search for placer gold. The district lies along the western edge of the Coast Range batholith, and for that reason, should be considered as favourable ground for the prospector. It is not far removed from Rainy Hollow district where copper-gold deposits are known, and Rainy Hollow district is also situated on the western margin of the Coast Range batholith. In addition to the Rainy Hollow deposits, bodies of galena and chalcopyrite are reported to occur some 30 miles south of the interprovincial boundary. Specimens of ore from these bodies were shown to the writer by the Indians at Dalton post, but time did not permit of making an examination of the locality.

The only deposit which, to the writer's knowledge, has been worked in the area, is a deposit of placer gold on Shorty creek, flowing into the head of Dezadeash lake. According to reports, an attempt was made to work this some years ago, and a minor amount of gold was obtained; but the attempted operations were on a large scale, and the result was a financial catastrophe.

Towards the close of the field season, some excitement was caused by Indians reporting placer gold on Squaw creek. Very little information was available, and the lateness of the season precluded making a visit to the locality. Squaw creek enters Tatshenshini river about 4 miles below Dalton post. This creek, according to report, rises in British Columbia. Staking took place on both sides of the boundary line; practically all the staking was done by Indians. The creek is reported to rise from a glacier, to have a steep gradient, and a large number of big boulders in its bed. The discovery was made at a bend in the stream, where the depth to bedrock is reported to be 6 to 8 feet. A small amount of gold, 11 ounces 12 pennyweights, was brought to Whitehorse from the Discovery claim. The gold is prevailingly coarse with a rough surface, and, quite evidently, comes from close to its point of origin. The gold is coated black.

Coal has also been reported to occur on Squaw creek.

SILVER-LEAD DEPOSITS OF FIFTEENMILE CREEK, YUKON

By W. E. Cockfield

INTRODUCTION

Considerable interest was aroused in Yukon by the staking during the winter of 1926 of a number of claims on Yukon river in the vicinity of Fifteenmile creek, 25 miles below Dawson. High values in silver and lead were obtained from some float found on the river bank, and as the occurrence is favourably situated with regard to transportation, the writer was instructed to visit it.

There are three distinct locations: the upper is about a mile below the mouth of Fifteenmile creek; the middle about 6 miles below the upper, opposite the mouth of Roal creek; and the lower about 5 or 6 miles farther down the river, opposite the mouth of Cassiar creek. The upper locations, in the vicinity of Fifteenmile creek, are re-locations of claims staked a number of years previous, but allowed to lapse.

GENERAL GEOLOGY

The geological conditions at all three localities are similar. The greater part of the bedrock of the district is schist, in large part quartz-mica schists of the Nasina series[1], but including also mashed diabases similar to the Moosehide diabase[2]. The schists include numerous bands of limestone and dolomite. These bands are usually discontinuous, and can be traced only for short distances along their strike. The schists are highly disturbed and evidence of faulting is marked. Intrusive into the schists are dykes of porphyrite.

MINERAL DEPOSITS

The ore deposits are with one exception confined to the bands of limestone or dolomite. The ore minerals, chiefly galena and zinc blende, but with some chalcopyrite and its oxidation products, azurite and malachite, occur as disseminations in the calcareous bands, or in small quartz stringers cutting these bands. The mineralization is scanty, and although high assays may be obtained from picked samples, it is believed that samples taken over reasonable mining widths would show low values.

Very little recent development work has been done. In most cases only short open-cuts have been driven. On the Camp Bird claim, float on the beach of the river has been traced up the slope to the deposit in place. From the talus, which has undergone a rough concentration by nature, a shipment of 5 tons of hand-sorted ore was made.

[1]McConnell, R. G.: "Report on the Klondike Gold Fields"; Geol. Surv., Canada, Ann. Rept., vol. XIV, pt. B, pp. 12–15 (1905).

[2]Idem., pp. 22–23.

LOCALITIES

Cassiar Creek. A deposit occurs about 2 miles above the mouth of Cassiar creek, on the right, or eastern bank of Yukon river. The outcrop is below mean water-level of the river, and only visible at certain seasons of the year. At this point lenses of limestone are extremely abundant in the schists, and one of these lenses carries galena and zinc blende in streaks and small masses. The streaks of galena apparently are short, and in most places the limestone is barren. The widest streak noted by those working the property measured about 8 inches and consisted of galena disseminated in limestone. An open-cut has been run along the strike of the limestone, and encountered three of these streaks, but they apparently pinched out in a few feet, for the writer could find no mineral in the walls and floor of the open-cut. A grab sample was taken of the material that had been removed from the cut. This included, however, only material that showed some galena. This was assayed and yielded 4·5 ounces of silver to the ton and 10·04 per cent lead.

Roal Creek. The occurrences at this locality are on the eastern bank of Yukon river, opposite the mouth of Roal creek. There are in all twelve claims, and they are the property of Louis Roal, P. Rost, and E. Chapman. At the upper workings, the country rock consists of schist cut by a porphyrite dyke. The schist contains beds and bands of limestone. A limy bed in the schist is partly replaced by disseminated galena and zinc blende. This bed is about 8 inches thick. The mineralization is rather scanty.

At the lower workings the country rock is schist with serpentine rock (Moosehide diabase) and a bed or replacement of dolomite. The dolomite in places carries considerable mariposite and is there a bright green. A short tunnel has been driven into the schist at this point, but does not penetrate to the dolomite-mariposite bed. There are no minerals of economic value visible at this point.

Fifteenmile Creek. At the upper discovery, namely near Fifteenmile creek, upwards of sixty claims have been staked, but by far the greater number have no mineral showings, and little has been done on them in the way of assessment work. The three principal claims lie along the beach of Yukon river, at the bend below the mouth of Fifteenmile creek. These are the Camp Bird, Yukon Chief, and Yukon Maid, owned and worked by P. Rost. From the Camp Bird, a shipment has been made of five tons of material that occurred as float on the beach.

The chief showing on the Camp Bird is somewhat similar to occurrences already described. Lenses of dolomite occur in the schist. These lenses have been highly faulted, and are difficult to follow for any distance. The dolomite contains seams of galena and zinc blende, with subordinate chalcopyrite, malachite, and azurite. These seams range in thickness from less than 1 inch up to about 8 inches, but, as a whole, the mineralization is scanty. Picked samples of the float on the beach have yielded high assay values, ranging from 200 to 500 ounces of silver to the ton, but it is doubtful if the deposits would average more than a few ounces over a reasonable mining width.

On the Crystal claim, lying east of the Camp Bird, and 700 feet in elevation above the river, the deposit varies from the type. The mineralization is confined to stringers of quartz that cut the schists. The stringers range from an inch to two in thickness up to 8 inches, and are sparsely mineralized with specks of galena and chalcopyrite.

GENESIS

There is, in the district, no known intrusive mass of sufficient size to cause the widespread mineralization in the schist. Disseminations of sulphides are common in many areas of crystalline schists and in certain cases their present manner of distribution may be attributed to regional metamorphism regardless of how the sulphides were originally introduced. Many such disseminations occur in the schists of Yukon, but in all known cases, the processes of concentration have not proceeded far enough to form workable ore deposits.

These deposits along the Yukon also have meagre mineralization, so that it is doubtful if mining could be made to pay.

SILVER-LEAD DEPOSITS OF RUDE CREEK, YUKON

By W. E. Cockfield

INTRODUCTION

Attention was first attracted to Rude creek as a placer gold camp in 1915, and the creek was worked to some extent in the spring and summer of 1916, but on most of the claims gold was not found in paying quantities, and after a short time most of the claims were abandoned. At that time an outcrop of galena was known on the creek, but it attracted little attention and was not staked until some years later.

Rude creek is about 5 miles long, has a steep gradient, and is a tributary of Dip creek, which in turn flows into Klotassin river. Rude creek lies some 15 miles west of Yukon river, and is reached by means of a trail from Isaac Creek landing, the distance by this trail to the workings being about 18 miles. The trail is mostly in rather poor condition for anything except travel afoot, and large stretches would require rebuilding before supplies could be hauled in or ore hauled out.

GENERAL GEOLOGY

The district was examined in 1916 by Cairnes[1] and the general geology may be summarized from his report as follows.

The oldest rocks of the district are schistose or gneissoid, and belong to the Yukon group, thought to be Precambrian. They consist of mica schists and gneisses, quartz-mica schists and gneisses, schistose and gneissoid quartzites, phyllites, and bands of crystalline limestone.

More recent than the members of the Yukon group are some andesitic volcanics, thought to be contemporaneous with the 'Older Volcanics' of Upper White River district. These have a limited development and are mainly andesites, basalts, and related types.

The most extensively developed rocks are granitic rocks, which form a batholith that was explored for a length of 50 miles without reaching either end, and has a width of from 15 to 20 miles. The rocks of this batholith range from granite to diorite, with accompanying porphyritic phases. Their age was not determined. They present, however, such striking similarities to the Coast Range Intrusives, that it was thought that they may be an outlying or subjacent part of the Coast Range batholith.

More recent than the granitic intrusives is a group of rocks corresponding to the 'Newer Volcanics' of Upper White River district. These are mainly andesites and basalts.

The most recent rocks are dykes of rhyolite, granite porphyry, and related volcanics.

[1]Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept., 1916, pp. 20–33.

The upper part of Rude creek, on which the silver-lead property occurs, lies wholly within the granite. The closest point at which rocks of the Yukon group occur is near the mouth of Rude creek.

CLAIMS

About twenty-five claims and fractions have been staked around the discovery. A group of eight claims, including the Discovery, has been optioned to C. U. Stuart of Boston, Mass., for a period of three years from March 30, 1927. The greater number of the outlying claims are also under option to Mr. Stuart.

Three cabins are on the claims and are sufficient to provide accommodation for a small crew.

ORE DEPOSIT

The ore-body consists of a replacement of granite by galena and other minerals along a small fissure in the granite. This fissure is somewhat irregular in its trend. The granite bordering the fissure is leached to varying distances, and minerals have been deposited in it to varying distances from the fissure, but in no observed case at a greater distance than 40 inches. Movement along the fissure apparently has been relatively slight, and the fissure has the appearance of a short and somewhat irregular contraction crack, formed at the time of cooling of the granitic mass.

The mineralization consists mainly of galena and zinc blende, with pyrite and carbonates of lead and iron. A small amount of black stain believed to be manganese oxide, and derived possibly from manganiferous siderite, coats much of the granite adjacent to the fissure. A section across the "vein" at its widest part is as follows:

	Inches
Galena, with some carbonates	4 to 4½
Leached granite with disseminated galena and streaks of galena	6
Leached granite with manganese (?) stain and some carbonates	30

The writer took three samples from the open pit: No. 1 being of the 4 inches next to the hanging wall; No. 2 of the next 6 inches, showing some galena mineralization; and No. 3 of the remaining 30 inches of the vein. These were assayed with the following results:

Sample No.	Gold, ozs. per ton	Silver, ozs. per ton	Lead, per cent
1	0·01	122·46	37·16
2	none	73·78	15·55
3	none	2·43	0·79

It is apparent that there is a streak of good ore 4 inches wide, a streak of fair ore 6 inches wide, and that the balance of the "vein" is practically barren.

The "vein" outcrops at the level of the creek bed, and the stream has been diverted by a bedrock drain. A pit has been sunk 8 feet on the deposit. On the west side of the pit, an adit 72 feet long has been driven westerly, with, at 49 feet, a crosscut to the south approximately 18 feet long. The deposit does not show in this underground work for more than a few feet beyond the portal. No fault was observed that would tend to throw the deposit to one side or the other of the adit. The only part of the vein found in the workings was concealed in the floor at the time of the writer's visit, but from descriptions it is evident that the vein pinched out within one set from the portal of the adit. The underground work has, therefore, been entirely wasted.

In the other direction, i.e., eastward from the portal of the adit, there is the lens 40 inches wide with a well-defined hanging-wall, and indefinite foot-wall, but this body pinches out on the floor of the pit towards the rock drain. The showing thus consists of a mineralized lens 12 to 14 feet long, with a maximum width of 40 inches, and a dip of 45 degrees to the south. As such lenses have in general a depth somewhat in relation to their length, it is safe to assume that the amount of ore in the lens does not exceed 5 tons, with an average content of 93 ounces of silver, and 24 per cent lead. This estimate excludes the greater part of the width of the lens because sampling revealed practically no values thereon.

There is not sufficient ore in sight or promise of sufficient ore to justify serious consideration of this property as a producer. Such deposits, however, are sometimes of importance in indicating the presence nearby of other, larger bodies. The writer, therefore, carefully examined the float in the creek, the old placer dumps, and the placer concentrates of the only placer claim working on the creek. A small amount of galena float has been found at various times on the creek, and also in the placer workings, but the quantity is not sufficient to justify the hope that large deposits of galena border Rude creek. In a region such as Rude creek, which has not been glaciated, galena float should be of common occurrence if large deposits of this mineral occurred in the vicinity, but this was not found to be the case. The writer was, therefore, forced to conclude that the chances were decidedly against the finding of large deposits of galena on Rude creek.

PUEBLO, TAMARACK-CARLISLE, AND WAR EAGLE-LEROI PROPERTIES, WHITEHORSE COPPER BELT, YUKON

By W. E. Cockfield

INTRODUCTION

Richmond Yukon Company, Limited, was engaged in 1927 in prospecting the Pueblo, Tamarack-Carlisle, and War Eagle-LeRoi groups in the Whitehorse copper belt. These groups are from 4 to 6 miles by road from Whitehorse. The Pueblo and Tamarack-Carlisle are owned by Richmond Yukon Company, and the War Eagle-LeRoi is under option, the price to be paid as a royalty on production.

Claims were staked in the Whitehorse Copper belt during the time of the Klondike gold rush in 1898 and 1899, and were prospected during the next few years. Some of the properties were operated at different times up to about the year 1920 or 1921. In most cases where continuous mining was attempted, the operations resulted in a heavy financial loss due to chiefly, perhaps, two causes: first, the deposits are of the type known as contact metamorphic, a type in which lenses and irregular bunches are common, but in which, frequently, the individual ore-bodies are entirely independent of one another, thus entailing the expenditure of large sums in the search for ore-bodies, particularly where this is done by means of underground workings such as drifts and crosscuts; and, second, few of the mines ever had in sight at one time sufficiently large ore-bodies to justify the erection of a concentrating plant; crude ore, therefore, had to be shipped at freight rates not greatly differing from what concentrates would have borne.

The chief shippers of the camp to date have been the Pueblo, Copper King, Grafter, and Valerie.

The Pueblo was the largest producer and shipped in the neighbourhood of 140,000 tons of ore. Following a cave-in, the mine was shut down, but was subsequently reopened, and in the opinion of the management at that time, all the ore that was extractable was removed. The Pueblo venture resulted in a heavy financial loss, which was, to a large extent, due to the cost of pumping and timbering. The mine was wet, making from 500 to 600 gallons of water a minute, and some of the ground was soft and difficult to hold. Pumping was done by steam power, using wood as fuel, and the power cost was consequently high.

The War Eagle and Carlisle groups were operated only in a small way, and the shipments from them did not exceed a few thousand tons.

GENERAL GEOLOGY

In 1906 the district was examined by McConnell[1] whose report is still the authoritative work on the district. The following brief summary from this report gives the essential facts with regard to the geology and ore deposits.

The rock formations, in order of age, consist of limestone, porphyrite, granite, and granodiorite, porphyrite dykes, and basalt. Of these only the limestone and the granitic rocks are economically important. The principal ore-bodies occur in the limestone close to or adjoining the granitic contacts, but discoveries have also been made in the granitic rocks at considerable distances from the limestone. Copper minerals have also been found in the porphyrites, but such occurrences have not proved of economic value.

ORE DEPOSITS

The principal copper minerals are bornite and chalcopyrite. Tetrahedrite and chalcocite occur, and minerals resulting from the oxidation of the sulphides, such as the carbonates, malachite and azurite, the silicate, chrysocolla, and the oxides, cuprite and malaconite, are prominent but are seldom important as ores except at the Pueblo. Cuprite is occasionally associated with grains of native copper.

The iron sulphides, pyrite and pyrrhotite, are not abundant. The iron oxides, magnetite and hematite, occur in large masses. Magnetite is rarely absent from the mineralized areas, and occurs in lenses from a few inches up to 360 feet in length. Hematite is less common, but is the principal mineral in the Pueblo lode.

Other metallic minerals of lesser importance are: arsenopyrite, stibnite, sphalerite, and molybdenite. Gold and silver occur in small quantities and both are occasionally found native.

The principal non-metallic minerals are garnet, augite, tremolite,[2] actinolite, epidote, calcite, clinochlore, serpentine, and quartz. Of these, garnet augite, epidote, calcite, and tremolite (wollastonite?) are the most abundant.

The ore-bodies fall into two classes: those in which the copper minerals are associated with magnetite and hematite; and those in which the gangue consists chiefly of the silicate minerals.

The Whitehorse deposits possess all the characteristics of contact metamorphic deposits and are unhesitatingly referred to that class. The location of the ore-bodies, and their constituent minerals leave little doubt as to the correct classification of the ore deposits. Bodies of this type are apt to be irregular and bunchy, a condition which has been borne out by many of the Whitehorse deposits and which undoubtedly adds considerably to the cost of mining.

The work of Richmond Yukon Company to date has been largely of the nature of prospecting with the diamond drill, the aim of the company,

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[1] McConnell, R. G.: "Whitehorse Copper Belt"; Geol. Surv., Canada, 1909.
[2] McConnell lists tremolite as one of the gangue minerals of the deposits. It seems probable that this s a mistaken identification for wollastonite.

apparently, being before planning any elaborate scheme of development work to establish whether or not there is sufficient ore on its properties to justify the erection of a concentrator. The field work latterly has been under the able direction of T. H. Kerruish, who has had experience in several of the Whitehorse properties and is fully conversant with the problems and difficulties attending their successful exploitation.

On the Pueblo, eleven holes, Nos. 1 to 10 and No. 21, have been drilled west of the old workings. The cores of these holes were not available for inspection to the writer, but from information supplied it is understood that holes Nos. 1, 5, 6, and 21 encountered ore at depths varying from 250 to 300 feet. Hole No. 1 is reported to have encountered 23 feet of cuprite ore at a depth of 250 feet; hole No. 5, 16 feet of ore; and hole No. 6, 14 feet of ore at depths of about 300 feet. Hole No. 21 encountered ore at 61 and 331 feet. The data furnished by these holes are not sufficient to permit calculating the strike, dip, and thickness of the ore-bodies encountered. As some of the holes are blanks it is evident that further drilling, or development work, must be done before any satisfactory calculation of tonnage can be made. Nevertheless, an ore-body lying west of the old workings is indicated.

North of the old workings, drill holes Nos. 16 to 20 indicate an ore-body trending at right angles to the former Pueblo lode. This newly discovered body was encountered in two holes; two of the other three holes showed mineralization, but no commercial ore. As before, the data are not sufficient to indicate the essential facts with regard to this body, and further drilling must be done before the available tonnage may be calculated. The indicated ore differs radically from the ore of the Pueblo lode; it has a silicate gangue, in contrast with the Pueblo hematite body.

The Tamarack-Carlisle property lies east of, but on the same altered zone as, the Copper King mine, the last of the Whitehorse properties to be worked prior to the Richmond Yukon Company venture. This altered zone is apparently an inclusion of limestone in the granitic intrusives. The limestone is highly altered, silicate minerals, such as garnet and epidote, and also copper sulphides having been introduced. At the time of the writer's visit the Carlisle workings were largely filled with water, but from descriptions by the management, a shaft 140 feet deep, partly vertical and partly inclined, has been sunk on the ore-body, with levels at 50, 98, and 134 feet. The upper workings were driven by the former management and on them was encountered a shoot of ore which has been largely removed by stoping. The lowest level also encountered a shoot of ore, which is apparently lenticular in shape, ending upwards on the second level, and having on the lower level a length of about 90 feet, with a maximum width of 20 feet. From the lower level crosscuts were run, and diamond drill holes were spread out fanwise below the level. These pierced the ore-body below the level. The east drift and south crosscut of the third level terminate in granite.

The altered zone extends some distance north of the shaft. In this area the introduction of silicate minerals into the limestone is quite marked, thus making this ground a favourable zone for prospecting. The depth to which the limestone inclusion and, consequently, the mineralization, extends, has not been tested. It would be somewhat difficult at this locality to determine the extent, in depth, of the limestone, owing to the fact that there is an interfingering of the granite and limestone, so that it is difficult to determine if the main mass of intrusives has been reached unless the drill holes penetrate some considerable distance into granite.

The War Eagle has a number of showings; the main workings are on the largest of these, which is a lens 45 feet wide. On this a shaft has been sunk to a depth of about 70 feet, with levels at 13, 33, and 50 feet, and a crosscut to the west at the bottom of the shaft.

To the north of the main ore-body, a vertical shaft has been sunk on a hematite magnetite body, which is apparently slightly off the strike of the main zone, and may be situated in a cross fracture. This shaft was full of water at the time of the writer's visit, and, consequently, was not open to inspection. To the west of this shaft, on the strike of the main zone, there is an open-cut with a showing of mineral. To the south of the main shaft, and situated along the main ore zone, a lens of high-grade ore has been partly removed by means of an open-cut. There are several small showings on the property.

The main showing is 125 feet long, 45 to 55 feet wide, and consists of two streaks of ore with a barren or low-grade streak between. The ore-bearing streaks are 18 and 25 feet wide on the first level and the barren or low-grade streak 12 feet wide. South of the main shaft, the eastern streak of ore has been stoped, apparently from the third level, to the surface. The third level is blocked with ice, and ice extended in the stopes almost up to the second level, making it impossible to determine the exact amount of stoping done. North of the shaft both streaks have been to some extent stoped from the first level upwards; but are untouched below. McConnell obtained an average of 2·7 per cent copper across the whole lens, including the barren or low-grade streak; but the average in the upper workings has since been reduced by the removal of much of the high-grade ore. The writer took three samples: Nos. 1 and 2 of the east and west streaks of ore, respectively, and No. 3 of a cut along the hanging-wall of the old stope in the second level. These were assayed with the following results.

Sample No.	Silver, ozs. per ton	Copper, per cent
1	1·31	1·53
2	2·95	9·34
3	2·40	1·65

These samples cannot be regarded as other than merely indications of what the ore-body may contain. The number of samples is not sufficient, in an ore-body of this character, to give average results, and from all the workings sampled a certain amount of ore has been removed.

The work of Richmond Yukon Company to the first of October, 1927, consisted of drilling an inclined hole to the west of the ore-body in order to tap the high-grade body visible in the south open-cut; and in cleaning out the shaft and levels preparatory to underground drilling during the winter.

The drill hole encountered ore about 100 feet from the surface, but failed to reveal any ore beneath the open-cut, though it passed through an altered zone, with some specks of mineral, at the depth calculated to be beneath the ore-body.

When the Pueblo mine was formerly operated a spur line connected it with the main line of the White Pass and Yukon route. The spur line is no longer ready for use, as many of the fills have been washed out, the cuts sloughed, and replacements and repairs are needed on ties, bridges, and culverts. It would require considerable money to place this spur line and the ore bunkers at Skagway in shape for handling crude ore. On the other hand, ore and concentrates sacked, receive the favourable rate, in carload lots, of $5.25 a ton from Whitehorse to Seattle, Tacoma, or San Francisco, and with the use of caterpillar tractors or trucks, the item of transporting the ore to Whitehorse would not be unduly heavy.

The silicate ores such as those of the Carlisle and War Eagle are readily amenable to concentration. The hematite ores of the Pueblo, on the other hand, would probably have to be shipped as mined, but this would be compensated in part by preferential smelting rates.

One essential fact with regard to the Whitehorse deposits must be kept in mind, namely, that the deposits are of the contact metamorphic type, and consist usually of disconnected lenses, situated near the contacts of the limestone with the intrusives. One lens does not necessarily lead to another, and in general each lens does not form a large ore-body. The costs of development and mining under such conditions must, undoubtedly, be high.

To what depths values, and consequently mining, may be reasonably expected to extend has never been determined. It may be safely assumed that the values will not extend far below the lower contact of the limestone with the granite, and the depths to which these limestones extend probably differ from area to area within the field.

FINLAY RIVER DISTRICT, BRITISH COLUMBIA

By Victor Dolmage

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Illustrations

INTRODUCTION

The Finlay is the main headwater branch of Peace river and is situated just west of the Rocky Mountain range, between latitudes 56 and 58 and longitudes 124 and 126. Finlay River district, as here described, includes a strip of country 10 to 20 miles wide east of Finlay river, thus embracing a part of the Rocky mountains, and a strip extending 60 to 80 miles west of the Finlay. Reference is made also to a section of country lying immediately south of latitude 56 and included in the accompanying map. Except for a few Indians and trappers, this region is uninhabited and is 250 miles distant from the nearest railway. Its southern part is, however, adjacent to a route along which it has been proposed to build a railway connecting the rich agricultural areas of Peace River valley with a Pacific Ocean port. If such a line were built the natural resources of Finlay River district would be brought near enough to transportation facilities to make their development feasible. Important mineral deposits have been reported from the district and have lately assumed a new importance due not only to their intrinsic values but also to the helpful influence their successful development would have towards making a railway through this country profitable. For the purpose of obtaining detailed and authentic information concerning the extent of, and the geological conditions surrounding, these reported mineral deposits, the writer was instructed to make the investigations which form the basis of this report. Three months were spent examining the known mineral occurrences of the district and geologically mapping certain parts of the district thought to be favourable to the occurrence of other deposits.

The work was greatly facilitated by the assistance of Dr. C. O. Swanson and Mr. Desmond F. Kidd and by much information and help obtained from the inhabitants of the district. Worthy of special acknowledgment are the information and many accommodations received from James Ferguson, who located the most important mineral deposit so far discovered in the district, from Emil Brunlund of the Consolidated Mining

and Smelting Company, from Mr. Gordon F. Dickson, engineer in charge of the General Holding Company's operations on the Fort Grahame mica deposits, and from various officials of the Hudson's Bay Company.

PREVIOUS WORK

In 1893 McConnell[1] mapped a strip of country bordering Omineca river from its mouth near Finlay Forks up as far as Old Hogem and extending west from there to Takla lake. He also mapped a wider strip of country bordering Finlay river from its mouth to its source at Fishing lakes. A section in the southern part of the district extending along Takla lake and from there east to Manson creek and south to Nation river was mapped in 1915 by Charles Camsell.[2] All geological data indicated on the accompanying map are the work of these two authors, except that included in the sections extending west along Ingenika river, and east along the Police trail from Fort Grahame to Boulder pass, and certain parts east of the Finlay, all of which were added by the present writer.

The geology and physical features of a small section in the southeast corner of the map-area were examined in 1875 by A. R. C. Selwyn[3] and at the same time the flora of this region was studied by Prof. Macoun.[4] In 1908 W. Fleet Robertson,[5] then Provincial Mineralogist, coming from the west over the trail from Hazelton examined the placers on McConnell creek at the headwaters of the Ingenika and continued east across the divide into Bower creek, followed this creek to the Finlay, and descended the river to Finlay Forks. The main drainage systems and trails of the whole district were explored and mapped in 1912-14 by F. C. Swannell[6] of the Department of Lands of British Columbia. The resulting map contains much accurate information obtained by Mr. Swannell from his own traverses. The geography of the accompanying map (No. 2156) is taken largely from Mr. Swannell's map.

MEANS OF TRANSPORTATION

The region, though 250 miles from the nearest railway, is easily accessible by navigable rivers. Fort Grahame, a Hudson's Bay Company post on the Finlay, is near the centre of the district and can be reached from Prince George in from five to seven days, depending on the stage of the water in the various rivers. The route to the district from Prince George consists of a motor road, 40 miles long, to Summit lake, and, from there, a chain of lakes and rivers. From Summit lake the route passes down Crooked river through Davie, Kerry, and Macleod lakes past Macleod to Pack river, down Pack river to Parsnip river, and down Parsnip river to Finlay Forks, where it joins with Finlay river to form Peace river; from there the Finlay is followed up to Fort Grahame and beyond. The Finlay can be navigated by large boats as far as Deserters canyon, 30

[1]Geol. Surv., Canada, Ann. Rept., vol. VII, pt. C (1897).
[2]Geol. Surv., Canada, Sum. Rept. 1915, pp. 70-75.
[3]Geol. Surv., Canada, Rept. of Prog. 1875-76, pp. 28-86.
[4]Geol. Surv., Canada, Rept. of Prog. 1875-76, pp. 110-232.
[5]Ann. Rept., Minister of Mines, B.C., 1908, pp. 66.
[6]Ann. Rept., Surveys Branch, Dept. of Lands, B.C., 1914, pp. 83.

miles above Fort Grahame, and by smaller boats from above the canyon to the mouth of Fox river. From Summit lake to Finlay Forks, boats carrying up to 3 tons are commonly used by the Hudson's Bay Company and other traders who take many tons of provisions over this route every summer. Until recently smaller boats were used and were poled by two or three men, sometimes assisted in crossing the lakes by small out-board engines. In the last two or three years, however, out-board engines have been so extensively improved that they have now replaced all other methods of propelling boats over this and similar routes. Small, light engines rated as high as 8 horsepower are now procurable, which are capable of driving boats carrying up to 3 tons through the swiftest waters of Finlay and Parsnip rivers and form a part of the equipment of every trapper and prospector, as well as of most Indians of the district. As a result of the introduction of these engines, the cost of transportation in the district has been greatly reduced. Whereas, formerly, the trip from Summit lake to Fort Grahame required twelve days or more, it is now made by one or two men in five days; the return trip is made in a correspondingly shorter time and the saving in cost per pound of freight is very considerable. In leaving the country it is customary to take one of these river boats down the Peace to Rocky Mountain canyon, there haul the boat over a 14-mile portage, and continue down the Peace to the railway at Peace River Crossing, about 290 miles below Finlay Forks. This route, though much longer, is down stream all the way and, therefore, much easier to travel. During the last two years, since the introduction of the more powerful engines, this longer route has been to some extent abandoned in favour of the much shorter Summit Lake route.

An estimate of the cost per pound of carrying freight in and out of the district, based on the cost of taking 32½ tons of supplies from Prince George to Fort Grahame in 1926, has been made by Mr. Dickson, engineer in charge of operations by the General Holding Company at the Fort Grahame mica deposits.[1] Mr. Dickson estimated that it cost 7·7 cents per pound from Prince George to Fort Grahame. He calculated that freight coming from Edmonton, via Peace River Crossing, to Fort Grahame, providing that the two rapids on the Peace, the Parle Pas and the Finlay rapids, were deepened so as to be easily passable, would cost 9·05 cents per pound, whereas out-going freight over the same route and under the same conditions would cost 5·09 cents per pound. However, as a result of observations made by the writer in 1927 he is of the opinion that freight from Prince George to Fort Grahame is now carried for considerably less than Mr. Dickson's estimate; the cost is probably less than 5 cents per pound.

The only other rivers that are at all navigable are the Ingenika and Omineca, tributary to the Finlay, and the Mesilinka (or Stranger), a tributary of the Omineca. The Ingenika, though swift and, at certain seasons, shallow, is free from canyons and can be ascended by small boats or canoes for a distance of 30 or 40 miles. The Omineca is more difficult to navigate and Black canyon, 5 miles above its mouth, is impassable

[1]Ann. Rept., Minister of Mines, B.C., 1926, pp. 152.

except during periods of low water. Above the canyon the river can be navigated by canoes for many miles, but only with great difficulty and much labour. The Mesilinka (or Stranger), though smaller and swifter, is free from canyons and, with difficulty, may be ascended as far as Tutizzi lake. It is, however, much easier to reach this lake by the Police trail from Fort Grahame.

The valleys of all the streams are, for the most part, wide, flat-bottomed, and floored by terraced sands and gravels over which excellent trails with easy grades may be built quickly and cheaply. The larger valleys are well adapted to the building of roads or railways, should these at some future time become feasible. Formerly all the main valleys were traversed by good trails but, owing to the navigability of the rivers, they have been abandoned and are rapidly becoming choked by fallen trees and new vegetation. The most famous of these old trails is the so-called "Trail of '98," which was built at the time of the Klondike gold rush to enable gold seekers to reach that district by an all-Canadian overland route. It leads up Finlay valley and on through Sifton pass and was intended to reach Atlin. It was well built and for a time was much travelled, but has since fallen into disrepair. Certain sections of it are still in excellent condition, but other sections are completely obliterated and the many well-constructed bridges have been washed away.

Another famous trail, called the Police trail, was built from Fort Saint John on Peace river to Fort Grahame and on to Hazelton, a distance of nearly 400 miles. It also was well built and for a time was patrolled by the Mounted Police, during which time it was kept in good condition. In recent years it has been little used and is rapidly falling into disrepair. A section of this trail from Fort Grahame to Boulder pass was used by the writer during the season's work and pack horses were taken over it without difficulty.

GENERAL CHARACTER OF THE DISTRICT

CLIMATE AND VEGETATION

As no systematic weather records have been kept in the region, any statements regarding climate must be based either on the verbal reports of the inhabitants or on conclusions drawn from the vegetation. Dawson points out that the assemblage of plants in this region closely resembles that found in a wide belt of country which stretches across Canada north of the prairies and is a region having a moderately heavy rainfall, summers not excessively warm, and cold winters. According to the inhabitants of Finlay River district, the winters are cold, but usually bright and clear with a moderate snowfall; the summers are usually wet during the early part, but July, August, and September are almost always fine and warm. The shortness of the summer is to some extent compensated by the extra long days due to the high latitudes in which the region is situated. Summer frosts are common and interfere with farming and gardening in the Fort Grahame section, but not in the vicinity of Finlay Forks where all kinds of vegetables and some grains are successfully grown. Potatoes and other hardy vegetables are grown successfully at Fort Grahame and even farther north. Small fruits such as strawberries, raspberries, saskatoons, and cranberries were seen growing in great abundance in all parts of the district visited.

In the lower parts of Finlay and Parsnip valleys there is a considerable amount of good agricultural land, at present largely covered by forests of spruce and cottonwood. The spruce is, on the whole, of rather poor quality.

TOPOGRAPHY

The principal topographic feature of the region is the great valley occupied by Finlay and Parsnip rivers. This is a broad, deep depression extending not only through British Columbia, but reaching into the United States, and known as the Rocky Mountain trench. On the east it is flanked by the lofty Rocky Mountain range and on the west by a broken succession of ranges only slightly lower though less rugged. The Trench is occupied at various places by such large rivers as the Kootenay, Columbia, Canoe, Fraser, Parsnip, and Finlay, all of which, except the last two, bend west from the Trench and discharge their waters into the Pacific. The Parsnip and Finlay flow northwest and southeast, respectively, and meet head on at latitude 56 to form Peace river, which bends sharply to the east, cuts directly across the Rocky Mountain range, and discharges its waters through the Mackenzie River system into the Arctic. The great gap, known as Peace pass, through which Peace river crosses the Rocky mountains, is remarkable in a number of respects. It is the only water-gradient pass that crosses the Rocky Mountain range except the Liard, which is nearly 300 miles farther north. It crosses the range at an elevation of only 2,000 feet and with a gradient so uniform and gentle that the even flow of the river is broken by only two comparatively small rapids, both of which are passable and could, at no very great cost, be made easily navigable. The principal obstacle to the navigation of the Peace river is the so-called Rocky Mountain canyon, situated many miles east of the Rocky mountains. Engineers have stated that a railway could be built through Peace pass to Prince George with a grade not greater than 0·4 per cent and that the work of construction, in comparison with the average mountain railway, would be classed as light.

Finlay river occupies the Rocky Mountain trench from Finlay Forks as far north as Fox river, a distance of 125 miles. Beyond this point the Fox occupies the Trench for 41 miles to Sifton pass, beyond which the Trench is drained to the north by a tributary of the Liard. The Finlay rises in Fishing lakes 35 miles west of the Trench and after flowing north for 25 miles bends east and then southeast, and enters the Trench at the mouth of the Fox.

In Finlay River district, the Rocky Mountain trench is from 4 to 8 miles wide and floored throughout by gravels and silts, usually well terraced. Only one rock canyon occurs in this section of the Trench. This is Deserters canyon, situated 82 miles above the mouth of the Finlay and 30 miles above Fort Grahame. Here the river is a rushing torrent confined within a width of less than 100 feet, whereas, elsewhere, throughout its course through the Trench, it is from 100 to 300 yards wide and usually divided into a number of channels. The current of the river is swift, attaining a speed, during high water periods, of 12 miles an hour; it winds from side to side of its broad valley, rapidly cutting away the soft sandy or gravelly banks and felling into its stream large numbers of the trees from the dense forests covering the entire bottom of the valley. The meanders are rapidly cut through, forming new channels and many oxbow lakes or sloughs, through which the river flows only during the periods of high water. At such periods it is a maze of intricate channels very confusing to the inexperienced navigator.

To the east of the Trench, the Rocky mountains rise abruptly to elevations of 5,000 and 6,000 feet; still farther east along in the crest of this range many higher peaks occur. Several large, transverse valleys enter the Trench from the east, the more important of which are the Akie,[1] Paul Branch, and Kwadacha (or Whitewater). Besides these traverse valleys there is a large, parallel valley lying 10 miles east of the Trench. This is a broad, open depression having an uneven bottom occupied by many lakes, swamps, and meandering streams and standing at a slightly higher level than the Trench and its tributary valleys.

The mountains west of the Trench are as high as, or higher than, those to the east, but are much less rugged. In the vicinity of Fort Grahame and farther north the mountains rise rather steeply from the floor of the Trench to elevations as great as 7,000 feet, but to the south the mountains adjacent to the Finlay on the west are much lower, and the region is traversed by several large rivers, the Omineca, Mesilinka, Osilinka, and Nation, all converging towards Peace pass. The only other important tributary joining the Finlay from the west is the Ingenika, which rises nearly 100 miles to the west and enters 16 miles north of Fort Grahame. West of the Finlay from 10 to 15 miles, and running somewhat parallel to it, is a depression extending almost the full length of the district. This depression is, however, smaller and more irregular than the parallel valley lying east of the Trench. It is occupied by parts of the Mesilinka and Ingenika rivers, Carina lake, and Pelly creek. West of this depression the mountains gradually increase in elevation to a maximum of 7,500 feet in a lofty granite range not far from the headwaters of Omineca and Ingenika rivers.

GEOLOGY

The accompanying table of formations is based largely on McConnell's descriptions and correlations and to a less extent on the observations of Camsell, whereas the descriptions of the various formations in the following text are based mainly on observations made by the writer in the field and on examinations of specimens in the laboratory.

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[1] The names used here are taken from Swannell's map published in 1917 and differ from the names on McConnell's map published at a much earlier date.

Table of Formations

Recent and Pleistocene	Alluvium and glacial drift
Tertiary	Andesite, trachyte, and tuff
	Sandstone, conglomerate, shale
Cretaceous	Sandstone, conglomerate, volcanic rocks
	Granitic pegmatite dykes
Jurassic (?)	Omineca batholith, granodiorite, quartz-diorite, and diorite
Carboniferous (?)	Schist, greenstone tuff, argillite cherty quartzite, and limestones
Cambrian (?) and possibly younger	Limestones
Cambrian (?)	Fine siliceous conglomerate, quartzite, slate
Precambrian (?)	Quartz-mica schist, mica quartzite, and limestone

PRECAMBRIAN (?)

The oldest and most widely distributed rocks form great bands of schist and quartzite which extend in a northwest direction and which McConnell correlated with a similar aggregation of rocks then known in southern British Columbia as the Shuswap series. Two wide bands of these rocks occur in the district, a larger one extending up both sides of Finlay river from Finlay Forks to the mouth of the Ingenika where it divides into two branches, and a smaller band paralleling the Trench, but situated 15 to 20 miles southwest of it.

The rocks composing these bands are mainly quartz-mica schist, mica quartzite, and acid gneiss, but there are also a few small bands of impure limestone and lenses of hornblende gneiss. All three main types are essentially quartz-mica rocks with small quantities of feldspar and garnet. The most abundant of the three principal rocks is the quartz-mica schist which constitutes about three-quarters of the whole. It is a coarse-grained, well-foliated schist consisting of approximately 50 per cent quartz, 30 per cent mica (biotite predominating slightly over muscovite), 15 per cent plagioclase, and the remaining 5 per cent of garnet occasionally associated with small amounts of calcite. The quartz grains vary in size up to 4 millimetres and have extremely irregular surfaces by which adjoining grains are closely interlocked. All the quartz grains show cloudy extinction. The mica occurs as thin, parallel films and shreds curving around and between the other minerals. The plagioclase, which is chiefly andesine, is decidedly fresh and in the form of smoothly rounded or angular grains quite different in outline from the quartz. Orthoclase is present in very small amounts and is entirely absent from many of the thin sections that were examined. Garnet is ever present in conspicuous amounts and occurs as bright red, rounded, and embayed grains, many of which contain small particles of quartz.

In many places the schist grades gradually into quartzite which differs only by containing a much larger proportion of quartz, usually over 80 per cent. Both the schists and quartzites are undoubtedly derived from siliceous sediments.

Gneisses were observed in Finlay River district at only a few localities. Several bands, totalling several hundred feet in width, were observed on West Mica mountain. These consist of 50 per cent quartz, 35 per cent plagioclase, 10 per cent biotite, and the remainder of garnet and orthoclase with a few minute grains of magnetite and zircon. The plagioclase is exceedingly fresh, is sharply twinned, and ranges in composition from andesine to labradorite. Orthoclase is present in very small amounts as anhedral grains interstitially spaced between the other minerals. The general appearance of these rocks and their large feldspar content suggest that they are probably derivatives of some igneous rock. In the long tunnel, driven on one of the mica claims, a band of coarse, dark coloured hornblende-garnet gneiss was intersected. It is about 75 per cent hornblende in greatly elongated grains having a parallel arrangement. The associated minerals are plagioclase, quartz, garnet, and calcite.

Small amounts of pyrite and chalcopyrite were found in association with this rock. This and a few other similar rocks are believed to have been derived from small basic bodies injected into the series at an early stage in its history. The limestones form only a very small part of the formation. They are present as thin, well-bedded lenses and usually contain numerous veins of siderite. They are nonfossiliferous and the belief that they belong with the schists is based on their stratigraphic position. The age of the schist series is not definitely known, but is presumably Precambrian.

CAMBRIAN (?)

On the Omineca, 12 miles above the mouth of the Osilinka, McConnell found a band of fine conglomerate, quartzite, and slate, extending along the river for 2 miles and overlying the presumably Precambrian schists. He found a band of similar rocks in the northern part of the district crossing the Finlay at the big bend north of Fishing lakes and occupying a similar position with respect to the schists. These conglomerates consist, according to McConnell, of pebbles of quartz and feldspar usually less than one-third of an inch in size, enclosed in a hard, siliceous matrix. On grounds of stratigraphic position and lithological similarity McConnell correlated these conglomerates and slates with the Bow River series as developed in the Bow River section of the Rocky mountains. The Bow River series of the type locality has since been shown to be in part late Precambrian, in part Lower Cambrian. Owing to their great similarity to some of the coarser quartzites of the Precambrian (?) these conglomerates were not positively identified in the sections mapped by the writer along Ingenika and Mesilinka rivers.

CAMBRIAN (?) AND POSSIBLY YOUNGER

Several wide bands of limestone parallel the bands of schist, as well as the principal valleys and mountain ranges. East of the district the Rocky mountains consist largely of limestone, one band, exposed in Peace pass, being over 22 miles wide. Part of this band is shown on the map crossing the Kwadacha, Paul Branch, and Akie. West of the Trench several smaller bands, 6 to 8 miles wide and more or less continuous, are shown on the map (No. 2156). The limestone is for the most part quite pure and white or grey. In some places it contains considerable argillaceous material which is usually distributed in narrow layers, giving the rock a pronounced banded appearance. Elsewhere the limestones are highly siliceous and very light coloured. In many places the limestone is intensely sheared and contains a high proportion of sericite. Large veins of siderite, usually weathered a bright red, occur in great numbers in the limestones of all parts of the district and in a few places, such as at Ferguson's mine, contain important amounts of lead, zinc, and silver.

No fossils have been found in the limestones, but because of their position above the schists McConnell considered them to be a part of the Castle Mountain group then known to contain members ranging in age from Middle Cambrian to Ordovician.

CARBONIFEROUS (?)

McConnell's map shows in the northern part of the district a range of mountains lying immediately west of the Trench from a point opposite the mouth of Paul Branch, to the northern limit of the area. These mountains were stated to be composed of greenish schists with bands of dolomite and were referred to as a volcanic series of uncertain age. In the southern part of the district McConnell mapped a large area of similar rocks extending west from Germansen creek to within a few miles of Takla lake. He describes the rocks of this area[1] as green ash rocks pressed and altered into schists, interbedded with layers of greywacke, felsite, hälleflinta, serpentine, and argillite. Camsell,[2] who examined the same section, as well as a continuation of it to the south along Takla and Stuart lakes, describes it as consisting of limestones, argillites, cherty quartzites, and green schists on the shores of Stuart lake, of slates with a few limestone bands on Takla lake, of volcanic flows, tuffs, and breccias on Germansen creek, and of green chloritic schists, slates, and narrow bands of dolomite on Manson river. A similar assemblage was observed by the writer along the north side of Tutizzi lake and similar rocks are reported to occur on Wrede creek and Ingenika river near longitude 126. All three occurrences lie directly along the strike of the beds and may safely be considered as parts of one continuous band of rocks. They lie above the presumably early Palæozoic limestones and are intruded by the Omineca batholith. No fossils were found in these beds by McConnell and he hesitated to assign them to any more definite period than Upper Palæozoic.

[1]Geol. Surv., Canada, Ann. Rept., vol. VII, pt. C, p. 25.
[2]Camsell, Charles: Geol. Surv., Canada, Sum. Rept. 1915, p. 73.

Camsell, however, correlates these rocks with limestones occurring along the shores of Stuart and Takla lakes, which were found by Dawson[1] to contain Fusulina and other fossils of Carboniferous age.

JURASSIC (?) OMINECA BATHOLITH

Several large masses of granitic rocks have been mapped along the western border of the district, all of which are believed to be parts of one large, continuous body, referred to here as the Omineca batholith. The rocks composing this batholith were first observed by McConnell on Omineca river, where he mapped a band 5 miles wide between New Hogem and Old Hogem. He found a body of similar rock at the north end of the district immediately west of Fishing lakes. On the trail between Silver creek and Germansen lake, Camsell found a band of granitic rock which he regarded as a continuation of the band found by McConnell on Omineca river a few miles to the north. Camsell mapped two other bodies of similar rock, one 6 miles wide on the trail between Manson creek and Nation river, and the other on the west arm of Takla lake extending south far beyond the limits of the area. Two very large masses of the same rocks were observed by the writer, one just west of Tutizzi lake and the other on the headwaters of Ingenika river west of Flameau creek. These exposures are very large and form parts of a great range of gigantic mountains which could be seen extending many miles to the northwest and southeast. Undoubtedly these large exposures, together with those on Omineca river and near Fishing lakes, form one large, continuous batholith. It is known also that this range of granitic mountains extends many miles northwest of Fishing lakes and it is highly probable that the Omineca batholith is connected with the Cassiar batholith, large areas of which were mapped by F. A. Kerr[2] northeast of Dease lake. A much smaller body of granitic rock was discovered by the writer northeast of the junction of the Tutizika and Mesilinka rivers. Though not connected surficially with the Omineca batholith, its proximity and similar composition suggest that it is an offshoot, or satellite, of the larger batholith.

The rocks of the Omineca batholith and this smaller batholith, or stock, are chiefly granodiorite, quartz-diorite, and diorite. Of these by far the most abundant is granodiorite composed largely of andesine, quartz, and biotite, with smaller amounts of orthoclase and hornblende and a few grains of magnetite, sphene, and apatite. Quartz-diorite, having a similar composition to the above but with less orthoclase and biotite, constitutes smaller, though important proportions of these batholiths. A marginal phase of the Omineca batholith was found immediately west of Tutizzi lake and consists essentially of andesine-labradorite, hornblende, and biotite.

The age of these intrusions is doubtful beyond the fact that they are post-Carboniferous.

PEGMATITE DYKES

In Butler range, which lies west of Finlay river and south of Fort Grahame, there are many, large, white pegmatite dykes penetrating the

[1]Dawson, G. M.: Geol. Surv., Canada, Rept. of Prog. 1876-77, p. 54.
[2]Kerr, F. A.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A.

presumably Precambrian schists, usually along their strike. They are composed mainly of white orthoclase, quartz, biotite, and muscovite, with small amounts of tourmaline, garnet, and beryl. The muscovite is abundant and a large proportion of it is of commercial grade. An unusual feature of this occurrence is the absence from the neighbourhood of any large body of granitic rock, which might be regarded as a source of the material composing these pegmatites. These dykes are more fully described in a later part of this report dealing with the mica deposits.

CRETACEOUS AND TERTIARY SEDIMENTS

Three small areas of unmetamorphosed sediments occur in or near the Rocky Mountain trench and a larger area of somewhat similar rocks occupies the northern part of Takla Lake valley. In the Trench these rocks extend from the mouth of the Ingenika north to the mouth of the Fox and probably far beyond. A small area of the same rocks was found by McConnell in the valley of the Omineca below the mouth of the Mesilinka, and another in Bower Creek valley. The rocks consist of coarse conglomerate, sandstone, and shale, the materials composing the conglomerate and sandstone being clearly derived from the underlying schists, limestone, etc. Plant remains found by McConnell in these beds determine their age to be Tertiary. The rocks of Takla Lake valley are more indurated, are coarser, and more steeply folded, the angle of dip amounting to as much as 70 degrees. Like the Tertiary beds to the east, these strike in the same direction as the underlying formations. This series extends north to Bear lake and Camsell suggested that they might probably be correlated with the coal-bearing Cretaceous beds of Groundhog district[1] situated 110 miles to the northwest along the strike of the folds and in the same general depression. In 1926 Dr. Swanson[2] while carrying out an exploration for private interests in a large section of country 20 miles north of Bear lake, found a large area of rocks similar in composition and structure to those of Takla lake and the Groundhog coal basin and containing small seams of coal. This discovery goes far towards proving the correctness of Camsell's supposition that the Takla Lake beds are a part of the same series as those of the Groundhog district. In the light of this information it appears that there is a large area between Takla lake and the Groundhog coal basin which might be worth prospecting for coal.

TERTIARY VOLCANIC ROCKS

Volcanic rocks presumed to be of Tertiary age were found by Camsell on the trail between Manson creek and Nation river. A large section of country in this locality is covered by these rocks, but owing to glacial drift they are exposed at only a comparatively few places. They consist, according to Camsell, of andesite, and diabase porphyry and breccia. A small area occupied by very fresh lavas was found by the writer along the trail between Mesilinka and Tutizika rivers near their junction. These consist

[1]Malloch, G. S.: Geol. Surv., Canada, Sum. Rept. 1912, pp. 77.
[2]Verbal communication.

of andesite, some of which contains a large proportion of glass. The flows are flat-lying, which with their fresh appearance and glassy content, indicates that they are of fairly recent origin, probably late Tertiary.

MINERAL DEPOSITS

In Finlay River district ores of silver-lead-zinc, copper, and gold have been found, as well as deposits of mica and coal. Of these, the silver-lead-zinc deposits are, at present, by far the most important and are being extensively investigated by a group of British Columbia capitalists. Copper deposits of considerable promise have been staked, and from time to time small quantities of placer gold have been obtained from several localities within the area. Mica-bearing pegmatites are plentiful in the district and on some of them a considerable amount of development work has been done, in the course of which several hundred pounds of marketable sheet mica was recovered.

COAL

Small seams of lignite have been observed on Parsnip and Osilinka rivers, but the coal of such low grade occurs in such small amounts as to have no commercial significance. A short distance east of this district, on Carbon and Peace rivers, valuable deposits of exceptionally good coal have long been known to exist and will play an important part in the development of this and the adjoining Peace River districts. The Peace River coals have been reported on by F. H. McLearn.[1] Although there are no published reports on the Carbon River deposits they are well known to be of considerable importance.

PLACERS

The early mining history of this region centres around the placer gold deposits which were found in several parts of the district. According to McConnell,[2]

> "The first gold discovery made in the Peace River country was made on the Parsnip 20 miles above its mouth by Bill Cust in 1861. In the following year Pete Toy's bar on the Finlay, a few miles below the mouth of the Omineca, was found and for a time proved wonderfully productive, the yield amounting to about $50 per man per day."

He further states that gold was discovered on Silver, Vital, and Germansen creeks, tributaries of the Omineca, in 1868, 1869, and 1870, respectively, and on Manson and Slate creeks, tributaries of Manson river, in 1871. No further discoveries were made for a considerable time until Tom creek was found in 1889. The area including all these creeks is believed to have produced over $1,000,000, most of which was taken out before 1890. According to McConnell the gold of this camp was found both in the recent stream gravels, which are shallow and easily worked but limited in extent, and in the "auriferous gravels underlying the boulder clay." He calls the latter "glacial gravels" and states that "They are widely distributed in the region and promise favourable results if worked on a large scale."

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[1]Geol. Surv., Canada, Sum. Rept. 1922, pt. B, p. 1.
[2]Geol. Surv., Canada, Ann. Rept. 1894, p. 38 C.

On the Finlay, McConnell found "fine" gold throughout its length, but not, except on Pete Toy's bar, in workable amounts. "Colours" were found at the mouths of the Ingenika, Kwadacha, Fox, and two smaller unnamed tributaries entering from the west 8 miles below Paul Branch, and 6 miles above the Fox. Excepting the Kwadacha, none of the eastern tributaries shows any traces of placer gold. Several bars on Ingenika river are rich enough to be worked at a small profit. An attempt to work some of these bars by machinery was made many years ago and a large boiler was taken at great expense to a point over 30 miles up the river, but was never put into operation. During the latter part of last season prospectors are reported to have made good pay by working bars on Ingenika river in the vicinity of Wrede creek.

In 1907 reports were widely circulated of rich placer deposits having been discovered on McConnell creek, one of the headwater branches of the Ingenika, situated about 100 miles west of its mouth. In the following summer these discoveries were investigated by W. Fleet Robertson, then provincial mineralogist, who found the reports to be greatly exaggerated. No gold of any account has ever been produced from the area. Two prospectors, Saunders and McClair, are reported to have obtained in 1924 several thousand dollars worth of coarse gold from a creek flowing into Fishing lakes from the west. According to Mrs. McClair, who accompanied her husband on the occasion, all the gold was lost when their boat capsized in Finlay river on their journey out to Prince George. The same two prospectors returned to the locality the following summer, but have entirely disappeared. All attempts made to locate the placers from which the gold is reported to have come have been unsuccessful.

Fine gold occurs in many of the bars on Peace river between Finlay Forks and Rocky Mountain canyon, but all attempts to work them profitably have been unsuccessful for various reasons, one being that the gold is too sparsely and irregularly distributed to permit the working of the deposits on an enormous scale.

MICA

Mica of excellent quality has been found at a number of places in the district, principally in the first range of mountains west of the Finlay and south of Fort Grahame. Within an area 6 by 10 miles, situated in this range 5 to 10 miles southwest of Fort Grahame, eight mica-bearing pegmatites have been discovered. All but one are owned by the General Holding Company of Edmonton who, for the past three years, have been investigating these deposits and have taken out sufficient mica to make one or two trial shipments. The one deposit of this area not owned by the above company is held by Mr. Ravenel, factor at the Hudson's Bay Company's post at Fort Grahame. He has done a small amount of development work on his property in the course of which a few hundred pounds of mica was recovered. Other deposits lying about 15 miles southeast, but in the same range of mountains, were staked during the season, but were not examined by the writer.

The mica occurs in large, white pegmatite dykes, of which there are a great many in the district. They lie in the quartzites and schists of, presumably, Precambrian age and also in the Carboniferous (?) greenstones, but so far as is known at present all those dykes carrying marketable mica are confined to the schists. In general, the pegmatites are lenticular in plan and arranged with the long axis parallel to the strike of the schists. They vary from 20 to 200 feet in width and are exposed over lengths of from 50 to 1,500 feet. One dyke on which considerable development work has been done, has been shown to have a shape somewhat resembling a greatly elongated ellipsoid with the major axis parallel to the strike of the schistosity and plunging southeast at a low angle, probably less than 12 degrees. Two other dykes, not so well exposed, appear to have a similar form and attitude, which suggests that the majority of the large dykes of this locality probably have this general shape and attitude.

In detail the outlines of many of the pegmatites are quite irregular. Protuberances and apophyses project into the schist and irregular masses of schist extend into the pegmatite or are completely engulfed in it. Many of the apophyses are of considerable length and, judging from observations made in other mica-producing districts, it is probable that these long, narrow offshoots form connexions between one pegmatite and another. The majority of such offshoots observed in Finlay River district consist almost entirely of quartz and muscovite with only small amounts of feldspar, and contain some of the best mica seen in the district.

All the pegmatites have the same colour and appearance, due to a pronounced uniformity of composition. They consist of about 65 per cent feldspar, 25 per cent quartz, and much smaller amounts of tourmaline, garnet, and pyrite; in one dyke a well-developed crystal of pale bluish green beryl was found. The feldspar is largely orthoclase with a very small amount of albite. The orthoclase crystals range in size up to 8 or 10 inches and invariably are pure white. Some are slightly translucent; others have a pearly opalescence due to a very fine microperthitic structure. Many of the orthoclase crystals contain a large amount of graphically intergrown quartz. Almost all of the quartz has a decidedly smoky colour. The mica is largely muscovite, but small amounts of biotite are everywhere present. The muscovite, seen in large, thick crystals, has a pale amber colour with a very faint greenish cast. The mica is of the highest quality and in thin films is beautifully clear. Very faint crystal zoning can be observed in some of the larger crystals. Crystals up to 13 inches in length are found. The tourmaline occurs as small, well-formed, jet black crystals in many places arranged in rosettes, and is commonly found in the country rocks adjoining the pegmatites. The garnets have a bright ruby red colour and appear to be of the same variety as those that occur in such large quantities in the schists throughout the district.

As previously mentioned, the origin of the pegmatite masses is largely a matter of conjecture, as no body of granitic rock, which might be regarded as their source, occurs within a distance of 30 miles. There are, however, some good reasons for believing that they may have their source in a body of granitic rock lying at some depth below the surface.

The General Holding Company have done some work on all of their deposits, but have devoted most of their attention to two bodies of pegmatite near their main camp, situated towards the north end of East Mica mountain $5\frac{1}{4}$ miles southwest of, and 3,200 feet higher than, Fort Grahame. An excellent trail leads to the camp from a point on Finlay river opposite to and one mile above Fort Grahame. Most attention has been given to the larger of these two pegmatites and it has been opened up by a shaft and several drifts. This dyke has a maximum width of about 33 feet and hashas been exposed on the surface by natural outcrops and trenches for a distance of nearly 300 feet, and by an open-cut 10 to 15 feet deep that follows the foot-wall for 160 feet. The small, inclined shaft passes under the pegmatite, showing its depth at this point to be not greater than 50 feet. From these workings it is evident that the pegmatite body is like a greatly elongated ellipsoid, of which the major axis is several hundred feet in length, strikes parallel to the schist (i.e., north 30 degrees west), and plunges at a low angle, not greater than 12 degrees, to the southeast. The intermediate axis extends from top to bottom of the dyke, dips west at an angle 70 degrees from the horizontal, and is 40 feet in length. It is probable, however, that part of the dyke has been eroded and that originally this dimension was somewhat greater. The minor axis crosses the dyke from side to side and dips to the west at a low angle. In the shaft, as well as in the long open-cut, a number of large mica crystals of excellent quality have been exposed.

The smaller dyke, situated a few hundred feet northeast and at a slightly lower level, has been exposed by several deep cuts and trenches. Enough work has not yet been done on it to reveal its true shape, but, though more irregular than the larger dyke, it has the same general attitude and very probably a similar shape. This dyke contains more pyrite, tourmaline, and garnet than any other of the district, but does not appear to contain much valuable mica.

What appears to be the richest dyke of the district is situated $3\frac{1}{2}$ miles southwest of the main camp near the summit of West Mica mountain at an elevation of about 6,900 feet. An open-cut 50 feet long and 12 feet deep at the face has been driven along the northeast side of this dyke. At the face of this cut the dyke is overlain by the schist and has the appearance of having the same general shape and attitude as the dykes just described. Several very large crystals of muscovite are exposed in this cut and enough mica was extracted from this deposit last summer to make a small shipment.

On the Birthday claims, situated about 4 miles south, a pegmatite 50 to 200 feet wide can be traced for over 1,500 feet. No work has been done on this dyke and no mica of commercial grade was seen in it. However, some large boulders, found on the eastern side of these claims and consisting mainly of quartz and mica, showed two or three valuable crystals of muscovite. On Ravenel's claim, situated 2 miles west of the Birthday claims, there are two small veins, 3 feet and $1\frac{1}{2}$ feet wide, respectively, exposed for a few feet on a vertical cliff overlooking Mica creek to the northwest. These consist largely of quartz and muscovite, the latter in large, well-formed crystals containing much mica of good grade. Small veins of similar material were also seen on the Cariboo and Sunset claims, but no marketable mica was observed in place on these claims.

Owing to the remote situation, severe climate, and attendant high cost of labour, transportation, and supplies, the only class of mica that at present and for some time to come can be hoped to be produced at a profit in this district is that consisting of large sheets ranging in value from $1 to $3 per pound. The quality of the mica has been proved by tests made on samples taken by Mr. Dickson, to be of the highest. The pegmatites are large and plentifully distributed through the district and no doubt many more will be discovered, so that profitable production is largely dependent on the amount of, and manner of distribution of, the mica crystals in the pegmatite dykes.

In no mica-producing field is the proportion of mica in the pegmatites large, and in the rich deposits of India it is usually less than one per cent of the material excavated. In order to carry on a profitable mining industry in Finlay River district the proportion of mica in the material excavated should be at least as great if not greater than 1 per cent. If the mica books are found to be sparsely and irregularly scattered through the pegmatite, necessitating a large amount of excavation in barren ground in order to find them, it would be quite impossible to mine them profitably; but if, on the other hand, large crystals should be found closely spaced and in more or less well-defined zones it might be possible to mine them with considerable profit. It is impossible from an examination of the district in its present undeveloped condition to form any definite opinion as to the amount of mica that will be found in these dykes. The work so far done, particularly that on West Mica mountain and on the larger of the two dykes at the main camp, offers some encouragement. Much of the material so far recovered has been partly destroyed by weathering, but when operations have reached a little greater depth the mica will be free from damage by weathering. There is some encouragement in the fact that the pegmatites of this district lie in a country rock of mica schist, for it has been proved in India that the pegmatites are much richer in mica where enclosed in a country rock of this character. In India, as well as other fields, experience has shown also that dykes rich in graphic granite are poor in mica, so that the rather large amount of graphic granite present in the dykes of Finlay River district is not an encouraging feature. As the slightest amount of movement of the earth's crust affecting the pegmatites, either during or after the formation of the mica crystals, is almost certain to destroy their commercial value, good deposits are not likely to be found in areas, such as the one under discussion, where great crustal disturbances are known to have taken place. However, many of the crystals so far found in this district are free from any defects due to such a cause and it may be that the great majority of them will be found to be undamaged by such movements. The fact that the large pegmatite on the Birthday claims, though exposed over an area 1,500 feet long and from 20 to 200 feet wide, contains virtually no mica of marketable size, shows that a considerable proportion of the pegmatite of the district is not mica bearing.

From the above remarks it is evident that whether or not mica can be profitably produced from this district depends almost entirely on the amount of high-grade mica found to be present in the pegmatites and, further, that the work so far done, although offering some encouragement, has not yet demonstrated that the mica is sufficiently abundant to be extracted profitably.

TIN

The occurrence of placer tin in Finlay River district has been reported many times. Many samples of "pan concentrates" from various parts of this district, tested by the Consolidated Mining and Smelting Company, are reported to have contained appreciable amounts of cassiterite. These and other reports have encouraged the few prospectors of the district to search for this metal, but no deposits in which cassiterite can be detected by ordinary methods of panning, have so far been found. No tin-bearing minerals were observed by the writer during his investigations and no formations were seen that might be regarded as a probable source of this metal, except the above-described pegmatites. Cassiterite is a common constituent of pegmatite dykes and in some, such as those of South Carolina and South Dakota, the amount of cassiterite present is great enough to permit it being mined. No cassiterite was found in the specimens of pegmatite taken by the writer from Finlay River district, but as there are many large pegmatites scattered throughout the district, only a few of which were examined, it is highly probable that the small amounts of cassiterite found in the gravels of the district originated in these pegmatites. As small amounts of tin are associated with the lead-zinc ores of the Sullivan mine in southeastern British Columbia, it was thought possible that the tin occurring in Finlay River district might be associated with the lead-zinc deposits of that district. No traces of tin, however, have so far been detected in the Finlay River deposits and ore and gangue are not of a type that would be expected to contain tin.

COPPER

Copper ores have been found at four widely separated localities in the district, namely: on Swannell river about 5 miles above its confluence with the Ingenika; east of the Finlay and about 20 miles north of Fort Grahame; on Ruby creek, which enters the Finlay at the big bend 15 miles north of Fishing lakes, and on Bower creek 8 or 10 miles above its mouth. Swannell River showings are on the east bank of the river just at the base of Ingenika cone and only a few miles distant from Ferguson's lead-zinc deposit; they are, therefore, easily accessible. These copper ores were discovered by James Ferguson, the locator of the lead-zinc deposits, and were staked by him and his partner in October, 1927. Unfortunately the writer was not informed of the existence of these deposits during his stay in that district and, therefore, the following information is based on reports by the owners. The ores are exposed in the face of a nearly vertical cliff about 20 feet high and consist of chalcopyrite in quartz. Specimens taken by the owners from the surrounding country rock were examined by the writer and found to consist of micaceous quartzite. From this, as well as the fact that Ingenika cone consists of quartzites belonging to the Precambrian (?) series, it is concluded that the deposit lies in this series of rocks. Specimens of the ore were also examined and found to consist entirely of quartz and chalcopyrite, the latter varying in amount in the different specimens from 2 per cent to 20 per cent. Assays of specimens taken by the owners show the copper content to vary from 2 per cent to 14 per cent, with small associated gold values.

The copper occurrence east of Finlay river and north of Fort Grahame has been known to the inhabitants for many years and for a time was held by a Mr. Barber of Calgary. The deposit is situated on the steep side of a high limestone mountain at an elevation far above timber-line. The showing consists of a mass of enargite several feet in length, enclosed in pure, unaltered limestone. Below the enargite the limestones over a large area are covered with malachite, giving the deposit, when viewed from a distance, the appearance of being much larger than it actually is. The ore consists almost entirely of well-crystallized enargite. Small amounts of pyrite and quartz can be seen in hand specimens and under the microscope small particles of covellite and chalcocite were seen, as well as still smaller amounts of greyish mineral thought to be tetrahedrite. The chalcocite and covellite, like the malachite, are of supergene origin. The surrounding limestones are unaltered and no igneous rocks are known to occur nearer than about 50 miles, so that the origin of this small, isolated mass of enargite is as yet very obscure. Persistent efforts to find a continuation of this deposit, or other deposits of a similar character, in the surrounding country, have been unsuccessful.

About 15 miles northwest of this deposit and at the same distance east of Finlay river, a large body of disseminated pyrite and marcasite enclosed in limestone and associated with veins of siderite was examined. No other minerals, however, are present and assays of samples taken show only traces of gold. Along a line joining these two deposits and extending far beyond to the northwest, rusty outcrops of siderite and pyritized limestone occur at intervals. Many of these have been examined by prospectors, but none has been found to carry any ore.

Large areas containing scattered disseminations of copper minerals occur in the Rocky mountains a considerable distance east of this district, but these have not been visited for many years and the writer was unable to obtain any specific data as to their size or location.

The discoveries on Ruby creek are of more recent date and probably of much greater importance. They are at present somewhat inaccessible owing to their great distance from Fort Grahame and to the fact that Finlay river north of the mouth of Fox river is practically unnavigable. For this reason the deposits were not visited by the writer. According to Mr. Frank Perry, the present owner of these deposits, they could, if the Moody trail were cleared, be reached by pack horses with little difficulty, by leaving the Moody trail in the vicinity of Sifton pass, crossing a high, grassy plateau to the west, and descending into the valley of Ruby creek. The deposits consist of pyrite and chalcopyrite in a quartz gangue and, although of low grade, are reported to be of considerable size. They are situated a few miles east of the large body of granodiorite that extends north from the vicinity of Fishing lakes.

The copper deposits on Bower creek were discovered, after the writer left the district, by Emil Brunlund of the Consolidated Mining and Smelting Company. The deposits are reported to be quite extensive, though low grade, carrying values in copper, lead, zinc, and silver. They are regarded by the company as having sufficient promise to warrant further work being done on them during 1928.

LEAD-ZINC-SILVER

The most important mineral deposit at present known in the district is the Ferguson lead-zinc-silver deposit, on Ingenika river 16 miles west of its junction with the Finlay. Other deposits of similar ore in the western part of the district have been discovered by trappers, who, however, prefer to keep the location of the discoveries secret rather than to stake and hold them under the regulations of the Mineral Act, which requires $100 worth of assessment work to be performed annually. Without the guidance of the discoverers it is almost impossible to find these occurrences and, though the writer spent several weeks in mapping the general region in which the deposits occur, none was found. Judging from the reports of the trappers and from the geology of the district these deposits are similar in many respects to the Ferguson deposit.

Deposits containing argentiferous galena have long been known to exist in the vicinity of Manson creek and are mentioned in a report by Geo. M. Dawson[1] published in 1880. Dawson did not, however, see the deposits and based his description on reports from a Mr. Woodcock of Victoria. According to this authority several veins that carry galena with high silver values occur in the vicinity of Boulder and Manson creeks. These were examined a few years ago by an engineer representing an Ontario mining company. The writer is informed on the best authority that the deposits are too low grade to be worked under present conditions.

The Ferguson deposit has long been known to the Indians of the district in which it occurs and has been visited from time to time by white men. About ten years ago it was staked by James Ferguson. In 1926 he bonded it to the Selkirk Mining Syndicate, Limited, of Victoria, controlled largely by Messrs. Charles McKay and C. W. Frank. Through the efforts of this company and by a favourable report on the deposit by Mr. Douglas Lay,[1] of the British Columbia Bureau of Mines, it was brought to the attention of the mining public and was investigated by two large companies. In the spring of 1927 the Selkirk Mining Syndicate employed J. M. Turnbull to make an examination of the deposit and prepare a map and report. This map was kindly placed at the disposal of the writer and was of assistance in the preparation of this report. Late in 1927 the property was bonded by a group of British Columbia capitalists who immediately dispatched an engineer and a force of men to spend the winter doing certain development work, which at the time of writing (January, 1928) is being vigorously carried on.

The deposit is situated on the summit of a small limestone hill about 1 mile south of Ingenika river and 16 miles west of its confluence with the Finlay. This confluence is 16 miles north of Forth Grahame and 56 miles north of Finlay Forks. It can be reached in a small river boat with

[1] Geol. Surv., Canada, Rept. of Prog. 1879-80, pt. B, p. 111.
[2] Ann. Rept., Minister of Mines, B.C., p. 151.

an out-board engine in from 3 to 5 days from Finlay Forks or in 1 to 2 days from Fort Grahame. The journey down stream from the deposit to Finlay Forks can be made easily in a day. The swift, shallow waters of Ingenika river are navigable only for small river boats carrying about 1 ton and at seasons of low water the ascent is made only with some difficulty. Finlay river, owing to its greater size, is easily navigated, as far up as the mouth of the Ingenika, by large boats carrying as much as 8 or 10 tons. Both Finlay and Ingenika valleys are bordered by extensive gravel and sand terraces over which trails or roads can be easily and cheaply built.

In the neighbourhood of the deposit Ingenika valley makes a sharp bend from a southeast to a northeast course, and at the bend expands from a normal width of 2 or 3 miles to one of nearly 10 miles. Towards the centre of this expansion two small limestone hills rise abruptly to 200 and 400 feet, respectively, above the surrounding terraces. On the summit of the smaller and more northerly of these two hills, lying 1 mile south of the river and now generally known as "Ferguson's" hill, outcrop the veins that constitute the deposit. The surrounding terraces are 200 feet above the river, so that the deposit is 400 feet above this level and 3,200 feet above sea-level.

Rock exposures are scarce and consist of either limestone or quartzite. Owing to the scarcity of exposures it was not found possible to determine in detail all the relations of the ore to the enclosing rocks. The quartzites outcrop east of a line running northwesterly. They are exposed just east of Ingenika crag close to the north bank of the river and, south of the river, compose Ingenika cone and an area 1 mile northwest. They are, undoubtedly, part of the wide belt of schists and quartzites bordering Finlay valley throughout the greater part of its length and which were referred by McConnell to the Shuswap series. These have been described previously and in this locality exhibit no unusual features. They strike northwest and dip 70 to 85 degrees northeast.

The limestones outcrop over several large areas north of the river in the vicinity of Ingenika crag and to the northwest. South of the river they form the two isolated hills already mentioned and also outcrop to the north over several limited areas. The limestone exposures appear to be part of a long, continuous band that was mapped by McConnell on the Omineca, and by the present writer east of Carina lake, on the Ingenika, and northwest along Pelly creek. The bulk of the limestone is white or light grey and consists of nearly pure calcite, but in it are also many dark bands of argillaceous material, varying from a small fraction of an inch to several feet in width. On Ingenika crag the limestone also contains many narrow, closely spaced bands of pure quartzite less than an inch wide. In many places, particularly in the vicinity of Ferguson's deposit, the limestone has suffered intense shearing and there contains a large proportion of sericite.

On the Omineca McConnell found this limestone to overlie the schists of the so-called Shuswap series lying both to the east and west and he correlated it with the Castle Mountain series of Bow River district, which there consists of members ranging in age from Middle Cambrian to Ordovician. In the Carina Lake and Ingenika sections the limestones

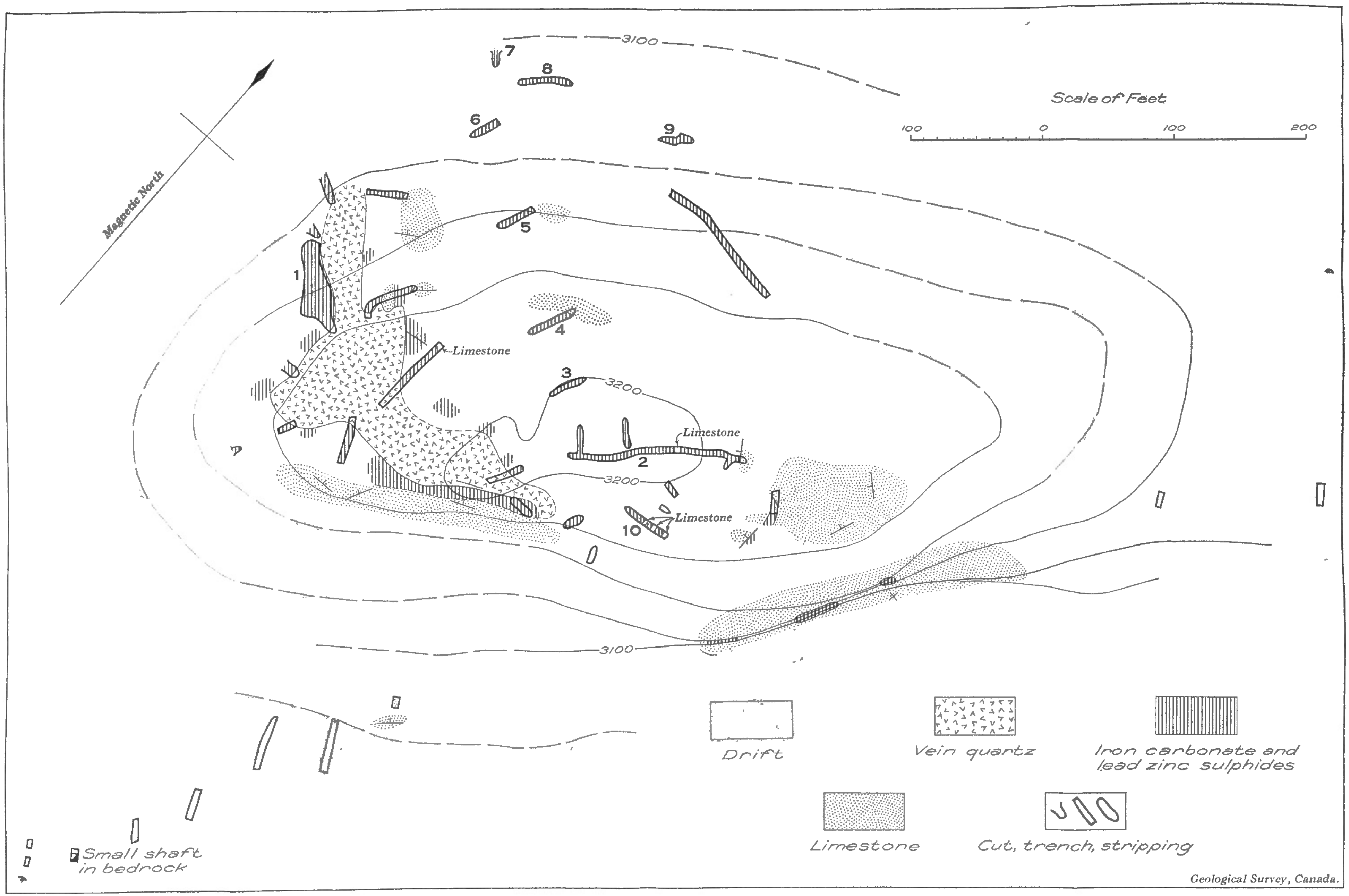

FIGURE 1. Ferguson property, Ingenika river, Cassiar district, B.C. Cuts, trenches, or strippings that are numbered are referred to in text.

dip to the east, apparently under the so-called Shuswap quartzites, but this apparent inferior stratigraphic position may be accounted for in the Ingenika section by an overturned fold. The Carina Lake section was not studied in as much detail, but it is probable that there, also, the series are overturned to the west.

Locally, and particularly in the vicinity of Ferguson's deposit, the limestones are intricately folded. On Ferguson hill and on the hill south of it a small syncline, plunging northwest at an angle of about 30 degrees, is exposed, in which, or close to it, the mineral veins are situated.

Clear evidence was found, in the form of striæ and grooves, of Ferguson hill having been ridden by glaciers moving down the valley in a southeast direction, and a considerable amount of glacial debris containing blocks of ore lies southeast of the hill.

The accompanying plan (Figure 1) shows the veins and workings as well as the geology of the deposit. The large, irreglar mass of vein-quartz appears to cut across the bedding of the limestone of the northern part of the hill, but on the summit and southern slopes it bends around, with the contour of the hill and the bedding planes of the limestone, in a manner that strongly suggests that in this part the quartz forms a lenticular mass conformable with the bedding. Near the top of the steep southern cliffs the quartz and sulphides clearly form lens-like bodies lying parallel to the bedding. Sufficient exposures, however, have not yet been made to enable the shape of this body of quartz and its relation to the folds of the enclosing rock to be fully determined, and such exposures as exist are capable of several interpretations. It is the opinion of some who have examined the deposit that the quartz body extends more or less vertically downward, maintaining a shape and size similar to the surface exposure. Others are of the opinion that this body of quartz is part of a system of five parallel, and nearly vertical, veins striking in a northerly direction. One objection to the acceptance of this theory is the failure of the postulated veins to show up in the well-exposed limestone cliffs only a short distance south and directly along the line of the supposed strike. One would not ordinarily expect five such large veins all to end abruptly along a line that is not marked by a fault or other structural features. The writer is inclined to the opinion that the deposit consists of replacement veins closely associated with the trough of the above-mentioned northward plunging syncline and that their continuation will, therefore, be found at increasing depths towards the north.

The richest ore lies close to the contact of the quartz body, but does not appear to penetrate it. The general tenor of the ore, as well as the ratio of lead to zinc, decreases with increasing distance from the quartz. The largest showing is in cut No. 1 (*See* Figure 1) where a mass of ore is exposed over a length of more than 50 feet, carrying 6·8 per cent zinc, 11·9 per cent lead, and 3·3 ounces of silver per ton, and containing two 5-foot bands of higher grade ore, one carrying 7·4 per cent zinc, 29·6 per cent lead, and 11·0 ounces of silver per ton, and the other carrying 5·1 per cent zinc, 16 per cent lead, and 4·1 ounces of silver per ton. Excellent ore is also present in all the cuts adjacent to the quartz body, as well as in cuts Nos. 5, 6, and 8 to the north, whereas lower grade ore with predominating zinc values is exposed in cuts Nos. 7, 2, 3, 4, 9, and 10.

The mineral composition of the ore and gangue is not clearly indicative of the conditions of temperature and pressure under which the deposit was formed, but the absence of any characteristic high temperature, or low temperature, minerals and the presence of large quantities of siderite strongly suggest that the deposit was formed under intermediate temperatures and pressures as defined by Lindgren[1].

The origin of this deposit, like that of others in the district, is obscured by the absence from the neighbourhood of any large body of igneous rock that might be regarded as the source of the metal-bearing fluids that deposited the ore. A small dyke of medium-grained basic rock outcrops on Swannell river a few miles above its mouth, but is much too small to be considered as a probable source of this ore. As previously mentioned, the numerous pegmatites of the Butler range suggest the probability of the presence of a body of granitic rock somewhere beneath these mountains, which, if it did exist, might well have produced the ore deposits as well as the pegmatites. It is also possible, even probable, that the small batholith exposed in the mountains northeast of the junction of the Tutizika and Mesilinka rivers extends beneath the surface as far as this deposit and was the source of the metals now composing it.

However, sufficient is not yet known regarding the origin of the pegmatites and ores to be of much practical assistance in finding other deposits of a similar origin, nor is it possible from this scant information to form any very sound opinions as to the probable continuation of the ore-bodies already discovered, but if, as seems most likely, the source of the ore is deeply buried beneath the deposits it is reasonable to hope that the ore-bodies may extend to great depths.

A large number of samples have been taken, all of which have yielded surprisingly uniform values. The average of four sets of samples each taken by a different engineer is as follows: silver, 7·51 ounces per ton; lead, 17·81 per cent; zinc, 6·80 per cent.

The mineral composition of the ore is simple, the only metallic minerals present being galena, zinc blende, chalcopyrite, pyrite, magnetite, marcasite, covellite, and limonite, and of these galena and zinc blende together constitute over 95 per cent. This condition renders the ore specially amenable to concentration processes, enabling a concentrate to be easily made that will consist almost entirely of galena and zinc blende. The gangue minerals are quartz and siderite.

The marcasite, covellite, and limonite are of supergene origin. The marcasite and covellite, however, are present in only minute quantities and the limonite though more abundant is derived largely from the siderite. From these facts it may be concluded that the deposit has not been affected to any appreciable extent by processes of surface enrichment.

A summary of the more significant facts from which conclusions may be drawn regarding the future possibilities of this region as a producer of

[1]Lindgren, W.: "Mineral Deposits", 1919, p. 205.

minerals would include the following. The presence of one large and promising deposit of lead-zinc-silver ore, with several smaller occurrences of similar ore. Two important showings of chalcopyrite ore. A zone east of the Finlay extending throughout the region contains much siderite and at intervals deposits of pyrite, one deposit of enargite, and at Lost creek a deposit consisting of magnetite, pyrite, arsenopyrite, and quartz. Of significance, also, is the presence of large numbers of pegmatites in the region between the Finlay and the Omineca batholith. The most striking peculiarity of the region is the absence of large bodies of igneous rocks from the general vicinity of the mineral deposits and pegmatites. From this, and also the fact that this is a region of great crustal disturbances, it seems probable that the fluids producing the mineral deposits and pegmatites originated in some large body of rock, probably a batholith, of acid or intermediate composition, situated far beneath the surface, and were enabled to travel these great distances from their source because of the intense fracturing and shearing of this greatly disturbed area. Assuming this to be correct it is reasonable to expect that the ore deposits of the district will persist to great depths.

CLEARWATER LAKE MAP-AREA, B.C.

By J. R. Marshall

CONTENTS

INTRODUCTION

Clearwater Lake map-area lies west of the main line of the Canadian National railways, and includes the headwaters of North Thompson river. A topographical and geological reconnaissance of this unexplored area was commenced in 1927. Messrs. N. F. G. Davis, A. H. Lang, and W. O. Richmond served as field assistants. Thanks are due to H. G. Nichols, resident mining engineer, Kamloops district, for assay results, and also to Angus Horne, Adolf Anderson, Normand Anderson, G. W. Stewart, and Mr. Buchanan for various courtesies.

Access to the district is by way of the valley of North Thompson river. A pack trail leaves the Canadian National railway at Thompson River crossing, and follows the east side of the river for 30 miles to Pass creek. At Pass creek the trail leaves Thompson valley, crosses a summit 6,000 feet above sea-level, and follows Azure River valley to its head. From the junction of North Thompson and Clearwater rivers, 75 miles north of Kamloops, a trail 50 miles long follows Clearwater valley to lower Clearwater lake. Hobson (upper Clearwater) lake may be reached from the east end of Quesnel lake, whence an old portage road, 6 miles long, leads to the north end of the lake.

STAGE OF DEVELOPMENT

In 1911 Adolf Anderson of Albreda, B.C., with one or two others, blazed a trail from the junction of North Thompson and Albreda rivers to the head of the North Thompson in order to investigate the fur possibilities of the country. In 1913, Anderson extended this trail across to Azure river. He reports he could find no trace of others having preceded him into that part of the district. From 1913 to the present, Anderson and his associates have trapped and prospected in various parts of the district. Very few people other than Messrs. Anderson, Horne, and Stewart, have gone into the area, and the three have given liberally both of their time and slender resources to pioneer work, and towards keeping the present trail in passable condition.

During 1927 rain fell almost continuously from the beginning of June until the middle of July, and from August 25 until September 21, when field work was discontinued. Thus the working season was very short.

The dense foliage in Thompson valley is evidence of a heavy annual rainfall. Snow lies to a depth of 14 feet in Azure River valley near the head of the river, remains on the summit between the Thompson and Azure River waters until July 1, and reappears on all of the slopes early in September. In Raush River valley, tributary to the Fraser, the snowfall is said to be considerably less than in Azure valley.

DESCRIPTION OF THE AREA

The area lies on the eastern border of the Interior Plateau and is a highly dissected upland with broad, rounded summits having uniform elevations of 8,000 feet above sea-level and numerous isolated peaks rising 1,000 feet higher. To the north the upland merges abruptly into the rugged alpine Cariboo range with serrated peaks 9,000 feet to 10,000 feet above sea-level. The streams within the map-area occupy valleys 3,000 feet to 4,000 feet deep. Glaciers have carved many picturesque cirques. Timber-line ends abruptly at 7,000 feet above sea-level. At the head of North Thompson, Azure, and Raush rivers and between Azure river and Hobson lake are extensive, permanent snow and ice fields.

North Thompson river occupies within the map-area a narrow trench with a general northwest trend, and a maximum width of 3 miles. The river has its source in Thompson glacier 35 miles northwest of Thompson River crossing on the Canadian National railway. It is navigable by small craft from the railway crossing to Louis creek, a distance of 15 miles. In this part of its course it winds back and forth across a flat 2 miles wide. Above Louis creek the valley narrows. The river descends in a succession of falls and rapids. From the railway crossing up to Louis creek, a distance of 15 miles, the rise is 700 feet, from Louis creek to Pass creek, 15 miles farther upstream, the rise is 1,800 feet.

The river valley is densely timbered, principally with cedar, spruce, balsam, and poplar. A small stand of white birch was observed at Cariboo flats, 6 miles from the railway. Alders and willows are plentiful in the swampy parts of the valley. Good commercial stands of cedar and spruce were observed at different points, the former up to 40 inches in diameter. From the railway to Cariboo flats, a distance of 6 miles, the valley bottom is suitable for agricultural purposes. Above Cariboo flats the soil is equally good, but much of the land is flooded as the result of damming of creeks by beaver. There are numerous grass meadows in the valley, and on the east side of the river almost any slope above timber-line provides excellent grazing for sheep.

Azure river rises in the north part of the map-area. It heads in extensive snow fields, from whence it flows south for a mile across flat meadow lands 6,000 feet above sea-level. Seven miles from its head the river after dropping 1,000 feet receives its first tributary of any size, Summit creek, which enters from the east. From this point the river follows a narrow canyon for approximately 20 miles to Azure lake. Along its course it receives several large tributaries. In the upper part of Azure River valley there is no commercial timber. Snow lies in places as late as July 1, and as early as September reappears on the slopes.

GENERAL GEOLOGY

The area bordering North Thompson river above the railway crossing is underlain by a thick series of metamorphosed quartzose sediments, including massive quartzite, quartz pebble conglomerate, and quartz-sericite schist with interbeds of limestone and argillite. The lowest observed member is a massive, coarse, light grey quartzite containing varying amounts of mica. Wherever the mica content is noticeable the rock is foliated and resembles a gneiss. The quartzite occurs in beds up to 100 feet thick, and grades upward into thinly bedded quartz-sericite and sericite schists, invariably crenulated and cleaved across the bedding. Interspersed with these beds are thinly bedded, schistose argillites, massive and slaty limestones, and quartz pebble conglomerate.

The general strike is east-west. Local variations occur. As a rule the dips are steep, 70 degrees to vertical. In many instances the cleavage makes an angle of 15 degress to 20 degrees with the bedding. All members of the series are intensely folded. The quartzite, limestone, and quartz pebble conglomerate beds are crenulated less than the less competent schistose rocks which, because of repetition due to folding, outcrop over greater areas than the more massive beds.

ECONOMIC GEOLOGY

Lenticular veins of white quartz up to 15 feet wide and irregular lenticular masses 100 to 300 feet broad were observed on almost every mountain summit and slope and, in addition, the rocks are commonly impregnated with small bunches and stringers of quartz. No persistent, fissure-like veins were observed, the individual veins and masses extending not more than 300 feet in any direction. Pyrite in grains and cubical forms occurs and, in a few cases, is accompanied by chalcopyrite, sphalerite, and galena in a gangue of quartz and siderite. In many cases the quartz at the surface shows no mineralization, but at a depth of 4 to 6 inches holds sparsely disseminated pyrite or is pitted due to the leaching of the pyrite.

In the limited area examined the lenticular veins and masses of quartz may be grouped into two classes: (1) those lying along the bedding or schistosity planes of the country rock; (2) those cutting across bedding and schistosity.

The veins and masses of quartz following the planes of bedding or schistosity are more conspicuous and probably are more numerous than those cutting these planes. They were observed on the slopes and summits of almost every ridge traversed and in many places stand out in bold relief. They are almost entirely confined to the less competent strata, that is to the schist and schistose argillites, and they commonly strike east and west, since this is the prevailing strike of the country rock, or make an angle of 15 degress to 20 degrees with the general strike where they follow the direction of schistosity. The quartz is creamy white and is cross-fractured in almost every direction. In almost every case the veins and irregular masses are barren of mineral, or at best contain extremely small amounts of pyrite. Veins and masses of this type are particularly numerous on the slope and summit east of Summit creek, a short tributary to Azure river. Here some of the veins are 10 feet and 15 feet wide, but do not exceed 300 feet in length. The quartz veins and masses which cross both the bedding and schistosity of the country rock differ in some features from the veins and masses that follow the bedding or schistosity. They are of lenticular shapes and have about the same dimensions as the bodies of the first-described group, but the quartz is not fractured, it is commonly accompanied by siderite, and, almost invariably, is mineralized. Veins and masses of this type were observed on the slopes and summits near the head of the Azure river and at the head of Hobson creek. The minerals observed in them are pyrite, chalcopyrite, sphalerite, and galena.

DESCRIPTION OF PROPERTIES

Summit Group

This group consists of nine claims on the ridge between Azure river and Hobson creek, and approximately 4½ miles south of the head of Azure river. The claims are owned by Angus Horne and G. W. Stewart of Blue River.

On the west side of Azure River valley, 600 feet above the valley bottom, a tunnel has been driven north 40 feet on claim No. 3 of the group. At the portal the rock is a thinly foliated, rusty-weathering, quartz-sericite schist striking east and dipping 70 degrees north; the schistosity strikes north 80 degrees east. The face of the tunnel is in dark green and grey quartz-sericite schists with thin bands of sheared quartzite. The tunnel crosses an irregular quartz lens visible at the surface. The quartz in the tunnel is milky white, massive, and without apparent cross fractures. In the tunnel the lens is 25 feet wide, strikes north 55 degrees east across the strike of the schists, and dips 70 degrees north. Massive and granular pyrite is freely distributed across the full width of the lens and is also sparingly disseminated in the schists for a distance of 1 foot from the walls of the quartz body. A channel sample taken across the full width of the quartz mass in the tunnel assayed $2 per ton in gold. A sample taken by H. G. Nichols, resident mining engineer for Kamloops district, gave gold values of $4 per ton.[1]

Five hundred feet northwest of the tunnel a small lens of milky white quartz is exposed in an open pit. The weathered surface is coated with iron oxide, some of which was crushed and panned, but failed to show any colours. The interior of the quartz is honeycombed as the result of the leaching.

Approximately 1,000 feet northwest of the tunnel, three irregular quartz masses outcrop within 200 feet of one another. The largest is 250 feet long, 20 feet wide, and strikes north 40 degrees east. Granular pyrite is sparingly disseminated at intervals through these masses. In the largest mass is a lenticular seam of pyrite 1 foot wide and 30 feet long paralleling the trend of the mass. A sample taken along the full length of this seam assayed $31 in gold and $3 in silver.

[1]H. G. Nichols: Personal communication.

Approximately $1\frac{1}{2}$ miles northwest of the tunnel an irregular quartz lens, 30 feet by 20 feet, and trending north 15 degrees west, outcrops in the bed of a small creek. One hundred feet west of this mass is a second lens 100 feet long and 15 feet wide striking north 20 degrees west. Quartz-sericite schists striking south 80 degrees east, dipping 70 degrees northeast, form the country rock. Pyrite is very sparingly disseminated through the quartz.

War Colt Group

This group of six claims, owned by Adolf Anderson and Lewis Kuntson of Albreda, is on the east side of Azure river 4 miles from its source.

On the east bank of the river a tunnel driven north 30 degrees east for 20 feet, intersects two quartz veins. At the portal of the tunnel is a vein of blue quartz 8 feet wide striking south 60 degrees east and dipping 60 degrees northeast. This vein can be traced for 50 feet along the strike. Pyrite, chalcopyrite, sphalerite, and galena are disseminated across the full width of the vein. A sample taken across the vein assayed gold $1.50 per ton, silver $1.00 per ton.

In the face of the tunnel the foot-wall of a second vein is exposed. The trend of this vein is about south 35 degrees east. It is sparingly mineralized with pyrite, chalcopyrite, and galena. A sample assayed gold trace, silver trace. Two hundred feet east of, and 400 feet above, the tunnel is an irregular mass of bluish white quartz measuring 60 feet by 25 feet. It is sparingly mineralized with pyrite, chalcopyrite, and galena. In all three veins considerable siderite accompanies the quartz as gangue.

Hobson Creek

Near the head of Hobson creek large blocks of white quartz occur in the glacial debris. Many of these blocks consist of 40 per cent pyrite and 60 per cent quartz, and do not appear to have been transported far.

At the foot of the glacier quartz veins, from 4 inches to 3 feet wide, occur in a shear zone 50 feet wide. Quartz-sericite schist with interbeds of coarse, reddish brown sandstone form the country rock. These strike east and stand on edge. The veins are confined to the schists, and follow the bedding planes. They can be traced, as lenses 30 feet long, for 200 feet to the east. There are also in this zone numerous small, lenticular quartz veins not exceeding 15 feet in length and up to 6 inches wide and striking northeast. Pyrite is sparingly present in both sets of veins, and also is sparingly disseminated in the schists.

HORN SILVER MINE, SIMILKAMEEN, B.C.

By Hugh S. Bostock

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Illustration

INTRODUCTION

The Horn silver mine is a small, silver-gold deposit of the fissure vein type on the east side of Similkameen valley 6½ miles south of Similkameen station, on the Great Northern railway, and about 3 miles north of the International Boundary.

The property was staked in 1901 by Mr. Joseph Hunter and shortly afterwards passed into the hands of Dr. Powell of Victoria. Operations were not seriously started until after Dr. Powell's death when his heirs arranged with Mr. E. W. Condit to take over the property and work began in 1914. After 1920 the management passed to Mr. P. W. Powell. In 1924, the property was taken over by the British American Corporation of Alaska, the name of which was later changed to the Horn Silver Mining Corporation. A 22-ton (per 24 hours) cyanidation mill was erected and in 1926 its operation began, but shortly afterwards suspended owing to the exhaustion of suitable ore for the process. At present work is being centred on development and exploration. The table below gives the record of production as far as figures are available[1].

Year	Production in tons	Total return in ozs.		Remarks
		Silver	Gold	
1915	115	7,779	23	
1916				
1917	320	....	....	Samples from carload lots assayed between 28·8 and 393·4 ozs. silver, and 0·02 to 1·02 ozs. gold per ton; average value of ore $39 per ton
1918	916	42,661	99	
1919	1,049	30,911	84	
1920	1,523	....	....	
1921	825	....	....	
1922	No production	....	....	
1923	"	....	....	
1924	47	....	....	
1925	43	....	....	A composite sample of the ore from the mine assayed 37·0 ozs. silver and 0·2 oz. gold per ton
1926	668	....	....	Treated in the mill

[1]B. C. Minister of Mines Reports.

A single claim, Horn Silver No. 1, has been the sole producer and contains within its limits all the workings of the mine. These are between 2,600 and 2,800 feet above sea-level upon a nose in the fork of a steep, box canyon which opens 1,000 feet below onto a large alluvial cone at the foot of the precipitous side of Similkameen valley. The buildings and mill stand near the apex of this cone, between 1,500 and 1,600 feet elevation, and the mill is connected to the workings by 3,000 feet of single cable aerial tramway.

GENERAL GEOLOGY

The mine workings are in a large body of alkali syenite which has intruded a series of metamorphosed sediments consisting of phyllites, mica schist, and quartzite. The contact with the sediments is about a quarter of a mile north of the mine, and extends in a general east-west direction. Veins, as yet unexplored, but similar to that of the Horn silver mine, have been found east of the workings and also nearer the contact, in the igneous rock, and for some distance within the sediments.

Directly about the mine the alkali syenite is the chief country rock. In it are several bodies of hornblendite and various dykes of rock types allied to the alkali syenite. The alkali syenite has been mapped by R. A. Daly[1] as part of the Similkameen soda granodiorite batholith which he considered to be of Tertiary age. The igneous rocks of the Horn silver mine are evidently part of this body and also related to the alkaline body of Kruger mountain a few miles southeast. The sedimentary rocks are part of the Anarchist series doubtfully of Upper Palæozoic age.

The limits of the alkali syenite body were not precisely determined. The mass extends from the mine a quarter of a mile north, the same distance south, a mile east, and to the floor of Similkameen valley on the west. The rock is grey and has a medium-grained, granitic texture. In some places large hornblendes, up to half an inch long and enclosing feldspars, have developed. The composition of the rock is, approximately: microcline, 37·5 per cent; orthoclase, 11·5 per cent; oligoclase, 3·9 per cent; hornblende, 23·8 per cent; augite, 20·3 per cent, with quartz, titaniferous magnetite, apatite, and titanite as accessories, as well as pyrrhotite, biotite, leucoxene, carbonate, and other alteration products. The feldspars in general are small and form patches of mosaic between the hornblendes and augites. The hornblende is strongly pleochroic and is deep blue-green. It commonly forms shells enclosing euhedral crystals of pale blue-green, very slightly pleochroic augite. Schiller structure is present in many instances in both augite and hornblende.

The hornblendite occurs in irregular, angular bodies in the alkali syenite. The bulk of these bodies is composed of very coarsely crystalline hornblende with variable quantities of augite and only a very little feldspar.[2] Along the borders, however, the texture becomes finer and microcline makes up a large percentage of the rock and encloses hornblendes and augites in a poikiloblastic structure. The hornblende and

[1] Daly, R. A.: Geol. Surv., Canada, Mem. 38, p. 425.

[2] Dolmage, V., per P. B. Freeland: B. C. Minister of Mines Report, 1925, p. A209. "The dark-green specimen" which is found in the lowest tunnel "is over 90 per cent hornblende and the remainder labradorite which would make it a basic hornblende gabbro verging on a hornblendite."

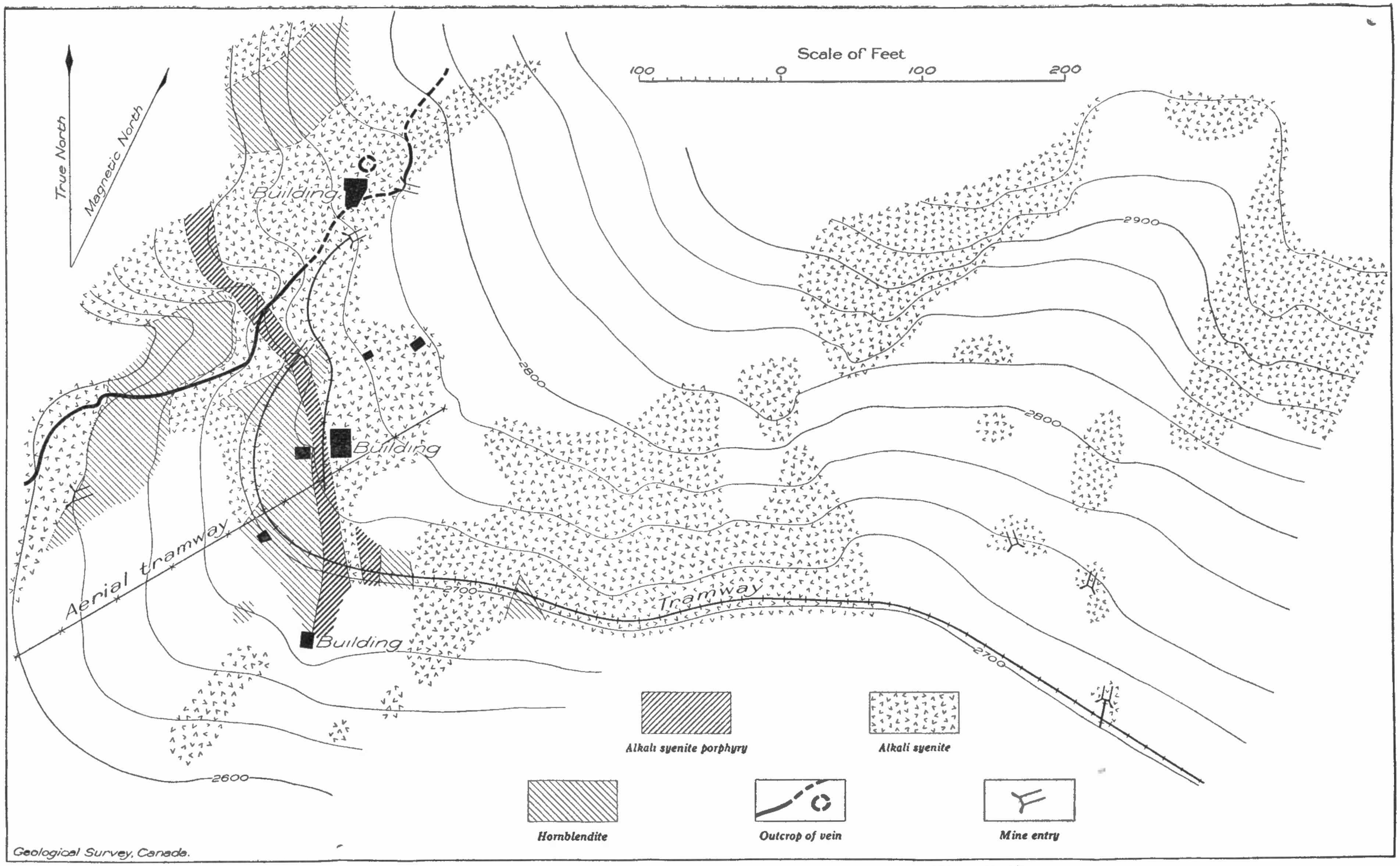

FIGURE 2. Surface geology of the Horn silver mine, Similkameen district, British Columbia

augite as well as the accessory minerals are the same as those of the alkali syenite. These bodies of hornblendite are, in all probability, partly digested remnants of a former intrusive that formed part of the roof of the alkali syenite.[1]

Several varieties of syenitic dykes, including alkali syenite porphyry and syenite porphyry, cut the alkali syenite and hornblendite. With a few exceptions these dykes are less than 3 feet wide and many are only a few inches wide. In general they are nearly vertical and strike about north.

The largest dyke is an alkali syenite porphyry and strikes slightly west of north. It is represented on the accompanying figure. It cuts both hornblendite and alkali syenite and includes fragments of these rocks. Some of the fragments are enclosed in lenses of quartz in a gneissoid zone parallel to the walls. The gneissoid material is a mosaic of fine feldspar and quartz with hornblende, garnet, and titanite thinly distributed through it in bands. The dyke proper is composed of euhedral phenocrysts of pink microcline, some as large as 2 by $\frac{3}{4}$ inches, which are oriented roughly parallel to the walls and are embedded in a groundmass of microcline, oligoclase, hornblende, and augite. Microcline forms more than 70 per cent of the rock. In addition apatite, titanite, biotite, quartz, garnet, and pyrrhotite are present.[2]

Numerous small, pink feldspar dykes, many only a few inches wide and evidently closely related to the alkali syenite porphyry, occur throughout the mine workings. Garnets commonly occur in them and some are as large as an inch across. Dykes of a syenite porphyry very similar in appearance to the alkali syenite porphyry, but of slightly less coarse texture and having white feldspars, occur along the east side of the tramway. This rock is composed of, approximately: microcline, 47·0 per cent; orthoclase, 3·6 per cent; oligoclase, 27·1 per cent; hornblende, 14·7 per cent; augite, 3·7 per cent; with small quantities of titanite, apatite, epidote, biotite, and carbonate.

ORE DEPOSITS

The ore deposits are apparently embodied in one main fissure vein, though this condition has not been conclusively demonstrated. The vein strikes about west-northwest and dips on the average about 28 degrees southwest. In thickness it varies from a few inches up to a maximum of $4\frac{1}{2}$ feet, but the average width in the workings is about 3 feet. The vein may be pictured as a sloping sheet gently warped and divided into numerous slabs by faults which offset them in an irregular, step-like manner, giving the vein, as a whole, a more nearly east-west trend. As a result, towards the east, where the hill slopes south, the vein, lying at a depth, is approximately parallel to the sloping surface, whereas on the west where the slope of the hill is to the west, the vein outcrops along a line which runs southwest down hill. The extent of the outcrop of the

[1]Daly, R. A.: Geol. Surv., Canada, Mem. 38, p. 433. A similar rock is described from the top of Richter mountain about 2 miles east of the Horn Silver mine.

[2]A rock from Kruger mountain of identically the same appearance and described as a porphyritic alkaline syenite is shown on p. 448, Mem. 38, Geol. Surv., Canada.

vein is shown on the accompanying figure. At both extremities it disappears under debris. The mine workings stretch along the strike of the vein about 700 feet east from the western entries to a line extending about 350 feet northeast from the eastern entry.

The vein in some places occupies a clean fracture, but more usually it contains horses or patches of brecciated wall-rock and in other places it consists of several parallel fractures, with the result that bands of wall-rock alternate with vein matter. Stringers from a fraction of an inch to a foot wide are found diverging from it generally at very acute angles. Variations in the wall-rock have had no effect on the direction of the fissure. The walls of the vein are usually sharply defined. Blocks of country rock in the vein and the wall-rock for an inch or so along the vein walls have been partly altered to an aggregate of chlorite, carbonate, sericite, and pyrite. The hornblendes and augites are completely altered, but the feldspars relatively slightly so and their positions are distinguishable.

The vein was examined particularly along the 2,700-foot level and the following mineralogical account is based chiefly on data obtained from that level.

The vein minerals, in their order of deposition from first to last, are: (1) quartz; (2) pyrite; (3) sphalerite and chalcopyrite, which appear to be contemporaneous; (4) galena and tetrahedrite (?) slightly latter; (5) hematite; and (6) finally native silver and calcite. Argentite and pyrargyrite are reported to occur, but no trace of either could be found in the specimens examined.[1] As a rule the vein consists of a gangue of quartz in which the other minerals occur as scattered patches, short irregular seams, and disseminated crystals in variable quantities. The ore consists of the sections of the vein richer in sulphides in general and, particularly, in native silver. In addition to the quartz, in many places the fragments of wall-rock make up a large percentage of the gangue in the vein. Small vugs are occasionally present in the quartz.

The quartz is characteristically milky and occurs in crystals up to one-quarter inch long. The pyrite is moderately fine grained and besides occurring in the wall-rock is the most widespread sulphide in the vein. Though in part it surrcunds patches of sphalerite, as a rule the other metallic minerals and the calcite enclose it and fill fractures in it. The sphalerite is dark and invariably contains minute specks of chalcopyrite more or less evenly distributed through it. Chalcopyrite is commonly present in small amounts around the borders of, and intergrown with, the sphalerite. Under the microscope a few small patches of a mineral with the microchemical properties of tetrahedrite were discovered, but so little could be found that the identification is not positive. In a few places a minute, brecciated structure is apparent in the sulphides, apparently due to slight crushing followed by recementing of the minute fragments of the minerals. Tiny veinlets of hematite less than $\frac{1}{20}$ inch wide fill joints in the alkali syenite and in the vein and are later than the sulphides. The native silver is in the form of flakes in fractures among the other minerals, but appears to be particularly associated with the pyrite. The calcite fills cracks in and between the other minerals.

[1] B. C. Minister of Mines Report, 1919, pt. N, p. 169.

STRUCTURE

The vein along the outcrop, as it rises from an elevation of 2,600 feet to one of 2,765 feet, changes in strike from north 80 degrees west to north 68 degrees west, and in dip from 25 degrees west to 34 degrees southwest. On the 2,700-foot level, in the central part of the workings, the strike is north 56 degrees west to north 38 degrees west and the dip from 32 degrees to 39 degrees southwest. In the eastern part the strikes are between north 80 degrees west and north 60 degrees west and the dips between 20 degrees and 30 degrees southwest. In the eastern section, a number of stringers branch from the main vein with considerable divergence in strike and dip from the average, though as a rule the small veinlets which occur here and there throughout the workings are roughly parallel to the main vein.

The joints and faults may be divided into sets. One set includes the mineralized fractures of the vein and veinlets and a few barren fractures parallel to them. The directions followed by these fractures have been given above. These are crossed by a second set striking between north and north 35 degrees east and dipping from 60 degrees west to vertical. The second set offset the vein to the northeast in some places as much as 40 feet horizontally. Slickensiding along them shows a downward movement on the east side along a plane dipping 15 degrees to 25 degrees north. It is those faults that predominate and give the vein the roughly east-west direction. A third set of fractures strikes between north 40 degrees west and north 30 degrees west and dips 75 degrees southwest to 80 degrees northeast. In a few places along these the upthrow is on the northeast side. A fourth group of fractures in the eastern part of the workings varies in strike from north 13 degrees to north 27 degrees east and in dip from 38 degrees to 58 degrees west, and have the upthrow on the east side. Some fracturing has occurred along the vein since mineralization and the vein matter is crushed.

The western two-thirds of the vein and the section directly above the 2,700-foot level in the southeast part of the area penetrated by the mine workings, have provided the production to date. This ore consisted of the vein matter as described, but in which the sulphide content had been greatly reduced by oxidation. The mill was designed for this type of ore, but shortly after the opening of the mill, the supply was exhausted and the vein was found to carry only unoxidized sulphide ore in quantities too small to warrant adapting the mill to treat it. The results of recent exploration, however, are encouraging, for the vein has been picked up about 200 feet, east and north of the mined sections, and there carries very high values in sulphide ore.

ASSOCIATED DEPOSITS

Besides the workings on the Horn Silver No. 1 claim, a little exploration has been done on two similar veins higher up the mountain. On the Silver Bell claim directly above the Horn Silver, at an elevation of about 3,240 feet, an adit has been driven for approximately 150 feet on a small vein of the same type which strikes roughly parallel to that of the Horn Silver but dips more steeply to the south. The wall-rock is alkali syenite porphyry and alkali syenite.

At an elevation of about 4,150 feet and half a mile east of the Horn Silver, a vein outcrops on the Woodrow claim. This vein is from 36 to 42 inches thick and is roughly horizontal. It is exposed for a distance of a little over 100 feet along the hillside, which faces southwest. It is fractured along numerous joints, the more prominent of which strike east-west and dip 14 degrees to 29 degrees south or strike north 9 degrees to 16 degrees and dip 73 degrees to 77 degrees west. On one of the latter, about the middle of the exposure, a downthrow on the west side, of 1 to 2 feet, occurs. The wall-rock is alkali syenite. The vein material is similar to that of the Horn Silver and consists of quartz with fragments of wall-rock and scattered sulphides. Pyrite, arsenopyrite, zinc blende, and galena were noted. The arsenopyrite was found finely disseminated with a little pyrite in the altered wall-rock. This showing warrants more attention.

Other veins of similar types are reported to the north.

PEAT BOGS FOR THE MANUFACTURE OF PEAT LITTER AND PEAT MULL IN SOUTHWEST BRITISH COLUMBIA

By A. Anrep

CONTENTS

INTRODUCTION

Projects involving the manufacture, on a commercial scale, of peat litter and peat mull have attracted considerable attention in southern British Columbia and in 1927 the present writer was instructed to investigate a number of peat bogs, mainly in the vicinity of Vancouver, in order to determine if the bogs were such as would afford a sufficient and suitable supply of raw materials for the proposed industry. Ten bogs in the vicinity of Vancouver, a bog near Chilliwack, another near Kelowna, a bog 3 miles north of Duncan, another near Tyee station, and several on the west coast of Vancouver island, were examined.

"The use of moss litter as bedding for horses and cattle (and, it may be added, in hen houses) has . . . increased enormously in Europe, where its advantages for this purpose have been clearly demonstrated. Peat mull, which is obtained as by-product in the manufacture of moss litter, is also largely used for various purposes . . . . Moss litter is manufactured from sphagnum peat, which must be as little humified as possible in order to be suitable for the manufacture of first-class moss litter. Dark, decomposed peat is less suitable, on account of its comparatively small moisture-absorbing properties. A simple, practical test to determine the quality of the peat is the following: a piece of the peat is squeezed by hand and if only clear water is squeezed out, and the remainder consist of light-coloured, undecomposed moss residue, the peat is, as a rule, well suitable for the manufacture of moss litter".[1]

The positions and relative sizes of the ten bogs examined in the Vancouver City district are represented on Figure 3, which has been prepared from the Fraser River Delta map.[2] Four of these bogs hold large amounts of material suitable for the manufacture of peat litter and peat mull, and further information regarding these bogs is given in a succeeding section of this report. The remaining six bogs are

[1]Nystrom, E.: "Peat and Lignite, Their Manufacture and Uses in Europe"; Mines Branch, Dept. of Mines, p. 230 (1908).
[2]Johnston, W. A.: "Fraser River Delta" map, publication No. 1965, Geol. Surv., Canada (1923).

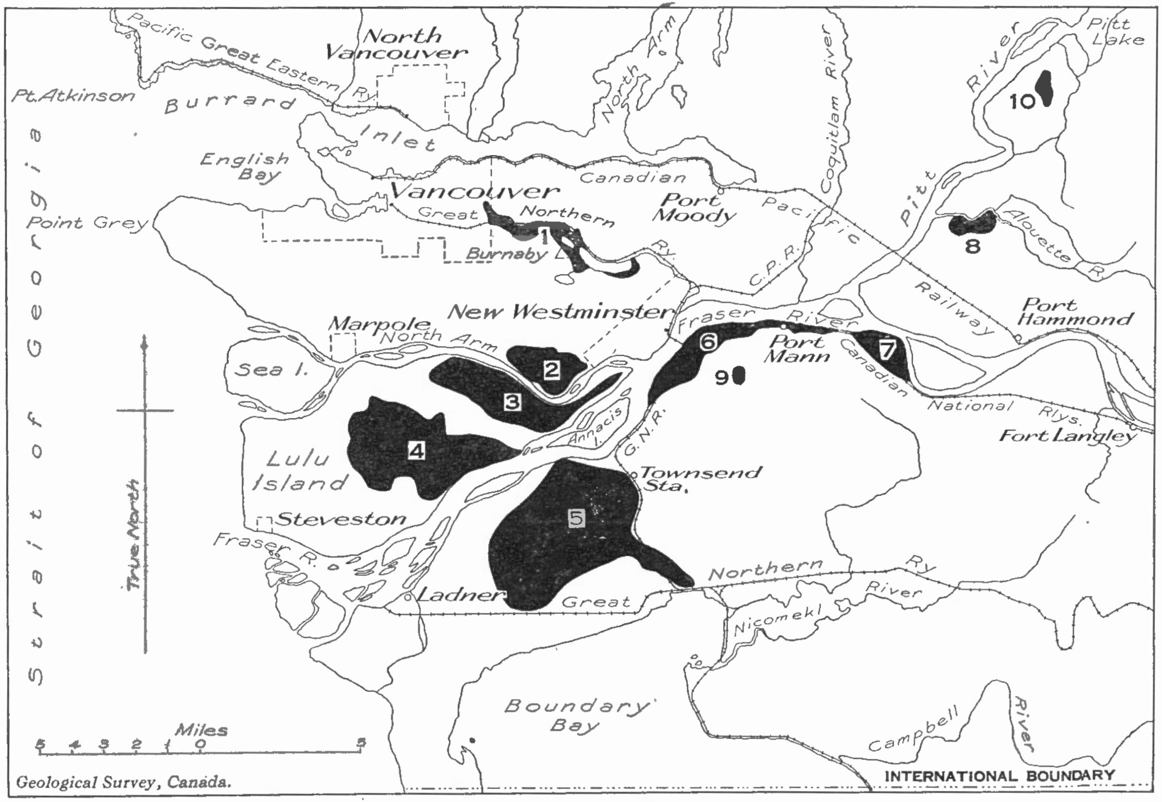

FIGURE 3. Vicinity of Vancouver, B.C., showing positions of peat bogs reported on: 1, Burnaby Lake; 2, Burnt Road; 3, Smaller Lulu Island; 4, Larger Lulu Island; 5, Delta; 6, Port Mann; 7, Tynehead; 8, Alouette; 9, Pacific Highway; 10, Pitt Lake.

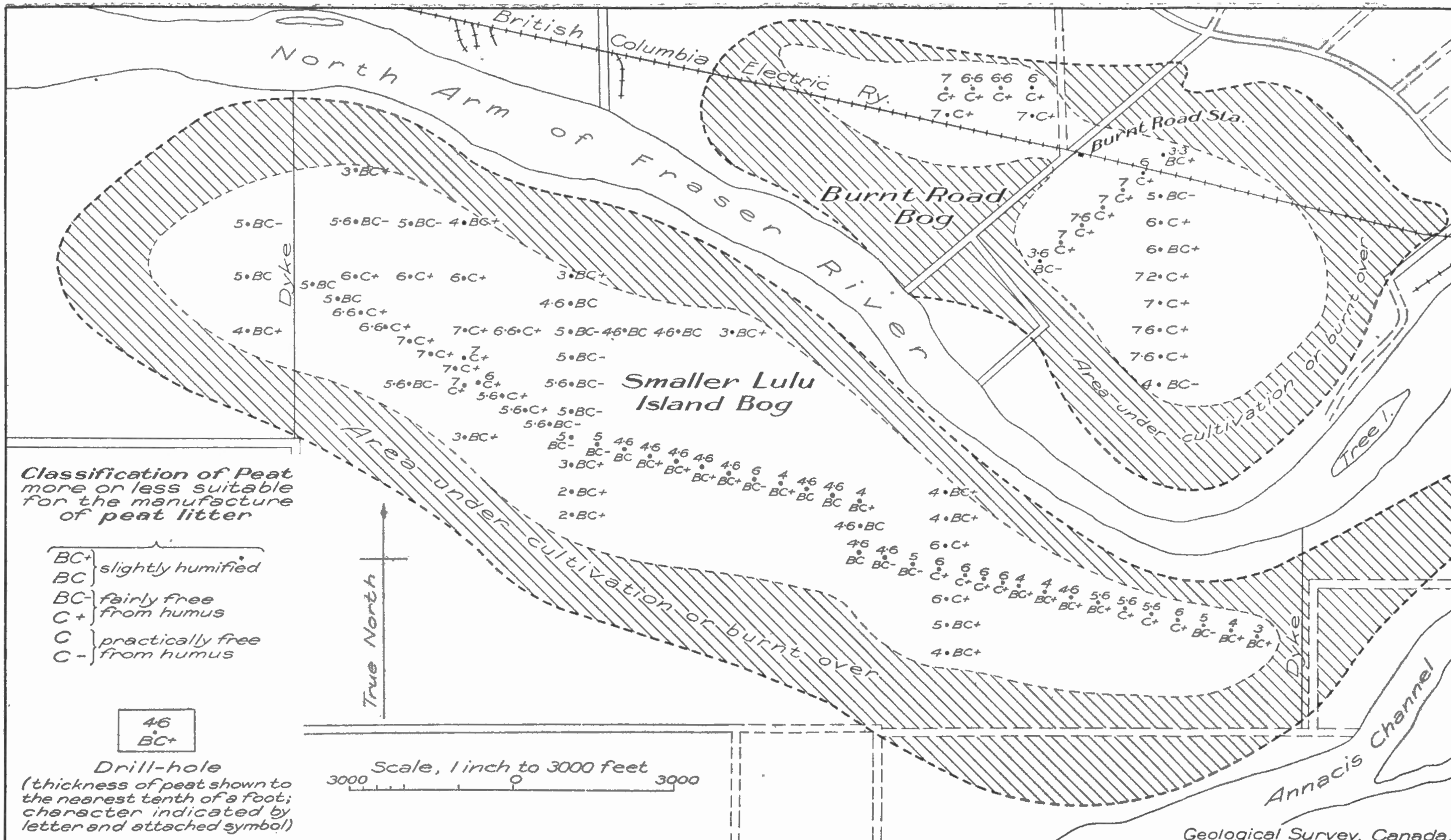

Figure 4. Burnt Road and Smaller Lulu Island bogs.

either marshy and practically void of sphagnum growth or the contained peat is so much altered as to be unsuitable for the manufacture of peat litter.

The bog near Chilliwack, in southeast ¼ section 10, township 23 (Jackson farm), was also found to be unsuitable. The original sphagnum moss covering has been nearly completely destroyed by fire, and the moss remaining has been considerably altered and occurs mainly in isolated, shallow patches.

The bog near Kelowna, in northeast ¼ section 8, and southeast ¼ section 17, township 21, has an area of about 140 acres. The contained peat is almost wholly formed of the remains of plants of the Carex family and, therefore, not suited to the manufacture of peat litter, but if properly drained this bog area could easily be converted into valuable agricultural land. Small pockets of peat, with a covering 1 to 2 feet deep of sphagnum moss, occur in the mountainous sections of Okanagan district, but would not afford an adequate supply of moss for a moss-litter plant.

The bog situated about 3 miles north of Duncan, Vancouver island, stretches north from the north shore of Somenos lake for about 4 miles, and with an average width of ½ mile. This bog, and a smaller one about 80 acres in extent and situated one-half mile south of Tyee station, are practically devoid of sphagnum moss and, therefore, not suited for the manufacture of litter. They could, however, if properly drained, be transformed into valuable agricultural land.

The peat bogs near Ucluelet, on the west coast of Vancouver island, are shallow pockets of peat in a mountainous area. They have thin coverings of sphagnum moss, but would not warrant any attempt to manufacture peat litter on a commercial scale.

BOGS IN THE VICINITY OF VANCOUVER

Burnt Road Peat Bog[1]

(*See* Figure 4)

This bog lies southwest of, and close to, New Westminster. The total area is, approximately, 1,500 acres. About 800 acres are under cultivation or, as along the north margin, the peat moss has been burnt. A limited number of borings indicate that the remaining 700 acres have a moss covering varying in depth between 4 and 8 feet and averaging 6·5 feet. The covering in its present state has a volume of 7,341,000 cubic yards. For commercial purposes in estimating the content, the usual practice is not to consider any part of a bog deposit less than 5 feet deep, and for shrinkage by draining and loss in manufacture, to deduct 2 feet from the average depth. Since the Burnt Road bog is already partly drained and has settled considerably, no part of the 700 acres need be omitted from consideration and only 1 foot need be allowed for further shrinkage and for wastage in manufacture. Providing for shrinkage and wastage, the content is 6,211,000 cubic yards, or 373,000 tons of dry peat litter, equivalent to 466,000 tons holding 20 per cent moisture.

[1]All amounts are approximate. A ton is considered as 2,000 pounds. A cubic yard of drained moss is assumed to be equal to 120 pounds of dry moss litter.

Analyses of Samples from Peat Litter Cover

—	Samples from depths of		
	0–3 feet	3–7 feet	0–6 feet
Sample No. I, from south of B.C. Electric railway—			
Absorption factor for moisture-free peat	23·2	14·6	....
Absorption factor for peat with 20 per cent moisture	18·5	11·7	....
Ash (dried at 105°C.)	....	3·4%	....
Sample No. II, from north of B.C. Electric railway, east part of bog—			
Absorption factor for moisture-free peat	....	....	9·3
Absorption factor for peat with 20 per cent moisture	....	....	7·4
Ash (dried at 105°C.)	....	....	4·3%
Sample No. III from north of B.C. Electric railway, west part of bog—			
Absorption factor for moisture-free peat	....	....	11·5
Absorption factor for peat with 20 per cent moisture	....	....	9·2
Ash (dried at 105°C.)	....	....	4·3%

Drillings indicate that the total depth of the bog varies between 2 and 15 feet and that the peat below the moss layer is considerably humified and could be converted to agricultural uses, as has already been demonstrated in places on the bog. The base of the moss layer is above sea-level and the deposit can be drained south into the north arm of Fraser river.

Smaller Lulu Island Peat Bog

(*See* Figure 4)

This bog lies in the western end of Lulu island and borders the north arm of Fraser river. The total area is, approximately, 3,300 acres. About 1,600 acres once had a covering of peat moss, which has been entirely destroyed by fires set alight and needlessly allowed to extend towards the central part of the bog when parts of the bog were being brought under a state of cultivation. At present only the extreme eastern part, and narrow strips along the northern and southern margins, are cultivated. About 1,700 acres representing the inner part of the bog still have a moss covering and borings indicate that it varies in depth between 2 and 7 feet and averages 5 feet. The covering in its present state has a volume of 13,713,000 cubic yards. Since the bog is already partly drained and has settled considerably, no part of the 1,700 acres need be omitted from consideration and only 1 foot need be allowed for further shrinkage and for wastage in manufacture. Providing for shrinkage and wastage, the content is 10,971,000 cubic yards or 658,000 tons of dry peat litter, equivalent to 823,000 tons holding 20 per cent moisture.

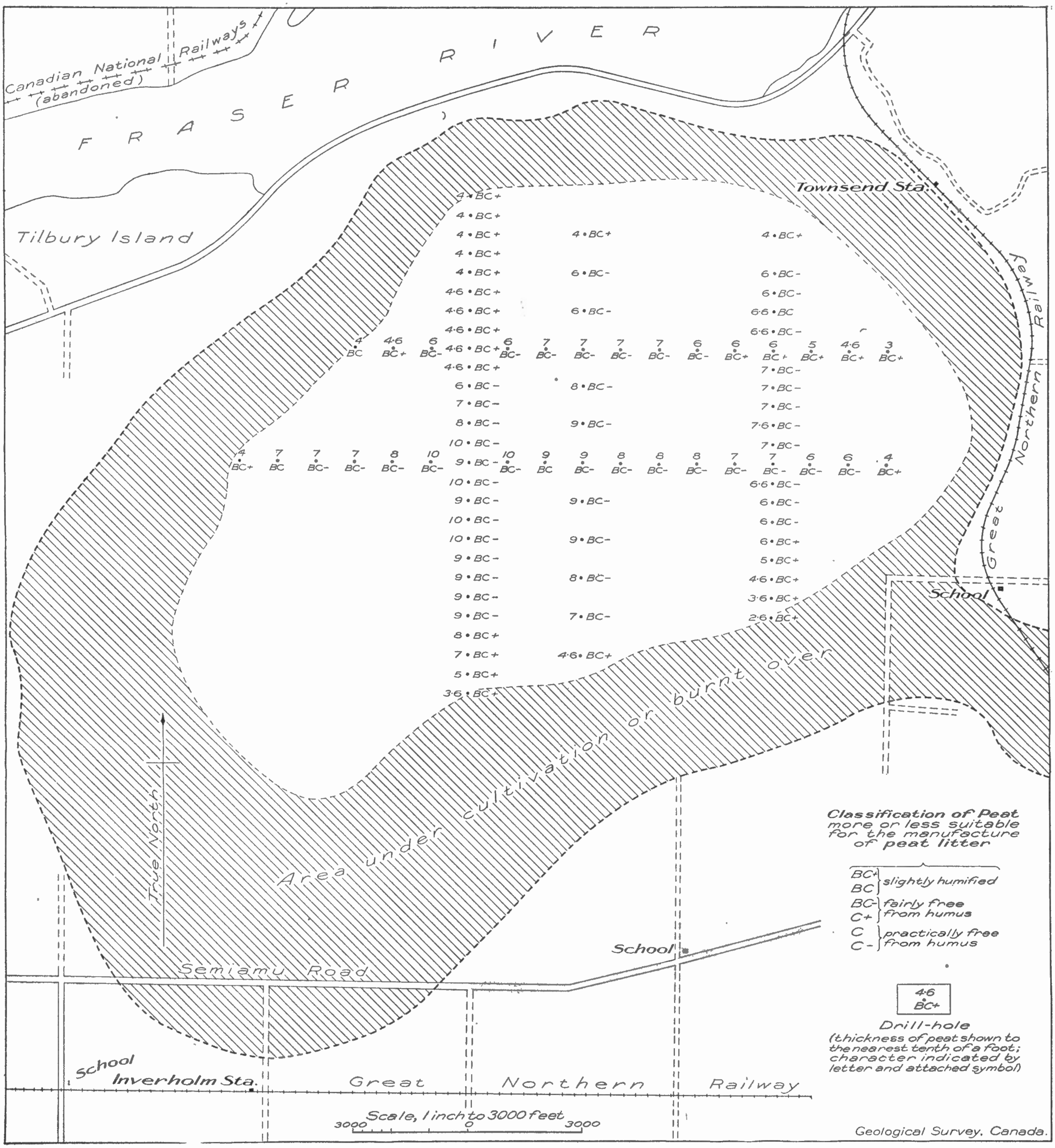

FIGURE 5. Delta bog.

Analyses of Samples from Peat Litter Cover

—	Samples from depths of		
	0–3 feet	3–7 feet	0–6 feet
Sample No. I, from southeast part of bog—			
Absorption factor for moisture-free peat	16·3	14·0	....
Absorption factor for peat with 20 per cent moisture	13·0	11·2	....
Ash (dried at 105°C.)	....	2·6%	....
Sample No. II, from central part of bog—			
Absorption factor for moisture-free peat	17·7	14·2	....
Absorption factor for peat with 20 per cent moisture	14·1	11·3	....
Ash (dried at 105°C.)	....	3·0%	....
Sample No. III, from western part of bog—			
Absorption factor for moisture-free peat	....	....	9·8
Absorption factor for peat with 20 per cent moisture	....	....	7·9
Ash (dried at 105°C.)	....	....	5·6%

Drillings indicate that the total depth of the bog varies between 2 and 20 feet and that the peat below the moss layer is considerably humified and could be converted to agricultural purposes. The peat moss layer can be drained to the north arm of Fraser river.

Delta Peat Bog

(*See* Figure 5)

This bog lies south of Fraser river. The total area is, approximately, 10,500 acres. The margins of the bog are under cultivation and a very considerable part has been destroyed by fire, but the central part is still in its natural state. Some 4,700 acres have a moss covering that, as indicated by borings, varies in depth between 2 and 10 feet and averages 8 feet. The covering in its present state has a volume of 60,661,000 cubic yards. No part of the peat moss area need be omitted from consideration, but 2 feet should be allowed for shrinkage and for wastage in manufacture. Providing for shrinkage and wastage, the content is 45,496,000 cubic yards, or 2,730,000 tons of dry peat litter, equivalent to 3,412,000 tons having 20 per cent moisture.

Analyses of Samples from Peat Litter Cover

—	Samples from depths of			
	0–3 feet	3–6 feet	6–9 feet	9–12 feet
Sample No. I, from central part of bog—				
Absorption factor for moisture-free peat	25·7	15·9	12·7	11·3
Absorption factor for peat with 20 per cent moisture	20·6	12·7	10·2	9·0
Ash (dried at 105°C.)	3·2%	2·6%	3·7%	....
Sample No. II, from eastern part of bog—				
Absorption factor for moisture-free peat	10·5	....	....	....
Absorption factor for peat with 20 per cent moisture	8·4	....	....	....

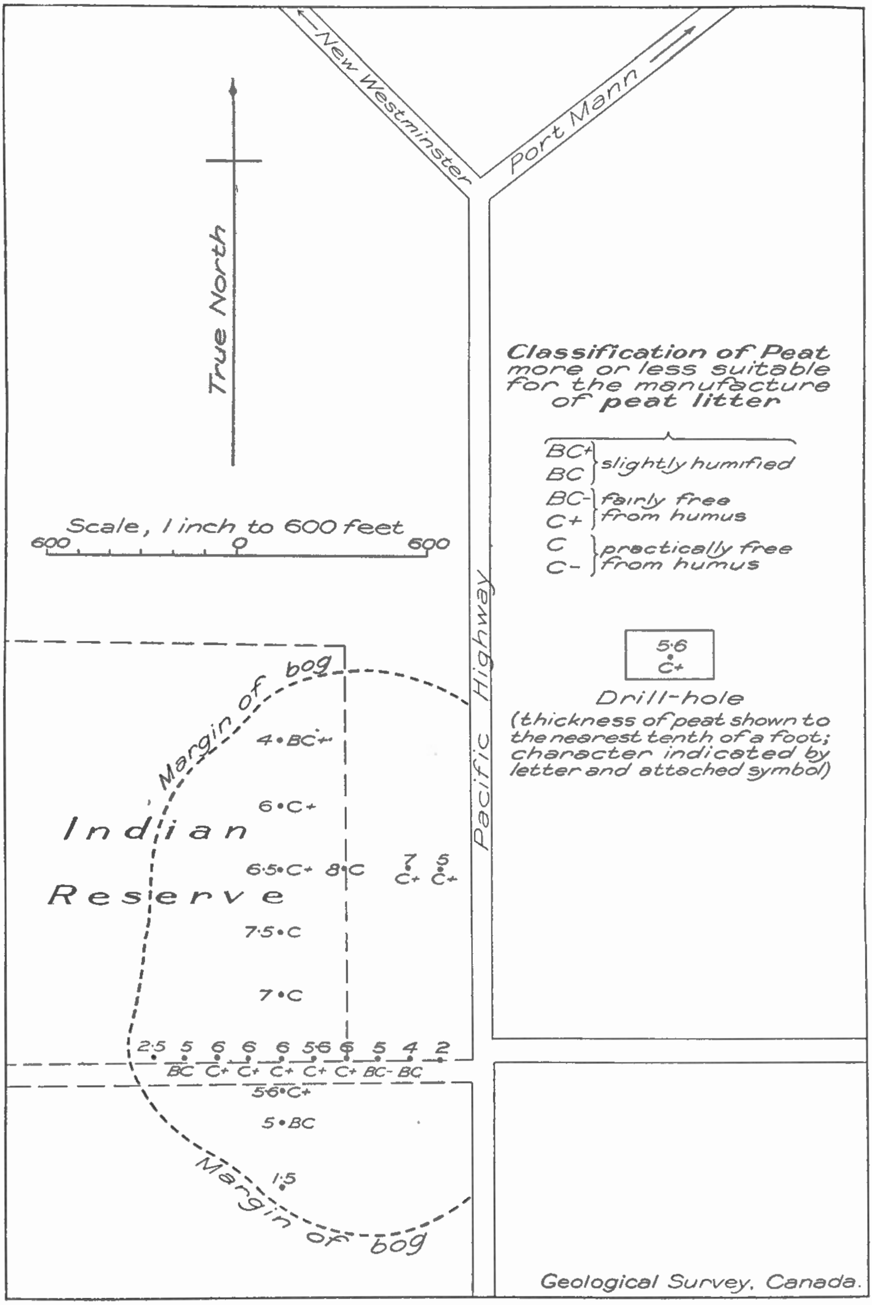

FIGURE 6. Pacific Highway bog.

Drillings indicate that the total depth of the bog varies between 2 and 25 feet and that the peat below the moss layer is considerably humified and could be converted to agricultural purposes. The peat moss layer is above sea-level and can be drained to Fraser river.

Pacific Highway Bog

(*See* Figure 6)

This bog adjoins the Pacific highway 3½ miles southeast of New Westminster. The total area is, approximately, 37 acres. The peat moss cover has been preserved almost in its natural state. Borings indicate that 27 acres have a moss covering varying in depth between 2 and 8 feet and averaging 6 feet. The covering in its present state has a volume of 261,400 cubic yards. No part of the bog need be omitted from consideration and since it is already partly drained and has settled somewhat, only 1 foot need be allowed for further shrinkage and for wastage in manufacture. Providing for shrinkage and wastage the content is 217,800 cubic yards or 13,000 tons of dry peat litter, equivalent to 16,000 tons holding 20 per cent moisture.

Analyses of Samples from Peat Litter Cover

—	Samples from depths of		
	0–3 feet	3–7 feet	3–5 feet
Sample No. I, from central part of bog—			
Absorption factor for moisture-free peat	19·5	17·6	....
Absorption factor for peat with 20 per cent moisture	15·6	14·1	....
Ash (dried at 105°C.)	2·8%	3·8%	....
Sample No. II, from margin of bog—			
Absorption factor for moisture-free peat	20·4	16·3	....
Absorption factor for peat with 20 per cent moisture	16·3	13·0	....
Ash (dried at 105°C.)	3·8%	5·5%	....

Drillings indicate that the total depth of the bog varies from 2 to 22 feet and that the peat below the moss layer is fairly well humified and could be converted to agricultural purposes. The peat moss layer is above sea-level and can be drained either to the north or the south.

COMMERCIAL POSSIBILITIES

Burnt Road bog, the smaller Lulu Island bog, Delta bog, and the Pacific Highway bog, have a combined content of nearly 5,000,000 tons of peat litter containing 20 per cent moisture. The material lies at the surface of the bogs, is fairly free from humus, and is favourably situated as regards manufacturing conditions and accessibility to markets. The two chief markets are afforded by the poultry and fruit industries, peat litter being superior to straw for bedding purposes, and peat mull, the fine material produced during the manufacture of peat litter, being an excellent packing material for hard and soft fruits.

In the vicinity of Vancouver, in Fraser River delta area, the number of hens is estimated to exceed 2,000,000 and some difficulty is experienced in keeping the fowl in a sanitary condition by using straw for bedding and a covering for scratching ground. In 1926 several of the owners of the larger chicken ranches imported from Europe a limited amount of peat litter and on using it instead of straw, found that the chickens became cleaner and brighter, scratched more vigorously, and laid more eggs. The superiority of peat litter to straw is due: to its high absorptive power for liquids, peat litter will absorb 8 to 20 times its weight of liquid, whereas straw absorbs only 2 to 3½ times its own weight; to its power of absorbing ammonia and other volatile substances, thus preventing a foul atmosphere in chicken runs; and to its disinfecting qualities, resulting from its ability to absorb and retain injurious waste products, and its power of inhibiting decomposition and putrefaction.

Peat mull not only is a highly valued packing material for fruit, vegetables, fish, meat, etc., but in Europe, because of its disinfectant and deodorizing qualities, it is largely employed for the collection of human excreta. Peat mull also affords an excellent bandaging and padding material for surgical and related needs. It is an excellent heat insulating material. Peat mull, because of its great absorptive power and its property of preventing decomposition, is used to convert crude molasses into a fattening food for animals.[1]

The manufacture of peat litter and peat mull is an important industry in various northern European countries. Precise statistical information regarding annual output is not available, but an idea of the extent of the industry is afforded by the following statements. Belgium produces peat litter and peat mull for local use and for export. Finland, in 1926, manufactured 465,000 bales, each of about 120 pounds weight, of peat litter and mull. Germany, in the same year, produced 235,000 tons of baled peat litter and peat mull, as well as large quantities consumed locally. Holland, it is estimated, manufactures about 200,000 tons annually and a large amount of this is exported. In Norway the annual production is about 500,000 bales, each weighing 160 to 180 pounds. Sweden, in 1926, produced about 228,000 tons. Russia, in 1926, manufactured only about 7,000 tons of peat litter and peat mull, but it is estimated that farmers for their own use produced about 820,000 tons.

At present no peat litter is manufactured in Canada. During the period March, 1926, to February, 1927, 677 tons were imported from Belgium, Germany, and Holland. Of this amount 589 tons were brought in through the port of Vancouver and delivered to the owners of chicken ranches in the vicinity of New Westminster at a cost to the consumers that varied from $40 to $60 per ton. The market prices of peat litter over a period of years in certain countries of northern Europe, are given in the subjoined table.

[1]For further details regarding the uses, and mode of recovery and manufacture of peat litter and peat mull, *See* "A Handbook on the Winning and the Utilization of Peat", by A. Hansding, translated by Hugh Ryan, Printed and published by His Majesty's Stationery Office, London, 1921.

Market Prices of Peat Litter in Northern Europe

Country	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Denmark	4 80	5 26	7 30	14 08	20 74	17 86	13 83	9 39	8 00	8 38	5 89	5 05	6 76	......
Finland	6 48	6 04	4 68	5 80	12 34	16 52	13 00	7 06	3 88	4 46	7 35	7 00	6 01	5 66
Holland	4 02	4 13	4 05	4 17	5 33	8 10	6 91	7 07	5 77	5 50	6 06	4 87	5 27	5 37
Norway	6 00	5 92	6 27	7 23	19 25	23 99	19 95	16 41	10 75	8 75	9 35	16 26	8 59	10 06
Sweden	3 88	3 97	4 32	5 29	8 23	11 57	10 29	8 40	7 87	6 34	6 00	6 29	6 21	5 33
Germany	5 93	6 98	7 26	7 14	......	......	13 03	4 55	3 94	3 40	4 04	4 76	......	......

The cost of manufacturing peat litter and peat mull in the vicinity of Vancouver would be considerably higher than in Europe, because of, among other reasons, the higher wages paid in Canada and the fact that practically all machinery would have to be imported. It is estimated that in Vancouver district the cost of producing baled peat litter would be between $18 and $20 per ton. Some idea of the possible local annual consumption may be derived from the following statements. A bale of pressed peat litter weighs 160 pounds. One bale per year is a sufficient allowance for 10 fowl. The 2,000,000 fowl of Fraser River delta area would require 200,000 bales, or 16,000 tons of peat litter per year.

Assuming the existence of an adequate market, the first essential for the commercially successful manufacture of peat litter and peat mull is an assured supply of raw peat of proper quality and in sufficient amount that the initial capital expenditure, together with an adequate revenue, may be repaid within twenty years. The necessary rights to a bog or bogs holding suitable raw peat and in sufficient amount, having been secured, the general procedure after having devised and installed a suitable drainage system, is to dig the peat either by hand or machine, allow the resulting bricks of peat to dry in the open until the moisture content falls to about 20 per cent, pass the air-dried peat through disintegrating machines and over screens to separate the peat litter from the finer particles or peat mull, and finally to compress the resulting materials into bales of about 180 pounds weight of peat litter or peat mull.

Other Field Work

Geological

G. Hanson. Mr. Hanson completed the geological study and mapping of an area of 200 square miles, embracing part of the drainage basins of Bear and Marmot rivers in the vicinity of Stewart on Portland canal, British Columbia. A report and maps are being prepared.

F. A. Kerr. Mr. Kerr continued the topographical and geological mapping of a strip of country along Stikine river from Telegraph Creek south to the International Boundary. This work will be continued in 1928.

C. E. Cairnes. Mr. Cairnes completed the study of the geology and ore deposits of Slocan mining area and extended his geological field work south into an adjoining map-area, British Columbia. The work in the southern area will be continued in 1928.

H. S. Bostock. Mr. Bostock completed the detailed study of the mineral occurrences at Hedley, British Columbia, and commenced the geological study and mapping of an area of about 400 square miles east from Similkameen river. This work will be continued in 1928.

J. F. Walker and H. C. Gunning. Mr. Walker, assisted by Mr. Gunning, completed the study of the geology and mineral resources of Lardeau area, British Columbia. A report and map are being prepared. Messrs. Walker and Gunning also examined various areas along the east side of Kootenay Lake valley.

C. S. Evans. Mr. Evans continued detailed geological mapping of the territory bordering Columbia River valley, British Columbia.

Topographical

A. C. T. Sheppard. Mr. Sheppard revised the Vancouver, B.C., one inch to one mile sheet.

J. A. Macdonald. Mr. Macdonald topographically surveyed part of the Topley map-area, British Columbia.

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