CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

MEMOIR 159

Bear River and Stewart Map-areas, Cassiar District, B.C.

BY
G. Hanson

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1929

Price, 20 cents

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View of mount McLeod and south fork of Marmot river.

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Bear River and Stewart Map-Areas, Cassiar District, B.C.

CHAPTER I

GENERAL CHARACTER OF THE DISTRICT

INTRODUCTION

Bear River map-area and part of Stewart map-area were mapped geologically by McConnell in 1911, but new discoveries of mineral deposits and recent mining development made re-examination of the areas desirable. Accordingly, topographic maps were prepared in 1925 covering Bear River drainage basin and the previously unmapped drainage basin of Marmot river. These maps were used as a base for geological work in 1926 and 1927 and the results of the work form the subject-matter of this report.

The field seasons in the vicinity of Stewart are short. The upper mountain slopes are usually covered with snow until late in July; frequent rains in September hamper outdoor work; and snow appears on the mountains in September and October. The normal field season in the area is, therefore, usually less than three months. The two field seasons spent in the district approximated five months of field work.

MEANS OF ACCESS

The area under consideration comprises parts of two map-areas: (1) west half Stewart map-area, and (2) west half Bear River map-area. The west half Stewart map-area includes the lower part of Bear river, the town of Stewart, and Marmot river. The west half Bear River map-area adjoins Stewart map-area on the north and includes the upper part of the drainage basin of Bear river.

The town of Stewart at the head of Portland canal, about 650 miles from Vancouver, is a regular port of call for coastwise steamships of the Canadian National Railway Company and the Union Steamship Company. It is the outfitting point for operations in the area. From Stewart all parts of the area are accessible. Gasoline launches make several trips daily between Stewart wharf and Marmot river. An automobile road extends 10 miles up Bear river, and horse trails give access to most of the outlying mineral properties. Because of the glaciers and steep slopes in Marmot River valley the roads and trails there are not as good as those in Bear River valley.

PREVIOUS GEOLOGICAL WORK

The first work in the area by the Geological Survey was done in 1910 by McConnell. In 1911 McConnell carried out geological mapping in the adjoining Salmon River area. Later geological work was done in Salmon River area by O'Neill in 1919 and by Schofield and Hanson in 1920. The mineral deposits have been examined and described from year to year by the Department of Mines of British Columbia. Geological work has also been done in the adjoining part of Alaska, by Westgate in 1920 and by Buddington in later years.

BIBLIOGRAPHY

McConnell, R. G.: "Portland Canal District"; Geol. Surv., Canada, Sum. Rept. 1910, pp. 59-90.

"Salmon River District, B.C."; Geol. Surv., Canada, Sum. Rept. 1911, pp. 50-56.

"Portland Canal District, B.C."; Geol. Surv., Canada, Sum. Rept. 1911, pp. 56-71.

"Portions of Portland Canal and Skeena Mining Divisions, Skeena District, B.C."; Geol. Surv., Canada, Mem. 32, 1913.

O'Neill, J. J.: "Salmon River District, Portland Canal Mining Division, B.C."; Geol. Surv., Canada, Sum. Rept. 1919, pt. B, pp. 7-11.

Schofield, S. J., and Hanson, George: "Salmon River District, B.C."; Geol. Surv., Canada, Sum. Rept. 1920, pt. A, pp. 6-11.

Ann. Repts. Minister of Mines, B.C., 1904-1926.

Westgate, L. G.: "Ore Deposits of the Salmon River District, Portland Canal Region, Alaska"; U.S. Geol. Surv., Bull. 722-C, pp. 117-140 (1921).

Buddington, A. F.: "Mineral Investigations in Southeastern Alaska"; U.S. Geol. Surv., Bull. 773, pp. 71-140 (1925).

"Mineral Investigation in Southeastern Alaska"; U.S. Geol. Surv., Bull. 783, pp. 41-62 (1926).

"Coast Range Intrusives of Southeastern Alaska"; Jour. Geol., vol. XXXV, No. 3, pp. 224-246 (1927).

"Types of Mineralization and of Coast Range Intrusives"; Econ. Geol., vol. XXII, No. 2, pp. 158-179 (1927).

Smitheringale, W. V.: "Mineral Association at the George Gold-Copper Mine, Stewart, B.C."; Econ. Geol., vol. XXIII, No. 2, pp. 193-208 (1928).

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PHYSICAL FEATURES

Bear River and Stewart map-areas lie in the eastern part of the Coast mountains which extend far northwestward and southeastward, and include all the mountains of the mainland, Pacific coast of British Columbia. The areas are entirely within the Coast Mountain system, but the boundary between this rugged tract and the plateau-like, subdued country to the east passes not far to the east, near the Bear-Nass River divide. The change from one type of country to the other is fairly abrupt; steep, bare mountain slopes and alpine peaks give place quickly to gentler wooded slopes and low, rounded peaks.

The total relief within the map-areas is great. Peaks rise to 7,800 feet above sea-level, whereas Bear river is only 400 feet above sea-level 13 miles from its mouth. The mountain slopes of Bear River valley are in general steeper than those in the adjacent Salmon River area. Slopes of 40 degrees for several thousand feet are not uncommon. In Marmot River valley, particularly on the south fork, the slopes are even steeper, being over 50 degrees in some places. In this part of the area the valley sides can be scaled in only a few places.

The north-south valley occupied in the north by American creek and in the south by Bear river and Portland canal, divides the area in two. The part west of the valley is a mountain ridge separating Bear and Salmon rivers and is known as Bear River ridge. The Bear River slope of the ridge is steeper than the Salmon River slope. The northern part of the ridge is covered with ice and snow which reaches down the slopes in several places as short alpine glaciers. The streams draining the eastern side of the ridge are very short, have no distinct valleys, but simply tumble down the mountain sides.

East of the main north-south valley is a mountainous tract drained by four principal streams. From north to south these are: Bear river, Bitter creek, Glacier creek, and Marmot river. All four flow westward to form the main part of Bear river lying in the north-south valley and draining south into Portland canal. These streams have deeply incised valleys with normal stream gradients, and enter the main valley at grade.

Much of the eastern part of the mountainous tract is snow covered, and long glaciers continue down the valleys to low levels. The glaciers in valleys tributary to Upper Bear river, Bitter creek, Glacier creek, and Marmot river are short and steep like those in the west of the main north-south valley. In several places the slopes are so steep and the valleys so narrow that, in certain times of the year, snow slides down continually in a narrow stream, building up snow fans in the larger valley. Several such snow fans form in Upper Bear and Marmot River valleys. Late in July most of the snow-slides cease, and then rocks tumble down the narrow gullies. A glacier flows northward into Bear-Strohn Creek valley at the low divide between Bear and Nass rivers, partly fills the valley, and spreads both east and west. Large alpine glaciers exist at the headwaters of Bitter creek, Glacier creek, and Marmot river, and are kept in motion by large feeding grounds. Ice erosion has given the area steep-sided, U-shaped valleys, but the ice has not yet receded far enough to permit the excavation of large cirques.

The principal stream valleys, as already stated, are steep-sided and U-shaped. All except the main north-south valley are narrow. The main valley has a flat floor half a mile wide over which the streams thread their way with frequent changes of course. All the streams in the area are rapid, glacially fed, and unnavigable. The grade of the main valley is 35 feet a mile up to the mouth of American creek and is somewhat steeper above that point. The grade of Upper Bear river is 100 feet a mile, that of Bitter creek is about 125 feet a mile, and the grades of Glacier creek and Marmot river are 400 feet and 250 feet respectively. The main north-south valley is straight, whereas the other valleys are curved.

CHAPTER II

GENERAL GEOLOGY

GENERAL STATEMENT

Stewart-Bear River area is at the eastern margin of the Coast Range batholith which forms the Coast mountains from Vancouver to the northwestern boundary of Yukon. It is generally conceded that intrusive rocks have been the source of most of the metalliferous deposits in British Columbia, and with this idea in view much geological work has been concentrated along the borders of the Coast Range batholith. The formations bordering the batholith in the area being described are of volcanic and sedimentary rocks, chiefly Mesozoic, but in part possibly older. They are part of a long belt of similar rocks fringing the batholith for most of its length in British Columbia. In some places in this belt the ages of the Mesozoic rocks have been determined within narrow limits, but in most places this is not so.

The oldest rocks of the Stewart-Bear River area are the Bitter Creek argillites. These are overlain conformably by a series of volcanic rocks composing the Bear River formation. Both these formations contain metalliferous deposits. Locally overlying the volcanic rocks is the Nass formation, a series of argillites and other sediments in general void of mineral deposits. Intrusive into the Bear River and Nass formations are stocks of augite porphyrite, most of which contain metalliferous veins. The eastern contact of the Coast Range batholith passes through the area and the batholith and its many related intrusives are later than the rocks previously mentioned. Pleistocene drift and Recent clays are present locally.

The Nass formation, in general barren of mineral deposits, is more largely developed northeast of the area where it occupies a large, elongated district lying east of and roughly paralleling the Coast Range batholith. The width of the mineralized country is, therefore, the distance between the western edge of the area occupied by the Nass formation and the eastern edge of the batholith. This distance in the vicinity of Portland canal is approximately 18 miles. In other words the mineral belt is, in general, coextensive with the area underlain by rocks that border the batholith and are older than the Nass formation.

Table of Formations

Recent and Pleistocene.............	Marine or estuarine clays, gravels, and sands, boulder clay, and glacial drift
Early Cretaceous or Late Jurassic..	Dykes
	Coast Range intrusives
Jurassic............................	Augite porphyrite and related intrusives
	Nass formation: argillites, quartzites, tuffs
	Bear River formation: agglomerates, tuffs, lava flows, argillites, limestones, thickness, 5,000 feet
Jurassic and (or) Triassic..........	Bitter Creek formation: argillites, quartzites, limestones, tuffs, lava flows, thickness, 3,000 feet

BITTER CREEK FORMATION

The name Bitter Creek was proposed by McConnell for a series of argillites in Bear River valley, and was derived from Bitter creek one of the main tributaries of Bear river.[1] The rocks of the formation are chiefly black argillites. In most places the beds are thick and blocky, but in some places, particularly at the headwaters of Kate Ryan creek and in the vicinity of Bromley glacier, the beds are thin and consist of black argillite and light-coloured quartzite in layers an inch or two thick. Light grey limestone is present in several places, but usually as thin, discontinuous beds, although lenses of limestone 100 feet thick are known. Tufts, breccias, and, probably, lava flows occur at several places. The rock has been severely sheared locally, as on Kate Ryan creek and along Bitter creek, so that it has been changed to micaceous schist.

The upper 500 feet of the formation is calcareous and contains several beds of limestone. The upper part also holds numerous interbeds of tuffaceous rocks. Tuffs also occur lower in the formation, but probably above the middle. Banded argillite-quartzite rocks occur from the middle of the formation downward. Most of the lower part of the formation consists of argillite and of banded argillite and quartzite. The coarser sediments contain pebbles of tuff, cherty argillite, and crystalline igneous rock.

The base of the formation is not exposed in the area and consequently the total thickness is not known. Because of numerous small folds the thickness of the exposed part can not be measured accurately. On Kate Ryan creek the formation is probably at least 3,000 feet thick and may be considerably more.

The formation is exposed on Marmot river in two northwesterly-striking bands separated by a band of volcanic rock. The southwesterly band is in contact with the Coast Range batholith and as the contact is not exactly parallel to the strike of the argillite the band in some places has been completely cut away. A small body of argillite at the contact in the vicinity of Bayview mining property on mount Dolly is probably part of

[1]McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1910, p. 63 (1911).

this band. Argillites near the International Boundary on Salmon river may also be a continuation of this band. To the southeast the band continues beyond the area and may join the sediments west of Kitsault river. The northeasterly band swings northward, becomes much wider in the vicinity of Glacier and Bitter creeks, but eventually narrows and terminates in the northern part of the area. Southeastward the band disappears under volcanic rocks in the high mountains at the head of Marmot river.

The southwestern band of the formation on Marmot river is the southwestern limb of a syncline. The prevailing dips are northeasterly, and the sediments apparently pass under the adjacent volcanic rocks to reappear and form the northeastern sedimentary band. The small area of sediments on mount Dolly is in the form of a sharp anticline, the sediments disappearing under volcanic rocks farther up on the mountain. The rocks in this band are harder than the other sediments in the area, due probably to thermal metamorphism resulting from batholithic invasion.

The sediments of the northeastern band south of the south fork of Marmot river lie in a sharp anticline slightly overturned to the west. This anticline plunges under the volcanic rocks to the south. North of the south fork overturning is not marked, but the anticline is asymmetric. Farther north the anticline flattens and the formation broadens considerably. In the broad part the main anticline becomes two anticlines with a shallow central syncline, and the whole is complicated by minor folds. Where the formation plunges under volcanic rocks north of Bear river it is in the form of a narrow, sharp anticline. The general dip of the western part of the argillites in the central part of the area is 35 degrees westward. The eastern part of the formation was not examined.

According to McConnell the Bitter Creek formation underlies the volcanic rocks at the western contact, but appears to overlie similar volcanic rocks at the eastern contact. He states that parts of the Bear River formation may be contemporaneous with, or even older than, the Bitter Creek formation.[1] Along the western edge of the Bitter Creek formation the relationship to the overlying volcanic rocks is clearly visible in many places. The sediments underlie the Bear River formation conformably and there is a transition zone characterized by interbedding of sedimentary and volcanic rocks. Dips are rarely seen in the volcanic rocks, but wherever they were observed they indicated concordance between the two formations.

BEAR RIVER FORMATION

The name Bear River formation was used by McConnell to designate a series of volcanic rocks exposed in Bear and Salmon River valleys.[2] That this name had been used previously for formations of different types and ages in other places has already been pointed out.[3] However, as the name is well established in Portland canal it seems advisable to continue to use it as the name of a formation in that general district.

The formation consists essentially of tuffs, breccias, and lava flows. A few thin beds of argillite, limestone, and calcareous tuff occur and also

[1]McConnell, R. G.: Geol. Surv., Canada, Mem. 32, p. 14 (1913).
[2]McConnell, R. G.: Geol. Surv., Canada, Sum. Rept. 1910, p. 64 (1911).
[3]Hanson, George: Geol. Surv., Canada, Sum. Rept. 1923, pt. A, p. 35 (1924).

a small amount of intrusive matter. The flows and fragmental rocks are not easily distinguished, as some breccias appear to have a flow matrix and some flows contain numerous fragments. Contacts between different rock types, too, are rather difficult to follow, as individual flows or beds do not continue far but lose their identity by merging with adjoining volcanic rocks. The usual types of fragmental rocks are breccia and tuff. The tuffs are usually of intermediate grain, but some fine-grained types resembling chert occur. The breccias contain many fragments of augite andesite. The lava flows range in composition from augite andesite to rhyolite, but the common type is andesite. Rhyolite occurs locally and is fairly plentiful in the vicinity of the Porter Idaho mine. The predominant colour of the rocks is green and this accounts for the local name "greenstone" for rocks of this formation. The coarser fragmental rocks are in many places purple, red, or brown. The green colour is due to the presence of chlorite, and the purple, red, and brown to iron oxides.

The beds of argillite in the formation rarely exceed 100 feet in thickness, but continue for long distances. Individual beds were not traced far with certainty, but this was due to difficulty encountered through forest and drift cover. A bed of argillite would be an excellent horizon marker if it could be traced and it would serve to show clearly the structure of the area. The few limestone beds are thin except in one place where a faulted bed is 100 feet thick.

The base of the formation consists of interbanded tuffs and sediments, the whole being somewhat calcareous. Tuffs predominate in the middle part of the formation and breccias and flows seem to be more plentiful near the top.

The thickness of the formation was not measured, but it is probably at least 5,000 feet on Upper Bear river and on Marmot river.

The formation is exposed on Marmot river in two northwesterly trending bands. The two bands join at the southeast corner of the area. The northeastern band does not continue northward past Marmot river, as it has been eroded. The southwestern band continues north to form Bear River ridge and in the northern part of the area it swings eastward and extends southward along the east side of the area and may join the northeastern band outside the confines of the area.

The Bear River formation overlies the Bitter Creek formation conformably. The change from argillite to volcanic rock is transitional through interbedding of sedimentary and tuffaceous rocks. The Bear River formation underlies the Nass formation. This contact was not studied, but is conformable.[1] In Salmon river a conglomerate is present locally at the base of the Nass formation,[2] and its presence indicates a possible though brief local break in the continuity of rock deposition.

Both bands of the formation on Marmot river are synclinal. Farther north the southwestern band becomes the eastern limb of a syncline and the western limb of an anticline. The axis of the syncline is represented approximately by Bear River ridge, and that of the anticline lies

[1]McConnell, R. G.: Geol. Surv., Canada, Mem. 32, p. 17 (1913).
[2]Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132, p. 13 (1922).

a short distance east of the northerly trending part of Bear river. The anticline has the shape of an inverted boat plunging at both the north and south ends. In detail the structure is more complex. Although few small plications were seen, several folds exist both transverse and parallel, which complicate the main structure. In the vicinity of the Porter Idaho mine on Kate Ryan creek, the volcanic rocks dip west. On the eastern slope of Bear River ridge the prevailing dip is also westward, but transverse folds and possibly faults have modified the main structure in this place and the detailed structure is not apparent. Along the westerly trending part of Bear river the rocks lie in a gentle easterly trending anticline, which appears to swing northward to join the main northerly trending anticline. The transverse fold flattens to the east and plunges steeply under the Nass formation.

The Bitter Creek argillites are exposed in the central part of the main anticline. The harder, more competent volcanic rocks have been gently folded transverse to the main line of folding and the lower, softer, and less competent argillites have been locally severely plicated.

NASS FORMATION

This formation outcrops in only one or two places and was not examined. The following description is taken from pages 17 to 18 of Memoir 32 by McConnell.

"The Nass formation consists of a thick argillite series alternating in places with coarse clastic beds and bands. These rocks definitely overlie the Bear River volcanics and in one place appear to alternate with them near their base. The Nass formation . . . . . (is) very similar in most respects to . . . . the Bitter Creek argillites, but less generally altered. They are seldom strongly cleaved and in some sections might be classed as shales. Beds and thick bands of tuffaceous sandstone occur with them in places, but are of subordinate importance. These consist of angular and subangular grains of quartz and broken feldspar crystals, with occasional small rock fragments, mostly slate and limestone, enclosed in a dark, fine-grained matrix, usually considerably altered . . . . . In the mountains north of Bear River summit the Nass argillites alternate near their base with heavy bands of . . . . . breccia precisely similar to that occurring in the upper portion of the underlying Bear River formation."

Nass argillites occur . . . .

"overlying the Bear River greenstones on the summits of the mountains situated north and south of Bear River pass. East of the Coast range they occupy the ridgy district extending eastward . . . . to the Nass river and probably extend for some distance beyond.

In the summit ranges the Nass argillites occur in a nearly flat attitude . . . . while along the eastern edge of the Coast range the inclination is steadily eastward. . . . . The Bitter Creek argillites . . . . . have prevailing westerly . . . . dips, thus giving the two formations the appearance of forming opposing limbs of a wide anticline[1]. . . . . The principal reason for classing them as two series is that while the Nass argillites definitely overlie the Bear River volcanics, the Bitter Creek rocks appear to underlie them to the west, and are intruded by them at various points. The lithological character . . . . also . . . . exhibits some differences. Limestones occur in the Bitter Creek formation and the proportion of coarse fragmentals is much less than in the Nass formation."

[1] "Syncline" appears in the report, but obviously "anticline" was intended.

AGE AND CORRELATION

The ages of the Bitter Creek, Bear River, and Nass formations are not definitely known. McConnell[1] could do no more than state that they "probably range from late Palæozoic to Jurassic." Schofield and Hanson[2] were of the opinion that the Bear River and Nass formations represented the Porphyrite group of Dawson and were of Jurassic, probably Upper Jurassic, age. Fossils collected from the base of the Nass formation on Salmon river represent new species and as yet do not serve as indexes to the age of the rocks. Fossils have been found in the Bitter Creek formation on Bear river, but are fragmentary and do not fix the age of the strata.

An attempt was made to trace the Bitter Creek sediments and Bear River volcanics from Marmot river southeast into Kitsault River basin, 15 miles distant, but the intervening area is largely covered by ice and snow and, therefore, the attempt failed. In the northern part of Kitsault River basin[3], a thick series of sediments, known as the Kitsault River formation, and consisting chiefly of black argillites, overlie an assemblage of volcanic rocks, chiefly tuffs and breccias, and named the Dolly Varden formation. Fossils were obtained from the basal part of the Kitsault River formation, but did no more than indicate that the strata were "either Jurassic or Cretaceous and very probably Jurassic". The general relations existing between the two formations indicate that the lower grades into the upper without any unconformity. About 15 miles north of Kitsault River area, the Nass formation is known to be present overlying the Bear River volcanics. It seems reasonable to conclude that the Kitsault River formation corresponds to the Nass formation, and the Dolly Varden to the Bear River. A possibility exists, however, that two sedimentary formations have been classed as one in upper Kitsault River basin. The Kitsault River sediments of the eastern part of the upper river basin clearly overlie the Dolly Varden volcanics, but though the same relation seems to hold in the western, upper part of the river basin, yet southward, as Alice arm is approached, the western band of sediments appear to tip under the central area of volcanics.[4] Furthermore, McConnell[5] was disposed to think that the southward continuation of this sedimentary band as displayed on Alice arm corresponded to the Bitter Creek formation. Thus it may be that the succession in Kitsault River area is the same as that established in Bear River area and that the strata in question consist of upper and lower sedimentary formations separated by a volcanic member.

The possible threefold division of the rocks on Kitsault river is mentioned, but is not viewed with favour. In discussion on correlation the twofold division will be followed. A reconnaissance has been carried 75 miles south from Alice arm to the mouth of Kitsumgallum river on

[1]Geol. Surv., Canada, Mem. 32, p. 12 (1913).
[2]Geol. Surv., Canada, Mem. 132, p. 9.
[3]Hanson, George: Geol. Surv., Canada, Sum. Rept. 1921, pt. A, pp. 7-21 (1922).
[4]Unpublished observations of the present writer.
[5]Geol. Surv., Canada, Mem. 32, p. 83 (1913).

Skeena river[1] The sedimentary strata representing the Nass formation with, in places, the associated volcanic member, continue to Skeena river. Along Skeena river, southwest from the mouth of Kitsumgallum river, volcanic rocks are exposed. They there belong to the Kitsalas formation which McConnell[2] "placed tentatively in the Triassic." The Kitsalas volcanics, involved in intrusive granitic bodies, appear at intervals for some distance northeastward along Skeena river to where they are succeeded by sedimentary strata of the Hazelton group which continue eastward and then southward along Bulkley river. Where the southern edge of the Hazelton strata cross Skeena river they overlie volcanic rocks classed by McConnell with the Kitsalas.

As a result of the different pieces of work done in the region and referred to in the preceding paragraphs, an assemblage of sedimentary and volcanic rocks has been definitely traced with only one gap from Skeena River-Bulkley River district, to Salmon River-Bear River district. The one gap—it is 12 miles wide and lies east of the Salmon River-Bear River district—is known to be largely occupied by a sedimentary series.[3] There can be no doubt that the various component formations, known locally by different names, correspond as a whole to the Hazelton group of Bulkley River district. Wherever throughout this region a volcanic member appears, it is conformably overlain by sediments; in some places but not all, the volcanic member is underlain conformably by a sedimentary series. It seems probable that the volcanic members are all at the same horizon, that the Bear River formation of Salmon River-Bear River area, the Dolly Varden formation of Upper Kitsault River area, and the Kitsalas formation on Skeena river are correlatives. If this be so, then the sediments overlying the Kitsalas on Skeena river are equivalent to the Nass formation. The name Hazelton group was originally proposed[4] to include all these strata, sedimentary and volcanic, and it seems desirable to retain the name with this implied meaning.

In the districts bordering Bulkley river the Hazelton group is divisible into four members.[5] These, in descending order, consist of:

Upper Sedimentary division.
Upper Volcanic division.
Middle Sedimentary division.
Lower Volcanic division.

Fossils from the Middle Sedimentary division are of lower Middle Jurassic age. It seems probable that the Lower Volcanic division is the volcanic assemblage repeated at intervals to the northwest and known as the Bear River formation in Salmon River and Bear River areas and that the overlying Nass formation corresponds to the three upper divisions in the south. If so the Nass formation is, in part at least, of lower Middle Jurassic age. The underlying Bear River volcanics are presumably of early Middle Jurassic or late Lower Jurassic age. The Bitter Creek sediments may be Lower Jurassic or even Triassic.

[1]Hanson, George: Sum. Report. 1922, pt. A, pp. 35-50 (1923).
Sum. Rept. 1923, pt. A, pp. 29-45 (1924).
[2]McConnell, R. G.: Sum. Rept. 1912, p. 59 (1914).
[3]Hanson, George: Sum. Rept. 1923, pt. A, p. 35 (1924).
[4]Leach, W. W.: Geol. Surv., Canada, Sum. Rept. 1909, p. 63.
[5]Hanson, George: Sum. Rept. 1924, pt. A, p. 26; Sum. Rept. 1925, pt. A, p. 104.

AUGITE PORPHYRITE AND ALLIED ROCKS

The intrusive rocks here dealt with form small, stock-like, and more irregular masses consisting chiefly of augite porphyrite, augite syenite, and gabbro. Most of the bodies intrude the Bitter Creek argillites near their contact with the Bear River formation. One elongated body lies at a contact between the two formations and one lies in rocks of the Bear River formation. Only the larger bodies are shown on the geological map accompanying this report. These intrusives have been grouped because of their general similarity, because all contain a considerable proportion of augite, and because they are probably of the same age. They resemble rather closely some phases of lava flows and intrusives of the Bear River formation and are probably of similar age and origin, but are considered separately because they have previously been mapped separately,[1] and because they consist largely of intrusive rock, whereas the Bear River formation consists largely of volcanic fragmentals and lava flows. These intrusives are quite different in appearance and mineral composition from the granodiorite intrusives of the map-area, and are not believed to be related to them in origin. McConnell has described and mapped intrusive bodies of augite porphyrite and of gabbro. He believes that the augite porphyrite is allied to the Bear River formation in origin, but that the gabbro is associated in origin with the granodiorite intrusives.[2] In the preparation of the map accompanying the present report, McConnell's mapping of the bodies of augite porphyrite was in large part accepted. Only one body of the gabbro was examined and mapped.

Augite porphyrite occupies a circular area 2 miles in diameter on Glacier creek, a smaller area on Bear river, a long, narrow band near Bromley glacier, and several smaller areas in various parts of the map-area.

The large body on Glacier creek consists of a variety of rocks probably largely but not solely intrusive. Massive andesite holding large inclusions of argillite, augite porphyrite, diorite porphyrite, other basic igneous rocks, and a small amount of volcanic fragmental rock are present. The main rock type is augite porphyrite, but it also is variable in character, and in some places, for instance, where it seems to be the only rock type, the grain is so variable that in a distance of a few feet a rock with large phenocrysts of augite gives place to a fine-grained rock with no phenocrysts. The andesite and other igneous rocks may be local phases of intrusives. The argillite masses are probably inclusions and perhaps roof pendants. The fragmental rock may be inclusions of breccia and tuff or may be brecciated phases of intrusives. In some places, the massive rocks seem to be intrusive, but in other places they are amygdaloidal and resemble lava flow. The sediments bordering this body on the north and west dip gently outward. The igneous rocks appear to pass under these bordering sediments and in part at least seem to form a sill-like body.

[1]McConnell, R. G.: Geol. Surv., Canada, Mem. 32 (1913).
[2]McConnell, R. G.: Geol. Surv., Canada, Mem. 32, pp. 16-20 (1913).

A long body of augite porphyrite near Bromley glacier and a smaller mass on upper Bear river were not examined in detail. They resemble, lithologically, the mass on Glacier creek. A roughly circular body, less than 100 yards in diameter, of augite porphyrite, on Kate Ryan creek, intrudes argillite of the Bitter Creek formation. Another small body, probably less than half a mile in diameter, occurs on the south fork of Marmot river. It appears to be intrusive into argillites of the Bitter Creek formation at their contact with Bear River volcanics. The rock is largely augite porphyrite holding numerous angular blocks, of varying size, of lavas and breccia.

The augite porphyrite is a dark rock mottled with square, black phenocrysts of augite $\frac{1}{4}$ inch or less in diameter. Thin sections of augite porphyrite exhibit large phenocrysts of augite in a fine-grained groundmass. In some sections the groundmass consists of fine needles of feldspar exhibiting flow structure, and in others it is cryptocrystalline and amygdaloidal. The feldspars in the sections were too much decomposed for identification.

An elongated, stock-like body of augite-bearing rock outcrops on Glacier creek. The rock is mainly a dark-coloured augite syenite containing augite orthoclase, and sodic plagioclase. An associated rock, either a phase of the syenite or a closely associated but separate intrusive, is a gabbro consisting essentially of augite and labradorite. Several augite syenite dykes seen elsewhere in the map-area may belong to the same period of intrusion as the stock on Glacier creek.

The augite porphyrite and augite syenite bodies are cut by granite and diorite dykes presumably associated in age and origin with the Coast Range batholith, but probably older than the batholith itself. No augite-rich rock was noted intruding the granitic rocks of the map-area. The augite porphyrite and augite syenite, therefore, are in all probability much older than the Coast Range intrusives. They resemble in general appearance certain augite-bearing rocks of the Bear River formation and it is believed that they are associated in origin with the Bear River volcanics and that they were intruded while the volcanics were being extruded. The smaller bodies of augite porphyrite may be plugs representing former craters that supplied the volcanic materials for the Bear River formation. Some of the larger bodies may also be plugs, representing larger craters where foreign rock types have been engulfed. A stock of augite porphyrite on Salmon river intrudes the lower part of the Nass formation,[1] but as higher horizons of this formation contain volcanic material, this stock also may be associated with the volcanism of the area.

COAST RANGE INTRUSIVES

The Coast Range intrusives occupy the southwestern corner of Stewart map-area and form several small stocks in Bear River and Stewart map-areas. The contact of the batholith enters the area from the south at Magee pass and continues northwestward across the two branches of

[1]Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132 (1922).

Marmot river. Farther northwest, in the mountain sides east of Portland canal, the contact seems to have been displaced by a fault. At Stewart, because of a tongue-like projection of the batholith extending east from mount Dolly on the Alaska boundary, the contact swings abruptly to a northeastward course which it follows for 2 miles to where it turns through north to a westerly course which it follows back to Bear river. At Bear river the contact is offset north by a fault, beyond which it follows a westerly course and passes out of the area into Alaska on the southern slope of mount Dolly.

Except for the sharp swing round the tongue of the intrusive extending eastward from mount Dolly, the line of contact is fairly straight and, in general, is nearly concordant with the strike of the beds of the intruded rock. On Marmot river the contact dips northeastward at nearly the same angle as that of the dip of the adjacent strata, but the strikes of the line of contact and of the adjacent strata make a small angle, so that argillites at the contact in the south are entirely cut away by the batholith farther north. On mount Dolly the contact and the adjacent beds of volcanic rock have the same strike and dip 60 degrees northeast. The sharp swing of the contact at Stewart and the tongue-like projection of the intrusive extending east from mount Dolly appear to be due to a local upward bulge of the upper surface of the batholith as depicted diagrammatically in Figure 1.

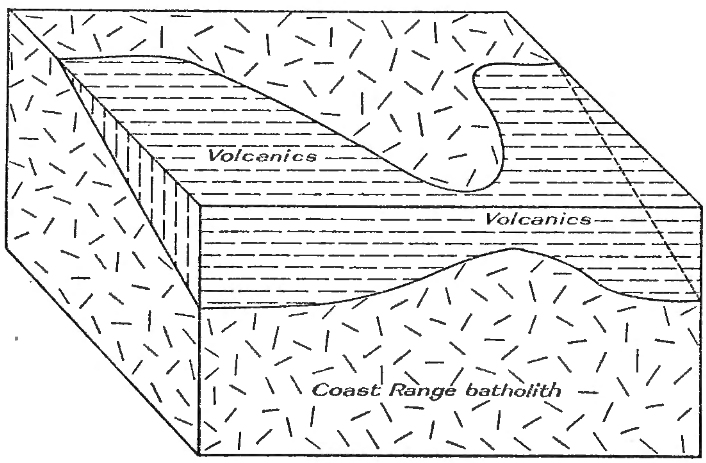

Figure 1. Diagram illustrating how an upward bulge of the Coast Range batholith might give rise at the surface to a tongue-like projection as in the vicinity of Stewart, B.C.

The rock of the batholith is, on the whole, massive, but locally has been slightly sheared. It is grey, medium to coarse-grained, and appears to be a normal granodiorite. The predominant dark mineral constituent is hornblende. Biotite is usually present, but in minor quantity only. The plagioclase feldspar is oligoclase-andesine. Orthoclase and quartz are present. Apatite, titanite, and iron oxides are the usual accessory minerals. The rock in most places is quite fresh and the plagioclase feldspar in thin section is clear. Six thin sections from different parts of the batholith showed but little variation in mineral composition.

A stock of granodiorite outcrops in Bear River valley near Glacier creek and another smaller stock occurs near the head of Bear river. The mineral composition of the rock of these stocks is the same as that of the batholith.

A small body of white intrusive rock outcrops below the Silverado mine. The rock consists almost entirely of sodic plagioclase and quartz; it contains no biotite nor hornblende. The exact size and shape of this body, and its relationship to the batholith are unknown. The mass is at least 200 yards wide and may be much longer. It lies at the contact between the batholith and volcanic rocks of the Bear River formation.

The various stocks are probably associated in origin with the main batholith. On Salmon river, in Alaska, there is evidence of at least the former existence of granodiorite older than the Coast Range batholith,[1] but no evidence was obtained by the writer to show that any of the stocks in Bear River valley are older than the Coast Range batholith.

The exact age of the Coast Range intrusives is not determinable in this district. The rocks intruded are probably not younger than Jurassic. The intrusive may, therefore, be late Jurassic or younger.

DYKES

Commencing in Salmon River valley,[2] a zone of closely spaced dykes of quartz porphyry and quartz diorite extends southeastward across Bear River ridge and Bear River valley and up the east slopes of the valley. This zone has been indicated on the accompanying map as having a width of about 1½ miles. Its boundaries have been arbitrarily drawn, for in some places very many dykes occur in adjacent strips of territory up to a quarter of a mile wide. But outside the zone country rock predominates, whereas within the zone, dykes form 75 per cent or more of the whole assemblage. On the upper part of Bear River ridge the individual dykes are distinct bodies separate from one another. On lower slopes of the ridge, in Bear River valley, the dykes are closer spaced and, due to coalescence, are larger. Still lower down the slopes the dykes so coalesce that the assemblage has the aspect of a stock. Farther southeast, in the vicinity of mount Dickie, the dykes become more and more widely spaced, narrower, and fewer, until the zone loses its identity.

Most of the dykes are vertical, strike parallel to the trend of the zone, and are between 50 and 150 feet wide, but narrower ones are fairly numerous and wider ones exist. Most of the dykes have approximately the mineral composition of the Coast Range batholithic rocks. They contain less orthoclase, however, and are mostly quartz diorites. Some are quartz porphyries and a few resemble gabbro.

[1]Buddington, A. F.: "Coast Range Intrusives of Southeastern Alaska"; Jour. Geol., vol. XXXV, No. 3, p. 228 (1927).

[2]Schofield, S. J., and Hanson, G.: Geol. Surv., Canada, Mem. 132, p. 27 (1922).

The dykes of this zone may be the top of an elongated stock. It is possible that a zone of weakness was developed parallel with the border of the Coast Range batholith during its intrusion, and that magma from the batholith riddled this zone with dykes. If this idea is correct the dykes will coalesce with the batholith in depth.

Large dykes and sills of granodiorite intrude the older rocks near the contact of the Coast Range batholith. These dykes and sills are offshoots of the batholith. They are very similar to the batholith in mineral composition, but are usually somewhat different in texture, often exhibiting porphyritic crystals. On mount Dolly a dyke of this type in volcanic rocks can be traced into the batholith where a short distance from the contact it merges with the batholithic rock.

Narrow, dark-coloured lamprophyre dykes are fairly common and appear to be the youngest rocks in the area. Some are older and some younger than the ore deposits with which they are occasionally associated.

PLEISTOCENE AND RECENT DEPOSITS

Glacial drift is present along the sides and lower limits of glaciers. Older boulder clay is plentiful along Bitter creek and probably also along the lower part of Bear river. Glacial erratics occur up to elevations 6,000 feet above sea-level, but are not numerous.

Recent silts, gravels, and blue clays containing marine shells were noted by McConnell[1] on the lower part of Bitter Creek valley, and along Bear river above Bitter creek for some distance past Bear lake. McConnell estimated the maximum thickness as 155 feet. Similar clays are present on Marmot river. The clays are 350 to 450 feet above sea-level, and the silts extend about 100 feet higher.

Bear River valley from American creek to its mouth is floored with gravels and sands deposited by the present stream. During times of high water, the stream commonly alters its course and, sweeping against the bands, undercuts them and in this way widens the treeless part of the valley bottom. A flat area several square miles in extent has been built up at the mouth of Bear river; on it is the town of Stewart. The flat is being rapidly extended seaward by stream-carried sediment. Data obtained by the Department of Public Works of Canada show that on the west side of Portland canal the low-water mark on the delta advanced 540 feet between 1909 and 1927. The rate in this place is 30 feet a year. It may be somewhat faster in the centre of Portland canal.

FAULTS

Faults are probably numerous in the area. Definite breaks were seen in many places and were topographically expressed, but it was difficult or impossible to determine the direction and extent of the throw or the offset. Only where faults cut across strata with individual characteristics could anything definite be learned about the extent of the movement along the fault plane.

[1]McConnell, R. G.: Geol. Surv., Canada, Mem. 32, p. 22 (1913).

A fault in Marmot River valley offsets a bed of limestone at least 400 feet. Many straight, narrow valleys in the area follow crushed zones, but in most cases the total amount of differential movement was not discovered. The zone of dykes already referred to is apparently offset considerably where it crosses Bear river. The contact of the Coast Range batholith is offset similarly where it crosses Bear river. On the mountain side east of Portland canal, in line with the above-mentioned points of offsetting, the batholith contact is again offset, but the extent of the movement is not so accurately known. Apparently a large fault strikes along Bear River valley from American creek to Stewart. It may branch at Stewart, one branch continuing as shown on the map and thence across Bulldog creek and along Georgia river to Portland canal and the other branch, if there is another, continuing along Portland canal. The fault probably branches at American creek, the main branch following the creek. It is not likely that any branch of this fault runs east along upper Bear river. The apparent horizontal offset along this fault in Bear River valley is approximately 1½ miles. The east side has apparently moved southward or the west side northward. In view of the fact that the rocks by which the apparent offset is measured are intrusive, and as the contacts of intrusives may turn sharply for no evident reason, it follows that the apparent offset along Bear river does not necessarily prove the existence of a fault. It is very likely, however, that a fault exists there. The fact that other faults in the area with similar strike show horizontal movement lends weight to the belief that movement along the big fault was chiefly horizontal. Evidence on this point is also furnished by the mineral deposits on opposite sides of the fault. As the fault offsets the Coast Range batholith, it is also later than the mineral deposits of the area. If the movement along the fault plane had been essentially vertical, marked differences should exist between the mineral deposits on opposite sides of the fault. Such differences do not exist.

Narrow, straight valleys in the area commonly follow faults. The extent of movement was not learned, but in places it was determined that the fault planes are vertical and the presence of horizontal fault grooves indicates horizontal movement. These faults strike north-northeast and are probably thrust faults with large horizontal and little vertical movement.

Several faults strike east-northeast and along one of these the horizontal offset is over 400 feet. These faults may be normal faults.

Faulting in a north-northeast direction preceded and followed ore deposition. Some at least of the faults striking east-northeast preceded mineralization, but the relationship between the two groups of faults was not ascertained.

CHAPTER III

ECONOMIC GEOLOGY

GENERAL STATUS OF MINING

Mineral deposits were discovered in Bear River valley in 1898 by prospectors searching for placer deposits. Staking of mineral claims began in 1898, but did not attain great proportion until 1908, when, owing to relatively extensive development work by the Portland Canal Mining Company, an influx of prospectors took place. Nearly all available ground in the valley was staked by 1910 and has since been held or restaked. The Marmot River part of the area was prospected about 1910, but vacant ground still exists. Mountain slopes in Marmot valley are extremely steep and this fact no doubt discouraged early prospectors. Marmot River valley is, however, much nearer to Portland canal than the northern half of Bear River valley and if other conditions are equal may afford, therefore, a better chance of profitable mining. Since the time of the first mineral strike in the area the attention of prospectors has been confined almost entirely to lode mining; although in 1912 small-scale placer mining was attempted on Bitter creek, but unsuccessfully.

Optimism was the keynote for several years after 1908. In 1911 the Canadian Northeastern railway completed the Portland Canal Short Line railway, a standard gauge railroad, from Stewart to the Red Cliff mine at the mouth of American creek. This railway was never much used and is now beyond repair.

Production began in a small way in 1909 and has been continued intermittently by several properties. The total production from Bear and Marmot rivers up to and including the year 1926 is approximately 5,000 tons of ore, from which the following quantities of metals were extracted.

1,000 ounces gold,
220,000 ounces silver,
830,000 pounds lead,
50,000 pounds zinc,
70,000 pounds copper,
several hundred pounds molybdenite.

The production was worth some $200,000 which is a very low figure considering the length of time the area has been known and the amount of money expended on prospecting and development. Most of the production has come from four properties, the Portland Canal, Red Cliff, Dunwell, and Porter Idaho mines. The L and L mines rank next in productive importance. Fifteen other properties have made small ore shipments. Physical conditions have been a severe handicap, costs of materials high, and transportation burdensome. Though the past mining record of Bear River valley is somewhat discouraging at the present time the outlook for profitable mining is decidedly encouraging.

Bear and Marmot Rivers valleys approximate 160 square miles. In this area twenty properties have produced ore. Development in Marmot River valley has not been nearly so extensive as in Bear River valley. The ratio of the value of production to the costs of prospecting and development is much higher than that in Bear River valley. The mineral deposits on Bear river are larger but lower in grade than those on Marmot river.

GENERAL CHARACTER OF THE MINERAL DEPOSITS

The mineral deposits are of two main types: (1) veins formed by open space filling and by replacement; (2) replacement deposits. Gradations exist between the veins formed by open space filling and those formed by replacement, and between the veins and replacement deposits. The veins, as contrasted with the replacement deposits, are tabular in form, continue for long distances, consist in general of gangue or metallic minerals or both, and are distinct from the country rock. The replacement deposits, on the other hand, are mostly not so markedly tabular in form, do not continue so far, consist of country rock and the replacing minerals, and the ordinary gangue minerals of the veins are not usually present in any quantity. The veins when forming were guided by fractures which may pass from one rock type to another, whereas the replacement deposits usually owed their outlines to bedding planes, planes of schistosity, or the outlines of easily replaced strata.

The metals that have been obtained from the ores of the area are gold, silver, lead, zinc, copper, and, on one property, molybdenum. Most of the deposits contain intimately intergrown gold, silver, lead, and zinc-bearing minerals. In most of these the lead and zinc proportions are approximately equal, but in a few the zinc content is negligible, and in a few others lead minerals are rare. The gold content seems to be about the same in all the silver-lead-zinc ores, that is the gold value per ton is usually no greater in high-grade than in low-grade ores of this type. The gold is contained chiefly in pyrite and sphalerite, and also in arsenopyrite where this mineral is present. The silver content in some of these deposits is about one ounce per unit of lead and is associated with galena. In others the silver content is high and is carried in silver-rich tetrahedrite and to a lesser extent in silver minerals. The richness of the deposits in silver depends chiefly on the percentage of lead and the quantity of tetrahedrite.

Several deposits are valuable for their copper and gold content. In these deposits the copper is present as chalcopyrite and the gold is either associated with this mineral or with pyrite and arsenopyrite. In a few deposits the arsenopyrite contains most of the gold, but in most this relationship has not been established. The arsenopyrite when present is not uniformly distributed through the deposits. If the gold is associated with this mineral, the gold values will also be sporadic and this is known to be true on several deposits of this type. Where arsenopyrite is not present, gold is less plentiful but is more uniformly distributed and seems to be carried mainly in the pyrite and chalcopyrite.

VEINS

Most of the veins are 5 feet or less wide, but are fairly uniform in width and continue along the surface for several hundreds of feet. A few of the veins are known to be at least 1,000 feet long, but only in a few cases has the full length been shown. Most of the high-grade silver-lead-zinc ores occur in veins 5 feet or less in width. Veins wider than 5 feet are fairly common and are on the whole much lower in grade. Veins of the silver-lead-zinc type wider than 5 feet may contain sporadic shoots of shipping ore, but as a rule they consist either of milling ore or else of material too lean for profitable mining. Those less than 5 feet wide contain as a rule ore that can be shipped profitably without concentration or else are too lean for mining. The narrow veins can not as a rule supply a sufficient tonnage for milling operations. As very narrow veins must of necessity be very rich if they are to be mined at a profit it follows that most of the shipping ore will be from veins 2 to 5 feet wide. When milling operations become established the greater tonnages will be derived in all likelihood from the wider veins.

The veins in which copper and gold are the main valuable metals show less variation in richness for different widths. A copper-bearing vein 12 feet wide may be just as rich, locally at least, as one 8 inches wide. The usual gold-silver-lead-zinc vein does not contain $40 per ton in all values if it is more than 5 feet wide, yet many of the narrow veins of the type a few inches wide may be worth over a hundred dollars per ton.

The veins do not exhibit any striking differences where crossing rock formations of different types. The few in granitic rocks are narrow. Some of those in argillites are quite wide and continuous, but small veins also occur. Those in volcanic rocks are also of various sizes. The richness of the veins does not depend on the nature of the enclosing rock, as both rich and lean veins occur in all the various rock types. Neither the richness nor the size depends on the rock type. The nature of the country rock may exert some influence on the nature of the minerals in the veins. Barite and jasper are common gangue minerals in veins in volcanic rock, but are very scarce in veins in the sediments. Some of the constituents of these two minerals were probably derived by the ore solution from the volcanic rocks in which the veins lie.

REPLACEMENTS

Most of the mineral deposits in the area are in vein form, but some of the larger are replacement bodies. Most of the replacement deposits lie in stratified rocks and their forms are determined by the presence of beds of different permeability or solubility. A few lie in schistose rocks where their form is controlled by the extent and intensity of shearing. Those in limestone are irregular in shape and the limestone is completely or nearly completely replaced where ore occurs. The deposits in argillite on the other hand are beds of argillite impregnated with mineral, but which forms only a very small proportion of the argillite beds. Replacements in tuffaceous rocks appear to be of a more bunchy nature than in argillite and approach, a little, to the limestone type. Replacements in schistose rocks resemble somewhat those inbeds of tuff, but in the schists the ore minerals commonly form small, closely spaced stringers, gashes, or short veinlets, lying mostly in the shear planes, as well as disseminations throughout the schist. The size and the closeness of the spacing of the veinlets in the schist usually determine the grade of the ore. Practically the only gangue material in the replacement deposits is country rock.

DISTRIBUTION AND GEOLOGICAL FEATURES

The known mineral deposits are not uniformly distributed, but exhibit a certain grouping. The grouping may be due to more prospecting in certain parts and less in other parts; it may be the result of geological causes; or it may be due in part to each of these factors. Most of the deposits of the map-areas contain lead, zinc, silver, and some gold. A smaller number contain copper and some gold. The copper deposits lie in four areas separated and surrounded by deposits containing gold, silver, lead, and zinc.

A small group of copper-bearing deposits exists in the vicinity of the Red Cliff mine, west of the Bear-American Creek valley. Another somewhat similar group of copper-bearing deposits occurs in the vicinity of the Dalhousie mineral claims. This is also on the west side of Bear river and the mineralized area may extend southward to include the holdings of the Prince John Mining Company. A third group of copper deposits is on Upper Bear river. The deposits of this group do not extend to high elevations on the north side of Bear river, but extend above the George copper deposits on the south side. A fourth group of copper-bearing deposits lies on Upper Bitter creek. This group includes the Olga, Sunshine, L. L. and H., Black Bear, and other mineral claims. Some of the deposits within the area occupied by the fourth group contain lead and zinc, but nearly all contain copper minerals. The deposits of the other three groups are almost exclusively copper deposits. The copper-bearing mineral in all the groups of deposits is chalcopyrite.

No convincing explanation of this segregation of the copper-bearing deposits has been discovered. Rock types, structure, and mode of occurrence evidently have had little if any influence in causing segregation, as the deposits occur as replacements in schistose rocks and in bedded formations, and as veins, and the copper-bearing areas have no structure peculiar to themselves. The strikes of the deposits show considerable divergence. Lacking any reasonable explanation whose soundness can be tested, it is assumed that the grouping is related in some way to the mode of origin of the deposits. The copper of each group of deposits may have been derived from a source of mineral deposits locally rich in copper, in which case the grouping is at once understandable. If the source were not locally rich in copper the copper-bearing minerals may have been deposited at a certain stage in the general period of ore deposition or at some more or less fixed distance from the source. As copper-bearing minerals are in general deposited closer to a source of ore deposits than silver, lead, or zinc minerals from the same source, the four copper-bearing areas may be continued underground in a roughly horizontal copper-bearing zone, over which and around the side of which gradations exist to a zone characterized by the presence of silver-lead-zinc deposits.

The grouping discussed above refers to the segregation of all the copper-bearing deposits into a few small localities in the map-area. The only grouping noted in connexion with the silver-lead-zinc deposits refers merely to a greater number of deposits in certain localities than in others. The explanation of this is not so obscure as in the core of the copper deposits and is indeed usually self evident. On the south fork of Marmot river, silver-lead-zinc deposits form a fringe to the batholithic contact. Most of them lie in a belt of argillite that is in contact with, and dips away from, the batholith. It is likely that the argillite did not fracture readily enough to permit any but the strongest fractures to pass through the formation. The ore deposits occupying the fractures would then be mostly close to the batholith and in the argillite. Another group or line of deposits crosses the lower part of Glacier creek. These deposits are located along a strong fissure zone known as the Portland Canal fissure zone. The veins were deposited along the many planes of weakness within the fissure zone.

STRUCTURAL RELATIONS

The mineral deposits of the map-area do not appear to exhibit any marked relationship to geological structure except in two small areas. It seems that in general they were deposited in all available open spaces regardless of structure. Geological structure may, however, have affected the formation and location of some of the mineral deposits in Marmot River valley and in the Portland Canal fissure zone. In Marmot River valley as already stated, a band of argillite lies in contact with, and dips away from, the batholith. Differential movement in an argillite formation does not as a rule result in large, open fractures. The argillite on Marmot river was apparently not greatly fractured and ore solutions from the batholith could not, as a rule, penetrate the argillite. It is probable that had the dip of the argillite been toward the batholith, the bedding planes of the argillite would have served as channel ways for ore solution with the result that mineral deposits would have been present over a larger area. Marmot River area, thus, seems to present an example of how geological structure may control mineralization in this case with unfavourable results. On the other hand, in the Portland Canal fissure zone, argillites dip westward, probably toward the source of the mineral deposits. The rocks are sheared, fissured, and faulted along planes that dip west also and in many places coincide with bedding planes. Zones of shearing, fissuring, and faulting, and the bedding planes, dip towards the source of mineralization, and mineralization is comparatively widespread. Had the dips of the strata, shear planes, fissures, and faults been eastward, mineral deposits would probably have been relatively scarce.

ALTERATION OF ORE AND COUNTRY ROCK

The country rock, on the whole, has not been greatly altered in the vicinity of mineral deposits. The permeating ore solutions have deposited pyrite, quartz, and chlorite in the wall-rocks, but except for pyrite impregnations the alteration is not in general noticeable except on microscopic examination. Alteration in argillaceous wall-rocks consists almost entirely of the deposition of pyrite; in harder rocks, chlorite and quartz as well as pyrite have been found.

The ores are mostly primary. No secondary enrichment has been proved and secondary action is of slight importance except in certain places. At the Porter Idaho mine oxidation is known to extend 450 feet beneath the surface. The oxidation at this place is fairly thorough, so that the ore stripped consists partly of rust containing residual nodules of quartz and sulphide. This is the only place in the map-area where deep oxidation has been proved, but even in this place underground development has not reached sufficient depth to show whether or not secondary enrichment has taken place. This example, however, serves to prove that deep secondary enrichment in the map-areas is quite possible.

DISTRIBUTION OF ORE IN THE DEPOSITS

Most of the larger silver-lead-zinc deposits of the area are too lean to be mined completely. In most instances the only ore is in the form of shoots within the mineralized body. A few deposits are rich enough to mine as a whole and these also contain shoots of richer ore. Individual shoots of ore in some deposits are big enough to occupy the whole width of the deposits for over 100 feet in length and depth, but most are smaller.

In a few lead-zinc-silver veins the chief value lies in gold or the gold content is the factor that raises the grade of the mineral deposits to that of commercial ore. In such veins the gold, so far as can be learned, occurs sporadically and the vein matter is ore only where the gold content is greater than a certain amount. In other veins of the silver-lead type, silver decides the value of the ore. In these veins the silver is contained usually in silver-rich tetrahedrite, and consequently the abundance and distribution of tetrahedrite determines the richness and the size of the ore-shoots. In some of these veins the silver-bearing minerals are part of the general mineralization, but in others they occur in fractures traversing the vein, appear to be later, and the richness of the ore is governed by the size and number of the fractures. In veins where the chief value is in lead and zinc, ore-shoots are simply under parts of the veins or parts of the veins where lead and zinc minerals are relatively more abundant.

Veins formed chiefly by replacement contain shoots of ore which originated perhaps through replacement of more easily attacked parts of the rock and hence are more thoroughly replaced. The replacement deposits are mostly of the copper-bearing type, but those containing silver-lead and zinc hold ore-shoots that are simply parts of the mineralized body where replacement has been more thorough. In the replacement deposits ease of replacement and not richer mineral has apparently controlled the size and richness of the ore-shoots.

The copper-bearing deposits contain gold and in general the gold value determines the grade of the ore. More thorough replacement and a greater concentration of chalcopyrite also cause variation in the value of the ore. Very little is known about the uniformity of individual shoots of copper-gold ore, but from surface assays it appears that the gold does not segregate to form richer shoots as might be expected but occurs sporadically throughout the whole deposit. The net result of the gold seems to be to raise the general standard of the whole.

Several points that may be of general interest were suggested by study of ore specimens in polished section. The better parts of the Dunwell vein contain tetrahedrite, whereas the leaner parts lack this mineral. Although the conclusion that the ore-shoot is due to the local presence of a richer mineral is obvious and may seem of no importance, it may in certain circumstances have a practical value. In sulphide bodies where the lead-zinc-silver and gold content is fairly uniform and the ore contains essentially galena and sphalerite, the local presence of tetrahedrite will indicate a richer ore-shoot. Rough examination of polished specimens will quietly determine the presence of such a mineral and consequently the presence of an ore-shoot. Assays will indicate ore-shoots, but ore examination will not only do this but will also show the cause. Ore-shoots of this type are quite different from those caused by a wider ore-body or by a higher ratio of ore mineral to gangue.

Another type of ore-shoot was suggested by ore specimens from the L and L Glacier Creek mines. Here primary vein matter has been fractured and the fractures filled with richer primary minerals. The extent of fracturing determines the size and shape of the ore-shoot. Ore examination in this case also indicates the cause of, as well as the presence of, the ore-shoot.

In deposits of the silver-lead-zinc type the order of mineral deposition as illustrated by polished specimens from twenty-five different mineral deposits showed little variation. Pyrite and arsenopyrite were the first metallic minerals to form and were followed by chalcopyrite, sphalerite, and pyrrhotite. Pyrite and arsenopyrite were in general contemporaneous. Chalcopyrite, sphalerite, and pyrrhotite were usually contemporaneous, but any one of the three in certain specimens might appear to be slightly earlier or later than the other two. Galena, tetrahedrite, and silver sulphosalts were formed next. These minerals are in general intergrown and were perhaps formed at the same time. In a few specimens the silver sulphosalts may be later than the other two. Later than any of the previously mentioned minerals is jamesonite and particularly an unidentified lead sulph-antimonide.

Some of the copper-bearing deposits contain hematite and magnetite, as well as the usual pyrite, arsenopyrite, and chalcopyrite. In these the chalcopyrite appears to be later than the other minerals mentioned.

In ores containing galena, sphalerite, chalcopyrite, tetrahedrite, pyrite, with or without other minerals, pyrite, chalcopyrite, and sphalerite were deposited prior to galena and tetrahedrite. The galena is distinctly later than, and appears to replace, the sphalerite. Tetrahedrite is present at the edges of areas of sphalerite included in the galena. Dots and rods of chalcopyrite are included in the sphalerite, but are rare in the galena. The conclusion is suggested that tetrahedrite is a result of the replacement of sphalerite and included chalcopyrite by the surrounding ore fluid, the copper for the tetrahedrite being supplied by the chalcopyrite inclusions.

Several properties in the vicinity of the Emperor and Lakeview mining properties contain much drusy vein quartz. This drusy quartz may have been formed by surface action. In some of these properties jamesonite and other lead sulphantimonides are present. In the L and L Glacier Creek mines an unidentified lead sulphantimonide occurs in narrow veinlets cutting across the other vein matter. It is clearly later than the other ore minerals and may be of secondary or surface origin.

AGE OF THE DEPOSITS

It is believed that the Coast Range batholith was intruded in late Jurassic or early Cretaceous time. It is also believed that the ore deposits of the area were derived from the batholith at the time of intrusion. If these assumptions are correct the deposits are early Cretaceous or slightly older. The ore deposits are assumed to be of one age, but the intrusion of the batholith may have taken considerable time or may have taken place in several stages, and ore deposits may have been forming throughout the whole of the intrusive period or at each of the possible stages of intrusion. No evidence is available that supports one of these conceptions more than any of the others.

FUTURE OF THE AREA

The future of the area can be considered under two headings: (1) future of deposits under development; and (2) future from the point of view of undiscovered deposits.

The future of the known deposits pertains to the extraction of the present ore-bodies and to the proving of greater tonnages. From the known properties it would seem that the Marmot River part of the area, though considerably smaller than the Bear River part, will produce the bulk of the high-grade ore. The lower grade deposits, however, seem more promising in the Bear River part. As for undiscovered mineral deposits little can be said except that both parts of the area warrant thorough prospecting.

It is impossible to tell what places are most favourable for prospecting, as the origin of the ores is not fully understood. The known deposits, however, provide some information that may assist in the discovery of other deposits.

The four areas containing chiefly copper deposits contain as well undiscovered copper deposits. Bear River ridge between the Prince John and Dalhousie groups of claims probably contains undiscovered copper deposits.

The mineral belt near the batholith on the south fork of Marmot river is apparently interrupted north of the Silverado mine. Many mineral deposits occur between the Silverado mine and the Harner group at

Magee pass. The belt probably continues southeastward toward Hastings arm. North of Silverado mine between Stewart and mount Dolly, a tongue of the batholith extends eastward up Barney gulch. It is not certain, but very likely, that the tongue of the batholith is also accompanied by a fringing mineral belt, so that mineral deposits may occur near it to the south, east, and north. The belt would then join with the mineral deposits on mount Dolly.

The Porter Idaho-Prosperity veins strike north-northwest and dip west and consequently in ascending the hillside on which they occur, they trend north to north-northeast. If these veins continue to the Stewart side of the mountain they should cross the mountain summit east of Stewart and then swing west toward Stewart. This area of volcanic rock between Barney gulch and Marmot river merits thorough prospecting.

The fissure zone crossing Glacier creek, known as the Portland Canal fissure zone, contains many veins, and mining has been carried out at several places in the zone. Some of the veins in the zone may be much better than the others in the zone, but the possibility should not be overlooked that in certain parts of the zone not only one but most of the veins may be well mineralized. If other veins are explored in the vicinity of the Dunwell or the Portland Canal mines, this exploration should be done at the height above sea-level of the best ore in the mines as well as on the surface. The Portland Canal fissure zone has not produced any high-grade ore, but is worth careful prospecting.

The parts of Bear River ridge nearest to Premier and B.C. Silver Mines should be prospected carefully, as it is always advisable to search for ore deposits of any kind in the vicinity of valuable ore deposits.

Narrow, straight gullies commonly mark the outcrops of faults. If the faults are pre-mineral in origin they may be ore-bearing. Consequently gullies of this type should be prospected.

It is probable that a post-batholith and post-mineral fault having a horizontal offset of 1½ miles follows Bear river. Copper deposits similar to those at the Red Cliff mine may then occur on the opposite side of Bear river about 1½ miles south of the Red Cliff.

On the whole the outlook for the future in both the Marmot and Bear River parts of the area is decidedly encouraging.

CHAPTER IV

DESCRIPTION OF INDIVIDUAL DEPOSITS

COPPER-BEARING DEPOSITS

GEORGE COPPER GROUP

The George Copper group of mineral claims is on the precipitous mountain slope south of Upper Bear river and about 20 miles by road and trail from Stewart. A full description of the mineral deposits on this property has been published recently.[1] The property formerly owned by W. B. George and associates was later acquired by the George Gold Copper Mining Company, Limited, and is now under bond to the Consolidated Mining and Smelting Company of Canada.

The first development work consisted of strippings and an adit on the lowest mineral exposure. This deposit was of large dimensions, but the grade was not considered high enough to warrant extensive development. Attention was then directed to mineral showings higher on the mountain side. These were explored by open-cuts designed to expose a maximum amount of vein matter at minimum cost. The open-cuts are well placed and careful sampling should show whether or not the veins should be explored in depth. Other mineral showings of merit on the property have not been broken into. Little is known of these except that their mineralization and size approximate that of the better known veins. The Consolidated Mining and Smelting Company of Canada began diamond drilling on the property in the autumn of 1927 and bored two long drill holes.

The country rocks at the George Copper mine are volcanics of the Bear River formation. They are chiefly massive andesite flows mainly green or grey in colour, but in some places exhibiting purple or red hues. The volcanic rocks are approximately flat lying. At the lowest mineral showing a band of argillites is intercalated with the volcanic members. Dykes cutting the older rocks are not uncommon. The volcanic rocks are probably in the upper half of the Bear River formation.

The lowest mineral zone consists of the bed of argillite about 60 feet thick which in this place contains disseminated pyrite and chalcopyrite. The upper mineral zones (*See* Figure 2) are veins formed largely, perhaps, by replacement, and dipping steeply southward into the hillside. They strike east and from west to east their outcrops rise from 4,325 feet to 4,825 feet above sea-level in a horizontal distance of 800 feet.

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[1]Smitheringale, W. V.: "Mineral Association at the George Gold-Copper Mine, Stewart, B.C."; Econ. Geol. vol. XXIII, No. 2, pp. 193-208 (1928).

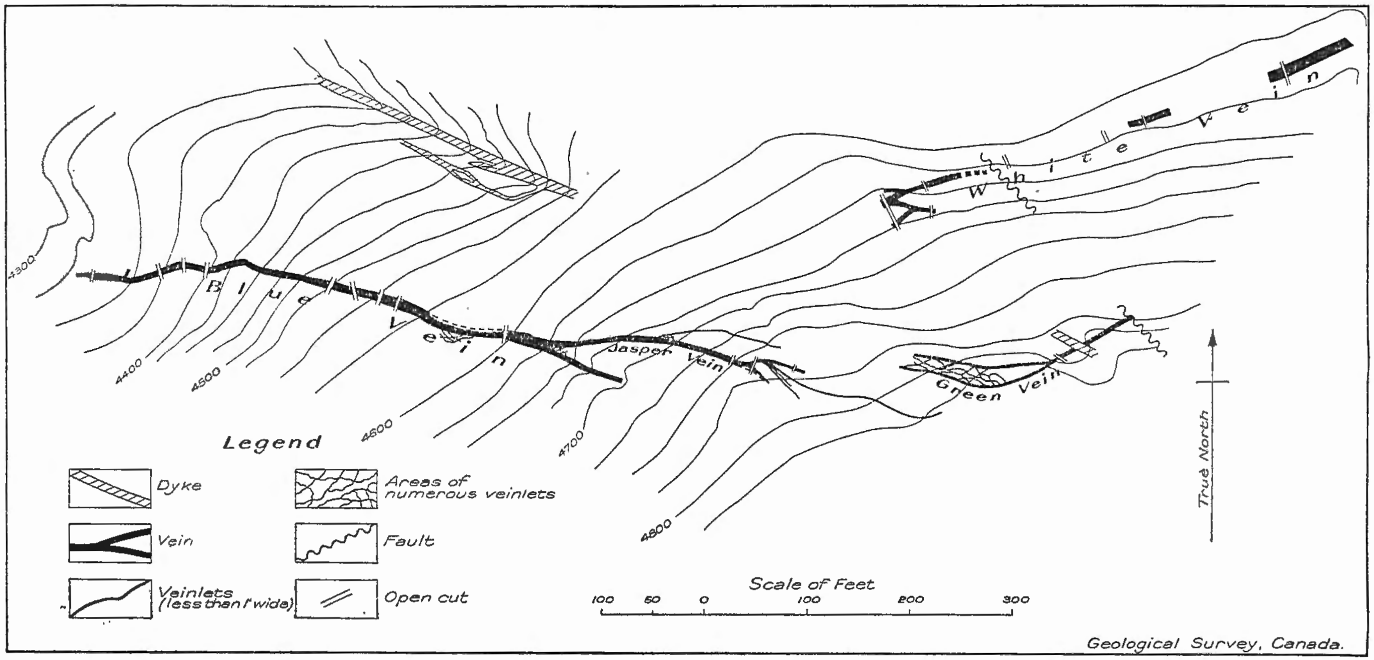


Figure 2. Surface plan of the principal mineral deposits of George Gold-Copper Mining Company.

The veins are known as the "Blue vein", "Green vein", and "White vein." The Blue vein divides and one of the branches is called the "Jasper vein." The Blue vein, including the Jasper vein, has been proved to be at least 700 feet long. Locally it is 10 feet wide, but its average width may not be more than 5 feet. The Green vein may be an eastward continuation of the Blue vein. It is known to be at least 200 feet long, is narrower in general than the Blue vein, but in a brecciated and branching part is 20 feet wide. The White vein is not certainly known to be a single lode as it is exposed only in a few places. It may be 500 feet or more long, in one place it is more than 10 feet wide, but the average width is much less. This vein is not well exposed between the end open-cuts.

The veins have numerous branches which appear to die out or pinch to stringers within a hundred feet of the main vein. The eastern part of the Blue vein and its apparent continuation, the western part of the Green vein, consist of vein branches and stringers in brecciated rock. This may be due to a local difference in the intensity of fracturing or to a difference in the type of rock traversed by the main fracture zone.

The chief minerals are chalcopyrite, pyrite, hematite, magnetite, arsenopyrite, quartz, jasper, and barite. Hematite, magnetite, and arsenopyrite are uncommon except in local areas. Quartz is more plentiful than jasper or barite, but country rock makes up most of the gangue matter. Judging from surface exposures arsenopyrite is more abundant in the Blue vein than in the others, but except for this feature all the veins are much alike.

Metallic minerals make up about 20 to 50 per cent of the vein matter. Chalcopyrite is usually as plentiful as pyrite. Some channel samples across the veins average 10 per cent copper and others show less than 1 per cent copper. Gold values vary from a few cents to $5 a ton. The gold content is quite variable and appears to depend on the quantity of arsenopyrite.

It is not known whether or not the width of the vein fracture is related to the type of rock fractured. The branching parts of the Green and Blue veins suggest that some such relation exists. As the beds of rock are practically horizontal, any influence exerted by rock type will find expression in long, horizontal ore-shoots or long, horizontal, lean areas.

RED TOP GROUP

The Red Top group is on the north side of Upper Bear river opposite the George Copper group. The mineral showings were discovered many years ago and have been developed in a small way from year to year. The development work, consisting of two adits 200 and 300 feet long and several open-cuts, has been done on two main mineral deposits, one being a chalcopyrite-bearing replacement deposit and the other a vein of the silver-lead type.

The rocks traversed by the vein are tuffs and lava flows of the Bear River formation striking northeast and dipping gently northwestward, and cut by several dykes. Some of these dykes on the Red Top group and farther west can be followed for distances of over a mile and vary very little in width.

The vein is 4,100 feet above sea-level, strikes north 80 degrees east, and dips 50 to 60 degrees southward. It has been traced by open-cuts for a distance of 800 feet. A crosscut adit 200 feet long has been driven northward from a point 300 feet below the outcrop of the vein, but has not gone far enough to encounter the vein. The vein varies from 1 to 8 feet in width and contains galena, sphalerite, pyrite, and a little chalcopyrite in a gangue of quartz, calcite, barite, and jasper. The value of the vein matter depends on its lead and silver content. Clothier has estimated the average lead content at 20 per cent and states that specimens containing 77 per cent lead assay 16·8 ounces in silver.[1] The vein is of good length and width and should be explored farther by open-cuts in order to give more information about its quality and to trace it beyond its present known length. Shoots of ore may be discovered in this way that can then be developed underground.

The chalcopyrite replacement deposit outcrops at an elevation of 2,900 feet. The country rocks at this deposit are approximately horizontal volcanic fragmentals and possibly lava flows, and an interbed of argillite. The mineralization consists of chalcopyrite disseminated through the argillite and to a lesser extent through the immediately overlying volcanic rock. The upper part of the argillite bed contains more copper than the lower part. The size and shape of the mineralized area are not clearly outlined and the geological structure is not clearly understood, but the accompanying plan (Figure 3) shows the writer's interpretation. The bed of argillite is evidently offset by two normal faults, with in each case the downthrow on the east side. A narrow streak of clean chalcopyrite lies in one of these faults, showing either that the faults are pre-mineral in age or that faulting took place between an early and a later period of mineralization.

A crosscut adit 150 feet below the outcrop of the mineral deposit crosses a body of pyrite and chalcopyrite 5 feet wide at 212 feet from the portal and enters another body of chalcopyrite near the face. The body nearest the portal is vein-like, strikes at right angles to the direction of the adit, and dips 65 degrees toward the face. This body has not been found on the surface. The mineralization near the face of the adit is in argillite and in overlying volcanic rock, and is of the same type as that in the argillite on the surface. It is assumed that this is the same bed of argillite as outcrops on the surface, and that it was downthrown to its present position by a fault (fault A, Figure 3; the amount of movement along fault B is assumed and may be more or less than that shown in the diagram). Further development can easily prove or disprove the assumption. According to this idea the mineralization follows the argillite bed and conforms rather closely to the strike and dip of the rock formation which is gently dipping and striking at right angles to the adit. The chalcopyrite in the fault fracture is worthy of notice as it may be wide enough, in other parts of the fault, to make ore.

[1]Ann. Rept., Minister of Mines, B.C., 1925, p. 95.

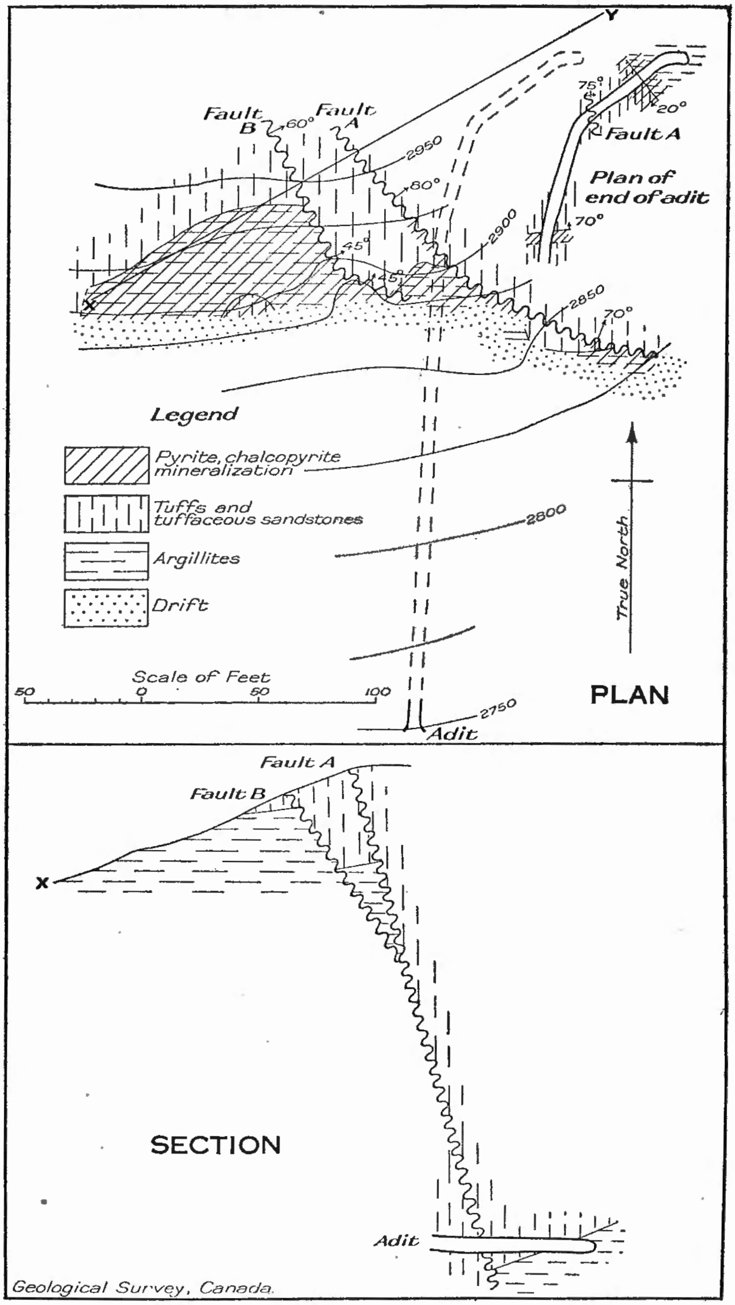


Figure 3. Lower showing on Red Top group, plan and diagrammatic cross-section.

ENTERPRISE GROUP

The mineral showings on the Enterprise group of mineral claims are above an elevation of 3,000 feet on the north side of Upper Bear river a mile or so east of the Red Top group. A vein of chalcopyrite 2 feet wide was discovered many years ago, and the early development consisting of an adit 100 feet long was on this vein. More recent development consisting of open-cuts has been done at a different place, on a mineral zone exposed at the base of a cliff.

The country rock in the vicinity of the mineral deposits consists of volcanic fragmentals and lava flows dipping gently northeastward. A small body of granodiorite, probably a stock, outcrops in the valley below the Enterprise group. This rock contains disseminated pyrite and chalcopyrite and may be the source of some of the copper deposits in its vicinity.

The vein on which the early development was done has not been explored further and apparently has not been traced on the surface for more than 100 feet. It was narrower than 2 feet in the adit and was below commercial grade.

The mineral zone exposed by the recent work has been traced imperfectly for 1,000 feet. It consists of light-coloured, probably bleached, volcanic rock with disseminated pyrite, chalcopyrite, galena, and sphalerite. The strike of the zone is roughly northwest. The dip is not known with certainty, but is probably northeastward at a low angle. The thickness of the zone is not known. No commercial ore has yet been uncovered. High-grade silver-bearing float is rather plentiful in the talus below and probably has come from the mineral zone or from some undiscovered mineral body higher on the mountain. Further prospecting should be done in the hope of uncovering better mineralization.

PRINCE JOHN GROUP

The Prince John group owned by the Prince John Mining Company is on the steep mountain slope west of Bear river opposite the mouth of Glacier creek. Two crosscut adits have been driven to explore a mineralized zone seen on the surface (*See* Figure 4).

The country rock is volcanic in origin, but has been sheared to a chlorite schist. The planes of schistosity strike north along the hillside and dip westward into the hill at moderate angles. The schist has been partly replaced by chalcopyrite and pyrite for a width of 40 feet. The length of the zone was not ascertained as no open-cuts were seen along the strike. The ore minerals occur disseminated in small particles through the mineral zone and also in small, lenticular veinlets and gashes parallelling the schistosity.

The mineral zone was cut by the upper adit, but was not found on the lower adit. In the upper adit the zone is parallel to and lies on the footwall side of a large dyke. The dyke is exposed in the lower adit. The zone may have a flatter dip than the dyke and if so and it continues in depth, it would pass beyond the face of the lower adit. Ore in mineral zones of this type, however, is usually in lenses of varying size deposited along the strike and dip by barren schist. It is possible that the mineral

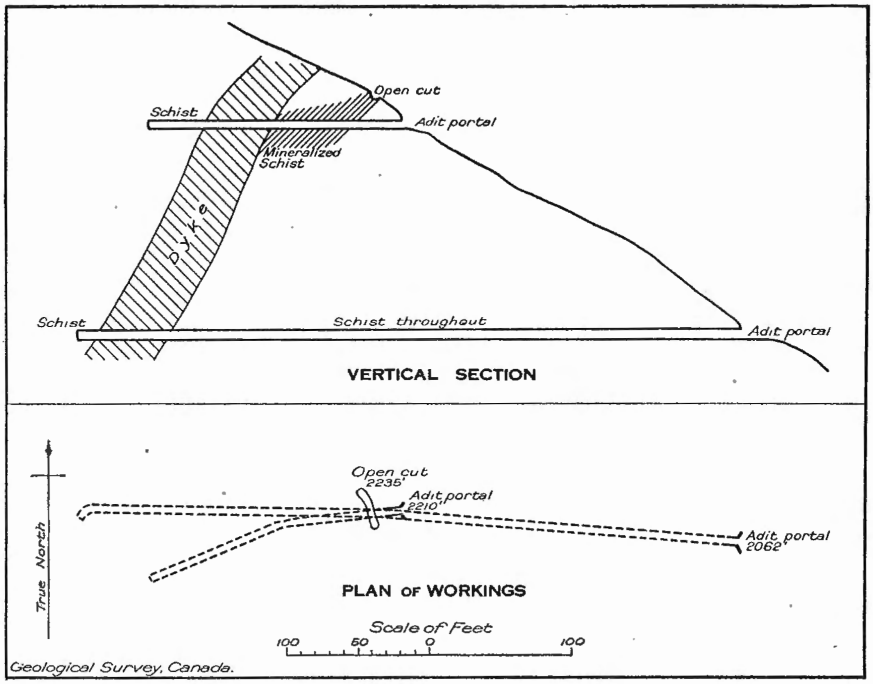


Figure 4. Plan and vertical section, Prince John group.

body cut in the upper adit is a lens and does not continue as deep as the lower adit. In the case of mineral deposits such as the Prince John the mineral zones should be explored on the surface along the strike, and if ore minerals are found in sufficient quantity should be further explored by diamond drills.

DALHOUSIE AND ROCK OF AGES GROUPS

The holdings of the Dalhousie Mining Company consist of the Dalhousie and Rock of Ages groups which are on the west side of Bear river opposite Bear lake. Mineral deposits are exposed at 2,600 feet and at 4,000 feet above sea-level. A comfortable camp has been built at the lower showing where timber is plentiful. Development work so far has not been extensive, but has been done in many places, so that several mineral deposits, apparently distinct from one another, are known, but no one deposit has been clearly outlined.

The country rocks are volcanics of the Bear River formation striking northeast along the hillside and dipping northwestward at moderate angles. The structure is clearly visible above timber-line, but at lower elevations strikes and dips are rarely seen. Modifications of the general structure may be present locally.

An area of volcanic rocks at an elevation of 2,600 feet is mineralized with pyrite and chalcopyrite. A large open-cut exposes mineralization over an area of 25 feet in diameter. As similar mineralization was found northwestward in open-cuts respectively 100 and 200 feet higher, the owners assume that the three mineralized areas form a large mineralized body striking northwestward. The outlines of the mineralized area or areas should be traced so that there may be no doubt of the length and width of the body or bodies. Clothier reports assay values of $12 in gold, silver, and copper, in samples from the lowest open-cut.[1] Two vein-like deposits have been uncovered a short distance above the camp. One contains pyrite and chalcopyrite and is 6 feet wide. The other contains hematite, pyrite, and chalcopyrite and is perhaps 10 feet wide.

Three rusty, bleached zones outcrop 1,400 feet above the camp. The zones are each from 40 to 100 feet thick, are about 100 feet apart, and conform to the strike and dip of the rocks. The central zone contains considerable sphalerite and galena. This zone is clearly a replacement deposit along a particular bed of rock.

Several other veins and replacement deposits occur on the property, but were not seen.

The mineral deposits should be traced on the surface to establish their lengths and widths. They should be sampled to determine the grade of the deposits, and if assays indicate commercial ore, the various deposits should be diamond drilled. The possibility of developing one or more large low-grade ore-bodies seems good.

HILL 60 GROUP

The Hill 60 group, formerly known as the Olga group, is at an elevation of 1,200 feet on the north side of Bitter creek about 3 miles above its mouth. The development work, consisting of open-cuts and an adit 300 feet long, was mostly done before 1910. About 150 feet of the adit is a drift along the mineral deposit.

The country rock is black argillite and grey, sandy quartzite of the Bitter Creek formation. A vein strikes northeast and dips northwestward crosscutting the country rock at a small angle. It has been traced on the surface for 250 feet; it disappears under drift at the southeastern end, and apparently is cut off by a fault at the northeastern end. The vein, consisting chiefly of quartz and brecciated argillite, is about 2 feet wide on the average, but in one place underground it divides into parallel quartz gashes and attains a total width of 9 feet. The vein is practically barren of sulphides except for small shoots of chalcopyrite. The best body of ore seen on the property is a lens of practically pure chalcopyrite 25 feet long and 8 inches wide at the widest part.

SUNSHINE GROUP

The Sunshine group of claims is at an elevation of 3,250 feet on the north side of the glacier on the north fork of Glacier creek. Most of the development work on the property was done by the Granby Consolidated Mining, Smelting, and Power Company while holding the group under option in 1922. The company made several open-cuts and drove an adit 400 feet long. The country rock is argillite of the Bitter Creek formation near the contact with a body of augite porphyrite.

[1]Ann. Rept., Minister of Mines, B.C., 1926, p. 94.

The largest mineral deposit exposed on the property is tabular and consists of chalcopyrite and pyrite in a gangue of country rock and quartz. This deposit strikes northeast and probably dips northwestward. The apparent width varies from 3 to 15 feet. The length is not proved, but occasional open-cuts along the line of strike expose similar mineralization which may be continuous for a distance of 500 feet or more. At one place a sample across 3 feet at the surface of the mineral body assayed 10 per cent copper. The adit was driven under the deposit, but although it crosscut chalcopyrite-bearing quartz stringers, it did not encounter commercial ore. The deposit may be a replacement along the bedding of the rocks or it may be a vein in a fracture zone.

Other copper-bearing mineral deposits are present on the property, but have not been explored sufficiently to trace out their boundaries.

The mineral deposits on this group of claims are large enough to warrant extensive exploration.

SILVER-LEAD-ZINC DEPOSITS

Deposits on American Creek and Upper Bear River

TERMINUS MINES, LIMITED

The holdings of Terminus Mines, Limited, are 4,000 feet above sea-level on the east side of American creek 3 miles above its mouth. The property was examined by Mr. F. F. Osborne, field assistant, and the following description is derived from his notes. Active exploration began on this property many years ago and by 1911 preparations were being made to ship ore. In this year 12 tons of ore were sacked for an initial shipment. Poor transportation facilities prevented any shipment of ore until 1925. In the meantime development has been carried out gradually and now consists of a crosscut adit 370 feet long with short drifts to either side, a raise to a sublevel 50 feet above the adit, and a shaft 50 feet deep connecting the sublevel with the surface.

The country rock consists of lava flows and fragmentals of the Bear River formation, intruded by numerous dykes of various kinds. The volcanic rocks contain much epidote. The dykes consist of feldspar porphyry, augite porphyrite, diorite, and lamprophyre. Most of the dykes contain rock fragments and consequently in many places resemble fragmental volcanic rocks.

The ore-body is a quartz sulphide vein which follows a shear zone traversing feldspar porphyry. A post-ore lamprophyre dyke also follows the shear zone and in some places has been intruded along the centre of the vein. The vein as revealed in the present workings is in most places less than 2 feet wide and has been proved to be at least 100 feet long, but the faces of the drifts are still in it, and it may be much longer. The ore consists of galena, sphalerite, pyrite, tetrahedrite, and perhaps silver minerals, in a gangue of quartz. Local concentrations of tetrahedrite cause small, rich ore-shoots. Six tons of ore shipped in 1925 ran 260 ounces in silver per ton, 3 per cent lead, and 23 per cent zinc.

The shear zone in which the vein lies is several times as wide as the vein and has not been thoroughly explored. Further exploration may result in the discovery of wider ore-bodies. As the dyke follows the shear zone, ore and dyke will in general be together, but the dyke may depart from the shear zone, whereas the ore will remain within it.

Two large, parallel, quartz-barite veins, each over 10 feet wide, containing disseminated galena, outcrop a short distance above the workings, but have not been exploited. Several, small, rusty areas visible near the shaft are local concentrations of pyrite and pyrrhotite in a bed of tuff.

KEYSTONE AND MORNING CLAIMS

The Keystone and Morning claims are in the valley of American creek a short distance above its mouth. The country rock on the Keystone is argillite striking north and dipping 45 degrees west and on the Morning is calcareous tuff. On the Keystone, open-cuts made many years ago extend for a distance of 1,000 feet. The open-cuts may have formerly traced a vein, but are now caved and do not expose vein matter. A short adit has been driven along the vein at the most northerly exposure. Here the vein is 2 feet wide, lies parallel to the strata, and consists of quartz containing fragments of argillite and sparsely mineralized with galena, pyrite, and chalcopyrite. In a shallow shaft 800 feet south of the adit, along the line of caved open-cuts, a vein of similar width, which is probably the same one, contains galena, sphalerite, chalcopyrite, and pyrite. The vein was seen at only the two places and in those places was not of commercial value.

On the Morning claim two short adits have been driven on a shattered zone in calcareous tuff. Pyrite is disseminated through the rock, but valuable mineral is rare.

RUBY SILVER MINES, LIMITED

The property of the Ruby Silver Mines, Limited, is located on La Sueur (or Mosquito) creek which flows into Bear river just above the mouth of American creek. The property was visited by Mr. Osborne, field assistant, from whose notes the following account is derived.

The country rock consists of black argillite with grey bands of quartzite, and is intruded by a dyke that follows the bedding. The rocks strike north-northwest and dip steeply northeastward. The mineral deposit is a quartz sulphide in contact with the dyke. An adit at an elevation of 1,250 feet has been driven for a distance of 190 feet southeastward along the vein. The vein is 3 feet wide near the portal, but narrows rapidly and pinches out near the face. The mineralization is pyrite, galena, and sphalerite in a gangue of quartz and calcite.

Properties West of Bear River

INDEPENDENCE GOLD MINING COMPANY

The holdings of the Independence Gold Mining Company are on Fitzgerald creek. Most of the exploratory work has been done at an elevation of 3,000 feet. The mineral deposits are situated along the zone of dykes previously described as striking southeast across Bear River ridge and valley, and consequently the country rock is mainly dykes of quartz diorite. Most of the development work, consisting of several open-cuts and a long adit, has been done on a vein 2 to 25 feet wide and proved to be at least 700 feet long (*See* Figure 5). The vein is parallel to the zone of dykes. It expands and narrows greatly within short distances.

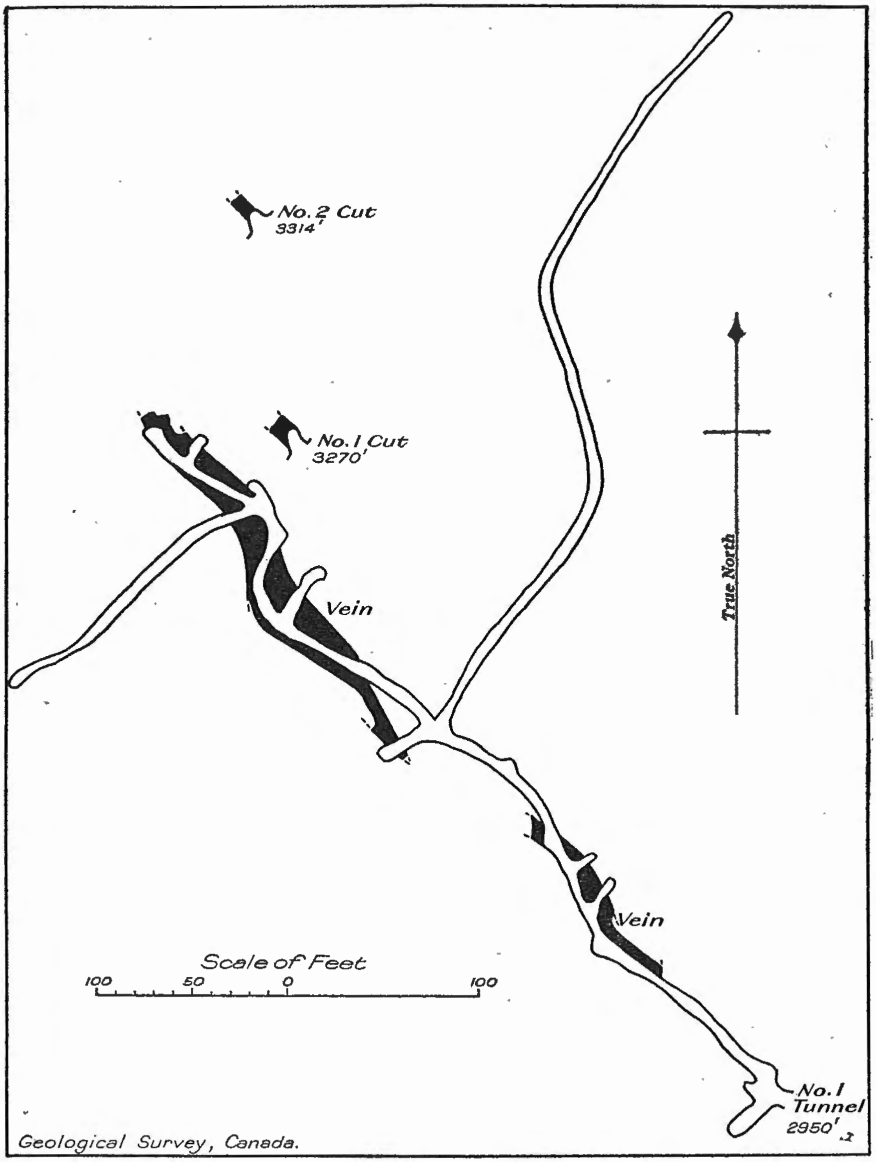


Figure 5. Main underground workings on property of Independence Gold Mining Company.

Several narrower parallel veins 2 to 6 feet wide outcrop a few hundred feet north of the large vein. The narrower veins lie mostly at the contacts between dykes and intruded volcanic rocks. The veins contain sparsely disseminated galena, sphalerite, and pyrite in a gangue of quartz, barite, jasper, and calcite. The chief value is in gold and silver, but most of the veins are below commercial grade.

The large vein has been traced for several hundred feet on the surface above the adit. Where exposed in the lowest or No. 1 open-cut it strikes northwest, but does not continue up the hill on this line of strike. Where exposed in the next higher, or No. 2 open-cut a short distance north of No. 1 open-cut, it has the same strike and can be followed up the hill for several hundred feet along this line of strike. The veins exposed in the two open-cuts appear to be identical in general appearance and are believed to be parts of one vein offset by a fault between the two open-cuts.

The adit beginning 320 feet below the lowest open-cut is a drift and follows quartz stringers of no economical importance for 75 feet. It encounters a wider part of the vein at 85 feet from the portal and follows this for 100 feet. At 275 feet from the portal it enters another large vein expansion which it follows to the face a distance of 210 feet. The vein matter in the wide part of the vein is of much better grade than that in the narrow parts. The large lens of the vein which is exposed at the face of the adit is of better grade than the other lenses. A long crosscut was driven northeastward from a point 275 feet from the portal of the adit in the hopes of picking up other parallel veins, but was not successful.

The face of the adit is 320 feet below the vein in outcrop. It is evident that a tonnage large enough to operate a 100-ton per day mill for several years could very likely be proved. Development has proceeded far enough to permit systematic sampling and sampling should prove definitely whether or not the vein matter can be mined with profit. As some of the dykes in the zone of dykes are younger than the vein they will probably interrupt it locally.

BAYVIEW MINING COMPANY, LIMITED

The holdings of the Bayview Mining Company, Limited, consisting of the Bayview and Gold Cliff groups of mineral claims, are on the eastern slope of mount Dolly 2½ miles north of Stewart. Most of the discoveries are near the contact of the Coast Range batholith, some within the batholith, some in adjacent argillite, and some in adjacent volcanic rocks.

The lowest mineral showings on the hillside are at an elevation of about 3,000 feet on the Gold Cliff group (*See* Figure 6). A vein is exposed at this place striking northwest and dipping 45 degrees southwest. It is 1 to 3 feet wide and has been traced by open-cuts for 200 feet. It strikes at right angles to the batholithic contact and lies partly in the granodiorite and partly in the adjacent volcanic rocks. Seventy feet above and 70 feet west of the upper exposure of the vein is another vein parallel in strike but dipping steeply southwest. This vein is 1 to 4 feet wide and has been traced up the hillside for 500 feet.

These veins consist of galena, sphalerite, pyrite, and tetrahedrite in a gangue of quartz. They are very well mineralized on the surface and in some places are practically solid sulphide. Surface exposures on the upper vein assay up to 250 ounces in silver a ton. Underground the vein is narrower and much lower in grade. The lower vein assays 150 ounces or less in silver a ton. The upper vein is developed by open-cuts and a drift adit 100 feet long. The lower vein is well exposed in open-cuts. A crosscut adit 45 feet long has been driven to intersect the lower vein but has not been driven far enough to reach its objective. These mineral showings are quite attractive and should be developed further.

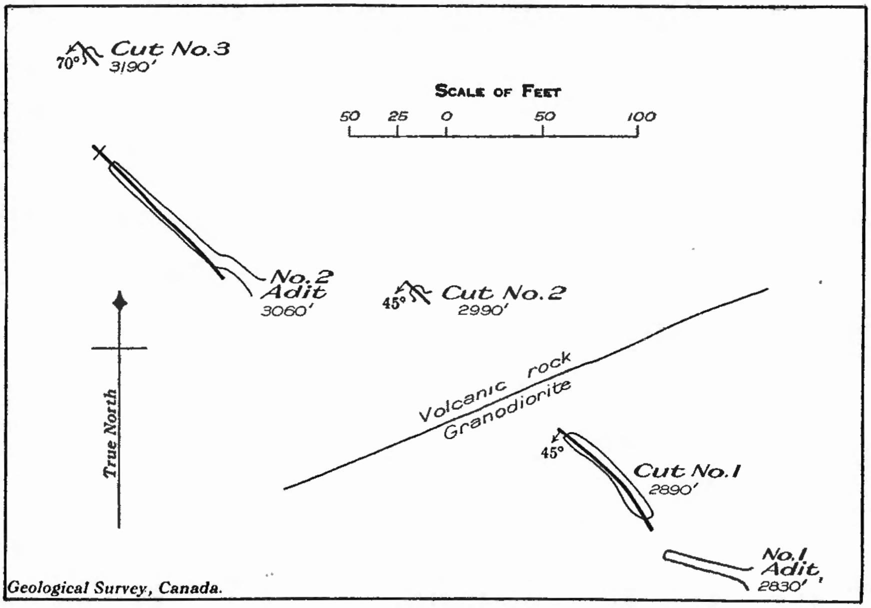


Figure 6. Sketch plan of lower showings on property of Bayview Mining Company, Limited.

Three veins have been explored on the Bayview group which adjoins the Gold Cliff group on the west. The workings are about 4,000 feet above sea-level. The veins are parallel to each other and to the contact of the Coast Range batholith which here strikes west. One vein is at the edge of the batholith and the other two in rock adjacent to the batholith within 700 feet of the contact. The veins are individually 2 feet or less in width and consist of pyrite, galena, sphalerite, and tetrahedrite, in a gangue of quartz. The development consists chiefly of open-cuts from some of which ore has been shipped. A total of 9 tons of ore shipped in 1925 assayed 170 ounces of silver per ton, 16 per cent lead, 21 per cent zinc, and a little more than a dollar in gold per ton.

The veins on the two groups contain shoots of ore that can be mined and shipped without much concentration. They are easy of access and close to Stewart. They warrant more thorough exploration.

Properties East of Bear River

ORE MOUNTAIN MINING COMPANY, LIMITED

The holdings of Ore Mountain Mining Company are north of Bitter creek and 1 to 2 miles east of Bear lake. The rocks are of the upper part of the Bitter Creek formation. The contact with the overlying Bear River formation is about 200 feet west of the lower showings and the zone of dykes previously referred to lies about 500 feet south.

Some development work has been done on a galena-bearing vein in sheared tuffaceous sediments at an elevation of 4,500 feet. This was largely snow covered at the time of visit, and, therefore, the vein could not be seen on the surface. An adit has been driven along this vein, but shows only several narrow stringers of vein matter.

Several parallel veins are exposed in open-cuts and short adits at an elevation of 3,300 feet. They strike north and dip steeply westward. The exposures are on a flat area on the mountain side, and the strike of the veins is along the hillside so that drift or crosscut adits must be fairly long to attain moderate depths. One of the veins is locally 4 feet wide and is a replacement vein in a shear zone. Pre-mineral and post-mineral faults striking north are present and also post-mineral faults, with small offsets, striking northeast. One of the latter faults is occupied by a narrow dyke and offsets a vein 6 feet. The vein matter is rusty and decomposed and primary minerals are rare. The veins may prove to be of importance, as according to Clothier they contain gold values in gold and silver.[1] A crosscut adit 150 feet long and 150 feet below the outcrop of veins on the flat area has been driven eastward. It is highly desirable that this be continued to intersect the veins so that they can be explored at this depth.

TYEE GROUP

The claims of the Tyee group are at an elevation of 500 feet on the east side of Bear river between Glacier and Bitter creeks. The country rock is a stock of granodiorite intrusive into volcanic rocks. A quartz vein 1 to 5 feet wide and 75 feet long is exposed by a shaft and open-cuts. The vein strikes northwest, is vertical, and consists of quartz and sulphides in approximately equal amounts by volume. The sulphide is chiefly pyrite, but some chalcopyrite is present. A crosscut adit 60 feet below the vein-outcrop, has not been driven far enough to reach the vein. The vein matter is not of commercial grade, but locally assays several dollars per ton in gold.

MAYFLOWER GROUP

The Mayflower group is 1,000 feet above sea-level east of Bear river between Glacier and Bitter creeks and adjoins the Tyee group on the east. The country rocks are tuffaceous sediments and tuffs of the lower part of the Bear River formation. The stock of granodiorite on which the Tyee is located outcrops just below the Mayflower claims.

[1] Ann. Rept., Minister of Mines, B.C., 1925, p. 92.

The workings consist of several open-cuts and three short adits. A shear zone 2 feet or less wide extends up hill in an easterly direction for 300 feet in the bottom of a small creek. The zone contains a quartz vein very sparsely mineralized with sulphide. Several quartz veins, individually a little wider than the one in the shear zone, join it and the adits have been driven along these branch veins. Two of the branch veins are 1 to 3 feet wide and are well mineralized with pyrite, galena, sphalerite, and chalcopyrite. The bare metals, however, are not present in sufficient quantity to constitute commercial ore.

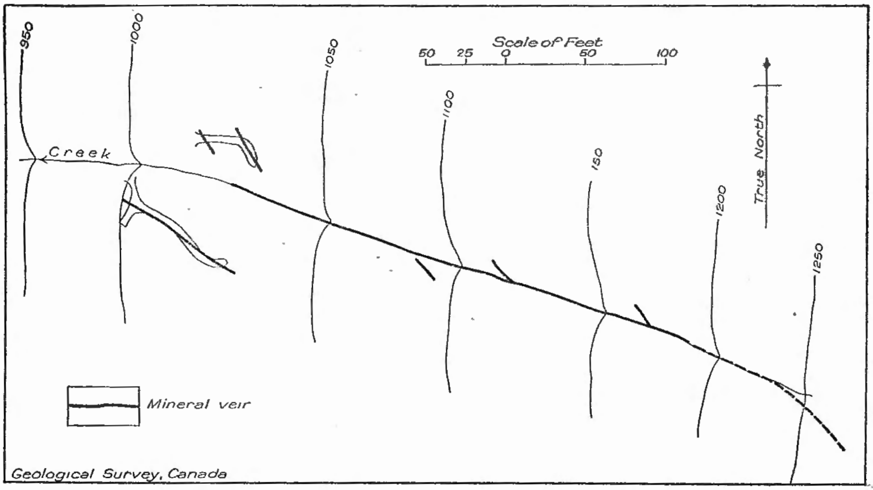


Figure 7. Plan showing vein system on Mayflower group.

Figure 7 shows the location of the veins exposed on the Mayflower group.

EMPEROR MINES, LIMITED

The holdings of Emperor Mines, Limited, are situated between Glacier and Bitter creeks at an elevation of 3,000 feet. A good deal of snow was on the ground at the time the property was visited and some of the open-cuts were not visible.

The country rock is argillite of the Bitter Creek formation striking north and dipping west at moderate angles. Numerous dykes and sills of quartz diorite, gabbro, and lamprophyre occur intruding the argillite.

Two quartz veins occur on the property. The veins are parallel, 200 feet apart, strike north, and dip 50 degrees west. The more easterly vein is 6 to 30 feet wide and has been traced by open-cuts for 500 feet. The other vein is 6 feet wide, is not known on the surface, and only in one place underground. The veins consist chiefly of quartz and a little calcite and are sparsely mineralized with pyrite, galena, sphalerite, and jamesonite. The smaller vein is a single body, but the larger one in places where it is widest consists of closely spaced quartz veins separated by argillite.

The quartz, like that in other veins in the vicinity east of the Portland Canal fissure zone, is habitually drusy. The ore minerals are disseminated through the vein, but not in sufficient quantity to constitute commercial ore.

The underground development consists of three adits driven in an easterly direction to cut the large vein. The upper adit is a crosscut for 125 feet where it enters the large vein. A drift follows the vein for 60 feet. A fault with strongly marked horizontal grooves is the east wall of the vein in this adit. The next adit 200 feet southeast and 10 feet lower than the upper adit is 30 feet long and is little more than a large open-cut on the large vein. The lowest adit 650 feet southwest of the upper adit and 180 feet lower is 950 feet long and reaches the smaller vein at 520 feet from the portal and the large one at the face. On this adit a fault with horizontal grooves is the west wall of the smaller vein. This fault is west of, and parallel to, the one in the upper adit.

LAKEVIEW MINES, LIMITED

The holdings of Lakeview Mines, Limited, are at an elevation of 2,000 feet between Glacier and Bitter creeks. The property adjoins the Dunwell on the east. The country rock consists of cherty quartzite and argillite of the Bitter Creek formation intruded by numerous dykes of quartz diorite granodiorite and gabbro. The sediments strike north and dip west.

The mineral deposit is a quartz-sulphide vein 1 to 4 feet wide and traced by surface and underground workings for 800 feet. The vein strikes northwest and dips 60 to 80 degrees southwest. It consists of pyrite, galena, sphalerite, and tetrahedrite in a gangue of drusy quartz, and contains small shoots of high-grade silver ore.

A shaft has been sunk on an ore-shoot 3 to 4 feet wide, but was full of water and could not be examined. The upper adit is 500 feet southeast of the shaft. It is 60 feet long and exposes another ore-shoot in the vein about 3 feet wide (*See* Figure 8). The middle adit 100 feet below the upper one and 275 feet south of it, is a crosscut for 250 feet and then a drift for 300 feet northwestward along the vein. This drift is directly below the ore-shoot exposed in the upper adit. The vein in the drift is 6 inches to 3 feet wide and is locally ore-bearing, but, judging from the proportion of sulphide in the vein, it is lower grade than in the upper adit. The lowest adit begins as a crosscut 800 feet southwest of the shaft and 250 feet below it, enters the vein 750 feet from the portal, and follows it as a drift for 175 feet. This adit is directly below the ore-shoot exposed at the shaft. The vein in this adit consists of drusy quartz very sparsely mineralized with sulphide and is below commercial grade.

A total of five tons of ore shipped in 1913 and 1914 averaged about 0·4 ounce gold and 400 ounces silver per ton.

Further development should be done in outlining the ore-shoots.

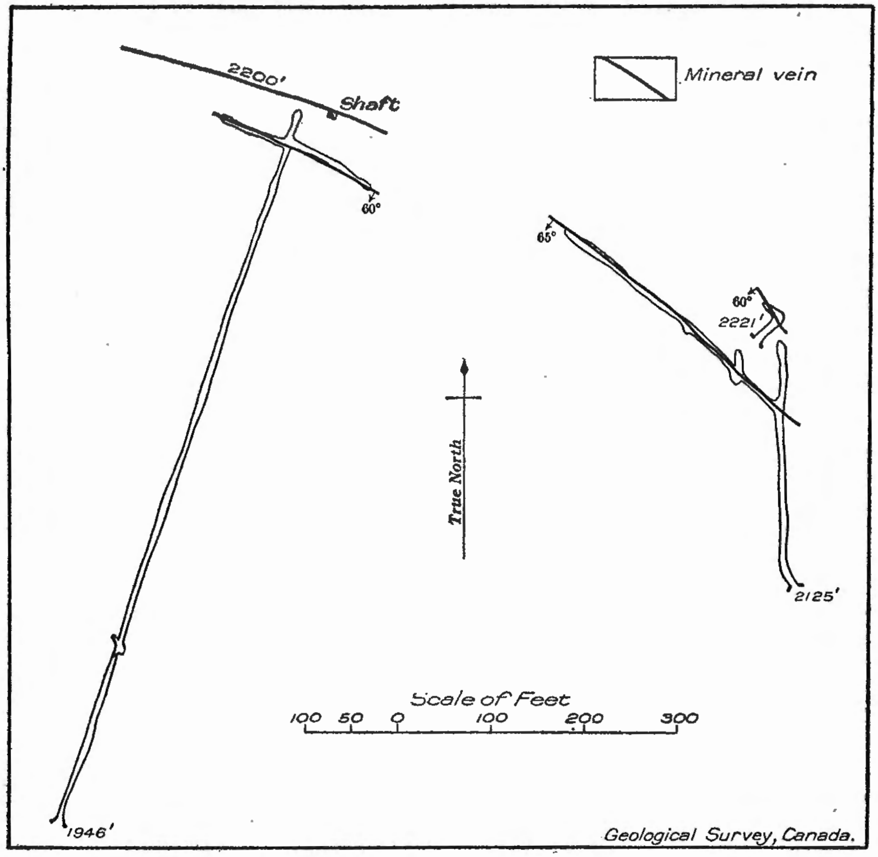


Figure 8. Plan of mineral veins and underground workings on property of Lakeview Mines, Limited.

RUTH AND FRANCIS GROUP

The Ruth and Francis property is at an elevation of 3,300 feet on the north side of Glacier creek and east of the Lakeview. The country rock is argillite of the Bitter Creek formation, intruded by numerous small and moderate sized dykes. The best-known mineral deposits are located along a creek bed following a fault (*See* Figure 9). Other mineral showings exist at a higher elevation, but are not being explored and were covered with snow at the time of visit. The fault strikes north 30 degrees east and is vertical. The extent and direction of fault movement are not known, but distinct horizontal grooves are present on the fault walls. The east wall of the fault is the east wall of the mineral deposit, but the west wall of the fault is obscured by mineral replacement.

The main deposit is a vein at least 150 feet long and in most places 2 or 3 feet wide, but locally 7 feet wide. It consists of sulphides and some quartz. The sulphides are jamesonite, sphalerite, pyrite, chalcopyrite, tetrahedrite, and galena, but the last three minerals are rare. The vein has been developed by two drift adits (Nos. 1 and 2, Figure 9). The adits are each 75 feet long, one is 50 feet above the other, and both have been driven north along the vein. A body of solid sulphide several feet wide in the upper adit according to Clothier assays 40 cents in gold, 31·6 ounces of silver, 15 per cent lead, 18 per cent zinc, and 8·3 per cent antimony.[1] The vein is less than 2 feet wide in the lower adit except at the face where

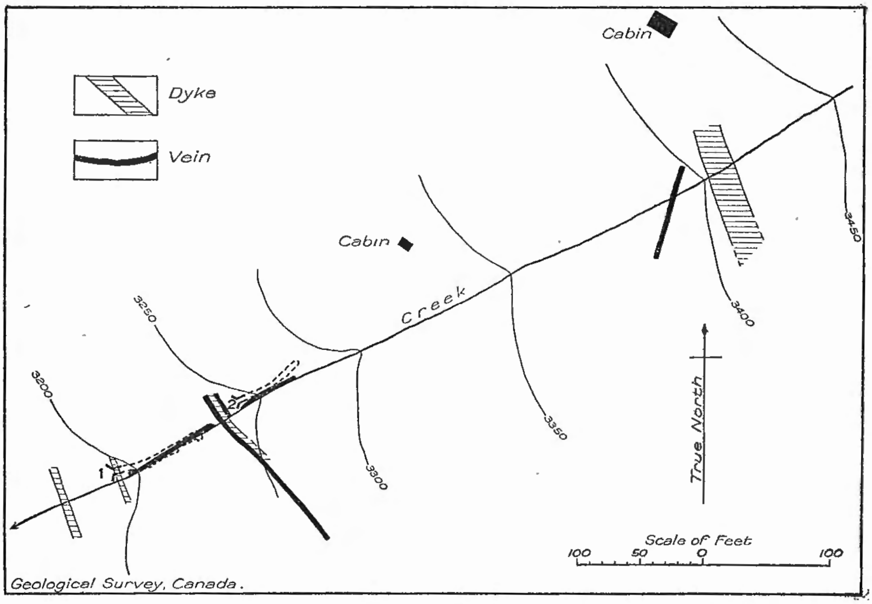


Figure 9. Plan of lower showings on Ruth and Francis group.

it widens rapidly to 5 feet. Other veins striking at various angles to the main vein are known. Two of these are shown in Figure 9. The cross veins so far as known are narrow, but in some places contain high silver values.

Fractures seen in the adits diverge northward from the fault. Some of these may be ore-bearing and the wider portions of the vein may be at the junctions of such fractures with the fault. Development, however, is not yet extensive enough to show any definite relations between wide ore-bodies and cross fractures.

Further development will be of considerable interest, as the main vein on this property is quite unusual in that it contains shoots of solid sulphide.

L AND L GLACIER CREEK MINES, LIMITED

The holdings of the L and L Glacier Creek Mines, Limited, are on the south side of the glacier on the north fork of Glacier creek. The camp and workings are at an elevation of 3,400 feet. The country rock

[1] Ann. Rept., Minister of Mines, B.C., 1926, p. 93.

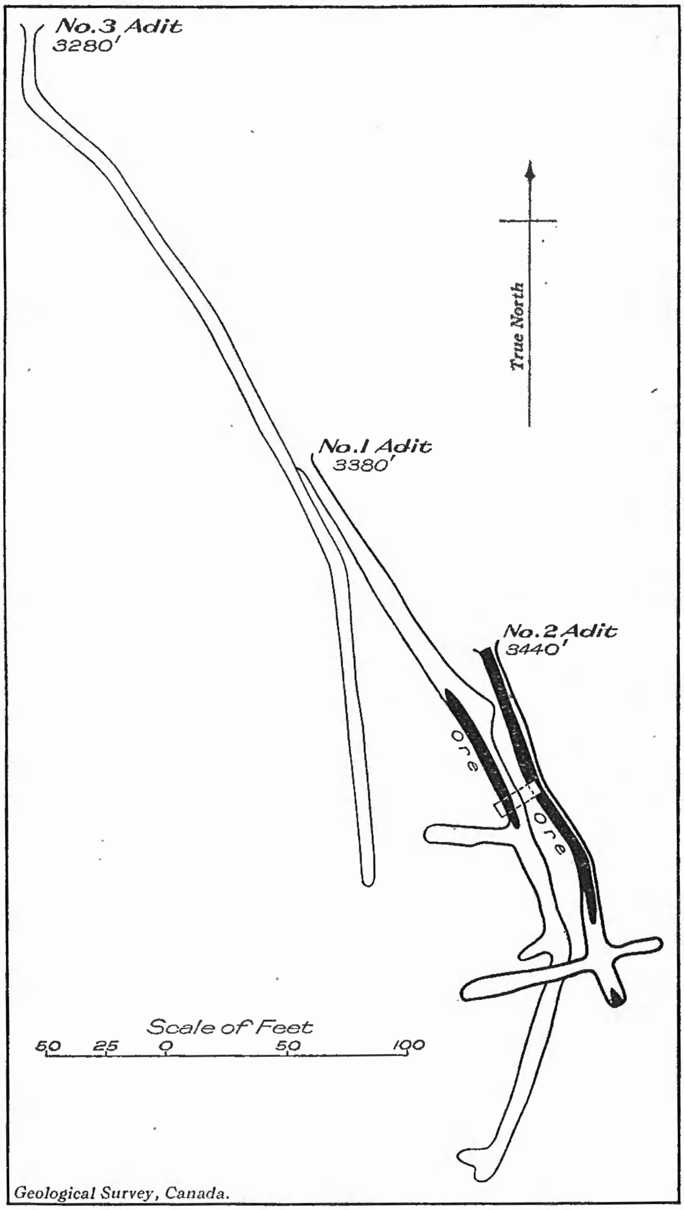


Figure 10. Plan of underground workings on property of L and L Glacier Creek Mines, Limited.

is augite porphyrite. The contact of the augite porphyrite with the Bitter Creek formation is on the opposite side of the glacier and appears to dip gently northward. Development on the L and L has been concentrated on a northwesterly striking vein which dips 70 degrees southwestward. The vein is 3 feet wide and consists of quartz with pyrite, chalcopyrite, arsenopyrite, pyrrhotite, sphalerite, galena, tetrahedrite, and an unidentified lead sulphantimonide. The most plentiful sulphides are pyrite, galena, sphalerite, and tetrahedrite. One shoot of ore has been discovered in the vein. It is 1 to 2 feet wide, 120 feet long, and extends from the surface to a depth of 120 feet at least.

The development on the property consists essentially of three drift adits (*See* Figure 10). The uppermost or No. 2 adit follows the ore-shoot for 120 feet where, although the vein continued, the ore-shoot ended. Believing that the ore deposit had been offset by a fault at this point those responsible for the development drove crosscuts to both sides in search of the faulted part. Eventually the drift was continued and some ore, which may be the northern end of a second ore-shoot, was found at the face of the drift. The middle or No. 1 adit is 100 feet northwest and 60 feet below the upper adit. This adit follows the vein for most of its length, but the ore-shoot is only 60 feet long on this level. Stopes exist between No. 1 adit and the surface. The lowest or No. 3 adit is 320 feet northwest and 160 feet below the upper adit. This adit follows the vein for most of its length, but the ore-shoot is not present.

Evidence furnished by polished specimens of the ore suggest two periods of mineralization. The first resulted in a vein of quartz with pyrite, chalcopyrite, and arsenopyrite, and some galena and sphalerite.

The minerals of the second period of mineralization are chiefly galena and tetrahedrite, which were deposited in fractures in the earlier, lean, vein matter. The ore-shoot consists chiefly of minerals formed during the second period of mineralization. Specimens of vein matter from the lowest adit show narrow stringers of galena and tetrahedrite traversing the earlier vein matter, and suggest that commercial ore extends downward nearly to this adit. Ore specimens from near the surface contain an unidentified lead sulphantimonide. The mineral occurs alone in narrow veinlets and is distinctly later than any other mineral in the vein.

Shipments of ore were made from the property in 1924 and 1926. A total of 59 tons of ore was shipped yielding 0·1 ounce gold, and 160 ounces silver per ton and 13 per cent lead.

The future importance of the property depends on the finding of other ore-shoots. Search should be made farther south on the vein on the surface in the upper adit.

ALBANY MINING COMPANY, LIMITED

The holdings of the Albany Mining Company, Limited, are on the south fork of Glacier creek. The camp and most of the workings are about 1,700 feet above sea-level The country rock is argillite near the contact of a large body of augite porphyrite.

The first development work done on this property consisted of opencuts and a short adit on a 2-foot quartz sulphide vein. Local bunches of sulphide in the vein assay 0·2 ounce of gold, 10 ounces silver per ton, and 10 to 20 per cent lead, but are not of commercial importance.

Development in progress during the summer of 1927 consisted of a drift adit on a 6-foot quartz vein paralleling the south fork of Glacier creek and outcropping on the east bank of the creek. The vein strikes north and dips west at 20 to 50 degrees. It consists of drusy quartz mineralized with pyrite, galena, and sphalerite. The vein where exposed is too low in grade to be of commercial importance.

Because of its size the large vein should be developed further. This development should consist of surface work in search of ore-shoots which when discovered should be outlined on the surface and underground.

RUSH COLUMBIA MINES, LIMITED

The holdings of the Rush Columbia Mines, Limited, consisting of the Columbia and the Gem groups, are on the middle fork of Glacier creek and adjoin the holdings of the L and L Glacier Creek Mines, Limited, on the west. The country rock is augite porphyrite.

The chief mineral deposit is a vein 1 to 8 feet wide, but in most places less than 3 feet wide. It lies in a sheared and shattered zone striking northeast and crossing the middle fork of Glacier creek. The vein has been traced for 800 feet on the northeast side and for 600 feet on the southwest side of the creek. Four drift adits have been driven on the vein on the northeast side of the creek and one on the southwest side. They are individually 45 to 90 feet long. Open-cuts expose vein matter consisting of quartz, siderite, pyrite, galena, sphalerite, and tetrahedrite. The vein matter in some of the open-cuts is ore, but no ore-shoots have been definitely outlined. The vein matter in the adits is not of commercial grade. The good ore found locally at the surface is probably not due to secondary enrichment and, if not, good ore should also exist at some places underground.

A total of 11 tons of ore was shipped from the vein in 1910 and 1913. The 1910 shipment consisting of 4 tons contained 0·08 ounce gold, and 375 ounces silver per ton, and 23 per cent lead. The 1913 shipment of 7 tons assayed $114 per ton in silver and lead.

BEN BOLT GROUP

The Ben Bolt group of mineral claims is located at an elevation of 2,500 feet on the south fork of Glacier creek. The country rock is argillite of the Bitter Creek formation striking northwest and dipping gently southwest near the contact of a body of augite porphyrite. According to McConnell the Ben Bolt group is at the southern end of the exposed portion of the Portland Canal fissure zone. He states also that the fissure zone on this group is traceable for 2,000 feet, is 100 feet wide, and consists of silicified and crushed slates holding numerous small stringers and lenses of quartz. Assays quoted by McConnell from a mineralized shoot show 10 to 15 per cent lead, 3 to 8 per cent zinc, and 5 ounces of silver per ton.[1]

[1] McConnell, R. G.: Geol. Surv., Canada, Mem. 32, pp. 36, 37 (1913).

The writer examined five adits on the property, and these are shown in their approximate positions in Figure 11. The mineralized zone dips southwestward at a low angle, so the actual thickness is much less than the width shown in Figure 11. The zone contains a great deal of quartz

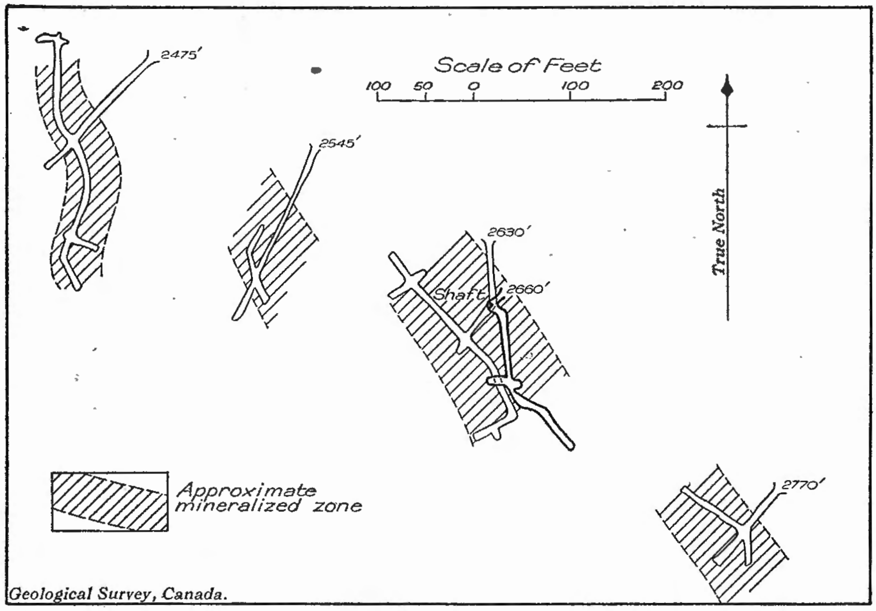


Figure 11. Underground workings on Ben Bolt group.

as stringers and large solid bodies and is everywhere very sparsely mineralized with pyrite, galena, and sphalerite. Drifts have been driven along the zone, probably on the best vein matter, but as far as ordinary examination could tell drifts elsewhere in the zone would have yielded similar results. A pre-mineral dyke is exposed in the drifts of the four lower adits. In these adits, too, the vein matter is present as several ill-defined quartz veins 6 feet or so wide and as closely spaced quartz stringers. In the uppermost adit the actual thickness of solid quartz probably exceeds 30 feet. Mineralization is very sparse, but because the quartz bodies are so large, sampling should be thorough enough to be conclusive before the showings are abandoned as too low grade for mining.

Properties on the Portland Canal Fissure Zone

The Portland Canal fissure zone was named by McConnell after the Portland Canal mine located on the zone.[1] The fissure zone is in the upper part of the Bitter Creek formation and is characterized by shearing, and faulting, and by the presence of several, parallel, mineral-bearing veins. The width of the zone is variable and is as great as 1,500 feet in some

[1]McConnell, R. G.: Geol. Surv., Canada, Mem. 32, p. 24 (1913).

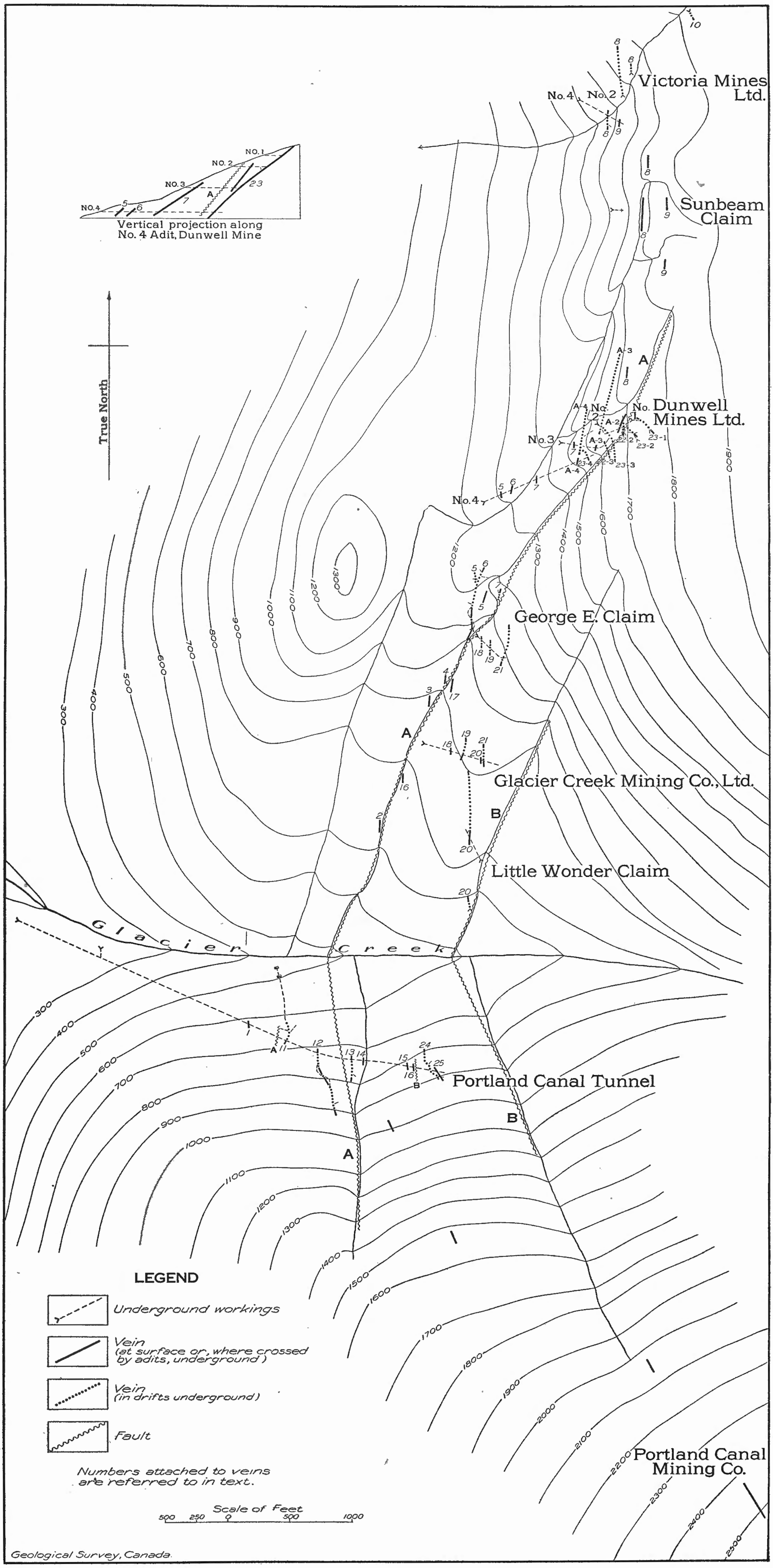


Figure 12. Northern part of Portland Canal fissure zone.

places. The length is upwards of 4 miles. The location of most of the mine workings and veins in that part of the fissure zone north of Glacier creek is shown by Figure 12. Only veins wider than 2 feet are shown on the plan and for simplicity some of the smaller mine workings are omitted.

The fissure zone at Victoria Mines, Limited, which is its most northerly known point, is in contact with the overlying Bear River volcanics. Southward the zone departs gradually from the upper contact of the sediments and passes through lower members of the Bitter Creek formation. Where the zone crosses Glacier creek it is still near the overlying volcanics, but is a few hundred feet from them. The fissure zone was not examined south of Glacier creek but there it appears to depart from the volcanic contact at a more rapid rate until at its most southerly known point it is well down in the Bitter Creek formation. The argillites strike north and dip west at 45 degrees. The strike varies locally to northwest or to northeast and the dip varies from about 10 degrees to 80 degrees. Several dykes intrude the argillites.

Prior to the formation of the metalliferous veins the argillites were subject to pressure which resulted in folding, shearing, and faulting. Shearing was not uniformly distributed throughout the argillite formation, but was restricted to a zone 1,500 feet or less in width known as the Portland Canal fissure zone. The shearing in the fissure zone was localized in many narrow, parallel zones along which considerable differential movement probably took place, so that the narrow shear zones are faults accompanied by shearing. The narrow shear zones follow rather closely the strike and dip of the argillites, but in many places crosscut at small angles, but everywhere in the same direction, so that, whereas the argillites strike north, the narrow shear zones strike a few degrees west of north. Less is known about the dip of the shear zones, but in mine workings it is in some places steeper and in other places less steep than that of the argillites.

Formed perhaps at the same time as the narrow shear zones are more clean-cut faults. Two of these faults are known in the Portland Canal fissure zone. The faults are parallel and their strike is north, approximately the same as the average strike of the argillites, but the faults are fairly straight and crosscut the argillites along the strike at all local curves or bends in the strata. Local bends are common, so that the faults crosscut in most places. The dip of the faults is in general steeper than that of the argillites.

The strike of the narrow shear zones and that of the faults, therefore, intersect at a small angle which is in general less than 15 degrees, but is as great as 45 degrees in a few places. The dip of the faults is in general steeper than that of the shear zone.

The net result of the shear zone-fault combination is that the shear zones on opposite sides of a fault are quite distinct from each other and join the faults at small angles.

After the faults and shear zones were initiated, differential movement still continued and took place along a few favoured shear zones and along the faults past the shear zone-fault junctions. Thus in the

Dunwell mine a shear zone striking northwest joins a fault striking north. Later differential movement took place along the shear zone and along the fault north of the junction.

After the formation of the faults and shear zones, the argillites were intruded by lamprophyre and other fine-grained dykes. The dykes strike north and their relationship to the strike of the shear zones is known in a few places. In these places the dykes follow narrow shear zones and the fault past the shear zone-fault junction. Thus in the Dunwell mine a dyke follows a shear zone striking northwest to its junction with a fault striking north, and from this point continues north along the fault.

After dyke intrusion differential movements still continued, as is shown by the dyke in the Dunwell mine, which is shattered and crushed at the junction of the shear zone and fault and at places here and there along the shear zone.

Later still the Portland Canal fissure zone was invaded by siliceous and ore-forming solutions. Quartz veins were formed in the many shear zones and locally along the two faults. Some of the veins in shear zones are quite barren of valuable mineral and most of the vein matter in the faults consists of barren quartz. Most of the known ore-bearing shear zones contain a dyke as well as an ore-bearing vein. For example, at the Portland Canal mine, Dunwell mine, Sunbeam claim, and Victoria mine the ore-bodies lie in contact with, and on one or both sides of, a dyke, and in the Dunwell mine ore continues along the fault and dyke north of the shear zone-fault junction. It seems that in some way the dykes have guided the ore solutions and perhaps helped to keep them within definite channels. No reason has been discovered to explain the presence of ore in some of the veins and the lack of ore in others.

In view of the foregoing remarks it will be evident that the writer believes that veins on opposite sides of faults are quite distinct from each other and that, therefore, no vein correlation can be carried across the faults. The veins are really in three groups, those west of the more westerly fault or fault A, those between the faults, and those east of the more easterly fault or fault B. Bearing in mind that the strike of the shear zone veins is a little west of north and that the faults strike north, it is evident that the veins of the first group when followed southward approach fault A, those of the second group approach fault A when followed northward and fault B when followed southward, and those of the third group approach fault B when followed northward. Because of the nature of the general structure it is possible to determine with a reasonable degree of certainty the course followed by any known vein and, thus, to correlate the veins of the same group as displayed at the surface and underground. On the accompanying plan, Figure 12, the known veins of each group are numbered consecutively from south to north according to the order in which they join or would join the major faults and if in the writer's opinion the same vein appears at several places it bears at each place the same number.

Before discussing vein correlation, Figure 12 will be discussed briefly. The contour lines show that the fissure zone outcrops along sloping surfaces. Faults A and B as represented on the figure appear to bend sharply at Glacier creek. Bearing in mind, however, that the faults dip west, a little consideration will make it apparent that the surface trends of the faults are not their true strikes. If either fault is projected downward along the dip to a horizontal plane passing through the point where the fault crosses Glacier creek, the intersection of the fault with the plane will be approximately straight and will be the true strike of the fault. The apparent bends at Glacier creek are, therefore, apparent only and are not real. For the same reasons the trend of the outcrop of a dipping vein that ascends a hillside is not the strike. By bearing in mind that the trend of the outcrop of dipping bodies on sloping surfaces is quite different from their strikes Figure 12 will be more easily understood.

Fault A passes below the portal of No. 1 adit, Dunwell mine, but is present in adits Nos. 2, 3, and 4, where it is known as the North-South vein, but on the figure is named A-2, A-3, or A-4, according as it is cut by adit Nos. 2, 3, or 4. It outcrops along a creek tributary to Glacier creek passing near the portals of the adits on the George E claim and the holdings of the Glacier Creek Mining Company. It is also cut by the adit known as the Portland Canal tunnel. Fault B outcrops along a creek bed that passes by the portals of the adits on the Little Wonder group. This fault was also crossed near the face of the Portland Canal tunnel.

The most westerly vein in the fissure zone, No. 1 vein, is exposed in the adit of the Portland Canal tunnel. Veins Nos. 2, 3, and 4 are exposed on the west bank of Fault A creek, south of the adits on the George E claim. Other veins may exist between veins Nos. 1 and 2, but none has been discovered. Veins Nos. 5 and 7 are exposed on the surface and also underground on the George E claim west of Fault A creek. Vein No. 5 divides underground into two branches numbered 5 and 6. The three veins crossed by No. 4 adit, Dunwell mine, west of fault A, or as it is there known the North-South vein, are probably continuations of veins Nos. 5, 6, and 7 on the George E claim. The vein crossed by No. 3 adit, Dunwell mine, west of fault A, is probably No. 7 vein. A vein exposed on the surface a short distance north of No. 1 adit, Dunwell mine, is probably east of No. 7 vein and is called No. 8 vein. If it continues north into the Sunbeam claim it should there be very near the more westerly of the veins on the Sunbeam claim and, consequently, those veins known as the Sunbeam and Sulphide veins are numbered 8 and 9 respectively. The No. 8 or Sunbeam vein if projected north along the strike would lie in practically the position occupied by the most westerly of the veins of the Victoria Mines, Limited. This vein, known on the Victoria claims as the Main Reef vein, is, therefore, numbered 8. The next vein east on the Victoria claims is then No. 9 and corresponds to the Sulphide or No. 9 vein of the Sunbeam claim. The next vein, east No. 10 vein on Victoria ground, has not been discovered farther south. The correlation between the Dunwell mine and the veins of the Victoria Mines, Limited, may not be correct, as individual veins may not continue so far or may be offset by faults. If, however, the veins are continuous between these properties, the correlation is probably at least approximately correct. In all, ten roughly parallel veins are, therefore, known west of Fault A.

The second group of veins are numbered in the same manner as those of the first group beginning with No. 11 vein. Veins Nos. 11 to 16 are exposed in the Portland Canal tunnel. A vein exposed on the east bank of Fault A creek a short distance south of the adit of the Glacier Creek Mining Company, if projected south along the strike would correspond approximately to vein No. 16, and accordingly is numbered 16. The next vein east, No. 17, is on the east bank of Fault A creek between the George E and Glacier Creek Mining Company adits. The three veins numbered 18, 19, and 21 in the adit on the George E claim east of Fault A creek and in the Glacier Creek Mining Company adit are known in these places as the First, Central, and Green veins. Another vein, perhaps a branch of the Green or No. 21 vein, is present in the Glacier Creek Mining Company adit and is numbered 20. The Green Vein No. 21 is a barren quartz-calcite vein of exceptional size on both the George E and Glacier Creek Mining Company properties, so the correlation between these two mining properties is probably correct. The veins exposed in the adits of the Little Wonder group, judging by their position, strike, and dip, are continuations of No. 20 vein of the adit of the Glacier Creek Mining Company. The next veins east, numbered 22 and 23, are exposed in the Dunwell mine. No. 22 vein, perhaps a branch of the Dunwell or No. 23 vein, is exposed in adits Nos. 2 and 3. The Dunwell or No. 23 vein is exposed in all the adits and on the surface of the Dunwell mine. These veins if they continue south far enough should be present near fault B east of the Green or No. 21 vein on the George E claim.

The only veins known to be east of fault B in the northern part of the Portland Canal fissure zone are exposed in the Portland Canal tunnel and are numbered 24 and 25.

Many veins are known in the Portland Canal fissure zone and a great deal of development work, distributed over the whole of the zone, has been done on these veins. The known veins should give a fairly accurate index to the value of those to be found in the future in the fissure zone. A significant feature of the known veins is that all are very much alike in most essential respects. The veins contain pyrite, galena, and sphalerite in a gangue of quartz and calcite, and those that contain ore do not hold high-grade ore, but ore that must be concentrates before shipment to smelters. The uniform grade exhibited by the vein matter is rather striking as nearby properties surrounding the fissure zone exhibit marked divergences in the grade of ore contained. The general condition probably indicates that all the veins in the Portland Canal fissure zone were formed during one period and by the same agents acting under uniform conditions. The uniform character displayed by the known veins strongly suggests that further exploration of the Portland Canal fissure zone will not disclose any veins differing in general characters from those already developed.

The ore-shoots so far discovered do not consist of high-grade ore, but of, as already stated, low-grade ore that must be concentrated before shipment to smelters. Only a few ore-shoots have yet been discovered, but it seems probable, because of the striking uniformity of all other characters exhibited by the veins, that any as yet undiscovered ore-shoots are also of comparatively low grade like the known ore-shoots. On the other hand, though all the so far discovered ore-shoots are small, there are no apparent reasons for supposing that no large ore-shoots exist. The sizes of the ore-shoots seem to be related to the sizes of the containing veins and for this reason the writer believes that though development of the smaller veins will not meet with financial success, development of the larger veins may disclose large ore-shoots.

VICTORIA MINES, LIMITED

The holdings of the Victoria Mines, Limited, consist of the Dandy and Main Reef groups and are situated at the northern end of the Portland Canal fissure zone. The country rock is argillite of the upper part of the Bitter Creek formation. The Bear River formation overlies the sediments on the lower part of the property and the lowest adit begins in volcanic rock. The early development done on the Main Reef group consists of a drift adit driven on the Main Reef vein previous to 1910. At this early date, too, several tons of ore were shipped. Development since the Victoria Mines, Limited, acquired the property consists of adits developing the Main Reef vein at different places, and searching for the northward continuation of the Sunbeam vein known on the adjoining property to the south, and of open-cuts and adits on other veins on the Main Reef and Dandy groups.

Several veins striking north and dipping west have been found on the property. The Main Reef vein (No. 8 on Figure 12) is known to be at least 700 feet long and varies from 1 to 4 feet in width. It is exposed on the surface 100 feet above No. 2 adit, has been drifted on for 400 feet in No. 2 adit, and is crosscut by No. 4 adit 120 feet lower. The vein, therefore, is known to extend to a depth of 220 feet. In most places the vein is in contact with a narrow, fine-grained dyke. The vein consists of quartz mineralized with pyrite, galena, and sphalerite. In most places the vein is below commercial grade, but a small shoot of ore from which some ore has been shipped exists in No. 2 adit near the portal.

Another vein is crosscut by No. 4 adit (No. 9 of Figure 12). This vein is 3 feet wide, is associated with a narrow, parallel dyke, and consists of quartz sparsely mineralized with pyrite, galena, and sphalerite. The vein is not known elsewhere on the Victoria holdings. Several other quartz sulphide veins developed by short adits exist farther up the hill. Only one of these, No. 10, is shown on Figure 12. The veins are 1 to 4 feet wide and consist of quartz mineralized with pyrite, galena, and sphalerite. The two upper veins contain a little chalcopyrite and arsenopyrite, as well as the usual pyrite, galena, and sphalerite.

The development on the property consists chiefly of adits. Two of them are 400 feet long each and seven others are individually 60 feet or less in length.

A 4-ton shipment of ore from the property in 1909 yielded 0·7 ounce of gold, and 20 ounces of silver per ton and contained 23 per cent lead. A 7-ton shipment in 1925 yielded 0·6 ounce of gold and 30 ounces of silver per ton and contained 35 per cent lead and 10 per cent zinc.

This ore is quite good, but the shoots so far developed are small. Perhaps the best development on this property would be to outline particular ore-shoots rather than to prove depth in veins which although they contain ore-shoots are for the most part too lean to constitute ore. One or two of the veins exposed in short adits on the hillside above the Main Reef vein are well mineralized and probably contain ore on a par with that shipped.

SUNBEAM MINERAL CLAIM

The Sunbeam mineral claim is part of the holdings of the Dunwell Mines, Limited, and lies between the main workings of the Dunwell Mines, Limited, and the Victoria Mines, Limited. The Sunbeam claim was staked many years ago and a vein was exposed by open-cut, but most of the development consisting of open-cuts and a crosscut adit was done recently by the Dunwell Mines, Limited.

Two quartz sulphide veins are known. The lower, known as the Sunbeam vein (No. 8, Figure 12), has been traced for 600 feet. It is 3 feet wide and is locally well mineralized with galena, pyrite, and sphalerite, and contains as well some tetrahedrite and native silver. The vein follows a narrow greyish dyke. The other vein, known as the Sulphide vein (No. 9, Figure 12), lies 200 feet east of, and parallel to, the Sunbeam vein. This vein is 2 to 6 feet wide, contains pyrite, galena, and sphalerite. Sunbeam vein follows a small dyke. The crosscut adit cuts these veins at depths of 180 and 260 feet respectively. The veins where cutting the adit are smaller and so sparsely mineralized that they were not developed further.

DUNWELL MINES, LIMITED

The Dunwell mine is on the east side of Bear river north of Glacier creek between the Sunbeam claim on the north and the George E claim on the south. The elevation of the lowest adit is 1,250 feet and of the highest 1,750 feet. The country rock is argillite of the Bitter Creek formation. Several quartz-sulphide veins cross the property and one of them has been the objective of extensive underground work during the past few years. After concluding tests, on the concentration of the ore, the company in 1926 erected an aerial tramway somewhat over a mile long connecting the mine with a 100-ton per day mill which the company built in the same year. Milling operations began early in 1927 and ceased later in the same year.

Several quartz sulphide veins are exposed in the Dunwell mine workings, but only one of them is of commercial importance. The North-South vein, fault A of Figure 12, is cut by adits Nos. 2, 3, and 4 of the mine. Fault A is shown on Figure 12 as A-4, A-3, etc., depending on which level or adit is represented. The veins encountered in the workings west of this fault (Nos. 5, 6, and 7, Figure 12) consist of quartz with very sparse sulphide mineralization and have not been followed up. A quartz vein east of the fault (No. 22 in Figure 12) was found in No. 2 and No. 3 adits, but although it contained some galena, sphalerite, and pyrite, was below commercial grade and was explored only by two short adits. The Dunwell vein, exposed on the surface and in the four adits, is the only ore-bearing vein so far discovered in the mine. This is No. 23 vein of Figure 12 and is shown there as 23-4, 23-3, etc., depending on which adit is represented. The vein joins the North-South vein and the two continue north as one. North of the junction the vein is known as the North-South vein.

The Dunwell vein is 1 to 7 feet wide, and on No. 3 level, where it has been drifted on for the greatest distance, including the north-south part, it has a known length of 800 feet. It has a known vertical depth of some 550 feet and a depth along the dip of about 800 feet. The Dunwell vein has an average dip of 42 degrees and the North-South vein a dip of approximately 50 degrees. The vein lies on either side or on both sides of a dyke 6 inches to 2 feet wide throughout most of its length and depth. The dyke is present in places only on No. 2 level and is not known above this level.

The vein is quartz mineralized with pyrite, galena, sphalerite, and tetrahedrite. The metallic minerals are disseminated through the quartz and in some places make up 75 per cent of the vein. On the surface and in No. 1 adit the vein is 5 feet wide, contains locally 50 per cent sulphide, but is not of commercial grade. Only one ore-shoot is known in the vein. It has a maximum strike length of 100 feet, a dip length of about 500 feet, and averages probably more than 4 feet in thickness. The ore-shoot does not extend higher than No. 2 adit and very little if at all deeper than No. 4 adit. It lies mostly in the Dunwell or No. 23 vein, but extends for 20 feet or less north of the junction with the North-South vein. The ore-shoot is wider than the rest of the vein along the strike, but above and below it, along the dip, the vein is just as wide. The ore-shoot contains higher grade vein matter than the rest of the vein. The North-South vein north of the ore-shoot is below commercial grade and is less than 3 feet wide. The Dunwell vein south of the ore-shoot is also below commercial grade and is less than 3 feet wide.

The available information does not suggest a complete explanation of the origin of the ore-shoot. Many of the veins and all of the known ore-bearing veins in the Portland Canal fissure zone are associated with pre-mineral dykes. In the Dunwell mine the dyke accompanying the vein is present in all the underground workings below No. 2 adit, where the vein is lean as well as where it is rich. The dyke is not present above No. 2 adit and the vein above this level, although it is as wide as it is at lower levels, is not of commercial grade. The dyke probably exerted considerable influence in the formation of the vein by guiding or holding the ore-forming solutions within certain channels, but probably had very little to do with the origin of the ore-shoot. The Dunwell vein joins the North-South vein from the southeast and on Nos. 3 and 4 adits (*See* Figure 12) 50 to 100 feet south of the junction the strike of the vein changes from northwest to north. It is possible that the northwesterly striking part of the vein, which is practically the ore-shoot, may have been formed in a wider or more open shear zone than the rest of the vein. The width of the ore-shoot may be explained in this way, but not the localization of higher grade vein matter. The writer has no data that will completely explain the ore-shoot.

The development at the Dunwell mine is extensive and is practically all underground. The vein has been entered by four adits driven into the mountainside at different elevations. No. 1 adit is a drift 180 feet long. No. 2 adit, 190 feet below and 300 feet west of No. 1 adit, is a crosscut for 280 feet and then enters the Dunwell vein on which about 400 feet of drifting had been done. Two raises have been driven along the dip of the vein to No. 1 adit. No. 3 adit, 160 feet below and 300 feet southwest of No. 2 adit, is a crosscut for 440 feet to where it enters the Dunwell vein. About 1,000 feet of drifting has been done on this level. The ore-shoot between adits Nos. 2 and 3 has been largely stoped out. A sublevel about 350 feet long exists 100 feet below No. 3 adit. The ore-shoot has been largely stoped out between No. 3 adit and the sublevel. No. 4 adit, 200 feet below and 750 feet southwest of No. 3 adit, is a crosscut for 900 feet to where it enters the Dunwell vein. About 400 feet of drifting has been done on this level. Raises have been driven along the vein to the sublevel and most of the ore has been stoped. A winze has been sunk on the vein for a short distance below No. 4 adit and diamond drill holes have been bored crosscutting the vein 100 feet below the adit.

The top terminal of the aerial tramway is at the portal of No. 4 adit. All the ore mined is taken out of the mine through No. 4 adit and from there sent down on the aerial tramway to the mill. The mill feed is the ore as mined and carries lead, zinc, silver, and gold. The chief mill products are: galena concentrates containing lead, silver, and gold; and sphalerite concentrates containing zinc, silver, and gold. Two hundred tons of run of mine ore shipped in 1926, prior to the erection of the mill, assayed 0·6 ounce gold, 24 ounces of silver, 19 per cent lead, and 16 per cent zinc. The grade of this shipment was better than the average of the ore mined.

GEORGE E CLAIM

The George E claim adjoins the property of the Dunwell Mining Company, Limited, on the south, and the Glacier Creek Mining Company's claims on the north. The country rock is argillite of the Bitter Creek formation.

Most of the development work was done many years ago by the Stewart Mining and Development Company and consists chiefly of underground work on several parallel quartz veins. The veins strike north and dip westward at moderate angles. East of Fault A creek an adit driven southeastward crosscuts three of the veins know as the First, Central, and Green veins (Nos. 18, 19, and 21, of Figure 12), 40, 140, and 300 feet from the portal. Drifts have been driven on all three of the veins. The First vein is 2 to 3 feet wide and contains a little pyrite, galena, and sphalerite in a quartz gangue. The Central vein is 3 to 6 feet wide and consists of quartz with sparse sulphide mineralization. The Green vein is 10 to 30 feet wide and consists of quartz and calcite with practically no sulphide. The Green vein contains small bunches an inch or two across of green chlorite included in quartz, and this probably accounts for the name "Green" vein. A short distance west of Fault A creek a fourth vein has been followed by a drift adit for 480 feet. Near the portal of the adit a winze 50 feet deep has been sunk on the vein. This vein is

2 to 3 feet wide and consists of quartz and some pyrite, galena, and sphalerite. It branches near the face of the adit into two veins (Nos. 5 and 6, Figure 12). It is in contact with a narrow grey dyke for most of its length in the adit. Another adit, 60 feet long, about 300 feet north of the long drift adit, exposes a 2-foot barren quartz vein (No. 7, Figure 12).

The vein in the long drift adit contains more sulphide than any of the others, but none of the veins contains commercial ore.

GLACIER CREEK MINING COMPANY, LIMITED

The holdings of the Glacier Creek Mining Company, Limited, lie in the Portland Canal fissure zone between the George E claim on the north and the Little Wonder claim on the south (*See* Figure 12). The country rock consists of argillite of the Bitter Creek formation, striking north and dipping west at moderate angles. A crosscut adit 625 feet long, crosscuts four quartz veins, the first, second, and fourth veins being known as the First, Central, and Green veins. The four veins are numbered 18, 19, 20, and 21 on Figure 12. The veins are parallel, strike north, and dip 45 to 70 degrees west. The First vein is 1 to 2 feet wide, the Central vein 3 feet wide, and the Green vein 4 to 20 feet wide. The other vein is 2 feet wide and is perhaps a branch of the Green vein. The Green vein contains bunches of green chlorite similar to those in the Green vein on the George E claim.

Some of the veins are of commercial importance.

LITTLE WONDER CLAIM

The Little Wonder claim is in the Portland Canal fissure zone adjoining the holdings of the Glacier Creek Mining Company on the south. Most of the development on this claim was done many years ago. The main adit begins as a crosscut and thereafter follows a vein (No. 20, Figure 12), for 500 feet. The vein strikes north and dips 70 degrees west. A raise 65 feet long connects with an upper drift adit 120 feet long and this is connected to the surface by a shaft. The vein is 1 to 5 feet wide and locally is well mineralized with pyrite with some galena and sphalerite. Another drift adit has been driven on the vein 100 feet lower. This adit was not examined. The vein matter in the adits does not appear to be of commercial grade.

PHOENIX SILVER MINES, LIMITED

The holdings of the Phoenix Silver Mines, Limited, are in the Portland Canal fissure zone immediately south of Glacier creek. The early development on the property has been described at length in the Annual Reports of the Minister of Mines of British Columbia for the years 1913 and 1914.

The first development was done in 1912 by the Portland Canal Tunnels, Limited, who held the ground until 1924. Numerous quartz sulphide veins were known in the Portland Canal fissure zone both north and south of Glacier creek and in 1912 the Portland Canal Tunnels, Limited, commenced driving a crosscut adit with the expectation of intersecting veins known on other properties north and south of their own holdings. The adit was started about 250 feet above sea-level and was made large enough (7 feet by 7 feet) to provide space for drainage and for haulage of all ore discovered. Work in the adit ceased in 1914 after a mile of crosscutting and drifting had been done. The adit is known as the Portland Canal tunnel (*See* Figure 12). The property was acquired by the Phoenix Silver Mines, Limited, in 1924, and this company has since done some development work on surface exposures of veins. The surface workings were not seen by the writer nor have they been described in the literature.

The veins crosscut and drifted on by the Portland Canal Tunnels, Limited, are quartz sulphide veins of varying width, but in general 2 to 6 feet wide. None is of commercial importance where developed in the adit. The adit, however, proves that the Portland Canal fissure zone has considerable depth as well as length, and that the veins are little if at all lower in grade in depth than they are near the surface.

Properties on Portland Canal and Marmot River

SILVERADO MINES, LIMITED

The holdings of the Silverado Mines, Limited, are on the mountain side southeast of Stewart. The country rocks are breccias and lava flows of the Bear River formation. The rocks are sheared locally so that in some places they have been changed into sericite schists.

The early development on the property was done on ore-bearing veins about 4,000 feet above sea-level. During the past three years, activity has been centred on veins discovered at an elevation of 1,800 feet. In the autumn of 1927 several new discoveries were made about 4,000 feet above sea-level some distance north of the earliest discoveries. The property is now controlled by the Premier Gold Mining Company.

The upper workings were not visited by the writer, but have been described in the annual reports of the Minister of Mines of British Columbia, from which the following description is compiled. Several quartz veins mineralized with pyrite and tetrahedrite are exposed in the workings. Two or three of those on which much of the early work was done strike northwest and dip gently eastward into the hillside. They are individually less than 2 feet wide, but contain small shoots of high-grade silver ore. Two vertical quartz-sulphide veins striking northwest and each 4 to 6 feet wide occur in the vicinity of the narrow, ore-bearing veins, but were not developed underground. After several adits, one of which is at least 400 feet long, had been driven in the upper veins, development in this part of the group ceased and was begun on the lower vein showings. The surface showings of the upper veins are higher grade than the underground showings.

A total of 9 tons of ore was shipped from the upper veins in 1921 and 1925. The ore averaged 150 ounces of silver per ton and contained 3·5 per cent copper.

At least four quartz-sulphide veins are exposed at the lowest workings. They have been traced on the surface for lengths of about 400 feet. They are roughly parallel and strike northwest. The two upper veins dip northeast and the two lower ones southwest. The largest, which is one of the two lower veins, is 5 feet wide at its junction with a branch vein. It contains quartz, pyrite, chalcopyrite, galena, sphalerite, tetrahedrite, and native silver, and at the junction with the branch vein is high-grade silver ore. A crosscut adit was driven to intersect this vein at a depth of 170 feet, but did not achieve its object, although it is long enough to have passed the vein. The other three veins are in most places less than 2 feet wide, but contain local bunches of rich silver ore.

The new discoveries are four quartz-sulphide veins.[1] One of the veins contains a shoot of ore about 1 foot wide and 150 feet long. Ore has already been shipped from two of the veins.

PROSPERITY GROUP

The Prosperity group of mineral claims is above 5,000 feet on the east slope of the mountain between Portland canal and Kate Ryan creek (the north fork of Marmot river). The group adjoins the holdings of the Porter Idaho Mining Company on the north.

The claims were staked a few years ago following discoveries of high-grade silver ore on the Porter Idaho group. The original locators made a few open-cuts on the discovery vein and shipped a few tons of high-grade silver ore. In 1927 a controlling interest in the group was purchased by the Premier Gold Mining Company, Limited. This company drove a crosscut adit in 1927 crossing the discovery vein 80 feet below the outcrop, and has commenced the driving of a long crosscut adit to develop the vein at greater depth. The portal of the long adit is on Porter Idaho ground.

The country rock consists of tuffs, breccias, rhyolite, and andesite of the Bear River formation intruded by a few lamprophyre dykes. The volcanic rocks on the Prosperity group and from there to the top of the mountain strike northeast along the hillside and dip at moderate angles northwestward into the mountain. The dykes are practically vertical and strike north-northwest. A short distance south and southeast on the adjoining Porter Idaho and Aberdeen properties the rocks are sheared locally, but on the Prosperity group shearing is not evident.

Several quartz-sulphide mineral deposits are known on the group, three of which have been explored by open-cuts (*See* Figures 13 and 14). The deposit on which most of the work has been done is a vein that has been traced on the surface for 400 feet. It strikes north-northwest and dips 50 degrees westward. It appears to narrow and becomes less well defined to the north, but may continue north of the last known outcrop which is at an elevation of 5,550 feet. To the south at an elevation of 5,325 feet it enters the holdings of the Porter Idaho Mining Company where it has also been traced for 400 feet to an elevation of 5,100 feet. The vein is 2 to 6 feet wide and consists of quartz mineralized with pyrite,

[1] "Preliminary Review and Summary of Mining Operations for the Year 1927 in B.C."; Minister of Mines, B.C.

sphalerite, galena, tetrahedrite, ruby silver, and other silver minerals. The vein is in most places fairly completely oxidized, so that the primary vein minerals are obscured. The fracture in which the vein lies appears to be a shear zone of fairly constant width and but little wider than the vein itself. In places where the vein is widest it nearly fills the shear zone. Where the vein narrows, the shear zone, although it is rusty over its entire width, contains only a few narrow stringers of ore.

One ore-shoot has so far been discovered in the vein. It is about 5 feet wide and at least 50 feet long on the surface. In the adit which crosscuts the vein 80 feet below its outcrop, the ore-shoot is also 5 feet wide, but its length is not yet known. It consists of very high-grade silver-lead ore which contains about 400 ounces of silver per ton and 25 per cent lead. The ore-shoot appears to be simply a swell or wider part of the vein. The boundaries of the ore-shoot do not appear to be sharply defined on the sides or ends, but this may be due largely to the presence of iron rust in the vein and in the sheared wall-rocks, which obscures the contact between vein matter and rock. Along the strike beyond the ends of the ore-shoot, the shear zone contains rusty sheared rock and stringers of quartz. This rusty sheared rock holds values in silver and lead contained probably in silver and lead-bearing minerals disseminated through the sheared rock and through the quartz stringers. The vein and ore-shoot have the appearance of having been formed chiefly by replacement. Ore-shoots have probably resulted from more thorough replacement in local areas.

The two other mineral deposits exposed in open-cuts strike northeast and dip northwestward in conformity with the strike and dip of the rocks. The lower body is 5,500 feet above sea-level and extends along the hillside 200 feet east and 100 feet west of the vein previously described. It is 2 feet or less in thickness and appears to consist of country rock containing quartz gashes and stringers lying parallel with the rock bedding, the whole being mineralized to an unknown extent with pyrite, galena, and perhaps silver minerals. The upper body is parallel, 50 feet higher and a hundred feet north of the lower body. It can be traced along the hillside by its rusty and manganese stained outcrops. It is known to extend from the main vein westward for 300 feet and may continue much farther. This body is like the lower one except that in places it is more than 4 feet thick and locally is well mineralized with pyrite, galena, and tetrahedrite. The local areas of mineralization have not been opened up, but are perhaps shoots of ore.

These two deposits are probably replacements along favourable beds of rock. The points where they intersect the vein are not well exposed, so their relation to the vein is not known. It is probable that they join the vein and have resulted from replacement by ore-forming solutions which issued from the vein shear zone and spread out along favourbale horizons.

A total of 29 tons of ore shipped from the ore-shoot in the vein in 1926 yielded 0·07 ounce gold and 416 ounces of silver per ton, and 26 per cent lead.

PORTER IDAHO MINING COMPANY, LIMITED

The holdings of the Porter Idaho Mining Company, Limited, are about 4,000 feet above sea-level on the east slope of the mountain between Portland canal and Kate Ryan creek (the north fork of Marmot river) and adjoin the Prosperity group on the south.

The Porter Idaho group of claims was staked in 1919 and has been under development on a small scale ever since. The group became the property of the Porter Idaho Mining Company, Limited, a few years after it was staked. It passed into the control of the Premier Gold Mining Company in 1928.

The country rocks are tuffs, breccias, rhyolites, and andesites of the Bear River formation. On the mountain side above the Porter Idaho group the rocks strike northeast along the mountain side and dip northwestward into the mountain at moderate angles. On the lower part of the group the attitude of the beds is the same. The upper part of the group, however, is covered with loose slide rock, and, therefore, the attitude of the rocks beneath is not known, but is probably the same as higher or lower on the mountain side. The rocks on the lower part of the Porter Idaho group and on the adjoining property to the west are sheared along a west-northwest direction. The shearing on the Porter Idaho claims has produced a foliated rock, but farther west the rocks have been changed locally to fissile schists. Several vertical lamprophyre dykes striking north-northwest intrude the volcanic rocks.

A fault, known locally as the Big Rig fault (*See* Figures 13 and 14), striking east and dipping 75 to 80 degrees north, occurs on the lower part of the Porter Idaho property. The surface expression of the fault is a long, shallow depression. In most places in the underground mine workings, the fault is a shattered and crushed zone 30 feet or more in width; in one place, 250 feet below the surface, it is a fracture, 6 feet wide, full of hard gouge. A narrow shear zone occupied by an ore-bearing vein known as the Winze vein lies north of the fault and as it approaches the fault, swings from a southerly to a southwesterly strike. The rock where the shear zone and the fault zone come into contact is crushed to such an extent that the relation of one to the other is not evident. They may have originated at the same time, in which case the shear zone may be considered as a branch of the fault. The fault may, however, be later than the shear zone. That the shear zone is not later than the fault seems fairly certain, as this shear zone and several other similar ones are known north of the fault, but none is known to cross the fault. A lamprophyre dyke crosses the fault, has not been offset by it, and is consequently younger. Underground, however, the dyke is broken and crushed where it crosses the fault, showing that slight movement continued along the fault even after dyke intrusion.

Five parallel, narrow, shear zones north of the Big Rig fault are occupied by ore-bearing veins. Ore is present in the shear zone, that is in the Winze vein, which comes in contact with the fault, and similar ore occurs locally in the fault zone a short distance west. The whole of the fault zone except where it consists of gouge appears to contain disseminated sulphides. The crushed rock, however, is everywhere covered with rust, so that boundaries of any mineralized area could not be made out. Because of the mineralization in the fault zone, it would appear that mineral deposition took place in both the shear zone and the fault, or in other words that the mineral deposits are younger than the fault. The mineralization in the Big Rig fault can be explained, however, in other ways. The ore in the fault zone west of the Winze vein may be a continuation of the Winze vein paralleling the fault, or it may be a part of

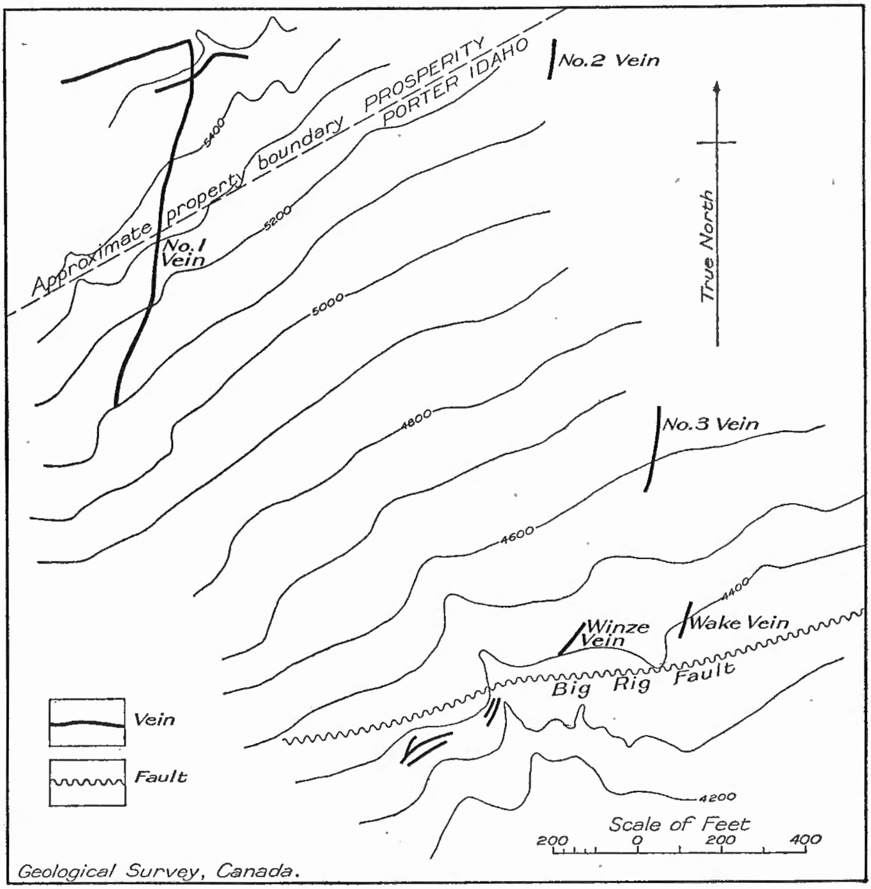


Figure 13. Plan showing known veins and faults on Porter Idaho and Prosperity groups.

the Winze vein dragged west by movement along the fault, or it and the general mineralization of the fault zone may not represent the Winze vein at all, but may represent a mineralized bed of rock that has been truncated by the fault. As the fault has been drifted on in only one level, it is difficult or impossible to state with certainty the relation of the mineralization to the fault, that is the age relation between the ore deposits and the fault is not established.

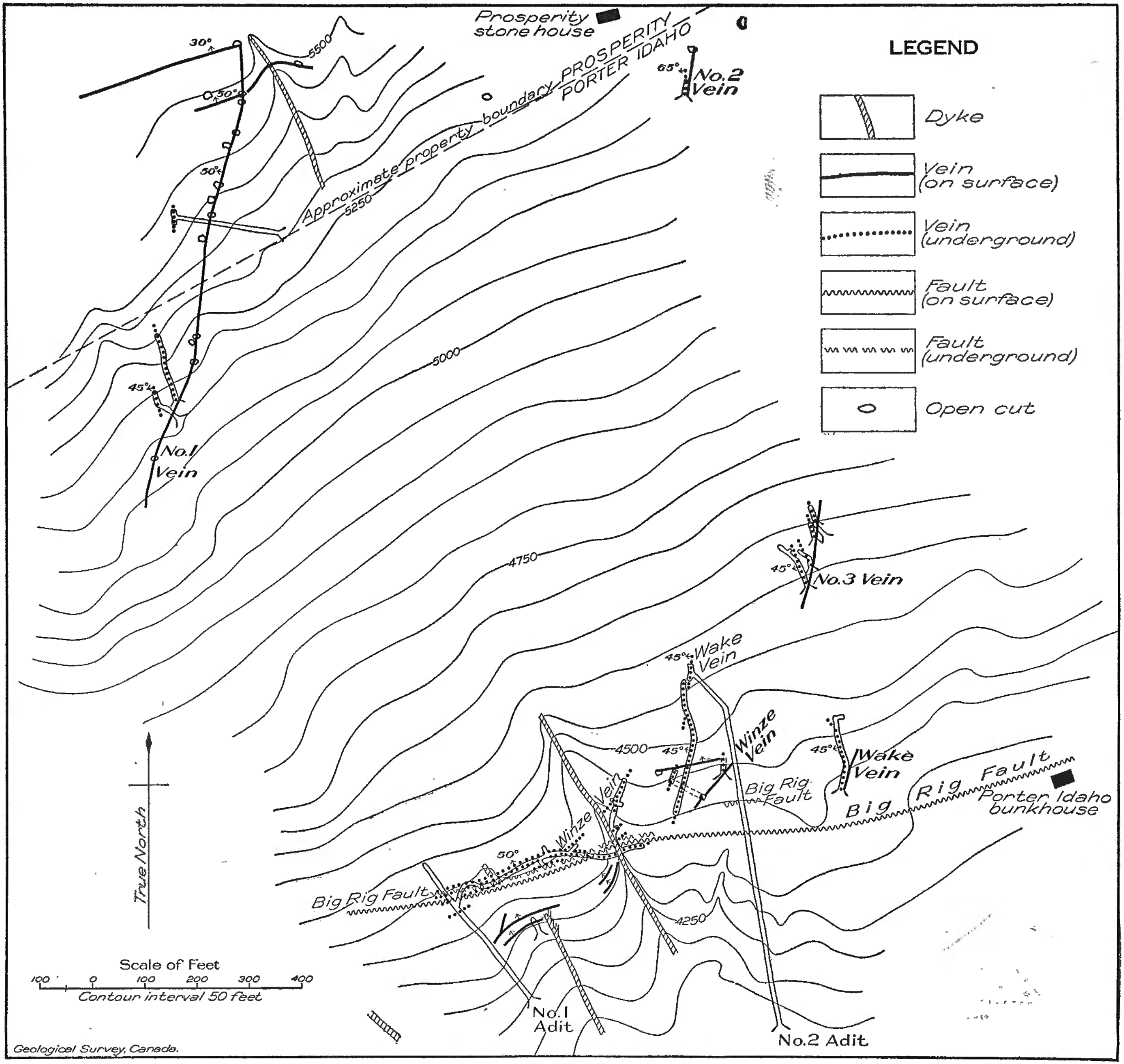


Figure 14. Plan showing workings and veins on Porter Idaho and Prosperity groups.

The age relation between the dyke crossing the Big Rig fault and the ore deposits is not known with certainty, but judging from the general lack of sulphide and rust in the dyke where it crosses the fault and the presence of rust in the adjoining rocks, it is believed that the dyke is post-ore in age. It is known that the main faulting took place prior to dyke intrusion.

Five veins in five narrow shear zones are the principal mineral deposits of the Porter Idaho mine. The veins are roughly parallel, strike in a northerly direction, and dip 45 degrees west. Two of the veins are known respectively as the "Wake" and the "Winze" veins, and for convenience in description the others have been respectively numbered 1, 2, and 3. The veins are 1 to 6 feet wide and like the vein on the Prosperity group appear to be replacements along narrow shear zones. The ore-shoots are in general 2 to 4 feet wide. In a few places ore-shoots pinch out as clearly defined, narrowing veins of high-grade ore, but in most places they change gradually along the strike from rich ore to sheared rock with quartz gashes and some sulphide mineralization. The veins consist of pyrite, galena, sphalerite, tetrahedrite, ruby silver, and other silver minerals, in a gangue of quartz and ankerite.

The Wake vein is exposed for a short distance on the surface and for 150 feet in a drift adit. This vein is also exposed 275 feet below its outcrop in a crosscut adit (No. 2 adit). The Winze vein 200 feet west of the Wake vein has been traced 100 feet on the surface. It is exposed in a shaft to a depth of 70 feet and in a drift driven from the shaft for a distance of 250 feet. The vein is also exposed 175 feet below its outcrop in No. 1 adit. No. 3 vein is exposed for a length of 200 feet. It is 400 feet north of the Wake vein and is on the line of strike of the Winze vein and may be the Winze vein. No. 2 vein outcrops about 900 feet north of No. 3 vein and is probably a vein lying west of No. 3 vein. No. 1 vein is 1,200 feet southwest of No. 2 vein. It is the southern part of the prosperity vein and has been traced for 400 feet in Porter Idaho ground. None of these veins is known south of the Big Rig fault. The southern extension of veins Nos. 1 and 2 and the northern extension of the Wake, Winze, and No. 3 veins are covered with loose slide rock.

The length and depth of the ore-shoots have not been established. The length of the ore-shoot in No. 1 vein is not known. The known exposures of Nos. 2 and 3 veins consist of ore. The Wake and Winze veins also consist mainly of ore, but judging from the form of the stopes, actual ore-shoots are about 20 feet long, and practically join along the strike of other ore-shoots of similar size.

Several mineral deposits of a different type occur. These lie parallel to the strike and dip of the rocks, are less than 2 feet thick, and have not been exploited. They were formed probably by replacement of favourable beds of rock. The mineralization along the Big Rig fault is over a width of at least 10 feet. This may be a mineral deposit along a bed of rock truncated by the fault, or it may be mineralization along the fault zone. Development on different levels will prove this point. The grade of the mineralization in the Big Rig fault is much lower than that of the veins, but some picked ore has been stripped from the fault.

A peculiarity of the veins on the Porter Idaho is that they are deeply oxidized. The ore as stripped commonly consists of rusty material containing residual fragments of sulphide and quartzose matter. The sulphide is chiefly galena with some of the other minerals previously listed. The lowest adit or No. 2 adit crosscuts the Wake vein at a vertical depth of 275 feet below the outcrop of the vein and 450 down the dip from the outcrop. According to samples from the vein at this depth the ore is still partly oxidized, but more of the nature of the primary vein matter can be discerned. Ankerite as well as quartz is here a common gangue mineral. Sphalerite is more plentiful than at the surface. Arsenopyrite, chalcopyrite, and pyrrhotite are present in minor quantity, they may also occur near the surface but were not noted in the material examined. Galena, tetrahedrite, and silver minerals are abundant and ruby silver is more abundant than in any of the material examined from near the surface. Native silver was also found in one of the deep ore specimens.

Prior to the driving of No. 2 adit, although the veins were known to be deeply and rather thoroughly oxidized, it was not believed that actual enrichment had taken place. However, the ore from No. 2 adit, containing as it does abundant ruby silver and some native silver, lends weight to the idea that some silver has been actually carried downward and redeposited at the base of the oxidized zone.

While No. 2 adit was being driven it was relatively dry until the Big Rig fault was crossed. Beyond the fault all open cracks in the rock were full of water and for some time the driving of the adit was greatly handicapped by the large flow of water. The fault gouge is apparently an effective barrier, preventing the surface water from moving downhill through fractures near the surface. It is quite possible that formerly the surface water on the upper side of the fault found some deep outlet and that surface oxygen was carried downward in this water and thus caused the deep oxidation.

The development at the Porter Idaho mine consists chiefly of adits. Two adits 100 and 150 feet long and one 20 feet above the other, have been driven along No. 1 vein. Ore has been stoped between the lower adit and the surface. A short adit has been driven along No. 2 vein, and some ore has been stoped. Five short adits, 50 to 100 feet long, have been driven on No. 3 vein. Ore has been taken from four of them. An adit 150 long has been driven on the Wake vein, and ore has been stoped. A short adit has been driven on the Winze vein and a shaft sunk to a depth of 70 feet. A drift 250 feet long has been driven from the shaft 45 feet below its collar. Ore has been stoped from the vein above the drift. All of the openings so far mentioned are merely about entrances into the veins to facilitate the stoping of ore.

No. 1 adit commences as a crosscut on the hillside below the Big Rig fault. It has been driven northward and encounters the Big Rig fault 250 feet from the portal. A drift at this point follows the mineralized and crushed ground eastward for 350 feet and then turns north as a crosscut and drift for 150 feet. The Winze vein is present in the drift to the east and also near the north end of the crosscut and drift to the north. A little ore has been stoped from the Winze vein and from the Big Rig fault in this adit. No. 2 adit commences as a crosscut below the Big Rig fault and has been driven north for 700 feet, where it encounters the Wake vein.

The Porter Idaho Mining Company commenced shipping ore in 1924. The ore shipments for the years 1924, 1925, and 1926 were taken chiefly from the Winze vein, but some came from the Wake vein, No. 2 vein, No. 3 vein, and also from the mineral deposit associated with the Big Rig fault in No. 1 adit. The shipments for the three years, totalling 498 tons, averaged 0·08 ounce of gold, 250 ounces of silver, and 350 pounds of lead per ton. The shipment in 1927 came from No. 1 vein. In this year 125 tons of ore were shipped averaging 0·1 ounce of gold, 519 ounces of silver, and 845 pounds of lead per ton. Total shipments for the four years are 623 tons which yielded 50 ounces of gold, 190,200 ounces of silver, and 278,400 pounds of lead.

As can be seen from Figures 13 and 14 and the foregoing description the future of the property is bright. The southward extensions of No. 1 and No. 2 veins are unexplored; the north and south extensions of No. 3 vein are untouched; the northern extensions of the Wake and Winze veins are yet to be disclosed; and developments on the Big Rig fault may yield large ore deposits. Added to this is the fact that ore has been shipped from all of the veins mentioned and that good ore has been encountered 450 feet below the surface.

ABERDEEN GROUP

The Aberdeen group of mineral claims adjoins the Porter Idaho on the west. Country rock consists of volcanic fragmental rocks and lava flows. They strike northeast and dip northwestward at moderate angles. Locally the rocks have been severely sheared in a northwesterly direction with the result that bands of fissile schist strike northwest. One of these bands of schist 100 feet wide is stained yellow with iron rust. Open-cuts have been made and a short adit has been driven on the shear zone, but no primary sulphide is visible.

DOMINION GROUP

The Dominion group of mineral claims is on the opposite side of the glacier on Kate Ryan creek, from the Porter Idaho mines. The country rocks are tuffs and lava flows of the lower part of the Bear River formation striking northwest and dipping northeast at moderate angles. Argillites of the Bitter Creek formation outcrop in a broad belt west of the property. A crosscut adit at an elevation of 3,750 feet has been driven northeastward for 90 feet. Several open-cuts on the precipitous slope above the adit disclose narrow quartz veins mineralized with pyrite, chalcopyrite, sphalerite, and galena. The veins seen by the writer are chiefly narrow stringers which give little hope of yielding commercial ore-bodies. From 400 to 500 feet above the adit are three rusty zones striking northwest and dipping northeastward at moderate angles. They lie parallel to the strike and dip of the rocks and may be, therefore, beds of tuff partly replaced by ore minerals. If it is at all feasible the zones should be prospected, for if they contain any ore-shoots, these may be large enough for profitable mining.

NORTH FORK BASIN GROUP

The North Fork Basin group of mineral claims is in North Fork basin at an elevation of 4,300 feet on the south side of the glacier on Kate Ryan creek. Mr. Osborne, field assistant, examined this property and the following description is taken from his notes.

The country rock consists of argillite of the Bitter Creek formation striking north to northwest and dipping steeply westward. Two veins are exposed in the workings, one of which strikes north and dips 45 degrees west, and the other strikes west and dips 60 degrees north. The vein striking north is exposed in a shaft sunk along the dip of the vein for 110 feet. An adit 80 feet below the shaft collar and 160 feet north has been driven south and joins the bottom of the shaft. The vein is a narrow shear zone about 3 feet wide containing quartz mineralized with pyrite, galena, sphalerite, and tetrahedrite. A fault forms the hanging-wall of the vein, and because of crushing and brecciation along the fault the vein is ill-defined. The other vein is exposed in a drift adit 80 feet south of the shaft. The adit begins on the vein and follows it for 40 feet, at which point the vein is offset by a fault. The vein is 1 foot wide and consists of quartz mineralized with pyrite, galena, sphalerite, and tetrahedrite.

A total of 10 tons of ore has been shipped from the northerly striking vein. Two tons in 1919 yielded 200 ounces silver per ton, 22 per cent lead, and 22 per cent zinc. Eight tons in 1924 returned 115 ounces silver per ton, 11 per cent lead, and 13 per cent zinc.

PATRICIA GROUP

The Patricia group of mineral claims is on the south fork of Marmot river about half-way between the forks and the glacier on the south fork. The showings are near the contact of the Coast Range batholith, some in the batholith, some in associated granodiorite dykes, and some in adjacent argillite. Only two open-cuts and an adit were seen, but other workings exist. The open-cuts at an elevation of 3,000 feet expose narrow quartz gash veins mineralized with pyrite and chalcopyrite. The veins lie on both sides of a large dyke of granodiorite. An adit 1,600 feet above sea-level has been driven north-northeast for 112 feet. It is a drift following a vertical quartz sulphide vein one foot or less in width which pinches out about 75 feet from the portal. A branch vein joining the vertical vein a few feet below the floor of the adit is also exposed in the adit for a short distance. The veins are well mineralized with pyrite, galena, and sphalerite, and are reported to contain good values in gold.

MARMOT METALS MINING COMPANY, LIMITED

The holdings of the Marmot Metals Mining Company, Limited, are on the north side of the south fork of Marmot river about 4 miles above the forks. The country rock is cherty, argillaceous quartzite and a thick bed of limestone, of the Bitter Creek formation, overlain by volcanic rocks of the Bear River formation and intruded by the Coast Range batholith and associated dykes and sills of granodiorite.

On the Montana claim, a vein striking northeast and dipping northwest has been traced on the surface for 300 feet. The vein is less than a foot wide, consists of quartz mineralized with pyrite, sphalerite, galena, and tetrahedrite and contains high-grade silver ore. It has been developed by short drifts and a shallow winze driven from a crosscut adit. A total of 21 tons of ore averaging $200 in gold, silver, and lead was shipped from the winze and drifts in 1913 and 1915. A few hundred feet northeast of the adit another crosscut adit has been driven to intersect the vein, but has not been driven far enough. Farther up the hill a drift adit 180 feet long follows a different vein and an associated dyke for 60 feet. The vein is vertical and strikes northeast. It is 3 feet wide at the portal, but narrows rapidly and pinches out. It consists of quartz mineralized with pyrite, galena and sphalerite, and tetrahedrite. A short ore-shoot 1 to 2 feet wide is present at the portal of the adit. An assay of a sample representing one foot of the width of the ore-shoot showed 85 ounces silver per ton, 14 per cent lead, and 21 per cent zinc.

Recent development has been concentrated on a different type of mineral deposit in a bed of limestone. The bed has been offset by two faults into three blocks each several hundred feet long. The faults strike north 60 degrees east and dip 50 degrees northwestward. Mineral deposits have been found in the upper block of limestone. The fault between the middle and upper limestone blocks is mineralized and consequently the fault is probably pre-mineral. The limestone is sheared parallel to the strike, and where argillaceous matter is present shear planes are quite distinct, but where the limestone is pure the whole has been changed to marble with no visible shear planes. Rusty mineralized zones strike northwestward in the upper limestone block. The width of the zones varies from 1 to more than 20 feet.

The rusty mineral zones contain chiefly sphalerite and minor amounts of pyrite, galena, and chalcopyrite. The boundaries of the mineralized areas are quite indefinite, and as development is not extensive, the exact size and shape of the mineral bodies are not known. The deposits may represent replacements along limestone beds or along shear zones. If a favourable bed outcropped at various places on the surface and dipped down hill it would present a broad outcrop in some places and a narrow one in others. The variable width of the deposits suggests a replaced bed rather than a replaced shear zone.

Mineral deposits in general that are formed by replacement of limestone are as a rule of extremely irregular shape, and consequently if they are to be clearly outlined development work must be extensive.

WASHINGTON GROUP

The Washington group is at an elevation of 3,800 feet on the south side of the south fork of Marmot river. The country rocks are lava flows, tuffs, and breccias of the Bear River formation, underlain on the lower part of the property by argillites of the Bitter Creek formation. The sediments and volcanic rocks strike northwest and dip northeast at moderate angles. The batholith contact passes less than a quarter of a mile west of the adit.

Four vertical, roughly parallel, rusty sheared zones striking north and 50 to 100 feet apart are exposed on the surface. They are not well exposed, so that the width of the mineralized part is not clearly defined, but rusty, sheared rock is 6 feet wide in some places. Pyrite, galena, and sphalerite, and perhaps tetrahedrite, occur in the zones, but owing perhaps to the oxidized nature of the outcrops sulphides are not plentiful. The rusty zones are in volcanic rock and have not been traced southward into the sediments. The theory is held by the management that they are offset by a fault a short distance north of the sedimentary volcanic contact. Northwesterly striking faults dipping northeast are numerous on the property, but the offsets seen rarely exceed 5 feet. An adit 100 feet below the lowest mineralized shear zone has been driven eastward to crosscut the mineral zones. It is over 400 feet long, but did not encounter any shear zone nor any ore, although it has gone far enough to cut all of the zones. The zones are either cut off by a fault or they do not extend downward as far as the adit.

HARNER GROUP

The Harner group is at an elevation of 4,500 to 5,000 feet in Magee pass one mile east of the Washington group. The country rock is argillite of the upper part of the Bitter Creek formation, and overlying volcanic rocks of the Bear River formation, the whole being intruded by a stock of augite porphyrite. The Coast Range batholith outcrops half a mile west of the property.

Two veins are exposed by open-cuts for lengths of 500 feet each. The upper vein strikes north-northwest and dips 40 to 70 degrees east, and the lower one west-northwest and dips 40 to 70 degrees north. There is a difference of elevation of 150 feet between the lowest and highest outcrops of each vein. The upper vein is 2 to 9 feet wide. As the surface exposures are oxidized, some rust may have spread laterally beyond the vein boundaries, making the vein appear wider than it actually is. The lower vein 1,000 feet south of the upper one is similar in size and appearance. A short adit driven on the upper vein exposes only a few rusty quartz stringers instead of a good sized vein as was to be expected from surface exposures.

The veins consist of quartz mineralized with pyrite, galena, and sphalerite. Sampling of unaltered vein matter has not been thorough, but good values in silver and gold are obtained from the outcrops. The surface showings are quite attractive and further underground development should be done.

OTHER MINERAL DEPOSITS

Time did not permit the examination of all of the groups of mineral claims in the map-areas, but in order to make this report more complete, all of the mining properties not visited, but which have been described in various published reports on the area, are listed, together with those described on preceding pages. There are many mineral claims and groups of mineral claims that are not included in the list as they have not been described. The main reports that have been consulted are the following:

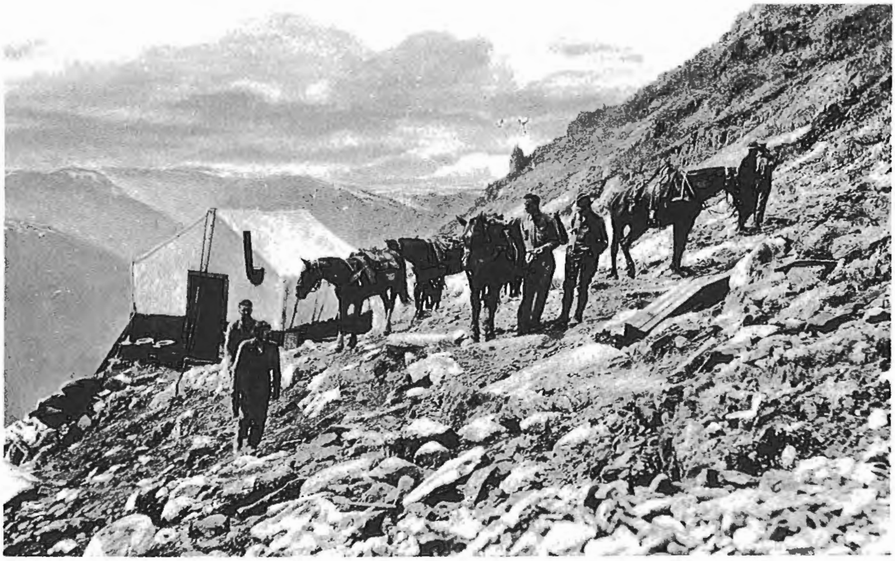
McConnell, R. G.: Geol. Surv., Canada, Mem. 32 (1913).
Annual Reports of the Minister of Mines of British Columbia for the years 1904-1926.

In the following list, the name of each property is followed by a statement indicating the publication containing a description of the report. The annual reports of the Minister of Mines of British Columbia are indicated by the letters B.C. followed by the year and page number; the memoir by McConnell is referred to as Mem. 32; the titles of any other publications are quoted in full. If a reference is in italics, the publication so indicated contains the more complete description.

Aberdeen group—B.C., 1923, p. 69.
Ajax claim—Mem. 32, p. 45; B.C., 1910, p. 64.
Albany Mining Co., Ltd.—B.C., 1925, p. 84; *1926, p. 92*. *See* Ben Bolt group.
American Girl group—B.C., 1904, p. 99; B.C., 1905, p. 79; B.C., 1906, p. 67; B.C., 1909, p. 68.
Americus Girl group—B.C., 1925, p. 92.
Anaconda group—B.C., 1926, p. 95.
Argenta Mines, Ltd.—*See* Comet and Vetron groups. B.C., 1925, p. 96.
Aztec group—B.C., 1920, p. 55; B.C., 1922, pp. 70-71.
American Creek Mining Co., Ltd.—B.C., 1910, p. 65.
Barite Gold Mines, Ltd.—B.C., 1924, p. 70; B.C., *1925, pp. 95, 96*.
Bayview group—Later United Empire group (which *see*), Later Bayview Mining Co., Ltd. (which *see*). B.C., 1919, p. 64; B.C., *1920, p. 54;* B.C., *1922, pp. 69-70;* B.C., 1924, p. 71; B.C., 1925, pp. 99, 100.
Bayview Mining Co., Ltd.—*See* Bayview, and Gold Cliff groups. B.C., 1925, pp. 99, 100.
Bear River Canyon Mining Co., Ltd.—*See* Independence claims. B.C., 1910, p. 62.
Bear River Mining and Developing Co.—B.C., 1908, p. 56.
Bear River Mining Co., Ltd.—*Mem. 32, pp. 54, 55;* B.C., 1910, p. 62; B.C., 1917, p. 67.
Ben Bolt group—Includes Jumbo and Azax claims (which *see*). *Mem. 32, pp. 36-38;* B.C., 1910, p. 64.
Big Casino claim—Later Big Casino Mining Co., Ltd. (which *see*). B.C., 1908, p. 57.
Big Casino Mining Co., Ltd. *See* Big Casino claim. *Mem. 32, p. 50;* B.C., 1910, p. 65.
Bitter Creek Mining Co., Ltd. *Mem. 32, pp. 57, 58;* B.C., 1910, p. 64.
Black Bear claim—B.C., 1924, p. 61.
Black Bear group—Mem. 32, pp. 55, 56.
Bonanza group—*Mem. 32, p. 52;* B.C., 1910, p. 64.
Catchem claim—Mem. 32, p. 53. *See* Kansas group.
Chicago group—Mem. 32, p. 38; B.C., 1911, p. 74.
Columbia group or Evening Sun and Columbia claims, or Lordigordy Mines, Ltd. (which *see*)—Later Rush Columbia Mines, Ltd. (which *see*). *Mem. 32, p. 44;* B.C., 1906, p. 66; B.C., 1907, p. 73; B.C., 1908, p. 56; B.C., 1909, pp. 62, 63; B.C., 1910, p. 63; B.C., 1912, p. 108; B.C., 1913, p. 89; B.C., 1919, p. 71; B.C., 1922, p. 74.

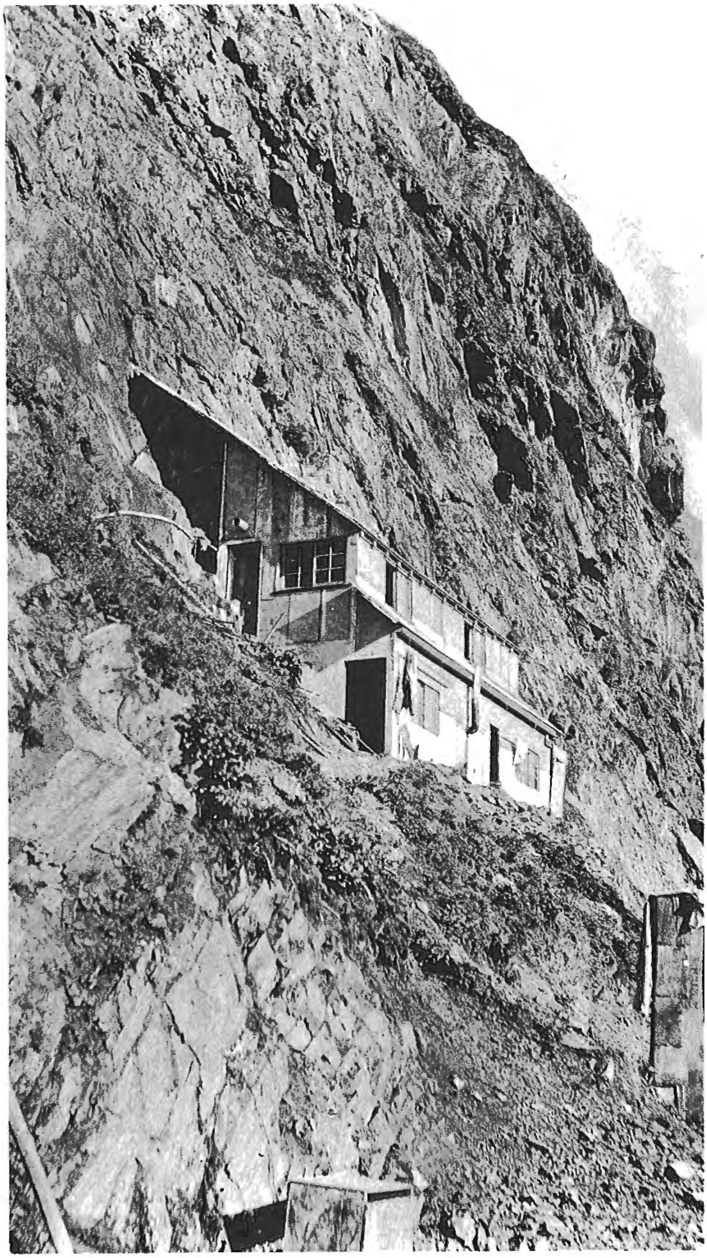
A. View looking northeast from mount McLeod, Marmot River valley.

B. Bunkhouse of L and L Glacier Creek Mines, Limited. Glacier on north fork of Glacier creek in background. (Page 44).



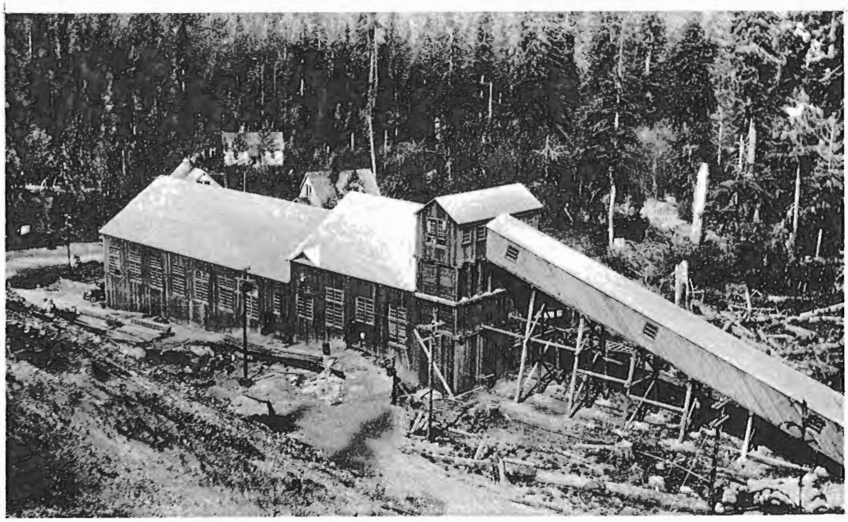
A. Scene on Prosperity group of mineral claims, 5,100 feet above sea-level, in 1927, when development on the property was in its initial stages. All equipment and supplies were brought up by pack horses. (Page 59).

B. Bunkhouse of Porter Idaho Mining Company, Limited. Long depression marking Big Rig fault seen in foreground. (Page 61).



Cliff dwelling on Washington group of mineral claims. The bunkhouse is bolted to the cliff. (Page 67).

A. Lowest adit and top terminal of aerial tramway, Dunwell Mines, Limited. (Page 56).



B. Mill of Dunwell Mines, Limited. (Page 56)

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