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DEPARTMENT OF MINES

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

GEOLOGICAL SURVEY

W. H. COLLINS, DIRECTOR

Summary Report, 1926, Part A

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OTTAWA
F. A. ACLAND
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AISHIHIK LAKE DISTRICT, YUKON

By W. E. Cockfield

CONTENTS

INTRODUCTION

The importance of the Coast Range batholith in connexion with ore deposits has been recognized in British Columbia and the adjacent parts of Yukon. In Yukon and the northern fringe of British Columbia, for instance, the mineral deposits of Atlin, Windy Arm, Wheaton, Whitehorse, Rainy Hollow, and Aishihik Lake districts all have a close genetic connexion with the batholith, or with underlying bodies of granodiorite which are closely related to the batholith. It has become increasingly apparent that a zone following the eastern contact of the batholith is an exceptionally favourable place to prospect, and with this in view, the program of work in Yukon, during the past few years, was to delimit the eastern margin of the intrusives along the more accessible parts of the contact, linking up the work of previous investigators. This work was started in 1922, and has been continued at intervals. In 1924 a map of Whitehorse district, comprising the results of several seasons work, as well as the areas mapped by several previous workers, was completed, and is now available.

Field work in 1926 was in continuation of this general plan. The area chosen was Aishihik Lake district, which lies immediately west and north of Whitehorse district. The mapping of this area completes the outlining of the batholith between Whitehorse district and Kluane Lake district, and practically finishes the mapping of the eastern contact of the batholith from the British Columbia boundary northwest to lake Kluane; thus finishing the mapping of all the more readily accessible parts of the eastern margin of the batholith in Yukon.

The area mapped lies between latitudes 60° 45′ and 61° 30′ and between longitudes 136° 00′ and 137° 30′ west. It is located north and west of Champagne, on the Whitehorse-Lake Kluane wagon road, about 65 miles from Whitehorse. This road served as a base, the surveys being carried north from it for the necessary distances. The Dalton trail, which leads north from Champagne to Selkirk on Yukon river, crosses part of the map-area, and as sections of this trail are in fair condition all the area is readily accessible. A further means of entry into this district is a trail, in rather poor condition, from the Whitehorse-Dawson wagon road at the 52-mile post, to Hutshi village, where it connects with the Dalton trail.

A rapid triangulation was carried over the district, tying in with Whitehorse and stations of the Whitehorse sheet. Plane-table surveys were made along selected routes. No attempt was made to map the area completely, but a number of routes were surveyed across it, which permitted outlining the general features of the whole region with a considerable degree of accuracy, and where possible the geology of the areas between the lines of survey was inferred. The narrowness of the batholith in this district made feasible the mapping of both the eastern and western contacts over a considerable distance.

TOPOGRAPHY

There are three physiographic provinces in Yukon that are continuous with similar divisions in adjacent parts of northern British Columbia and Alaska. These are the Coastal system, the Interior or Yukon plateau, and the Mackenzie Mountain system. Of these only the first two need be considered here in connexion with Aishihik Lake district.

From southern British Columbia to near the sixtieth parallel the Coastal system includes only the Coast range if the island range to the west be considered as part of the Coast range, but near the head of Lynn canal the simplicity of this province is interrupted, and from that point north and northwest the Coast range passes inland and becomes the innermost member of the Coastal system which, for this portion of its length, consists of a series of ranges and mountain masses separated by broad, deep valleys. From the head of Lynn canal, northwestward, the Coast range gradually becomes less prominent, and finally merges into Yukon plateau near lake Kluane.

The Coast range consists of an irregular complex of peaks and mountain masses that have a rough alignment along a northwesterly trending axis; the range is everywhere extremely rugged and precipitous, and consists of sharp, needle-like peaks separated by deeply cut valleys. In British Columbia the summits attain elevations of 8,000 to 9,000 feet above sea-level, but in Yukon they are much lower and stand at an average elevation of 5,000 to 6,000 feet above the sea.

The Interior, or Yukon, plateau stretches from northern British Columbia through Yukon and Alaska to Bering sea. It is in reality a broad geosyncline, which is higher at the margins than at the centre, sloping from both the east and west towards an axis which coincides very closely with the position of Yukon river and its tributary, Lewes river. The summits of the plateau back from the main waterways form a gently undulating plain which is broken only here and there by isolated mountain masses that rise above the general level. Into this upland surface the streams have cut broad valleys to varying depths. The upland surface in the vicinity of the main waterways is everywhere maturely dissected.

The descriptions just given of the Coast range and the Yukon plateau apply in a general way to Aishihik Lake district, which is situated along the margin of the Coast range, and thus includes parts of both provinces. The main difference lies in the fact that the Coast range in this section of the territory is lower, and consequently less rugged and precipitous than it is to the southeast. Some of the peaks have a tendency towards a sharp outline, and the valley walls, particularly along the smaller valleys, are steep, but numerous flat-topped forms which are more characteristic of the plateau province also occur. In fact, there is no marked division between the two provinces, and it is doubtful if the term Coast range should be applied to that part of the province north and west of Takhini and Dezadeash valleys. The only reason for applying the term is the continuation of the granitic batholith across the region. The hills to the south and west are much higher and more rugged than the Coast range in this part of its course, and finally culminate in the peaks of the St. Elias range, many of which may be seen from the district. To the northeast the hills are much lower, and this part of the plateau seems to have been naturally dissected.

The main valley of the district is Dezadeash valley, an east-west depression that stretches from Lewes river to the foot of St. Elias range, and is occupied in its eastern part by Mendenhall and Takhini rivers, flowing east; and in its western part by Dezadeash river, which drains into Alsek river. The divide between Mendenhall and Dezadeash rivers is only a few hundred feet in height, and is formed of sands and silts. It seems probable that this valley was once the site of a single river, draining, perhaps, to the west, and that the present drainage system is the result of glaciation.

The other main valleys of the area have a north to northwest trend. These include the valley occupied by the upper part of Mendenhall river and Hutshi lakes, and Nordenskiöld river, and in which the divide between the waters of the Mendenhall and the Nordenskiöld is only a few feet high; the valley occupied by Aishihik river and Aishihik lake, and by the west fork of Aishihik river and Sekulmun lake. There is also a northeasterly trending valley from the head of Mendenhall river to the Whitehorse-Dawson road. Most of these valleys afford good routes for travel.

GENERAL GEOLOGY

The rocks of the area include both igneous and metamorphic types. The igneous types include both volcanics and intrusives; the latter, the Coast Range intrusives, form one of the major features of the district. The volcanics occur only at a few scattered points, and are not as important as in areas to the north and south. The following table gives the list of formations.

Table of Formations

Recent and Pleistocene....	Superficial deposits.......	Alluvium and glacial drift
	Dyke rocks..............	Quartz porphyry and related types
Jurassic..................	Coast Range Intrusives...	Monzonites, granodiorites, granites, and related types
	Older Volcanics...........	Andesites with associated tuffs and breccias
Precambrian (?)..........	Yukon group.............	Mica schist, quartz mica schist, chlorite schist, granite-gneiss, and crystalline limestone

YUKON GROUP

This name was applied by Cairnes[1] to include the metamorphosed rocks of both igneous and sedimentary origin along the Yukon-Alaska boundary north of Yukon river. The correlations he made at that time show clearly that he included in this group all the schistose and gneissoid rocks of Yukon basin, which had been determined by different workers to be the oldest in their respective districts, and which had been variously classed as pre-Devonian, pre-Silurian, or pre-Ordovician according to the age of the oldest overlying beds. Cairnes offered proof that the members of the Yukon group were in all probability Precambrian. As some of the correlations were made over considerable distances, and as degree of metamorphism is not by itself a reliable key to age, it is perhaps best to consider the Yukon group as a whole only tentatively as of Precambrian age, although the lack of definite evidence, in spite of the increased number of investigations among these rocks, that it is not Precambrian, tends to strengthen the original correlation.

The rocks of the Yukon group in Aishihik Lake district include both sedimentary and igneous types, and represent probably, different ages within the Precambrian, but they have been so highly metamorphosed that in many cases it is difficult to ascertain the nature of the original rocks, and consequently, to determine their history. The group is represented by mica schist, quartz-mica schist, chlorite schist, granite-gneiss, and crystalline limestone. This group forms, for the greater part of the area, the rocks into which the Coast Range batholith was intruded, and, therefore, the degree of metamorphism is high.

The mica schist is a greyish, medium-grained rock showing an abundance of mica, particularly on cleavage planes. Specimens examined under the microscope are seen to consist mainly of biotite and quartz, with minor amounts of chlorite and iron ore. Some specimens also contain calcite. The quartz grains are intergrown with a sutured texture, and the mica is usually arranged in leaves parallel to the planes of schistosity.

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

The quartz-mica schist is very similar in appearance and composition. Quartz is, however, the dominant mineral, with biotite or sericite subordinate. The quartz grains are nearly always intergrown, and have an arrangement along parallel lines with leaves of biotite or sericite arranged along the planes of schistosity. The rock has a decidedly quartzitic appearance, and is undoubtedly an altered sediment.

The chlorite schist is a greenish to greyish rock with a glistening appearance on a freshly broken surface. Individuals of biotite can be detected with the naked eye. Under the microscope the rock is seen to consist almost entirely of chlorite, biotite, and hornblende. A few small laths of feldspar, and minor amounts of iron ore also occur. The rock has a decided schistose appearance, and is most probably an altered igneous rock.

Granite-gneiss is one of the most abundant of the metamorphic rocks of Aishihik Lake district. It is most extensively developed along the western flank of the intrusives, but is also fairly common on the eastern margin. It is a greyish to pinkish rock, with a characteristic gneissoid texture, and in many cases with the development of phenocrysts, forming an augen gneiss. Under the microscope the essential constituents are seen to consist of quartz, orthoclase, plagioclase feldspar, biotite or hornblende, and micropegmatite. The quartz and feldspar show in some cases pronounced granulation; in most cases, however, the quartz grains are intergrown. The mica is usually arranged in parallel lines. In some specimens the rock is much more basic than those described above, and consists largely of plagioclase and augite, with minor amounts of secondary minerals, and exhibits less intense granulation. These variations were noted, however, at only one locality.

The crystalline limestone is abundantly developed along the trail leading up Mendenhall valley, and occurs plentifully in the region about the southern end of Aishihik lake; it is, moreover, in many cases associated in minor amounts with the other schistose rocks in other parts of the district. The limestone is white to brown and is more or less siliceous. The recrystallization is so complete that all trace of the original bedding has been destroyed. Lenses and veins of quartz, barren of sulphides, are common in the limestone; and in the vicinity of bodies of granitic rocks, garnet, epidote, and other silicate minerals are extremely abundant. In such cases careful search was made for sulphides, but without success. No fossils were obtained from the limestone in Aishihik Lake district.

OLDER VOLCANICS

The rocks included in this group have only a limited development in the district. The chief occurrence lies on the hills north and east of Hutshi lakes, and in all probability these rocks extend north on both sides of Nordenskiöld valley to join with areas of similar rocks shown on the Braeburn-Kynocks and Tantalus maps[1]. Other areas occur on the ridge

[1]Cairnes, D.D.: Geol. Surv., Canada, Maps 10A and 11A, 1910.

between Hutshi lakes and Aishihik lake, and on the western side of Aishihik lake. Other small bodies were noted chiefly on the summits of the higher hills.

The andesites are green to red rocks, and exhibit, macroscopically, phenocrysts of feldspar. Under the microscope the feldspar is seen to be largely andesine, and the ferromagnesian mineral, hornblende or augite. Crystal tuffs containing fragments of crystals of these minerals in many cases accompany the andesites, as well as breccias with fragments of andesite and other rocks. There is little definite evidence to be obtained as to the age of these rocks in Aishihik Lake district, on account of the lack of sedimentary strata which would serve as time-markers. They are cut by the granitic intrusives wherever the two are found in contact, and are younger than the members of the Yukon group. In Whitehorse district to the southeast, some of the members of the Older Volcanics cut sediments of Lower Jurassic age, and are in turn cut by the granitic intrusives, which, from the evidence collected in Yukon and British Columbia, may range from Jurassic to early Cretaceous time.

GRANITIC INTRUSIVES

The granitic intrusives form one of the major geological formations of Aishihik Lake district, both in areal extent, and in importance as possible ore-bringers. The granitic intrusives southeast of the district have a north-northwesterly trend, but at the eastern edge of the district they turn abruptly in a more westerly direction, and continue across the district in this direction towards the northern end of lake Kluane. They form a fairly narrow band 8 to 10 miles wide across the area, and a tongue of these intrusives also extends from Sifton mountains in the southeast of the map-area towards Hutshi lakes, and apparently dies out in the hills northwest of these lakes.

The Coast Range intrusives include a considerable variety of rock types, but they have in general a granitic habit. The typical rock is coarse grained, greyish, and composed of quartz, feldspar, and mica or hornblende. Pinkish varieties also occur, as well as types that have a porphyritic habit, exhibiting crystals of feldspar 1 inch to 2 inches long in a mass of finer-grained material. Types rich in ferromagnesian minerals, and consequently darker in colour, also occur.

The typical rock of the Coast Range intrusives is medium to coarse grained, with the essential constituents visible to the naked eye. Under the microscope the main minerals present are seen to be quartz, orthoclase, plagioclase feldspar of intermediate composition, and biotite or hornblende or both. The quartz in most cases forms less than 20 per cent of the rock and the ratio of alkali feldspar to lime-soda feldspar is usually 5:3 to 3:5. The rocks, therefore, fall into the class of monzonites and granodiorites. In some cases the percentage of quartz increases to nearly forty, and the lime-soda feldspar becomes distinctly subordinate, placing the rocks definitely in the granite family. This variety is, however, less important areally than the monzonite or granodiorite type.

An attempt was made to determine whether there was a progressive change in composition across the batholith or along its strike, but the conclusion was reached that the variation from the normal type around any single locality was greater than the variation exhibited by the normal types either across the batholith or along its strike. No regular change in the normal type of intrusive was detected, but it must be remembered that the batholith at this point is narrow, and possibly no striking change is to be expected.

The main body of the batholith in Aishihik Lake district, as already noted, is in the form of a dyke-like body, 8 to 10 miles wide, with a tongue of granitic rocks occurring 6 miles to the north. The contacts of the batholith with the intruded rocks are rarely exposed, owing to the mantle of superficial deposits, which occupies the valley bottoms and much of the hill-sides and upland surface. Where observations could be made on the eastern contact, it was found to dip steeply, the angles observed being 55 to 70 degrees. The presumption is that the western contact had also a considerable dip. The general form of the batholith in this district, cutting as it does in a fairly narrow band across the country, regardless of the topography, supports the view that the contacts, in the vicinity of the surface at least, are steep. This view must perhaps be modified by the fact that the type of survey conducted permitted only of obtaining a limited number of points along the contacts, chiefly adjacent to routes of travel, with the remainder of the contact interpolated between these points. Taken as a whole the contacts, where observed, are highly irregular. The western contact is, unfortunately, concealed for the greater part of its length within the district by the valley deposits of the West Fork of Aishihik river. Along the eastern contact, where exposures could be found, the contact was found to be highly irregular, and the shattering effects of the intrusive upon the wall-rock were well illustrated. To the north of Moraine lake, blocks and fragments of the schistose rocks are included in the granites. The blocks vary from a few inches up to many yards in diameter, and in many instances the smaller blocks have rounded and indefinite outlines pointing to partial absorption by the intrusive. Tongues and stringers of granitic material pierce the inclusions, but lit-par-lit injection was not noticed, either in the case of the inclusions or in the wall-rocks of the batholith.

For the greater part of its length in Aishihik Lake district the batholith is in contact with the schistose rocks of the Yukon group, and it cannot be determined what part of the metamorphism of these rocks is due to the intrusion of the batholith, and what part is due to other causes. Along many of the contacts garnet is found in the schists, pointing to a certain degree of contact metamorphism. Where the limestones of the schistose group are in contact with the granites the degree of contact metamorphism is high; garnet, epidote, and other silicate minerals are abundant and in some cases make up the bulk of the intruded rock, but the zone where these minerals are found is quite narrow; in no instance were silicate minerals noted more than a quarter of a mile from the granitic contacts.

Pegmatite dykes may be included among the contact phenomena of a granite batholith. No true pegmatite dykes were noted along the eastern margin of the Coast Range batholith, nor have any such dykes been reported elsewhere along the eastern margin of the batholith in Yukon. The western contact of the batholith has not received much study in Yukon, but in the short stretch of the western contact exposed in Aishihik Lake district, pegmatite dykes containing large crystals of tourmaline are fairly abundant.

A study of the batholith and adjacent rocks along its eastern margin, from Atlin district in northern British Columbia northwest to Aishihik Lake district, reveals some important facts that have a bearing not only on the geological structure but also on the types of ore deposits that may be expected. The presence, on the tops of many of the higher hills, of bodies of the intruded rocks, leads to the belief that these are possibly remnants of the roof of the batholith. In Wheaton district, where work of a detailed character has been done,[1] several long, relatively narrow curtains of pre-Jurassic rocks occur in the batholith, are cut by the valleys to depths of 3,000 feet or more, and at the level of the valley bottoms are almost as wide as at their highest points. In the same district, small, irregularly-shaped patches of the older rocks outcrop at widely different elevations. These cannot be parts of the roof of the batholith but are inclusions. The method of batholithic invasion which best answers the known facts appears to be that of overhead stoping—the batholith advancing by the breaking away from the roof of fragments or blocks which sank in the magma that rose to replace them. The batholith also appears, in general, to have intruded the overlying rocks in the form of great tongues and dykes, from which branched off smaller portions. However, there is not the minute interfingering of the batholith and the older rocks that occurs in connexion with the Precambrian batholiths. There is little in the way of addition of granitic material to the intruded rocks, except in the form of distinct bodies such as dykes and sills. That a certain amount of marginal assimilation occurred seems evident, for at the contacts of some of the darker rocks the granite becomes darker as the contact is approached, but this is operative for a few feet only.

It is almost certain that a cover was maintained over the magma until it cooled. Further, it would appear that the roof of the batholith was highly irregular. This is, perhaps, best illustrated on the hills north of Champagne, where the summits are granite and, therefore, not at the roof of the batholith; passing northward, the schist contact appears at a distance of about 2 miles and at an elevation of at least 2,000 feet lower; still farther northward, schists are exposed in the bottom of Mendenhall valley; and on the higher hills to the north of this valley granite once more appears. If it be assumed that these granite bodies are connected beneath the schist cover, the original roof of the batholith must, indeed, have been highly irregular. Moreover, a study of the areal geology from Atlin to Whitehorse shows that there are numerous outlying bodies of granodiorite that are identical in appearance and composition with the intrusives of the batholith itself, and

[1]Cairnes, D.D.: "Wheaton District"; Geol. Surv., Canada, Mem. 31, pp. 74-76 (1912).

no evidence has as yet been presented to show that these are of a different age. They can, perhaps, best be regarded as peaks of the granitic body, which have, as yet, been barely deroofed.

The mineral deposits located along this part of the eastern contact of the batholith also give some indication of the shape of the body. The following table is a summary of the types of ore deposits that occur along the eastern margin of the batholith from Atlin district northwest to Aishihik Lake district, and includes only those whose genetic connexion with the granitic intrusives may be assumed or has been expressly stated by the authors concerned.[1] All deposits, however, that are connected with outlying bodies of granites have been included.

Deposit	District	Country rock	Type
Gold-silver	Atlin	Slate, schist, andesite, and Coast Range intrusives	Hydrothermal
Gold-tellurium	Atlin	Slate	Hydrothermal
Silver-lead	Atlin	Granite and associated dykes	Hydrothermal
Antimony-silver	Atlin	Shale and argillite	Hydrothermal
Gold-copper	Atlin	Granite	Hydrothermal (?)
Copper	Atlin	Schist	Contactmetamorphic
Gold-silver-lead	Windy Arm	Andesite	Hydrothermal
Gold-silver	Wheaton	Slate, schist, andesite, and granite	Hydrothermal
Silver-lead	Wheaton	Argillite	Hydrothermal
Antimony-silver	Wheaton	Andesite	Hydrothermal
Copper	Wheaton	Schist	Contact metamorphic
Copper	Whitehorse	Limestone and granite	Contact metamorphic
Copper	Giltana lake	Schist	Contact metamorphic
Copper	Nordenskiöld river	Andesite	Contactmetamorphic (?)

It will be readily seen from this table that there are two types of mineralization, namely, contact metamorphic and hydrothermal. Contact metamorphic deposits are believed to have been formed under conditions of high temperature and pressure, and consequently soon after the intrusion of the batholith. The hydrothermal deposits in this region, from a study of their mineral associations, belong mostly to deposits of the upper vein zone, that is, deposits formed under conditions of moderate temperature and pressure. As these occur not only in the surrounding rocks, but in the granodiorite also, it follows that they were formed at a later date than the contact metamorphic deposits, after the upper part of the granodiorite intrusion had solidified and cooled.

Moreover, as the mineral deposits of this region occur in a belt following the eastern margin of the batholith, and as the deposits have been found to be genetically connected with the batholith, it follows that the rocks to the east of the main boundary are really the roof of the batholith. This is further borne out by the facts that numerous outlying bodies of

[1]Cairnes, D.D.: "Atlin Mining District"; Geol. Surv., Canada, Mem. 37, pp. 72–121 (1913).
"Windy Arm District"; Geol. Surv., Canada, Sum. Rept. 1916, pp. 34–44.
"Wheaton District"; Geol. Surv., Canada, Mem. 31, pp. 85–145 (1912).
"Lewes-Nordenskiöld River Coal District"; Geol. Surv., Canada, Mem. 5 (1910). Appendices I and II.
McConnell, R. G.: "Whitehorse Copper Belt"; Geol. Surv., Canada, 1907.

granodiorite occur to the east of the main margin of the intrusives and no evidence has yet been found in this region that these outlying bodies differ in age from the main body of intrusives. It follows that on the whole the eastern margin of the batholith in this region slopes gently eastward with recurrent upward projections whose summits have been laid bare to the east of the main margin. This conclusion does not agree with that of Schofield[1], namely, a steeply-dipping and smooth-flowing eastern contact, with a narrow contact metamorphic zone.

The deposits of the contact metamorphic type occur for the most part at considerable distances from the main margin of the batholith and are found at the borders of outlying bodies of granodiorite. Deposits of this type, with one possible exception, are confined either to limestone, schist, or to the granodiorite. At one locality, Beeker creek[2], a deposit of this type occurs in a schist inclusion, and deposits of hydrothermal origin occur in the granodiorite at approximately the same elevation. As the hydrothermal deposits are low temperature types, compared with the contact metamorphic, and as the differences in this case cannot be explained by zoning as ordinarily understood, it, therefore, appears that the time at which the deposits were formed becomes the deciding factor; that deposits formed soon after the intrusion of the batholith were of the contact metamorphic type; and that near them may be found deposits of the upper vein zone formed in the dying stages of volcanism from the same intrusion.

DYKE ROCKS

The common dyke rocks of the district are, in general, merely phases of either the Older Volcanics or of the Coast Range intrusives, that is, either dykes of andesites or of granite porphyry, which are apparently closely connected with their respective periods of volcanism. There are, however, a number of dykes, chiefly in the northern end of the region, which, from their lithological characters, seem to correspond closely with more recent rocks found in other parts of Yukon. They are, for the most part, quartz porphyries and related types and are readily distinguished in the field, for they have always a white to yellow groundmass holding occasional crystals of quartz, feldspar, or mica. The quartz crystals are in many cases of the smoky variety. These rocks break readily into thin, irregular plates with a roughly conchoidal fracture, and give a ringing sound when struck with the hammer. They are, presumably, late Tertiary or early Pleistocene, for where definite evidence as to their age has been obtained in this and other districts, they are found to be the most recent of all the consolidated rock formations.

SUPERFICIAL DEPOSITS

The superficial deposits represented on the map are the thick accumulations in the valleys. The thinner deposits on the hill-sides and upland are not shown as a rule. The superficial deposits include, in addition to glacial

[1]Schofield, S. J.: "Salmon River District". Schofield and Hanson: Geol. Surv., Canada, Mem. 132, pp. 64-66 (1922).

[2]Cairnes, D.D.: "Wheaton District"; Mem. 31, pp. 110–111, 140-145 (1912).

drift, gravel, sand, clay, silt, soil, rock talus, and volcanic ash. These cover the valley floors to unknown depths and also spread over considerable parts of the hill-sides and upland. One of the most notable features of these deposits is the considerable thicknesses of fine, white silts. These are most conspicuous at the northern end of Hutshi lakes, as terraces along the west fork of Aishihik river, and along parts of Dezadeash river. Another notable feature is the occurrence of benches of gravel on the ridge between Hutshi lakes and Aishihik lake, and on the ridge between Aishihik lake and Sekulmun lake. The benches occur at all elevations up to the top of the lower saddles of these ridges. The streams entering the lakes have cut deep canyons in them and show that in places the gravels are at least 100 feet thick. The streams draining the lakes have, also, cut through the superficial deposits of their former valley bottoms, leaving terraces that increase in elevation above the present stream bed downstream. As these valleys were occupied by glaciers it is probable that the gravel deposits were formed along the margins of the valley glaciers either by streams draining toward the valleys or by streams draining along the edges of the ice. The retreat of the ice was toward the south and as the main divide between the waters draining to the Yukon and to the Pacific ocean by way of Alsek river lies to the north, lakes were formed between the retreating ice and the divide.

A number of terminal moraines were noted. One of these occurs in the valley between Sekulmun and Aishihik lakes, a second at the head of Cracker creek, and a third in the valley that stretches from the head of Mendenhall river to the Dawson wagon road. Other smaller moraines are common. In some instances the moraines have been flooded, giving rise to lakes of extremely irregular shape.

MINERAL DEPOSITS

No mineral deposits are being worked in Aishihik Lake district. Deposits of copper are known to occur in the vicinity of Giltana lake, and others have been reported from Nordenskiöld valley, a few miles northeast of the map-area, but on the whole the district may be classed as unprospected. This is perhaps not surprising, as the economic transportation of ore would be somewhat of a problem. The type of topography would facilitate the construction of roads should these be needed, but the long haulage to the head of navigation on Takhini river, the loading there, and the re-handling at Whitehorse and Skagway would entail such expense that only ore of very high grade could be profitably handled.

On the whole, Aishihik Lake district is considered a favourable field for the occurrence of mineral deposits. The importance of the granite batholith in connexion with ore deposits has already been pointed out. Some of the creeks crossing the western contact of the batholith, towards Kluane lake, have produced considerable amounts of placer gold, and there is no apparent reason why the creeks that cut the rocks adjacent to the western contact in Aishihik Lake district should not also carry placer gold. The chief difficulty lies in prospecting. The superficial deposits are, probably, very thick, and in many instances are not frozen, which renders prospecting by the methods ordinarily employed in Yukon out of the question. It is possible that points may be found towards the heads of these creeks where the superficial deposits are sufficiently thin to permit the prospector to reach bedrock, and thus test the ground.

The only lode deposits known in the area mapped occur at Giltana lake, and it is years since any work has been done on them. The claims were staked in 1907 and 1908 and were reported on by Cairnes.[1] The following summary of his account is included for the sake of completeness.

The deposits are located on both sides of Giltana lake. On the northwest side the ore occurs at the contact between granite and limestone, and is in the form of narrow lenses of quartz and mineral. The widest lens observed was about 4 feet wide and, generally speaking, the lenses are only from 1 to 2 feet wide. They have no present economic value.

On the northeast side of the lake the rock formation is mica schist with limestone and quartzite. In places, the schist is mineralized with magnetite carrying copper minerals, chiefly chalcopyrite and malachite. The schist bands show almost all stages of mineralization from barren schist to nearly solid iron ore. The ore-zones average 6 to 10 feet wide, although one of 20 feet exhibiting intense mineralization was observed, and have been traced for distances of 50 to 200 feet, to where the mineralization becomes scanty or follows parallel bands. Three prominent ore bands were observed at different elevations on the face of the hill overlooking the lake. The deposits are genetically connected with intrusions of granite which occur in the vicinity. The best of the copper ore carries 1·35 per cent to 9 per cent copper and only a trace of gold.

A second copper deposit was reported by Cairnes from the hills overlooking Nordenskiöld valley north of Hutshi lakes.[2] In this case the ore occurs at the contact of andesite and limestone, and consists of magnetite impregnated with copper minerals, chiefly chalcopyrite, malachite, and azurite. The main mass is in the form of a hill of almost solid iron ore, about 200 feet wide and from 300 to 400 feet long. A second occurrence, where the richest ore is found, was exposed in a small open-cut where the ore was 10 to 12 feet wide, and was apparently not connected with the mass referred to above. A sample from the large mass showed no gold and 1·8 per cent copper; a sample from the open-cut yielded 0·025 ounce of gold to the ton, and 5·55 per cent copper.

SALINE DEPOSITS

Saline encrustations occur at many points along the valley of Dezadeash river and also along Aishihik river. This material is white and occurs around the edges of lakes and small ponds, being left as a residue after the evaporation of the water. These saline encrustations also occur at many points as a thin deposit on top of the soil; in some of these cases there is apparently an abundance of stagnant water early in the

[1]Cairnes, D. D.: "Lewes and Nordenskiöld Rivers Coal District"; Geol. Surv., Canada, Mem. 5, Appendix II (1910).
[2]Cairnes, D. D.: Op. cit., Appendix I.

spring, and the encrustations are left as the water evaporates. Samples of these encrustations, collected by D. D. Cairnes,[1] were examined in the laboratories of the Mines Branch, Ottawa, and proved to contain hydrated sulphates of lime and soda, with a small quantity of magnesium sulphate and insoluble argillaceous and organic matter. They are slightly ferruginous and contain small quantities of chlorides and phosphates. The potash content in six samples was shown to be from 0·2 to 0·3 per cent K_2O.

CONCLUSIONS

Mining has made practically no headway in Aishihik Lake district, but from the geology of the district there is no apparent reason why deposits of copper, silver, lead, or gold may not be present. Mineralization may extend a considerable distance east of the batholith. It is true that not all parts of the batholith are ore-bearing, and that on long stretches of the contact no mineral discoveries have been reported. The evidences of ore deposits cited above show that mineralization has taken place along the contacts in Aishihik Lake district, and, since this is the case, other ore deposits may be reasonably expected to be present.

[1] Cairnes, D. D.: Geol. Surv., Canada, Sum. Rept. 1916, pp. 33–34.

PRELIMINARY REPORT ON STIKINE RIVER AREA, B.C.

By F. A. Kerr

CONTENTS

Illustration

INTRODUCTION

It has long been known that a fairly broad area along the eastern contact of the Coast Range batholith constitutes a zone where geological conditions are favourable for the occurrence of mineral deposits. That this is so has been amply borne out by the discovery of many valuable ore deposits in the areas adjacent to Portland canal, Alice arm, Atlin lake, and other points farther north and south. One serious obstacle to the development of the mineral resources east of the Coast range has been the decided lack of economical transportation. At only a few places, where the Coast range is cut by long arms of the sea or by great rivers, or is traversed by railways, has it been feasible to develop mineral deposits profitably. This absence of transportation facilities, combined with the physical character of the country, has discouraged prospecting in areas which otherwise offer considerable possibilities of reward. Stikine river, although it has formed a highway of entry to the Cassiar for fifty-two years, has failed to be a means of developing that section of the zone along the contact through which it passes. Some desultory prospecting has resulted in the discovery of mineral deposits of copper, gold, and silver-lead-zinc at several places along the river and on the Iskut, one of its larger tributaries.

With the hope of opening up a new area for the prospector, and in order to gain more knowledge about the Coast Range batholith and to continue the systematic mapping of its eastern contact, work was begun in 1926 on a large area along Clearwater (Chutatine), Stikine, and Iskut rivers. No accurate maps of this part of the province were available, so that a large part of the first field season was spent in establishing a triangulation control system and in topographic mapping.

Edward Hughes, W. A. Jones, and G. W. H. Norman rendered good service in the field during the summer of 1926. The Barrington Transportation Company materially assisted in the progress of the work by

affording efficient transportation to and from camps, regardless of the difficulties occasioned by making other than scheduled stops.

Hitherto, very little geological work had been done in the area. Dawson and McConnell traversed the river in 1887 and some descriptions of the area and properties within it occur in the Annual Reports of the Minister of Mines, B.C.

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Ann. Repts., Minister of Mines, B.C., 1875-1925.

LOCATION AND ACCESSIBILITY

Stikine river drains a large section of the northern part of British Columbia. The upper part of the river flows westerly to a point near Telegraph Creek where it bends southwest and then south and crosses the Coast range at an acute angle. Tributaries in the northeastern part of the basin rise on the southeastern slopes of the Cassiar range, from which they derive an abundant supply of water. West of this, the river drains a plateau region that is relatively dry and contributes little to the volume of the stream, but, still farther west, the heavy precipitation over a large area on the eastern side of the Coast range finds its way to the Stikine, making it a fairly large river.

The area actually covered during the field season of 1926, on which this report is based, includes the first 30 miles of Stikine river below Telegraph Creek. The total area to be covered extends from Telegraph Creek south to the International Boundary, which crosses the river about 25 miles above its mouth. This area includes about 115 miles of the main river, a large part of the Clearwater (Chutatine), and other tributaries. The area is relatively narrow, comprising, on either side of the river, a strip that in most places does not extend much beyond the summits of the mountains bordering the river valleys. The greater part of the area lies within the Coast range, and only a small northeastern part lies within the Interior Plateau region.

Access to the area, and transportation within it, are almost entirely by means of Stikine river. For 140 miles, from its mouth to Telegraph Creek, the river is navigable during part of the year. The navigation season for the larger boats starts with the breaking up of the ice early in May, though after mild winters the river may be open by the middle of April. The season ends with low water in the autumn, which as a rule puts a stop to navigation on the upper part of the river about the first of October, though sometimes as much as a month later. For the section up as far as Grand rapids the season could probably be prolonged. In 1926 boats made the trip regularly once a week from Wrangell, Alaska, near the mouth of the Stikine, to Telegraph Creek. During certain stages of water the Scud and Clearwater (Chutatine) rivers, tributaries of the Stikine, can be navigated by small boats for short distances, and the Iskut by larger boats for 25 miles.

Pack-trails follow the telegraph line from Atlin and Hazelton to Telegraph Creek. A fairly good wagon and automobile road connects Glenora and Telegraph Creek and extends beyond to Dease lake. There are a few trappers' trails in the northern part of the map-area, but none below Grand rapids. In winter, traffic to Telegraph Creek is mainly by dog team from Atlin. There is a little travel on the ice of the river.

TOPOGRAPHY

The upper part of Stikine river drains a section of the Interior Plateau region. The southwestern limit of this physiographic province, which on the Stikine is represented approximately by the valleys of the tributaries Sixmile (Dodjatin) creek and First South Fork (Inhini) river, is marked by a fairly abrupt slope rising from 4,500 feet above sea-level to 6,500 feet. The northeastern boundary lies at the base of the Cassiar range about 100 miles to the northeast. The plateau area is cut off partly, if not wholly, from the corresponding part of central British Columbia by a high mountain at the head of Iskut river, known as Iskut mountain. From its somewhat flat, snow-covered top there is a gradual slope northward.

The plateau region, within which only a few miles of the river below Telegraph Creek can be considered to lie, is not as plateau-like as other sections of British Columbia that are so designated. The general elevation ranges from 3,500 to 4,500 feet. Large parts of it are relatively flat, but elsewhere single peaks and groups of peaks rise to elevations of more than 6,000 feet. Many of these are the result of Tertiary and possibly Pleistocene volcanism, but some are well-rounded eminences of older rock. Much of the area is underlain by nearly horizontal Tertiary lavas, the presence of which has contributed to the plateau character of the area.

Stikine river and its tributaries have cut great gashes in the plateau, some of which have been incised in broad valleys. The valley of the Stikine at Telegraph Creek has been cut down to an elevation of 500 feet. Away from the main drainage channels the valleys for the most part are broad and open, with intervening, well-rounded hills. Volcanism has in part accentuated, and in part modified, the plateau character of the region. The damming of old river channels by lava flows, thus diverting the drainage, and the building up of mountain masses of lava have detracted from the mature topographic aspect; on the other hand the extensive lava flows have contributed greatly to the flatness of certain sections. Glaciation, by deepening the valleys and causing the diversion of streams, has added ruggedness, but, at the same time, by rounding the surface forms and filling depressions with glacial debris has emphasized the plateau appearance. Regional uplift with consequent rejuvenation has helped to destroy the plateau character.

There is, in the map-area immediately west of the abrupt rise marking the southwest limit of the Interior plateau, a section of the Coast Range physiographic province that deserves special consideration. The important characteristics of this section are best exemplified in the area southeast of the Stikine between First South Fork (Inhini) river and Glacier (Yehinico) creek, a distance of about 12 miles. As in the plateau area, there is a pronounced topographic unconformity between the abrupt slopes of the deep valleys and a relatively flat or gently sloping upland surface with a general elevation of 6,000 to 7,000 feet, which is several thousand feet above the plateau region. The differences between this section and the plateau region are mainly the result of its greater elevation with a consequent greater precipitation resulting in more rapid water, and ice erosion. The corresponding section of the country on the northwest side of the river lies between Sixmile (Dodjatin) creek, which joins the Stikine just below the First South Fork, and Clearwater (Chutatine) river. In this area, however, the number of deeply incised, large valleys is greater, and their tributaries are more numerous than to the southeast, as a result of which the relatively flat upland surface has been more largely destroyed. In the vicinity of Stikine river this section of country intermediate between the Coast range and the Interior plateau is, as already stated, rather sharply marked off by bounding major valleys. Away from the Stikine, to the northwest and southeast, the boundaries are not so well defined and one section grades into the other.

The Coast range is characterized by extreme ruggedness; long, abrupt slopes, in many places almost vertical, rise to sharp needle peaks and sawtooth ridges. All sorts of fantastic shapes have been carved by the ice and snow which cap the mountains and which at some places, even in summer, extend down to the lowest valley bottoms. Bounded by great, U-shaped, glaciated valleys and cut by many smaller V-shaped gashes, huge mountain masses, especially near the main river, in many places stand out as isolated monuments to the work of erosion, which under conditions of heavy precipitation in a severe climate has worked havoc in a relatively short time. In the most easterly part of the range cirques are found mainly on the north side of peaks and steep valley slopes, but, farther within the range, they are abundant and occur on all exposures.

Along the Stikine there are many peaks higher than 5,000 feet, a few over 6,000, and one of 7,000 feet. The relief is very marked, because the river, even as far inland as Telegraph Creek, is less than 500 feet above sea-level. In general there seems to be a gradual increase in the elevations of the mountains from 6,000 feet on the eastern side of the range and 4,000 feet on the western side, to a central axis with a northwest-southeast trend, marking the International Boundary. To the northwest between latitudes 57° and 57° 30′ the elevation along the axis reaches 10,000 feet, with a maximum of about 10,300 on mount Ratz. Approaching Stikine river to the south there is a decrease in the general elevation with a marked depression near the river. Between Stikine river and Portland canal the general elevation is somewhat lower than north of the river; there is only one small area in which the elevations exceed 7,000 feet.

On the eastern side of the Coast range, in the vicinity of Stikine river, many of the tributary valleys terminate in cirques partly filled with small glaciers. Farther west within the range the glaciers increase in size. Along the lower 60 miles of the river all the valleys on the west side and even some of the larger ones on the east side are occupied by glaciers that extend down nearly to the level of the Stikine.

Whereas the Stikine valley at Telegraph Creek and above is only large enough to accommodate the river, in the mountains it is sufficiently large to permit the development of meanders. Between the First South Fork (Inhini) and the Clearwater (Chutatine) these meanders are in places fairly well entrenched, but below this the river is confined only in two places where it has cut canyons for short distances in the rock along the side of the valley. In the mountains the valley is wide and U-shaped, and many of the tributary valleys are of a similar type. Most of these are cut down to the level of the main river, but some hang high above it.

GENERAL GEOLOGY

During the summer of 1926 it was not possible to obtain a sufficient understanding of the geology to describe completely or coherently the features within the area. Some rock outcrops occur along the river, but for the most part are widely separated. On the slopes of the valley below timber-line outcrops are scarce, except along the streams where in many places they form continuous sections. Above timber-line outcrops are abundant, though the flat tops of the mountains to the east are usually covered with drift and to the west snow and ice obscure large areas.

In a large part of the area examined the strata, intensely folded, are cut by innumerable normal faults of Tertiary age. There are thus a great number of blocks, the relationship of which it has been impossible to establish because the sequence has not yet been wholly determined. In addition to an older assemblage, three rock groups have been differentiated: a thin series of horizontal Tertiary and (or) Pleistocene lavas overlying partly cemented gravels; a thin series of Eocene conglomerates, sandstones, shales, tuffs, and lavas, folded and faulted; and Upper Cretaceous conglomerate and sandstone, tilted and faulted. The older rocks are mainly volcanics, of which in certain sections of the area there must be a tremendous thickness. Associated with these are sedimentary series, some of which are interbedded with them; some may lie above and others below. These volcanics and sediments, all of which are intensely folded and faulted, are mainly Mesozoic, though a lower series of sediments is probably Palæozoic. Intruded into this complex is the Coast Range batholith with several satellites. From an abbreviated study it appears that intrusion was not confined to one period alone.

PALÆOZOIC AND MESOZOIC

The complex of older volcanics and sediments that outcrop in the greater part of the area, is divisible into several groups. A great thickness of slates, schists, and quartzites, with some limestone and possibly some volcanics, outcrops in the northeastern part of the area. Just west of the batholith there occurs a somewhat similar series in which there is a thick band of limestone. The rocks of these two groups are considerably folded and metamorphosed; the limestones are generally crystalline; the argillaceous and arenaceous materials of the series have been altered to slates, argillites, schists, and quartzites. They are thought to be of Palæozoic age. At the mouth of the First South Fork (Inhini) river there occurs another group. This is made up largely of argillite, slate, and quartzite. These rocks are as a rule black and finely bedded. They are somewhat less metamorphosed than those thought to be of Palæozoic age. Farther south there are outcrops indicating other smaller areas of similar rocks. At Glenora and several other points nearby there are calcareous grits, limestones, and conglomerates which are associated with these. Also there are coarse conglomerates at numerous places, especially between the Clearwater (Chutatine) and Shakes creek, which seem to form the base of a series including some of the rocks described above. Most of these groups belong, apparently, to the same series, which may be the youngest of the complex. It is not yet established that none of the older volcanics overlies them. Some of the black slates and quartzites, together with isolated patches of limestone, are interbedded with the volcanics. The greater part of the complex is made up of altered lavas, tuffs, breccias, and volcanic conglomerates which are predominantly green, and to a minor extent red. In the main these are massive, and show few structural features. All the rocks are intensely folded. In many places the beds are vertical, even overturned. No very definite structures have been worked out. Tertiary faulting has cut the rocks into innumerable blocks. They are largely if not entirely of Mesozoic age.

INTRUSIVES

The work during the past season did not progress sufficiently to permit much study of the Coast Range batholith itself. Several smaller masses were noted, all granitic in character and believed to be associated with the major batholith. The largest of these lies to the north of Glacier (Yehinico) creek; the others are scattered throughout the northeastern part of the map-area. They are intrusive into several series of rocks whose relations are not yet understood sufficiently to determine connexion of these masses with one another and the main mass. The Coast Range batholith itself intrudes the same complex and is cut by granitic dykes. The rock of this mass near the contact at Devils Elbow is badly sheared and seems to have been considerably deformed. The dykes, which cut the contact approximately at right angles, are sinuous, faulted, and slightly sheared. They, too, appear to be deformed, but to a less extent than the batholith, and are, therefore, considerably younger.

UPPER CRETACEOUS

From the First South Fork (Inhini) to Fourmile (Cataline) creek there are exposures of a series that rests unconformably on the older complex. Conglomerates with pebbles up to one inch in diameter predominate.

Interbedded with these are thin beds of sandstone. Both types of material are light grey. The pebbles of the conglomerate are well rounded and the matrix is mainly fairly fine grains of quartz. The sandstones are similar to the matrix. The series seems to have been water-lain. On the First South Fork (Inhini) it exceeds, probably, 100 feet in thickness. In general, the strata of this series show a slight dip to the southwest, which could be attributable to faulting alone without folding.

A collection of fossil leaves from one of the sandstone members has afforded a definite criterion of the age of this series.

EOCENE

Ecocene rocks occur along the river between Brewery and Shakes creeks. The base of the series is marked by a very coarse conglomerate made up largely of the underlying volcanics. Above this there is exposed in one place about 100 feet of fine conglomerate, sandstone, and shale. These are interbedded, the first predominating and the last occurring in only a few thin beds. They too are made up largely of materials from the underlying volcanics, and may be in part tuffaceous. Near the mouth of Bear (Tsikhini) creek some highly carbonaceous sandstone is exposed. This almost assumes the aspect of coal and is said to be sufficiently combustible to use in a forge. A few inches of this material appear in a bed of grey sandstone which is mainly quartz. The sediments are overlain by a number of lava flows interbedded with tuffs.

The whole series is considerably deformed. Beds opposite the mouth of Bear (Tsikhini) creek are vertical and at no place were they found to be even nearly horizontal. They have been subjected to considerable faulting, probably accompanied by some tilting of the blocks, but whether this is the cause of all the deformation is not clear. They may also have been somewhat folded and appear to be much more deformed than the Upper Cretaceous rocks farther up the river.

Tuya Lavas

The horizontal lavas which cover a large part of the Interior plateau, and their associated cinder cones, have previously been described.[1] A few small areas occur along the river between Telegraph and Carlson (Kunishma) creeks. They represent, probably, remnants of what was once a complete filling of the river valley between these two points. Just above Shakes creek there are two other small masses. These may have been part of the same flow as those near Telegraph creek. They are undeformed and lie directly across faults that cut all the other rocks.

[1]Cockfield, W. E.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, pp. 30–31. Kerr, F. A.: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, pp. 94–96.

ECONOMIC GEOLOGY

The map-area presents the same general geological relationships as exist in some of the important mining districts at or near the coast—notably Portland Canal, Alice Arm, and Atlin. It lies diagonally across the eastern contact of the Coast Range batholith, the zone to the east of which has long been known to be favourable for the occurrence of mineral deposits. Sufficient discoveries have been made in Stikine area to show that it, also, is well mineralized. Free milling gold has been found on the west bank of the Stikine just north of the contact. In a corresponding position on the opposite side silver-lead-zinc and copper deposits have been worked. Higher up the river on the east side copper prospects (said to be bornite) have also been somewhat developed, and at a few other localities small mineral deposits, mainly of copper, have been discovered.

DEVILS ELBOW DEPOSITS

Situated on a mountain, locally called Devils Elbow mountain, are a number of deposits that have, probably, attracted more attention and been worked more extensively than any others in the area. Devils Elbow mountain is on the east side of Stikine river between Grand rapids and Devils Elbow. The properties are reached by trail from the Jackson ranch on Stikine river, at the mouth of Green (Tsuhini) river. The deposits are distributed over a considerable area. The highest observed occur at an elevation of 3,600 feet, whereas the lowest, about a mile nearer the river, are at 1,800 feet (Figure 1). Similar deposits, which belong probably to the same period of mineralization, are said, on good authority, to occur even higher, and farther from the river, and also at the river itself, giving a distribution of 2 to 3 miles horizontally and about 4,000 feet vertically.

Considerable work has been done on one claim between 2,000 and 2,200 feet elevation. A good trail has been cut and graded to this point. Unfortunately, a fire swept this area in the summer of 1926 and by destroying the vegetation on the steep slopes, left the ground so bare that rain and snow will, probably, obliterate much of the trail. Development at the property consists of numerous open-cuts and three adits in the face of a cliff at 1,980, 2,128, and 2,205 feet elevation. All three are driven approximately north; the lowest (No. 3) is 300 feet long, the middle (No. 2) 60 feet, and the upper (No. 1) 20 feet. Two cabins, one near the adits and the other higher up on the hill, are located on the property. The claims are owned by Peter Hamlin, Dan McShane, and John Bodel of Telegraph Creek, C. A. Ferro of Victoria, and others.

The most important geological feature of the area is the contact of the Coast Range batholith, a granitic intrusion. The strata making up the series into which the igneous rock is intruded are mainly sediments; but the small mass between localities 19 and 20 (Figure 1) appears to be volcanic. On the map the strata are divided according to lithology into two groups; one mainly calcareous and the other mainly non-calcareous. The stratigraphic sequence, from top to bottom of the series, in general conforms with the vertical disposition on the hill-side, the highest beds occur-

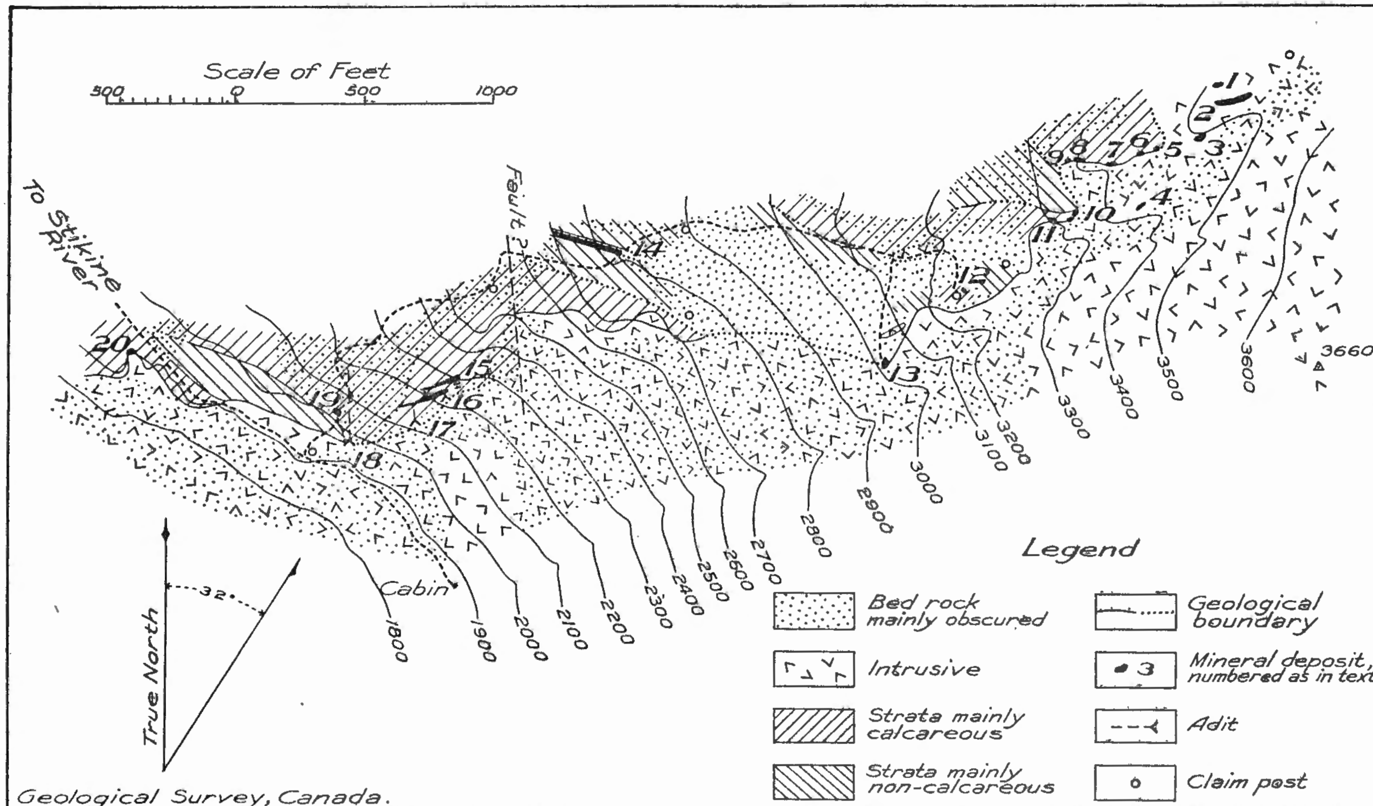


Figure 1. Mineralized area, Devils Elbow mountain, Cassiar district, B.C.

ring on the top to the east and the lowest at the bottom to the west. This, however, is not necessarily a fixed rule, for in some places there may be repetition of parts of the series due to minor folds. The top group, localities 5 to 9, is mainly grey limestone, some of which is massive and some bedded. The purer limestones are crystalline; some which are arenaceous are granular, and others which are argillaceous are compact. The second group is of non-calcareous strata, mainly hard, light and dark grey argillites and quartzites. West of this is a band of calcareous beds similar to the first group; then a wide band, mainly argillites and quartzites, with some calcareous beds. Lower down, in the section that includes the adits, is a great thickness of bedded and massive limestone similar to that higher on the hill. Below this there is exposed a small area of hard, dense, dark green material which closely resembles some of the volcanics of the area. This is thought to lie below all the limestone, being exposed here on the crest of a small anticline, or it has been cut off at its lower contact by a fault. On the opposite side of the river, where the limestone series is well exposed, no very dark band occurs within it, but one does occur at its base. These rocks are all considerably altered. They are much distorted by minor folds and cut by many small faults.

The intrusive is granitic in character, made up largely of feldspar. It is variable in composition and texture. In some places it shows an abundance of hornblende, where elsewhere this mineral seems to be absent. The quartz content does not seem to be constant; in some places it is fairly large. The rock was not examined microscopically. It is not likely that the phases along the contact would be representative of the whole mass. The composition is probably that of a granodiorite. The rock is in the main fine-grained with, in places at the contact, a dark grey aphanitic phase. It is considerably altered, sheared, and faulted. On the upper part of the hill there are numerous small inclusions of sediments in the intrusive.

Both the intrusive and the sediments are cut by dykes, probably acid in composition, which though less deformed than the rock containing them, are also somewhat sheared, faulted, and sinuous.

The batholithic material and the sediments are both considerably altered by dynamic metamorphism. Near the contact and in certain other zones the rocks have been subjected to considerable metasomatism, which will be discussed later. The dykes, though sheared, were not affected in this way.

On the west side of the river, from the top of the hill to the river several miles away, the contact of the granite and of the limestone series, which seems to conform with it, dips about 45 degrees north. The general dip of the contact on the east side of the river is probably about the same. In the area mapped (Figure 1) the dip is northward, but the angle may be greater than 45 degrees. The strike of the limestone formation is slightly inclined to the contact and the dip is somewhat less steep to the north; in other words the beds are truncated obliquely to the strike and dip by the batholith. It is not thought that the present dip of the contact represents the original attitude. The whole appears to have been considerably deformed: the dip in general was probably steepened, and what was originally a fairly uniform and sharp contact has been greatly distorted. Many small faults cut the contact, so that in places sediments and igneous rock are considerably intermixed.

The later dykes filled fractures about at right angles to the strike of the contact. Along these fractures there may have been some movement. Indeed it seems that one dyke occupied a fault along which there was considerable displacement. This has been indicated on the map. A rather pronounced depression cuts the cliff and parallels the westerly sloping hill-side. It is filled with loose material except where exposures of a dyke stand up prominently in the bottom. The absence of altered limestone along the cliff where exposed above locality 15 suggests that the igneous rock is some distance away. If this is correct there must be two abrupt swings in the contact, a feature which might well be the result of faulting. The dykes are themselves sinuous and are displaced by faults.

For 50 feet or more along the contact with the volcanics west of locality 18 there is a breccia zone—angular fragments of volcanics cemented with intrusive material which here, in places, even in the interstices between the fragments, is medium grained.

As previously described the contact is irregular. Also in certain sections mineralizing fluids have considerably altered both the sediments and the igneous rocks, so that the contact is now not very clearly defined. All the deposits observed in the area occur near the contact: most of them are at the contact, but some seemingly lie within the granite and others within the sediments. One deposit (locality 14) appears to be well within the sediments, but at the base of the cut in this deposit, a hard, grey, aphanitic rock is found which is probably a contact phase of the granite. The presence of igneous rock near the surface but away from the main contact may be the result of an original protuberance of the batholith. The deposits at locality 12 and those southwest of the upper cabin which are not indicated on the map are probably of the same nature. The only deposits which clearly occur away from the contact are those in the limestone above the adits (localities 15 to 19).

All the deposits except those of localities 1 to 4 and 13 are in highly altered limestone, or between it and the igneous rock. Those which appear to be wholly within the batholith are of the same type—the sedimentary roof, abundant remnants of which are found in the adjacent igneous rock, having been removed from above the mineral masses by erosion. All are essentially contact deposits.

The shape of the deposits as exposed is more or less indicated on the map, but their size is somewhat exaggerated. They are not continuous. Though overburden may obscure their continuity in some places, in many there are sufficient outcrops to make the relationship clear. Deposits 5, 6, and 7 may possibly be linked together; at locality 14 there is a continuous exposure for 285 feet, and at locality 15 there are two long exposures. Elsewhere the mineral masses seem to be more or less isolated.

There are four different kinds of deposits found in the area: magnetite-pyrrhotite, zinc, lead, and copper. In some places the various kinds are completely isolated, whereas in others two or more kinds may be present intermingled or grading into one another. Deposits 1 to 4, 13, and the base of 10 are of the magnetite-pyrrhotite class; 5 to 12, 14 to 18, and 20 are of the zinc, lead, or zinc-lead class; 19 is of the copper class.

Magnetite-pyrrhotite occurs in solid mineralized masses (lenses) at the contact. On casual inspection these would seem to be made up of only the two minerals. However, there is some pyrite apparent and analyses show small percentages of copper and lead which are probably present as chalcopyrite and galena. Also there is some gangue: quartz, garnet, epidote, and other silicates. The percentage of each of the metallic minerals is variable, not only in different deposits but within the same deposit. In places there are fairly large, irregular masses, as much as a few feet across on the exposed surface, which appear to be almost entirely coarsely crystalline pyrrhotite; elsewhere there are similar masses of coarsely crystalline magnetite. In some places there is an intermingling of smaller masses and again of fine grains of the two minerals. Pyrrhotite is found in places as distinct veins cutting the magnetite. Pyrite occurs in relatively small, irregular masses with both of the other minerals. Gangue is present in varying amounts, probably not exceeding 50 per cent anywhere. It occurs either in small, irregular masses, rarely exceeding a few inches in diameter, or as fine grains. Altered sediments which are closely associated with the mineral masses resemble the gangue and are probably made up of about the same minerals and have the same origin.

Deposits of the magnetite-pyrrhotite type appear to lie directly on the igneous rock or in it, rather than in the sediments. Altered sediments are generally found associated with these, though in some places the mineralized masses seem to occur as lenses in the granite itself. All the deposits are covered with an iron cap—a few inches of rusty brown material, largely limonite and gangue minerals. Their size is not very great; the largest exposed is probably not much more than 50 feet long and only a few feet thick. None of them would seem to have any economic value at present.

Deposit 1 has not been opened up. There is a small exposure of iron capping such as occurs over the other deposits, and broken pieces show similar mineralization.

Deposit 2 has an iron cap, the shape and size of which is shown roughly on the map (Figure 1). This deposit has been opened by a small cut a few feet wide and just deep enough to show the character of the mineralization which has no noteworthy features.

Deposit 3 is similar to 2. Deposit 4 is somewhat larger than the first three described and is opened up by a cut about 4 feet wide and of the same depth. The deposit has an iron cap similar to that at 2. In the base of the cut there is exposed what appears to be mainly magnetite. An analysis of this by the Department of Mines, Ottawa, showed no zinc or lead, 0·09 per cent copper, and 0·07 ounce of silver per ton. Another sample, of which the owners had an analysis made, carried no values, but one taken from above the magnetite, of altered sediment or gangue-like material, is said to have carried about $5 in zinc. The depth to which this and the other small deposits extend is not known, but it is unlikely that it is greater than the length and probably it does not exceed 20 feet in any of these deposits. Each deposit can be seen to be fairly well surrounded by igneous rock, with some small masses of sediments. Other small deposits of the same nature probably occur in the vicinity of the known deposits; their presence in some cases may be already indicated by exposures of iron cappings.

At the base of deposit 10 there is exposed about 1 foot of magnetite-pyrrhotite. Deposit 13 is exposed by an open-cut about 50 feet long and 2 to 3 feet deep. Near the centre of the cut and just beyond either end there are exposures of the batholith. Just above the cut and even at several places in the cut there are sediments and altered sediments. The total length of the deposit along the direction exposed is not much over 50 feet and its thickness though variable probably does not average more than a few feet. The width of the body is probably not very great. In the deposit there are large exposures of both magnetite and pyrrhotite in irregular masses. Some of the latter has a peacock tarnish which gives it somewhat the aspect of chalcopyrite. Two samples from this deposit, which the owners had analysed, showed no values.

Galena and sphalerite usually occur intermingled or closely associated, though in a few places one alone is present. They show little intermingling with the magnetite-pyrrhotite deposits, though in places they are very closely associated. In such places they always occur on the side away from the igneous rock. The mineralization is generally in the sediments, at or near the contact. Some deposits are clearly replacements of the sediments by gangue and sulphides—either selectively along the bedding or in masses regardless of bedding, or by dissemination. Others which appear to be lenticular bodies of gangue and sulphides lying between the igneous rocks and the sediments are probably of the same type, but in them replacement has proceeded so far as to destroy any evidence of the previous existence of any other kind of material. The sulphides occur irregularly in the gangue. In some places they are disseminated through it in small crystals. Galena is more commonly found in this form than sphalerite. In many instances the crystals are more abundant along definite lines, creating an effect somewhat similar to veins. More often, however, the concentration of the sulphides is in irregular masses. These are generally small—of only a few inches in thickness and of somewhat greater length. No large masses of solid sulphides were noted. As a consequence of the irregularity of distribution, values are greatly variable. Sampling on a small scale is, therefore, not very reliable as an indication of what a mineralized mass may average.

The gangue associated with the galena and sphalerite is similar to that with the magnetite and pyrrhotite. It is mainly green; though in the adits it is brown. Whether or not this difference in colour is due to weathering was not determined. The gangue is made up mainly of quartz, garnet, and other silicates.

Deposits 7, 8, 9, 10, 11, and 20, and that in the cut southwest of deposit 10, are clearly at the contact. Deposits 5, 6, 12, and 14 also are probably at the contact. Deposits 15, 16, 17, and 18 are all probably within 100 feet of it.

The rock at deposits 5 and 6 is largely obscured. In both cases there are only a few square feet of iron capping exposed. Material broken from this though badly weathered shows some galena. These deposits are probably similar to 7, 8, 9, or 10.

Deposit 7 is similar in extent of exposure to 5 and 6, but is opened up by a small cut about 3 feet wide and 1 foot deep. Rock of the batholith is exposed a few feet away from the cut. The material taken from the cut is badly weathered, but shows some scattered galena. No accurate knowledge of the size or value of the deposit was obtained, except that toward the batholith it does not extend farther than the few feet between the cut and the igneous rock exposed. It is probably comparable in size and nature to 8, 9, or 10.

Though deposits 5, 6, and 7 may be continuous so far as it is possible to judge from the exposures, it is not likely that they are—in fact it seems probable that they are similar in this respect to 8 and 9, and 10 and 11.

At deposit 8 there is a fairly large cut about 5 feet wide and deep. In it there is mineralized altered strata over a width of about 5 feet, from the contact in the southeast corner where igneous rock is exposed to the top at the face of the cut where unaltered or slightly altered sediments occur. The rock in the face, except at the top, as well as that on both sides of the cut, is mineralized. That beyond the cut on either side is partly obscured, but although the relationships along the contact are not entirely clear it seems that the mineralized mass does not continue for more than a few feet on either side. Between deposits 8 and 7 where the contact is exposed in places there is no distinct iron cap, which would seem to indicate a lack of continuity of these deposits. Deposit 8 is made up of a massive body of gangue and sulphides, irregularly shaped and as much as 4 feet thick, and selectively replaced beds. It would appear that the former is a more highly developed stage of the latter. Above the mineralized section the bedded limestone is apparently not greatly altered. The distribution of the sulphides, both galena and sphalerite, is irregular. The massive body of gangue and sulphides which lies adjacent to the contact is not always richer than the selectively replaced beds which are farther from the contact, although in the outer part of this zone there seems to be a tendency toward impoverishment with increase of distance from the igneous rock. Two analyses from this deposit gave:

—	Silver (ozs. Troy per ton of 2,000 lbs.)	Lead %	Zinc %	Copper %
Centre of deposit	6·08	6·03	9·51	none
Top of deposit	5·23	7·24	7·63	trace

Deposit 9 is somewhat similar to 8, but is not as highly mineralized. The rock is fairly well exposed for a few square yards, but owing to distortion and shattering of the beds the relationships are not clear. Practically no development work has been done on it. There are a few small, rusty spots and some mineralized material has been broken out, but the rock appears to be mainly unaltered or slightly altered. It seems that there may be a slight general mineralization with some small masses which may be similar in content to the samples from deposit 8. No definite mass like that at 8 or 10 could be outlined. The deposit does not appear to be continuous with 8, though there may be patchy mineralization in between. In the direction away from 8 there is nothing that would seem to indicate that it is continuous for any distance.

Deposit 10 and that of the cut southwest of it are similar to 8, but the mineralization seems to be confined more to a narrow, lens-like mass or masses. The openings at these two deposits are about 2 to 3 feet wide and 3 to 4 feet deep. In the unnumbered deposit the contact can be seen, whereas in the other no igneous rock is exposed. In both, the mineralized masses occur in bedded limestone which in places is partly altered and may contain some sulphides. On one side of the southern of the two cuts the lens peters out in 1½ feet from a thickness of 8 inches, whereas on the other side 3 feet away it is about 2 feet thick. It is also exposed in the face of the cut and probably has a dip in the direction in which the cut has been driven. The other cut exposes a similar mass. In the side the mineralized body can be seen cutting across the bedding. It clearly comes to a blunt point toward the outer edge of the cut and dipping in the direction in which the cut is driven thickens fairly rapidly. The mineralized bodies in both cuts are similar to the more massive material in 8, except that some magnetite-pyrrhotite is exposed at the base of 10. Between these cuts and north of deposit 10 the limestone in places is altered and there are small exposures of iron capping suggestive of underlying mineral bodies which might be continuations of those exposed, or separate masses. The sulphides seem to be confined to very small lenses, with possibly some scattered mineralization beyond.

—	Silver (ozs. Troy per ton of 2,000 lbs.)	Lead %	Zinc %	Copper %
Analysis of sample from 10	5·94	2·29	3·99	trace
Sample from cut southwest of 10	14·88	18·85	10·11	trace

Deposit 11 is similar to 9, and its relationship to the two just described is akin to that of 9 to 8. The contact is shattered; there is no definite sulphide-bearing body, but there is some scattered mineralization that appears to be mainly galena. It is probably comparable to the mineralization which occurs beyond the definite lens-like masses previously described. Beyond deposit 11 toward 10 the contact is exposed, but there is no definite mineralization, which shows that the masses found to the north are not continuous southward for any great distance.

At locality 12 galena occurs in a few small, stringer-like masses. These are not over 1 inch thick. Only a little of this material is exposed in loose blocks taken from a cut in which the rock is in part at least altered limestone.

Southwest of locality 12 there is mineralization over a small area which is not indicated on the map. The rock, which is badly weathered, appears to be an altered limestone. Some galena can be seen even in the much rusted surface material. This deposit is probably somewhat similar to 12, also to 11 and 9, with the igneous rock lying close below the surface.

Deposit 14 is similar to 8 and 10. Both sphalerite and galena are present, but they are not so closely intermingled as in some other deposits. The sphalerite occurs at the base of the deposit, which is thought to be in contact with igneous rock, and the galena above. There is a lens-like body with some scattered mineralization as at 8 and 10. The scattered mineralization, which appears to be mainly galena, can be traced on the surface for some distance. The band appears to be about 2 feet wide.

Silver (ounces Troy per ton of 2,000 lbs.)	Lead	Zinc	Copper
	%	%	%
1·07	none	21·04	trace
8·10	7·6	16·2	

Deposits 15, 16, 17, and 18 can best be described as a group. The limestone cliff into which the two upper adits are driven shows in the main a light grey surface. Across the face of it, however, are some irregular, dark patches. Owing to its precipitousness these could not be examined in detail. The upper patch as shown on the map was examined at locality 15, where it is about 4 feet thick. At this point it was found to be made up of highly altered and mineralized material which is similar to that found in the deposits higher on the hill. Analysis showed the surface portion, which is somewhat weathered, to carry:

Silver (ounces Troy per ton of 2,000 lbs.)	Lead	Zinc
	%	%
1·15	1·04	1·19

On the western part of the lower large patch there is a small cut. This shows mineralization which appears to be considerably richer than the specimen from 15 and is said to carry values similar to those of other deposits tested. The thickness here appears to be less than 2 feet. The patches apparently represent exposures of irregular, mineralized bodies. The maximum thickness of any body exposed is less than 6 feet. The length and shape are shown on the map. The dip is not known. If it follows that of the bedding, of which there is some slight suggestion, it would be steep north. The strike of the deposits across the face of the cliff seems to follow roughly the bedding. The character of the material in these masses resembles, probably, that found in the lenses already described, but since they occur at some distance from the contact there may be some differences. The downward extension of the mineralized bodies exposed on the surface may be cut in the adits, but as little is known of their dip and they are extremely variable in shape and extent, it is, therefore, hazardous to draw any definite conclusions from the available data.

Of the three adits driven in this limestone that at locality 16 is located on the original discovery; the others were driven to cut the "vein" at depth. At locality 16 masses of quartz and other gangue minerals, with chalcopyrite, sphalerite, and galena, have been developed irregularly as if along fractures, leaving boulder-like masses of unaltered, or slightly altered, crystalline limestone. The distribution of sulphides is irregular. They occur as very small masses scattered through the gangue or altered limestone, which here is light brown rather than the green that characterizes most of the other deposits. Drifts of a few feet east and west and a winze (which was full of water) apparently failed to show more consistent mineralization. A picked sample from here was analysed.

Silver (ounces Troy per ton of 2,000 lbs.)	Lead	Zinc
	%	%
47·46	4·99	21·73

The copper, lead, and zinc contents probably differ greatly in the various small masses. The deposit differs from those elsewhere, although it may be the downward extension of one of the bodies exposed on the surface of the cliff just above the adit. The mineralization seems to be comparable to the selective replacement along bedding planes, but here replacement has occurred along other lines, possibly so induced by fractures.

The walls of the adits at localities 17 and 18 were covered with dirt and no accurate data could be obtained from them. In the adit at locality 17 there are fairly broad zones which are entirely altered. Quartz-chalcopyrite and quartz-galena-sphalerite mineralization were noted in zones several feet thick. It is said that zinc, lead, and copper occur in bands, in the above order. A number of specimens were taken from a mineralized zone about 10 feet wide, and analysed.

Silver (ounces Troy per ton of 2,000 lbs.)	Lead	Zinc
	%	%
0·34	0·36	0·66

By picking a number of small pieces from across the zone it was hoped to get some idea of its value. The result, however, may be too low. The mineralized zones appear to be mainly altered limestone with sulphides confined more or less in bands. This is suggestive of selective replacement along the bedding. These zones may be continuous with the mineralized bodies exposed on the face of the cliff above the adits.

In the adit at locality 18 there is said to be no mineralized zone similar to that in the other two, but there are some narrow zones, one of which occurs at the face. These narrow bands may correspond to the thicker bands noted in the other adits and exposed on the surface. The surface showings, also, narrow toward the west. A short distance from the portal there is some black, slate-like material mineralized with galena and chalcopyrite. This is of an appearance somewhat different from the other bodies, but whether the sulphides occur in the slate or in adjacent calcareous beds is doubtful. The sulphide-bearing rock in the dump is similar to that found in other adits. Both galena and chalcopyrite were noted. The rock in the adit is in part slate or argillite and quartzite. It is cut by several faults which, though striking at various angles, mainly parallel the adit. Their dip varies, but is, in general, steep.

The whole section represented on the surface by the area between localities 15, 16, 19, and the cut above this last point, and penetrated below the surface by the adits, is more or less mineralized. The zone of which it is a part seems to parallel the contact of the batholith and to extend not much more than 100 feet from it. In this zone an irregular distribution of altered limestone carries sulphides confined to somewhat definite, but irregularly shaped, bodies, some of which are exposed on the surface and follow the bedding. Besides these definite bodies there are scattered sulphides, such as occur in the adit of 16. Although there are fairly good sulphide concentrations in the mineralized parts, as shown by analysis of the sample from the adit at 17, it is probable that the average for the whole zone would be low.

Deposit 20 is similar in size and character to 10.

Deposit 19, which is the only one designated as of the copper class, is a mineralized lens in bedded limestone. It is the only deposit that shows a relative abundance of copper. In an irregular mass of altered limestone similar to those at 8, 10, and other localities, there is a lens-like body which appears to be largely chalcopyrite. This is small and does not seem to exceed a few feet in any direction. Associated with it in the altered limestone mass, which has a maximum thickness of about 6 feet, are galena and sphalerite. Except for the chalcopyrite the deposit resembles those at 8, 10, 14, and other localities higher on the hill.

All the deposits of the copper, lead, and zinc classes occur apparently at the contact with limestone or in limestone, though in many places the gangue or altered rock in no way resembles the original. No definite evidence of mineralization was noted in the argillites, quartzites, or volcanics, and they do not seem to have been altered as was the limestone. The rock of the batholith near the contact in mineralized areas is rusty. It contains in places considerable pyrite, and appears to have been somewhat altered by the mineralizing solutions. No deposits seem to have been formed wholly within the igneous rock.

The sulphides are accompanied in most places by a green rock which is used by the prospector as a criterion for the location of the deposits. This material is probably largely the result of alteration by the mineralizing fluids, though in some places it has the appearance of having been introduced into cavities as a dyke or vein, which has led the miners to refer to the masses as dykes. It occurs both as a gangue for the sulphides and beyond them, and in places where there are practically no sulphides at all.

Mineralization is undoubtedly associated with the batholith. The mineralizing fluids were, probably, a final differentiate from the intrusive. They seem to have migrated to some slight extent along the contact before precipitation took place. The presence of magnetite and pyrrhotite indicates that while these were being deposited, the temperature (and pressure) was probably high. The sphalerite lies beyond these minerals and the galena beyond the sphalerite—that is, farther away from the igneous rock. The method of deposition is mainly by replacement of the limestone, which was more susceptible to alteration than the other rocks; hence the deposits are confined to this material. The mineral-bearing fluids were highly siliceous. Silicification of the limestone with the development of quartz, garnet, epidote, wollastonite, and other minerals, accompanied the mineralization. However, in some places these changes took place without the deposition of sulphides, either because in certain sections the solutions failed to deposit their sulphides, or they carried none. If the former was the case the altered barren zones might be traceable to mineralized masses; at any rate they can be considered as probably indicating deposits nearby.

Silver is found with both zinc and lead, but bears no very definite relationship to either. Pyrite is not abundant, but occurs with some of the magnetite-pyrrhotite deposits.

The mineralization is patchy. Although there are deposits at many points along the contact, the greater part of them show no mineralization. The face of the hill-side must be considered as affording as good a cross-section of the zone likely to be mineralized as any that may be developed by underground exploration. The lack of continuity of mineralization at the surface seems to indicate that the exposed individual deposits are probably not continuous for any great distance below the surface. It might be possible, however, to outline and trace to some depth a zone such as that between localities 15 and 18 or between localities 5 and 9, in which there are numerous mineralized sections, and, therefore, in which mineralization may be expected to continue. To assume that deposits reoccur at depth in such a zone would, of course, be extremely hazardous; definite knowledge of the extent or richness of the zone can be ascertained only by thorough exploration. There is no reason to suppose that the deposits will be richer or more extensive at depth. If the structure is such that at depth, along the contact, the limestone is replaced by other rocks, then it seems probable that the deposits, too, would end.

Considering the visible extensive mineralization it is not unreasonable to expect that, somewhere, large deposits exist, but whether they do exist, and where, can be ascertained only by further exploration. Nothing as yet observed points very definitely to their location. The two zones described above (15 to 18 and 5 to 9) seem to offer the best location for any underground exploration. The old workings, including the three adits and the several small cuts, can hardly be considered as testing fairly the deposits at depth. As the mineralized zone tends to parallel the contact and, therefore, in general has a steep dip north, the horizontal drifts diverge from it at a considerable angle and hence prove nothing very conclusive. However, the fact that some mineralization occurs at the end of the long adit may indicate that below this point, nearer the contact, more extensive mineralization exists. Later explorations, on claims higher on the hill, have been well planned. An attempt has been made to follow the mineralization on the surface and open it up by small cuts. Unfortunately, much time was spent on the small deposits isolated in the igneous rock, which, probably, have little or no value.

In future exploration an effort should first be made to fix the location of the contact and to work from that into the sediments, more particularly the limestone. But the other sediments should not be overlooked as they may contain veins. It is reported that on the Apex, higher up the hill, a vein was discovered. Snow prevented a visit to this property. The deposit there is said to be some distance from the contact, distinctly vein-like in character, and of considerable size. Analysis of a picked sample from this gave:

Silver (ounces Troy per ton of 2,000 lbs.)	Lead
	%
138·60	58·0

If the information in regard to this discovery is correct it would seem to have greater possibilities than the others. Any underground exploration of the two most favourable zones should follow the contact as far as possible, either by means of adits driven about northeast or by slopes with a dip corresponding, as far as possible, to that of the contact. In either case the workings would thus be confined to the zone likely to be mineralized, and the small individual deposits discovered could be stoped out to such a distance as their size and value warranted.

OTHER PROPERTIES

Within the map-area there are several other prospects that have been worked, but none of these was visited in 1926.

Considerable placer mining was done on the bars of the Stikine in the early days. Some yielded very good returns. The Clearwater (Chutatine) also has yielded some gold and continues to do so. Reports indicate that last summer about 15 ounces were taken out. Two separate outfits plan to test sections along this river during the summer of 1927.

CONCLUSION

There are undoubtedly certain sections within the map-area that warrant the consideration of the prospector. There is a broad zone bordering the Coast Range batholith in which there are numerous small satellites either exposed on, or indicated to be close to, the surface. This whole zone is worth careful prospecting. The known deposits occur in various kinds of rock: Devils Elbow prospects mainly in limestone; the Fourmile (Cataline) Creek copper deposit in volcanics; Stikine River gold in volcanics or non-calcareous sediments; and bornite in the Bear (Tsikhini) Creek intrusive. Any of the various types of sediments and volcanics may carry mineral deposits and even parts of the plutonic masses which have been re-intruded have possibilities. Except for the testing of stream gravels for placer gold the area does not seem to have been very thoroughly prospected. Fairly good transportation facilities are available. Stikine river forms a means of entering the area and could be used for export of ores. Though the country on either side is very rugged, there are long, wide valleys that penetrate it and may afford suitable locations for roads or railways. The area is not one that can be easily prospected. Trails are scarce; travel very difficult; the climate is rigorous, and precipitation is heavy. The obstacles are great, but the possibility of reward appears to warrant the effort to overcome them.

LAKELSE LAKE MAP-AREA, COAST DISTRICT, B.C.

By J. R. Marshall

CONTENTS

Illustration

INTRODUCTION

Lakelse Lake map-area lies in the eastern margin of the Coast range, in British Columbia, in north latitude 54° to 54° 30′ and west longitude 128° to 128° 40′. The Canadian National railway traverses the northern limit of the area, which is accessible from Terrace, a town of approximately 500 people, about 90 miles east of Prince Rupert. A good road leads from Terrace to Lakelse lake 14 miles south of the railway, and another to Copper City at the junction of Skeena and Zymoetz rivers, 5 miles northeast of Terrace. A horse trail follows the north shore of Zymoetz river to its junction with Kitnayakwa river. South of Terrace 6 and 12 miles, trails leave the wagon road and lead, respectively, to the summit of Thornhill mountain, and to some mineral claims on Williams creek. Otherwise the district is without trails, or is served only by a few crude trappers' trails impassable for horses. Owing to the extremely rugged character of the area much of it is difficult of access, and, therefore, is visited only by trappers in the late autumn and winter.

N. F. G. Davis and C. F. Barton served very efficiently as geological field assistants. Thanks are due to the many kindly disposed people of Terrace for valuable assistance rendered and courtesies extended, particularly to Messrs. C. E. Gilbert, P. M. Monckton, F. Nash, J. Frost, M. Hatt, Captain Colthurst, Michaud Bros., O. P. Brown, and Thos. Turner.

Considerable detailed geological work was done on the summit of Thornhill mountain and the ridges along Williams creek since mineral claims are located in these parts. In the remainder of the area reconnaissance traverses were run to intersect the contact of the Coast Range batholithic rocks with the older rocks of the district.

Terrace is located in the heart of a broad, fertile valley that extends from Kitimat arm, at the head of Douglas channel, northward to Nass river, a distance of approximately 100 miles. In and around Terrace the soil is particularly fertile and well adapted to fruit growing and mixed farming.

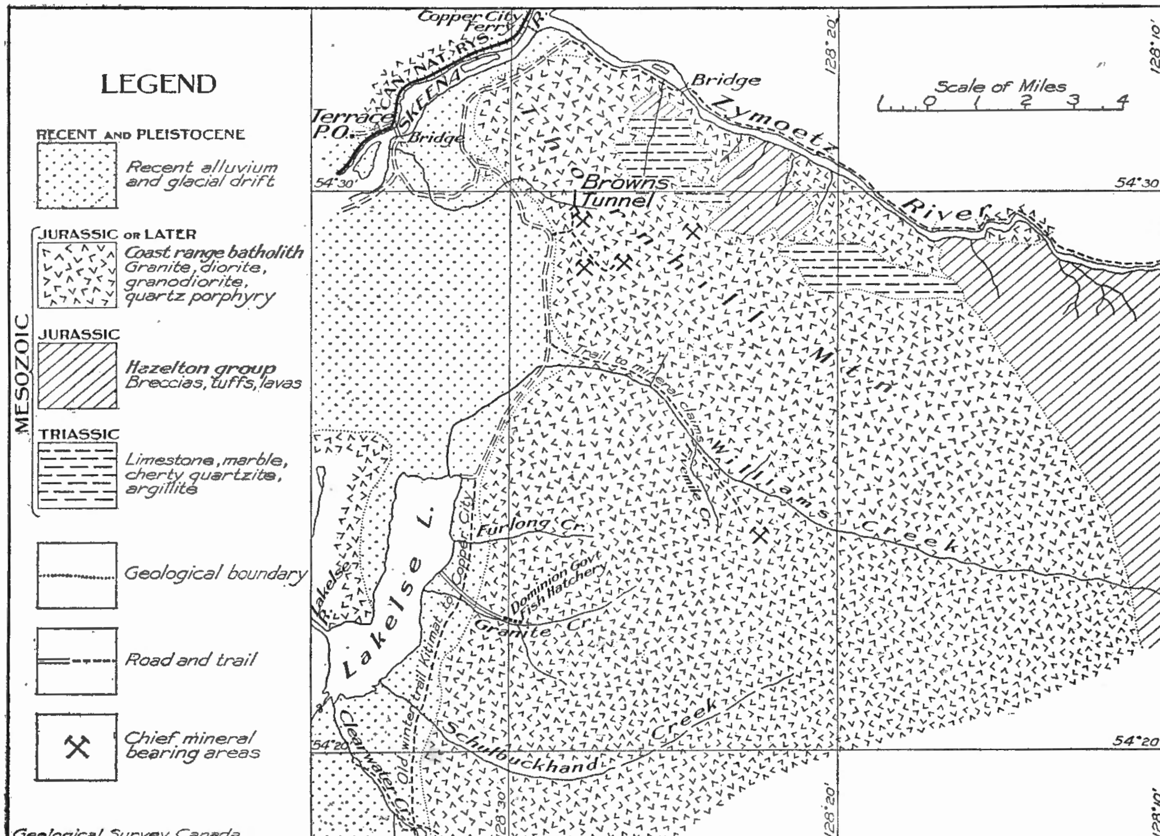


Figure 2. Lakelse Lake area, Coast district, B.C.

Already a small, thriving settlement has been established in this inland area, strategically situated on the only trunk line traversing the district. To the north in the Kitsumgallum Lake valley promising mineral discoveries have been made, and at present important development work is being pushed on some of the claims. To the south and east the country drained by Zymoetz river and its tributaries has long been known to be mineral-bearing. Gold, silver, lead, copper, iron, and coal are widely distributed. In Lakelse valley many of these valuable minerals have been found. If the results of the work now in progress at Kitsumgallum lake prove favourable, work on deposits in the Lakelse and Zymoetz Rivers areas will receive fresh impetus.

The greater part of the area adjoins the wet coastal belt and, to a certain degree, shares the same climate. At Terrace, the warmest and driest part of the area, the mean annual temperature is approximately the same as that at Vancouver and Prince Rupert. The temperature rarely rises above 90° F. and seldom falls below zero. Precipitation is greater than at Vancouver, but less than at Prince Rupert, the annual rainfall being about 40 inches and the snowfall about 4 feet. Kitimat and Prince Rupert are about equal as regards precipitation, 132 inches per year. In some parts of the district trap-line blazes were observed 14 feet from the ground, thus indicating heavy snowfall.

The area lies entirely within the Coast range and is characterized by high, rugged mountains with densely timbered slopes up to 4,500 feet, and many canyon-like valleys. These latter are particularly prevalent in that part of the area between the headwaters of Kitimat, and the South fork of Zymoetz rivers, where many of the mountains rise to elevations of 7,500 and 8,000 feet, have permanent snowfields, and drop off almost vertically for 1,000 and 2,000 feet.

GENERAL GEOLOGY

The rocks of the Coast Range batholith occupy by far the greater part of the district. They consist of diorite, granodiorite, granite, and porphyritic granite, and intrude and include highly metamorphosed limestones, marbles, cherty quartzites, and argillites of probable Triassic age. Along the eastern margin of the area the Coast Range rocks also invade the volcanics of the Hazelton group, which overlie the limestone series.

Table of Formations

Period	Formation	Lithology
Recent and Pleistocene....	....	Gravels, Glacial drift
Upper Jurassic (?)........	Coast Range batholith....	Diorite, granodiorite, granite, porphyritic granite
Lower Middle Jurassic.....	Hazelton group...........	Red tuffs, breccia, lava flows
Triassic and Carboniferous (?)	....	Limestone, marble, cherty quartzite, argillite

TRIASSIC AND CARBONIFEROUS (?)

These rocks are present on the eastern slope of Thornhill mountain and in the vicinity of Bell's claims on the summit of the ridge south of Williams creek. They occur as roof pendants within the Coast Range batholith. The most extensive exposures are on the east slope of Thornhill at an elevation of 3,700 feet, in a cliff locally known as "Seven Stripes." At this locality the strata dip 15 degrees to the north, and are cut by dykes from the batholith. In section, the cliff shows in descending order:

	Feet
Cherty quartzite with some tuffaceous material	185
Grey limestones and marbles	95
Massive cherty quartzites	105
Grey limestones	80

Below this cliff the section continues down the Zymoetz River slope. The total estimated thickness is 1,000 feet. The limestone carries very imperfectly preserved fossil shells and impressions of shells.

Near Dahl's claims, on the east slope of Thornhill mountain, a long spur runs northwest from the clusters of peaks at the east end of the ridge. The summit of this spur is composed of thinly bedded, flat-lying, crystalline limestone and marbles, estimated to be 1,000 feet thick. The lower slope of the ridge is heavily timbered and drift-covered and a complete section could not be observed. South of Williams creek, a number of isolated patches of limestone, marble, and argillite occur within the Coast Range batholith. These are small and not thick, the maximum thickness being 100 feet.

Hanson[1] observed rocks similar to these in Zymoetz River area, and assigns to them a Triassic age.

Nowhere within the area were these rocks observed in actual contact with the overlying volcanics of the Hazelton group.

HAZELTON GROUP

Rocks of the Hazelton group outcrop along the eastern border of the area, and have their most extensive development on Zymoetz river, where they consist mainly of stratified tuffs of brilliant red colours. The ridges near the heads of Williams creek and bordering the south fork of Zymoetz river appear to be made up entirely of these brilliantly coloured tuffs, with which are associated breccias and some thin andesitic and rhyolitic flows. No sections of these rocks were measured, but the thickness was estimated at 3,000 feet. They are very much folded and in places sheared and slickensided. Near the divide between the South fork of Zymoetz river and Kitnayakwa river they are intensely folded and fractured, and are known to contain native silver, grey copper, galena, and chalcopyrite.

[1]Hanson, George: Geol. Surv., Canada, Sum. Rept. 1925, pt. A, p. 103.

COAST RANGE BATHOLITH

The Coast Range intrusives are the youngest rocks in the district and occupy fully nine-tenths of the area. They are the diorite, granodiorite, and granite, phases so characteristic of this member in other areas. Locally, porphyritic varieties, with phenocrysts of quartz or feldspar, are also present. The massive diorites and granodiorites are the common phases and are uniform in appearance over large areas. These rocks intrude the other rocks of the area, and are themselves invaded by numerous dykes of widely varying dimensions and compositions—lamprophyre, diorite, granite, porphyritic varieties, and aplite, all of which are presumed to be of about the same age as the Coast Range rocks.

ECONOMIC GEOLOGY

The district lies along the eastern border of the Coast Range batholith, and is, therefore, theoretically, a very favourable locality for prospecting. The geology is similar to other mineralized areas along the border of the batholith and within the Interior plateau. Sedimentary rocks of early Mesozoic, and, possibly, late Palæozoic, age, and volcanics and sediments of Mesozoic age, are freely invaded by the main batholith and its numerous apophyses, and large blocks of them lie within the batholith.

Mineral claims were staked in the district as early as 1905; since that time considerable prospecting has been done, principally on the slopes and summit of Thornhill mountain, and on the summit of the ridge immediately south of Williams creek. Prospecting has been confined to these particular areas because they were and still are, the more readily accessible parts of the district, and the least remote from transportation. Little or no prospecting has been done along the contact of the Coast Range batholith, where the rocks invaded by the batholith are everywhere fractured and folded, and are of such a nature as to be more susceptible to replacement than the more massive rocks of the batholith to which the prospector has directed all his attentions. The results achieved show that gold, silver, lead, zinc, and copper are widely disseminated; and molybdenum and tungsten have also been found. That these have not been found in larger quantity is not surprising considering the small part of the district that has been prospected, and the fact that, with few exceptions, the prospector has been content to do his minimum yearly assessment work on claims, many of them worthless, with the hope of securing capital for development, thus neglecting to improve on his early discoveries by extending his work into the unprospected parts of the district.

Golden Nib

The most promising discovery is about 7 miles south of Terrace on the west slope of Thornhill mountain, 350 feet above the Lakelse Lake wagon road. Numerous prospects are located on this slope, but the best showing is on the Golden Nib, owned by William Dahl and at present under option to O. P. Brown, who has installed a small compressor and an overhead tram for carrying ore to the road.

The country rock is a porphyritic granite, 150 to 200 feet wide, sheared and fractured across a width of 50 feet. On either side of the shear zone the porphyritic granite grades into granite, and this into the typical diorite of the Coast Range batholith. The shear zone has a north-south trend, and has been traced northward above the tunnel site for 500 feet. Below this point the rocks are soil-covered. Fractures in the porphyritic granite are veined with quartz which is mineralized with pyrite and some chalcopyrite.

An adit 350 feet above the wagon road has been driven 100 feet in the sheared rock, on the trend of the shear zone. The adit follows a quartz vein 2 feet wide, dipping 75 degrees east. This width is maintained in the adit for a distance of 70 feet. The mineralization in the vein consists of pyrite and some chalcopyrite, which occur in streaks that vary in width from a fraction of an inch to 6 inches, and are seldom more than 2 feet in length. Pyrite is sparingly disseminated in the porphyritic granite. Seventy feet from the portal the vein splits into several small stringers included in a width of 6 feet. All these, except one 2 inches in width, are barren. This 2-inch stringer, which is solid pyrite, is continuous to the face of the adit. At the time of examination this small stringer was being worked.

One hundred feet to the west, and 75 feet higher, also in the sheared porphyritic granite, is a second adit, driven to the north for 75 feet. The face of the adit shows mineralization across a width of 5 feet, bordered on one side by 18 inches of country rock and quartz sparingly mineralized with pyrite, and followed by 6 inches of solid pyrite in quartz. The remainder of the face is country rock and quartz sparingly mineralized.

Hand-picked specimens of the pyrite are said to assay as high as $60 a ton in gold. A shipment of approximately 30 tons of hand-picked ore was sent in September to the smelter. This represents the total production from the property.

Beaver Group

These claims are on the west slope of Thornhill mountain, south of the Golden Nib and approximately 3,700 feet above sea-level. Four claims constitute the group, the Beaver, Golden Lady, Star, and Fisher claims. The principal showing is on the Golden Lady. The country rock is quartz diorite sheared and fractured across a width varying from 25 feet to 150 feet. The zone trends northeast for approximately 900 feet. In a small ravine, elevation 3,700 feet, the shear zone has a width of 150 feet. An horizontal quartz vein 1 foot to 3 feet thick, strike north 70 degrees east, outcrops at this elevation, and follows the north side of the ravine for 30 feet where it terminates abruptly against a face of the diorite. One hundred and fifty feet to the east and on the south side of the ravine, what appears to be the faulted and offset part of this vein is 6 inches to 1 foot wide. On the north side of the ravine fractures in the quartz up to 2 inches in width are mineralized with hematite, now weathered. Pyrite is also sparingly disseminated through the vein. By mortaring and panning considerable gold is reported to have been taken from this vein.

About one-quarter mile south of the Golden Lady, and at an elevation of 3,850 feet, a quartz vein, 3 feet wide, strike north 70 degrees east, is exposed in a ravine on the Beaver claim. This vein has been traced up the hill-side, at intervals for 200 feet. Pyrite, chalcopyrite, and galena are very sparsely disseminated in milky white quartz.

Ptarmigan Group

These claims, the Ptarmigan, St. Paul, Society Girl, and Sadie, are on the summit and east slope of Thornhill mountain. The country rock is chiefly granodiorite, but the granite and porphyritic granite phases are also present. All these are freely intruded by granite and aplite dykes.

On the St. Paul claim an aplite dyke 15 feet to 20 feet wide, trend south 70 degrees west, has been traced for about 2,500 feet into the adjoining claims. The dyke throughout this length has quartz veins along both walls. On the St. Paul claim the better vein is on the foot-wall of the dyke. The principal showing is in an open-cut at an elevation of 4,500 feet. The vein here is 4 feet wide, dips 40 degrees north, and is sparsely mineralized with pyrite, chalcopyrite, galena, and specks of free gold. The mineralization is in splashes and not continuous for any distance along the strike. In the open-cut the mineralized part of the vein shows the following cross-section from bottom to top.

	Inches
Barren quartz	1
Sparsely mineralized quartz	2
Barren quartz	14
Mineralized quartz	4
Barren quartz	10
Mineralized (very sparsely) quartz	6
Barren quartz	10

This vein continues across the Society Girl claim with a width of 6 inches to 18 inches. Near the boundary between the Sadie and Society Girl claims a northeast-southwest fault offsets the northwestern side of the vein approximately 400 feet to the northeast.

South of No. 2 post on the Society Girl, and 300 feet below it, an open-cut discloses a 6-inch quartz vein in sheared granite. The vein pinches out along the strike in a distance of 20 feet. It is sparsely mineralized with galena, chalcopyrite, and pyrite. About 200 feet north of this open-cut, a quartz vein 6 inches to 2 feet wide, strike north 80 degrees east, dip 70 degrees northwest, has been traced for 200 feet. Pyrite, chalcopyrite, galena, sphalerite, and some scheelite are present in a gangue of quartz, barite, and feldspar. The scheelite occurs as nodules up to 3 inches in diameter, and irregular streaks in the quartz. Fine specimens of scheelite, some showing free gold, have been taken from the vein.

Approximately 1,500 feet northeast of No. 2 post on the Society Girl, an open-cut has been made in a shear zone 20 feet wide with northeast-southwest trend. Galena, grey copper, pyrite, and chalcopyrite are sparsely disseminated across a width of 8 feet. Parallel to this, and 200 feet to the north, is a shear zone 75 feet wide, that contains 20 per cent quartz, which is sparingly mineralized with pyrite and chalcopyrite.

One mile south of the Ptarmigan group, claims have been staked on a very fine-grained, grey granite. An oval area approximately 500 feet in diameter contains numerous rusty patches 6 inches to 2 feet in diameter and a number of pegmatite dykes 1 foot to 5 feet wide and 20 feet long. The outer border of the rusty areas is composed of pyrite. Inside of the rusty border are muscovite in radial and crystal forms, and nodules of molybdenite and crystals that may have been tourmaline but are now completely altered. The molybdenite occurs as nodules, radially laminated, 1 inch to 2 inches in diameter, within the rusty patches, and also as disseminated grains and flakes in the granite and pegmatite dykes. Several of the nodules coalesce to form larger masses.

About 1 mile southeast of the molybdenite claims, William Dahl has staked silver-lead claims on the east slope of Thornhill mountain at an elevation of 3,700 feet above sea-level. These claims are near the source of a small creek which joins Zymoetz river 6 miles above its mouth. The country rock is quartz diorite, sheared and fractured. Seven hundred feet above the creek bed is an horizontal ledge of quartz 1 foot to 18 inches thick, which has been traced for 60 feet along a strike south 45 degrees east. Streaks of cubical galena 4 inches wide and 1 foot long occur at intervals along the strike. Associated with the galena are pyrite and chalcopyrite.

In a steep ravine 100 feet higher, a brecciated zone 100 feet wide is made up of a number of quartz veins up to 6 inches in width, all showing small displacements due to faulting. About one-quarter mile southwest of this, the diorite is fractured, much weathered, and stained with iron oxide across a width of 300 feet. Pyrite in grains and nodular masses is freely disseminated through this mass. Mr. Dahl reports that assays made for him show the pyrite to run very low in gold values.

WILLIAMS CREEK SECTION

About 12 miles south of Terrace a trail leaves the Lakelse Lake wagon road and follows the north side of Williams creek to Fivemile creek. There it crosses to the south side of Williams creek and proceeds southeasterly for about 3 miles to the Copper Queen and Surprise groups of claims, owned by J. Bell and T. Turner, of Terrace.

The Coast Range intrusives outcrop at many points along the trail and form the ridges on both sides of Williams creek in this vicinity. A medium to coarse-grained, light grey granite is the predominant rock along the trail. In the immediate vicinity of the claims, diorite, granite, both porphyritic and non-porphyritic, freely invaded by dykes of porphyritic granite, are equally conspicuous. All these are sheared and fractured and in places converted to gneiss and schist. A number of irregular masses of limestone, marble, cherty quartzite, and argillites, of small extent and thickness, lie within the intrusive rocks as roof pendants. The largest of these masses extends in a northwest-southeast direction for 1,500 feet, is about 300 feet wide, and estimated to be 100 feet in thickness. Along the contacts with the intrusive, contact metamorphic deposits of magnetite with some chalcopyrite have formed.

Approximately one-quarter mile east of Bell's camp and at an elevation of 3,700 feet, a steep ravine follows a shear zone in granite and diorite. The zone trends southeast for 1,000 feet and is 100 feet wide. A number of small bodies of limestone occur in this zone, also several granite and diorite dykes which invade both the sediments and the main igneous rocks. In the bottom of the ravine, magnetite and very sparsely disseminated pyrite and chalcopyrite are found along the contacts of the limestone with the intrusives. Accompanying these are much granular and crystalline epidote and iron garnets of resinous appearance. At 4,700 feet elevation, on the east side of the ravine, an open-cut 20 feet long has been made on a granite-limestone contact. A quartz vein 2 feet wide has 15 inches of chalcopyrite for a length of 5 feet. This is the only body of chalcopyrite observed in the ravine.

On the summit of the ridge, elevation 5,000 feet, a number of widely separated open-cuts have been made along contacts similar to the one just mentioned. The largest sedimentary mass observed on the summit of the ridge occurs about one-eighth mile south of the head of the ravine to which reference has been made. This mass, 1,500 feet long, 300 feet wide, has a northwest-southeast trend, and was estimated to be 100 feet thick. It occurs as an inclusion within the diorite and is invaded by a dyke of porphyritic granite that also cuts the diorite a short distance to the west. Along the limestone-diorite contact, magnetite with some chalcopyrite was observed. Similar conditions were observed in all of the other open-cuts visited. These cover an area on the summit of the ridge about 1 mile in a north-south direction by three-quarters of a mile east and west. The mineralization is entirely of the replacement type, the country rocks having been partly replaced by magnetite.

KITNAYAKWA RIVER

Snowflake Group

These claims are about 12 miles up Kitnayakwa river, a tributary of Zymoetz river, about 28 miles from its mouth. The claims are about 40 miles from Copper City.

The rocks are the brilliant red tuffs of the Hazelton group, with which are interbedded rhyolite and andesite flows from 4 feet to 10 feet thick. The rocks are intensely folded and very much fractured. The principal showing is at the top of a small waterfall on Gabriel creek. Here a tunnel has been driven southeast for 100 feet along the contact of an andesite flow with the red tuffs. The beds trend south 25 degrees east and dip 80 degrees to the southwest. The andesite bed is 5 feet thick. Along both contacts the red tuffs show paper-thin fractures parallel to the bedding, and spaced from 1 inch to 3 inches apart. On the hanging-wall side these paper-thin fractures are filled with native silver, grey copper, galena, chalcopyrite, and pyrite. On the foot-wall side of the lava bed, fractures a fraction of an inch in width have quartz and calcite fillings with thin filaments of grey copper and chalcopyrite. The proportion of mineral to rock and gangue is extremely small.

SOUTH FORK OF ZYMOETZ RIVER

This part of the district has been visited by very few people. It appears to be a most promising section for prospecting since it lies along the contact of the volcanics with the Coast Range batholith. Some very rich specimens of float, carrying grey copper, galena, and chalcopyrite, are reported to have been found in the bed of this stream.

OTHER NATURAL RESOURCES

HOT SPRINGS

A number of hot springs occur about one-half mile east of the south-east corner of Lakelse lake. The largest rises in an oval pool, with bowl-shaped sides, 100 feet in diameter. Over the surface of the pool a thick cloud of vapour may be seen, the temperature of the water being 185°F. The water is said to contain sufficient lithium salts in solution to be of medicinal value, and to have a very small percentage of sulphur. Near the pool a comfortable cottage has been erected, and excellent accommodation is available for those wishing to make use of the waters, which are piped into the cottage. During the season of 1926 (an unusually wet one) a fairly large number of people visited the resort.

TIMBER

Throughout the district the lower slopes of the mountains and the valley flats are densely timbered. Timber-line is about 4,500 feet. All the coast species of timber are found, with balsam and hemlock exceeding the other varieties. In the valley bottoms along Williams creek and Kitimat river there are considerable red cedar and hemlock, up to 3 feet in diameter, in scattered patches.

GAME

Goats and marmots are plentiful above timber-line, and, in the flats along the rivers and creeks, bears of all sorts are frequently encountered, but particularly in August when the salmon are running. Deer, moose, or caribou were not seen, though moose are reported to frequent the head of Williams creek. Ducks and geese are numerous on Lakelse lake, and ruffed and blue grouse and ptarmigan were seen in places. Salmon and trout are plentiful in Lakelse lake and in Kitimat river. A well-equipped fish hatchery is in operation at Lakelse lake.

ALPS-ALTURAS GROUP, SLOCAN MINING DIVISION, B.C.

By C. E. Cairnes

Illustration

INTRODUCTION

The Alps-Alturas group has the distinction of being one of few properties in Canada that have shipped ore for antimony content alone.[1] Only a few thousand tons of antimony ores have been produced in Canada and of this the largest shipments have come from West Gore, Hants county, Nova Scotia, where the deposits also contain important gold values. A lesser production has come from New Brunswick and Quebec. In the Yukon a few small shipments have been made from antimony veins in Wheaton River district, carrying, in some cases, high values in silver. In British Columbia, veins carrying a high percentage of stibnite have been discovered in Bridge River country and near Tatlayoko lake, but from these no shipments have been made. A few hundred thousand pounds of antimony have been recovered as a by-product from the refining of British Columbia lead ores. The Alps-Alturas group has, however, shipped about 105 tons of ore valued entirely for its antimony content.

LOCATION AND OWNERSHIP

The Alps-Alturas group includes the Alps claim, Alps fraction, and Alturas claim, and covers in all 95·78 acres of mineral lands. It is owned by Alps Mining Company, Limited, with main office at 122 Hastings St. W., Vancouver, B.C. Messrs. W. J. McMillan and W. H. J. McMillan are President and Secretary-Treasurer respectively. The property is situated in Slocan mining division, West Kootenay district, in one of the most rugged and picturesque sections of the southern Lardeau mountains. The claims are located at the head of Martin creek, the west branch of Kane creek which flows south and joins Carpenter creek at Three Forks station on the Nakusp-Kaslo branch of the Canadian Pacific railway. The mine workings are accessible by road over the first 3·7 miles from Three Forks and by pack-trail over the remaining 6·8 miles and lie at an elevation of about 7,650 feet, or 5,050 feet above the railway. At this altitude snow lies on the ground over a large part of each year and small mountain glaciers remain as evidence of the great field of ice which covered this region in the Glacial period.

In company with an assistant, Mr. J. G. Pearcey, the writer visited this property in the middle of August, 1926, and spent a couple of days

[1]Smitheringale, W. V.: "Antimony: An Outline of the World's Antimony Deposits and a Proposed Classification; with Notes on the Properties and Uses of Antimony and its Compounds"; Bull. Can. Inst. Min. and Met., April, 1927, pp. 457–465.

in an examination of the antimony deposits and in more general geological observations in their vicinity. The work included a telemeter traverse along the last 6,300 feet of the trail leading from the Alps basin at elevation 6,100 feet to the workings 1,550 feet above, in which distance the rocks are mostly well exposed. The distance along the road and trail leading from Three Forks station was estimated by pacing and is consequently subject to corrections based on any future more accurate surveys. Elevations were based partly on aneroid readings and partly on vertical angles and slope distances measured with the telemeter.

HISTORY

In July, 1898, the three claims of the group were surveyed for the Golden Canyon Gold and Silver Mining Company, who drove the lower or No. 1 tunnel in search of gold values. In driving this adit some stibnite (antimony sulphide) was encountered about 95 feet from the portal, and further prospecting on the surface above this level revealed much more of this mineral. As a result of these discoveries and the failure to find any important gold content in the veins, all further development work was concentrated on the extraction of the antimony ore. Prior to 1915 the property had been operated under lease by J. S. McArthur and Company of Glasgow and London who took out considerable ore from an open-cut above the present uppermost or No. 3 level. In 1915 the property was acquired by Mr. W. J. McMillan of Vancouver who had long held an interest in the group. He made some shipments during the period of the war and later organized the company of which he is now president.

PRODUCTION AND ASSAY RETURNS

According to a prospectus of the Alps Mining Company issued early in 1926, some 105 tons of antimony ore averaging 57·20 per cent antimony have been shipped from this property. A car of this ore sent to J. S. McArthur and Company, Glasgow, Scotland, and containing over 31 short tons, ran 53·28 per cent antimony. Another carload of about 26·5 tons sent to Chemical Company of Jersey City gave a return of 58·87 per cent antimony. A third shipment of about 21·5 tons to Great West Smelting and Refining Company of Chicago was found to contain 59·50 per cent antimony. The ore as mined was high grade and associated chiefly with quartz gangue from which it was readily hand-sorted before shipment. A sample of the ore analysed by the Mines Branch of the Department of Mines, Ottawa, was credited with the following composition:

	Per cent
Antimony	46·20
Sulphur	18·80
Arsenic	0·10
Zinc	0·00
Lead	0·13
Iron	0·90
Magnesia	1·36
Lime	2·38
Insoluble	24·40

Gold, 0·14 ounce Troy per ton of 2,000 lbs.
Silver, 2·52 ounces Troy per ton of 2,000 lbs.

GEOLOGY

The geology in the vicinity of the Alps-Alturas property includes an unusually interesting assemblage of igneous and sedimentary rocks of Mesozoic and, possibly, late Palæozoic age. Except for the later granitic intrusives, these have all suffered more or less severe metamorphism that has resulted, locally, in completely masking their original character. The sediments include relatively small patches of slate and platy argillites situated, mostly, one-half mile or so to the south of the workings, where they appear to form the axis of an anticlinal fold striking a little north of west and overlain on either flank by greenstones of probable volcanic origin. No other definitely sedimentary types were recognized, but certain cherty beds of dense texture and mottled appearance were observed at a number of places on the property and may be of sedimentary origin. In each case, however, their close association with greenstones suggests an igneous derivation for the silica, of which they are mostly composed, either by chemical precipitation from volcanic emanations or by clastic deposition as fine-grained acid tuffs. In the vicinity of the workings, again, are highly metamorphosed rocks which may have been sediments. Some resemble the cherty rocks mentioned above except that they are more altered in appearance. Others are somewhat coarser in grain. Both types are intercalated with greenstones, which are prevailing rocks in this section.

The igneous rocks include both volcanic and intrusive types. The volcanic rocks, conveniently referred to as greenstones, are of andesitic or more basic composition and are generally recognized in the field by their dark green colour and fine texture. In part, they are quite massive and, in part, more or less sheared and schistose. In part, too, they have been invaded and saturated by later granitic material which has worked its way along joint cracks or other fractures and along planes of schistosity, assimilating and replacing the older rock to such an extent that it is difficult in places to distinguish the granitic rocks from the older greenstones. Altogether, these greenstones occupy a broad belt striking northwesterly across the head of Martin creek. They constitute the principal rocks on the Alps-Alturas property and outcrop across a width of at least half a mile. To the southeast they are probably continuous with rocks of like character in Slocan mining area where they have been found to contain a variety of mineral deposits.[1]

The intrusive rocks probably belong to two distinct periods of which the earlier is thought to be represented by a ledge, about 100 feet wide, of partly serpentinized rock cutting across the northeastern corner of the Alps claim in a north 55 degrees west direction. To the northwest it appears to cross the divide between the basins of Carpenter and Wilson creeks, its position on the summit being marked by a low saddle. In the opposite direction it is thought to pass under the Alps glacier at the head of Martin creek, and to continue for a considerable distance beyond. Its total length would, in this case, be well over a mile. In its general strike

[1]Cairnes, C. E.: "Notes on the Mining Industry in Slocan District, B.C."; Bull. Can. Inst. Min. and Met., Feb., 1927, pp. 189–191.

this ledge has much the appearance of a sheet or sill, in that it trends, and may also dip, with the formations on either side. On the Alps-Alturas property it is known as the serpentine or "north" ledge. It is composed altogether of secondary minerals, largely dark green serpentine and soapstone, which in places have undergone further extensive alteration to a buff-weathering rock composed mostly of a ferruginous magnesian carbonate containing a little quartz and pyrite. The original character of this ledge is a matter of doubt. Its shape and present composition suggest that it represents the alteration product of a basic dyke, a transformation analagous to that which has been identified elsewhere along the southeasterly extension of the greenstone belt.

The later intrusive rocks are probably all of about the same age and constitute the youngest rocks in this section. They are chiefly batholithic granitic types from which offshoots in the form of stocks, dykes, and aplitic stringers have penetrated the older rocks in every direction; have effected most of the metamorphism shown by these older rocks; and are responsible for the ore deposits on this and adjoining properties. These intrusives vary considerably in composition. The larger batholithic bodies and related stocks, such as are exposed one-half mile and more to the south of the mine workings, are mainly granite and granodiorite. These are light-coloured, massive rocks of medium texture and show little evidence of alteration except possibly in the chloritization of their ferromagnesian minerals. Where, however, these later intrusives are, as previously described, intimately associated with the greenstones, they are commonly more basic, as a result, it might appear, of assimilation of these older rocks. In the vicinity of the workings some narrow, twisted dykes of intermediate composition were observed. These carried disseminated grains of pyrite as well as specks of a copper mineral, probably tetrahedrite. Farther north some distinctly acid dykes with aplitic apophyses were observed cutting the serpentine or north ledge and appeared to have been important factors in its carbonization.

MINERAL DEPOSITS

The Alps-Alturas property is chiefly notable for its deposits of antimony ore. The conditions that have determined the location of these deposits are unusually interesting. The workings include four short adits, aggregating a little over 400 feet, and follow up an irregular ravine in a steep, rocky slope (Plate I) between elevations of 7,650 and 7,880 feet. The ravine marks the position of a zone of shearing and intense metamorphism. This zone has a general east and west strike and extends far to the east and probably also far to the west of the present workings. Its course resembles that of a braided stream in which islands of more massive rock are surrounded by more sheared, and, therefore, less resistant, material. At the workings the maximum width of the zone is about 75 feet, but in places farther east it is wider. The zone on the whole is characterized by the intense alteration of the constituent rocks; by the presence, in particular, of an abundance of bright green specks and flakes of chrome mica, probably mariposite; and by substantial evidence of its economic importance as furnished by the deposits of stibnite. The stibnite is associated with a network of quartz veins that traverse the zone of shearing and are, apparently, most persistent where their strike coincides closely with the trend of this zone. Stibnite was first noticed in a quartz vein in the lowest, or No. 1, adit driven in from the south side of the shear zone. Subsequently, more important deposits were discovered in quartz veins outcropping about 65 and 200 feet respectively above this adit. At the lower of these two points and near the north wall of the shear zone, the vein was drifted on for 90 feet, the full length of No. 2 adit. This vein has a general east-west strike and dips at an angle of about 40 degrees to the north. Ore of good quality was found in the first 65 feet from the portal and has been mostly stoped out above the level, the first stope breaking through to the surface. On the north side of the adit and about 35 feet from the portal the vein widens out to form a lens of quartz 8 feet long with a maximum width of 4 feet. This lens carries a good percentage of stibnite and is the only important showing of ore now exposed on the property. Towards the face of this adit, again, the vein is 2½ feet wide and contains a little stibnite.

About 200 feet above No. 1 adit a quartz vein carrying a high percentage of stibnite was developed by an open-cut, and produced considerable ore. No. 3 adit, 90 feet long, was run a few feet below this open-cut to tap the ore-shoot at depth, and apparently encountered an extension of the vein between 30 and 42 feet of the portal. Some stoping was done above the level at this point, but only small stringers of ore were reported. A width of between 3 and 4 feet of crushed quartz is now exposed at 30 feet from the portal, but, except for some copper stains, no mineral was observed.

A fourth or No. 1A adit was driven for a few feet along the north wall of the shear zone almost on a level with, and 85 feet to the northeast of, No. 1 adit. No ore or vein matter has yet been encountered in this adit.

The ore on this property is a very simple type. It consists of the sulphide of antimony, stibnite (Sb_2S_3), in a gangue composed almost entirely of quartz. The stibnite occurs as bladed, fibrous, or massive lumps, aggregates, and streaks irregularly distributed through the quartz which, except for occasional minute copper stains, contains little or no other visible ore minerals. Assays of the ore have, however, revealed low gold and silver values as well as traces of lead. The stibnite is here and there coated with a reddish stain where oxidation has developed a thin film of antimony oxysulphide, kermesite (Sb_2S_2O). The stibnite and the quartz appear to have been introduced together, but most of the stibnite has segregated in shoots in the wider or lens-like expansions of the veins. Fragments of wall-rock surrounded and partly replaced by quartz and stibnite are not infrequent and were, probably, rifted from the walls of the veins at the time of the incursion of the ore-bearing solutions.

The association of the stibnite with vein quartz is well demonstrated and as there is, in the vicinity of the workings, an abundance of quartz veins that have not been investigated, it is not unlikely that these or others nearby may contain deposits of stibnite of like character to those already found. These quartz veins, however, are notably irregular and individually do not appear to be continuous over any considerable distance. Most of the ore hitherto developed has been worked out, and there is no assurance that the good showing in No. 2 adit will persist to any considerable depth. Nor has any connexion yet been established between the vein in this adit and the vein in the open-cut 135 feet above. The small showing of stibnite in the lowest or No. 1 adit is not on the same quartz vein as either of the larger antimony deposits, but is of interest in indicating that the antimony is not confined to any particular vein but may be found in quartz veins occurring elsewhere within the zone of shearing in which the deposits to date have been found.

Economic interest in the Alps-Alturas property has been mostly centred on its deposits of antimony ore, but the possibilities of the property are not confined to the development of these occurrences nor even to values in other metals that may be found at other localities in the sheared and metamorphosed zone in which the antimony ore occurs. A quartz vein traversing the serpentine, or north, ledge was observed to carry a little galena, and on the south side of this ledge another vein carrying a foot of clean stibnite is said to have been discovered. Northeast of the workings, again, and between them and the north ledge, is a middle ledge represented by a narrow but persistent zone of shearing striking southwest and possibly connected in this direction with the larger zone, already described, which it resembles in the general character of the metamorphism of the rocks traversed and, in particular, in the presence of the same bright, green mica. This ledge contains a quartz vein or lens from 2 to 3 feet in maximum observed thickness and at least several yards long. In places this vein is specked with a copper mineral resembling tetrahedrite, which in weathering has stained the quartz about the mineral particles a characteristic copper green. Isolated grains and small lumps of stibnite were also observed. Neither of these minerals, however, was sufficiently abundant to be commercially important, but it is possible that further prospecting in this vicinity may reveal more extensive mineralization. Another interesting locality that may pay to prospect more carefully lies about one-third of a mile east of the present workings where the big shear zone on its easterly strike intersects the north, or serpentine, ledge and where metamorphism has been particularly intense.

The quartz veins carrying the antimony ore appear to have been introduced at a comparatively late stage in the period of metamorphism and mineralization consequent upon the intrusion of the later granitic rocks of this section. The earlier stage was characterized by intense metamorphism of the older rocks, particularly where these were traversed by shear zones or other lines of weakness that afforded egress to the hot gases and solutions effecting the transformation. Characteristic of this earlier and higher temperature stage was the development of an abundance of carbonate minerals, carrying iron, magnesia, and lime, and of quartz, talc, chrome mica, and pyrite. At a later stage, and probably at considerably lower temperatures, the quartz veins, carrying stibnite and, in some places, a sprinkling of other sulphides, were introduced.

In conclusion it may be said that aside from the small workings that have produced the antimony ore, this property is barely prospected and quite undeveloped and, as a consequence, its possibilities are unknown. At present there is little antimony ore in sight, but its extraction might pay for sufficient development to prove other ore-shoots in the immediate vicinity of those already discovered. The property is handicapped to a considerable extent by its distance from convenient transportation, which necessitates the use of pack-animals for nearly 7 miles. The claims, too, stand at such a high elevation that surface prospecting is limited to a relatively short period of each year. The workings are well above timber-line, and there is little water convenient to the mine. Much of the difficulty encountered in small-scale operations on this property would be eliminated if antimony or other ores of value were discovered in sufficient quantity to warrant development and production on a large scale. Under such conditions it would pay to tram the ore down into the Alps basin, about 1,550 feet below and one-half mile to the south of the present workings where timber and ample water and waterpower are available, and where a permanent camp with mill, reduction plant, or other facilities might be constructed. At present, however, and although geological conditions are apparently excellent for mineral deposition on a large scale, little has been revealed to indicate that such deposits exist.

PLACER GOLD AND LEAD-ZINC DEPOSITS, DOGTOOTH RANGE, KOOTENAY DISTRICT, B.C.

By C. S. Evans

INTRODUCTION

The seasons of 1925 and 1926 were spent making a detailed study of the geology along the Rocky Mountain trench, north from Windermere map-area to the main line of the Canadian Pacific railway, and west across Dogtooth range to Beaver river. The report deals with the economic deposits of the Dogtooth range. The geology of the district will be discussed in a memoir in course of preparation. Efficient assistance in the field was rendered by W. A. Jones in 1925 and E. J. Lees in 1926.

The Dogtooth range is the most northeasterly division of Purcell mountains and is bounded on the northeast by the Rocky Mountain trench, occupied by the north-flowing Columbia river, and on the west and southwest, respectively, by Beaver river and the north fork of Spillimacheen river. From Beavermouth, at the junction of Beaver river with the Columbia, southeast for 40 miles, the range is clearly defined; most summits are well over 8,000 feet in elevation, although the average elevation of Columbia river is only 2,500 feet. Beyond this the range is continued by wooded ridges, about 4,500 feet in elevation, for 22 miles southeast to where Spillimacheen river enters the Columbia. Steamboat mountain still farther to the southeast may represent a continuation of the range.

PLACER HOLDINGS ON QUARTZ AND PORCUPINE CREEKS

Quartz creek flows north-northwest and joins the Columbia at Beavermouth. Porcupine creek is tributary to Quartz creek and lies in a southward extension of the valley of the main stream.

Quartz and Porcupine creeks have long been known to hold placer ground and stories are current of gold having been found there by prospectors of the early sixties. The first published account, of which the writer is aware, is given by G. M. Dawson[1] who states that gold was discovered in 1884 on Quartz creek. The Provincial records of 1888 show that active work was carried out during the summer of that year, when 23 days of sluicing gave a recovery of something over $1,000. Work during the following year proved unsuccessful as the gold was "scattered amongst a mass of large boulders, which made it expensive to work".

During the season of 1926 work was done by the Quartz Creek Syndicate, formed of the following: Mr. C. P. Price, of Beavermouth, B.C., and Messrs. J. F. Townsend, C. Hassard, L. E. Anderson, and H. J. Read,

[1]Dawson, G. M.: Geol. Surv., Canada, Ann. Rept., vol. III, pt. R, p. 131 (1889).

of Medicine Hat, Alberta. The holdings consist of four bench claims and three creek leases. The creek leases are on Quartz creek and extend $1\frac{1}{2}$ miles northwest from the mouth of Porcupine creek, 10 miles southeast of Beavermouth. The bench claims extend for 2 miles southeast of the junction of the creeks along the east slope of Porcupine Creek valley.

Most of the season of 1926 was spent by the syndicate in digging the ditch, building the penstock, and laying the pipe system to within hose reach of the ground chosen for washing at the northwest end of the bench claims. Sufficient water is available to supply two 2-inch nozzles under a head of about 200 feet. Mr. Price estimates that 1,000 miner's inches could be obtained during the summer. A certain amount of interrupted sluicing done at the end of the season gave a recovery of $240 from about 225 cubic yards of ground. The greater part of the gold recovered consisted of 10 to 50 cent specks: the largest nugget found was valued at $12.

The bench on which the bench claims are staked is situated on the east side of Porcupine creek. The down-stream end is opposite the junction of Quartz and Porcupine creeks at an elevation of 5,700 feet, and the bench extends southward for a little over 2 miles, where it meets the present creek at an elevation of 5,900 feet. Throughout this length it ranges in width from 200 to 700 feet, is heavily wooded, and, since it is not cut by streams, shows no exposures of gravel except at the workings. Here the average depth of the gravels is 6 feet, with an overburden of forest decay, and, occasionally, peat, from 1 to 3 feet. The gravels are poorly sorted, clearly of glaciofluvial deposition, and consist of sand and pebbles in which there are many rounded and subangular boulders up to 3 feet in diameter. The rock fragments are representative of the strata of the basin; quartzites, limestones, and slates. Beneath the gravels, disintegrated blue phyllite bedrock forms a layer averaging a foot in thickness. As far as can be seen from the small area (100 square feet) of bedrock exposed in the workings, the bench appears to have been cut in phyllite and to be slightly lower back from the rim. No generalizations can be made from so small an exposure.

The present creek is 600 to 700 feet below the level of the bench at its northwest end. The slope is steep from the bench rim down to just above the stream, where there is a narrow, but rounded, bottom into which the stream has cut a sharp notch 20 to 100 feet deep through old gravels, talus, and slates and phyllites. The talus seems to have come from the steep rock slope on the west of the creek. The slope above the bench is mostly covered with talus, but there are several small remnants of higher benches at elevations of 6,200 to 6,500 feet.

The creek leases are on an alluvial flat the surface of which is 3 to 20 feet above the bed of the creek. The material is finer than that of the bench and represents material derived by stream erosion of the steep, lower parts of Porcupine and Quartz creeks above their confluence, and deposited because of the low gradient below their junction. Most of the ground is on the east side of the creek and the flats range in width from 100 to 1,000 feet: the depth of the alluvium is not known. The gravels may include some of the reworked bench gravels as well as later materials carried down by the streams. Some work has been done here in the past and it is said that the values are better than on the bench. The lower parts of the valley opposite the bench are not regarded as favourable by the prospectors.

The gold found on the bench occurs in the glaciofluvial deposits and in the disintegrated phyllite. It is believed that this softened phyllite represents the original fresh bedrock at the time of deposition of the pay gravels. In about ten pans washed from the disintegrated phyllite the gold particles were in no instance larger than 3 to 5 cents: most of them ½ to 1 cent. It is clear that the glaciers existed here during the deposition of the pay gravels, but from the facts that the bench remains, and its upper junction with the present stream is not truncated, it would appear that no extensive erosion by glaciers has occurred since its formation, though the valley glacier reached an elevation of at least 7,250 feet. No information as to the actual extent of the payground is available. Values of $1 to $2 a yard are said to have been obtained for several hundred feet up- and downstream from the small hydraulic pit at the northwest end of the bench claims. Similar values are also said to occur on the creek leases and colours are reported from the present stream gravels downstream to the Columbia.

The valley of Quartz and Porcupine creeks is underlain by slates and phyllites, above which, as seen on the lateral ridges, occur limestone and quartzite strata. Many small veins and stringers of milky white quartz parallel the cleavage of the slates and phyllites, and a number of stronger veins occur in the massive strata. Small amounts of pyrite and occasionally galena and chalcopyrite are found in the veins and the secondary development of ferruginous carbonates is pronounced in the enclosing strata. No free gold has been seen in any of the veins, though quite small assay values of this metal have been reported. These veins, however, probably form the source of the gold.

The owners of the placer claims intend to continue work during the season of 1927. The success of the undertaking depends, of course, on the extent and richness of the gold-bearing ground, and although gold has been panned at various places in the valley no systematic testing by pits has yet been carried out. A very apparent difficulty lies in the economic handling of the many large boulders.

LEAD-ZINC PROPERTIES OF JUBILEE AND LEAD MOUNTAINS

ROSE GROUP

The Rose group is situated between elevations of 4,150 and 4,350 feet on the east slope of Lead mountain, about 2 miles west of Columbia river, southwest of Castledale post office. On this property disseminations and replacements of galena and some sphalerite occur in a sandy magnesian limestone, about 250 feet thick, overlain by drab slates and underlain by rusty grits dipping steeply to the southwest (60 degrees). Two adits, 100 and 250 feet long, respectively, have been driven westward into the limestone, and the surface is exposed by shallow pits and strippings. The limestone is closely fractured, and in most of the deposit the sulphides occur thinly seaming the fracture planes and as small, scattered pellets in the limestone. The 250-foot adit shows this type of mineralization for the first 130 feet from the mouth, the first and last 20 feet of this distance being the richest, with a lead content of about 4 per cent. From 130 feet to the face of the adit very little sulphide occurs. Such disseminations are also shown for about 500 feet along the slope on the surface, though a few 10-inch pockets of nearly solid galena were found at the entrance to the 100-foot adit. From an examination of the adit and the nearby surface it is inferred that the pockets are isolated replacements. Samples from a stripping, 10 by 20 feet, just north of the 250-foot adit, are said to have given 20 per cent lead. The mineralization is seen to decrease inwards along both adits, but extends farthest in the 250-foot adit, the lower, so that the sulphides may be confined to a fracture zone of steeper dip than that of the formations and may be found at lower elevations in the eastern part of the limestone, close to the grits. An alternative explanation is that these deposits may be only marginal to a main zone of mineralization that may lie directly to the east of Lead mountain and is now hidden by the drift.

GIANT MINE

This property is described in the reports of the British Columbia Minister of Mines for 1909 and 1923, and in the Summary Report of the Geological Survey, Canada, for 1925. It is now under bond to the Pacific Mines, Ltd., of Vancouver. During the season of 1926 diamond drilling was carried on, of which no information could be had other than "results favourable enough to warrant driving of a 600-foot crosscut tunnel to tap the lead . . . this tunnel . . . is now in approximately 300 feet."

Most of the mineralization of the Jubilee Mountain and Lead Mountain area appears to be confined to the Ottertail magnesian limestone in which occur numerous veins and bedding replacements of barite. The sulphides, galena, sphalerite, and in some places chalcopyrite and chalcocite, occur as scattered replacements or as small pockets of richer ore, in the barite and limestone. No large body of ore has been developed, but it seems reasonable to suppose that in this area where the total amount of visible sulphide is great, though scattered, conditions favouring the local deposition of workable bodies of ore should have existed. The area is close to rail transportation.

OTHER FIELD WORK

GEORGE HANSON. Mr. Hanson commenced detailed geological work in the Bear River mineral area, Portland Canal district. The field work will be completed in 1927, after which the map and a detailed report dealing with the many mineral deposits of the area will be prepared.

VICTOR DOLMAGE. Mr. Dolmage completed a detailed examination of the geology and copper ore deposits near Allenby. This work was commenced in 1923, but not continued until 1926. A report, accompanied by a map and detailed plans and sections, is now nearing completion. Mr. Dolmage also examined the Rock Candy fluorite deposit north of Grand Forks.

C. H. CRICKMAY. Mr. Crickmay continued from 1924 a geological survey of the vicinity of Harrison lake.

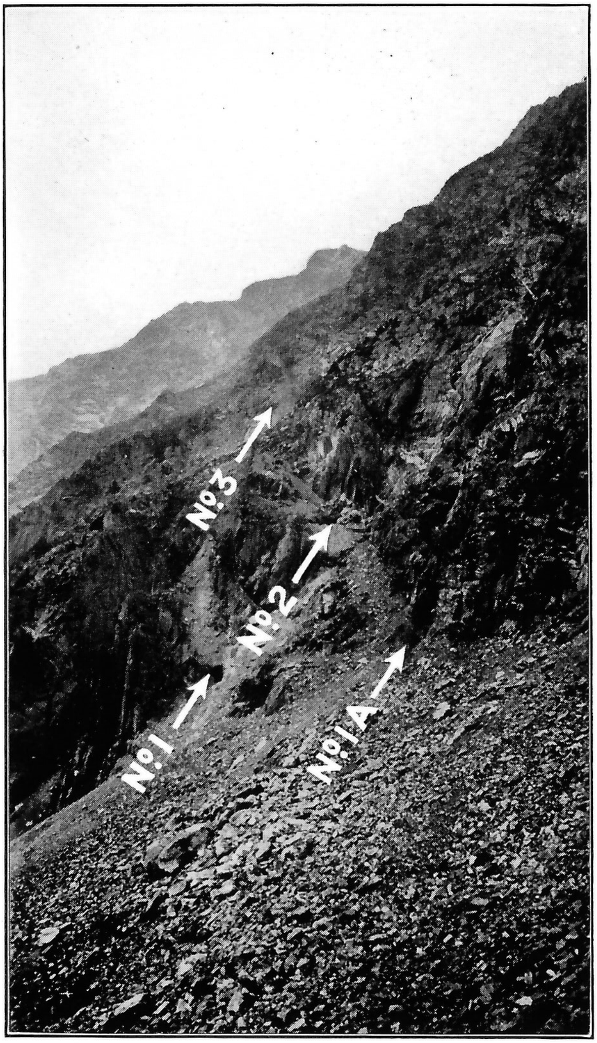
H. S. BOSTOCK. Mr. Bostock made a detailed investigation of the Nickel Plate gold-arsenic mine and neighbouring prospects in the vicinity of Hedley. The field of work is to be enlarged in 1927, after which a map and report will be completed.

C. E. CAIRNES. Mr. Cairnes continued a systematic survey of the geology and ore deposits of Slocan mining area, which he began in 1925. This work is to be completed in 1927.

J. F. WALKER and M. F. BANCROFT. Mr. Walker and Mr. Bancroft completed the greater part of an examination of the geology and mineral resources of Lardeau area. After field work in 1927 a map and report will be published.

C. S. EVANS. Mr. Evans continued detailed geological mapping of the territory bordering Columbia River valley from Windermere area north to beyond Golden. This work will be completed in 1927.

PLATE I



View of the workings on the Alps-Alturas property, Slocan mining division, B.C. (Page 48.)

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The annual Summary Report of the Geological Survey is issued in parts, referring to particular subjects or districts. This year there are three parts, A, B, and C. A review of the work of the Geological Survey for the year forms part of the Annual Report of the Department of Mines.